AQUACULTURE

Generic Environmental Best Management Practice Guideline for Aquaculture Development and Operation in the Western Cape

Provincial Government of the Western Cape:
Department of Environmental Affairs and Development Planning

Edition1
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Edition 1

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PREAMBLE

The Department of Environmental Affairs and Development Planning (DEA&DP or "the Department" hereafter) have compiled this Best Management Practice (BMP) guideline to be used as the baseline from which to develop an environmentally sound and sustainable aquaculture sector. As much as it is intended that this guideline be integrated into the standard operational procedures of any aquaculture activity, it represents a starting point from which all stakeholders in the aquaculture sector may develop species -, sub-sector - and farm / operation specific environmental management programmes.

During the authorisation of new aquaculture projects or during the expansion of existing projects, this guideline should be read in conjunction with the *Guideline to the Authorisation Requirements of Aquaculture Activities in the Western Cape*. This related guideline outlines the authorisation process and thus plays an important role in ensuring the creation of a legally compliant, environmentally responsible and sustainable aquaculture sector.

NOTE: This guideline has been specifically compiled for use in the Western Cape Province. Use outside of this province must be sanctioned by the Western Cape Department of Environmental Affairs and Development Planning.

EXECUTIVE SUMMARY

This guideline is one of two documents that have been compiled by DEA&DP to assist aquaculturists with the development of an environmentally responsible and sustainable sector. The objective of the guideline is to provide best management concepts that can be used in the aquaculture sector.

The guideline is divided in various sections that deal with different aspects of best practice. In order to provide a general introduction to the aquaculture sector, the first section deals with the nature of aquaculture, globally and locally in the Western Cape. This section also investigates the roles of the various stakeholders in the aquaculture sector and clarifies the best practice approach.

The second section of the guideline provides a detailed outline of the methodologies required in the planning of an aquaculture venture in a manner which is conducive to the implementation of best practices. Such integrated planning will also assist with compliance issues in the authorisation of new projects.

The third section deals with the authorisation process required for new aquaculture ventures. This is done by reference to the associated guideline which is entitled, *Guideline to the Authorisation Requirements of Aquaculture Activities in the Western Cape.*

The fourth section contains all the environmental, management and operational specifications that make up best practices around aquaculture. These specifications are divided into:

a) The approach required towards the surrounding biophysical environment.
b) The approach required towards the infrastructure environment.
c) The approach required in the operation or production activities in aquaculture.
d) The approach required in dealing with the social environment.

Each of the subsections above contains many aspects, each of which are discussed and followed by recommendations as to achieving best practices.

The firth section deals with best practice standards. Although few standards of this nature exist in South Africa, examples are given of what steps can be taken in achieving acceptable standards around general environmental management, the maintenance of water quality, product safety and acceptable social interaction.

The sixth section provides examples of contingency planning in aquaculture by giving the basic steps that can be taken in events such as water contamination, the escape of production organisms, disease breakout and fire.

The seventh section deals with monitoring, auditing and review of best practices by providing guidance on audit methodologies and outlining the approach required in the review and update of project specific best practices.

The last section deals with the steps that need to be taken in the decommissioning of aquaculture activities, including informing of authorities on rehabilitation.

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SECTION 1: INTRODUCTION

It is intended that this BMP guideline assist in minimising the potential environmental impacts of aquaculture activities on the surrounding environment. Furthermore, a recent national questionnaire based survey (Botes *et al*. 2006) indicated that sector participants regarded such a BMP guideline as a necessary tool in the development of the aquaculture sector. Nevertheless, the success of this BMP guideline depends on the willingness and acceptance of its application by the respective stakeholders in the aquaculture sector.

1.1 WHAT IS AQUACULTURE

Aquaculture is defined as the propagation, improvement, trade or rearing of aquatic organisms (i.e. plant and animal) in controlled or selected aquatic environments (i.e. fresh, sea or brackish waters) for any commercial, subsistence, recreational or other public or private purpose.

Aquaculture does not include capture fisheries, which entails the harvesting of aquatic organisms from an environment in which no attempt has been made to manage or otherwise influence any organisms by containment, feeding or application of any husbandry techniques.

The aquaculture sector employs a range of production techniques that can be classified according to the nature of water use, the environment in which the activity is practiced, the scale and intensity, the degree of "openness" to the environment, the species, the housing facilities for the production organisms and more. Firstly, aquaculture is carried out as either freshwater aquaculture or marine aquaculture (or mariculture), which is practiced in fresh and marine waters respectively. Estuarine and brackish water aquaculture straddles the divide between fresh and marine water aquaculture.

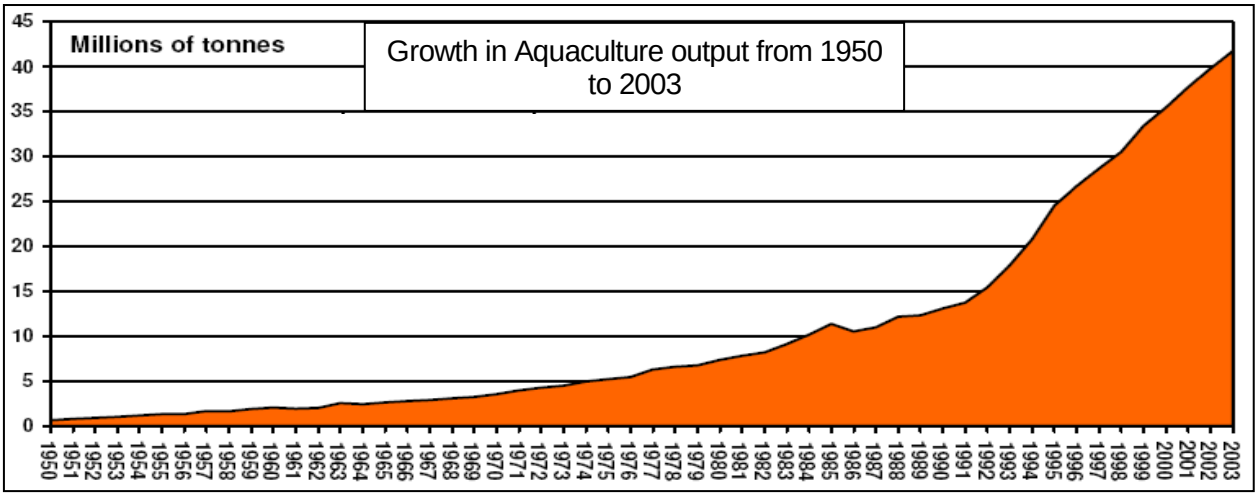
Aquaculture can further be defined in terms of the intensity of production. The typical classification in this regard refers to extensive production as opposed to semi-intensive and intensive production, where the level of technology, capital expenditure, running costs, control, risk and volume of production per unit area typically increases from the less to the more intensive practices. Associated, but not necessarily linked to this, is the magnitude of production that can be broadly divided into small-scale operations (often subsistence ventures), medium scale enterprises and large-scale enterprises (often referred to as industrial aquaculture).

A range of production facilities are used in aquaculture, which can be broadly categorised into tank culture, pond culture and cage culture systems. Within each of these categories various subcategories can be identified. Tank culture can range from typical glass tanks to tanks of various sizes constructed of fibreglass, plastics, concrete or other materials. Pond culture typically refers to earthen ponds, but various plastic, concrete and other pond linings are common. Cage culture systems range from basic penned enclosures to basic floating cages and technologically advanced cages.

Categorisation by species not only refers to marine or freshwater species, but also to the typical species groups such as reptiles, finfish, crustaceans, molluscs, aquatic plants or algae.

1.2 THE STATUS OF AQUACULTURE

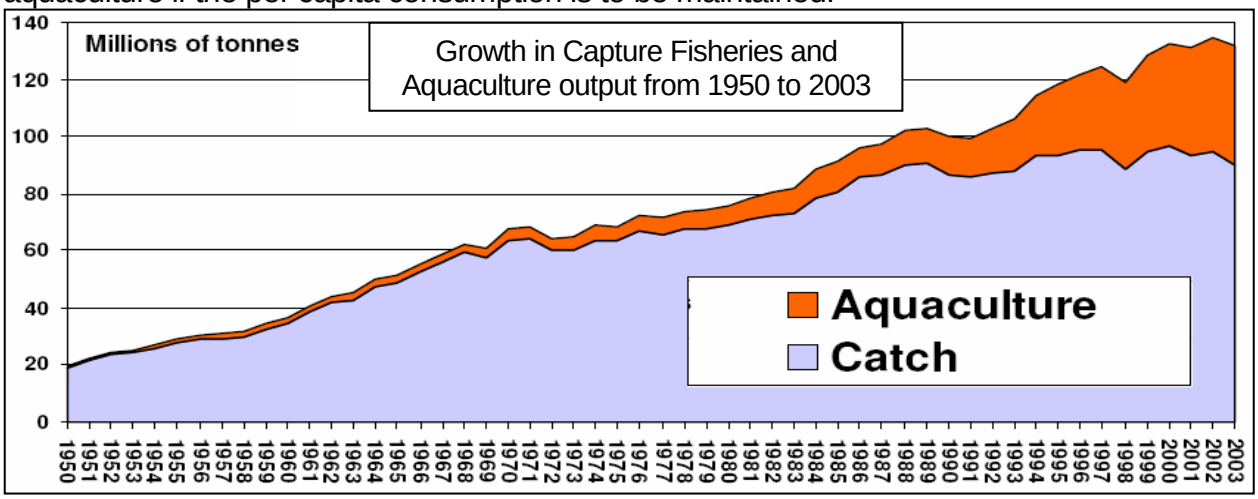
Globally, aquaculture is growing more rapidly than any other food-producing sector. World aquaculture production totalled 45.7 million tons in 2000 and was valued at US$56.5 billion (FAO, 2002). In 2000, farmed fish, crustaceans and molluscs contributed to 27.3% of total world supplies while almost 40% of the aquatic products used by man today are derived from aquaculture.



(Graph taken from "WTO AND FISHERIES: AN UPDATE", IIFET 2006 Portsmouth Proceedings and based on FAO Statistics)

Globally, market forces, the diversification of the economic base, the sustainable utilization of resources and a quest for food security drive the development of aquaculture. In this regard, aquaculture has developed into a diverse industry, with many countries participating in the production of more than 300 species of fish, shellfish, crustaceans and aquatic plants.

On average, global aquaculture has experienced a compounded growth rate of 9.2% per annum since 1970 (FAO, 2002). This is considerably greater than that of capture fisheries and the terrestrial agriculture sector, which experienced an average compounded growth of only 1.4% and 2.8% respectively, for the same period (FAO, 2002). This trend is set to continue as world fisheries production has effectively leveled off and the demand for fish continues to increase. This means that the shortfall in supply will have to come from aquaculture if the per capita consumption is to be maintained.



(Graph taken from "WTO AND FISHERIES: AN UPDATE", IIFET 2006 Portsmouth Proceedings and based on FAO Statistics)

The per capita supply of food fish from global aquaculture (excluding China) has increased four-fold in the past three decades, from 0.6 kg in 1970 to 2.3 kg in 2000 (FAO, 2002). This suggests that the contribution made by aquaculture to global protein security has continued to increase per capita, in spite of human population growth.

In spite of its vast natural and human resources, the participation of Africa in the global aquaculture sector is lacking and aquatic species indigenous to the continent have developed into aquaculture species of international importance in countries outside of Africa. Developing countries from Southeast Asia and South America have secured significant participation and economic benefits from the sector, but African countries have been unable to do so.

Africa's contribution to global aquaculture production is very low in relation to the contributions made by other continents. Africa contributed to 0.4% of global production in 1995 (Hecht and De Moor, 1997). However, in line with global trends, the aquaculture sector in Africa, although small, has also experienced considerable growth. In this regard, African aquaculture production increased from 11,800 to 82,014 tons from 1985 to 1995 (FAO, 1997; Hecht and De Moor, 1997). In 1998 approximately 57% of the fish and shellfish produced on the African continent came from three countries bordering the Mediterranean, with Egypt producing the most (Hecht, 2001). Thirty-three sub-Saharan countries produced the remaining 34,000 tons, of which 93% can be attributed to 6 countries, these being Nigeria (16700 tons), South Africa (4500 tons), Zambia (4100 tons), Zimbabwe (3800 tons), Namibia (1300 tons) and Kenya (1100 tons) (Hecht, 2001). The other 27 countries, for which information is available, produced a total of only 2500 tons (Hecht, 2001). Most of the products in the six major producing countries originated from large and capital intensive private operations or joint ventures between the private and the public sector, whereas by contrast, the farms in the 27 minor producer countries are small-scale or subsistence operations. Hecht (2001) concluded from his study that national aquaculture development programs for rural areas in most sub Saharan countries have not been sustainable, despite substantial international donor funding and a highly suitable environment.

The development of aquaculture in South Africa can be divided into several epochs or time categories. Firstly, the colonial era during which exotic fish species were introduced and produced, mainly for angling purposes. The apartheid era saw the development of private sector commercial aquaculture (particularly trout and oysters) and government led "homeland" aquaculture initiatives to address food security issues. Thirdly, the post-1994 democratic era, which witnessed the development of large-scale commercial aquaculture and a trend towards more entrepreneurial rural aquaculture.

During the late 1980's and early 1990's the Provincial Nature Conservation Departments changed their policies to stop the production and stocking of exotic fish into indigenous waters. This resulted in the withdrawal of Government support for the aquaculture sector, leading to the closure and privatization of many Government aquaculture facilities. The period of political transition in the early 1990's resulted in a lack of policy and funding to support aquaculture research and development, and without this support, the South African aquaculture sector developed at a slower rate than in other parts of the world.

Despite the lack of a national aquaculture policy since 1994, there have been attempts to develop small-scale commercial aquaculture in the rural context on the back of larger commercial enterprises. These initiatives have been motivated by Government's policy of promoting Black Economic Empowerment (BEE) and supporting emerging farmers.

The further growth of aquaculture in South Africa depends on the successful integration, use and development of natural resources (water, land, climate, energy and biodiversity), human resources (labor, skills and technology), economic resources (capital, infrastructure and market access) and a facilitative regulatory environment. On the back of rapid international development it is clear that aquaculture can become an effective vehicle for participation, skill enhancement, empowerment, food security and socio-economic upliftment.

1.3 THE PROFILE OF AQUACULTURE IN THE WESTERN CAPE

Both in terms of production volume and crop value, the Western Cape Province is the most significant contributor to the collective aquaculture output in South Africa. In a recent benchmarking survey (Botes *et al*., 2006) it was found that the Western Cape is the economic hub for aquaculture production in the country and makes the most significant contribution to GDP in terms of export based production. The survey found that 43.8% of aquaculture producers are situated in the Western Cape, followed by Mpumalanga, KwaZulu Natal and the Eastern Cape with 12.5% each. These statistics reveal the importance of the Western Cape Province in terms of aquaculture development and the need for this BMP guideline.

Various marine and freshwater aquaculture species are currently cultivated in the Western Cape Province. These include:

a) Marine species
    - Abalone (*Haliotis midae*)
    - Various marine finfish under investigation (including cob (*Argyrosomus spp.*))
    - Mediterranean mussel (*Mytilus galloprovinvialis*)
    - Pacific cupped oyster (*Crassostrea gigas*)
    - Seaweed species (*Gracilaria spp*.)

b) Freshwater species
    - African catfish (*Clarias gariepinus*)
    - Carp (*Cyprinus carpio*)
    - Goldfish (*Carrasius auratus* and other *spp*.)
    - Ornamental fish (various ornamental species)
    - Rainbow and brown trout (*Oncorhynchus mykiss* and *Salmo trutta*)
    - Largemouth bass (*Micropterus salmoides*)
    - Chinese grass carp (*Ctenopharyngodon idella*)
    - Koi carp (*Cyprinus carpio*)
    - Marron (*Cherax tenuimanus*)
    - Mozambique and other tilapia species (*Oreochromis spp*)
    - Nile crocodile (*Crocodylus niloticus*)
    - Water hawthorn (*Plantae aquaticae*)

Aquaculture is practiced in various manners in the Western Cape; from marine pump-ashore units to estuarine aquaculture, pond and tank type production and cage culture.

