CRAWFORD BAY Aquaculture Licence Application

Environmental Scoping Document

1. PURPOSE OF DOCUMENT

Maxima Fish Farms Pty Ltd has prepared this Environmental Scoping Document for the Environmental Protection Authority (EPA), as part of the environmental assessment process supporting an application for a Barramundi aquaculture proposal at Crawford Bay, Buccaneer Archipelago. The EPA determined that the proposal warranted a formal assessment in accordance with the *Environmental Protection Act (1986)* (EP Act), and the level was set at Public Environmental Review (PER) with a 4 week public review period.

As a part of the application process, Maxima Fish Farms (MFF) has been in consultation with all appropriate agencies including WA Fisheries, Department of Environment (DoE), and the EPA. The proposal was also referred to the Commonwealth Department of Environment & Heritage (DEH) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

This proposal submitted by MFF is to implement sea cage culture utilising 20 grow out cages and 8 nursery cages to produce a maximum of 1,000 tonne of Barramundi per annum in an open water system situated on the northern side of Crawford Bay.

The purpose of this document is to establish:

- The key characteristics of the proposal.
- The environmental issues and factors that may be affected by the proposal.
- The proposed scope of works.
- The estimated scope and duration of the processes required to accomplish this assessment with relevance to the PER.

2. IDENTIFICATION OF PROPONENT

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3. SUMMARY DESCRIPTION OF THE PROPOSAL

Location

The proposed Barramundi aquaculture site is approximately 87 hectares and is located in Crawford Bay, Yampi Sound, Western Australia. Crawford Bay is located approximately 210 km NNE of Broome in the north-west of Western Australia. The bay is approximately 6.3 km long and 4.2 km wide near its west-facing opening and there are three small islands in the northern region of the bay. The co-ordinates of the proposal site and a map are demonstrated in Attachment 1.

Proposal

This proposal submitted by Maxima Fish Farms (MFF) is to implement sea cage culture utilising 20 grow out cages and 8 nursery cages to produce a maximum of 1,000 tonne of Barramundi per annum in an open water system situated on the northern side of Crawford Bay. The key characteristics identifying the details of the proposal are described in Table 1.

All fingerlings will be sourced from an accredited hatchery. It will be preferable to source the fingerlings from the Kimberley College of TAFE or Darwin Aquaculture Centre, NT provided that the number ordered is available when required. If not, fingerlings will be sourced from other accredited hatcheries according to the Fisheries WA translocation protocol. Health testing of the fingerlings will be conducted by the Animal Health Laboratories, WA Department of Agriculture or by another laboratory under the WA Fisheries senior pathologists' instructions to ensure freedom from disease. Initially, the fingerlings will be reared in the land based recirculation system located in Cone Bay until a minimum average size of 60mm (average weight of 5 grams) is obtained. The fish will then be transported to the nursery cage system.

Table 1: Key Characteristics Identifying the Details of the Proposal.

Element	Description
Life of project	• Increase production over 4 years to a maximum of 1000T/yr. • Ongoing
Location	Crawford Bay, Yampi Sound, Western Australia. ~210 km NNE of Broome
Species cultured	Barramundi (*Lates calcarifer*)
Expected Barramundi production • maximum	 • 1000 tonnes/annum
Size of proposed aquaculture lease area • maximum	 • 87 hectares
Maximum number of cages • nursery • grow out	 • 8 • 20
Size of cages • nursery • grow out	 • 6m (length) x 6m(width) x 5m (depth) • Between 40m, 60m and 80m circumference.
Volume of cages (dependent on circumference) • nursery • grow out	 • 180 cubic metres • 636-2,547 cubic metres
Stocking density within cages • nursery • nursery maximum • grow out • grow out maximum	 • 10-15 kg/m^3 • 20 kg/m^3 • 15-20 kg/m^3 • 40 kg/m^3
Feed input • maximum • Source	 • 1,200 tonnes/annum • Ridley AquaFeed 45/20
Waste produced (Nitrogen and Phosphorous in solid and dissolved form) • maximum	 • 184 kg/day

The fingerlings will be stocked conservatively to reduce stress and in turn reduce the risk of disease or parasite infection. It is intended to stock the nursery cage system at 10 to 15 kg per cubic metre and the grow-out cage system at 15 to 20 kg per cubic metre respectively. The stocking density of the grow-out cage system will not exceed 40 kg per cubic metre, except during crowding for grading and harvest operations. The length of time a "batch" of Barramundi will be grown in the sea cages will be between 12-22 months. Initially the cycle will be closer to

12 months than 22 months (predominately for economic reasons). As the proposal continues and increases production, the cycles will be closer to 22 months. Due to the 12-22 month cycles, production will be continuous as opposed to seasonal, which will be closely monitored and controlled via conservative stocking densities.

It is proposed that the nursery cage system will consist of 8 square cages of dimension 6 by 6 by 5 metres deep. The cage system will consist of 4 pairs of cages running parallel to each other divided by a working platform. The mesh size of the polyester knotless nets utilised will range between 6 and 10mm. Each cage will consist of 2 nets to allow easy removal of 1 net for regular cleaning without disruption to production. The nursery cage system will be anchored within a mooring grid designed by mooring specialists and the entire nursery cage system will be encompassed by a predator proof 32mm wire net of 3.2mm gauge. 50mm polyethylene or nylon bird exclusion nets will be utilised to prevent bird entanglement and fish escapes. The fingerlings will be retained in the nursery cage system until they reach a minimum of 160mm and a maximum of 250mm before being transferred into the grow-out cage system.

The grow-out cage system will consist of 20 sea cages. It is proposed that the circumference of the polar circle grow-out cages will range between 40 and 80 metres and the net will have 5 metre deep side walls which will result in a depth of 8 metres in the centre. The volume of the smaller cage (40 metre circumference) is approximately 636 cubic metres and conservatively has a carrying capacity of 12.5 tonne (stocking density of 20 kg per cubic metre). The volume of the cage of 80 metre circumference is approximately 2,547 cubic metres which results in a conservative carrying capacity of 51 tonne.

The main collars of the floatation device, hand rail and stanchions are constructed of high density polyethylene (HDPE). The polyethylene pipe that forms the collars and hand rail are joined using a technique known as butt-fusion. Nets of 2 differing dimensions (25mm or 32mm) will be utilised but all will be constructed using a marine wire produced by One Steel. The 25mm net consists of a 2.8mm wire and the 32mm has a 3.2mm gauge is heavily galvanised to provide multiple layers of protection from corrosion. The net is joined using wire coils of the same dimension as the net for added strength. The net is then secured to the collars at 0.5 metre intervals to 2 cables using 50mm wide webbing straps, or 14mm polyester double braid rope and galvanised D-shackles. The cages will be anchored within a mooring grid designed to withstand cyclonic conditions. Bird exclusion nets will be utilised for each individual cage.

At the onset of the proposal with the exception of sea cages and a feed storage barge with centralised feeder, no additional infrastructure is required within Crawford Bay. All staff will be accommodated on Turtle Island, Cone Bay and will commute by boat to the site on a daily basis. Turtle Island is an operational work base for pearling and aquaculture ventures within Cone Bay where housing and work facilities are in existence. All rubbish, discarded equipment and fish mortalities will be returned to the Cone Bay site for sorting. Materials that can be, will be reused, all food waste is composted, paper and card products are incinerated and plastics and aluminium are crushed and stored in 200 litre drums and transported to Derby for recycling. An ensiler will be utilised for any fish mortalities and other waste products that do not fit these categories are disposed of in 200 litre drums and transported to the Derby waste management facility. The island base has an air conditioned storage container in which all hazardous products are kept. Diesel fuel is stored in a 40,000 litre tank and unleaded fuel is stored in 200 litre sealed drums. As the proposal develops it may become necessary to situate a working barge within Crawford Bay that is able to accommodate staff and store large volumes of fish food and other equipment and supplies. However this is not the preferred option and if eventuates will undergo the appropriate assessments and approvals required at that time.

The fish will be fed a manufactured pellet ranging in size between 4.0mm and 11.0mm dependent on the average size of the fish within each cage at the given time. It is estimated that 1,200 tonne of feed will be required per annum once the total production reaches 1,000 tonne of fish each year. Feeding regimes and behaviour will be closely monitored by video image to prevent overfeeding and wastage. Size data will be regularly collected and utilised to calculate growth rates and feed conversion rates.

Harvesting will be conducted using a “Seine” net and fish pump or wet brail. The fish will be pumped whole into large slurry bins with lids and transported to the port of Derby by a suitable vessel. A refrigeration transport truck will then distribute the fish to Perth for processing and marketing.

4. BASIS FOR JUSTIFYING PROPOSAL AND SELECTING PREFERRED OPTION

Observational studies were undertaken in the areas and localities surrounding Cone Bay to determine the most appropriate site for this proposal. Other areas looked at included, but not limited to, were Strickland Bay, Cascade Bay, Lachlan Island and the Inland Sea. A few areas could not be considered for the proposal site due to their proximity to other leases (eg pearling in

Strickland Bay and nearby waters), where certain distances must be maintained between lease boundaries and activities according to the regulations imposed on each individual lease type.

Of all the sites visited and observed, Crawford Bay was deemed the most appropriate for the sea cage proposal. The most important criteria being the close proximity of the proposal site to the infrastructure based in Cone Bay, this being the Pearl Farm base and accommodation on Turtle Island. The importance behind this is that there will be minimal infrastructure requirements and therefore minimal environmental impacts at the proposal site. The only infrastructure required is the sea cages and associated mooring systems and a feed storage barge.

