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4.0 DESCRIPTION OF THE PROPOSAL

4.1 Description of the Proposed Development

A description of the proposed development including:

4.1.1 Project and Location of Components

The proposed prawn farm will consist of 259 ha of production ponds, with associated water supply, storage, distribution, drainage, treatment and discharge systems. It will also incorporate a centralised administration, laboratory, processing feed storage and machinery storage/maintenance areas. Figure 4-1 shows the layout for the development.

Important aspects of the proposed layout unique to this development include:

- Ocean intake and discharge systems;
- Configuration of the layout to provide three independent production areas within the overall farm development, each with its own water supply, drainage, water treatment and re-use facilities;
- Treatment systems incorporating primary sedimentation areas that will allow removal of sediment during the season, discharging to settlement ponds for further sedimentation and biological treatment;
- The facility to increase the operating depth in the sedimentation areas and settlement ponds from 2.0m to 3.0m when required to accommodate short-term increases in hydraulic or nutrient loads; and
- A design that will facilitate integration of new technologies if appropriate in the future.

The main components of the project will be:

- A seawater intake system consisting of a 1200mm nominal diameter ocean intake pipeline extending approximately 350m offshore, a wet-wet submersible pump station located on the back of the primary dune, and a 5040m long rising main pipeline, 1000mm nominal diameter, discharging to an on-farm seawater storage. The design capacity of the pumping system will be 180ML/d;
- An 11.3 ha seawater storage with a maximum storage depth of 4.0m, and a freeboard of 1.0m, and an active storage capacity of 370ML;
- Plastic-lined supply channels servicing each pond, with water pumped from the seawater storage. Two re-lift pumps will be located on two of the main supply channels;
- 259 one hectare grow-out ponds, 1.5m deep and with 0.5m freeboard. Ponds will be clay lined (0.5m thick) and incorporate rip rap protection on the inside banks;
- Drains servicing each of the grow-out ponds. These drains will be clay lined (0.5m) and will be graded to minimise flow velocities and erosion potential;
- Three primary sedimentation areas. The primary sedimentation ponds consist of two cells and will be 3m deep under normal operating conditions, with 1.0m freeboard. Each cell will provide a hydraulic retention time of approximately 8 hours under peak exchange conditions. Only one cell will be used at any one time, allowing for the other cell to be dried, and sediment removed. Sedimentation areas will be lined with 0.5m compacted clay;

- Three settlement pond areas, sized to provide a hydraulic retention time of 48 hours under peak exchange conditions. Treatment areas will be 2.0m deep under normal operating conditions, with 1.0m freeboard. Treatment areas will be lined with 0.5m compacted clay;
- Re-cycling pumps on each of the settlement pond areas, allowing recycling of water back into the farm as required;
- A main discharge pump station and ocean discharge pipeline to pump all excess exchange water. Settlement ponds will drain to the discharge pump station, which will consist of a 3 pump submersible pumping arrangement. The pump and pipeline will be designed to discharge the maximum rate of 200ML/d from the farm. The HDPE pipeline will extend 500m offshore, the last 100m of which will be diffuser.

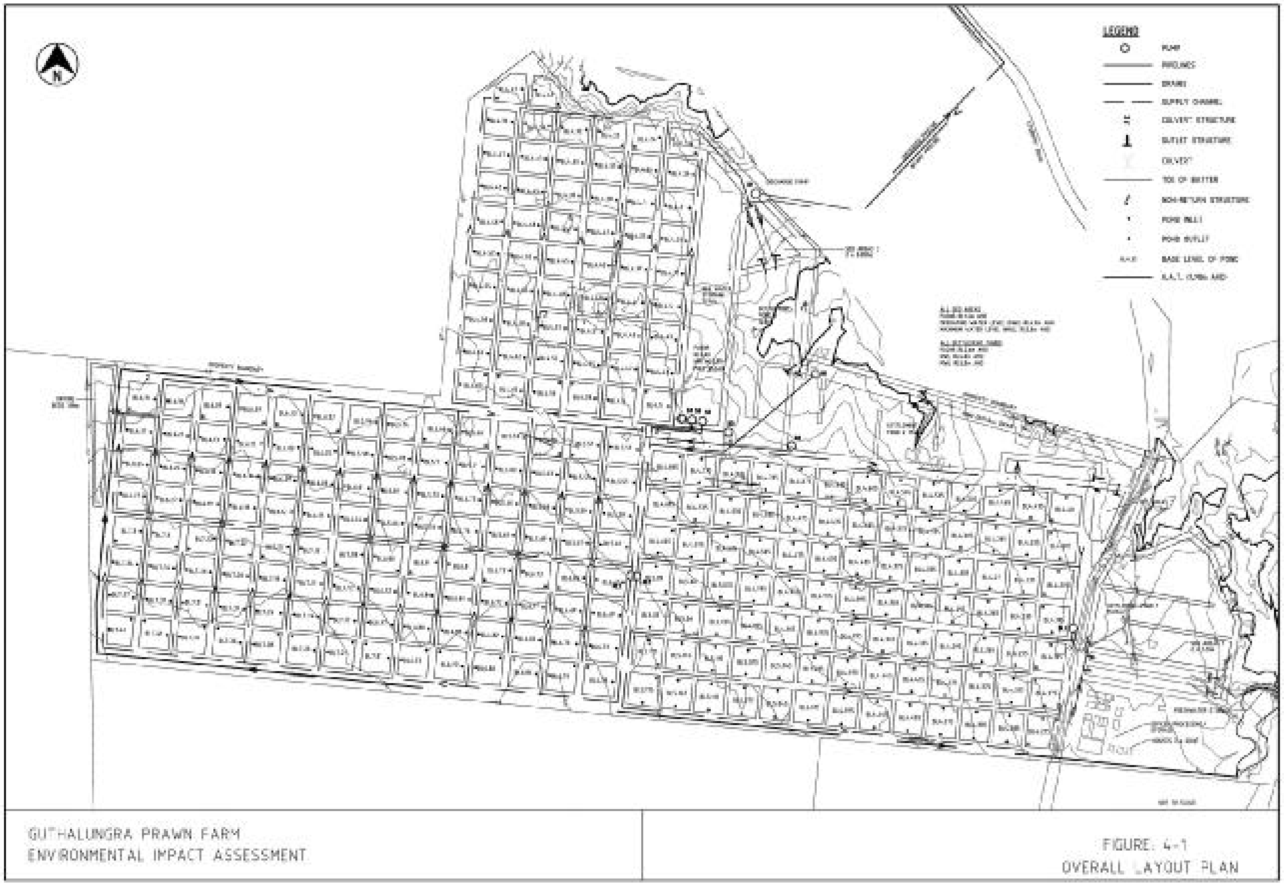

Figure 4-1
Overall Layout Plan

Each of these elements is discussed in more detail below.

a) Seawater Intake System

The location of the seawater intake pipeline and pump station is shown in layout plans and on the longitudinal sections attached in Appendix B.

The main design criteria for the system are:

- To be able to reliably pump up to 180ML/d of seawater to the farm under a wide range of tidal conditions. This flow rate was calculated from estimated peak exchange rates for the farm, and is a conservatively high estimate because it excludes any allowance on-farm re-use;
- To provide, as far as practicable, good quality water;
- To be able to withstand extreme weather conditions, such as cyclones;
- To have minimum impact on the coastal and marine environment, both during construction and operation;
- To have minimum aesthetic impact;
- To be maintainable at a reasonable cost;
- To allow for staged construction over 4 years;
- To minimise the degree of marine hazard created;
- To minimise the risk of damage or vandalism; and
- To be cost-effective.

To ensure a good quality supply, and to provide an acceptable degree of submergence under all tide conditions, a minimum water depth of 3 – 5m at the water intake point is considered necessary. Given that the minimum tide level is LAT (-1.62m AHD), this means that the pipeline needs to extend to a bed depth of -4.5 to -5.5m AHD.