In addition to the Western Cape's leading position in the South African aquaculture sector, the province is also home to the Marine and Coastal Management Branch of the Department of Environmental Affairs and Tourism (MCM: DEAT), four tertiary institutions with strong links to aquaculture (the Universities of Cape Town, Stellenbosch, Western Cape and the Elsenburg Agricultural College) and the Aquaculture Institute of South Africa (AISA).

1.4 THE ROLE OF THE DEPARTMENT IN TERMS OF AQUACULTURE

The Department seeks to be an integral stakeholder and partner in the growth and equitable intensification of a sustainable aquaculture sector in the Western Cape. Insofar as this is concerned, the main focus areas of the Department are:

e) Sustainable environmental management and integrated development planning, and
f) Ensuring equal access and sustainable use of the province's natural resources.

This equates to ensuring that aquaculture practices are environmentally responsible and that new aquaculture development is based on principals of sustainability. DEA&DP aims to achieve this through its involvement in:

a) Integrated environmental management,
b) Environmental planning,
c) Biodiversity management,
d) Coastal management,
e) Provincial and regional planning, strategies and policies,
f) Pollution and waste management, and
g) Law enforcement.

This inclusive approach by DEA&DP will contribute towards the environmentally, socially and economically sustainable growth and development of aquaculture through the creation of an administratively just and procedurally accessible system for aquaculture in the province.

The Department has both a regulatory function and a facilitative responsibility in terms of equitable, sustainable and responsible development planning around aquaculture, both at a macro (provincial) and micro (project) scale. It is thus obliged to consider the unique regulatory and facilitative nature of aquaculture. The Department is also in a position to use the opportunity, provided by facilitation of responsible and sustainable aquaculture, to contribute towards achieving the national objectives of socio-economic development, food-security, human resource development and equitable access to resources.

The Department does not stand alone in its regulation and facilitation of the aquaculture sector in the Western Cape. Various other government departments, tertiary institutions and producer organisations also play a significant role in the sector (refer to section 1.10). It is of significant importance that these roles and responsibilities be integrated by good communication and cooperation.

1.5 BACKGROUND TO BEST MANAGEMENT PRACTICE (BMP)

BMP's are defined as the management of activities to achieve an ongoing minimisation of the activities' environmental harm through cost-effective and continually assessed measures.

By their nature, BMP's refer to a wide range of interventions that can be made to improve or optimise performance in financial, social, environmental and other areas or sub-categories. The term has however been adopted strongly into the realm of responsible environmental management and it is in this context that it has been used in this guideline. In this context this BMP guideline promotes the minimisation of unavoidable environmental impacts and the prevention of avoidable impacts associated with aquaculture activities.

This BMP guideline document has been compiled in the most appropriate manner so as to be implementable in freshwater and marine aquaculture and across all aquaculture species and production systems. Due to the varied nature of aquaculture with regard to sites, species, scale, techniques, financial positions, markets and environmental conditions, not all of the principles and management practices, as proposed in this document, will be relevant to all facilities. It is thus important that this guideline be considered as a baseline document from which more comprehensive species -, sub-sector - and farm or operation specific environmental management program can be developed.

1.6 THE IMPORTANCE AND AIMS OF BEST MANAGEMENT PRACTICES IN AQUACULTURE

The importance of BMP's in aquaculture is driven by:

a) The need for aquaculture to be in compliance to legislative obligations,
b) The need for resource protection and conservation,
c) The need for resource use to be equitable, responsible and sustainable,
d) The need for the aquaculture sector to become recognised as environmentally responsible and sustainable,
e) The need for the aquaculture sector to provide independent norms and standards by which it can be held accountable, and
f) The need for the sector to illustrate adequate environmental due diligence.

Specifically, this BMP guideline aims to:

a) Be relevant to the nature of the aquaculture sector,
b) Be practical and provide for ease of implementation,
c) Provide options for management,
d) Be flexible,
e) Provide a mechanism for environmental self-regulation,
f) Fall within the legal requirements for aquaculture development and operation (although it does not provide any exemption from legislative matters), and
g) Provide clear standards for performance and monitoring.

It is within the objectives of this guideline to provide BMP techniques to minimise the potential environmental impacts associated with aquaculture. This will result in more consistency of performance and clarity of environmental objectives for all stakeholders within, across and outside of the sector. Nevertheless, the guideline's effectiveness lies in it being reasonable and practicable in its application. In determining if a BMP intervention is reasonable and practicable, consideration must be given to the following:

a) The current state of technology in the aquaculture sector and the technology required to make any intervention in a sustainable manner,
b) The financial considerations and implications of any actions or interventions and the resultant effects of such financial implications,
c) The likelihood of a successful outcome from any actions or interventions and the sustainability of the outcome,
d) The nature of any impacts or the potential impacts against which actions are taken, and
e) The sensitivity of the receiving environments and the likely effects if no actions or interventions are made.

1.7 STRUCTURE AND APPROACH IN THE BEST MANAGEMENT PRACTICE GUIDELINE

This BMP guideline is structured into distinct sections for ease of reference and use. The structure is as follows:

Section 1 **Introduction**
The section provides background and guidance to the relevance of the BMP guideline, the status of aquaculture and the role of the DEA&DP in terms of aquaculture development in the Western Cape.

Section 2 **Integrated Planning – Aquaculture Project Formulation**
This section deals with the concepts of planning aquaculture in a sustainable manner through consideration of strategic development frameworks (at a macro level) and the environment (biophysical, economic and social) in which a project may operate (micro level).

Section 3 **Authorisation Procedures for Aquaculture**
This section refers primarily to a supporting document, entitled *Guideline to the Authorisation Requirements of Aquaculture Activities in the Western Cape.* This document provides details as to the legislative process involved in the authorisation of a proposed aquaculture facility or activity.

Section 4 **Environmental Management in Operational Aspects of Aquaculture**
This section deals with the generic environmental specifications (*the best management practices*) that apply to aquaculture activities and the environment (including the biophysical, infrastructure and social environment) that surrounds these activities.

Section 5 **Best Management Practice Standards in Aquaculture**
This section provides guidance on set norms and standards (both national and international) related to aquaculture and the measurable benchmarks, which are attained by responsible and sustainable BMP interventions.

Section 6 **Environmental Contingency Planning in Aquaculture**
This section provides a basic guideline as to the content of a contingency plan, which can be developed for implementation in the event of an environmental emergency occurring on an aquaculture facility.

Section 7 **Monitoring, Auditing and Review**
In order to ensure that BMP interventions and activities remain an integral part of standard operational procedure, this section provides guidance on the monitoring of BMP interventions by means of auditing.

Section 8 **Aquaculture Decommissioning Procedures**
This section deals with the steps that are required in the event of project termination so as to ensure that environmental scars are not left as a legacy of any aquaculture activity.

Section 9 **Conclusion**
The section contains a concluding paragraph.

Sections 4 (***Environmental Management in Operational Aspects of Aquaculture***) has been subdivided into four further subsections:

Section 4.1 BMP: The Surrounding Biophysical Environment
This section includes management aspects of the surrounding biological and physical environments that are not directly related to the core aquaculture activities. In general, these aspects (e.g. fire and vegetation management etc.) would require attention and management regardless of the fact that the core activity is aquaculture.

Section 4.2 BMP: The Infrastructure Environment
This section deals with the environmental management aspects related to the use, maintenance and installation of project infrastructure in a manner that will prevent undue degradation of the environment.

Section 4.3 BMP: The Production Activities
This section deals with the aspects related to the core aquaculture activities as they influence the environment. Management of the aquaculture organism, feed and water quality are some of the issues addressed in this section.

Section 4.4 BMP: The Surrounding Social Environment
This section on the social environment includes a reference to general conditions of employment, training and the interaction of an aquaculture activity with the social environment in which it operates.

Each aspect covered through sections 2 to 8 has been approached by means of providing clarity of the issue or aspect and the applicable BMP approach.

1.8 HOW TO USE THE BEST MANAGEMENT PRACTICE GUIDELINE

From the aforementioned it will be clear that the BMP guideline consists of various sections, not all of which will be applicable to all of its users. The following table depicts the main user groups with an indication of the typical manner in which each should use the BMP guideline.

User Group	Typical approach to the use of the BMP guideline
Existing aquaculturists	These aquaculturists should use the BMP guideline as: a) A reference to create farm / project specific BMP's. b) A reference to improve on existing farm / project specific BMP's. c) A reference for internal performance auditing in terms of BMP's.
New aquaculturists	These aquaculturists should use the BMP guideline as: a) A reference to check that the planning of any new aquaculture ventures or projects has been done in accordance with BMP's. b) A guideline to assist with the inclusion of BMP strategies into the respective applications for authorisation that are required for new aquaculture ventures. c) A supporting document to the authorisation guideline for aquaculture, entitled *Guideline to the Authorisation Requirements of Aquaculture Activities in the Western Cape*. d) A reference to create farm / project specific BMP's. e) A reference for internal performance auditing in terms of BMP's.

DEA&DP and other regulatory authorities	These authorities should use the BMP guideline as: a) A reference to enhance their understanding of aquaculture and how the sector interacts with the environment. b) A reference to check that new aquaculture ventures and projects have taken due consideration of BMP's. c) A reference for auditing and monitoring the performance of existing aquaculture ventures in terms of BMP's.
Facilitative authorities	These authorities should use the BMP guideline as: a) A reference to enhance their understanding of aquaculture and how the sector interacts with the environment. b) A reference to which new aquaculture projects and ventures can be referred to, to ensure sustainability in development and legal compliance.
Aquaculture service providers	These service providers should use the BMP guideline as: a) A reference to enhance their understanding of aquaculture and how the sector interacts with the environment. b) A reference to check that the services provided are not in conflict with BMP standards that the sector aspires to.
General public and interest groups	The general public should use the BMP guideline as: a) As a reference to enhance their understanding of aquaculture and how the sector interacts with the environment. b) As an indicator as to the aspirations of the aquaculture sector in terms of BMP's.

1.9 LEGAL STANDING AND LEGISLATIVE MANDATES

In South Africa the protection of the environment at large is governed by a range of resource-based legislation and by the rights of the people to a clean and safe environment in terms of the Constitution (1996). Therefore, all people have an obligation towards the protection and responsible use of the environment. Although this environmental responsibility is bestowed upon all the stakeholders in aquaculture, this document serves only as a guideline towards the achievement of this responsibility. This BMP guideline is not legally binding, unless specifically cited by any relevant authority in the issuance of licences and authorisations. In such an event the BMP activities in the guideline may become prescriptive by virtue of the fact that such licences and authorisation are legally binding.

In order for the BMP guideline to be fully effective in its objective to promote sustainable aquaculture development, the respective authorities involved in the licensing and authorisation of aquaculture must move towards the adoption thereof. In this manner, these authorities can move to a point at which compliance to the BMP can be included as a legally binding condition of licences and authorisations.

The primary legislative mandates of the Department are as follows:

a) Convention on Biological Diversity (1992),
b) National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA),
c) National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004),
d) Marine Living Resources Act, 1998 (Act No. 18 of 1998),
e) Environmental Laws Rationalisation Act, 1997 (Act No. 51 of 1997),
f) Western Cape Planning and Development Act, 1999 (Act No. 7 of 1999), and
g) Western Cape Environmental Implementation Plan.

The provision of the abovementioned legislative mandates does not imply that aquaculture activities are exempt from any other legislative frameworks under the auspices of other Departments.

1.10 LINKAGES IN ENVIRONMENTAL BEST MANAGEMENT OF AQUACULTURE

As stated in section 1.4 above, the Department does not stand alone in the regulation and facilitation of the aquaculture sector in the Western Cape Province. Various other government departments and other stakeholders also play a significant role in the sector. The primary list of stakeholders can be subdivided and summarised as follows:

a) Provincial Departments:
    - The Department of Environmental Affairs and Development Planning (DEA&DP),
    - The Department of Agriculture, and
    - The Department of Economic Affairs.
b) National Departments:
    - The Department of Environmental Affairs and Tourism (DEAT),
    - The Marine and Coastal Management Branch of DEAT (MCM: DEAT),
    - The Department of Agriculture (NDA),
    - The Department of Water Affairs and Forestry (DWAF),
    - The Department of Science and Technology (DST),
    - The Department of Trade and Industry (DTI), and
    - The Department of Land Affairs.
c) Other parastatal organisations:
    - CapeNature,
    - South African National Parks (SANP),
    - The South African Bureau of Standards (SABS),
    - WESGRO,
    - The Aquaculture Institute of South Africa (AISA),
    - The NEPAD Secretariat for Fisheries and Aquaculture, and
    - The National Agricultural Marketing Council (NAMC).
d) Tertiary institutions:
    - The University of Stellenbosch (US),
    - The University of Cape Town (UCT),
    - The University of the Western Cape (UWC), and
    - The Elsenburg Agricultural College.
e) Other organisations:
    - The Aquaculture Association of Southern Africa (AASA),
    - The Southern Aquaculture Working Group (SAWG),
    - The Abalone Farmers Association of South Africa (AFASA),
    - The Western Cape Trout Association (WCTA),
    - The Marine Finfish Farmers Association of South Africa (MFFASA),
    - The Oyster and Mussel Forum,
    - The Tilapia Association of South Africa (TILASA),
    - Other producer related associations,
    - The World Wildlife Fund (WWF), and
    - Wildlife and Environment Society of South Africa (WESSA).

SECTION 2: INTEGRATED PLANNING – AQUACULTURE PROJECT FORMULATION

As part of best practices the accurate, informed, responsible and flexible planning of aquaculture is essential. The planning stage of aquaculture facilities (new or expanding), is crucial not only from a viability perspective, but also as an opportunity to incorporate aspects which may lead to a reduction of undue environmental impacts. New facilities, and any expansion of existing facilities, must be designed and planned to minimise risk or harm to the environment. Adopting this approach in design and planning will also be advantageous when best practices are implemented in the operational phase (as per section 4).

2.1 CONSIDERATIONS AROUND THE MACRO-PLANNING ENVIRONMENT

People, economic activities, social needs, infrastructure and natural resources are not evenly distributed across the landscape and these variations impact directly on economic growth, social justice and the ability of the natural environment to support human activities, now and in the future.

No definite zoning or macro-planning initiatives have been developed specifically for aquaculture, but there is a strong drive towards the recognition and development of aquaculture nodes (especially for marine aquaculture). Nevertheless, it is important to consider the overarching macro-planning structures and frameworks used in the Province before the positioning or initiation of any aquaculture venture. The main macro-planning frameworks that are currently applicable include the:

a) Growth and Development Strategy (leading to the next framework);
b) Western Cape's Provincial Spatial Development Framework (WCPSDF);
c) Sustainable Development Implementation Plan (SDIP); and
d) The Western Cape Poverty Reduction Strategy.

Insofar as aquaculture is concerned the purpose of the WCPSDF is to:

a) Guide Municipal (district, local and metropolitan) Integrated Development Plans (IDP's) and Spatial Development Frameworks (SDF's), and Provincial and Municipal Spatial Development Plans (SDP's);
b) Help prioritise and align investment and infrastructure plans of other Provincial Departments, as well as National Departments' and Parastatals' plans and programmes in the Province;
c) Provide clear signals to the private sector about desired development directions; and
d) Increase predictability in the development environment, for example by establishing "*no go*", "*maybe*" and "*go*" areas for development.

Although development initiatives for aquaculture should be aligned with the greater WCPSDF, such alignment is particularly relevant at project level in which the related IDP's and SDF's are important from both a resource (i.e. environmental services) and infrastructure (i.e. public infrastructure service clustering) perspective. In this regard, it is important that local and district authorities (that oversee IDP's and SDF's) are consulted in the process of aquaculture development so that these macro-planning implications are fully understood in the planning of aquaculture development.

2.2 AQUACULTURE SITE SELECTION CRITERIA (MICRO-PLANNING)

The primary goal in site selection for aquaculture is in the choice of an area that is capable of housing a venture that will be economically viable, socially acceptable and environmentally responsible. The following is a list of the major considerations in terms of environmentally responsible aquaculture site selection (which must be considered in parallel with the development criteria in the remainder of this section 2).

2.2.1 LAND, RESOURCE AND SITE ACCESS

2.2.1.1 LAND OWNERSHIP AND TENURE

Aquaculture activities require both land and water in that the water based production is always supported by land based activities of the aquaculture proponents or operators. Even offshore and freshwater cage culture operations are associated with land based storage and/or processing facilities. The planning for a new aquaculture venture must consider its requirements in terms of land ownership or legal tenure. In this regard, land for aquaculture can be allocated or occupied through:

a) Private ownership or through consent from private landowners;
b) Lease or rental of private or State owned land;
c) Lease or rental of communal land; and
d) The formation of Public Private Partnerships (PPP's) or Community Public Private Partnerships (CPPP's) through which legal access may be gained to State owned land and assets.

The Department of Land Affairs plays a key role in the authorisation of access to State and communally owned land, while the National Treasury is active in the formation of PPP's and CPPP's. The formation of such partnerships is an important vehicle in the establishment of sector based Small, Medium and Micro Enterprise (SMME's), which will form an integral part of the successful future development of the sector.

2.2.1.2 ACCESS TO NATURAL RESOURCES

Aquaculture depends on water and each project type (differentiated by species, production system, scale, etc.) depends on a certain quantity and quality of water. In this regard, the planning process for a aquaculture venture must consider matters of legal access to water. Such legal access to the water and other resources are secured through compliance to the respective resource based legislation (refer to: "*Guideline to the Authorisation Requirements of Aquaculture Activities in the Western Cape*", which is associated with this BMP guideline).

2.2.1.3 PHYSICAL ACCESSIBILITY

The resources upon which aquaculture depend are often located in relatively inhospitable areas (e.g. mountain areas for trout farming, exposed coastal zones for pump-ashore marine aquaculture and open water sites for cage culture). For this reason it is imperative to ensure that aquaculture sites are accessible for all operations, including:

a) The supply of feeds and services;
b) The dispatch of products; and
c) Access by personnel.

2.2.2 EXISTING AND NEW SERVICE AND INFRASTRUCTURE NEEDS

The essential services and associated infrastructure upon which most aquaculture operations depend on are:

a) Roads and a road network;
b) Electricity and an electricity supply network;
c) A sewerage reticulation system and linkage to, or self sufficiency, in terms of sewerage and wastewater treatment;
d) Potable water; and
e) Solid waste collection and removal systems (serviced or internally operated).

It is important that these services are catered for or included in the planning of any venture. If a service installation is required, care must be taken to prevent undue environmental impacts and the service needs must be within the capacity of the service provider.

2.2.3 THE CAPACITY OF THE RECEIVING ENVIRONMENT

The capacity of the receiving environment relates to the degree to which environmental services (e.g. assimilation of nutrients from an aquaculture farm) are required for a project. In the first instance, the surrounding environment to any project must have an adequate capacity to "*cope*" with the existence of a project or venture (including the ability to sustain the supporting infrastructure and services). In the second instance, these environmental services require statutory authorisation (refer to: "*Guideline to the Authorisation Requirements of Aquaculture Activities in the Western Cape*", which is associated with this BMP guideline). This environmental service capacity relates to many aspects ranging from water requirements, nutrient assimilation capacities, social capacities, aesthetical capacities, etc.

2.2.4 THE ENVIRONMENTAL VALUE OF A SITE

The environmental value of a site refers to its conservation worth or importance. Such a worth or importance is made up of many aspects that include species diversity (biodiversity), levels of endemism, land use, heritage, social perception and social values, aesthetic value, robustness of the environmental services, nature of the resources and more. All of these aspects must be brought into consideration in the planning and development of an aquaculture venture (refer also to: "*Guideline to the Authorisation Requirements of Aquaculture Activities in the Western Cape*", which is associated with this BMP guideline).

An aquaculture venture does not necessarily pose a significant threat to the surrounding environment (regardless of scale or the conservation worth of the area). In determining this, the potential impacts of any venture must be understood and an accurate assessment made of the respective and cumulative impacts by quantitative and measurable means. In this manner the potential impact and risk to the environment can be determined before a venture is undertaken. This assessment is not necessarily a statutory EIA, as this will be determined by the scale and nature of the planned or proposed venture (refer also to: "*Guideline to the Authorisation Requirements of Aquaculture Activities in the Western Cape*", which is associated with this BMP guideline). Nevertheless, an understanding of the potential environmental impacts will equip any aquaculture proponents with the information necessary to allow for rightful permission to access and farm with the natural resources and environmental services. It will also equip proponents with a better understanding of the

interaction between the environment and the aquaculture activities so that production and performance may be optimized.

2.2.5 SHARED RESOURCES AND OTHER USERS

Cognisance must be taken of the fact that natural resources always have multiple uses and users. These users are not limited to people, but includes the environment itself. In this regard, newly proposed aquaculture ventures must consider the impacts and effects on these other users when resources and environmental services are shared. Resource use and allocation must be equitable, fair, within the sustainable capacities of the environment and not exclusionary in nature. The rights of existing water and resource users must be adequately regarded before additional demands are placed on any such resources.

2.2.6 FLOODS, TIDES AND OTHER WATER CHARACTERISTICS

Due to the general proximity of aquaculture ventures to water, the dangers posed by such waters through flooding, tidal actions and currents must be taken into consideration in the planning of any aquaculture ventures. Aquaculture activities should be sited outside of areas that are prone to flooding and preferably outside of the 1:50 year flood lines and beyond the intertidal zones. Consideration must be given to the effects of currents in marine and estuarine aquaculture activities and all cage culture infrastructure must be adequately designed to withstand severe flooding or offshore conditions as applicable.

2.2.7 CONSIDERING THE SURROUNDING LAND USE

The sections above have covered various aspects related to the environment surrounding any aquaculture activities. In addition to these, cognisance must be taken in the planning phase of the nature of the land use surrounding any aquaculture activities. Aquaculture activities must be compatible in this regard, must not impact negatively on surrounding land uses or users and should, where possible, enhance the integrated use of resources. This points to the preference of having aquaculture activities clustered or centralized around development nodes, but this should not be exclusionary in nature.

2.2.8 UNIQUE MANAGEMENT AREAS

Certain areas are protected and/or managed under the auspices of National -, Provincial - or Local legislation or even by private landowners with specific objectives and goals, which are often collectively associated with conservation. Although aquaculture activities are not excluded from developing in close proximity to these areas, cognisance must be taken of any conservation buffer zones and potential impacts between the aquaculture developments and any conservation or unique management areas. Where legislative frameworks are associated to these areas, activities such as aquaculture may be precluded within their boundaries, but in certain instances low impact developments may be tolerated or allowed.

2.2.9 GEOLOGY, TOPOGRAPHY AND CLIMATE

Related to the suitability of any proposed aquaculture development site is the suitability of the physical environmental aspects that range from geology, to topography, to hydrology and climate. As any one, or a combination, of these aspects can cause the non-viability of any aquaculture venture, it is imperative that they be assessed as part of the planning process.

2.2.10 PERSONNEL AND SKILL REQUIREMENTS

As part of understanding the social environment in which any projects take place, it is important to know the personnel and human resource requirements for an aquaculture venture. Furthermore, access to the human resources in terms of availability, empowerment, qualifications and proximity must be assessed before any development takes place.

2.3 DETERMINING THE RESOURCE NEEDS FOR A NEW AQUACULTURE PROJECT

In section 2.2 reference has been made to the resources and environmental services required for aquaculture. Nevertheless, specific resource assessments are required to ensure the success of any ventures. The primary resources that are required (and for which the availability must be adequately and sustainably available) are discussed below.

2.3.1 FINANCIAL RESOURCES AND ECONOMIC VIABILITY

The availability and sustainability of financial resources to undertake an aquaculture venture is a budgetary issue that is not addressed in this guideline, apart from cautioning against the potential environmental risks posed by any aquaculture ventures which fail due to a shortage in financial resources. It is also important to note that many aquaculture ventures are predisposed to financial failure due to a misinterpretation or misunderstanding of the importance around resource assessment and integrated best practice planning.

2.3.2 WATER RESOURCE NEEDS

Water is a primary resource upon which aquaculture depends for various reasons:

a) It provides the medium in which aquaculture organisms survive and are housed;
b) It is the carrying medium for oxygen and temperature upon which aquaculture organisms depend for survival and production performance;
c) It can, in certain aquaculture types, be the medium, which carries nutrients and feeds to the aquaculture organisms in production; and
d) It is used as a medium to carry accumulated and excess nutrients and metabolites away from the production system.

Considering the importance of water in aquaculture, the following questions need to be asked during the assessment of the required water resources for any aquaculture ventures:

a) Can a water resource of sufficient volume and quality be accessed legally?
b) Which other users or uses depend on the water resources identified for any aquaculture activities and can aquaculture developments be accommodated in this regard.
c) Can an application be made so as to ensure that the extraction and use of the water resource for aquaculture is legally compliant?
d) How will water resources be stored and used within the aquaculture production systems?
e) What effects will the use of water have on the volume and quality of the water resource?
f) What measures of mitigation are required to ensure that the water quality and volume are maintained within reasonable limits?
g) Where will effluent or excess water be directed after use in any aquaculture systems?
h) Can an application be made to ensure that a discharge of the water is legally compliant?
i) In the case of cage culture or shellfish rafting, has the assimilative or production capacity of the water resources (or area in the case of marine cage culture) been determined.

Assessment of water resources is vital to any aquaculture projects to ensure sustainability. Furthermore, legal compliance around the use of water must be done in accordance with the National Water Act, 1998 (Act No. 36 of 1998), administered by the Department of Water Affair and Forestry (DWAF)(refer also to: "*Guideline to the Authorisation Requirements of Aquaculture Activities in the Western Cape*", which is associated with this BMP guideline).

2.3.3 FEED RESOURCE NEEDS

Many aquaculture production systems depend on feed inputs, either directly or indirectly (through fertilisers). These feed resources are often the primary cause of water quality impacts associated with aquaculture activities and thus require careful planning and management. For systems where direct feed inputs are required (this excludes most filter feeding organisms and aquatic plants), the following questions need to be asked during the assessment of the required feed resources:

a) What feed types are typically required for the target production species? This can range from pelleted feeds, extruded feeds, milled feeds, plants, fresh feeds, live feeds and more.
b) What quantities of feed will be required to reach the projected production output?
c) Have sustainable feed resources been identified and secured at an acceptable price and within a logistically manageable distance from the project?
d) Do the feeds require any further processing on site and what are the storage requirements?
e) Will the feeds ensure that the products meet the necessary phytosanitary and chemical standards (i.e. are there any medications, chemicals or additives in the feeds or are any of these substances required).
f) Can a feed management system be implemented that records feeding rates and the related production performance?
g) What are the likely impacts that the feeds will have on the water resources to be used for the aquaculture activities?

2.3.4 STOCK AND SPECIES RESOURCES

It is important that suitable species and genetic stock is sourced and used in any aquaculture systems to ensure optimal production and to reduce the risks to the environment and biodiversity. In this regard, the following questions need to be asked during the assessment of possible production species:

a) Are the target species suited to aquaculture conditions and will they grow and perform in such a manner so as to ensure adequate production performance?
b) Are the project locations (especially in terms of climate, water quality, housing facilities, feeds, technology levels and identified markets) suited to the target species?
c) Are the species indigenous, extralimital or exotic and can the necessary applications be made to ensure that their use is legally compliant?
d) Are brood stock, fingerling, spat or juvenile supplies of the species readily available and are the projects geared to deal with brood stock, reproduction or juvenile care?
e) Are the genetic lineages of the selected stock suited to the aquaculture environment, will these lineages perform adequately in production and do they pose any risk in terms of genetic contamination to any species in the surrounding environment?
f) Are the species any threat to the surrounding environment in terms of impacts related to predation, displacement, competition or physical environmental damage?

2.3.5 HUMAN RESOURCE AND SKILL REQUIREMENTS

Human resources bring the required skills, technologies and manpower to any aquaculture projects. The need for aquaculture skills (and especially experience) and the application of technologies is often underestimated in the South African aquaculture sector and thus the following questions need to be asked during assessment and planning of any aquaculture ventures:

a) What skills, technologies and human resources are required for any aquaculture projects?
b) Are these skills, technologies and human resources available and within the means of the projects?

2.4 DETERMINING THE SCALE OF AN AQUACULTURE OPERATION

In the planning and assessment of aquaculture ventures the scale of operations are an important consideration, determined by many factors that include the financial means, the location, the limitations posed by husbandry constraints, the availability of stock, the markets, the required technologies and more. From a resource and legal compliance perspective, the need for future expansion should also be considered when planning the scale of aquaculture operations. When all of these factors have been considered, this must be checked against the legally available land, water and other resources.

Furthermore, consideration must be given to the concepts of corridors, transitional zones, clustering (nodes) and cumulative impacts. The following briefly explains these concepts:

a) Corridors refer to areas within an aquaculture venture (usually if the development footprint is relatively large), which allows for the free movement of ecological elements (primarily fauna). This is most relevant to aquaculture projects that are sited within relatively undisturbed areas, but can also be relevant to urban and industrial areas where "*greenbelts*" may be established. Where possible, allowance should be made for such ecological corridors.
b) Transitional zones refer to the areas that border aquaculture ventures and allow for an ecological transition from the aquaculture activity to an adjacent undisturbed area, conservation area or area of special management interest.
c) Clustering (or nodes) refers to the grouping of individual aquaculture ventures into a common geographical area, which allows for focussed development and management around common resources, services and infrastructure. This also allows for geographic consolidation of potential impacts.
d) The concept of cumulative impacts refers to the fact that any aquaculture venture should not be considered only in terms of its own potential impact on the environment. Aquaculture ventures will rely on resources and environmental services that may be common to multiple users (including the environment itself). The establishment of aquaculture facilities must therefore be done with due consideration of the potential contribution made to the total impact of all aquaculture and other developments reliant on the same resources and environmental services. In this context, the contribution of a venture to this cumulative use or impact must be such that the ecology and the environment at large can sustain the total event, effect or occurrence.

2.5 CONSIDERATIONS AROUND THE SOCIAL ENVIRONMENT

The management of the social effects and interactions of aquaculture ventures is dealt with in more detail in section 4.4. Nevertheless, it is important that the social environment be carefully considered in the planning of any aquaculture ventures, as this aspect contributes significantly to sustainability and legal compliance. In this regard, the following points need to be considered during the assessment of the social environment and interaction therewith:

a) Adequate opportunity (public participation) must be provided to all surrounding communities and other stakeholders to voice an opinion (positive or negative) in terms of any planned aquaculture ventures (refer to: "*Guideline to the Authorisation Requirements of Aquaculture Activities in the Western Cape*", which is associated with this BMP guideline).
b) If a venture is to be sited in close proximity to a community that would perceive the venture as a disturbance in terms of noise, odours and other impacts, these perceptions need to be managed by the provision of adequate information and active liaison with such a community.
c) If a venture is to be sited in close proximity to a community that would regard the venture as a source of employment or other services and business opportunities, these services and opportunities should be encouraged and managed.
d) Poverty alleviation, the development of partnerships, the creation of employment, skills development and socio-economic advancement must be incorporated as key considerations in the planning of any aquaculture ventures.
e) Mechanisms must be developed to ensure continual interaction and liaison between any ventures and their surrounding communities to ensure the free flow of information and to ensure that the communities become social partners of the ventures.
f) Adequate provision must be made in the planning to allow an aquaculture venture to meet its legal obligations in terms of employment conditions.

SECTION 3: AUTHORISATION PROCEDURES FOR AQUACULTURE

Associated and supporting this BMP guideline is the DEA&DP aquaculture authorisation guideline (*Guideline to the Authorisation Requirements of Aquaculture Activities in the Western Cape*), which explains the authorisation for new aquaculture ventures in the Western Cape Province in detail. The document includes guidance on the applicable authorities, the information requirements and the chronological approach to gaining the necessary statutory approvals for the establishment of new aquaculture ventures in terms of the applicable resource based legislation. The core objectives of the authorisation guideline are:

a) To provide guidance on the process, steps and procedures to follow in applying for the authorisation of an aquaculture activity in terms of the legislation over which DEA&DP are mandated,
b) To provide guidance on the process, steps and procedures to follow in gaining authorisation for an aquaculture activity in terms of other resource-based legislation administered by other authorities, and
c) To provide guidance on the integration of the respective authorisation processes overseen by the different authorities.

SECTION 4: ENVIRONMENTAL MANAGEMENT IN OPERATIONAL ASPECTS OF AQUACULTURE

This section deals with the generic operational environmental specifications (BMP specifications) that apply to aquaculture activities and the environment that surrounds these activities. These specifications are intended as a reference and guide for both existing and new aquaculture activities in the Western Cape. Furthermore, these specifications should be integrated into the daily operational procedures of any aquaculture venture to ensure a sustainable aquaculture sector. For new aquaculture projects, such integration is better achieved if best practice considerations are already implemented during the design and planning stages, as covered in section 2.

SECTION 4.1: BMP: THE SURROUNDING BIOPHYSICAL ENVIRONMENT

4.1.1 MANAGEMENT OF VEGETATION

Vegetation management refers mainly to the approach required in dealing with the vegetation (including aquatic vegetation) within and around any aquaculture production facilities.

BMP Concepts and Approach

a) Wherever practical, the vegetation on and around aquaculture ventures should be indigenous, while plant species regarded as invasive are prohibited and should be removed.
b) An active alien vegetation eradication programme should be implemented where alien vegetation occurs. Such a program should however caution against erosion and soil destabilisation after eradication.
c) Special attention must be paid to invasive aquatic plant species that could invade the core water supplies or the production systems. Such invasive aquatic species require dedicated control and management. Control can be achieved by physical removal, responsible and careful chemical treatment or by biological control measures.
d) Wherever practically possible, the planting of indigenous plants and trees should be encouraged. This lessens the aesthetic impact of aquaculture activities, serves as ecological transition zones or corridors and contributes to the environmental integrity any aquaculture venture.
e) Where virgin or sensitive vegetation occurs, general access should be limited and well-maintained footpaths used in places where these areas need to be traversed.
f) Cut, trimmed, mowed and felled vegetation must either be removed to a suitable disposal site or composted on site for further application. Cut vegetation can also be used as brush pack in the control of erosion, but care must be taken to prevent the spread of seed of alien species in this manner. The burning of vegetation is discouraged, unless done under favourable climatic conditions and with the permission of the local disaster or fire management services.
g) Where any vegetation stripping is required, this is to be kept to a minimum footprint and in compliance with any legislation that may apply. Where appropriate, clearing should be done in a phased manner and cleared areas rehabilitated as soon as is practically possible.
h) Care should be taken during the translocation of aquaculture organisms from other locations, or when using equipment from other farms, so as to prevent the spread of invasive aquatic plants.

4.1.2 MANAGING NON-PRODUCTION AND NON-PREDATORY ANIMALS (FAUNA)

At some stage most aquaculture facilities will be faced with the presence of fauna that are neither related to the production activities, nor pose a predatory (or parasitic or disease) threat to the production activities. In maintaining best practices, the approach taken to these animals should be responsible and should cause the least possible harm to these organisms.

BMP Concepts and Approach

a) Wherever practically possible, and where these animals do not pose a risk to the aquaculture facilities, these animals must be accommodated and be granted freedom of movement and existence. Catching of wild animals, by any means, is illegal and should not be considered unless authorised or done in conjunction with the relevant delegated authorities.
b) Where aquaculture facilities are surrounded by boundary walls or fences, these must be of such a nature so as to prevent injury, harm or death of any animals that inhabit the area.
c) Channels, dams and other infrastructure must be designed and built in such a manner so as to prevent injury, harm or death of any animals.
d) Under no circumstances may animals that pose no risk to the aquaculture activities be shot, trapped, killed, bewildered, injured, poisoned or harmed in any manner. Acceptable deterrents may be used to discourage animals from entering into or inhabiting aquaculture facilities.
e) No animals (including predatory animals) may be poisoned. The only exception to this is in the responsible control of vermin, in which case recognised poisons may be used in the prescribed methods.
f) Aquaculture feeds and other production resources that may attract animals should be stored in such a manner so as to prevent access to these animals and to prevent animals from becoming trapped, killed or harmed.
g) Operators of aquaculture facilities must ensure that feed and equipment stores do not become overrun with rodents or other pests. A responsible control program for such vermin must be implemented.

4.1.3 STABILISATION AND SOIL MANAGEMENT

Due to the use of water in aquaculture, the management of soil stability and water erosion is of importance. Ignorance of the importance of soil and stabilisation management in and around aquaculture facilities can cause significant infrastructure damage, stock loss and negative environmental impacts.

BMP Concepts and Approach

a) The soil of the terrestrial environment, surrounding aquaculture activities, should be stable, protected from erosion and maintained as a suitable growth medium for natural vegetation.
b) Where vegetation is removed, this should be done in a phased manner to prevent unnecessary destabilisation and erosion.
c) When undertaking any earthworks, the topsoil must be stripped separately and retained for later re-use. Topsoil stockpiles must be stable, less than 2 meters high and free of invasive alien vegetation.
d) Following the exposure of any soils for construction, shaping or other activities, a suitable vegetation cover must be established immediately thereafter to ensure soil protection. Where appropriate, straw stabilisation or hydro seeding with environmentally compatible grasses and plants may be used to prevent erosion.
e) Barren soils should be tilled, treated with fertiliser or compost and vegetation cover encouraged and irrigated.
f) The upper contours of any terrestrial components of aquaculture facilities (and at intervals on the lower contours of large or steep sites), should have stormwater cut-off

trenches capable of accommodating a 1:50 year flood. Water must exit stormwater trenches below the terrestrial components of production facilities, in a manner that does not cause downstream erosion or degradation. Soil in the stormwater trenches must be protected from secondary erosion by means of suitable flow speed inhibition. This can be done by stone packing, vegetation establishment, brush packing or through the channel design characteristics.

g) All slopes with a gradient exceeding 2:1 on the terrestrial areas of aquaculture facilities must be protected from erosion. This can be accomplished with good vegetation cover, brush packing, sand bagging, retaining walls, log stepping, etc. The chosen method will depend on the availability of materials and the degree of instability.
h) Any erosion must be treated without delay. Where applicable, anti-erosion compounds may be used to prevent erosion, but the application methods must conform to the manufacture's recommendations.
i) Paths and roads must be formalised and stabilised against erosion by means of suitable materials, compaction and functional design. Stormwater cut off trenches can be used to prevent erosion.
j) Access points to production facilities (e.g. slipways or pontoon launches and jetty ramps) should be stabilised down to water level, preferably with vegetation or through more formal structures such as concrete landings, etc.

4.1.4 MANAGING SENSITIVE AREAS

Many aquaculture facilities are established alongside sensitive environmental areas such as tidal zones, estuaries, water tributaries, wetlands, rivers, etc. In order to achieve best practice standards these aquaculture activities should be conducted so as not to disturb these areas unnecessarily.

BMP Concepts and Approach

a) In general, access to sensitive areas should be kept to a minimum by means of designing access around these areas, by fencing them off and by educating employees of their existence and sensitivity.
b) Sensitive areas should not be used as storage areas or sites for old, disused or periodically unused equipment.
c) Sensitive areas should not be used for the dumping of waste of any nature (including vegetation matter such as mowed grass).
d) Natural features such as outcrops, rock faces, trees and natural vegetation should be protected when found in proximity to aquaculture facilities.
e) All buildings over 60 years of age, all fossils, archaeological and palaeontological materials, graves and burial grounds, wetlands, mountain catchments, forests, dune habitats and inter-tidal zones are protected by law and may not be disturbed in any manner without authorisation to do so.

4.1.5 FIRE MANAGEMENT

Fire is an ongoing risk, mainly to the terrestrial infrastructure that is used in aquaculture. The potential risk for fire must be minimised, while the necessary emergency procedures and emergency equipment to deal with fire, must be on-hand and in a working order at all times.

BMP Concepts and Approach

a) An appropriate number of fire extinguishers and fire fighting equipment must be available on aquaculture production facilities. Working fire fighting equipment must be available where hydrocarbon fuels or other flammable substances are stored and used.
b) Vegetation cover on any aquaculture projects should not be allowed to reach unsafe organic fuel loading capacities, as this may be pose fire risks.
c) All "*hot*" works (welding, gas cutting, etc.) must be done with a working fire extinguisher close on hand.
d) Employees that smoke should be made aware of the fire risks associated with smoking. The implementation of a dedicated smoking area could assist with lowering the fire risks associated with smoking.
e) Fire should not be used for the disposal or incineration of waste generated on aquaculture projects.
f) A fire contingency plan must be developed and made known to all employees that work on aquaculture facilities. Such a plan should include the location and operation of fire fighting equipment, the identity of a responsible and trained staff member that will act as a fire marshal, the contact numbers of fire fighting and emergency services and the site evacuation procedures.
g) Contact numbers for the nearest fire fighting and emergency services should be clearly displayed in an accessible area.

4.1.6 NOISE, LIGHT AND ODOUR MANAGEMENT

Noise generation by aquaculture activities is generally minimal, but can become a disturbance when the activities take place in close proximity to human settlements. Likewise, odours are generally not problematic in aquaculture, except when raw feed products are processed, in certain postproduction processing activities, in certain instances in the cleaning of production facilities and filters or in the laying fallow of ponds. Excessive light pollution is generally limited in aquaculture and is usually used for security purposes only. In spite of the limited impacts of noise, light and odours, it is important that these aspects be considered and managed to prevent any undue impacts.

BMP Concepts and Approach

a) Where practically possible, pumps, aerators and other noise generating devises should be equipped with a sound dampening cover or container.
b) All pumps, aerators and other noise generating devises (including motor vehicles) should be in a good working order to prevent excessive noise.
c) The use of noise dampening methods such as the planting of windrows should be considered if noise generation becomes excessive.
d) All employees should be made aware of the fact that unnecessary noise, light and odour pollution should be prevented by means of responsible conduct.
e) Where practically possible, sources of potential light or noise pollution should be placed in areas where they will cause the least possible disturbance.
f) Above average noise generation should be limited to normal business hours.
g) If odours are generated from any aquaculture facilities, efforts should be made to limit their impact on surrounding settlements, communities and operations. This can be done by taking cognisance of wind direction and speed, ensuring that odour generating activities are completed in as short a space of time as possible and by ensuring that any dead aquaculture organisms (or unused feed) are disposed of responsibly.

SECTION 4.2: BMP: THE INFRASTRUCTURE ENVIRONMENT

4.2.1 APPROACH TO THE RESPECTIVE CULTURE SYSTEMS

The aquaculture sector employs a range of production techniques in many different culture systems that range from tanks to ponds, cage culture systems and more. Tank culture can range from typical glass tanks to tanks of various sizes constructed of fibreglass, plastics, concrete or other materials. Pond culture typically refers to earthen ponds, but various plastic, concrete and other pond linings are common. Cage culture systems range from basic penned enclosures to floating cages and technologically advanced submerged cages. It is important that all aquaculture systems be managed with the interest of the production organisms and the surrounding environment in mind.

BMP Concepts and Approach

General Concepts

a) Production systems should be designed and constructed in a manner that allows for the safety of employees, the farmed organisms and the surrounding environment.
b) Aquaculture production systems should be structurally sound and not leak unnecessarily.
c) Aquaculture systems should be readily accessible for daily operations.
d) Aquaculture systems should be designed and constructed in a manner that prevents the escape of production organisms.
e) Where electricity is used, the electrical installations must be safe and regularly maintained.
f) In aquaculture, cover netting is used for keeping predatory animals such as birds and otters out and for providing shade. Such netting must be used and maintained in a manner that does not pose a threat to birds and other animals:
    - Shade cloth or bird netting (including submerged predator netting) must be of a mesh size, structure and rigidity so that entrapment or injury to birds and other animals is prevented.
    - Cover netting should be UV and weather resistant to prevent it from tearing and becoming tattered.
    - Netting must be firmly secured to prevent it from tearing in windy conditions or from trapping predatory birds or other animals.
    - Although the colour of cover netting should not be bright (to lessen the aesthetic impact), it should be clearly visible for approaching birds.

Specific Concepts

Pond Culture Systems

a) Aquaculture ponds and dams must be designed and constructed to allow for complete drainage.
b) Aquaculture ponds and dams should have adequate overflow capability and flood protection (e.g. by means of stabilized spillways), but should also allow for early detection of rising water levels that could cause flooding. This means that inflow and outflow control is of importance.

c) Where earthen ponds and dams are used, the inner walls must be of a suitable slope to prevent internal erosion and collapse. Furthermore, the effects of surface wind and wave erosion must be combated by means of vegetation establishment or stone packing.
d) If pond or dams sediments are removed, these must be disposed of responsibly or used as compost.
e) Trees and other large plants should not be allowed to grow on the retaining walls of earthen ponds and dams as their roots may weaken the structure.
f) Adequate control measures should be put into place to prevent moles and crabs from digging into the retaining walls of earthen ponds and dams as these may destabilize the structure.
g) Aeration apparatus (e.g. agitators, paddlewheels, etc.), pumps and water inlets should be placed and managed so as to prevent internal erosion of earthen ponds and dams.
h) Electrical installations associated with pond culture (e.g. for pumps, aerators and electric fences, etc.) should be safe and well maintained.

Tank Culture Systems

a) Aquaculture tanks must be designed and constructed to allow for complete drainage.
b) Aquaculture tanks should have adequate overflow capability and flood protection, but should also allow for early detection of rising water levels that could cause flooding. This means that inflow and outflow control is of importance.
c) Electrical installations associated with pond culture (e.g. for pumps and aerators, etc.) should be safe and well maintained.

Cage Culture Systems

a) Cage systems must be positioned to prevent the potential for obstruction of, or collision with, other water vessels. Furthermore, cage systems must be clearly marked and offshore systems must be fitted with the necessary beacon lighting.
b) Cages and cage anchor lines must be designed to withstand severe weather conditions and general wear and tear. Furthermore, cages and cage anchor lines must be inspected regularly to ensure integrity of structure and anchorage at all times.
c) Cage platforms must be kept in good order (clean, free of unnecessary equipment, etc.) and must provide a safe working environment. The necessary safety equipment (e.g. life rings) must be kept on the platform in an accessible position.
d) Service barges and boats must be designed and maintained to withstand local weather conditions and must be fitted with the necessary safety equipment to provide a safe working environment.
e) Cage netting must be kept clean, free of algal growth and free of any damage that could lead to the escape of fish or the penetration of predators.
f) No chemicals may be used for the cleaning of cage nets, unless approval is obtained from the relevant authorities (DWAF in the case of inland operations and MCM: DEAT in the case of offshore operations). It is recommended that high-pressure water hoses and drying or sunning be used to clean cage nets of algae and debris.
g) Where applicable, the floatation of cage systems must be checked regularly for leaks and repaired or replaced where necessary.
h) Where possible, cage units may be moved from time to time to lessen the localised build-up of organic sediments. If this is done, care must be taken to prevent the tearing of nets and new anchor lines must be firmly secured.
i) Where possible, cage floor funneling and airlifting can be used to extract dead fish and solid organic material from the floors of cage units.

Shellfish Rafts and Drags

a) Shellfish rafts, drags and lines must be positioned to prevent the potential for obstruction of, or collision with, other water vessels. Where applicable, these rafts, drags and lines must be clearly marked and fitted with the necessary beacon lighting.
b) Rafts, drags and lines must be inspected regularly to ensure integrity of structure and anchorage at all times.
c) Raft platforms must be kept in good order (clean, free of unnecessary equipment, etc.) and must provide a safe working environment. The necessary safety equipment (e.g. life rings) must be kept on the raft in an accessible position.

4.2.2 MANAGING ROADS, ACCESS AND SECURITY

Access to aquaculture facilities should be controlled for security reasons and to prevent the uncontrolled movement of individuals and vehicles that may cause environmental degradation. Roads into and around aquaculture facilities must be stable, safe and free of erosion.

BMP Concepts and Approach

a) Where possible, access routes to aquaculture facilities should be fitted with a gate or other form of access control. Prohibition of entry for unauthorised persons should be displayed and enforced.
b) Where applicable, perimeter fences and boundaries should prevent access to unauthorised persons.
c) Facilities and stores should be kept locked after hours and when a site is not occupied.
d) Roads must be maintained in a stable condition by compaction, watering, grading and asphalt coverage where necessary. A stable, erosion free driving surface must be created. The creation of multiple tracks and the incremental increase of road width, through not keeping to and maintaining the existing roads, should not be allowed.
e) Dust on roads must be minimised by watering or by other forms of surface stabilisation.

4.2.3 MANAGING ELECTRICITY SUPPLIES AND COMMUNICATIONS

Communication networks and electrical installations must be managed and maintained in a condition that is safe to the environment and the people working in and around any aquaculture facilities.

BMP Concepts and Approach

a) In many cases, bulk electricity suppliers and communication service providers are responsible for the provision of these respective services. The operators of aquaculture facilities must ensure that these service providers are aware of best practices and that they act accordingly to prevent impacts to the environmental.
b) Installations of and modifications to internal electricity networks must be performed by qualified electricians, who must ensure the safety of such works and adherence to best practice concepts.
c) Infrastructure, operations and activities (including high trees) on aquaculture sites may not interfere with overhead or any other electrical and communication networks. Special care should be taken in this regard when infrastructure is modified.

4.2.4 MANAGING NON-PRODUCTION WATER SUPPLIES

This section deals with the water resources which are not directly related to the production of aquaculture organisms. This includes water supplies for sewerage systems, landscaping, general washing, drinking, etc. Water quality and quantity around these uses must be managed responsibly.

BMP Concepts and Approach

a) Where water is not provided by a service provider, care must be taken that supplies are adequate (in volume and quality) and that the extraction thereof is legally compliant.
b) Water for landscaping should be used sparingly and, where possible, be sourced from aquaculture discharges or from grey water generated by washing and other non-sewerage activities.
c) Care must be taken to ensure that water sources are safe for drinking by employees. If this is not the case, a secondary supply of drinking water must be provided.
d) Water must be used wisely. Taps must be closed when not in use, while taps and pipes must be maintained to prevent leakage.
e) Non-hazardous wash water must be led into the sewerage system (where appropriate and legal to do so) or responsibly disposed of in areas of open lawn or in similar areas where there is no potential for environmental risk.
f) If water has been contaminated with hazardous chemicals, it may not be released into the environment. This water must be kept in conservancy tanks for disposal at suitable hazardous chemical disposal sites.

4.2.5 REFUSE AND WASTE MANAGEMENT

Aquaculture produces various waste streams, which can be categorised as follows:

a) General waste (fish feed bags, paper, plastic, glass, etc.).
b) General organic waste from landscape maintenance (refer also to section 4.1.1).
c) Production related organic waste (e.g. old feed, dead aquaculture organisms and material removed from filtration units)(refer also to sections 4.3.4 and 4.3.6).
d) Sewerage and non-production related waste water (refer to sections 4.2.4 and 4.2.6).
e) Production related waste water (refer to section 4.3.2).
f) Post production and processing waste (refer also to section 4.3.9).
g) Hazardous waste materials and chemicals (refer also to section 4.3.7).

Waste management must be formalised to ensure that it does not cause pollution and potential environmental degradation.

BMP Concepts and Approach

a) General waste must be collected into suitable water, wind and animal proof waste containers so that it can be removed to a disposal site on a regular basis. If this is not done by a service provider or directly to a recognised disposal site, the area used for disposal must be legally compliant.
b) Where possible, general waste should be separated into glass, paper and plastics so that these can be recycled.
c) Emptying out of waste containers should be regular to prevent overfilling.

d) Waste should not be allowed to litter aquaculture facilities or the surrounding areas (especially applicable to wind blown litter).
e) A culture of waste reduction, collection and disposal must be instilled with all employees by means of guidance and edification.
f) Vegetation matter from landscaping activities must be removed to a suitable disposal site or composted for later use.
g) The following approach applies to production related organic waste:
    - Old feed should be disposed of via composting (for small volumes) or via a formalised waste disposal system (for large volumes).
    - The approach to dead aquaculture organisms is explained in section 4.3.6.
    - Filter waste should preferably be composted and not disposed of via postproduction water resources.
h) Where postproduction and processing waste (e.g. intestines, gills, heads, shells, etc.) is generated, it should be dealt with in one or more of the following manners:
    - For small volumes (i.e. less than 50 kg. per week), a system of liming and burying or incineration may be employed, provided that this does not cause groundwater pollution or other impacts of significance (e.g. health risks, odours, etc).
    - For large volumes (i.e. more than 50 kg. per week), it is recommended that a silage system be employed, which can liquefy and stabilise waste material by grinding and lowering the pH. This silage can then be incorporated into animal feeds as a high protein supplement.
    - A suitable bulk service provider may be contracted to remove processing waste.
    - Waste may be removed to a recognised disposal site equipped to deal with the waste type.
    - Waste may be incinerated, provided that it is formalised and legally compliant.
    - Shellfish waste should be responsibly recycled back into the environment.
i) Hazardous waste (e.g. expired chemicals) must be disposed of via an approved hazardous waste disposal site.

4.2.6 MANAGING SEWERAGE AND ABLUTION FACILITIES

Ablution facilities and sewerage management is important in preventing pollution and in providing a safe and sanitary environment for farming and for employees. All employees must be provided with guidance around the correct use of ablution facilities, as this is important in maintaining a hygienic environment and in curbing the spread of disease.

BMP Concepts and Approach

a) Provision must be made for the responsible management and treatment of sewerage. The first choice would be for linkage into a formal sewerage system, failing which the use of sewerage conservancy or bio-remedial systems of adequate capacity and functionality may be considered. In rural areas, French or soak-away systems may be used if this is done responsibly and without contamination to groundwater sources.
b) Conservancy, bio-remedial, French or soak-away systems should not be located in water rich areas. Generally, these systems should be at least 25 meters from any aquaculture production water and preferably downstream from production activities.
c) Sewerage infrastructure should be well planned, well maintained and the layout thereof mapped in as-built plans.
d) Sewerage pipes must be buried at an appropriate depth so that they do not interfere with the surface activities, while remaining practically accessible for maintenance and repair.
e) Conservancy tanks must be emptied regularly to prevent overfilling and spillage.

f) The use of recognised biological accelerators in conservancy tanks and soak-away systems is recommended.
g) Ablution facilities must be kept in a clean, neat and hygienic condition.
h) Hazardous chemicals, dead aquaculture organisms and other non-sewerage materials may not be dumped into sewerage systems.

4.2.7 CHEMICAL AND HYDROCARBON FUEL MANAGEMENT

Various chemicals and hydrocarbon fuels are used in the management and maintenance of aquaculture activities and facilities. Their use must be managed carefully as they can impact severely on the environment, can affect the aquaculture organisms and other species negatively and can cause chemical residues in the aquaculture products.

The use and storage of all chemicals and fuels must be done in a responsible manner to ensure environmental safety. The main groups of chemicals (excluding production related chemicals which are dealt with in section 4.3.7), are:

a) Herbicides and insecticides.
b) Pesticides used in vermin control.
c) Hydrocarbon fuels.
d) Other (detergents, solvents, etc.)

BMP Concepts and Approach

a) Care must be taken in the storage and handling of all chemicals and hydrocarbon fuels (petrol, diesel, oils, etc.) as these are potential environmental pollutants. In certain instances the methods of storage are prescribed by the South African National Standards (SANS) issued by the South African Bureau of Standards (SABS), or by other legislation such as the Occupational Health and Safety Act, 1993 (Act. No. 85 of 1993) and NEMA.
b) Only recognised and registered chemicals may be used as herbicides, insecticides, pesticides and for other purposes. The use of chemicals must be responsible and in accordance with the prescribed application methods. Material Safety Data Sheets (MSDS) must be readily available and referenced during use, storage and disposal.
c) Bait type pesticides should be used with care to prevent poisoning of non-target species.
d) Chemicals must be stored in a dry, well ventilated, secure and lockable area, which is in compliance with the Occupational Health and Safety Act, 1993 (Act. No. 85 of 1993) and other applicable legislation. Only authorised employees may have access to such stores.
e) Chemicals should be recorded in a chemical register, indicating the date of purchase, use and expiry. Expired products and empty chemical containers must be disposed of responsibly at a recognised disposal site for these materials and according to the directions provided in the MSDS.
f) It is recommended that chemicals and fuels not be used near water, or in water logged areas, as this poses a particular threat to aquatic ecosystems (this excludes chemicals that are specifically for use in water).
g) Fuels must be stored in suitable containers in a safe and lockable storage facility that allows for the containment of any spillage. Storage methods for small and bulk volume fuels are prescribed by the SANS issued by the SABS.
h) Mixing or handling areas for chemicals and filling areas for fuels must allow for the containment, treatment or removal of any spillage. Non-spill funnels should be used and these may not be cleaned in a manner that causes environmental contamination.
i) Absorbents and remedial (*mop up*) materials should be available and used on any spills.

j) Care must be taken to ensure that fuel devises do not leak. Any leaks must be repaired without delay and the necessary hydrocarbon absorbents used on contaminated areas.
k) Protective gear and clothing must be provided to employees that work with dangerous chemicals (as per the Occupational Health and Safety Act, 1993 (Act. No. 85 of 1993).
l) Working fire fighting equipment must be available in and around any chemical and hydrocarbon fuel stores.

4.2.8 MANAGING BUILDINGS AND STORAGE

The structural integrity of buildings and storage spaces is largely determined during design and initial construction. It is therefore essential that the design of such infrastructure be done carefully to accommodate potential environmental issues. Nevertheless, these structures must be maintained in a good order, kept clean, free of vermin and in a safe condition for employees. Additionally, storage areas should be well ventilated and dry.

BMP Concepts and Approach

a) Unauthorised access to buildings and stores should be controlled to prevent theft and vandalism. Access to vermin and animals such as rodents, monkeys and baboons must also be controlled.
b) Buildings should be regularly maintained so that they remain structurally safe and aesthetically acceptable.
c) Responsible rodent and vermin control programs must be employed in buildings and storage areas.
d) Sufficient ventilation must be provided in buildings and stores.
e) Buildings and stores must be equipped with the necessary fire fighting and first aid equipment and the applicable emergency contact numbers clearly displayed.

4.2.9 PLANNING FUTURE ACTIVITIES AND EXPANSION

The expansion of aquaculture activities must be planned to minimise potential environmental impacts. In addition to this, applicable statutory authorisations for upgrade and expansion activities must be obtained prior to commencement thereof.

BMP Concepts and Approach

a) Plans for expansion and upgrade must be checked for environmental compatibility.
b) Local and district authorities must be consulted to ascertain their statutory requirements.
c) Relevant provincial and national authorities must be consulted to determine any further legislative requirements (refer also to: "*Guideline to the Authorisation Requirements of Aquaculture Activities in the Western Cape*", which is associated with this BMP guideline).
d) Where construction activities take place, specific provision must be made for the control of erosion and stormwater, soil stabilisation, rehabilitation, dust prevention, employee safety, waste removal and for the other provisions that constitute best practices.

SECTION 4.3: BMP: THE PRODUCTION ACTIVITIES

4.3.1 MANAGING SUSTAINABLE PRODUCTION CAPACITIES

The capacity of the receiving environment for aquaculture is a measure of its ability to accommodate the activity in a sustainable manner. This is determined by the degree to which environmental resources and services (e.g. the service of assimilating nutrients from aquaculture) are used. To remain sustainable, the host environment must have an adequate capacity in terms of the required environmental resources and services.

Although production capacities are determined by many factors (e.g. markets, production space, feed, etc), it is often limited, from an environmental perspective, by the availability of oxygen and water. Where oxygen is the limiting factor, over utilisation of the environment can be ignored as oxygen depletion by aquaculture is relatively limited and re-oxygenation is usually rapid. Where water is the limiting factor, over utilisation of the environment is relevant as water pollution can cause environmental degradation. Water pollution can however also occur in instances where water is not the limiting factor to production and the potential environmental impacts of aquaculture are not limited to water pollution.

Whatever the limiting factor, it is important to operate within the sustainable production capacities to prevent environmental degradation.

BMP Concepts and Approach

General Concepts

a) To prevent environmental degradation through aquaculture generated water pollution, it is recommended that the sustainable production capacities of an operation be determined in relation to the available water resources. In this regard the quality objectives of the water resource (determined by DWAF) should be consulted.
b) Aquaculture proponents should keep detailed records which allow for forward-looking production estimates to ensure that sustainable production capacities are maintained.

Specific Concepts

Pond and Tank Culture Systems

a) The limiting production factor in pond culture is often oxygen, but this depends largely on the pond size to biomass ratio, the climate, the rate of water displacement and any oxygen addition through aerators or agitators.
b) Where water discharge takes place, care must be taken that the legal water quality criteria (attainable by consultation with DWAF) are met. Where applicable, some form of postproduction water treatment can also be used (e.g. sedimentation or filtration).

Cage Culture Systems

a) Oxygen can be a limiting factor in cage culture, but provided species specific stocking densities are maintained and cages are well positioned, this is of less environmental importance. The limiting factor can however be the assimilative capacity of the water

resources in which the operation is situated. These limits must be understood to prevent potential environmental degradation.

b) For freshwater inland cage culture, the nutrient based model by Phillips and Beveridge (1987) should be used to determine the sustainable production capacity of a water resource. The model calculates the production capacity by allowing for an increase in phosphorus, generated by the cage culture activities, to a predetermined level. In turn, this allows for the prevention of nutrient enrichment and eutrophication, which could result in algal blooms that are harmful to wild and farmed organisms and the ecology.
c) Due to currents, tidal actions and the vast water volumes associated with marine cage culture, the tracking of nutrients is difficult. Nevertheless, nutrient enrichment of the marine environment does take place and it may be particularly relevant in semi-enclosed coastal bays or areas with restricted water displacement. Various capacity models have been developed for marine cage culture, but these are significantly influenced by historic and local nutrient levels, currents, tides, climate, substrate and many other variables. These models determine (1) the applicable substances being added to the environment, (2) the environmental pathways that these substances follow and (3) the likely effects of the substances at a given target site or on a given organism or set of organisms. It is recommended that the addition of nutrients to a marine ecosystem by cage culture be scientifically investigated by specialists with adequate expertise.
d) The largest proportion of solid waste released by cage culture activities, predominantly organic carbon and nitrogen, settles on the sediments in the vicinity of the operation. Organic enrichment of the benthic ecosystem may result in increased biological oxygen demand and the formation of anoxic sediments, with, in extreme cases, out gassing of carbon dioxide, methane and hydrogen sulphide, enhanced re-mineralisation of organic nitrogen and a reduction in macro-fauna biomass, abundance and species composition.

In determining sustainable production capacities for aquaculture, it is important that a distinction be made between "contamination" and "pollution". Contamination is a trait of aquaculture, but this does not necessarily imply that aquaculture causes pollution. Environmental changes brought about through aquaculture may or may not cause negative environmental impacts. The boundary between these regimes is defined by the degree of environmental change that is acceptable.

Environmental capacity determination for aquaculture is not a once off exercise and requires continuous monitoring, decision-making and adaptive management.

4.3.2 WATER MONITORING AND MANAGEMENT

Aquaculture activities add nutrients, metabolites and other wastes to the water column, which creates the potential for water quality deterioration. These impacts could include the creation of eutrophic zones, fluctuations in dissolved oxygen, algal blooms, changes in species compositions and more. Water quality and quantity management is therefore of primary importance in aquaculture.

BMP Concepts and Approach

a) The use of water in aquaculture must be legally sanctioned. Such compliance is attained by adherence to the National Water Act, 1998 (Act No. 36 of 1998), administered by DWAF. In general, if the use of water is not defined in the Act as a *Schedule 1 Use*, an *Existing Lawful Use* or a *Generally Authorised* use, a *Water Use License* is required from

DWAF (refer also to: "*Guideline to the Authorisation Requirements of Aquaculture Activities in the Western Cape*", which is associated with this BMP guideline).

b) Water use for aquaculture, although often non-consumptive, must be limited to the quantities allowed for by DWAF or the controlling authority of the water resource (which, in the case of marine pump-ashore systems, is MCM: DEAT).
c) Ideally, the quality of water that enters an aquaculture facility should be comparable with the quality of water that exits the operation. Failing this, the discharge water must be within the quality standards stipulated by DWAF for the particular resource (this includes discharge of water into the sea).
d) In certain instances the treatment of discharge water may be required to achieve the stipulated discharge quality criteria. Such treatment may include sedimentation, decantation, biological oxidation, filtration (chemically, physically and biologically), water recycling, nitrification, foam fractionation, carbon absorption, ion exchange, algal systems, ozone and more. Materials removed by water treatment and filtration should be used for composting (where appropriate) or disposed of responsibly.
e) Where practical, nutrients or suspended solids can be removed by filter-feeding organisms (e.g. oysters and mussels) or aquatic plants. The use of discharge water for irrigation or in hydroponics can also be beneficial to the environment.
f) Where practical, the regular moving (site rotation) of cage culture systems may reduce the localised water quality impacts of such systems. Technologies such as submersible pumps, mixers and funnel-shaped waste catchment devices may also contribute to the collection and dispersal of nutrients.
g) Feeding must be strictly controlled through a specific feeding regime that maximises feed conversion efficiency, limits direct feed wastage and above normal faecal and metabolite releases from the production organisms. Furthermore, aquaculture feeds should be:
    - As low as possible in phosphorous, while the phosphorous present should be highly attainable through digestion and absorption.
    - As low as possible in inedible components such as fines (i.e. dust).
    - Water stable but highly digestible to the production species.
h) Samples of the inlet and outlet water of production facilities should be analysed at a laboratory that has been accredited by the South African National Accreditation System (SANAS) for the following constituents (this being the minimum set of constituents which may be supplemented by conditions set through authorisations and licences):
    - Ortho- and Total Phosphate as Phosphorous (mg/l).
    - Nitrate as Nitrogen (mg/l).
    - Nitrite as Nitrogen (mg/l).
    - Ammonia as Nitrogen (mg/l).
    - Chemical Oxygen Demand (mg/l).
    - Electrical Conductivity (mS/m).
    - Suspended Solids (mg/l).
i) For inland cage culture the inlet water, the water in which the production takes place and the downstream water should be sampled and analysed for the abovementioned constituents. For marine cage culture, or inland cage culture on large water bodies, samples should be taken at strategic points that represent scenarios for the baseline (i.e. uncontaminated) conditions and the post-impact conditions. This may consist of multiple sampling points.
j) Water quality analyses should be conducted at least once in six months (or as prescribed by the applicable approvals, authorisations or licences), the results of which should be copied to the relevant authorities which have authorised the aquaculture activity.

k) Where significant water quality impacts are detected, this can be addressed by lowering the stocking densities, correcting the feeding rates, feed types and feed management, by increasing the water displacement or by the moving of cage culture operations.
l) Where practically possible (i.e. where aquaculture is located on a freshwater stream or river) a South African Scoring System (SASS) assessment should be conducted upstream and downstream of the facilities at least twice a year. Likewise, water related impacts in marine aquaculture can be detected by monitoring species densities and composition in the surrounding environment.

4.3.3 MANAGING SPECIES AND SPECIES ESCAPE

The introduction of alien aquaculture species (including translimital species), potential diseases and foreign genetic traits into an area can pose a significant environmental risk. The global redistribution of aquaculture species is not well controlled and has caused irreparable environmental damage in certain areas. This, coupled with the unseen and unpredictable ability of some species in escaping from production facilities, makes the choice and management of aquaculture species important.

BMP Concepts and Approach

a) Prior to the commencement of any aquaculture activities, use of the target species must be authorised in terms of the applicable legislation, administered by DEA&DP (for all species) and MCM: DEAT (for marine species only). The primary legislative frameworks in the regard are provided by NEMA, the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) and the National Marine Living Resources Act, 1998 (Act No. 18 of 1998)(refer also to: "*Guideline to the Authorisation Requirements of Aquaculture Activities in the Western Cape*", which is associated with this BMP guideline).
b) Unless authorised, only locally indigenous species may be used. Care must also be taken that secondary species are not accidentally introduced with the target species.
c) No live organisms, marine or freshwater, may be transported to or from aquaculture facilities without a transport permit from CapeNature. In addition to this, permits are required from MCM: DEAT for the transport of any marine species.
d) Aquaculture species that are able to hybridise should not be farmed together, while species that are able to hybridise with indigenous species in the surrounding environment should not be used as production candidates.
e) Whenever possible, the genetic make-up of an aquaculture population should be compared with the genetic make-up of the same species, if it occurs in the surrounding environment. The potential genetic impact should be established and if found to be significant, such species should be avoided.
f) Prior to the purchase and stocking of any organisms, the disease and parasitic status and risk of the species must be investigated in context to the area from which it originates, the area to which it will be taken and the degree to which any potential disease may pose a threat to the surrounding environment. In certain instances the introduction of aquaculture organisms may require specific veterinary assessments, treatments and quarantine measures. Assistance in this regard can be obtained from the Department of Agriculture (Veterinary Services).
g) Aquaculture operators must make specimens of the production organisms available to authorities that need to determine the species, disease status or genetic characteristics.
h) Adequate steps must be taken to prevent the escape of production organisms, especially from the hatchery environment where individual organisms may be very small. In this

regard, regular inspection of production infrastructure and escape barriers is important. Escape barriers may include netting, grids, sand and other filters, predator ponds, chemical treatment areas, soak away systems, etc. Barriers should be adequate to prevent escape during flooding, overflows and during other unforeseen circumstances.

i) In cage culture the integrity of the nets should be inspected regularly and safety nets used to prevent the escape of fish during stocking, harvesting, sampling and grading.
j) Generally, aquaculture species are propagated from a tailored gene pool and thus not suitable for restocking or supplementation of natural stocks.

4.3.4 FEED MANAGEMENT

Feed and feed management is a primary cause of direct and indirect pollution of water resources used for aquaculture. The management and responsible use of feed is not only an important environmental consideration; it is also a key factor in determining the financial viability of most aquaculture ventures.

In recent times, aquaculture feeds in South Africa have been significantly improved to reduce their environmental impact. Unattainable dietary phosphates, other non-digestible components and dust levels have been reduced, while water stability, palatability and digestibility have been enhanced.

BMP Concepts and Approach

a) Only registered aquaculture feeds should be purchased from recognised feed companies that produce high quality feeds. Aquaculture operators should be familiar with the nutrient make-up, the primary ingredients and production techniques for the feeds used.
b) Feed producers should provide the date of manufacture, information pertaining to the ideal storage conditions and estimated shelf life.
c) Feed stores should be lockable to prevent theft.
d) Feed should be stored and used on a "*first-in-first-out*" basis to prevent unnecessary aging and deterioration in quality.
e) Feed storage areas should be well ventilated, dry and free of vermin that can damage, contaminate and consume feeds. Dampness and heat can also damage feeds.
f) It is good practice to store feeds on individually stacked pallets that can allow for full ventilation of bags that would otherwise be in direct contact with floor and wall surfaces.
g) Feed types and feeding strategies are specific to each species, to the culture conditions, climate and growth stage. In this regard, feed types and feeding rates should be recorded daily so that feed conversion efficiency can be calculated and monitored.
a) Water quality monitoring should be correlated and checked against feeding rates and production biomass so that adjustments can be made to the feeding program.
b) Palatable feeds of the correct pellet or grain size should be used to ensure low levels of feed loss. Other factors such as feed position (e.g. floating or sinking) and feeding time of day must also be considered to minimise feed wastage.
c) Feeding tempo and methods should be suited to the specific species, while feed distribution in a production unit must be even to ensure that all individuals are fed.
d) Uneaten feed is a sign of over-feeding and this should be corrected on the feed program.
e) Employees that are responsible for feeding should be well trained in feed application so that they can detect subtle changes in feeding behaviour. If feeding is not active it may be necessary to suspend, delay or modify the feeding program.

f) Water current speed, flow rate, turbidity, barometric pressure, oxygen levels, wind, territorial behaviour and other factors may influence feeding and thus the feeding strategy should be flexible and adaptive to ensure optimal intake and minimal wastage.
g) Where automated or demand feeding devices are used, care must be taken to prevent over feeding and the feed application monitored in relation to production performance.
h) Empty feed bags should be disposed of through an organised system for general waste.
i) Small quantities of old or spoilt feed can be composted, but larger quantities should be disposed of responsibly through an organised waste removal system.
j) The harvesting of kelp for the feeding of abalone must be legally sanctioned and done in a manner that prevents localised stripping of the resource. Likewise, other natural feed resources must be used sustainably.
k) Where unprocessed feeds are used (e.g. trash fish or vegetable matter), special care must be taken to prevent over feeding and the maintenance of water quality.
l) Where fertilization is used to enhance algal and plankton blooms on which aquaculture organisms may feed, this must be done within the capacity of the water resource and in a manner that prevents the release of enriched water to the surrounding environment.

4.3.5 DISEASE MONITORING, CONTROL AND TREATMENT

Aquaculture disease is an threat, not only because of its potential impact on production, but also due to the potential of infecting downstream populations and the environment in general. Aquaculture operators must be aware of the impacts that disease could have and should manage towards prevention and preparedness for any outbreaks that may occur.

South Africa subscribes to the Aquatic Animal Health Code, issued by the Office International des Epizooties (OIE) and therefore this international disease code applies. None of the identified diseases in this code are permitted and are notifiable by law.

BMP Concepts and Approach

a) No aquaculture organisms should be introduced from an unrecognised source.
b) No live organisms, marine or freshwater, may be transported to or from aquaculture facilities without a transport permit from CapeNature. In addition to this, permits are required from MCM: DEAT for the transport of any marine species.
c) Prior to the purchase and stocking of any organisms, the disease and parasitic status and risk of the species must be investigated in context to the area from which it originates, the area to which it will be taken and the degree to which any potential disease may pose a threat to the surrounding environment. In certain instances the introduction of aquaculture organisms may require specific veterinary assessments, treatments and quarantine measures. Assistance in this regard can be obtained from the Department of Agriculture (Veterinary Services).
d) When juveniles or brood stock are caught wild, it is advisable that these be quarantined to diagnose, investigate, monitor and treat potential diseases and parasites.
e) Aquaculture operators should monitor the health status of aquaculture organisms as part of the daily operational activities. This includes behavioural monitoring, sampling, diagnostic dissection, microscopic investigation and more.
f) It is advisable that a health assessment be conducted on aquaculture facilities by an aquaculture pathologist, at least twice a year. The assessment should be diagnostic, with recommendations of treatments or management of any diseases or parasites.

g) If an identified disease on the OIE Aquatic Animal Health Code is detected, the nearest State Veterinarian must be informed immediately, where after quarantine, culling and stock disposal measures may be implemented.
h) Treatment of aquaculture diseases must be done by recognised methods and under the guidance of a qualified aquaculture pathologist. All treatments must be recorded in detail to reflect the date, treatment methods, substances, dosages, etc.
i) The storage and use of aquaculture chemicals and medications must be done in a safe and responsible manner as per their respective MSDS.
j) If a disease breakout occurs, production systems should be isolated from each other and the surrounding environment. A qualified aquaculture pathologist should be consulted to assist with further management inputs and treatments.
k) The following practices can be implemented to reduce the risk of aquaculture disease:
    - Screening or quarantine of brood stock for known pathogens and parasites.
    - Appropriate treatment of brood stock prior to entering the hatchery environment.
    - Isolation of production sectors with independent water supplies and equipment.
    - Installation and use of foot baths and hand washing facilities for employees.
    - Regular disinfection of equipment and working areas.
    - Restrictions on access to foreign vehicles and people.
    - Management of bird and predator populations that could be disease carries.
    - Minimising the potential for disease vector hosts to enter the aquaculture system.

As it is not possible to eliminate all bacteria and parasites from an aquaculture facility, disease management requires a holistic approach, which includes the management of water quality, hygiene, feed, stocking densities, stress, predators, husbandry techniques and more.

4.3.6 MANAGING MORTALITIES

It is a normal occurrence for some aquaculture organisms to die from natural or production induced causes. The rate of such mortalities must be monitored to ensure that the numbers remain within acceptable limits. Furthermore, the disposal of dead organisms must be done in an environmentally responsible manner.

BMP Concepts and Approach

a) As a general norm, no more than 1% of the total number of individuals in a single production unit should die in a 24-hour period.
b) If mortalities are detected the behaviour of the remaining stock must be monitored carefully. If large numbers die, the first step is to check the physical and chemical characteristics of the water (e.g. temperature, pH, oxygen content, etc.) and implement the necessary corrective measures. Failing the detection of any adverse water conditions, a recognised aquaculture pathologist should be consulted.
c) Orderly notes must be kept of the numbers of dead organisms and the behavioural patterns of the population as a whole.
d) Dead organisms must be removed from the production systems as soon as they are detected. If samples are required for diagnostic purposes, these must be taken and appropriately stored for this purpose.
e) Small numbers of dead organisms can be disposed via a subterranean pit, dug out in an area that is poor in groundwater. Each disposal must be followed by copious amounts of lime and one pit should not receive more than 30 kg of biomass per month.
f) If large numbers die, the cause of death must be determined before disposal. In this case the dead organisms can be disposed of by incineration if done responsibly, safely and

with prior notification to local and district authorities and surrounding landowners. Certain local and district authorities also have facilities for the disposal of such organic matter.

4.3.7 MANAGING AQUACULTURE CHEMICALS

Although noxious chemicals are not common in aquaculture, no recognised list of acceptable chemicals exists for South Africa. Chemicals are mainly used for the treatment of diseases and parasites, while some hormonal preparations, anaesthetics, disinfectants and water treatments are also found. Some concerns around the use of chemicals include the potential longevity of bioactive compounds in animal tissues, the fate and effect of these compounds or their residues in the aquatic environment (i.e. toxicity to non-target organisms) and the creation of antibiotic resistance. The use of chemicals must be done in a responsible manner and operators must ensure the safety of the surrounding environment. The use of aquaculture chemicals is also a significant factor which influences safety, consumer acceptance and marketability of products.

BMP Concepts and Approach

a) Aquaculture operators should be encouraged to reduce their reliance on chemicals through the use of sound husbandry practices aimed at disease and stress prevention. More emphasis should be placed on preventive measures where the use of chemicals is a last resort when other measures have proved to be inadequate.
b) Responsible use of chemicals and treatments in aquaculture is characterised by:
    - Chemical application based on an accurate diagnosis.
    - The use of an appropriate compound and application method.
    - Chemical dosage for the minimum effective time.
    - The keeping of records and evaluation of treatments.
    - An awareness of potential chemical residues.
c) Chemicals should be used for specific and not general purposes and this should be done according to the recommendations of an aquaculture pathologist or according to the prescribed application methods. Dosages, application methods and the resultant outcome should be known and recorded in a treatment register.
d) The use of chemical cocktails should not be permitted.
e) In the use of chemicals, consideration must be given to the potential for residues and the need for withdrawal periods before consumption of the aquaculture products.
f) Chemicals must be stored in a dry, well-ventilated and lockable store. Chemicals must be clearly labelled and the purchase date, use and expiry date must be recorded. Expired chemicals must be disposed of at a suitable hazardous waste disposal site.
g) The advice of a recognised aquaculture pathologists or expert must be sought where the application methods for chemicals is uncertain.
h) Employees should be trained in the handling and use of chemicals and they should be provided with the necessary protective gear.
i) To prevent the development of disease resistance, the prophylactic use of antibiotics should be avoided. Furthermore, it may be necessary to limit exposure to certain drugs, practice rotational use of different antibiotics and alter the application methods.
j) The use of anti-fouling agents to keep cage culture nets clean is a common practice. Only recognised, environmentally safe and copper free anti-fouling agents are allowed.
k) Malachite Green is a common bactericide and fungicide in aquaculture, but this substance should be discouraged at all costs due to its carcinogenic properties.

The next page contains a table of some chemicals used in aquaculture. This is not an authoritive or comprehensive list and has been adopted from: "*NCC, 1989. Fish farming and the safeguard of the natural marine environment of Scotland. The Nature Conservancy Council. Based on a report by the Institute of Aquaculture, University of Stirling".*

Chemical	Use	FW/SW	Method	Remarks
Therapeutants				
Acetic acid	Ecto-parasites	FW	D	Use with $CuSO_4$ in hard water
Formalin	Ecto-parasites	FW/SW	D A	165-250 ppm up to 1 hour, 20 ppm 4 hours use in sea cages as bath
Methylene Blue	Ecto-parasites, fungus	FW/SW	D F S B	Eggs and fish, occasional use in cages as a dye marker
Acriflavin (or Proflavine hemisulphate)	Ecto-parasites, fungus, bacteria	FW	D	Mostly for surface bacteria, fish and eggs occasional use only
Nuvan (dichlorvos)	Fish lice	SW	B	1ppm for 1 hour, canvas round sea cage
Salt	Ecto-parasites	FW	DB	Occasional alternative to formalin
Buffered Iodine	Bactericide	FW	B	Disinfect eggs 10 minutes 1000 ppm
Oxytetracycline	Bactericide	FW/SW	T	Antibiotic for systemic disease
Oxolinic acid	Bactericide	FW/SW	T	Antibiotic for systemic disease
Romet 30 (Sulfadimethoxine and orthomeprim)	Bactericide	FW/SW	T	Antibiotic for systemic disease
Tribrissen (Trimethoprim/sulphadiazine)	Bactericide	FW/SW	T	Antibiotic
Hayamine 3500	Surfactant, bactericide	FW	A	Quaternary ammonium compound used for treating bacterial gill diseases
Benzalkonium Chloride	Bactericide	FW	A	Surface antibacterial; 'Roccel' (similar to above)
Chloramine T	Bactericide	FW	A	As above and for some protozoa
Vaccines				
Vibrio Anguillarum		SW	B	Not widely used
Enteric Redmouth		FW	B S I	Widely used in trout culture
Aeromonas Salmonicida Vibro		SW	I	Not widely used
Anguillarum				
Anaesthetics				
MS222 (tricaine methane-sulfonate)		FW/SW	B	Widely used approx 1:10,000 dilution
Benzocane		FW/SW	B	Requires acetone to dissolve
Carbon dioxide		FW/SW	B	Sometimes used at harvest
Disinfectants				
Calcium hypochlorite		FW/SW	S	General disinfectant for tanks, etc.
Liquid Iodophore e.g. FAM30		FW/SW	S	For equipment and footbaths
Sodium hydroxide		FW	S	Most commonly used for earth ponds
Water Treatments				
Lime		FW	A	Used in earth ponds
Potassium permanganate		FW/SW	BA	Oxidizer and detoxifier
Copper sulphate		FW/SW	A	Algaecide and herbicide

FW - Fresh Water, SW - Salt Water, B - Bath, A - Addition to Water, F - Flush System, D - Dip, I - Injection, S - Spray, T - Treatment of Feed

4.3.8 GRADING, MOVING AND HARVESTING

Aquaculture organisms are regularly graded for uniformity in size, growth monitoring and the prevention of cannibalism. As with stocking and harvesting, this requires a degree of handling, which must be done in a manner that causes the least possible stress or injury and which eliminates the potential of escape.

BMP Concepts and Approach

a) No live organisms, marine or freshwater, may be transported to or from aquaculture facilities without a transport permit from CapeNature. In addition to this, permits are required from MCM: DEAT for the transport of any marine species.
b) Aquaculture organisms should not be graded and moved unnecessarily.
c) Grading and moving should be preceded by a period of starving so that the metabolism of the organisms does not impede their stress tolerance. Metabolites and faecal matter also have the potential of fouling the water in which organisms are moved.
d) Where possible, grading and moving should be done at lower temperatures to reduce metabolic rates and stress.
e) Grading, moving and harvesting equipment and techniques should not cause unnecessary injury and stress and should be adequate to prevent escape.
f) Harvesting and killing must be done by the most humane method possible.
g) When fish are graded and moved on a cage culture system, netting should be placed between the working surface and the cage net to prevent the escape of any fish that are accidentally dropped during handling.

4.3.9 MANAGING POSTPRODUCTION AND PROCESSING ACTIVITIES

Postproduction handling and harvesting is an independent field of study and specialisation. In terms of best practices, much of the handling and processing of aquaculture organisms is guided by national and international codes of practice, laws, health standards and quality control procedures such as Hazard Analysis and Critical Control Point (HACCP). The applicability of these is determined by the type or level of processing, the product, the target market and the ability (financially and technically) of the aquaculture operators. Nevertheless, the handling and harvesting procedures are often closely linked to the production activities and some basic best practices are required to ensure a responsible approach.

BMP Concepts and Approach

a) Harvesting equipment and techniques should not cause unnecessary injury and stress and should be adequate to prevent escape.
b) Harvesting and killing must be done by the most humane method possible.
c) Where applicable, depuration or purging could be used to remove pathogens, chemical or treatment residues and taints from harvested organisms.
d) Post harvest products should be chilled and handled with care to prevent deterioration of the quality. Phytosanitary responsibility must be maintained throughout the harvest chain and potential contact with microbiological contaminants should be eliminated.
e) The harvest cycle and processing chain should be kept as short as possible and end products should be chilled or frozen as soon after processing as possible.
f) Processing should be done a chilled environment and under roof.
g) Employees involved in processing should be trained for the task and be fully briefed on the phytosanitary risks associated with personal hygiene.

h) A high degree of phytosanitary and hygienic cleanliness should be maintained in any processing area or plant.
i) Wastewater from processing activities should be strained, filtered and disposed of via a capable sewerage system or another legally sanctioned route of discharge.
j) Where practically possible, all processing waste should be ensiled by grinding and lowering the pH so that a stable liquid is formed which can be incorporated into animal feeds as a high protein supplement. Where this is not possible, the burying or incineration of waste material may be employed, provided that these actions are legally sanctioned and not detrimental to the environment.

The two most common concepts in the maintenance of best practices in postproduction processing of aquaculture products in South Africa are the *SANS* of the *SABS* and *HACCP*. In many cases neither of these apply, while in other cases the quality of aquaculture products are rigidly managed by control systems based on these concepts.

Notes on SABS

The SABS's Food and Health Division provides phytosanitary and hazard certification and testing services to the food industry. This includes:

a) Chemical testing of foods for: nutrients, proximates, glycemic carbohydrates, fatty acid profiles, minerals, trace metals, vitamins, mycotoxins, oils, pesticide residues, agro-chemical and veterinary remedy residues.
b) Microbiological testing of foods, food products and swabs for microbial contamination and for the presence of pathogens, antimicrobial efficacy testing of disinfectant agents and environmental monitoring of facilities for microbial contamination.
c) Agricultural trials for the verification of pesticide efficiency and for the determination of maximum residual levels (MRL) of pesticides.

For aquaculture, these certification and testing services are mainly aimed at:

a) Canned fish, marine molluscs and crustaceans.
b) Frozen fish and marine molluscs.
c) Frozen rock lobster.
d) Frozen shrimps, langoustines and crabs
e) Smoked fish.

The use of these services is dictated by the required level of phytosanitary and quality management and by the requirements of certain target markets, especially export markets.

In addition to product certification services, the SABS also provides certification of compliance to other phytosanitary, quality and hazard control systems. These include:

a) EurepGAP: A food safety system developed specifically by European retailers, which includes integrated aquaculture assurance.
b) British Retail Consortium (BRC) Global Standards, which cover the requirements for certification of food, consumer products, packaging and non-GM foods.
c) HACCP certification of food processors, manufacturers, distributors, handlers and retailers. This includes the International Organisation of Standardization (ISO) code 22000:2005, which is a system-based management approach aligned to ISO code 9000 and includes the HACCP requirements that cover the whole food safety value chain.

Notes on HACCP

HACCP is a systematic preventative approach to food safety that addresses physical, chemical and biological hazards through continuous prevention rather than through finished product inspection. HACCP is used in the food industry to identify potential food safety hazards, so that key actions, known as Critical Control Points (CCP's), can be taken to reduce or eliminate the risk. This method, which in effect seeks to plan out unsafe practices, differs from traditional "*produce and test*" quality assurance methods, which are less successful and inappropriate for highly perishable foods.

HACCP is based on seven established principle steps:

a) **Principle 1: Conduct a hazard analysis.** This determines the food safety hazards and identifies the preventive measures that can be taken to control these hazards.
b) **Principle 2: Identify critical control points.** A CCP is a point, step, or procedure in a food process at which control can be applied and, as a result, a food safety hazard can be prevented, eliminated, or reduced to an acceptable level. A food safety hazard is any biological, chemical, or physical property that may cause food to be unsafe for human consumption.
c) **Principle 3: Establish critical limits for each critical control point.** A critical limit is the maximum or minimum value to which a physical, biological, or chemical hazard must be controlled at a CCP to prevent, eliminate, or reduce the risk to an acceptable level.
d) **Principle 4: Establish critical control point monitoring requirements.** Monitoring activities are necessary to ensure that the process is under control at each CCP. It is good practice to list each monitoring procedure and its frequency in the HACCP plan.
e) **Principle 5: Establish corrective actions.** These are actions to be taken when monitoring indicates a deviation from an established critical limit and these must be recorded in the HACCP plan. These corrective actions will ensure that no product injurious to health or otherwise adulterated, enters the market.
f) **Principle 6: Establish record keeping procedures.** The HACCP regulation requires that all processing plants maintain certain documents, including a written HACCP plan, hazard analyses, records of CCP monitoring, critical limits, verification activities and the handling procedures for hazard deviations.
g) **Principle 7: Establish procedures for verifying that the HACCP system is working as intended.** Validation ensures that the HACCP plans are adequate and succeed in their function, that is, they are successful in ensuring the production of safe products. Verification procedures may include such activities as review of HACCP plans and microbial sampling and analysis.

4.3.10 MANAGING AND CONTROLLING PREDATION

Predatory animals are attracted to aquaculture facilities as the high concentrations of prey items lessen the effort of obtaining a meal. The intention is to prevent predator access while not injuring, trapping, harming or killing these animals in the process.

BMP Concepts and Approach

a) Netting is commonly used to keep birds from entering into aquaculture facilities. The netting should be clearly visible and prevent entanglement, injury or death.
b) Where practically possible and environmentally acceptable, the elimination of perches for birds around aquaculture facilities can reduce the occurrence of bird predators.

c) Electrified fences around aquaculture facilities should discourage access rather than injure any animals.
d) Traps may not be used to injure any predators of aquaculture organisms. Traps may only be set if the animals can be caught live and without injury, for translocation to alternative areas. This must be done in consultation with CapeNature.
e) No poisons may be left out for aquaculture predators and no animals may be shot.
f) The main aquaculture predators and their respective control measures can be summarised as follows:
    - Birds (e.g. Cormorants, Kingfishers, Gulls, Fish Eagles, Pelicans, Herons and others) should be discouraged by cover netting. Dogs can also be used effectively in discouragement of birds while other scare tactics (e.g. gas guns and scarecrows) are less effective.
    - Otters should be discouraged by adequate fencing, submerged predator netting around cage culture facilities and by live trapping for translocation (if authorised by CapeNature). The scent of dogs will assist with keeping otters away.
    - Frogs and crabs may be kept out of an aquaculture facility by curtain fencing and the screening of water inlets and outlets.
    - Seals and sharks around marine cages should be discouraged by predator netting around the cage culture facilities.

4.3.11 PRODUCTION RECORDS

Comprehensive records are a cornerstone to the viability of any operation and it is an important component of best practices. Such records will ensure that matters are dealt with in an orderly and logical fashion, which could prevent unnecessary environmental impacts.

BMP Concepts and Approach

a) Farm records should be written or electronically logged in a logical and tidy manner. Record should be safely kept and accessible for daily management and reference.
b) Where possible, farm record should be supported by photographs, water quality analysis reports, incident reports, MSDS's and other information that may be of assistance.
c) As a guideline, farm records should include the following:
    - Dates of all entries.
    - Identification of the person who made the entries.
    - Climatic and water quality data. This would usually involve parameters such as air temperature, rainfall, water temperature, dissolved oxygen levels, etc.
    - Water quality analysis records.
    - Copies of all applicable permits and authorisations for the aquaculture activities.
    - A copy of the BMP guideline and other appropriate management plans.
    - A detailed and up to date stock register of the farm.
    - Production sampling records.
    - A detailed feed program for the farm together with records of the feed stocks.
    - A mortality record.
    - Health records.
    - Chemical and treatment application records.
    - Chemical registers indicating stocks, MSDS's, purchase and expiry dates.
    - A complaints register.
    - A daily diary of significant events, incident reports, feed response, etc.

SECTION 4.4: BMP: THE SURROUNDING SOCIAL ENVIRONMENT

4.4.1 MANAGING EMPLOYEE FACILITIES AND EMPLOYMENT CONDITIONS

The conditions under which employees work, as well as the influence of aquaculture activities on surrounding communities, is part of the environmental footprint of any aquaculture activity. In this regard, aquaculture operators must ensure favourable, safe and legally compliant employment conditions, the preservation of basic human rights and the provision of adequate employee facilities such as ablutions, etc.

BMP Concepts and Approach

a) Provision must be made for clean and accessible ablution facilities for men and women on any aquaculture facility.
b) Provision must be made for clean drinking water for all employees.
c) An area should be provided where employees may store personal goods and belongings. This area must be safe, dry and provide adequate privacy and protection from inclement weather for people and their belongings.
d) Protective gear (especially waterproof overalls) must be provided for certain tasks and for the handling of chemicals.
e) Aquaculture facilities should carry first aid equipment and at least one employee should be trained in first aid provision. Relevant emergency service contact numbers should be clearly displayed on all facilities.
f) Basic legal employment conditions (i.e. for working hours, minimum wages, etc.) must be followed to ensure the maintenance of employment rights.

4.4.2 MANAGING EMPLOYEE TRAINING, EDUCATION AND AWARENESS

Ensuring that employees are correctly trained is not only a social and legislative responsibility, but promotes morale and boosts productivity. Trained employees are better able to handle diverse production conditions and will decrease the potential of undue environmental impacts caused by inappropriate employee actions.

BMP Concepts and Approach

a) Employees must be provided with opportunities for training and furtherance of their respective or chosen skills. This should be determined by consultation between employer and employee.
b) In-house training can be effective, but external, recognised training programs should also be encouraged.
c) For responsible aquaculture, basic training in the following would be advantageous:
    - Environmental awareness.
    - Feeding and feed management.
    - Water quality management and monitoring.
    - Sustainable aquaculture husbandry.
    - Aquaculture ecology.
    - First aid and fire safety management.
d) Training programs should be coupled to incentives or promotion in position or responsibility.

e) It is recommended that all new employees be exposed to an environmental awareness training session (based on best practices) and that all employees should be drawn into such a session at least once a year.

4.4.3 MANAGING COMMUNITY INTERACTION AND ENHANCEMENT

Aquaculture activities will influence surrounding communities at various levels. It is important to manage these interactions in such a manner that the communities become allies to the production activities rather than display any hostility.

BMP Concepts and Approach

a) When new aquaculture facilities are planned the surrounding communities must be informed and they should be provided with an opportunity to voice concerns and support.
b) Once established, the communities must be informed of the ongoing aquaculture activities adjacent to the areas in which they live and work.
c) Whenever possible, new employees should be sourced from the surrounding communities in preference to importing personnel from further a field.
d) Where possible, outside contractors should be sourced from local communities.
e) Efforts should be made to encourage aquaculture and environmental awareness by allowing and facilitating visits by schools and other community groups.
f) Where practically possible, discounted aquaculture products should be made available to local communities.

4.4.4 DEALING WITH COMPLAINTS

As with any development, aquaculture facilities will be subject to complaints at some stage. Some of these may be caused by a lack of understanding, but others may be of extreme importance. Nevertheless, complaints must be dealt with appropriately to ensure due consideration to the complainant and to ensure public and environmental safety. The following procedures should be followed in dealing with complaints:

a) All complaints must be recorded in a well-kept complaints register with details of the nature of the compliant, the person or organisation that lodged the complaint, the date and the name of the responsible person dealing with the complaint.
b) The compliant must be fully investigated. Further clarity may also be obtained from production and environmental records, from employees, from third party specialist or from the complainant.
c) A strategy to deal with the compliant must be formulated, documented in the complaints register and communicated to the complainant.
d) The formulated strategy should be implemented by the allocation of resources.
e) The effects of the strategy should be monitored and the strategy modified if need be.
f) Once the situation leading to the compliant has been resolved, the complainant must be informed. The date hereof should be recorded in the complaints register.
g) Actions should be taken to prevent the situation from reoccurring and, if necessary, a contingency plan should be developed (refer to section 6).
h) If a situation leading to a compliant cannot be resolved under normal production conditions, an amicable solution should be devised with inputs from the complainant.
i) If required, the relevant authorities should be involved in the resolve of a compliant.
j) The complaints register should be reviewed regularly to ensure that all complaints have been dealt with effectively.

SECTION 5 – BEST MANAGEMENT PRACTICE STANDARDS IN AQUACULTURE

In South Africa no conclusive set of standards exists specifically for aquaculture. Nevertheless, certain aspects can be drawn back to standards that have been dealt with in this BMP guideline. Some of the main aspects and associated standards that should be used in goal setting for a more environmentally conducive aquaculture sector are:

a) To achieve **general environmental standards,** sector participants must seek to:
   - Comply with the relevant environmental legislation administered by DEA&DP when planning, developing and operating aquaculture facilities.
   - Comply with the relevant marine legislation administered by MCM: DEAT when planning, developing and operating aquaculture facilities.
   - Comply with the legislation and ordinances administered by CapeNature when planning, developing and operating aquaculture facilities.
   - Comply with the water related legislation administered by DWAF when planning, developing and operating aquaculture facilities.
   - Comply with the ordinances or regulations of local and district authorities when planning, developing and operating aquaculture facilities.
   - Implement and adhere to this BMP guideline.

b) To achieve **water quality standards,** sector participants must seek to:
   - Comply with the National Water Act, 1998 (Act No. 36 of 1998) administered by DWAF.
   - Continuously comply with quantitative and qualitative water quality standards set by DWAF and other water resource management agencies, both for intake and discharge purposes.
   - Implement and adhere to this BMP guideline.

c) To achieve **product safety standards,** sector participants must seek to:
   - Ensure that legal phytosanitary standards are met.
   - Ensure that product safety criteria of the respective target markets are met.
   - Consider the implementation of HACCP systems, even if such interventions are of a basic nature and limited to specific hazard control points.
   - Implement the SANS and SABS testing and certification where required.
   - Implement and adhere to this BMP guideline.

d) To achieve **social standards,** sector participants must seek to:
   - Adhere to the laws that govern basic human rights and employment conditions.
   - Respect all people employed in aquaculture and all people that come into contact with the aquaculture sector.
   - Strive towards poverty alleviation, the advancement of food security, the creation of employment, the creation of partnerships with historically disadvantaged individuals and communities and socio-economic development.
   - Take particular notice of the social health implication brought about by HIV and AIDS.
   - Implement and adhere to this BMP guideline.

SECTION 6 – ENVIRONMENTAL CONTINGENCY PLANNING IN AQUACULTURE

Environmental best practice in aquaculture includes the development of environmental contingency plans. These plans should contain details on the tasks and actions to be taken in addressing environmental emergencies, the performance criteria for such actions, the responsible persons, reporting procedures and post-contingency review mechanisms. The plans must be communicated to all employees, the applicable local and district authorities and emergency services. In order to maintain an acceptable level of preparedness, the plans should be put to practical testing and regularly updated.

Contingency plans are site and project specific and could cover many aspects. The following only provides some generic examples as to the actions in such plans:

a) Examples of actions to be taken in the event of contaminated water reaching an aquaculture facility:
    - Close off incoming water supplies.
    - Identify and isolate area of contamination.
    - Activate internal water reticulation and re-circulation.
    - Increase oxygenation and stop feeding.
    - Identify contaminant type and solution.
    - Remove dead organisms and dispose appropriately.
b) Examples of actions to be taken in the event that polluted water is discharged from an aquaculture facility without prior treatment:
    - Close off discharge water flows.
    - Identify the nature of the pollutant and extent of pollution.
    - Notify applicable authorities as required.
c) Examples of actions to be taken if the escape of aquaculture organisms is detected:
    - Identify route of escape and repair to prevent further escape.
    - Remove organisms from affected production units if necessary.
    - Determine how many organisms have escaped.
    - Notify applicable authorities as required.
d) Examples of actions to be taken if a disease breakout is detected:
    - Isolate affected production units if possible.
    - Identify disease if possible.
    - Consult fish pathologist or State Veterinarian if necessary.
    - Apply treatments based on diagnosis.
    - Remove dead or infected organisms and dispose appropriately.
    - Monitor effects of treatments.
    - Quarantine if necessary.
    - Notify applicable authorities as required.
e) Examples of actions to be taken if a fire were to break out:
    - Identify affected areas and evacuate employees.
    - Notify emergency services if applicable.
    - Apply fire control measures (e.g. use fire fighting equipment).

Aquaculture operators should compile specific contingency plans for all potential risk areas that can be identified. These plans should be documented and kept in an accessible area.

SECTION 7 – MONITORING, AUDITING AND REVIEW

7.1 INTRODUCTION TO AUDITING

In most cases internal auditing of aquaculture activities through monitoring and adaptive management is sufficient to maintain high standards. Nevertheless, it is good practice to arrange for periodic independent environmental audits to determine the level of compliance to any specified standard or to the BMP guideline. Audits against the BMP guideline will ensure that it remains relevant to the conditions and the environmental management requirements of any aquaculture facility. A qualified auditor will detect and note any significant or potential environmental impacts so that the best possible management practices can be formulated to eliminate or lessen such impacts.

The aim of an audit is primarily to:

a) Check the degree to which a facility meets a set of predetermined standards or the implementation of best practices.
b) Check that proper records are kept.
c) Determine the effectiveness of specifications in the predetermined standards or in the BMP guideline.
d) Aid in logical communication and feedback between aquaculture proponents and the applicable authorities.
e) Recommend changes and updates to the predetermined standards or the BMP guideline.

7.2 INTERNAL AUDITING METHODS

Each aquaculture facility should task at least one employee to implement best practices. This person should be responsible for:

a) Ensuring that the other employees are aware of best practices and the BMP guideline.
b) Monitoring the implementation of best practices and the condition of the environment.
c) Informing all parties of aspects or conditions that could cause environmental damage so that these may be addressed appropriately.
d) Keeping a diary, photographic record (where possible) and complaints register for recording all matters pertaining to the implementation of best practices.
e) Updating the BMP guideline.
f) The responsible person should be mandated with the authority to take immediate action in the event that a response is required to prevent environmental damage.

It is recommended that internal audits be done by means of an audit checklist as shown below. A short report describing the level of implementation and compliance to the predetermined standards or best practices should be prepared after each audit. Copies of the audit sheets and reports should be made available to any appointed external auditors.

Example of audit checklist format:

Requirement / Issue /Specification	Compliance			Comments/ recommendations	BMP Ref.
	Yes	Part	No		

7.3 APPOINTMENT OF AN EXTERNAL AUDITOR

When required, it is recommended that a person with the following credentials be appointed to conduct external audits of aquaculture facilities:

a) Be knowledgeable in environmental auditing procedures.
b) Be knowledgeable and trained in environmental management.
c) Be knowledgeable and trained in aquaculture.
d) Be registered with a recognised auditing or aquaculture organisation.

The qualifications of an auditor should be made known to recipients of the audit results and where possible, the same auditor should be used for consecutive audits to ensure consistency in the standard of auditing and reporting.

7.4 FREQUENCY OF AUDITS

It is good practice to conduct regular and ongoing internal audits. The results of these should be provided to external auditors that may be appointed. This will show due diligence and could prevent an auditor from viewing aspects of non-compliance in a negative light.

Although it is good practice to have annual external audits, the permits, licences and authorisations of an aquaculture facility may stipulate this frequency.

7.5 RECIPIENTS OF AUDIT RESULTS

It is good practice to ensure that the following parties received copies of any external audits on an aquaculture facility:

a) DEA&DP.
b) MCM: DEAT for marine aquaculture units.
c) DWAF and other appropriate water management institutions.
d) The Department of Agriculture.
e) CapeNature.
f) Local and district authorities as may be applicable.

7.6 REVIEW AND UPDATE OF THE BEST MANAGEMENT PRACTICE GUIDELINE

This BMP guideline is intended as a foundation for the development of more comprehensive, project specific environmental management systems. To achieve this, the content of this guideline will require review and update at project level, which could be incorporated into the auditing process. The BMP guideline must be treated as a live document which requires ongoing improvement by means of regular review and updating.

The following steps relate to the review and update of the BMP guideline at project level:

a) Notes should be kept of aspects in the guideline that are not applicable, impractical, outdated or not adequately addressed. The notes should be made available to any auditor that may be appointed, who should consider them in updating the BMP guideline.
b) An appointed auditor or other professional should be tasked with reviewing the BMP guideline at project level, so that it remains relevant in the achievement of high standards in environmental management.

SECTION 8 – AQUACULTURE DECOMMISSIONING PROCEDURES

Aquaculture projects are terminated from time to time for a number of reasons. This section deals with the basic steps that are required in the event of project termination so that environmental scars are not left as a legacy of any aquaculture activities.

8.1 INFORMING THE RELEVANT AUTHORITIES OF DECOMMISSIONING

As many aquaculture projects are subject to specific statutory authorisations, the applicable authorities must be informed when activities are terminated. These authorities include:

a) DEA&DP.
b) MCM: DEAT for marine aquaculture units.
c) DWAF and other appropriate water management institutions.
d) The Department of Agriculture.
e) CapeNature.
f) Local and district authorities as may be applicable.

The reason and decommissioning procedures must be explained in correspondence to the authorities and they should be copied into the results of a post-decommissioning audit.

8.2 REMOVAL OF THE AQUACULTURE ORGANISMS

At decommissioning, all aquaculture organisms must be removed responsibly (e.g. by sales, donations or humane killing). This eliminates the risk for redistribution into areas where they are not environmentally compatible. Where practical, a chemical such as Rotenone could be used to rid facilities of any last remaining fish. If organisms are killed, they should be disposed of responsibly and, where necessary, in consultation with local authorities.

8.3 REMOVAL OF THE INFRASTRUCTURE

Any insecure or unsafe infrastructure should be demolished at decommissioning. Alternatively, the responsibility for such infrastructure must be handed over to the landowner or appropriate third party that may undertake the necessary repairs. Rubble, including supply piping, fencing and cabling from any demolition activities must be appropriately disposed before the area is stabilised and vegetated. The post-decommissioning site should resemble a state similar to that prior to commencement of any activity.

8.4 SITE REHABILITATION

Following the removal of infrastructure, the receptiveness of the soil for re-vegetation should be enhances by means of ripping, topsoil application or the use of fertilisers and compost. Quick growing, indigenous plant species that provide stability must be established. This should be followed with more permanent indigenous plant species.

8.5 ENVIRONMENTAL AUDIT AFTER DECOMMISSIONING

To ensure that decommissioning and rehabilitation is acceptable, an external audit should be conducted. One such audit should take place immediately after decommissioning and rehabilitation and a second after six months.

SECTION 9 – CONCLUSION

Following this BMP guideline will ensure that potential environmental impacts are minimised and it will equip the aquaculture sector with the required approach to deal with environmental matters on a day-to-day basis. It is however imperative that this BMP guideline becomes part of the standard operational procedures of the farming activities and that it be regularly updated.

SECTION 10: ACRONYMS

AASA	- Aquaculture Association of Southern Africa
AFASA	- Abalone Farmer's Association of South Africa
AIDS	- Acquired Immune Deficiency Syndrome
AISA	- Aquaculture Institute of South Africa
BEE	- Black Economic Empowerment
BMP	- Best Management Practice
CPPP	- Community Public Private Partnership
DEA&DP	- Department of Environmental Affairs and Development Planning
DEAT	- Department of Environmental Affairs and Tourism
DST	- Department of Science and Technology
DTI	- Department of Trade and Industry
DWAF	- Department of Water Affairs and Forestry
EIA	- Environmental Impact Assessment
FAO	- Food and Agriculture Organisation of the United Nations
GDP	- Gross Domestic Product
HACCP	- Hazard Analysis and Critical Control Point
HIV	- Human Immune Virus
IDP	- Integrated Development Plan
IIFET	- International Institute for Fisheries Economics and Trade
MCM: DEAT	- Marine and Coastal Management Branch of the Department of Environmental Affairs and Tourism
MFFASA	- Marine Finfish Association of South Africa
MRL	- Minimum Residue Level
MSDS	- Material Safety Data Sheet
NAMC	- National Agriculture Marketing Council
NEMA	- National Environmental Management Act, 1998 (Act No. 107 of 1998)
NEPAD	- New Partnership for Africa's Development
NPA	- National Ports Authority
OIE	- Office International des Epizooties
PPP	- Public Private Partnership
SABS	- South African Bureau of Standards
SANAS	- South African National Accreditation System
SANP	- South African National Parks
SANS	- South African National Standards
SASS	- South African Scoring System
SAWG	- Southern Aquaculture Working Group
SDF	- Spatial Development Framework
SDP	- Spatial Development Plan
SDIP	- Sustainable Development Implementation Plan
SMME	- Small, Medium and Micro Enterprise
TILASA	- Tilapia Association of South Africa
UCT	- University of Cape Town
US	- University of Stellenbosch
UV	- Ultra Violet
UWC	- University of the Western Cape
WCNCLAA	- Western Cape Nature Conservation Law Amendment Act, 2000 (Act No 3 of 2000)
WCPSDF	- Western Cape's Provincial Spatial Development Framework
WCTA	- Western Cape Trout Association
WESSA	- Wildlife and Environment Society of South Africa
WTO	- World Trade Organisation
WWF	- World Wildlife Fund

SECTION 11: GLOSSARY

Anoxic……In the absence of oxygen.

Antibiotic resistance……..A trait developed by bacteria after prolonged. exposure to antibiotics, causing non-susceptibility to further exposure.

Aquaculturists…… A person who practices aquaculture.

Benthic……The first layer of solid material at the bottom of a water body.

Biological accelerators……..Bacterial agents used to speed up any biological reaction or process.

Biological control……A process in which one biological organisms is used in the control of another through intervention by man.

Biological oxygen demand……The net amount of oxygen required by any biological process or set of biological processes.

Biophysical environment…… The biological (i.e. living) and physical (e.g. soils, climate etc.) natural environment.

Cage culture……...The practice of aquaculture within a defined pen or net cage or structure that is contained within a larger water body.

Capture fisheries……The harvesting of aquatic organisms from an environment in which no attempt has been made to manage or otherwise influence the organisms by containment, feeding or application of any husbandry techniques.

Constitution…… The Constitution of the Republic of South Africa, 1996.

Crustaceans……...Any of various predominantly aquatic arthropods of the class Crustacea, characteristically having a segmented body, a chitinous exoskeleton, and paired, jointed limbs.

Cumulative impacts……...The net resultant impact of two or more elements or activities exerting respective individual impacts. This is used in the context of an impact that in itself may not be significant but is significant when added to the impacts of other activities.

Depuration……..A process of keeping an aquaculture organisms in a different environment from the production environment to achieve a change in a specific characterises, e.g. the meat texture or taste.

Development nodes ……Areas suited to clustered development through providing accessible resources, good infrastructure, markets, limited environmental impacts etc.

Environmental footprint……The total area of physical, social, economic and environmental impact and influence of an activity.

Environmental services……Services provided by natural processes, e.g. assimilation of nutrients by natural bacterial decomposition.

Epochs……A period or time scale.
Equitable……Marked by or having equity; just and impartial.
Essential services……... Infrastructure services such as roads, sewerage services, telecommunications, potable water and electricity.
Exotic species…… A species that is not an indigenous species; or an indigenous species translocated or intended to be translocated to a place outside its natural distribution range in nature, but not an indigenous species that has extended its natural distribution range by natural means of migration or dispersal without human intervention.
Eutrophication…….A characteristic of water in which higher than natural levels of nutrients are found.
Finfish……A term used in aquaculture for all regular fish types.
Grey water……..Waste water that contains no sewerage discharge.
Historically disadvantaged……The socio-political disadvantage of certain demographic groups in South Africa caused by the previous political dispensation prior to democratisation in 1994.
Husbandry techniques……..Techniques used in production such as feeding, grading, housing, sampling, propagating etc.
Infrastructure environment……All aspects associated with infrastructure and the related interactions between these infrastructure elements.
Intertidal zone…….The area between the high water and low water marks.
Material Safety Data Sheet……..An information sheet provided with chemicals, which described methods of use, handling, storage and actions to be taken if poisoning, spillage or inappropriate use occurs.
Paddlewheel……...A device used in aquaculture to aerate water. It consists of motor driven paddles which rotate to agitate the water surface.
Pond culture……... The practice of aquaculture within a depression in the earth, which may be lined with any material to assist in waterproofing or the creation of a more suitable production environment.
Predator net……Netting used mainly in cage culture to keep predators at bay.
Predator pond……A water pond used in aquaculture with predatory organisms which can eliminate target or production species that escape via such a system.
Pump-ashore……..A term in aquaculture used to describe the activity of pumping water from the sea into an aquaculture facility.

Resource based legislation……..-+All legislation associated with the management and protection of natural resources such a water and the environment.

Silage……..In aquaculture this refers to ground and liquefied processing waste that has been stabilised by the lowering of pH.

Tank culture……The practice of aquaculture in any artificial tank system, which may be constructed from various materials such as glass, plastics, concrete etc.

Translimital species……...An indigenous species that is found outside of its natural range.