Crawford Bay also demonstrated better water flow rates and high tidal and current dynamics than other areas therefore potentially having higher flushing rates. Areas that were seen to have lower water flow dynamics (eg the Inland Sea) were not considered appropriate due to their potential for fast nutrient build-up and reduced flushing abilities. The site in Crawford Bay was also shown to have optimal depth and benthic structure (i.e. mud) for the sea cage proposal therefore having minimal impact on the site compared to other areas observed which encompassed coral reef structures or had more complex mangrove systems. The Crawford Bay site also offers greater protection against adverse weather conditions in comparison to all other areas.

5. REGIONAL SETTING OF PROPOSAL

Biophysical Context

Land/Topography/Soils

Crawford Bay is situated in Yampi Sound of the Buccaneer Archipelago, north of Derby.

The land surrounding Crawford Bay consists of King Leopold sandstone (see Attachment 2) and in most parts the rock face is a minimum of 10 metres above the high tide mark. Within the bay there are few existing beaches and mangrove areas but these are small and interspersed throughout the bay. The land surrounding the bay is Commonwealth land used by the Australian Department of Defence.

Benthic Habitat

The proposed lease area consists of mud bottom, as does the majority of Crawford Bay. During site selection, small fringing reefs were located near the rocky outcrops at the entrance to the bay and a few mangrove areas were noted within the bay. There were no sea grass beds found which indicates that this type of benthic habitat is consistent with Yampi Sound where a mud bottom dominates

Flora & Fauna

During site selection, no bird nesting behaviour was observed. It is envisaged that if bird nesting was to occur in the region it would be on the land surrounding the proposed sea cage system and the proposal would provide no interference. The existing beaches are small and do not provide significant surface area for turtle nesting. There are 13 threatened species and 23 migratory species listed within a 3 nautical mile radius of the area (see Attachment 3). Large marine mammals (dolphins), reptiles (crocodiles and turtles) and fish (various pelagic and reef species) have been noted in Cone Bay adjacent to the proposal site and are therefore, presumed to enter the waters of Crawford Bay as well. Possible issues of entanglement and provisioning with waste feed may occur, and the potential impacts of these will be investigated. Sightings of whales are not common in Cone Bay and it is expected the same will be observed in Crawford Bay.

Social Context

Current Usage

Crawford Bay is adjacent to Cone Bay, where Maxima Pearling Company currently operates both pearling and barramundi aquaculture ventures utilising the land base of Turtle Island. Maxima Fish Farms is an extension of Maxima Pearling Company and it is proposed that the existing infrastructure on Turtle Island which provides water, power and housing to the Cone Bay ventures will also be utilised by employees of the Crawford Bay proposal. To ensure that Crawford Bay is still accessible for recreational users, the sea cages will be clearly marked with navigational markers and arranged in such a way as to allow ample room for vessels to skirt the sea cages and mooring systems. The area surrounding the proposed site and sea cages is not deemed exclusive to aquaculture operations.

Cultural Heritage

The proposal site is located within state waters and there are no World Heritage properties, National Heritage places, Ramsar wetlands, listed Commonwealth Heritage places or areas of remnant native vegetation within the vicinity of the site. Although the area was included in the 1994 Report of the Marine Parks and Reserves Section Working Group (*A Representative Marine Reserve System For Western Australia)* undertaken by CALM with the result being a recommendation for conservation but zoned as multiple-use which includes the development of aquaculture ventures such this proposal. Maxima Fish Farms have been in consultation with members of the Yaluun Community and no aboriginal site issues have arisen from discussions to date.

6. SUMMARY OF POTENTIAL ENVIRONMENTAL IMPACTS, THEIR SIGNIFICANCE AND POSSIBLE MANAGEMENT RESPONSES

A preliminary risk assessment has been conducted to identify the main potential environmental, ecological and social risks that may arise from sea cage grow out of Barramundi and possible management responses to prevent and /or minimise the risk (see Attachment 5 - Potential Environmental Impacts, Their Significance and Management Responses.)

Preliminary Impact Assessment

Biophysical Factors

Disease Transfer – Potentially there is a risk of spread of endemic disease across the Barramundi population within the region and/or the introduction of exotic diseases and/or organisms. Management practices such as adhering to translocation protocols, regular health monitoring and disease testing of farm stock, stringent disease testing before introduction to the marine environment, conservative stocking densities, net maintenance/cleaning to ensure there is no restriction of water flow, using brood stock endemic to the region, improvement in hatchery techniques and staff training and education in animal health issues will reduce the risk.

Entanglement of Marine Life in Nets – The risk of entanglement is low as the nets are constructed of heavy gauge wire mesh that provides great strength and stability in the water. This prevents predation by crocodiles and sharks and provides a barrier for any other marine life in close proximity. Overhead netting to exclude birds is made of heavy gauge polyethylene or nylon material that is pulled taut over the cages to ensure birds can not become entangled in excess net. In addition, regular inspections of cages will be conducted to ensure all equipment is intact, equipment requirements will be minimal, all equipment will be dismantled and stored appropriately when not in use and spatial separation between cages will provide ample passage for underwater marine wildlife.

Provision of Artificial Habitat to Marine Fauna – Equipment requirements will be kept to a minimum and feeding will be closely monitored by use of video monitoring to reduce the risk of attracting marine fauna within sea cage proximity. The Cone Bay trial has observed some species of fauna within close proximity to the cages on different days but it does not appear that any one species remains within the vicinity for any period of time. Daily log sheets recording species, number and behaviour have been kept since the inception of the Cone Bay trial and will be

initiated into the Crawford Bay proposal and maintained for future developments and comparisons.

Impact of Fish Escapes – Fish escapes from the sea cages may impact on the genetics of the endemic Barramundi population within the region. Genetic variation can result from number of factors, including the introduction (due to translocation) of differing genetic material from Barramundi that are from different locales and also due to the simple fact that broodstock are specifically selected for the purposes of aquaculture (Department of Fisheries WA, 2002). The implications of genetic variation are that the "natural" population, over generations, will become 'less fit' and therefore unable to successfully adapt to environmental changes, for example climatic changes. The risk of fish escaping is low. To further minimise this risk, MFF will be utilising steel nets trialled in the Cone Bay development which have proven durable during adverse weather and to date, predator proof. To prevent accidental escape all staff are trained in net changing activities and regular maintenance checks are conducted on the steel nets to ensure no holes are present. Stringent transfer and harvest guidelines have been developed to reduce fish escapes during these processes and strict adherence to the regulations imposed in the *Fisheries Management Paper No. 159* (Department of Fisheries WA, 2002). Prevention is the main focus for this factor as no practical 'post-escape' contingency plan could be easily implemented for such an open system.

Provision of Additional Food Source from Waste Feed – There is a potential for excess feed to be made available to the marine wildlife outside the sea cages. Feeding will be closely monitored by use of video monitoring to determine the most efficient feeding regime. Recording of all marine wildlife will be undertaken to enable the proponent to determine the potential likelihood of waste feed issues occurring. The Cone Bay trial has observed some species of fauna within close proximity to the cages on different days but it does not appear that any one species remains within the vicinity for any period of time.

Effect on Coral Reef, Mangrove and Seagrass Areas – The site was selected due to the substrate consisting of mud and the lack of seagrass and coral reefs in the vicinity. This will ensure that any shading effect caused by the sea cages does not negatively impact on important sea grass and coral reef communities. The expected impact on Mangroves should be minimal as the proposal does not come in direct contact with the mangrove area within Crawford Bay, but is within close proximity. All anchoring systems will be a minimum of 100 metres from the above mentioned areas and the cages a minimum of 200 metres. Regular monitoring and comparisons with base-line data will ensure there are no adverse effects.

Benthic Substrate Changes- The benthic substrate directly below the cages will potentially be impacted due to both nutrient inputs, eg excess feed, wastes produced from the cultured Barramundi and physical effects, eg anchors and mooring systems, shading effects. The benthic substrate directly below and surrounding the cages within the proposal area is predominately mud. Mud is considered to be a rather hostile environment with little floral and faunal assemblages therefore impact is expected to be minimal. The benthic macro invertebrate composition will be determined and monitored in order to assess any adverse effects directly under and surrounding the sea cages. Specifically designed anchoring systems for mud bottoms will be utilised to reduce the impacts of dragging anchors. Benthic quality will be monitored closely to detect any adverse changes. Feed monitoring and conservative feed regimes will reduce any nutrient input impacts and conservative stocking densities will help to reduce waste production. Fallowing of sites will be introduced and become standard practice.

Pollution Management Factors

Biological Inputs – Biological or nutrient inputs include excess manufactured feed, fish waste and naturally occurring fouling that may need to be removed from the cages. All can impact on water quality and cause changes to the benthic substrate. Due to the high tidal energy environment of the region, conservative stocking densities, feed monitoring utilising video monitoring, conservative feed regimes, spatial separation of cages, and construction of the net utilising wire mesh that requires little or no cleaning it is expected that the impact will be minimal. To monitor the inputs and impacts within the region an environmental monitoring baseline study will be conducted prior to operation of the proposal and an ongoing environmental monitoring and management program will be developed.

Chemical Inputs – It may be necessary to treat farmed fish with chemicals if an unacceptable level of disease is apparent. Treatment will commence only after consultation with the WA Fisheries Senior Fish Pathologist and administered under the pathologists instructions. To date, there has been no disease treatment required at the Cone Bay development and it is felt that the risk remains low for all future proposals due to a management plan incorporating conservative stocking densities and stringent disease testing before introduction to the marine environment.

Pollution – Pollution can be caused by a number of factors such as litter and fuel spills. To minimise or prevent this impact all waste will be collected from the site and regular equipment inspections and maintenance will take place. Petrol and diesel powered vessels will service the

proposed site but all maintenance and refuelling will take place at the island base in Cone Bay. In addition programs to increase staff environmental awareness have been implemented and inductions of all staff with an emphasis on environmental obligations are conducted by MFF and MPC.

Social Surrounds Factors

Access Loss to Marine Environment and Cultural Heritage Issues – There is a perception that aquaculture ventures alienate other marine resource users and/or compete for sheltered waters. To ensure the proposed site is accessible for all users the sea cages will be clearly marked to allow passage around the proposal area, site is selected a distance from reefs, mangroves and areas of cultural significance and the area surrounding proposed site and sea cages will not be deemed exclusive to aquaculture operations. Other users will have easy access to all shorelines and will be able to safely move around the farm.

Visual Amenity – There is also a perception that aquaculture infrastructure will impinge on the aesthetic value of an area. This is not particularly relevant to this proposal as there will no major infrastructure in the proposal site except for the sea cages and a feed barge. The cages will not lower the visual amenity of the area as they are not readily seen until in close proximity to them. The feed barge will also be a low-lying, small sized pontoon-style structure big enough to house the feeding equipment. All accommodation and other storage will occur on the existing land-based area, Turtle Island in Cone Bay.

7. PROPOSED STUDIES AND INVESTIGATIONS

The following investigations will be conducted prior to the onset of the proposal. The results of these studies will help facilitate predictive modelling of the potential impacts on the environment due to nutrient inputs resulting from the proposal. Comparisons of these investigations can then be made with other monitored marine sea cage aquaculture projects to identify the "acceptability" of and level of monitoring required for the proposal. The results of these studies and investigations will be presented in the PER and will enable a reliable and practical EMMP to be developed for Crawford Bay.

The key issue that the proposed investigations aim to provide an understanding of is predicting what impacts the proposal will have at various environmental levels. This then enables the EPA

to make an informed decision when assessing whether the management strategies the proponent proposes to undertake satisfy the related Environmental Quality Objectives (EQO).

7.1 Quantitative Baseline Water & Sediment Study

An environmental monitoring and management plan (EMMP) already exists in Cone Bay (Maxima Pearling Co, 2005) and was developed from studies that were previously conducted to form base-line environmental parameters in Cone Bay by Brown and Root in early 2000. The environmental surveys and investigations that will be carried out within the Crawford Bay region will be similar to those conducted in Cone Bay.

Prior to the proposal date, initial environmental data will be collected and analysed to obtain a 'base-line' environmental profile of the Crawford Bay proposal site and suitable reference sites. The data collected will assist in managing the project to ensure environmental impact is minimal and that all natural variability of key environmental indicators are recorded.

The collection of baseline water and sediment data as proposed in this section will enable MFF to undertake the following tasks for inclusion in the PER document:

1) Characterise and describe the existing quality and natural variability of the marine environment in Crawford Bay prior to the implementation of the proposal;
2) Development of environmental quality criteria (EQC) for a range of selected environmental indicators that are relevant to the proposal; and
3) Investigate and summarise MFF's impact predictions. For example, comparison of the model outputs and impact predictions with respect to water quality, against base-line water quality data.

In terms of water and sediment baseline data the following will be presented and summarised in MFF's PER:

- water and sediment quality data collected from Crawford Bay from the start of 2004 to the end of 2005, arising from the Cone Bay EMMP;
- water and sediment data to be collected from the 6 week sampling program as proposed and described below;

- ❖ water and sediment quality data from Crawford Bay collected as part of the ongoing monitoring requirements stipulated in the current Department of Environment Licence to operate the Cone Bay aquaculture facility. This requires ongoing 6 weekly analysis of water quality and 3 monthly analysis of sediment quality. (Data collected during the assessment process and available up to the finalisation of the PER document will be presented.)

A discussion/commentary will be included in the PER on whether the water and sediment baseline data collected to date is sufficient and adequate for the purposes described above.

In terms of the collection of baseline data, key parameters to be sampled will include:

- Water Quality

  The water quality parameters within Crawford Bay will be assessed prior to sea cage culture of Barramundi. A minimum of 4 sampling stations will be selected and a number of parameters will be monitored over a 6 week period. Water samples are collected using a submersible pump that is lowered to the required depth in the water column. The entire system is flushed for approximately one minute before sampling commences. Field sampling is completed within a three hour period. At each station, five litres of unfiltered seawater is decanted into polyethylene storage containers and stored on ice in the dark until return to the laboratory. Samples are then processed immediately on return to the laboratory, frozen and air-freighted to Perth for analysis. The following water parameters will be measured:

  - *Nutrients, phytoplankton and total suspended solids*

    Water quality samples will be collected during the 6 week period and will be analysed for nutrients such as total nitrogen (TN) and total phosphorous (TP), phytoplankton in the form of chlorophyll *a* and total suspended solids (TSS).

    Chlorophyll *a* levels are determined after filtering 2 L of seawater over a glass-fibre filter (Whatmann GF/A) using a filter tower with a vacuum pump. The filter paper is wrapped in aluminium foil and frozen until dispatched to a NATA registered laboratory for analysis. Chlorophyll *a* in the water column is an early warning measure of phytoplankton response to increased nutrient availability and as a result, is a good indicator for environmental quality guidelines (EQGs) (Sim *et al*. 2004).

Total Suspended Solids (TSS) are determined after filtering a known volume of seawater (normally 2 L) over a pre-weighed glass-fibre filter (Whatmann GF/A) on return to the laboratory, using a filter tower with a vacuum pump. The pre-weighed filter papers are wrapped in aluminium foil and frozen until analysis. TSS is not considered to be a strong indicator of organic enrichment however, baseline data will be taken more so as a comparative tool to detect changes within the proposal area. Total Kjeldahl Nitrogen (TKN) is expected to be a far better indicator of organic enrichment and will be incorporated into the baseline and ongoing EMMP (see also Benthic Quality below). Loss on Ignition will also be incorporated.

- *Physico-chemical parameters*

  Data will be collected weekly for the 6 weekly period. It is assumed that the water body within Crawford Bay is well mixed due to a high energy tidal system within the region but to demonstrate this, water column profiling will be conducted at selected stations. Depth profiling of temperature, salinity, dissolved oxygen (DO) and pH will be conducted utilising a Hydrolab multiprobe and an OxyGuard Handy Gamme MkIII, at approximately 1.0 metre intervals. Turbidity (water clarity) will also be measured using a Secchi disc to the nearest 0.5 metre interval.

- Benthic Quality

The benthic quality parameters within Crawford Bay will be assessed prior to sea cage culture of Barramundi. Again, a minimum of 4 sampling stations will be selected (the same stations utilised for water sampling but after water samples are taken to avoid water contamination) and a number of substations within each station will be selected to investigate spatial variation. Initially, parameters will be monitored over a 6 week period and will be collected weekly.

The samples will be collected during neap tides and it is preferable for collection to coincide with neap day. Sampling will be conducted on an outgoing tide approaching “slack” tide. A total of five core sub samples from within an approximate one metre squared quadrant will be collected and combined to form one sample.

The sample collection procedure will take place as set out in the “Cone Bay Sea Cage Aquaculture Environmental Monitoring and Management Program” (Maxima Pearling Co, 2005) as follows:

- Samples will be collected from a boat utilising a WIldco core sampler.

- ❖ A total of five sediment cores will be taken from within an approximate 1x1 m quadrant to make up one sample. As this is conducted from a boat the sampling will be random.
- ❖ Four replicate samples will be taken from cage sites and three replicate samples will be collected all other sampling stations.
- ❖ All replicate samples for each station or sub station will be analysed separately to obtain an understanding of within site variability.

- *Nutrients*

  Parameters to be analysed at each station and substation include total nitrogen (TN), total kjeldahl nitrogen (TKN), particulate organic matter (loss on ignition (LOI)), total phosphorous (TP) and red-ox potential.

- *Benthic Infauna*

  The diversity and abundance of benthic macro invertebrates to the Family level will be assessed prior to the onset of the proposal at all sampling stations and substations. A 500mL sample will be collected using a benthic grab and sieved using a 0.5mm mesh size to increase the retention of total macro invertebrates. Samples will be stained, sorted and identified to family level once received by a registered laboratory.

- <u>Other Base-line Parameters</u>

Rainfall

Daily rainfall measurements will be recorded during sampling periods to assist in determining the affect rainfall has on nutrient loading of the surrounding waters.

Mangrove Systems

Mangrove monitoring sites within Crawford Bay (test sites) and Cone Bay (control sites) will be established. The sites will be selected based on current mangrove distribution and proximity to the proposed site. Proximity of the mangrove community to the aquaculture lease and the sea cage sites will be recorded. Once areas have been selected, specific sampling sites will be identified by use of GPS coordinates to allow accurate comparisons to be made over time of the same region of the mangrove community. Two sampling sites per mangrove area are to be established. One will be on 'ground-level' and focusing on a small area or tree(s) which will allow for comparisons at a detailed, individual level. The other photograph will be (as much as possible) from a 'birds-eye-level' that should encompass the mangrove area as a whole to allow for comparisons of the area at the community level.

Reef Systems

Coral outcrops within Crawford Bay will be selected as will control sites outside of the Bay. These areas will be monitored prior to the proposed operation and then at 6 monthly intervals coinciding with sampling for the Mangrove Areas. Three sites will be located and sampling sites will be identified by use of GPS coordinates to ensure the same quadrants are photographed and observed at each sampling date. The distance between the coral communities and aquaculture lease and sea cage sites will be measured and recorded. As for the Mangrove Areas, one ground-level' photograph, focusing on the quadrant allowing for comparisons at a detailed, close-up level and, where possible, one photograph encompassing the coral reef area as a whole to allow for comparisons of the area at the community level. General comments and photographic references will be recorded and logged appropriately.

Biota

Observational notes will be collected on a daily basis during the sampling period. The notes will detail the species and number of any visible mammals, birds, reptiles and fish fauna within or in close proximity to the proposal site.

7.2 Development of an EMMP

In addition, an Environmental Monitoring and Management Plan (EMMP) will be developed specifically for Crawford Bay, which will commence at the onset of the proposal and will be ongoing. The data collected and analysed for the ongoing EMMP will be the same as the data collected for the base-line study to provide comparative information. The EMMP will be presented in the PER in a first draft format. Further consultations with the EPA will enable the development of a completed EMMP that will be implemented at the onset of the proposal. A risk-based monitoring and management framework for the operational phase of the proposal will be developed, generated from the identification of the EV and the EQO. This framework will include:

- Early warning environmental quality indicators
- Framework for establishing percentile-based environmental quality criteria (EQC) from reference site data and
- Outline of the management actions that will be implemented in the event the EQC are exceeded

Sampling Sites

The 4 sampling sites for the baseline and sediment water quality analysis have been chosen preliminarily (Attachment 4). Sampling site No. 1 is already a control site for the Cone Bay EMMP and therefore has data that will be utilised as 'background' data for the Crawford Bay EMMP. This site will become an "impact" site once the cages are in place and production is underway. Two more "impact" sites within the proposal site will be incorporated into the EMMP when production begins. The sites indicated by 2, 3 & 4 will continue to be reference points to determine if any outputs from the proposal are impacting the surrounding areas. These reference sites were chosen because of their proximity to the proposal site (ie allows the proponent the time required to undertake the sampling procedure at all sites in a certain time period), however, they are separated sufficiently from the proposal site and each other by a number of islands and current systems. This will allow for comparisons at a number of different levels and hence early detection of potential issues. They have also been selected based on positioning that may be useful in the development of future aquaculture lease applications and therefore be utilised as reference sites for more than one aquaculture lease site. The position of the reference sites (2, 3 & 4) may change as a result of the hydrodynamic studies or if the practicalities of sampling are too difficult (eg fast moving currents, problems with access to areas etc). Finalised sample sites will be incorporated into the PER.

Mangrove Systems

The sites will be monitored twice yearly, once at the end of the wet season (April/May) and once at the end of the dry (September/October). At the time of monitoring general comments about the health of the mangrove will be recorded, species identified, species abundance will be estimated and photographs will be taken for future reference and to estimate growth or recession of the mangrove system.

Reef Systems

The sites will be monitored twice yearly, once at the end of the wet season (April/May) and once at the end of the dry (September/October). General comments and photographic references will be recorded and logged appropriately to enable species identification, abundance and general health of the system.

7.3 Benthic Primary Producer Habitats (BPPH) Identification and Evaluation

Identification of the key BPPH(s) in and around the proposed lease area will be incorporated into the PER which will include maps and aerial photographs showing the location and spatial extent

of each BPPH type. Investigations into the current condition of these areas will also be included in the PER.

Investigations into the extent of the predicted direct and indirect impacts (if any) on all of these BPPH's will be undertaken in accordance with the EPA Guidance Statement No. 29 – Benthic Primary Producer Habitat Protection for Western Australia's Marine Environment. As part of the evaluation of potential impacts on BPPHs, the PER will include maps showing the proposed infrastructure and its location, and zones of impact (ie. where there is predicted to be permanent loss of habitat), effect (eg. areas within which there may be sub-lethal effects of discharges from the proposal on BPPHs and other key benthic communities) and influence of the proposal (ie. the areas beyond which there will be no detectible environmental effects where reference sites could be located).

The PER will demonstrate how impacts have been avoided or, if avoidance is not possible or practicable, demonstrate how impacts have been minimised by best practice management strategies with respect to siting, design and management (eg. feeding rates/regimes).

7.4 Predictive Modelling of the Potential Impacts

Conceptual Modelling

The PER will describe and schematically represent the conceptual cause-effect pathways for each key stressor (eg. nutrients, sedimentation, organic enrichment) associated with large-scale finfish aquaculture in the tropics. Results from the water and benthic quality parameters sampled for the base-line study will enable the determination of each of these key stressors. Establishing the conceptual cause-effect pathways will assist MFF to focus attention on the most informative and relevant indicators for impact prediction and operational monitoring.

Hydrodynamic Modelling

Desktop hydrodynamic modelling will be similar to the previous study for Cone Bay conducted by Brown & Root, January to March 2000. MFF will also liaise with the EPASU for advice on the scope of predictive modelling work to be undertaken. This information will enable the prediction of the following features:

- Flushing rates within the bay
- Circulation patterns within and at the opening of the bay
- Effect of sea cages on circulation within the proposal area.
- Predicted dispersion/settlement patterns of the waste products being emitted from the sea cages.

- Potential ecological consequences of the proposal

Field investigations will be conducted to ascertain the accuracy of the desktop modelling results. Field investigations will include:

- Drogue studies to determine circulatory patterns.
- Wind speed and direction
- Tidal range and cycle

The data gained from the modelling can also be utilised in the development of the EMMP in determining the zone of influence of the site.

Potential Ecological Consequences of Differing Scenarios

The modelling will enable MFF to predict the potential consequences that discharges from the proposed aquaculture venture under differing scenarios would have on the environment. For example, the effects that increasing feed rates have on nearby mangrove & coral reef areas or the effects of seasonal variations (eg cyclones, run-off etc) contributing to the potential impacts from the proposal. A schematic diagram of the proposal location, infrastructure and zones of impact will be included.

7.5 Identification of EV and the Development of EQO and Management Strategies

The Environmental Quality Management Framework will be used as the basis for evaluating and spatially defining the effects of the proposal on environmental quality. In doing so, the principles underpinning the establishment of Environmental Quality Objectives (EQOs) for the Pilbara coastal waters study will guide the establishment of interim EQOs against which this proposal's environmental quality effects can be evaluated.

Consistent with the guidance provided in the Pilbara Coastal Water Quality Consultation Outcomes: Environmental Values and Environmental Quality Objectives (DoE, 2006) and given the location of the proposal within a 'Wilson Report' area (CALM, 1994), the following interim levels of ecological protection for the Ecological Integrity EQO will form the basis for assessing the extent and severity of the proposal's impacts on environmental quality:

- A 'maximum' level of ecological protection applies outside the lease area; and
- A 'high' level of ecological protection to apply within the lease boundary.

8. ENVIRONMENTAL FACTORS AND PRINCIPLES RELEVANT TO THIS PROPOSAL

A summary table outlining environmental factors and proposed management applications is presented in Attachment 5 – Potential Environmental Impacts, Their Significance and Management Responses. The principles relating to this proposal are addressed in Attachment 6 – Principles Relevant to this Proposal.

9. APPLICABLE LEGISLATION

The key legislation to which the proposal will be subject to is the *Fish Resources Management Act* 1994 and the *Environmental Protection Act* 1986. A referral application was submitted to the Department of Environment and Heritage (DEH) under Chapter 4 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). However, the DEH declared that the proposal is not a controlled action and approval is therefore not needed at a national level. The Department for Planning and Infrastructure requested that each of the cages be equipped with Category 2 navigational lights. The proponent has already implemented this request in the trial project and will be adhering to this request for the Crawford Bay proposal. The proponent also adheres to the standard navigational markers set out in the Department of Fisheries "Standardised Lease Marking Incorporating Prescriptive Requirements for Different Leases". Other legislative matters that the proponent will abide by include the *Conservation and Land Management Act* 1984 and the *Wildlife Conservation Act* 1950.

10. COMMUNITY AND OTHER STAKEHOLDER CONSULTATION PROGRAM

Community Consultation:

Maxima Pearling Company and therefore Maxima Fish Farms have an ongoing relationship with traditional occupants of the area, Larinyuwar [Yaluun] Aboriginal Community. The Company and Yaluun meet to discuss any new venture plans or update on existing projects being undertaken within the area and productively work through any issues of cultural and community significance. Meetings regarding the proposed Barramundi Aquaculture projects took place prior to commencement of the Cone Bay trial. Yaluun is most supportive of the Barramundi venture becoming a commercial project, identifying many positives for their community. As a part of the

application to vary an aquaculture licence in the Cone Bay, responses from Tourism WA and Kimberley Marine Tourism Association indicated that they had no objections to that variation or any similar projects in the future. However, this scoping document will provide all applicable sectors of the community to make comments and the proponent is happy to respond to and address any issues that the community may have.

Government Agencies and Other Interested Parties:

MFF representatives co-ordinate meetings with Fisheries WA, Environmental Protection Authority [EPA] and Department of Environment [DEP] for preliminary discussions of planned projects, follow up of proposals within the approvals process and in particular to discuss current applications such as this. Applicable documentation is then prepared in addition to these face to face meetings and submitted to each relevant Department to commence the approvals process. The local CALM representatives have been contacted in regards to the proposal and stated that they did not think they would have any major issues with the project as long as the EPA, DoE and Fisheries WA regulations and conditions are adhered to. MFF extends an ongoing invitation to all relevant Government Agencies to visit the proposed Barramundi Aquaculture site.

The Crawford Bay Aquaculture License Application has been submitted to the Department of Fisheries, WA which will ensure that all other interested parties are consulted accordingly. The public will be able to comment as a result of the application to Fisheries WA and also as a result of the ensuing PER that will be submitted by the proponent.

11. PROJECT AND ASSESSMENT SCHEDULE

An estimated schedule for the proposal is as follows:

EMMP development and consultations	February - December 2006
Initial data collection for PER Investigations (water & benthic quality analysis)	Mid February - Late March 2006
Final Draft Submission of Scoping Document	Mid May
Development of EMMP	May – September 2006

Results of initial Investigations for PER	June 2006
Submission of PER to EPA	July 2006
Release of PER for four week review	August - September 2006
Responses to issues raised from Public Review	September - October 2006
EPA response and report to Minister	October 2006
Appeal Period – two weeks	October - November 2006
If no appeals – issuing of approval and conditions	November 2006
If appeals are lodged, the time-line will be extended	
Other Licensing and Management Approvals (eg WA Fisheries)	November 2006
Installation sea cage system in Crawford Bay	November - December 2006
Grow out of Barramundi in Crawford Bay	December – Ongoing
EMMP continuation relative to the EQC's set and reporting to relevant authorities	December- Ongoing

12. PEER REVIEW

Dr Mehdi Doroudi of "Doroudi Consultants" will be responsible for providing a peer review of findings and conclusions from any environmental surveys and investigations.

13. STUDY TEAM

Nicholas Miller (Managing Director, Maxima Pearling Company)

Nicholas Miller has worked in the pearling industry since 1981, starting as a labourer on pearl farms and progressing into management roles with various companies in the industry. Nicholas is experienced in pearl farming and spat production methods as well as the management of marine assets and pearl oyster hatcheries. His employment history is as follows;

1991 – 1998

Assistant Manager – Production Broome Pearls

Master of vessel Territory Commander

Management of pearl farms at both Roebuck Bay and Kailis Cove

1998 – 2000

Employed by Nor West Pearls as General Manager

September 2000 to present

Employed by Maxima Pearling as General Manager and is now the Managing Director.

Guy Westbrook (Managing Director, Maxima Fish Farms)

1989 – 1990

Seafarms - Farm Manager, 200 tonne marine farm growing Atlantic Salmon in sea cages. Duties included production planning, budgeting, ordering, farm operations including net repair, net changing, feeding and feed management, fish health management, grading, mooring construction, and compliance.

1990 – 1992

Aquatas - Farm Manager, 1,200 tonne Salmon marine farm. Duties as above.

1992 – 2003

Nortas - Group Operations Manager – Responsible for Salmon and Ocean Trout production of 3,000 tonne per annum inclusive of all stages from hatchery to harvesting. Guy represented the company and industry in various forums including, FRDC Atlantic Salmon Aquaculture Sub-program Implementation Committee, Aquafin CRC salmon program group, Tasmanian Salmonid Growers Association Farm Management Group, Emergency Disease Response Committee, and joint industry training initiative setting up the Finfish Traineeship curriculum. In addition Guy was also a member of the Nortas Management Board.

2003-2005

Tassal Operations Pty Ltd – Special Projects Manager – Represented Tassal during the development of the Tasmanian Atlantic Salmon Selective Breeding Program, internal project looking at improving the efficacy of bathing Atlantic Salmon for treatment of Amoebic Gill

Disease, in particular more efficient use of oxygen, use of oxygen in sea cages to improve fish performance, and use of underwater lighting to improve growth and lower incidence of precocious maturity.

Skills

- Freshwater production of Atlantic Salmon and Rainbow Trout – breeding, triploidy induction, all female production.
- Freshwater production systems – flow through and recirculation.
- Marine farm production systems – sea cages, nets, fish husbandry, feeding, net maintenance, mooring construction, fish grading, harvesting.
- Humane slaughter methods, quality control (HACCP Internal Auditor), fish health assessment and treatment.
- Budgeting, Project Management
- Farm efficiency improvement.

Donna Cahill (Research and Development Supervisor, Maxima Pearling Company)

Donna graduated from James Cook University, Townsville, Queensland in 1994, with a Bachelor of Science Marine Biology major. Donna has eight years aquaculture experience with a variety of species, including pearl oysters, pacific oysters, abalone, scallops, King George whiting, mulloway and barramundi. Donna has extensive 'research and industry' experience and is presently employed with Maxima Pearling Company as Research and Development Supervisor.

Dr Mehdi Doroudi (Doroudi Consultants)

Dr Doroudi has over thirteen years experience in various aspects of aquaculture and fisheries and completed his Doctorate in Aquaculture at James Cook University. The subject of his research was the development and culture of black-lip pearl oyster larvae. Mehdi has particular experience in the culture (hatchery and grow-out) and health management of fish (rainbow trout, sturgeon, silver perch, snapper and mulloway) and shellfish (pearl oysters and prawns). He has also strong experience in live-feed (algae, Artemia and rotifers) culture and the development of alternative diets. He has worked in the Caspian Sea, Persian Gulf, Oman Sea, Queensland, Western Australia, New South Wales and Victoria. Mehdi is currently the Principal Veterinary Officer (Aquatic Animal Health) at the Department of Primary Industries, Victoria.

14. REFERENCES

Brown and Root Services Asia Pacific Pty Ltd, July 2000. *Hydrodynamic and Ecological Studies in Cone Bay, Western Australia.*

CALM, 1994, *Report of the Marine Parks and Reserves Selection Working Group,* A Representative Marine Reserve System For Western Australia, June 1994

DEH, Species of National Environmental Significance Database, DEH website.

Department of Environment, 2006, *Pilbara Coastal Water Quality Consultation Outcomes – Environmental Values and Environmental Quality Objectives,* Department of Environment, Government of Western Australia, Marine Series Report No. 1

Department of Fisheries WA, 2002, *The Translocation of Barramundi (Lates calcarifer) for Aquaculture and Recreational Fishery Enhancement in Western Australia,* Fisheries Management Paper No. 159.

EPA. EPA Principles of Environmental Protection, Position Statement No. 7.

EPA, EPA Guidance Statement No. 29, *Benthic Primary Producer Habitat Protection for Western Australia's Marine Environment.*

EPA, Environmental Impact Assessment (Part IV Division I) Administrative Procedures 2002.

EPA, 2005 *Manual of Standard Operating Procedures For Environmental Monitoring against the Cockburn Sound Environmental Quality Criteria (2003-2004), A Supporting Document to the State Environmental (Cockburn Sound)* Policy 2005, EPA Report 21

Government of Western Australia, State Water Quality Management Strategy No. 6, *Implementation Framework for Western Australia for the Australian and New Zealand Guidelines for Fresh and Marine Water Quality and Quality Monitoring and Reporting (Guidelines No's 4 &7: National Water Quality Management Strategy).*

Maxima Pearling Company, 2005, *Cone Bay Sea Cage Aquaculture Environmental Monitoring and Management Program.*

Pearl Producers Association, November 2004. *Workshop Report: 2004 Environmental Risk Assessment of the Pearling Industry.*

Sim, C. and Masini, R. 2004. *A framework to guide the development of environmental monitoring programs for marine aquaculture in seagrass dominated coastal environments in South Australia.* Department of Environment, Government of Western Australia.

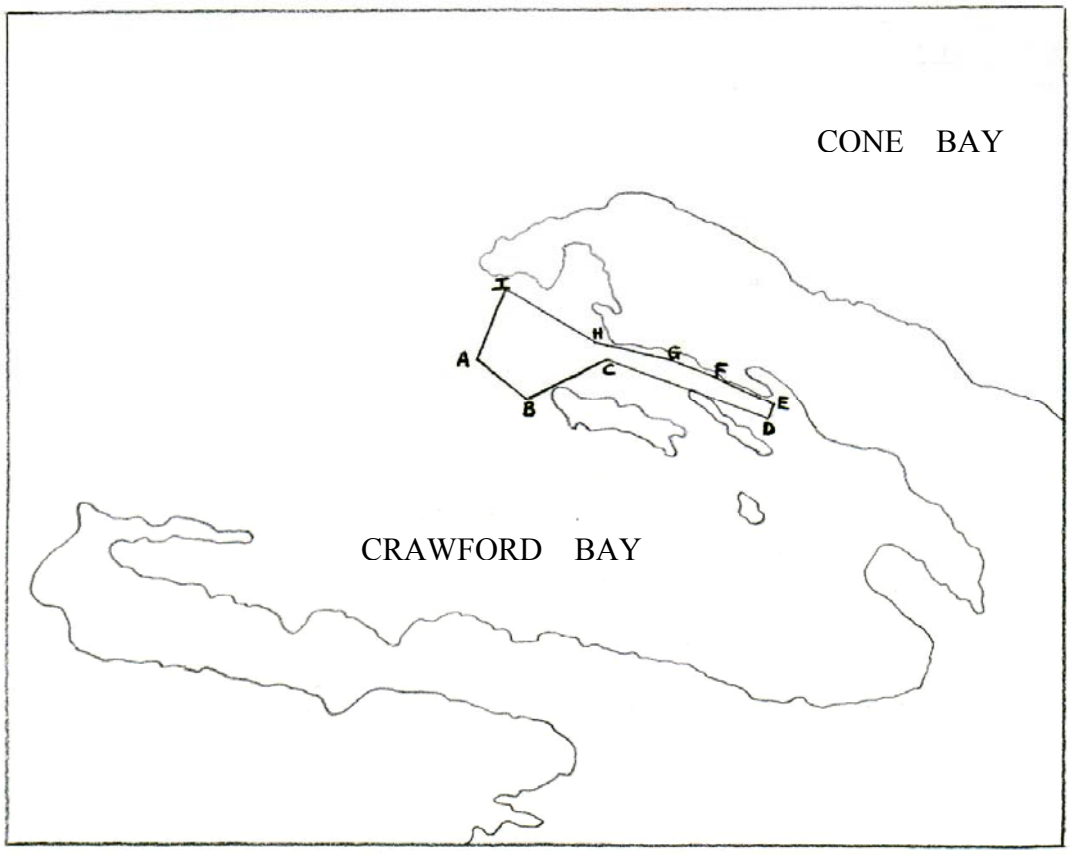
Attachment 1

Location of Crawford Bay

Proposed Lease Site and Coordinates

Boundary Corner Coordinates: WGS84

Point	Latitude	Longitude
A	16° 29.0985′S	123° 27.6417′E
B	16° 29.3142′S	123° 27.8826′E
C	16° 29.1050′S	123° 28.2666′E
D	16° 29.4057′S	123° 29.0438′E
E	16° 29.3403′S	123° 29.0807′E
F	16° 29.1878′S	123° 28.8057′E
G	16° 29.0941′S	123° 28.5762′E
H	16° 29.0157′S	123° 28.2172′E
I	16° 28.7215′S	123° 27.7849′E



1 nautical mile

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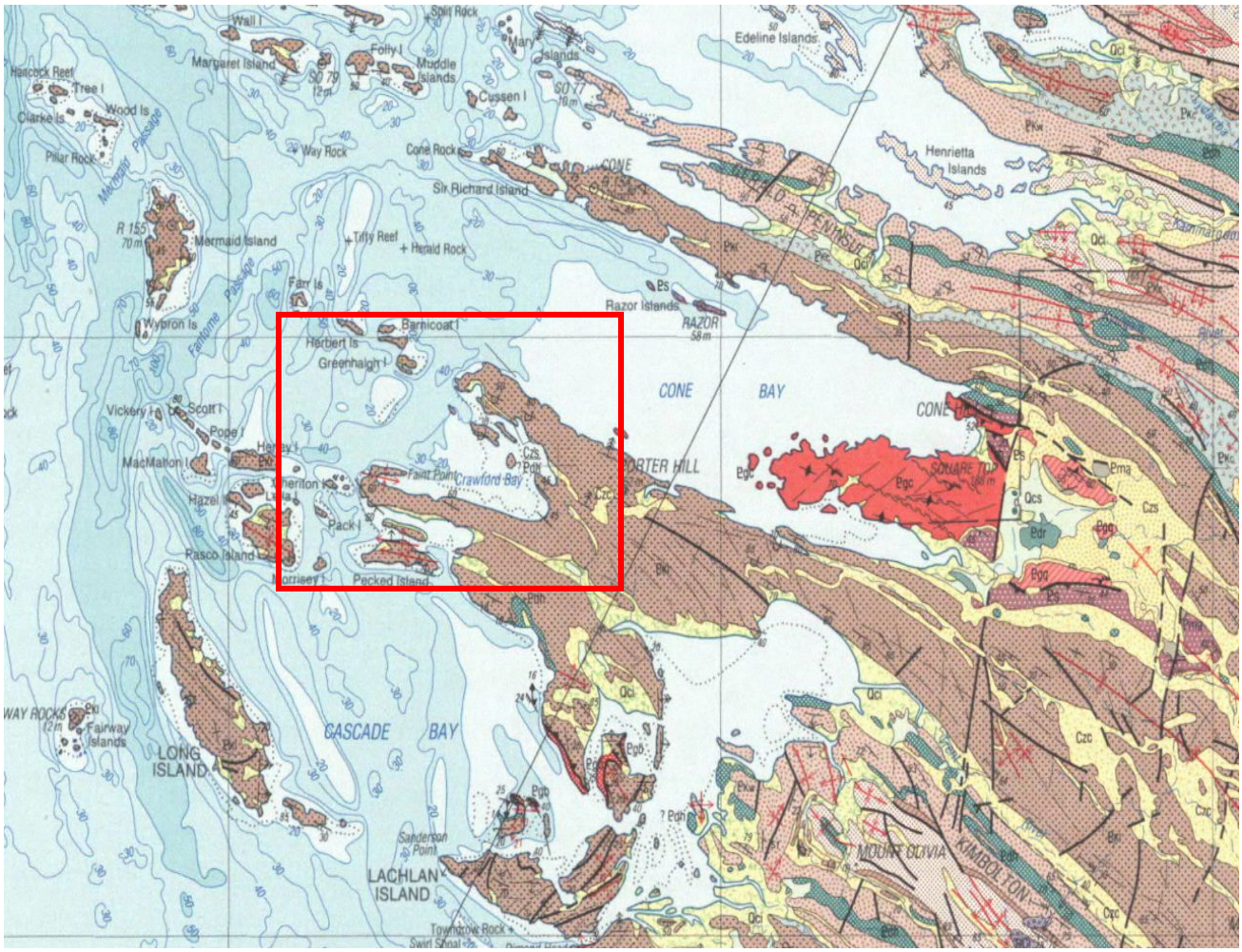
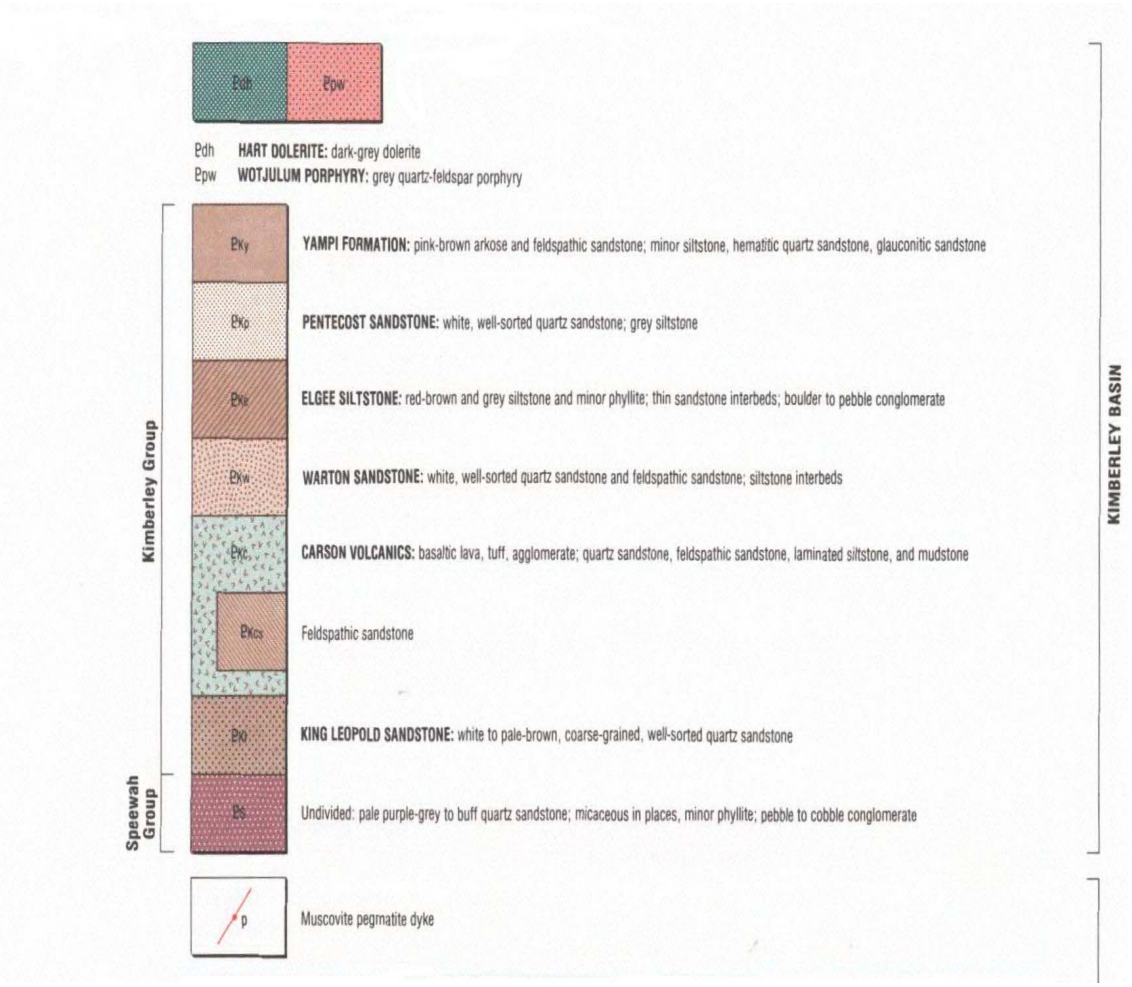
Attachment 2

Geology of Crawford Bay

Crawford Bay indicated by red square



Soil Profile : Legend



Attachment 3

List of Threatened and Migratory Species

A search conducted for the proposed Crawford Bay site (16˚ 29´ S, 123˚ 28´ E) listed 13 threatened species and 23 migratory species within a 3 nautical mile radius of the area. They are indicated in table below.

(Source: Department of Environment & Heritage website: *Species of National Environmental Significance Database*.)

Threatened Species [Dataset Information]	Status	Type of Presence
Birds		
Erythrotriorchis radiatus ***** Red Goshawk	Vulnerable	Species or species habitat likely to occur within area
Erythrura gouldiae ***** Gouldian Finch	Endangered	Species or species habitat may occur within area
*Geophaps smithii blaauwi****** Partridge Pigeon (western)	Vulnerable	Species or species habitat likely to occur within area
Rostratula australis ***** Australian Painted Snipe	Vulnerable	Species or species habitat may occur within area
Mammals		
Dasyurus hallucatus ***** Northern Quoll	Endangered	Species or species habitat may occur within area
Megaptera novaeangliae ***** Humpback Whale	Vulnerable	Breeding known to occur within area
Reptiles		
Caretta caretta ***** Loggerhead Turtle	Endangered	Species or species habitat may occur within area
Chelonia mydas ***** Green Turtle	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea ***** Leathery Turtle, Leatherback Turtle, Luth	Vulnerable	Species or species habitat may occur within area
Eretmochelys imbricata ***** Hawksbill Turtle	Vulnerable	Species or species habitat may occur within area
Natator depressus ***** Flatback Turtle	Vulnerable	Species or species habitat may occur within area

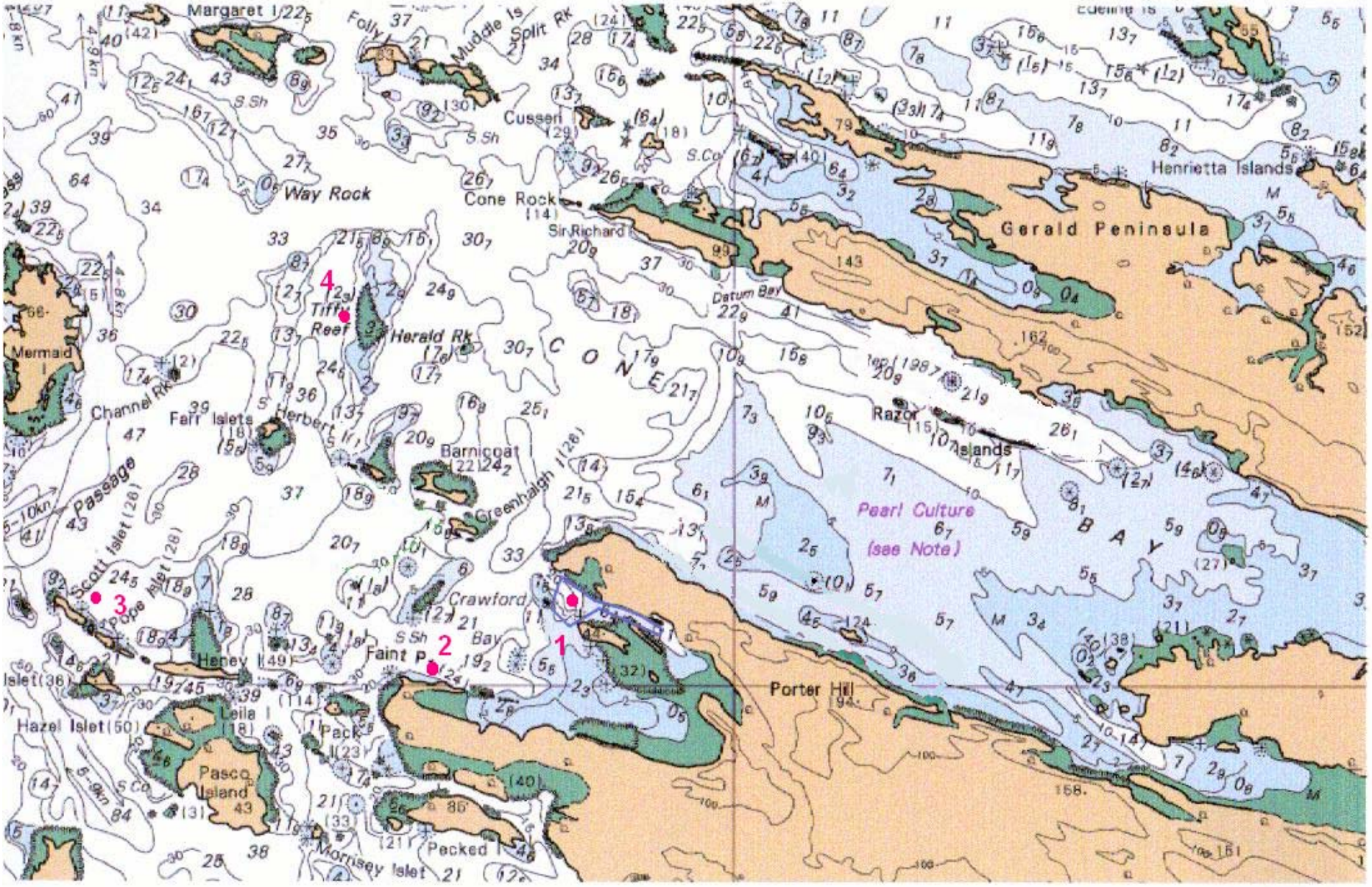
Sharks		
Pristis microdon ***** Freshwater Sawfish	Vulnerable	Species or species habitat likely to occur within area
Rhincodon typus ***** Whale Shark	Vulnerable	Species or species habitat may occur within area
Migratory Species [Dataset Information]	Status	Type of Presence
Migratory Terrestrial Species		
Birds		
Erythrura gouldiae Gouldian Finch	Migratory	Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle	Migratory	Species or species habitat likely to occur within area
Hirundo rustica Barn Swallow	Migratory	Species or species habitat may occur within area
Petrophassa smithii blaauwi Western Partridge Pigeon	Migratory	Species or species habitat likely to occur within area
Poecilodryas superciliosa cerviniventris Derby White-browed Robin	Migratory	Species or species habitat likely to occur within area
Migratory Wetland Species		
Birds		
Charadrius veredus Oriental Plover, Oriental Dotterel	Migratory	Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole	Migratory	Species or species habitat may occur within area
Numenius minutus Little Curlew, Little Whimbrel	Migratory	Species or species habitat may occur within area
Rostratula benghalensis s. lat. Painted Snipe	Migratory	Species or species habitat may occur within area
Migratory Marine Species **Mammals**		
Balaenoptera edeni Bryde's Whale	Migratory	Species or species habitat may occur within area
Dugong dugon Dugong	Migratory	Species or species habitat likely to occur within area

Megaptera novaeangliae ***** Humpback Whale	Migratory	Breeding known to occur within area
Orcaella brevirostris Irrawaddy Dolphin	Migratory	Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca	Migratory	Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin	Migratory	Species or species habitat may occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations)	Migratory	Species or species habitat likely to occur within area
Reptiles		
Caretta caretta ***** Loggerhead Turtle	Migratory	Species or species habitat may occur within area
Chelonia mydas ***** Green Turtle	Migratory	Species or species habitat may occur within area
Crocodylus porosus Estuarine Crocodile, Salt-water Crocodile	Migratory	Species or species habitat likely to occur within area
Dermochelys coriacea ***** Leathery Turtle, Leatherback Turtle, Luth	Migratory	Species or species habitat may occur within area
Eretmochelys imbricata ***** Hawksbill Turtle	Migratory	Species or species habitat may occur within area
Natator depressus ***** Flatback Turtle	Migratory	Species or species habitat may occur within area
Sharks		
Rhincodon typus Whale Shark	Migratory	Species or species habitat may occur within area

Attachment 4

Sample Sites for the Base-line Data and continued EMMP for Crawford Bay

● = Sample Sites ▬ = Proposed Lease Site.



Attachment 5

Potential Environmental Impacts, Their Significance and Management Responses

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management
Biophysical Factors					
Fauna – Disease	Proposal site and surrounding areas	To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge	Spread of endemic disease across the Barramundi population within the region.	Develop procedures manual for sea cage grow-out. Development of a disease contingency plan	Translocation protocols to be adhered to, stringent disease testing before introduction to marine environment. Minimise handling, net inspection and cleaning protocol. Use of brood stock endemic to the region.
Fauna – Translocation and Disease Issues	Hatchery, proposal site and surrounding areas	To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge	Introduction of exotic diseases and organisms	Determine the likelihood of disease introduction and the possible 'points of entry". Development of a disease contingency plan	Translocation protocols to be adhered to and stringent disease testing before introduction to marine environment. Conservative stocking densities whilst in hatchery. Minimise handling. Sterilisation and maintenance protocols of hatchery and associated equipment. Staff training. Improvement in hatchery techniques. Disease contingency plan to be in accordance and consultation with the requirements and suggestions provided by the WA Fish Health Laboratories.
Fauna – Marine Wildlife	Proposal site	To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge	Entanglement of Marine Life in Nets	Development of logsheets for recorded sightings to be incorporated in the EMMP. Investigate and implement strategies to reduce impacts as a part of the Environmental Management Plan	The risk of entanglement is low due to the construction and material of the sea cages. Heavy gauge wire mesh will reduce predation by sharks and crocodiles. Overhead netting made of heavy gauge polyethylene or nylon will exclude birds. This netting will be taut over the cages so no entanglement will occur. Regular inspections of equipment and strict maintenance programs will be implemented. Adequate spatial separation of cages will allow ample room for passage of underwater marine animals.

Fauna – Marine Wildlife	Proposal site	To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge	Provision of Artificial Habitat to Marine Fauna	Development of logsheets to be incorporated into the EMMP Investigate and implement strategies to reduce impacts as a part of the Environmental Management Plan	Equipment requirements to be kept to a minimum. Feeding closely monitored by use of video image to reduce risk of attracting marine fauna within sea cage proximity. Maintenance of logsheets and record taking procedures. Results from the Cone Bay logging program has demonstrated that although some species of fauna have been seen in close proximity to cages, it is not predominately one particular species or long periods of time that presence is recorded.
Fauna – Genetic Variation Issues	Proposal site and surrounding areas	To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge	Impact of Fish Escapes	Ensure that all staff are aware of the potential effects of escaped farmed fish on the native fish populations. Development of procedures and protocol for net changing, transfer and harvesting activities. Investigate and implement strategies to reduce impacts as a part of the Environmental Management Plan	The risk of fish escapes is very low due to strong, sturdy cage construction. These cages have proven to be able to withstand pressures form adverse weather conditions and predation. Strict procedures will be followed during net changing and harvesting activities to reduce escapes during these processes. Staff training in the correct procedures of the above mentioned activities. Prevention is the main focus for this factor as there is no practical 'post-escape' contingency plan for such an open system.
Fauna – Marine Wildlife	Proposal site	To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge	Provision of Additional Food Source from Waste Feed	Development of logsheets to be incorporated into the EMMP. Investigate and implement strategies to reduce impacts as a part of the Environmental Management Plan	Closely monitored feeding levels (ie by video monitoring) will enable 'fine-tuning' of feed rates and allow adjustments to occur before any problems can occur. Results from the Cone Bay logging program has demonstrated that although some species of fauna have been seen in close proximity to cages, it is not predominately one particular species or long periods of time that presence is recorded.

Flora – Mangroves & Coral Reefs	Surrounding areas	To maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge	Impacts on Mangrove systems and Coral Reefs (ie Benthic Habitats)	Determine locality and extent of mangrove and coral reef areas within Crawford Bay. Determine the potential impacts on these sites in accordance with Guidance Statement No. 29. Develop baseline data set and records, including photos, to be incorporated into the EMMP. Using the desktop modelling results, form impact predictions from the proposal Develop management strategies to minimise any potential impact.	Site was selected due to low abundance of mangrove areas in the bay. Mangrove areas will be assessed via observations and photographic archive as a part of the EMMP. This will allow for comparison over time between areas in order to determine if there are any changes. All anchoring systems will be a minimum of 100 metres from the mangroves and the cages will be a minimum of 200 metres.
Flora – Seagrass Beds	Proposal site	To maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge	Shading Effect	Record all seagrass beds and determine potential impact of the proposal.	The site was selected specifically due to the fact that there were no seagrass beds in the vicinity of the proposal site. Site selection was also determined by the absence of abundant and major coral reef, mangrove and beach areas and the presence of a mud bottom and high tidal energy properties.
Marine - Seabed	Proposal site	To maintain the integrity, ecological functions and environmental values of the seabed and coast.	Benthic substrate changes under sea cages	Analyse Benthic substrate properties and determine benthic macro invertebrate diversity and abundance. Determine the potential impact of sea cages upon the benthic substrate in accordance with Guidance Statement No. 29. Develop conceptual cause-effect pathways and determine key stressors causing impacts Using the desktop modelling results, form impact predictions from the proposal. Set levels of protection based on the Environmental Quality Management Framework	Aquaculture sites selected where the substrate consists of mud only and no sea grass occurs. Purpose built anchoring system utilised for mud bottoms. Sea cages not anchored in close proximity to coral reef. Benthic monitoring program to assess changes in substrate and diversity of macro-invertebrates below the sea cages and in the zone of influence. Conservative stocking densities. Feed monitoring and conservative feed regimes. Fallowing of sites will be introduced and become standard practice.

Pollution Management Factors					
Water Quality (Marine)	Proposal site and surrounding waters	To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards	Water pollution from biological inputs	Form Base-line data set as a comparative tool for the ongoing EMMP Develop EMMP for Crawford Bay Using the desktop modelling results, form impact predictions from the proposal. Set levels of protection based on the Environmental Quality Management Framework Develop conceptual cause-effect pathways and determine key stressors causing impacts	Aquaculture site selected in high tidal energy environments. Water monitoring program to assess changes in water quality at the site and in the zone of influence. Spatial separation of sea cages. Conservative stocking densities. Feed monitoring and conservative feed regimes. Cage maintenance requirements are low. Cages cleaned using high pressure seawater. No chemicals or detergents utilised and no antifouling chemicals used.
Water Quality (Marine)	Proposal site and surrounding waters	To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards	Water pollution from chemical inputs	Develop strict procedures and protocols in the use and handling of all chemicals. Predictive desktop modelling of the dispersion/settlement patterns in Crawford Bay and flushing rates etc. Develop draft contingency plans for accidental fuel spills etc. Develop EQO and subsequent management strategies to avoid or minimise potential impact.	There is currently no routine use of chemicals. They are only used as a "last resort" and will only commence after consultation with WA Fish Health Labs senior pathologist. Risk is considered low due to other management factors that should prevent the use of chemicals at all. Regular equipment maintenance programs to prevent accidental fuel spills. No chemicals or fuel will be stored in Crawford Bay.
Waste Disposal	Proposal area.	To ensure that liquid and solid wastes do not affect groundwater or surface water quality, nor lead to soil contamination.	Potential for litter	Develop management strategies to minimise the potential impact	Staff will commute to the site on a daily basis and all rubbish etc will be removed and transported to the Cone Bay land based site for correct disposal. Regular inspections on sea cages and associated equipment. Increased environmental awareness of staff. Induction of staff with emphasis on environmental obligations.

Social Surrounds Factors					
Recreation	Proposal site	To ensure that existing and planned recreational uses are not compromised	Access loss to marine environment due to sea cages, resulting in perceived alienation of other marine resource users and competition for sheltered waters.	Identify main community users to establish communicative relationships. Develop management strategies to minimise potential impact.	Arrangement of sea cages in neat orderly manner and clearly marked to allow ample room for passage of vessels around the proposal site and sea cages. Site not deemed exclusive to aquaculture operators.
Cultural Heritage	Proposal site	To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.	Impacts on native title or culturally significant areas.	Identify any new native title issues or areas of cultural significance.	Research and communications to date have indicated that there are no areas of cultural or native title significance. However, ongoing communications and liaisons with appropriate groups will enable quick responses to any changes in the above mentioned areas. Site selection a distance from reefs and mangrove areas or areas of cultural significance.
Visual Amenity	Proposal site	To ensure that aesthetic values are considered and measures are adopted to reduce visual impacts on the landscape as low as reasonably practicable	Perceived lowering of aesthetic value due to presence of sea cages.	Identify main community users to establish communicative relationships. Develop management strategies to minimise potential impact.	Sea cages are low profile and dark in colour. Navigational markers are required by regulation, however are not considered to lower the aesthetics of the area. All cages, markers and feed barge will be set out in a neat & orderly manner with consideration to minimising visual impact.
Other Factors					
Decommissioning	Proposal site	To ensure, as far as practicable, that rehabilitation achieves a stable and functioning landform which is consistent with the surrounding landscape and other environmental values.	Irreversible changes to the proposal site and surrounding areas		Only sea cages, and therefore anchors, are present in the proposal site and being mud bottom there should be no permanent or irreversible damage to the site. Structure of the cages is such that there is very little effort and resources required to dismantle and remove if necessary. The EQC's that will be set as a result of the EMMP should prevent any irreversible damage to occur to the environment within the proposal site and therefore will allow the environment to return to it's 'pre-proposal' state if the project were to end.

Attachment 6

Principles Relevant to this Proposal

Principle	Relevant Yes/No	If yes, consideration
1. The precautionary principle Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In application of this precautionary principle, decisions should be guided by: a) careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and b) b) an assessment of the risk – weighted consequences of various options	No	
2. The principle of intergenerational equity The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.	Yes	Impacts to be minimised by the management responses discussed in attachment 5.
3. The principle of the conservation of biological diversity and ecological integrity Conservation of biological diversity and ecological integrity should be a fundamental consideration	Yes	Site selected to minimise impact on natural resources such as seagrass, mangroves and coral reefs. Baseline study and monitoring program to assess water and benthic parameters including diversity and abundance of benthic macro invertebrates. Predictive hydrodynamic modelling undertaken to determine potential impacts of nutrient outputs from the sea cages.
4. Principles relating to improved valuation, pricing and incentive mechanisms a) Environmental factors should be included in the valuation of assets and services. b) The polluter pays principles – those who generate pollution and waste should bear the cost of containment, avoidance and abatement. c) The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste. a) d) Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structure, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solution and responses to environmental problems.	Yes	Mandatory and scaled licence costs reflect proposed nutrient loading factors from manufactured feed. Close monitoring of feed regimes to reduce wastes produced will be undertaken by the proponent.
5. The principle of waste minimisation All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment	Yes	Monitor feed regimes to reduce wastes produced. Equipment maintenance and reuse to reduce waste product.