The length of the intake pipeline is however constrained by the need to minimise inlet pipeline friction losses, and by cost considerations.

Bathymetric survey indicates that a pipeline extending 300m offshore as shown in Figure 4-2 would have an inlet located at bed depth about – 5.0m AHD, being 3.4m below LAT and 4.1m below MLWS. This alignment has been adopted because it represents a reasonable compromise between the need to maximise inlet depth, versus friction loss and cost constraints.

Figure 4-2
Ocean Pipeline and Pump Station Locations

The general arrangement of the proposed inlet structure is provided in Appendix B. The structure will include an inlet screen arrangement located on a concrete pad. The screen will be constructed from Grade 316 Stainless Steel. Features of the design include:

- Reduction of the inflow velocity through the inlet structure apertures to less than 0.2m/s. Experience elsewhere indicates velocities of this magnitude are required to minimise the potential for fouling by seaweed and are low enough to avoid the capture of most fish species;
- Easy cleaning of the inlet structure by removal of the intake lid and lifting of the remaining screen structure to a surface barge for cleaning. The intake will be secured by a loose fitting quick hitch anchoring system that will avoid problems caused by bio-fouling;
- Ready access to the intake pipeline via removal of the intake lid;
- Relatively simple and cost-effective construction;
- Robust design that can withstand extreme weather conditions;
- Minimization of sand intake as a result of the elevated intake; and
- Minimization of the degree of marine hazard posed by the structure.

The pump station and intake pipeline design are interdependent, and are driven by the need to minimise intake head losses to optimise pumping conditions.

A range of pumping/pipeline systems were evaluated including:

- Multiple intake pipes of various diameters and types to reduce head loss;
- In-line centrifugal pumps, housed in a deep dry-well installation; and
- Submersible pumps located in a wet-well system.

For the purpose of hydraulic calculations, the MLWS (Mean Low Water Spring) level of - 0.95m AHD (Australian Height Datum) was adopted as the minimum design tide level. Whilst lower levels may occasionally occur, they would be relatively infrequent and of short duration. Reduced pumping rates could be tolerated for these periods.

Friction losses along the intake pipeline are primarily dictated by pipe length, diameter and internal roughness. Polyethylene (HDPE), steel or polyethylene-lined steel pipes were all considered during concept design. Whilst steel or polyethylene-lined steel would overcome problems of pipe flotation that can occur with HDPE pipes, they would be considerably more expensive to purchase and install compared to polyethylene pipes, and would be prone to corrosion.

HDPE pipes are preferred due to their lower cost, durability and easier construction. If laid on the sea bed however, provision is required to weight or anchor the pipeline to avoid flotation. Polyethylene pipes are only produced up to 1000mm diameter in Australia, although larger sizes can be imported.

Analysis of losses in the intake pipeline indicated that two 1000mm polyethylene intake pipes or a single 1200mm pipe would be required to reduce losses to a level which would avoid an excessively deep pumping station. There are advantages in having a dual pipe inlet system in terms of cleaning and ability to continue to use one pipe whilst the other pipe is being cleaned. A dual 1000mm pipe system is therefore proposed for the intake pipeline. Inlet losses for this type of system at a design flow rate of 180ML/d over a 350m length are approximately 0.8m.

HDPE has a lower specific gravity than water, and hence the pipelines will tend to float unless weighted down or anchored. For ocean pipelines this is commonly done using concrete anchor blocks fixed to the pipes at regular intervals.

Even though both the discharge and the intake pipelines will, as a minimum, be partially buried, anchor blocks will be used to ensure pipeline stability. The design concept for the anchor blocks is shown in Figure 4-3.

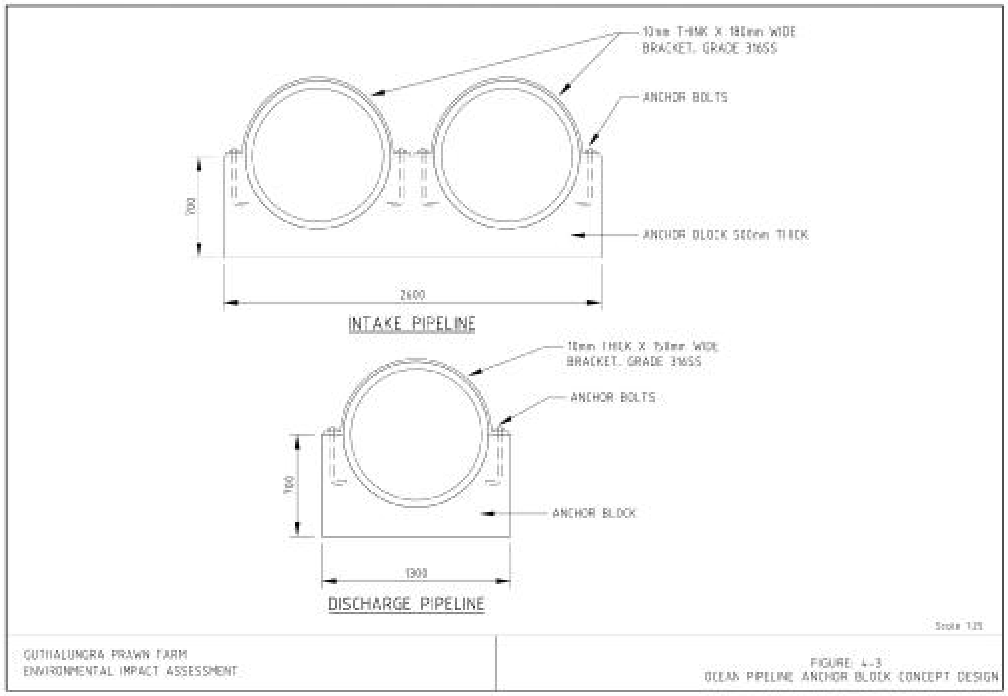

Figure 4-3
Ocean Pipeline Anchor Block Concept Design

The anchor blocks will be located every 5-10m along the pipelines. Anchor blocks will only be used seaward of Ch 5200, which is about the low water mark.

An assessment of the feasibility of in-line centrifugal pumps indicated that, to provide the necessary Net Positive Suction Head (NPSH), the pumps would need to be located at a depth of -12m AHD. This would result in a very expensive pump house and is impractical.

The alternative of large submersible pumps is preferred due to their much lower NPSH requirement. A conceptual general arrangement for the proposed system is shown in Appendix B.

A three pump system will be used because:

- Multiple pump units will allow the pump station capacity to be progressively increased, as the farm is developed;
- Multiple pump units will provide operational flexibility, enabling pumping rates to be varied according to demand; and

- Multiple pump units will reduce the impact of individual pump failure on maximum pumping capacity.

Control instrumentation will include:

- Sequenced and staged start-up of pumps to overcome initial dynamic effects;
- Minimum water level cut-out;
- Pump malfunction or shut-down;
- Loss of discharge pressure cut-out; and
- Sequenced pump shut-down.

Provision has been made for periodic cleaning of the intake pipeline and pump station via "pigging". Advice was obtained from a pigging contractor regarding design requirements. Pigging involves pushing a cylindrical polyethylene "pig" through the pipe using water pressure. The pig is constructed of polyethylene and abrades the inside of the pipe, removing material that has accumulated. Pigging of continuous pipe lengths up to 10 km has been undertaken, with accurate monitoring of the pig location using telemetry.

The pump station will incorporate the ability to launch a pig into the intake pipeline and push it out to the intake structure, where it is retrieved. Pigging of the rising main will occur in the reverse direction. The pump station design also allows for pigging of the pipework within the pumps station itself.

There will also be provision for allowing the intake pumps to be used for pigging of the disposal pipeline. Connection will be provided to a pig launcher in the disposal pipeline adjacent to the intake pump station, allowing a pig to be pushed either seawards (where it would exit the end of the disposal pipeline), are back towards the farm (where it would exit into the storage dam).

It is anticipated that pigging will be conducted annually during the off-season to minimise the build-up of marine growth in the pipes. Pigging will be conducted by qualified contractors.

It is anticipated that pigging will be conducted annually during the off-season to minimise the build-up of marine growth in the pipes. Pigging will be conducted by qualified contractors.

The pump station will essentially be a below-ground structure. The only above ground infrastructure will be a cabinet for power and control switching, a gantry for maintenance purposes and an on-ground transformer.

The rising main will consist of buried 1000mm diameter HDPE pipeline. From the intake pump station, the pipeline route will follow an existing unmade road reserve to Coventry Road. Along Coventry Road the pipeline will be located on the eastern side of the existing road. The pipeline will cross an area of salt pan immediately north of the proposed farm. The route in this area was selected to minimise the amount of pipeline installation required across salt pan, given the risks and potential problems associated with such construction.

Air entry and air release valves will be located as shown on the longitudinal sections to minimise problems caused by dynamic water pressures.

b) Seawater Storage

The intake pipelines will discharge to a seawater storage that will provide a buffer between water supply and demand. A typical cross-section of the storage embankment is shown in Appendix B. The bank will incorporate a compacted clay cut off trench and 1.0 m thick clay blanket on the inside batter.

Under normal operating conditions the storage level will vary between 3.0m AHD and 6.0m AHD, providing an active storage capacity of 370ML. This is equivalent to 4.35 days supply assuming average exchange rates. The storage will have rip-rap protection on the inside batter extending over the operating depth of the storage to minimise erosion and optimise water quality.

c) Supply Channels

Water will be pumped from the seawater storage by three low lift pumps, discharging to main supply channels. These channels will in turn feed distribution channels that will supply ponds.

Re-lift pumps will be installed on the main supply channels supplying the upper parts of Production Area 1 and Production Area 2. This was necessary to minimise earthworks associated with construction of elevated channels from the seawater storage to supply the upper parts of the farm.

All channels will be of trapezoidal cross section, and will be lined with 0.75mm thick HDPE plastic liner to optimise water quality, and to minimise erosion. Each channel will be graded to enable drainage at the end of the season. Water will be passed into the ponds via 300mm diameter inlet pipes. Concept designs for the channels and associated structures are provided in Appendix B.

d) Production Ponds

A total of 259 one hectare earthen grow out ponds will be constructed, using clay material won from the site. The ponds will be of conventional design, with an operating depth of 1.5m, gravity water supply and drainage via intake and outlet pipes. Ponds and will be lined with 0.5m thick compacted clay layer. Rip-rap protection will be provided on the inside batter along the water line to minimise bank erosion and optimise water quality in the ponds.

Typical pond cross-section is shown in Figure 4-4.

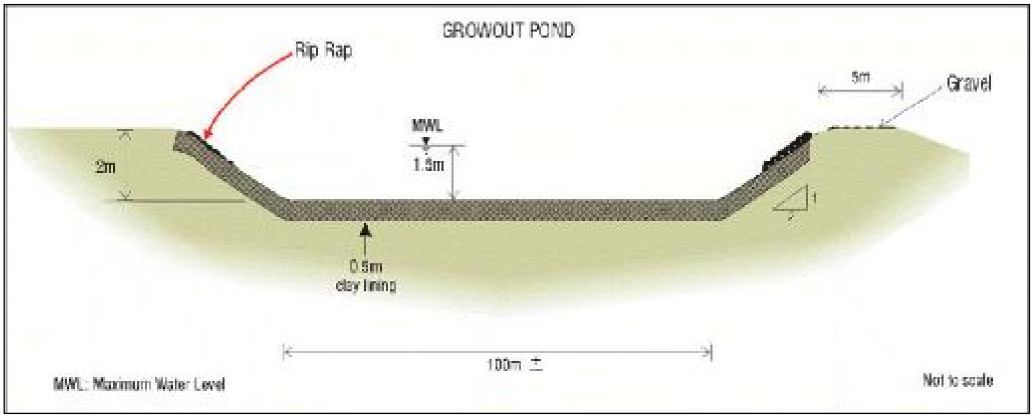

Figure 4-4
Typical Grow out Pond Cross-section

Geotechnical investigation of the site (refer Appendix G) indicates that ample clay material suitable for pond construction exists across the site. The investigation indicated there is approximately 4.3 million to 5.9 million cubic meters of soil at the site suitable for pond construction. Permeability testing of remoulded samples indicated the soils have good water retaining characteristics, with permeabilities ranging from 1 x 10^{-9} m/s to 3 x 10^{-11} m/s. A 0.5m liner thickness was selected on the basis of constructability, cost and potential environmental risk (refer Section 7.5.3).

The farm will operate as three independent farms in one, as shown in Figure 4-5. The three production areas will be the following sizes:

- Production Area 1: 91 ha;
- Production Area 2: 112 ha; and
- Production Area 3: 56 ha.

This arrangement will have the following benefits:

- It will reduce the size of each farm entity to a level where it can be effectively managed. Logistics associated with stocking, feed management and staffing suggests that an upper limit of about 100 ha of growout ponds per operating entity is desirable to maximise operating efficiency;
- It will allow for each production area to operate independently of water supply and exchange systems. This will provide production area managers with full control over water quality management, and hence control over on the performance of their farm area; and
- It will reduce the risk of disease by limiting the ability for disease to spread across the farm by water transfer.

e) Drains

Water will drain from each pond via outlet flow control structures and outlet pipes. Each pond will be serviced by a drain to convey exchange and harvest release water to treatment systems downstream.

Drains will be trapezoidal and clay-lined as shown in Appendix B. Drain levels and grades have been based on ensuring water can be released from the ponds during harvest without being effected by high tailwater levels. Design allowances have been based on similar arrangements working effectively on Pacific Reef Fisheries property at Ayr.

Drain bed grades will be relatively flat, typically 0.3 – 0.4m/1000m, to minimise the potential for erosion, and to hence avoid associated maintenance and water quality problems.

Figure 4-5
Production Area Configurations

f) *Pond Release Water Treatment System*

Water will drain to water treatment systems, with each production area being serviced by an independent treatment area. The treatment system will consist of two main elements:

- Primary sedimentation areas; and
- Settlement ponds.

The primary treatment areas will be designed to allow sedimentation of the coarse fraction of suspended solids. A Hydraulic Retention Time (HRT) of approximately 8 hours will be provided. Each sedimentation system will have two cells. A typical cross section of the sedimentation areas and settlement ponds is shown in Figure 4.6.

Facility will exist to direct inflows to either cell, of the sedimentation pond area, with only one cell in use at any one time. Outflows from the cells will be via a variable height overshot weir and pipe structure at the downstream end. Cells will be drained via pumping into the settlement ponds.

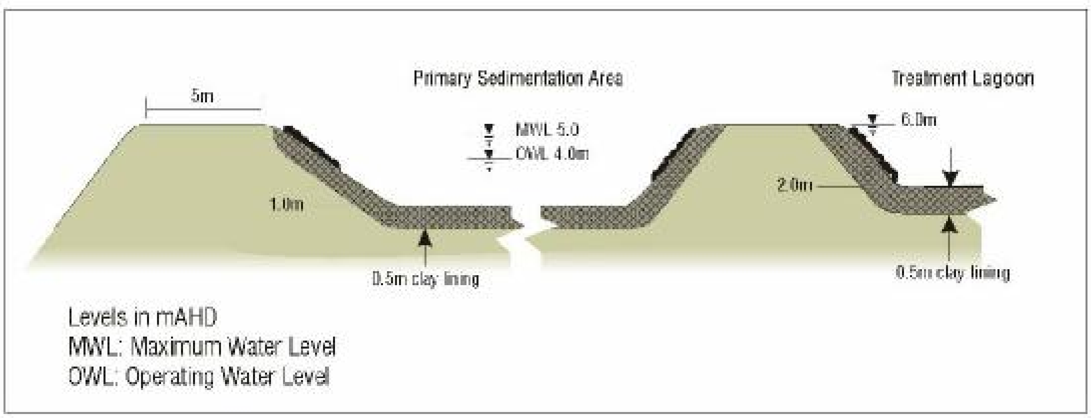

Figure 4-6
Primary Sedimentation Area and Settlement Pond Typical Cross Sections

It is proposed that each cell of the sedimentation pond will be used for approximately half of the growing season each. Cells will be pumped dry and the sediment removed and disposed to landfill.

The cells will be constructed 1.0m deeper than the settlement ponds to enable the target Hydraulic Residence Time (HRT) of 8 hours to be achieved under normal operating conditions.

Under normal operating conditions, the water level in the sedimentation cells will be 4.0m AHD. Capacity will exist, however, to increase the level to 5.0m to improve the HRT in the event of water quality problem within the farm. Production Areas 2 and 3 and the upper half of Production Area 1 will be able to drain to the levels under gravity without impinging on the ability of the ponds to drain during harvest. The relatively low level of the bottom half of Production Area 1 will mean that it will not be able to gravity drain to a level of 5.0m AHD in the sedimentation cells. The drainage system for this area will include a relift pump and flow control bank at the downstream end, to allow water to be lifted to the higher (5.0m AHD) level when required.

g) Settlement Pond Areas

Water will discharge from the sedimentation areas into settlement ponds, where further sedimentation and biological treatment will occur. Settlement ponds have been sized to provide a minimum of 48 hours HRT under peak discharge conditions, as shown in Table 4-1.

Table 4-1
Settlement Pond Characteristics

	Peak Flow Rate (ML/d)	Surface Area (ha)	Hydraulic Retention Time (d) 4.0m Water Level	Hydraulic Retention Time (d) 5.0m Water Level
Treatment Lagoon 1	126	15.0	2.4	3.6
Treatment Lagoon 2	126	17.4	2.8	4.1
Treatment Lagoon 3	81	12.4	3.1	4.7

As discussed above, it will be possible to raise the water level to 5.0m AHD to provide additional treatment to accommodate periods when water quality problems occur on the farm. Settlement Ponds will be clay lined and will incorporate rip-rap protection on inside batters.

As can be seen in Figure 4-1, flow training walls will be constructed within the settlement ponds to eliminate short-circuiting of flows. It is proposed that the performance of the settlement ponds will be monitored during the initial years of operation. The proposed layout will provide ready access to the settlement pond areas, and as such will allow for the introduction and trialling of further water quality improvement measures, such as bio-remediation or the integration of fish species into the settlement ponds.

It will be possible to pump from each lagoon to re-use water on-farm. Reuse pump locations have been selected away from inflow points to ensure optimum re-use water quality. Settlement ponds will overflow to the main outflow drain via an overshot weir and pipe outlet structures. The main outfall drain will flow around the northern boundary of the site as shown in layout plan. Water will be pumped from this drain to Abbot Bay via the main discharge pump station and pipeline. The main outfall drain bed will grade from 2.0m AHD at its upstream end to 1.5m AHD at the pump station. The drain will be lined with 0.5m of clay, and will have a maximum water level of 3.5m AHD.

h) Main Pump Station and Pipeline

The discharge pump station and pipeline will have a design capacity of 200ML/d, in accordance with the peak discharge estimate for the farm.

The pump station will consist of a 3 pump submersible pump arrangement, similar to that proposed for the intake system. The pump-well will be a concrete caisson type construction with a floor level of approximately –2.0m AHD. The pump and pipe system will include the same provisions for pigging as the intake system.

The discharge pipeline will consist of a single line of 1000mm diameter HDPE, and will be laid adjacent to the water intake pipeline. It will extend approximately 500m offshore, as shown in Figure 4-2.

The pipeline will generally follow the natural topography as shown on the longitudinal sections. In the intertidal zone, cover over the pipe will be increased to 2.0m to minimise the risk of pipe exposure under extreme conditions.

The final 100m of discharge pipeline will serve as a diffuser. Diffuser ports will be located along this pipeline as shown in Figure 4.7.

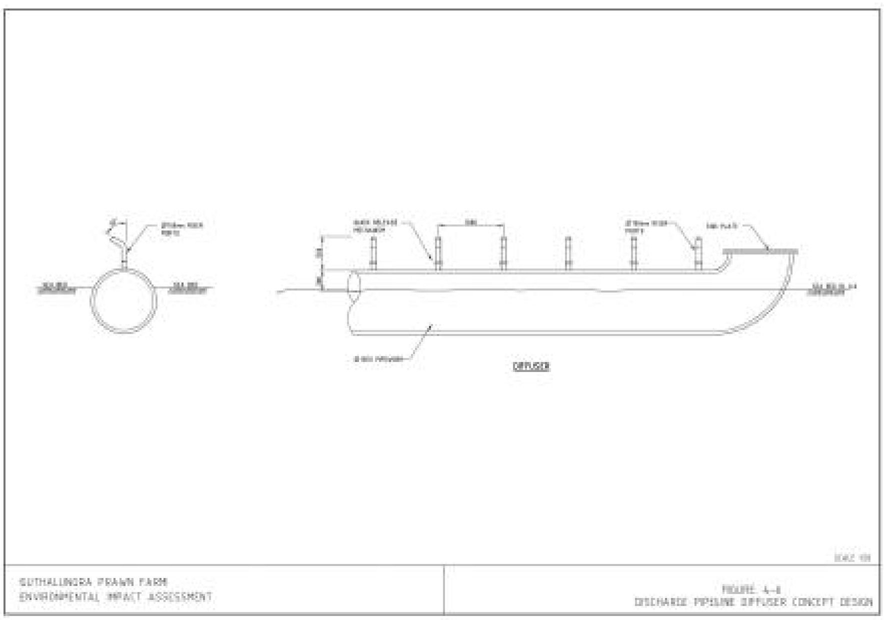

Figure 4-7
Ocean Discharge Pipeline Diffuser Concept Design

Diffuser ports will be fabricated from 10070mm diameter UPVC or similar, and will be located every 1000mm along the diffuser length of the pipeline. The exit velocity through the diffusers will be approximately 3.0m/s at peak discharge.

Diffusers will be orientated to direct flows to the north, and will aligned at an angle 60 degrees to the vertical. This orientation was used as the basis for initial estimation of near-field dispersion of the discharge plume, which was subsequently used in the larger scale dispersion modelling completed by James Cook University.

Diffuser ports will be designed to be readily removable to enable cleaning or replacement if damaged. They will be inspected and maintained annually.

i) Administration Building / Processing / Maintenance / Storage Area Construction

Figures in Appendix B show the general site layout for the main administration area, which will be located just east of Coventry Road on the southern boundary of the property. It will consist of:

- An administration office;
- A laboratory facility;
- Food processing facility;
- Staff parking and amenity areas;
- Machinery storage sheds and workshop;
- Three freezer stores;
- Feed storage sheds;
- A fuel storage area;
- Three staff residences;
- Water and wastewater treatment systems; and
- Potable water systems.

The administration office and laboratory will be constructed in the first year. It will be a conventional brick veneer iron roofed building of approximately 850m^2, built on a concrete slab.

The food processing facility will also be constructed in the first year. This will be a structure similar in style to that which exists at Pacific Reef Fishers, Ayr farm, being a free standing portal frame structure with metal cladding.

The machinery storage, workshop and maintenance area will be full roofed with concrete floor. It will be a relatively simple portal frame design with high clearance and will incorporate office / storage room. These sheds will be steel clad with extensive provision for vehicular access.

The feed storage sheds will be of similar style to the machinery workshop areas. They will be constructed progressively as the farm is developed.

j) Roads and Site Access

Road works proposed as part of the project include upgrade of the existing road from Guthalungra to the site, construction of on-farm roads and access tracks, and construction of an access track from Coventry Road to the water intake pump station.

To accommodate expected increases in traffic loads on the road from Guthalungra to the farm, upgrade works are proposed, and will be undertaken in consultation with Bowen Shire Council. Works will include re-profiling of the surface of the existing road and placement of crushed rock will be placed to improve trafficability. Pacific Reef Fisheries will work closely with Bowen Shire Council to ensure the road is adequately maintained in the future.

Most on-farm access will be along pond embankment crests. The extent of formed roads on the farm area will be minimal. Where they are required, they will consist of formed and gravelled carriageways. Access roads around the administration/ processing/ maintenance compound will be sealed to reduce dust and accommodate higher traffic loads in these areas.

An access track will be constructed from Coventry Road to the water intake pumping station. The track will be located alongside the pipeline route, and will provide access to the pumping station for construction purposes, for periodic daily inspection, and for annual maintenance.

Daily inspections will be undertaken using either 4WD motorbike or light vehicle. Annual maintenance will require access by heavy non-articulated trucks, to remove pumps for maintenance or transport cleaning pigging equipment to the pump station. The track will also provide access for heavy vehicles during times of emergency, such as pump failure.

To minimise the environmental impacts of the access track, a relatively low standard carriageway will be constructed. The form of the track will vary slightly, according to the subgrade conditions, and the depending upon the degree to which the track will be inundated in wet conditions.

In sections where the track is located on higher ground, the track will consist of little more than a cleared pathway that has been graded to provide a cross-sectional profile that drains and can be maintained. No re-grading of the longitudinal profile will be undertaken, and no placement of gravel or other surfacing material will be carried out.

The Intake Pump Station and pipelines will be located on an existing unmade road reserve which is approximately 50m wide. The pipeline route between the pump station and Coventry Road traverses several areas of land that are subject to extended periods of inundation. These areas include the marsh between the primary and secondary coastal dune, and between the secondary dune and the ridge on which Coventry Road is located.

Reliable access to the pump station will be required during construction to allow heavy machinery and equipment to reach the pump station site. This will include hydraulic excavators, cranes, concrete delivery trucks, and trucks for supplying construction materials and equipment. During operation it will also be important to have year-round access to the pump station to allow heavy vehicle to reach the site in the event of pump breakdown. Regular access using light vehicle or 4WD motor-bikes will also be required for inspection purposes.

A number of design options have been considered for the access track, based on the need to minimise environmental impacts. These have included low-level causeways, alternative means of access via sea or air, or overland via amphibious vehicles. A low-level gravelled access track is proposed, as shown in Appendix B, incorporating cross-drainage culverts to maintain surface flow characteristics. Part of the track formation will incorporate the rising main pipelines, as discussed above.

Where the track crosses lower-lying depressions that become regularly inundated, subgrade will be excavated 4m wide and to a depth of 1000mm, and backfilled with rock to provide a more stable carriageway. Where soft sub-grade conditions are encountered, the rock will be underlain with geofabric. A low level causeway will be constructed to provide year-round access. The causeway will include cross-drainage to maintain the hydrological characteristics of the area. Figure 4-8 shows the type of cross-section proposed for much of the access causeway.

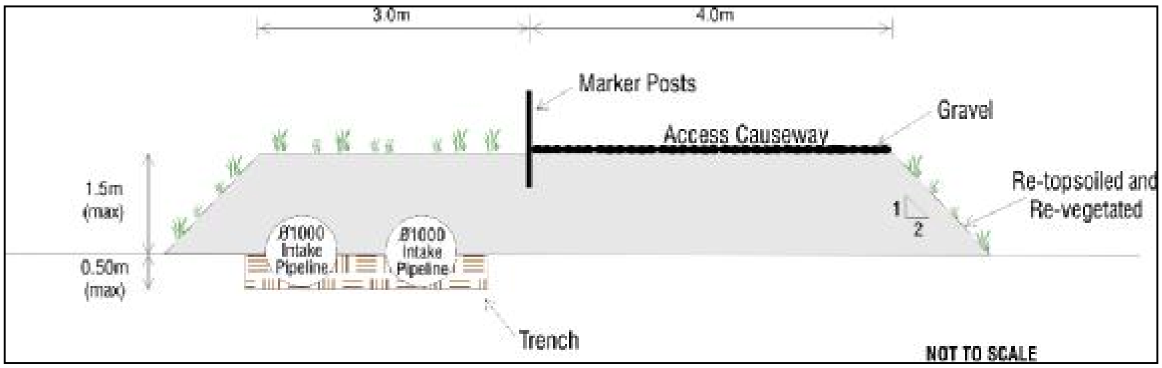

Figure 4-8
Intake Pump Station Access Causeway Cross-section

The track will vary in height up to 1.5m above natural surface, and will be fully re-topsoiled and revegetated.

In sections where the track is located on higher ground, the track will consist of little more than a cleared pathway that has been graded to provide a cross-sectional profile that drains and can be maintained. No re-grading of the longitudinal profile will be undertaken, and no placement of gravel or other surfacing material will be carried out.

Rock backfill will only extend 200mm above the original natural surface level, to minimise impacts on surface flows. The porous nature of the rock will allow movement of residual surfaces flows through the causeway. In areas subject to inundation, the causeway will be marked with 2.0m high wooden marker posts, placed every 20m alongside the causeway. This arrangement is considered adequate on the basis that access by heavy vehicles during wet periods is not normally expected, with access limited to lighter vehicles during the wet season.

4.1.2 Acid Sulphate Soils

A comprehensive survey of Acid Sulphate soils according to QASSIT guidelines was undertaken. There is small amount of Potential Acid Sulphate Soils (PASS) on site and management of these are addressed in the Acid Sulphate Management Plan. There is also PASS on the salt pan and across the wetland. The estimated volumes to be excavated below 5.0m AHD are:

- Production Pond Area:- 2.42 million m^3
- Seawater Storage:- 0.3 million m^3
- Treatment Lagoon -1:0.5 million m^3
- Treatment Lagoon 2:- 0.48 million m^3
- Pipeline:- 0.03 million m^3

In total: 3.73 million m^3 of ASS may need to be removed and treated. The details of this survey are described in Section 6.3.

4.1.3 Groundwater and Hydrological Investigations

Depth to groundwater varied from 7.5m at the higher southern boundary of the site (Bore 1) to 1.0m near the salt pan (Bore 6) (see Appendix O). Increases in watertable levels were noted in several bores after initial intersection of the aquifer, suggesting confined aquifer systems. Groundwater salinity was similar to that of seawater, with an average salinity across all bores of 32 500 mg/L. Subsequent levelling of the bores and analysis of regional groundwater information showed that groundwater levels at the time of sampling graded from east to west, and was approximately 2.0m AHD at the south-west end of the site, reducing to 0.4m near the salt pan at Coventry Road.

In addition to this, localised shallow freshwater perched aquifer systems are present in the area, as evidenced by several bores in the area, typically near the Elliot River. These bores draw from the shallow alluvial aquifers. Groundwater and hydrological investigation are described in detail in Section 6.4.

4.1.4 Processing and Potable Water

a) Potable Water Demand for Processing

The project includes the construction of a seafood processing and freezing facility. This process involves:

- Chilling of prawns in an iced brine mixture immediately upon harvesting to stun the animals and minimise stress;
- Sorting of prawns by size;
- Cooking of prawns in salt water;
- Chilling of cooked prawns in salt water for 24 hrs at -2ºC;
- Package and fresh distribution;
- Snap-freezing to -25ºC; and
- Packaging and storage.

The main water requirement for this process will be for cooking and chilling of the prawns. This will require approximately 100 kL/d of salt water, which will be sourced directly from the main seawater storage on the farm and will be treated with either ozone, or chlorination followed by UV.

An additional 30-50 kL/d of potable water will be required for wash down and cleaning. This water will be sourced from the potable water supply.

b) Potable Water Demand for Domestic and Office Use

Fresh and potable water will be required for:

- Use in the processing facility;
- Use in the laboratory;
- Toilets, hand washing and drinking water; and
- Irrigation of lawns and surrounds (fresh but not necessarily potable).

Estimates of domestic demand have been derived from expected staff numbers for the project. The basis for sizing of key components of the system is provided in Appendix C.

Water demand estimates are based on the following assumptions:

- 55 full time day-visit staff;
- 3 full time on-site staff;
- 25 casual production staff (Nov. – May);
- 30 casual processing staff (Jan. – June);
- Three families accommodated on-site, each with three people;
- Processing water requirement of 40 000 L/d;
- Day staff consume on average 100 L/d; and
- A family of four consumes 4 000 L/d, including gardening, lawn watering etc.

Whilst water demands are influenced by staffing requirements, the main determinant of potable water supply is the demand for processing. The maximum water demand during peak growing and processing periods is estimated to be 61.4 kL/d. The annual demand is estimated to be approximately 14 000 kL.

If lawn/gardening watering is excluded from the above figures (1.6 kL/d), total average daily consumption reduces to 59.8 kL/d, and annual consumption would be 12,300 kL/annum.

A range of options were considered for supply of fresh water including:

- Rainwater collection from roofs;
- Use of surface water, particularly the dam adjacent to the administration/processing area;
- Groundwater;
- Carting of water from a nearby potable supply; and
- Reverse osmosis water treatment.

Of the above sources, all appear feasible, although water carting on a continuous basis and reverse osmosis (RO) would be prohibitively expensive. RO remains a possible future option however, as this technology improves and becomes more affordable.

The strategy for supply of fresh and potable water is based on access to the range of feasible sources available. The primary source of supply would be from the existing dam near to the office/processing area (refer Figure 4-1). This dam holds approximately 20000 – 25000 kL of water when full.

The dam wall is presently in poor condition, and lacks an appropriate spillway. It is approximately 1.5m high at its highest point. To improve its security and provide some freeboard, it is proposed that the dam wall will be increased by 0.5m, and a spillway constructed with a spilling level equal to the current minimum overtopping level. This is discussed more fully below.

The dam will have sufficient capacity to supply the required fresh and potable water in all but exceptionally dry years. In such years it is proposed that groundwater be used to supplement supply. Local landholders already extract fresh water from perched aquifer systems along the Elliot River floodplain. Initial exploratory drilling for fresh water at the site has indicated that freshwater supplies are available however the extent of the water resource is unknown. Further drilling will be undertaken during the detailed design phase of the project to confirm the extent of groundwater available.

Should both surface water and groundwater be unavailable, water will be transported to the site from Bowen. This would be relatively expensive, however it is considered only as a contingency, and is not expected to be required very often.

In addition, to the above, all rainwater runoff from roofs will be collected and used for potable purposes. The site will include approximately 5,500m^2 of roofed area. Assuming an average annual rainfall of 1040mm, this represents approximately 5,800 kL of water that could be collected each year. This constitutes approximately 40% of the total annual demand.

c) Water Storage

An existing dam on a depression that runs through the site east of Coventry Road will be used to store water for potable supply. Figure 4-1 shows the location and indicative area of inundation of the existing storage. The approximate capacity of this dam is 20000 – 25000 kL, although bathymetric survey has not been undertaken. The area of the storage when full is estimated to be only several hectares. The existing dam wall has not been well maintained and is in a relatively poor condition.

Raising of the dam embankment by 1.0m, to provide freeboard, reinstatement/repair of earthworks, and construction of an appropriate spillway are proposed as part of the project.

The dam has a catchment area of approximately 40 ha. Diversion of additional flows into this storage from the catchment area upstream of the production ponds west of Coventry Road is also proposed, as part of the stormwater management arrangements for that area. The catchment area of this diversion is approximately 308 ha. It has been assumed that the dam spillway will require sufficient capacity to pass a 1 in 100 year ARI runoff event from the upstream catchment. Runoff calculations for the existing catchment indicate that the peak 1:100 year discharge would be approximately 2.5m^3/s. Stormwater runoff calculations for the diverted catchment (refer Appendix H) indicate the 1:100 year flow rate from this area is 13.90m^3/s. The total spillway capacity would therefore need to be approximately 16.4m^3/s.

Upgrading of the dam will therefore include:

- Raising of the embankment level by 1.0m to a finished crest level of approximately 4.5m AHD. Selected clay material will be used to raise the embankment, placed and compacted in accordance with appropriate engineering standards;
- Repair of any deteriorated sections of bank by excavation of any areas in poor condition and backfilling with compacted clay;
- Re-topsoiling of the crest and downstream batter using topsoil won from the earthworks from the nearby treatment pond construction works;
- Placement of crushed rock on the bank crest to improve access and further protect against erosion;
- Lining of the upstream batter of the embankment with rip rap to minimise erosion and maintain water quality; and
- Construction of a spillway at approximately 3.5m AHD, which equates to the existing bank level.

This spillway will be approximately 25m wide to pass the 1:100 year peak flow. The spillway and return slope will be an earthen grassed structure.

Storage of all other potable and fresh raw water supplies will be via self-contained concrete or polyethylene storage tanks adjacent to the processing area.

d) Potable Water Treatment

Water treatment will be required to supply potable water from the dam or from groundwater. Chlorination of rainwater is also desirable, particularly if the water is to be used for processing. Raw water would be used for lawn/garden watering.

The dam receives runoff from the upstream catchment which mainly consists of grazing land. As such the water will have relatively high levels of suspended solids. From time to time elevated levels of organic material and faecal coliforms could also be present due to wash-off of animal faeces from grazing land.

There does not appear to be a significant risk of any other form of contamination of water in the dam.

On this basis, it is proposed that water sourced from the dam be treated via sand pressure filtration and disinfection by chlorination, as shown in Figure 4-9. Monitoring for bacterial contamination from all drinking water sources will be undertaken weekly. Monthly water samples will be analysed for manganese and iron. pH and conductivity. Six monthly water samples will be analysed for heavy metals.

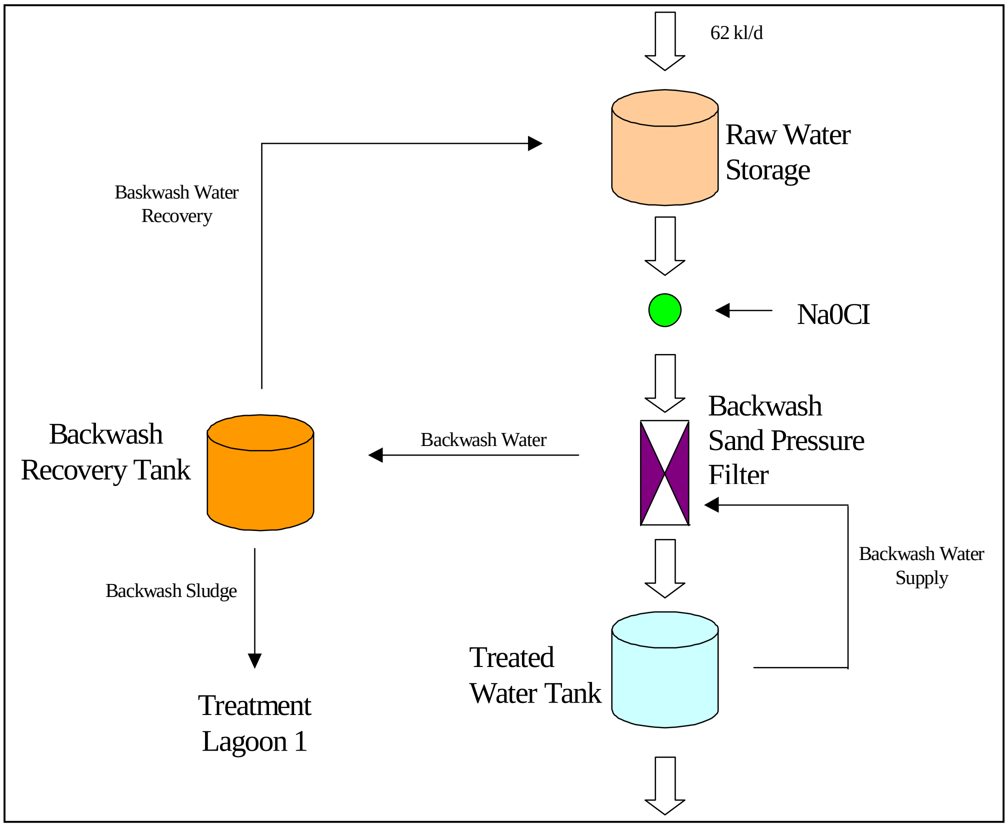

Figure 4-9
Potable Water Supply Treatment Strategy

The treatment system has been sized on a design flow rate of 62 kL/d, calculated from the staffing and demand projections discussed above.

Sand filter backwash sludge will be disposed to the Settlement Pond 1.

e) Wastewater Treatment

The administration/processing/workshop areas will generate two types of wastewater:

- Processing wastewater, which will be saline; and
- Domestic wastewater.

Processing Wastewater

The processing facility will generate 130 – 150 kL/d of water from the cooking and chilling process, and from washdown and cleaning. The waste stream will be saline, and will have high levels of suspended solids and dissolved organics from the cooking process. There is also a risk that this waste stream could be a vector for disease propagation and transmission.

The proposed treatment process for this water is shown in Figure 4-10. The strategy consists of:

- Collection and flow balancing tanks;
- Primary static screening (wedgewire slot 0.5mm) to remove larger particulate material;
- Secondary screening using cartridge filtration to remove particulate material down to 0.1mm;
- Disinfection by chlorination;
- De-chlorination via natural volatilisation and aeration in an de-chlorination lagoon; and
- Discharge to Settlement Pond 1.

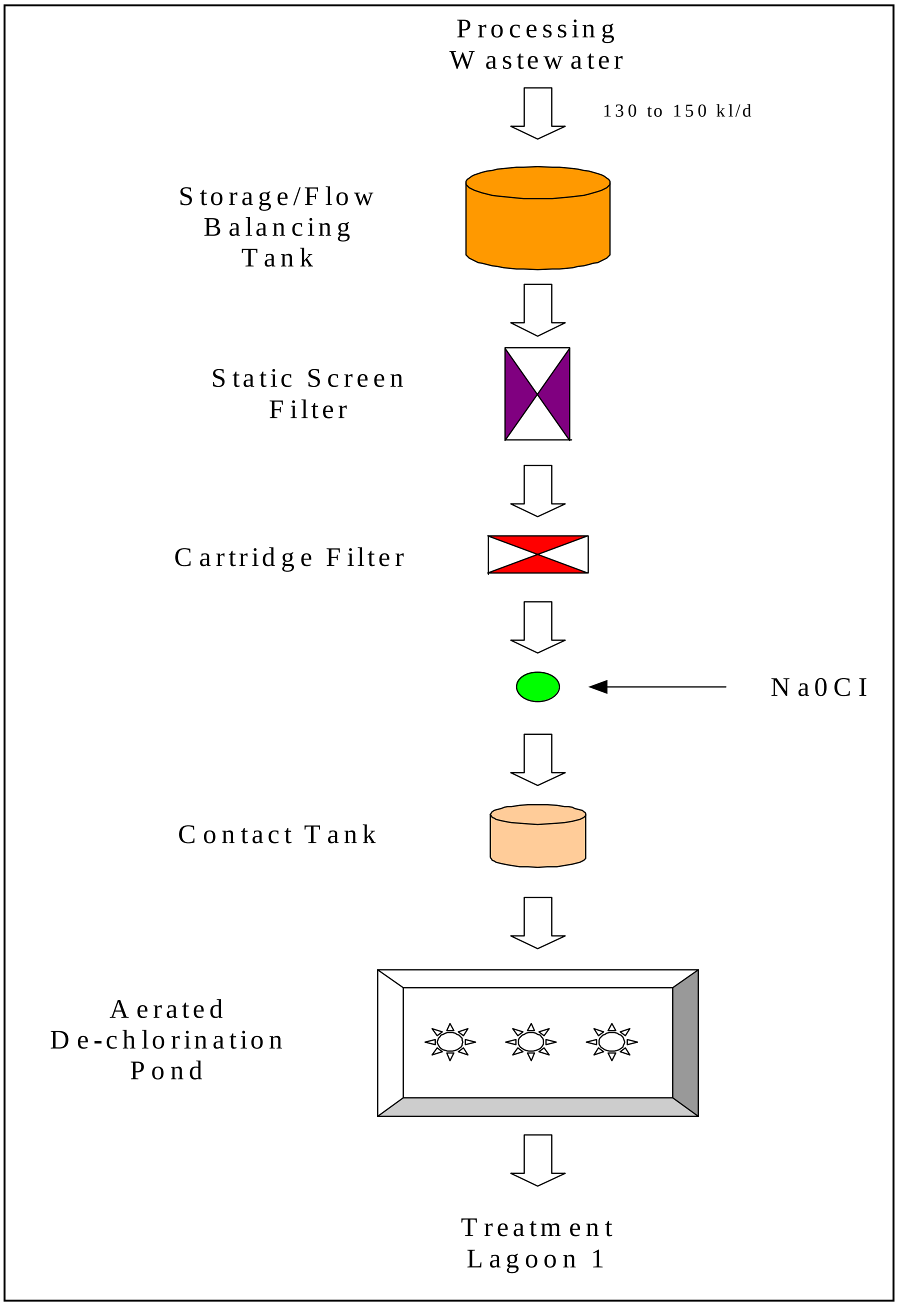

Figure 4-10
Processing Wastewater Treatment Strategy

This treatment approach minimises the risk of disease transmission, and will ensure that the biological processes taking place in the Settlement Pond 1 are not disrupted by elevated residual chlorine levels in the treated wastewater.

Domestic Wastewater

Domestic wastewater will be produced from the ablution facilities associated with the administration office and processing workers facilities. The laboratories will also produce small amounts of grey water, and the three residences will produce domestic effluent. The hydraulic loading estimates for these sources has been based on the staffing numbers used for the potable water demand calculations, as shown in Appendix C. It has been assumed:

- An effluent production rate of 200L/EP per day is appropriate; and
- Day-visit staff produce 0.2 EP of effluent.

The estimated maximum daily sewage production rate is 30.8 EP (6.16 kL/d), and annual production is estimated to be 1740 kL.

Figure 4-11 shows the general strategy proposed for domestic wastewater treatment.

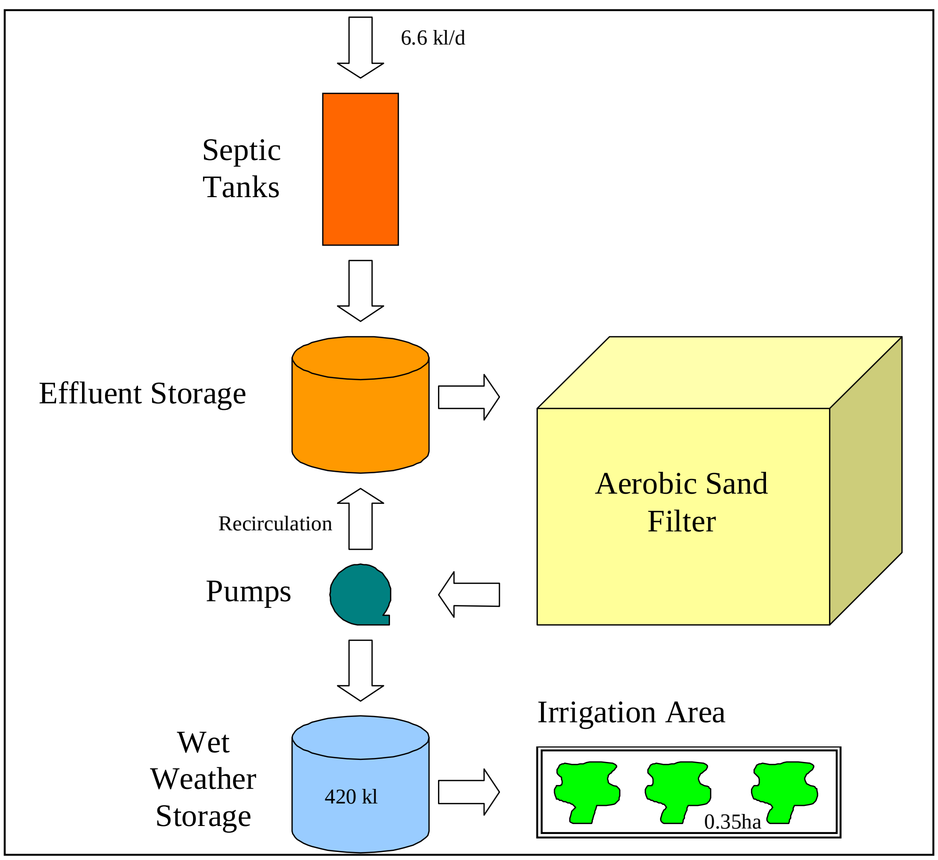

Figure 4-11
Domestic Wastewater Treatment and Disposal Strategy

The strategy for treating and disposing of this effluent will be to:

- Reticulate sewage and grey water to septic tanks located close to the source. Separate septic tanks will be constructed for each of the domestic residences, and for the administration building/ablutions facilities;
- Overflows from the septic tanks will be reticulated to a central effluent storage, which will overflow to an aerobic sand filter. This filter will be located below-ground, and will be approximately 8m wide x 17.5m long x 0.75m deep, in accordance with standard design criteria (SA Health Comm., 1998);
- Water will be pumped from the aerobic sand filter to a wet weather storage with approximately 420 kL capacity. This will be equivalent to 60 days average effluent production. This storage will be in the form of elevated plastic or concrete tanks; and
- Water will be pumped from the wet weather storage tanks and irrigated on site. Several potential irrigation areas exist. Irrigation will be via sub-surface dripper, supplying native trees. Assuming a conservative estimate of 5ML/ha. annum, the area required for land disposal will be approximately 0.35 ha.

The treated water storage tank will be sized to provide "wet weather" storage. If longer periods occur when irrigation is not possible, treated water from this tank will be carted to Bowen for disposal to the municipal treatment facility.

4.1.5 Flooding and Storm Surge

Flooding and storm surge has been addressed in detail in Section 6.4, Section 7.2.6 and Appendix H.

4.1.6 Structures in the GBRMPA

The GBRMPA includes Abbot Bay. A description of the project components is provided in Section 4.1.1. The seawater intake and discharge pipelines will be the only structures located in the GBRMPA. These structures will consist of:

- Twin 1000mm diameter HDPE intake pipelines extending 300m offshore, as shown in These pipelines will be buried along their full length;
- An intake screen as shown in Appendix B; and
- A single 1000mm diameter HDPE discharge pipeline, extending approximately 500m offshore. This pipeline will be buried for all but the last 100m, which will incorporate diffusers.

Measures to mitigate the environmental impacts of construction of these structures are described in Section 7.0.

4.2 Design Criteria

4.2.1 Construction and Operating Standards

The construction and operating standards of the growout ponds, the laying of the pipeline the construction of the pump station and auxiliary features of the farm are described in Section 4.3.

4.2.2 Design and Operation of the Prawn Farm Water Discharge Treatment Facilities

The farm will consist of three production areas, hereon known as Production Areas 1, 2 and 3. These Production Areas will be constructed over a four year period. Each Production Area will be self-contained with its own grow out ponds and treatment streams. A description of these areas is provided in Table 4-1 and Section 4.1.

Water from the Guthalungra prawn farm will be drawn from Abbot Bay. The water quality at the point of intake is variable with concentrations of Total Nitrogen between 100 and 400 μg/L. This is considerably lower than for water drawn from many estuarine creeks on the Queensland coast for prawn farms, which is can be consistently as high as 400 μg/L or greater (APFA). The operation e.g. filling, grow out and harvesting of the three stages of the prawn farm ponds will consist of the following:

- There will be 7 groups of ponds in Stage 1 with each group containing 14 ponds and one group with 7 ponds;
- There will be 9 groups of ponds in Stage 2 with seven group containing 14 ponds and two groups containing 7 ponds;
- There will also be 5 groups of ponds in Stage 3, with 2 groups of seven and three groups of 14 ponds;
- It will take one (1) week to fill and stock each group of ponds. For example, the 14 ponds in group one (Stage 1) will be filled and stocked in the first week of August (referred to as week 1). In week 2, the next group of 14 ponds will be filled and stocked. This process continues each week until all 7 groups of ponds have been filled and stocked;
- Each individual pond is 1 hectare in size (100m x 100m);
- Each individual pond is 15ML in volume (10,000m^2 surface area x 1.5m depth);
- At the commencement of Week 5, 0.5% of water is exchanged per day per pond to offset stock growth;
- After Week 6, 98 ponds have been filled and stocked. This equals 98 hectares in size and 1470ML in volume;
- By the first week of October (Week 9), the daily % of water exchanged increases to 2% per pond; and
- Refer to Appendix D for spreadsheets of discharge water calculations.

The good water quality from Abbot Bay will reduce the need for overall water exchange within the farm, whilst reducing the gross TN discharge load from the farm.

The ponds will be filled during August when water temperatures (23°C) are suitable for stocking post larval *Penaeus monodon*. The prawns have a growing season of 180 days in which time they will grow from <1gm to up to 25 gm. The stocking program in the ponds will be staggered over the months of August, September, October, November and December, so that prawns will be harvested in March, April, May and June of the following year. Maximum discharge will occur during the months of February and March, when pond exchange requirements are the greatest, and harvesting is also taking place. From June to August the ponds will lay fallow, during which time they will be dried and ripped in preparation for the next season.

- The percentage of water exchanged per day will increase every month until harvest. For example, by mid January (Week 21) 21ML of water will be exchanged per day for all 14 ponds; and
- The first group of ponds will be harvested in February (Week 25). Immediately after harvest, all pond water for the relevant group of ponds will be discharged, totalling approximately 40ML per day per group of ponds.

With the advancement of Production Area 1 ponds, the daily total water exchange (ML per day) will gradually increase from September (week 5). Discharge from Production Area 2 ponds will occur from mid October (week 10), and discharge from Production Area 3 ponds will occur from December (week 17).

The initial peak in Production Area 1 water exchange, will occur in February (week 25), at a calculated rate of 126ML per day. This occurs prior to the harvest of the initial, most mature group of ponds in Production Area 1. Over the following 5 weeks, total discharge volumes from Production Area 1 ponds will decrease until all groups of ponds have been harvested. This process is will be repeated for Production Areas 2 and 3.

The incremental maturation of Production Area 2 and Production Area 3 ponds will steadily increase total discharge volumes for the entire prawn farm. Production Area 2 discharge volumes will peak in March (week 31), at a calculated exchange rate of 126ML per day, and will continue to decrease after harvest. