NSW DEPARTMENT OF
PRIMARY INDUSTRIES

Hunter and Central Coast Sustainable Aquaculture Strategy

Readers' Note

This document is part of a larger publication. The remaining parts and full version of the publication can be found at:

http://www.dpi.nsw.gov.au/fisheries/aquaculture/publications/general-management-and-policy/hunter-and-central-coast-sustainable-aquaculture-strategy

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Operating the Farm

Hunter and Central Coast Sustainable Aquaculture Strategy
Land Based Aquaculture

A NSW Government Initiative

Hunter and Central Coast Sustainable Aquaculture Strategy

A NSW Government initiative of Department of Primary Industries, Department of State and Regional Development, Department of Environment and Conservation, Department of Lands, Department of Infrastructure, Planning and Natural Resources and NSW Premiers Department to encourage sustainable aquaculture in New South Wales.

Operating the Farm

Table of Contents

1. Commercial Farm Development Plan

A Commercial Farm Development Plan (CFDP) is required under the Fisheries Management Act, 1994 as part of the application for an aquaculture permit. At the core of the CFDP is the need to address stock and environmental management issues as these have the potential to put at risk all aspects of an aquaculture operation. CFDP should contain all the factors that would normally be included in an environmental management plan (EMP).

The CFDP must be reviewed every 5 years or as otherwise determined by the Minister and an amended plan submitted.

In the event that the CFDP has not been complied with (eg. no farm production for a number of years) the Minister may ask to show cause why the aquaculture permit should not be cancelled.

Land based intensive aquaculture in its various forms requires a fair degree of technical skill as well as prudent business management for the sustainable operation of the enterprise. The development of a CFDP that integrates the business aspects with environmental management can improve productivity and economic returns. The CFDP has the potential to identify ways of reducing costs associated with energy, water and waste management while maintaining sound environmental practices and good community relations.

The CFDP should outline how each growing cycle will be established and managed in an environmentally and commercially successful manner. The CFDP should provide the framework for the ongoing management and monitoring for the life of the proposal and demonstrate how the farm can comply with statutory obligations under environmental licences or approvals. This can be important in demonstrating due diligence and reducing the risks of non-compliance with regulatory obligations.

The CFDP should demonstrate sound environmental practice during the operation (and if appropriate decommissioning) of the farm including:

- business management including annual production goals, products, markets, training and incentives programs for environmentally sound performance,
- stock management including post harvest processes,
- pond and water management,
- management of other environmental issues such as erosion control, chemical storage, odour, noise, dust and waste,
- management of predator issues,
- contingency plans to respond to disease emergencies, incidents and operational abnormalities or any breakdown in environmental performance,
- monitoring of environmental performance and compliance,
- complaints handling procedures including community consultation strategies,
- reporting mechanism on environmental performance.

2. Business management

2.1 Annual production goals, products, markets

Business planning doesn't stop once the business has been established. A business plan is a living document that should be revisited, on a regular basis, or when major events occur or change of species, technology, production rates or management is proposed. The progress of the enterprise should be checked against the business plan. The plan should be reviewed and updated as the business evolves. (*See Business Planning section*)

Swot analysis to check ongoing performance of aquaculture farm

- Review past performance
- Analyse strengths and weaknesses
- Look for opportunities and threats
- Adjust the plan if necessary

2.2 Personnel management and training

Qualified and experienced staff are essential in the operation of a successful aquaculture business. Training in occupational health and safety issues (including first aid) should be considered and appropriate occupational health and safety policy/guidelines should be implemented for the farm. Appropriate signs should be erected for worker safety as well as to remind workers of stock management protocols. Rostering of staff and employment of suitably trained casual labour during peak work times (eg. harvest time) should be planned in advance so there is always suitably qualified staff on the farm.

All new and existing staff should be made aware of the need for the aquaculture enterprise to be operated in an environmentally sustainable manner. It is essential that appropriately qualified and/or experienced staff undertake monitoring of the ponds and stock, including specific training on disease recognition and water quality testing. Training could include:

- critical issues with regard to stock management, health and welfare,
- importance of quality control of the product post harvest, quality assurance and food safety issues,
- pond/tank water management procedures,
- compliance with the permit and license conditions for any discharge water,
- commitment to waste prevention and energy conservation,
- contingency management procedures,
- importance of monitoring and reporting.

A number of aquaculture courses exist and are available at both tertiary and TAFE levels. The operation may also consider outsourcing for specific services in relation to the monitoring requirements.

Preferred management:	On-site trained staff with the ability to implement regular water quality and disease monitoring, good husbandry practices and sound waste management

3. Stock management

3.1 Species management

Only those fish species authorised under an Aquaculture Permit may be cultured on the aquaculture site. It is a requirement to obtain a specified disease clearance for certain finfish sourced from interstate (eg. eels and barramundi).

Before fish are introduced to the culture environment, conditions should be favourable for survival and growth. Water quality variables such as temperature, salinity, pH, dissolved oxygen, ammonia and nitrite need regular monitoring. Potential predators need to be excluded.

Stock should be carefully acclimatised to the culture environment to minimise stress. Water quality parameters should have similar readings between transport and receiving waters. In ponds it is usually preferable to stock during the cooler part of the day. Small cages are useful to monitor initial survival of a sample of the stock.

Recognised hatcheries should be consulted for sourcing seed stock. Where possible, periodic monitoring of the proposed purchase batch during the larval development should be conducted to ensure a history of good health and vigorous development. Laboratory tests to confirm disease free status should be considered.

Stock containment practices must ensure that no farmed stock is released into the environment. Water discharge structures must be screened, in accordance with stock size.

3.2 Stocking densities

In general, stock performs better at lower stocking densities. However, up to a point, increasing stocking density will also increase production together with disease risk and management. Optimum stocking density will vary with species, culture facility design and with operator production strategies and skill. Factors to be considered in calculating densities include:

- Production strategies;
- Farm Design;
- Operators skill and management.

If stocking densities are to be increased, it is wise to trial on a small scale prior to scaling up. Endeavouring to farm stock at "intensive" densities on under capitalised farms and without a sound technical background in water quality and disease management can result in business failure.

3.3 Health management

Management practices need to be designed to minimise stress and reduce disease risk. Initially, the purchase of certified pathogen-free stock is advisable where possible. It is highly desirable to have the capacity to quarantine new stock for an appropriate period of time (3-5 days) to check their health status before stocking into the facility. Introduction of seed stock to a facility without quarantining is a common pathway of disease transmission.

(a) Disease prevention

Disease-specific prevention programs should be put in place to minimise the risks of disease outbreaks occurring. A monitoring protocol should be prepared to identify disease on the farm. Daily monitoring of feeding activity, regular monitoring of both water quality and disease and reporting of stock behaviour are essential.

Priority should be given to ponds or tanks that have:-

- High biomass or high feeding rates particularly during summer months,
- Episodes of poor water quality,
- Signs of sick stock or poor feeding responses,
- Sign of abnormal swimming.

Some disease agents can be introduced to the farm via waterborne, terrestrial, or (less commonly) airborne carriers. Proper management procedures should be implemented to minimise the risk of these carriers entering the ponds or tanks. These procedures should include testing of seed stock to ascertain their disease status and quarantining. The farm should be designed and operated to ensure the operator has the ability to isolate, quarantine and apply treatments to individual ponds or tanks. Equipment and operator transfer between tanks/ponds is a common way of spreading infectious agents once on the farm. Nets, boots etc. should be sterilised using baths (chlorine/iodine) or sun dried.

(b) Disease contingency planning

A contingency plan to deal with likely disease outbreaks in an individual pond/tank or the whole farm is essential. This plan should be included in the CFDP.

The Aquaculture Permit conditions require immediate notification in the event of any disease/suspected disease or any significant deterioration in the wellbeing of the stock (eg >5% mortality). Department of Primary Industries may issue directions including quarantine (such as prohibition of effluent discharge) of the premises in such an event. The permit holder is prohibited from releasing effluent or selling fish with a Declared Disease (suspected or otherwise).

Protocols should include:

- Demonstrated ability to and management procedures to modify the water circulation and treatment system,
- Strict management of equipment to ensure that the disease is not accidentally transferred,
- Strict protocols to ensure staff do not contract the disease or transfer the disease on their hands, boots or clothes,
- Strict management of all wastes to ensure that solid or liquid material does not become a source of infection at other sites.

Provision should be made for the disposal of dead stock and the site must be kept in a clean state. Some high security species eg. barramundi, require that all solid wastes, sludges or waste water is treated prior to disposal or irrigation.

If there is a disease outbreak in one section of the farm, extreme care must be taken to ensure it is not transferred to other ponds or tanks or into the wild.

Preferred management:	On-site trained staff with appropriate facilities for regular water quality and disease monitoring, quarantining facilities and/or arrangement with accredited laboratory or veterinarian to provide these services.

No aquaculture therapeutants (chemicals) should be used unless approved for use (eg. salt) by the National Registration Authority. They should be used in accordance with the manufacturer's instructions as outlined on labels and other supplementary documents, veterinarian directions and relevant State and Federal legislation. Farmers should maintain accurate records regarding the use of chemicals including type, concentrations, reason for use, quantities, frequencies, duration of administration, size and species of stock treated and the result. Movement of stock (eg. harvesting) which have undergone chemical treatment should be recorded. Records of use should be retained for three years.

(c) Therapeutants and chemicals

This strategy places a high emphasis on disease prevention through sound site selection, design, planning and operational systems to minimise the occurrence of disease problems. However, a variety of therapeutants and chemicals may be used to facilitate production or to control diseases or parasites. These include hormones to induce spawning, anaesthetics, antibiotics, antiparasitics, antifungals, herbicides, immunostimulants, vaccines, pesticides, disinfectants, soil and water treatments and feed additives.

Most therapeutants used in aquaculture are of low regulatory priority (eg. salt and fertilisers). The National Registration Authority have approved minor use permits for a number of other chemicals. These permits are species specific.

Inappropriate use of chemicals is not only illegal but can result in:-

- Product having chemical residues with possible market rejection of the product;
- health and safety risks to consumers, workers and neighbours;
- production of chemical resistant strains of pathogens;
- waste of money on chemicals which are used inefficiently;
- adverse off-site impacts on the environment.

All chemicals should be stored and used in accordance with manufacturers' instructions. Appropriate instructions, training and protective clothing should be given to staff using chemicals. Containers must be disposed of in accordance with the manufacturers' instructions and the requirements of the local waste authority (council or waste board).

Pesticides must be used in accordance with the Pesticide Act which places a responsibility on those applying the chemicals and the landowner on whose land the chemicals are used to ensure that there are no unacceptable impacts on the environment.

(d) Predator controls

Predator control should be considered part of health management. To reduce unwanted introduction of eels and finfish, screening of intake and discharge structures with appropriate sized mesh is recommended. For bird predators, a number of management methods should be considered, such as netting of all ponds or at least fingerling ponds, overhead wires, use of dogs, the use of repellent systems and increased personnel around ponds at peak bird feeding times. Generally it is considered that a mixture of bird management methods is necessary as an effective deterrent (See section on *Planning and Design*).

Preferred management	Screening of all incoming pond water, regular clearing of trash fish from storage water and channels or as a minimum screening of fingerling ponds and repellent systems for other ponds.

Licenses to control native avian predators

It is illegal to kill native species without a permit from the Department of Environment and Conservation (DEC). The DEC is responsible for nature conservation and the protection of native animals in NSW. There are provisions under the National Parks and Wildlife Act for the DEC to licence the killing of native species under certain circumstances. Potential predators of fish, such as cormorants, fall into this category. In addition some of these species may also fall under "migratory species of interest" under the Commonwealth Government's EPBC Act. An assessment may be also be required of the likely impacts of shooting the species of birds and a Commonwealth approval may be required (see *Integrated Approvals Section*).

The ultimate goal, however, is for native animals to be managed by using only non-lethal deterrents such as netting and scare devices. This also applies to other agricultural situations, such as flying foxes feeding on fruit crops.

Killing cormorants or other native animals should always be a last resort.

Operators should not rely on the DEC continuing to issue licences to kill predators in the long term and the aquaculture industry should actively investigate other deterrent options.

The DEC has been working with the aquaculture industry to develop alternative approaches. These approaches should include sound site selection as well as screening and/or scare mechanisms. These non-lethal approaches should be the first line of defence. Aquaculture operators should contact the local office of the DEC to discuss these approaches to gain additional advice/information based on DEC's knowledge of bird behaviour in the area taking into consideration seasonal and other factors. This information may be of assistance in improving the efficiency of non-lethal approaches.

Licences issued by DEC under section 121 of the National Parks & Wildlife Act to lethally harm protected fauna is considered to be an extreme measure for managing damage to fish stocks and is unlikely to be issued.

The decision to issue a s.121 licence to kill cormorants or other protected native animals will be based on an evaluation of the following:

- Evaluation of the mitigation measures previously used and their effectiveness,
- Monitoring information on bird species and numbers visiting the ponds and their pattern of behaviour including the time of day when numbers are highest,
- DEC information regarding the population of the “target species” in the area taking into consideration breeding and dispersal behaviour,
- Proposed target species and numbers to be culled. Outline the strategy for culling these target species,
- Evaluation of the likely effectiveness of culling target species taking into consideration seasonal and other behavioural factors,
- Proposed monitoring of bird visitations post culling.

A fee is charged by the DEC for processing licence applications, which is aimed at recovering the administrative costs of assessing an application on its merits. Any funds left over from application fees are used for researching the impacts of licences on native species and for the education of the aquaculture industry and the community about non-lethal methods of managing native predators.

In the event that a s.121 licence "to harm protected fauna" is issued,

1. Operators should whenever possible "shoot to scare" rather than "shoot to kill".
2. If protected fauna is "lethally harmed", the operators should recognise the need for appropriate and humane euthanasia to be applied to injured and maimed animals.
3. All dead birds should be frozen and delivered to DEC to determine the food they have been eating. This information will form the basis for a better understanding of the predator behaviour.
4. Operators should use weapons that pose least danger to neighbouring communities.

If the birds are listed under the Threatened Species Conservation Act, applications for licences to harm threatened species must also be made under the provisions of this Act, which requires more detailed information and a much more thorough and detailed level of assessment. **As a general rule, DEC is not likely to issue a licence to "lethally harm" threatened species**.

Monitoring requirement

A log should be kept of the presence of potential predator birds on the farm on a weekly basis. This information will be useful if a licence is being applied for. The effectiveness of various management devices to manage the birds should be noted. If a licence to shoot birds is issued under s 121 of the NPW Act, a record must be kept of all birds shot and the circumstances. A copy of the log should be provided to DEC when the frozen dead birds are delivered for analysis.

3.4 Feed management

The costs associated with purchase and delivery of formulated feeds for

aquaculture are usually the major component of total operating costs. The goal is to feed efficiently and select the most "cost-effective" diet for the target species (ie. the diet which will produce the most rapid growth and best food conversion efficiency for the least cost). Over feeding results in poor water quality and wastage whereas underfeeding will result in poor growth and health. It should be noted that fish are twice as efficient as chickens at converting feed into flesh and five to ten time more efficient than beef cattle.

Apart from economic imperatives, feed inputs are the major contributors to pond/tank water quality deterioration and eutrophication of effluent waters. To minimise these environmental problems, and to make the most efficient use of expensive feeds, farmers should:

- Regularly monitor the growth of the stock, regulate the ration and grade stock to improve FCR's and growth.
- Select the feed which best meets their species nutritional requirements (eg for protein and essential amino acids, digestible energy, total fat and essential fatty acids and trace minerals and vitamins). Find out as much about the feed from the manufacturers as possible.
- Select the appropriate pellet size for the size of fish being fed; do not change from one type of feed to another too rapidly. This can put animals "off their feed" and contribute to the undesirable build-up of uneaten food in the culture facility. When changing feed types, blend the two types together for a period (6-8 days) to allow fish to adapt slowly.
- Select feed made from fresh, well stabilised ingredients. Do not keep feed for longer than a few months; Store feed in a cool, dry place to prevent mould problems occurring and pests should be excluded (eg. rats).
- Monitor pellet physical attributes and its water stability. If the feed being purchased has more than a few percent "dust" or "fines", inform the manufacturer and/or send it back. If it dissolves too rapidly in the water, let the feed manufacturer know or trail another brand.

Improvements in feeding strategies (ie. feeding frequency, feeding rates and delivery methods) can significantly improve farm profitability. Feeding systems should be managed to maximise growth and minimise waste.

Preferred management:	system to adjust feeding quantities through stock grading, monitoring of growth, feeding responses and health issues.

The quantity of feed eaten should be monitored regularly and feed delivery adjusted accordingly. Most importantly, farmers need to know the biomass of their stock (ie. how much all the animals weigh). If fish mortality goes undetected, overfeeding can result which in turn can lead to water quality problems and more mortality. Recommended feeding tables are available for a number of species.

In general, feed should be delivered to give all animals the best opportunity to eat as much as they need. For bottom dwelling animals, feed should be distributed as evenly over the pond surface as possible. For surface or mid-water column feeders, feed can be spread over a smaller area as long as animals are not too crowded when feeding. Feeding should be suspended when water quality or disease problems are suspected (eg when dissolved

oxygen is low or when algal blooms are excessive).

Preferred management: system to broadcast feed homogenously for efficient use.

3.5 Harvest management

Harvest procedures can often affect product quality, marketability and consequently selling price. Harvest procedures should be chosen to minimise stress, even if animals are to be killed. "Rested harvest" is the term given to killing fish to minimise the build up of lactic acid in fish muscle. This can be important as lactic acid can affect the onset of rigor mortis and influence flesh quality. Pre-harvest procedures should be designed to:

- ensure withholding periods of any therapeutants have been complied with;
- ensure facilities are ready for purging fish (if necessary);
- ensure all harvest supplies, any processing and packing materials and all personnel are available and informed of the proposed procedure.

Harvesting methods might include the use of nets, traps, trawls or draining the pond/tank. Drain harvesting of pond fish requires correct design and a degree of skill. Where pond water is drained, effluent water should be treated in the reconditioning system to ensure suspended solids and nutrients settle prior to reuse or discharge. With saline water, water quality performance objectives must be met prior to any discharge to the estuary. With freshwater ponds, sufficient storage must be available to hold and treat the water prior to recycling in the ponds/tanks or use for irrigation. (For tank culture, if there is a trade waste agreement, the water could be discharged to sewer in accordance with the agreement). De-watered sludge from tank culture must be captured and disposed of according to regulations.

4. Safe food issues

NSW Food Authority (formerly “Safefood”) was established in early 1999 and administers the Food Production (Safety) Act 1998. When fully implemented, it will be responsible for food safety arrangements from catch or harvest to "back door of retail". NSW Food Authority is progressively developing Food Safety Scheme regulations for the industry sectors, which it will cover. NSW Food Authority’s legislation requires these Food Safety Schemes to be based on risk assessment to ensure that all known risks are addressed and that resource allocation is commensurate with those risks. Information on the latest developments can be sourced from www.foodauthority.nsw.gov.au .

4.1 Hazard rating for different products

The food safety hazards needs to be identified for each product and is a combination of the inherent hazards of the seafood, the particular hazards of the process and the general hazards associated with all food handling. The following tables summarise the hazards applicable to seafood caught, harvested, processed and sold within NSW, and indicates the priority of the hazards identified.

Table 21. Bivalve Mollusc Hazards

Hazard		Farmed	Wild Caught
Biological	Pathogens [1] Vibrios Viruses	**High** **Med/High** **High**	Low/Med Low Low
Biological Toxins	ASP[2] DSP[3] NSP[4] PSP[5]	**High** **High** **High** **High**	**High** **High** **High** **High**
Chemical	Metals Agrichemicals	Low Med	Low Low

1. Bacterial Pathogens of faecal origin eg. Salmonella, Shigella
2. Amnesic Shellfish Poisoning
3. Diarrhoetic Shellfish Poisoning
4. Neurotoxic Shellfish Poisoning
5. Paralytic Shellfish Poisoning

Table 22 distinguishes farmed from wild caught by assuming farming in rivers and estuaries are subject to greater risk of contamination. This may not always be valid particularly since wild catch may also be in estuaries, but it is a starting point for the risk assessment process. The significance of the biological toxin hazard for scallops is not known.

Table 22. Aquaculture Product Hazards

Hazard		Crustaceans	Finfish
Biological	Pathogens [1] Vibrios *L. monocytogenes*	Low Medium Low	Low Low Low
Chemical	Metals Agrichemicals Feed Ingredients Aquaculture Compounds	Low Low Low Low	Low Low Low Low

1. Bacterial Pathogens of faecal origin eg. Salmonella, Shigella

4.2 Priority hazards in seafood

For each of the hazards identified as a high priority, the likelihood and severity of the hazard was assessed by studying:

- The likelihood of the hazard being present,
- The level at which the hazard is present,
- The illness(es) associated with the hazard.

An assessment report by Ross and Sanderson ranked the hazards associated with wild catch and farmed fish in order of the following "priority" in Australia. A number of the hazards are less relevant for aquaculture species but are indicative of the types of issues which should be considered.

Viruses in bivalve molluscs

Viruses in bivalve molluscs result from contact with contaminated water or infected food handlers. Normal cooking methods will not necessarily destroy viruses. Viral contamination post cooking can occur due to use of contaminated water, contact with infected food handlers or raw food product. Food safety management systems have been developed to control viral contamination of bivalve molluscs including:

- Ongoing microbiological surveys of growing areas and bivalve mollusks,
- Classification of growing areas based on sanitary conditions,
- Periodic closure of growing areas where necessary,
- Depuration (an effective tool only when used in conjunction with the above controls).

Algal biotoxins in bivalve molluscs

Algal biotoxins in bivalve molluscs is caused by algae and other microorganisms present in waterways which produce toxic substances, which can accumulate in bivalve molluscs and if levels are high enough, result in serious health effects in humans. Control strategies used in biotoxin management programs include:

- Monitoring of algal levels,
- Monitoring of algal toxin levels in the shellfish meat,
- Closure of harvest areas where necessary.

Histamine or scombroid poisoning

Histamine or scombroid poisoning is thought to occur following the ingestion of histamines and other amines produced by certain bacteria present in the gills and intestines of certain fish eg scombroid group (tuna, mackerel, sardines and anchovies) and certain other non-scombroid species. The toxicity of histamine is not affected by cooking or canning. Temperature abuse appears to be the major factor contributing to the formation of histamine in fish. Therefore control of the hazard relies primarily on effective chilling of the fish after catch and ensuring the fish remains cool during all subsequent handling and processing.

***Vibrios* species in seafood**

Vibrios species in Seafood occur naturally in marine and coastal or estuarine environments in both tropical and temperate regions of Australia (eg *V. cholerae).* The number of *Vibrios* that may be present in the water and seafood varies with season, with higher levels during the warmer months. In most cases, levels detected in freshly caught or harvested fish and shellfish are usually not high enough to directly cause illness in the consumer. *Vibrios* are usually

destroyed by heat treatments and therefore the consumption of raw foods, cross-contamination and temperature abuse are the main causes of outbreaks. Control of *Vibrios* in seafood relies on:

- Maintaining temperature control from catch/harvest to plate
- Preventing cross-contamination of raw and cooked foods

Enteric bacteria in shellfish

Enteric bacteria in shellfish are generally regarded as those bacteria capable of causing foodborne illness such as haemolytic uraemic syndrome (HUS) due to faecal contamination of either the environment or of the food during processing. Enteric bacteria are fairly heat sensitive, and therefore problems are usually associated with consumption of raw foods or foods contaminated after processing. In marine environments, enteric bacteria will die off fairly rapidly and therefore their presence in waterways would be an indication of significant recent pollution that could pose a risk to human health. Like viruses, enteric bacteria present a risk to seafood consumed raw, in particularly bivalve molluscs, as their filter feeding systems results in enteric bacteria concentrated. Management systems that are used to control viruses in shellfish, were originally implemented to control enteric bacteria in shellfish and are highly effective.

***Listeria monocytogenes* in ready-to-eat smoked fish products**

Listeria monocytogenes is a pathogenic bacterium that has been isolated from a variety of raw and cooked ready-to-eat products. *Listeria monocytogenes* will usually be destroyed by effective heat treatments, although contamination can occur after processing. It can also be readily isolated from moist or wet factory environments and can grow under refrigerated temperatures. Because of this *Listeria monocytogenes* is of concern in many ready-to-eat foods, including seafood products such as smoked salmon and mussels. Due to the variable nature of food poisoning by *L. monocytogenes*, management options are not clear-cut. Some suggested control measures include:

- Effective cleaning and sanitation of the processing facility,
- Proper temperature control during processing, transportation and distribution,
- Setting of a shelf life that limits the potential for growth in the product,
- Education of at-risk-consumers.

Botulism in vacuum packed ready-to-eat seafood products

Botulism is caused by the consumption of food contaminated with botulinum toxin. The toxin produce by *C. botulinum* is heat sensitive and will be destroyed by normal cooking temperatures. Therefore, botulism has been identified as a potential hazard in vacuum packed ready-to-eat seafood products. Botulism from commercial food is rare in Australia. To prevent the growth of *C. botulinum* and toxin production:

- Heat treatments must be designed to destroy *C. botulinum* spores;
- Refrigerated storage temperatures must be maintained throughout the cold chain;
- Preservatives such as salt and acid can be used to inhibit its growth and subsequent toxin production.

Parasites in seafood

Parasites able to cause disease in humans have been reported to occur in Australian fish. Parasites are usually rendered inactive by freezing or normal cooking temperature and are therefore mainly a risk in products such as sushi and sashimi, where the fish is consumed raw. In Australia, parasite infection due to the consumption of seafood is rare. In Japan, where raw, lightly cooked or pickled fish is often consumed, parasite infections are relatively common. With the increase in popularity of raw fish dishes such as sushi and sashimi in NSW, the risk of parasite infection may increase. The risk can be reduced by:

- Avoiding harvest areas where large populations of marine mammals (possible intermediate hosts or vectors) are present;
- Using farmed fish which are thought to be of lower risk than ocean and estuary caught fish;
- Visual inspection (handling) of fish to identify parasites that may be present in the flesh.

Table 23. Seafood Processing Biological Hazards

Product/Process	Hazard			
	Cl b[1]	L.m[2]	S.aur[3]	Gen[4]
Cold smoked – to be cooked			L	
Cold smoked – ready-to-eat	L	**H**	L	L
Hot smoked – ready-to-eat	L	**H**	L	L
Cold/Hot smoked – ready-to-eat vacuum or MAP	**H**	M		
Raw fish – to be cooked – vacuum or MAP	M			
Cooked whole prawns		L	L	M
Cooked peeled prawns		M	M	M
Cooked crab meat		M	M	M
Canned products	L			
Dried seafood		L	L	L
Salted seafood		L	M	L

1. Cl. b = *Clostridium botulinum*
2. L.m = *Listeria monocytogenes*
3. S. aur = *Staphylococcus aureus*
4. Gen = general pathogens, *Vibrios*, *Salmonella*, etc.

4.3 Comprehensive Quality Assurance (QA) systems

Comprehensive quality assurance (QA) systems should be established for the aquaculture enterprise to assure product quality. A number of accredited systems have been developed and these usually revolve around Hazard Analysis Critical Control Point (HACCP pronounced “hass-up”) principles.

The Seven Steps to HACCP

The Seven Steps to a HACCP Plan are as follows:

1. Work out what the hazards are. ‘Hazards’ for the produce at the farm including pre-harvest as well as harvest and post harvest issues.
2. Identify the *Critical Control Points*. These are the steps where the really important things can go wrong, so they are critical to eliminating the hazards. eg product exposure to high temperatures (pond side) following harvest.

3. Set the '*critical limits'* for each Critical Control Point. Again, these will vary from business to business, but examples could be chiller temperature. If the critical limit is exceeded, a problem can occur.
4. Monitor the *critical control points*. See whether the targets are being met and track the results. When things go wrong, they can be detected immediately.
5. Establish corrective *Actions*. These are the things to be done when monitoring shows there is a problem.
6. Verify that the HACCP system is working correctly. It is all very well having an effective system, but it must be doing the job required. This step might involve microbiological testing, for example.
7. Keep an accurate record so those responsible know what is happening and can track trends so that improved management decisions can be made. Record keeping must be thorough. It can help to prevent disastrous mistakes. Regulators also need records for compliance and auditing purposes. Producers who have their quality systems accredited need comprehensive records that can be audited by a third party. Independent auditing can also help prove to customers that the stated procedures are being followed.

Hazards may be introduced into any stage of the handling and distribution of fish products. Prevention relies on:

- Attention to the design and construction of the premises;
- Equipment design;
- Water quality controls;
- Appropriate purging protocols (if necessary for aesthetic or health reasons);
- Pest/vector control programs;
- Cleaning control programs;
- Personal hygiene and health awareness.

These practices are defined as Good Manufacturing Practices (GMP) and Good Handling Practices (GHP). Of particular importance is the need to prevent cross contamination from raw to cooked product and the exclusive use of potable water and ice at all times. Automatic temperature controls are necessary for the maintenance of quality and in some cases is vital for ensuring food safety. Temperature control throughout the distribution chain, from harvest to retail, is an essential precaution.

4.4 SafeFood seafood premises checklist

(a) General requirements

Premises and equipment should be maintained to prevent physical contamination and kept clean and hygienic eg. flyscreens on windows; effective pest control programs; birds not permitted in the seafood handling and storage areas; work areas visually clean and free of pests with no accumulation of waste, dirt or grease.

(b) Food handling areas

Floors, walls and ceilings should be well constructed of solid, non-absorbent and sealed non-toxic materials to prevent the entry of dirt, dust and pests and so they can be easily cleaned. The floors should be in good condition, not eroded and well drained. The joints between walls and floors should be sealed with floor grates and solid traps accessible for cleaning. Work surfaces should be impervious to grease, food particles or water and easy to clean. Food contact surfaces including appliances and equipment should be made of durable, corrosion resistant material that will not contaminate food. Working areas

should be well lit, with light fittings which are easy to clean and will not contaminate work area if broken. The area should be sufficiently ventilated to minimise the build up of condensation, fumes, smoke or vapours.

Fish bins or other containers used to hold seafood should be constructed from non-toxic material with smooth surfaces that are easily cleaned. The bins or containers should be kept in good repair.

(c) Refrigerated storage

The refrigeration and cold storage systems should provide adequate cooling and freezing performance capabilities to deal with large batches of stock. The walls of refrigeration and cold storage areas should be easily cleaned and equipped with thermometers. If fish are to be cooked or processed, then refrigeration systems should have space to separate cooked and raw seafood. The system should have capacity for ice without contamination for raw or cooked seafood. The ice storage areas should be in good repair, non-corrosive and easily cleaned.

(d) Chemical, packaging and waste storage areas

Chemicals should be stored away from food handling area off the floor in appropriately labelled containers with lids. Packaging containers and materials should be stored off the floor in a dry, well-ventilated area. Fish waste should be stored in leak-proof and non-absorbent containers segregated from food handling and other storage areas. Containers should be easily and securely closed. Any waste temporarily stored in food handling areas should be clearly labelled.

(e) Hand washing facilities

Hand washing facilities with warm running potable water, soap/detergent and disposable towels should be readily available within seafood handling areas. These facilities should be maintained in a clean and sanitary condition.

(f) Water supply

Any premises handling seafood should be provided with a suitable and adequate supply of water. A potable water supply should be available in a quantity and pressure that ensures cleaning activities can be conducted effectively.

5. Water management

5.1 Tank, raceway and pond preparation

Preparation of ponds, raceways or tanks for stocking is a crucial step in the actual cultivation of a crop and if incorrectly undertaken, can lead to significant financial loss. In the case of all-in all-out production regimes, this usually follows a farm dry-out, repair and maintenance phase.

A pond, raceway and tank preparation protocol should be developed with a timetable for activities such as maintenance, repair and re-installation of screens, aeration and filtration equipment, pumps and pond and tank structures. Pond preparation usually occurs during cooler non-productive months.

Recirculating aquaculture systems.

In recirculation tank systems pre-activation of the biofilter can be accomplished by seeding with appropriate bacteria. Alternatively, fish may be stocked and a gradual increase in feeding over 4-6 weeks can result in bio-filter colonisation. Biofilters usually take a period of months before being fully colonised and stable.

Dryout periods (Ponds)

Generally, complete dry-out of the entire farm is favoured for some species as this practice has shown to reduce disease incidence and result in higher production. At the end of the previous growing cycle, the ponds need to be dried out completely. A drying period can be completed in about one month under favourable weather conditions.

The bed of the pond is usually tilled (to a depth of 5 – 10 cm) to ensure the oxidation of residual organic matter remaining from the previous crop. Excess silt can be removed and pond walls repaired if necessary. Where soils are acidic, agricultural lime may be added. In the case of disease outbreaks in the previous season, calcium hydroxide ($Ca(OH)^2$) or calcium oxide (CaO) may be used as a caustic disinfectant, to kill residual pathogens and pests.

Establishing optimal plankton populations for larvae/fry rearing stages

Aquaculture pond systems operate in a photosynthetic environment with promotion of an aquatic food web, usually based on plankton in the water column. Various nitrifying plankton and bacteria remove nitrogen. Following pond preparation, correct phytoplankton and zooplankton populations need to be established. There is often more art than science in achieving and maintaining optimal plankton populations. However, sudden weather and other water quality changes can play a significant role in destabilising the plankton populations. Appropriate use of fertilisers (type, quantity, frequency, etc.) and a procedure on how and when to increase or decrease plankton blooms should be detailed.

5.2 Pond/raceway/tank water management

Intensive aquaculture involves the addition of relatively high protein formulated feeds (essentially a potential pollutant) to the culture system. This results in elevated nutrient levels in the system and their effluent.

Poor water quality has been associated with disease outbreaks in aquaculture ponds, raceways and tanks. Correct water management prevents unnecessary stress to cultured species which in turn maximises growth and minimises opportunity for outbreak of disease.

Recirculation systems (tanks or ponds) are prone to water quality problems associated with the build up of potentially toxic substances resulting from the stocks metabolic wastes. Of particular concern is nitrogen in its ammonia and nitrite forms which can be toxic to stock. Biofilters within the culture system have an essential function in removing ammonia and nitrite from water. In the case of recirculation tank systems this is usually achieved by use of nitrifying bacteria (eg *Nitrobacter* sp and *Nitrosomonas* sp.) grown on purpose built biofilter systems. Most tank facilities operate under a partial water exchange routine to replace water lost through backwashing, cleaning and exchange. Water exchange could account for up to 3% of total tank volume per day.

Incoming pond, raceway and tank water should be filtered with appropriate mesh size screens to prevent entry of unwanted organisms. A plan for routine water recirculation and exchange to maintain transparency of pond water and the population of plankton should be developed.

Dissolved gas (essentially oxygen and carbon dioxide) management is crucial in aquaculture operations. Appropriate aeration will result in increased productivity and reduced waste products within the discharge water. Dissolved oxygen is usually the most critical parameter. Carbon dioxide is more of a problem in tank recirculating and transport systems and is a function of design, loading and pH control. Mechanical aeration systems should:

- promote water circulation,
- maintain oxygen levels within acceptable limits (>4ppm for warm water species and > 6ppm for cold water species),
- minimise stratification in the water column, and
- maintain oxygen levels during periods of poor water quality eg high biomass, under some chemical treatments, during inclement weather and following algae bloom “crashes”.

Monitoring

Monitoring of the physical, chemical and biological parameters and maintaining them at optimum levels is essential. Parameters include Dissolved Oxygen, pH, Salinity, Temperature, Ammonia, BOD, Total Alkalinity, Hardness, Ozone, Nitrite and plankton density.

Preferred management:	provision for regular monitoring of pH, Temperature, Ammonia and DO and an arrangement with an accredited laboratory for full water analysis.

5.3 Effluent Water reconditioning system

Effluent water quality issues include:

- dissolved wastes from metabolic activities of stock and biological breakdown of waste feed particles and faecal matter,
- particulate nitrogen and phosphorus originating from waste food particles, faecal matter, algal cells, soil particles (in ponds) and sediments (from poor

quality intake water),
- suspended solids from organic matter, soil particles (in ponds) and sediments (from poor quality intake water),
- excess phytoplankton.

As aquaculture technology has evolved, it has moved towards improved techniques in the management of water quality and in the recirculation of discharge culture water. Reuse may extend from semi/flow through systems with utilisation of the discharge water in downstream crops (eg. shellfish, broad acre crops, orchards or hydroponics commonly referred to as integrated farming) through to complete recirculation of water as currently exists in many native freshwater fish ponds with the only discharge at the end of the growing season.

Properly managed reconditioning systems on most commercial freshwater pond aquaculture farms in NSW can achieve 100% recirculation with the make-up water only needed to replace evaporative losses. In most cases, well aerated ponds are able to assimilate nutrients wasted as metabolites during the growing season. In the case of estuarine pond systems, there is one NSW farm that operates on this basis albeit with lower stocking densities than more intensive farms. However, with improved design and management techniques, the goal of less than 3% exchange daily with the reconditioning ponds, and zero discharge to the natural environment (during growing periods) is achievable at higher stocking rates.

The potential benefits of water reconditioning/recirculation are:
- reduced water requirements which may be a limiting factor (especially with freshwater supplies in water embargoed catchments),
- reduced water discharge which can reduce stress on rivers or estuaries,
- improved quarantine by minimising pathways for introduction of diseases and pests,
- improved on-farm water quality control particularly where the external water source is variable in quality,
- additional economic benefit (eg value adding through use in irrigation),
- reduced energy requirements (eg pumping and heating).

The reconditioning/recirculation system must reintroduce the water to the culture system as close as possible to optimal requirements for the culture species. This usually involves treatment of the water in a sequential process by:
- ❑ removal of solids by use of screens, filters or gravity settlement,
- ❑ removal of metabolic wastes utilising biofilters (eg nitrogenous and phosphorus compounds),
- ❑ removal of other dissolved compounds and biological material (bacteria and plankton) by oxidation and precipitation,
- ❑ adjustment of temperature, pH or other characteristics for optional conditions.

The most common technique for treatment in pond systems is to use settling ponds to remove solids and to some extent dissolved nutrients. The retention time in the system is a critical issue with the minimum acceptable time being 24 hours with a recommended of 6 days of equivalent prior to discharge back to the ponds or to the natural waterbody. Effluent ponds can be designed in a particular way to help achieve these goals.

The water treatment system should not itself impact on water quality such as

increasing turbidity through silt re-entrainment or adding plankton blooms. In some systems, ecological systems within the reconditioning ponds can assist in improving the water quality such as wetland systems, other aquatic organisms, etc.

Preferred management:	For estuarine pond systems, retention of water in the reconditioning ponds for longer than 6 days prior to reuse or discharge

Monitoring

It is important to monitor the reconditioning system routinely using the above parameter to ensure that it is operating effectively. Contingency plans should be established to quickly correct the problems in the water quality. Factors affecting the performance may include:

- the overall load in the system (essentially how much feed is being used);
- the quality of the influent water to the reconditioning system (eg final portion (5-20%) of pond drainage tend to concentrate nutrients and solids);
- residence time of the water - recommended as minimum of 24 hours;
- weather (temperature, cloud cover, rainfall, wind);
- biological parameters (plants, plankton, bacteria);
- pond management practices.

Preferred management:	provision for regular daily monitoring of pH and DO plus on site facilities for basic water quality analysis of other parameters and an arrangement with an accredited laboratory for full water analysis.

5.4 Discharge of reconditioned water

(a) Saline water

Estuarine and marine aquaculture farms are permitted to discharge reconditioned water to natural waterbodies (estuary or ocean) provided they comply with the conditions of the Aquaculture Permit, the Development Consent and a licence under the Protection of the Environment Operations (POEO) Act.

The conditions of these approvals will relate to the location of outlets and the treatment of the water prior to discharge. The conditions will require outlets to be screened (at appropriate sizing relating to the size of stock) to prevent the escape of fish. In the event of disease problems Department of Primary Industries may order the farm water to be quarantined with no discharge being permitted from the premises.

Compliance with best practice principles in a licence will ensure that pollution is minimised. There are administrative fees associated with the DEC licences as well as a scale of fees based on discharge volume and associated operational parameters for the farm.

Discharge of reconditioned water to tidal waterways

Where there is discharge to natural waterways, the interim water quality

objectives for protection of aquatic ecosystems need to be taken into account. Where oyster leases or major fishing grounds are located near by, there may be additional requirements for protection of water quality for safe consumption of foods.

The NSW Government *Water Quality and River Flow Interim Environmental Objectives; Guidelines for River, Groundwater and Water Management Committees* should be referred to for details of the water quality objectives in the relevant catchment (See *Site Selection* Section). The Interim Objectives Booklet for each catchment should be consulted for further information.

There are eleven Water Quality Objectives that provide benchmarks or reference level to guide water quality planning and management. Of these eleven, the following may be relevant in areas where discharge of reconditioned water is to tidal or estuarine waterways:

- Aquatic ecosystems – maintaining or improving the ecological condition of waterbodies and their riparian zones over the long term;
- Visual amenity – aesthetic qualities of waters;
- Secondary contact recreation – maintaining or improving water quality for activities such as boating and wading, where there is low probability of water being swallowed;
- Primary contact recreation – maintaining or improving water quality for activities such as swimming, in which there is a high probability of water being swallowed;
- Aquatic foods (cooked) – Refers to protecting water quality for safe consumption of foods taken from natural waterbodies.

The DEC licence conditions including load and concentration limits, and monitoring and reporting requirements will be determined on a case by case basis. These conditions will be developed with a view to maintaining the water quality objectives determined for the relevant waterway. Final objectives will be determined in the context of water management plans developed by local water management committees, except in catchments where a Healthy Rivers Commission Inquiry has been conducted and recommended objectives accepted by the Government.

Monitoring volume of discharge

The DEC licence may place limits on the daily discharge from the farm (eg. 10,000kL/day) based either on direct flow discharge or indirectly based on intake pump operations.

The volume discharged can be calculated by

- using flow monitoring equipment (approved by the DEC); The flow meters must be fitted to all discharge points and must provide daily and weekly flow levels; The net flow must be calculated taking into consideration the rainfall during the period; monitoring equipment must be regularly maintained and calibrated; Written records must be kept; or
- estimating the flow based on the intake pump capacity taking into consideration the pump operating parameters calibrated against the pond volume and the daily and weekly pumping activities. This indirect estimation method is likely to overestimate the discharge volume on farms that treat and recycle water as intake water can be lost by evaporation especially during

summer months.

Monitoring water quality

Discharge concentration limits for aquaculture developments that hold an environment protection licence under the POEO Act will be determined on a case-by-case basis with a view to maintaining the water quality objectives determined for the relevant waterway, and will include consideration of issues such as existing water quality, streamflow and cumulative impacts. Licence limits will usually be set for a number of parameters, including BOD, NFR, TP, TN, DO and pH.

Typical concentration limits for estuarine aquaculture developments that hold an Environment Protection Licence under the POEO Act are as follows but these may vary on a case by case basis.

Table 24. Monitoring of Discharged Water[⊗]

Parameter	**Sensitive waters** including estuaries where prawn farms located	
	90% limit	**100% limit**
BOD		20 mg/L
NFR[∅]	60 mg/L	90 mg/L
TP		1 mg/L
TN		10 mg/L
DO		>4 mg/L
pH	6.5 to 8.5	

The Queensland EPA (in consultation with the CSIRO) have recently suggested the following performance measures for prawn farms averaged over the growing season and measured as the level above the background and based on a average 4% daily water exchange rate:

- Total suspended solids 12kg/ha/day
- Total Nitrogen as 0.48kg/ha/day
- Total Phosphorus as 0.06kg/ha/day

Reporting and compliance

Monitoring of the above parameters and an annual Statement of Compliance are required under the CFMP and the POEO Act.

(b) Fresh water

Under the Hunter and Central Coast Sustainable Aquaculture Strategy, freshwater aquaculture farms are not permitted to discharge water to natural waterways (exception maybe provided for species approved for flow through production).

Freshwater must be:

- totally recycled in the aquaculture enterprise with no (or virtually no) water available for disposal;
- discharged through a trade waste agreement to a town sewerage system

[⊗] *Sampling point must be up-current of the discharge point between 5-10m from the bank and 5-10m from the discharge point and/or in the intake channel*

[∅] *Exceedence of NFR allowed if NFR> in receiving waters at time of discharge and the farm is being operated in accordance with best practice*

(only available for tank culture in industrial areas);
- used as a substitute for raw water in agriculture, hydroponics or horticulture; or
- disposed of by irrigation or evaporation.
- For Salmonoid farm discharge treated to an acceptable DEC levels.

Discharge concentration limits for aquaculture developments that hold an environment protection licence under the POEO Act will be determined on a case-by-case basis with a view to maintaining the water quality objectives determined for the relevant waterway, and will include consideration of issues such as existing water quality, streamflow and cumulative impacts. Licence limits will usually be set for a number of parameters, including BOD, NFR, TP, TN, DO and pH.

Because of the importance of the efficient use of the water as a resource, wherever possible the discharge water should be used as a substitute for raw water in the irrigation of crops rather than a disposal scheme.

The reuse of water on site may require a licence under Part 2 of the Water Act. Users must ensure that the restrictions in place in the Hunter-Central Coast under embargoes are complied with. This includes the reuse of water from aquaculture facilities for irrigation or other uses. DIPNR has requirements for water quality levels to be achieved through any reuse application. Riverine discharge of aquaculture waters must achieve acceptable DEC or catchment target levels.

Substitute for raw water

As part of an integrated farming enterprise, commercial horticultural or agricultural crops may be operated and could utilise the water instead of raw water from the river or groundwater. Other “substitute” uses on the aquaculture farm may include irrigation of landscaping or gardens established as screening or as part of a “tourist” facility. In some locations, it may be possible to form a relationship with nearby farmers to on-sell or take the water. However, the economics of pumping or transferring the water to another farm should be fully costed.

Provision must be made to store the water during rainy periods, when application of water is not required for growth. As with other aspects of the aquaculture property, the land for irrigation should not be within 50 metres of a natural waterbody (and 500 m for barramundi).

Other factors relating to good farming and irrigation practice should be followed including:
- soil characteristics for sustainable plant growth
- avoiding sloping land unless drip irrigation,
- efficient application methods, metering/monitoring so not to over water,
- adequate erosion management provisions,
- avoiding land with salinity or potential salinity problems.

As aquaculture is labour intensive, intergrated projects should consider having a separate labour force.

Reference could be made to the NSW Guidelines for Dairy Effluent Resource Management regarding land application criteria. Under normal circumstances

where water is used as a substitute for raw water, specific licence conditions for its use are not required.

Disposal schemes

Where it is not possible to form a relationship with an agricultural, horticultural or other water user, it will be necessary to develop a disposal scheme to "get rid" of the water. These may include high volume irrigation schemes or evaporation in basins which will require a higher level of environmental assessment during design and a higher level of management during operation. These schemes may need to be licensed under the POEO Act.

5.5 Sludge management

Dried sludge and sediment at the bottom of drained ponds may be either ploughed into the base of the pond or removed depending on the nature of the material.

Sludge from tank aquaculture may need to be collected daily and de-watered. Depending on the location and the type of culture, the sludge should be disposed of regularly through:

- a trade waste agreement with disposal to landfill or to the sewer,
- sent to a commercial composter, or
- used in agriculture – being incorporated in the soil using techniques similar to those used for the disposal of sludge from cattle feedlots or piggeries.

6. Managing other environmental issues

Maintaining good relations with neighbours, tourists, the wider community, relevant regulatory agencies, financiers and customers is simply good business practice. The environmental management plan for the farm should consider issues that may impact on these relations.

6.1 Working hours

Generally the hours of operation shall be restricted to those indicated below except in areas where there are no residences within the noise catchment (this catchment will vary with the topography but could be expected to be about 1 km)

Activity	Monday to Friday	Saturday	Sunday/ Public holidays
Construction work	7:00 am - 6:00 pm	8:00 am - 1:00 pm	Nil
Noisy operations eg. lawn mowing and truck movements	7:00 am - 6:00 pm	8:00 am - 1:00 pm	Nil
Other "quiet" operations & the operation of circulation pumps & other equipment	Anytime	Anytime	Anytime

6.2 Noise

On farm noise sources such as those associated with equipment for feeding,

pumping, aeration, harvesting, maintenance and construction need to be managed, particularly in noise sensitive locations and at noise sensitive times. Sound can be enhanced at night time due to the effects of temperature inversion, air drainage and light winds blowing from the noise source to the neighbours. Consequently, the responsibility is on the operator of the farm to ensure that noise impacts do not unreasonably affect neighbouring residents not only during the day but also evenings or weekends.

Minimising noise at source

With all plant and equipment, every effort should be made to reduce the noise levels at the source, for example with insulation or maintenance programs. In some case enclosing the equipment in sheds or vegetated bund walls can be used to reduce noise levels. Noisy malfunctioning equipment should be repaired immediately and maintenance programs should ensure that these malfunctions do not occur regularly. For farms needing a licence under the POEO Act, there is a requirement that all plant and equipment should be operated and maintained so as not to exceed the prescribed sound pressure levels for the equipment. The noise levels are based on the performance of new equipment fitted with residential silencers where appropriate. The operator should monitor noise levels to confirm performance in accordance with the method, location and frequency set by the DEC's licence.

The use of noisy predator scare systems, sirens, PA systems, vehicle backing or other noisy devices that may be a noise nuisance should be minimised. These types of devices should not used except in the event of emergency or as required under Occupational, Health and Safety Regulations.

Noise goals at receptors

The daytime or night-time noise level ($L_{A10(15minute)}$) from the operations on the project site for existing meteorological conditions (winds up to 3m/s) shall not exceed the background noise level at the nearest receptor by more than 5dB. Typically the criteria for rural areas would be background + 5dB, however the NSW Government "Industrial Noise Policy" should be referred to. The ($L_{A10(15minute)}$) noise level must be measured or computed at the most affected point on or within the residential property boundary or, if this is not more than 30 metres from the residence, at the most affected point within 30 metres from the residence, using "fast" response on a sound level meter. The background noise level at the nearest receiver locations should be determined in accordance with the methods detailed in Section 3 of the Industrial Noise Policy.

If the noise has substantial tonal or impulsive characteristics, 5 dB(A) must be added to the measured level. To prevent sleep disturbance, the ($L_{A1\ (1minute)}$) noise levels should not exceed the background noise level by more than 15 dB when measured at the most affected point 1 metre from a bedroom window of the nearest affected residences.

Noise impacts that may be enhanced by temperature inversions must be addressed by documenting noise complaints received to identify any higher level of annoyance from the change in impacts or impact patterns as a result of inversions; and where levels of noise complaints indicate a higher level of annoyance, developing and implementing actions to quantify and ameliorate any enhanced impacts under temperature inversion conditions.

It is important to let neighbours know ahead of time if there are likely to be any unusually noisy operations especially in the evening – for example predator scare devices or harvesting at night. Where possible agreed protocols for the noisy activities should be developed.

6.3 Odour

Odour emissions from aquaculture facilities are likely to be principally associated with pond dry out procedures, storage of feeds and management of any dead stock or fish processing wastes. It is an offence under the POEO Act to emit an offensive odour from an DEC licensed facility.

Minimisation of impacts of odours should be considered in the farm layout (eg. feed storage area, equipment, waste, cleaning and maintenance depots) and operational procedures (pond/tank dry-out procedures). Solid waste should be stored, transported and disposed of so as not to cause an odour nuisance.

Sediment from ponds or sludge from tanks must be disposed of in a manner that will minimise odour or leachate problems. Sediments in ponds should not be disturbed until dry when it can be either incorporated into the bed of the pond or removed. Sediment from tanks should be stored in a designated storage area (within appropriate bunding or sediment trap to prevent sediment runoff to adjoining areas/waterways) so it does not become anaerobic and generate odours prior to;

- spreading as top soil in appropriate crop or pasture areas; or
- transport to a commercial composter or landfill.

6.4 Dust

Dust can pose problems during construction stages if the construction erosion and sediment procedures are not followed (*See Planning and Design section*). Appropriate surfacing of high traffic roads and vegetation of wind exposed areas can minimise dust emissions. Until disturbed areas are stabilised, sprinklers can be used to minimise the spread of dust. It is recommended that neighbours be advised ahead of work schedules likely to generate dust to avoid potential problems.

6.5 Visual appearance

A neat and tidy operation with appropriate vegetative screen plantings, earth moundings and low key coloured shed which are sited well in the landscape is more likely to create a good impression on neighbours. In rural environments, landscaping should be used to soften the impact of “industrial” look of shed complexes including “natural looking” planting of native species along boundaries.

Orderly and well-maintained facilities also promote confidence in the operation’s environmental performance.

6.6 Energy and greenhouse issues

While energy competes with other issues for limited resources within a business, implementation of energy efficiency initiatives can lead to benefits which extend beyond energy savings to include pollution prevention, process efficiencies and

increased productivity.

Farm operations should be designed to minimise energy usage (eg. by incorporating gravity distribution of water between the ponds) and through the use of renewable energy technologies where possible such as solar or wind power.
In addition, there should be awareness of energy usage and conservation opportunities including:

- Monitoring annual and quarterly energy expenditure;
- Promoting reduced energy management patterns and maintain equipment for optimum performance;
- Isolate and remedy energy wasteful actions or activities including minimising unnecessary vehicle use.

Aquaculture operators may also be able to minimise their greenhouse gas emissions by participation in programs being run by the Sustainable Energy Development Authority (SEDA) and through cooperative agreements under the Greenhouse Challenge Program. To further assist new development proposals the Department of Infrastructure, Planning and Natural Resources is developing guidelines for considering potential greenhouse gas emissions associated with proposed projects as an environmental factor based on the methodology developed by the Australian Greenhouse Office.

6.7 Waste management

Waste management protocols should be developed to reduce and recycle waste and to store and dispose responsibly of waste material. Generally waste materials should be sorted and stored in suitable containers for recycling, reuse or disposal.

The *Protection of the Environment Operations Act 1997* establishes a classification system for wastes which is documented in the *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes* (Waste Guidelines – EPA 1999). The legal obligations in respect of the management of wastes are based on their actual classification as determined in accordance with the Waste Guidelines. The Commercial Farm Development Plan should include details of the name of the contractor and where the waste is to be removed. Receipts for all wastes (including solids and liquids) removed from the project site shall be held on site for a period of 12 months.

Table 25. Waste categories likely to be generated by aquaculture farms

Types of waste	Implications
Non-liquid inert waste *These types of waste are subject to minimal regulation*	
Virgin excavated natural material (VENM) eg. clay, gravel, sand, soil or rock that has not been mixed with other waste. This category does not include chemical contaminated soils or acid sulfate soils unless treated to meet criteria approved by DEC.	If material is to be brought onto the site for the construction of ponds, it should be clearly established that the material is from an approved quarry or meets the VENM classification. In addition if there is excess material to be removed from site following pond construction, ensure that it is not mixed with other materials or waste so it meets the VENM classification. If acid sulfate soils are to be removed from site, ensure that it is treated in accordance with the ASS Manual (ASSMAC) prior to removal from site to neutralise/remove the acid generating potential.
Building and demolition waste not mixed with other wastes or containing asbestos	Preferably building waste should always be sorted into components (eg. brick/concrete, glass, timber and metal) for reuse or recycling.
Packing and office waste (paper, plastics, glass, metal and timber) not mixed with other wastes	Preferably these should be recycled. A major source of waste is the plastic or paper bags used to transport feed. Reductions in the use of feed as a result of efficient feeding management result in reduced waste generated. The recycling of feed bags should also be discussed with the feed supplier or the supply of feed in bulk form.
Solid waste	
Food waste	Should pursue options to recycle material (eg. fishmeal, compost). Otherwise dispose of to an approved landfill.
Cleaned pesticide, biocide, herbicide or fungicide containers (cleaned in according to AVCARE protocols)	Avcare Protocols require recycling of containers as a first option. For copies of the Avcare Container Management Strategy, contact: Avcare, Level 2, AMP Building, Hobart Place, Canberra, mail to Locked Bag 916, Canberra ACT 2601. Phone 02 6230 6399 Fax 02 6230 6355., Email: avcare@ozemail.com.au
Pond/tank sludge that does not contain heavy metals or hazardous chemicals	The preferred use of the material is in compost mixes and/or direct incorporation into the soil for agricultural purposes. Where these preferred uses are not available or inappropriate, landfilling is acceptable at an approved landfill. Composting and agricultural applications of sludge may not be appropriate for sludge arising form salt-water ponds/tanks.
Industrial waste	
Asbestos waste from old buildings or industrial plant	Any asbestos should be managed in accordance with the requirements of Clause 29 of the *Protection of the Environment Operations (Waste) Regulation 1996* and disposed at a lawful waste management facility.
Hazardous liquid or non-liquid waste	
Quarantine waste	This material must be stored, handled, transported and pre-treated in accordance with the requirements of the Australian quarantine and Inspection Service (AQIS) prior to disposal at an approved disposal facility approved by AQIS. It should be noted that most landfills are not licensed for disposal of quarantine waste.

Types of waste	Implications
Chemicals, pharmaceuticals and poisons	If chemicals are not to be use, inquiries should be made with distributors about the possibility of returning the material. Alternatively inquiries could be made as to whether other users are interested in taking the material. As a last option, the *Assessment, Classification and Management* Guidelines should be followed regarding the safe disposal of the material.
Liquid wastes *other than hazardous above*	
Group A: Oils, solvents and solvent containing liquids	Arrangements should be made with a contractor to remove these materials from the site preferably for reuse or recycling.
Group B: Liquid food waste or grease traps from food processing	Arrangements should be made with a contractor to remove these materials from the site preferably for reuse or recycling
Group C: Sewage – if on-site system	Where connection to a reticulated sewerage system is not an option, on-site sewage treatment should be in accordance with the Guideline -–*On-Site Sewage Management for Single Households 1998*.

7. Environmental contingency planning

A contingency plan should be established with specified management actions documented to deal with problems should they occur.

Issues that should be dealt with in the plan include:

- water quality incidents in growing ponds/tanks, reconditioning ponds or storage ponds,
- disease outbreaks,
- feeding problems,
- predators,
- chemical spills,
- flooding,
- dam/pond security,
- power failure or mechanical failure of key equipment (especially important for tank systems).

The contingency plan should include protocols which all staff should be made aware of. The contingency plan should include:

1. agreed indicators that suggest that there is likely to be a problem;
2. requirement to alert appropriate senior person in the company immediately;
3. what actions will be taken should the conditions deteriorate;
4. what actions should be taken in the event that the problem results in an environmental breaches occurring;
5. what actions should be taken in the event that the problem results in a loss of stock;
6. when the regulatory authority and others should be alerted.

Other issues that may need to be included in the contingency plan include drought proof planning in relation to pond/tank and/or potable water supplies in areas where water supply may not be reliable.

8. Decommissioning when a change in land use

The abandonment of failed aquaculture sites was a feature of the 1970s and 1980's when projects were established without an appropriate consideration of site selection, environmental and market factors. The objective of the Hunter and Central Coast Sustainable Aquaculture Strategy is to ensure that aquaculture enterprises are established and operated in a sustainable manner. As a result, emphasis has been placed on the need for careful site selection, design, operation and business management. The principles and technical knowledge behind the best practice in the AIDP are now well understood and consequently there is confidence that enterprises established following this best practice are not likely to fail.

In the event that no production occurs at an aquaculture farm for a number of years, the aquaculture permit may be cancelled because of the failure of the permit holder to comply with the requirements of the Commercial Farm Development Plan. If an aquaculture enterprise is to cease operations, the site should be secured to the extent that it will not generate unacceptable off-site environmental impacts or potential occupational health and safety problems (eg. electrical infrastructure, chemical storage, building security).

Decommissioning works may include:

- Closure of water intake and outlet channels and remove pipes and pumps from any river or estuary;
- Stabilisation of any disturbed areas in the riparian zone;
- Stabilisation of ponds/dams and if necessary filling in of ponds/dams and restoration of topography;
- Revegetation of any disturbed site areas.

9. Interfacing with the community

The managing and maintaining of good public relations is essential for an individual farm and also for the industry as a whole. Aquaculture, in part due to its novelty, attracts a large amount of community interest. It is important to recognise this interest and deal with it in a proactive manner.

9.1 The community

Consumers are increasingly concerned with the environmental credentials of food production and the aquaculture enterprises can benefit from demonstrating its environmental credentials. The public should be dealt with openly and honestly even when things go wrong. It may be useful to seek advice in preparing a public relations management plan for promoting the products as well as for dealing with routine enquiries as well as complaints. Proactive and transparent management of community relationships can pay long-term dividends.

9.2 Tourism and fishout facilities

Making provisions for the public to visit the facility either as part of a tourist visitor centre (with displays and information), with opportunities for purchase of product,

can help provide an open-door approach to the local as well as the broader community. This can help to promote the role of the aquaculture farm in the local economy as well help promote the industry as a whole.

In the same way, a well-run fish-out facility can also provide a useful liaison with another sector of the community. However, with both tourist and fishout related activities, the full environmental and operational costs should be considered.

9.3 Complaints handling procedures

All major aquaculture farms will be required to establish Complaint Handling Protocols under their conditions of consent. The council (if not the consent authority) should be informed of the procedures so if complaints come directly to council, they then are aware of where to refer the complaints. If DEC is the "appropriate approval authority" under the POEO Act, the Complaints Handling Protocols will be a component of their licence.

The Complaints Handling Protocols shall include:

- a contact number and a site contact person who will follow up complaints;
- complaints register including a record of the complainant, the date/time, the nature of the complaint,
- proposed mitigation measures and follow up with the complainant;
- any contingency measures when repeated complaints are received including provisions for additional monitoring and amelioration measures;
- any compliance performance agreements with residents; and
- any reporting procedures to relevant government agencies or council.

When analysing the cause of complaints, consideration should be given to whether the impact causing the complaint resulted from normal operational procedures or from an "incident" or occasional procedure.

- If it resulted from occasional procedures, discussions should be held with complainants regarding whether it was the timing or nature of the impact and where these variables can be changed so as not to cause a nuisance. In many cases an agreement can be reached between parties with regard to notification that the procedures are going to occur and their timing, duration and intensity to reduce annoyance.
- If it resulted from normal operation procedures, these procedures should be reviewed in discussions with the relevant approval authorities.

10. Integrated compliance monitoring and reporting

10.1 Monitoring

An environmental monitoring program should be carefully designed and related to the key environmental indicators that demonstrate the potential sustainability of the aquaculture farm. The program should monitor operational parameters as well as quantify the extent and nature of any off-site environmental impacts attributed to the farm. Parameters that may be relevant include:

- parameters relating to critical operational issues, for instance in relation to

stock health issues or management;
- water management parameters;
- if relevant, noise or odour parameters including complaints.

The program should outline the need for and use of any proposed monitoring, including:
- the key information that will be monitored, its criteria and the reasons for monitoring (which may be compliance with regulatory requirements);
- the monitoring location, intervals and duration;
- methodology for sampling and analysis by a suitably qualified person/ laboratory;
- trend analysis of performance (compared baseline and previous results);
- procedures to be undertaken should the monitoring indicate a non-compliance or abnormality;
- links to management practices so that information from the monitoring program can adapt management practices to improve the performance (operational or environmental).

10.2 Record keeping

Comprehensive record keeping is essential, not only as a requirement of licence and permit conditions but as a fundamental tool in farm management and trouble shooting. A computerised database for record keeping should be established for tracking both the business and environmental performance. This makes data storage and analysis routine and reliable and reduces the effort in reporting.

From a business management point of view, the data sets make analysis of expenditures, production levels, returns and environmental performance for sound future planning. In addition the data is available for reporting to the relevant government agencies on the environmental performance. DEC usually requires records to be held for a minimum of 3 years so that the details of longitudinal trends can be checked, if necessary.

10.3 Reporting

(a) Annual reports

A single annual report must be prepared within 6 weeks of the anniversary of the development consent (and then annually) to comply with the reporting requirements under Development Consents, Aquaculture Permits, Environmental Protection Licences and any reporting requirement of any other approval. Monitoring and reporting requirements for aquaculture developments that hold an environment protection licence under the POEO Act will be determined on a case-by-case basis, and might include additional parameters or requirements to those shown in Table 26 below.

Table 26. Monitoring Parameters for the Annual Report

Monitoring parameters	Saline		Freshwater	
	Ponds	Tanks	Ponds	Tanks
Production levels	✔	✔	✔	✔

Stock health incidents	✔	✔	✔	✔
Water recirculation/ reconditioning program	✔	✔	✔	✔
Quality/quantity of discharge water released to natural waterbody (non salmonoid)	✔	✔	N/A	N/A
Quality/quantity of salmonoid farm discharge water released to natural waterbody	N/A	N/A	Salmonoid farms only	Salmonoid farms only
Total nutrient load released from Salmoniod farm	N/A	N/A	Salmonoid farms only	Salmonoid farms only
Reuse of freshwater discharge water	N/A	N/A	✔	✔
Sludge	✔ if not incorporated in pond walls	✔	✔ if not incorporated in pond walls	✔
Waste management	✔	✔	✔	✔
Predation management	✔	N/A	✔	N/A
Incidents	✔	✔	✔	✔
Complaints management	✔	✔	✔	✔
Noise and odour	only if it becomes an issue with the community			

In addition to environmental matters, the report should include matters relating to stock management including translocation issues, disease management, sales and production. The report should include the results of monitoring in tabular and graphical formats and indicate whether the environmental performance complies with the conditions of the approvals.

(b) More regular reports

With farms that discharge water to natural waterbodies, DEC may require more regular reporting (eg. monthly or quarterly). These reports should include a summary of the monitoring data, drawing DECs attention to any trends that may be inconsistent with approval conditions.

(c) Incident reporting

There is an obligation on the aquaculture operator to report environmental accidents or incidents that may not be authorised under an approval to the appropriate regulatory authority. Under the POEO Act, there is a responsibility to immediately notify any pollution incident to the “appropriate regulatory authority” - DEC for licensed aquaculture farms and usually council for others.

If an event occurs which is causing or is likely to cause environmental harm, the authority may require that a written report be prepared within 7 days outlining:

- what happened (materials and quantities involved, time and duration of event);
- who was involved and who witnessed it (names and addresses);
- what were the consequences (include remedial actions taken);
- why the incident occurred (eg human error, failure in design or maintenance or natural disaster);
- how it can be prevented from happening in the future (proposed measures to prevent or mitigate against a recurrence).

Table 27. Incident Reporting

Incidents	Authority	When
Disease outbreak or unusual behaviour of the stock	Department of Primary Industries	As soon as practicable but within 24 hours
Incidents involving breaches of quarantine or translocation protocols	Department of Primary Industries	Immediately and in not more than 24 hours
Incidents causing or likely to cause environmental harm whether on or off the premises which are not authorised under the approval (eg. chemical spills, accidental release of untreated pond water)	DEC pollution line if Appropriate Regulatory Authority or Council or DIPNR	As soon as practicable but within 24 hours
Flooding issues	DIPNR	As soon as practicable
Dam safety	DL	As soon as practicable
Incidents involving harm to birds or other native fauna which are not authorised under the approval	DEC	Immediately and in not more than 24 hours
Bushfires	Fire authority and local council	Immediately

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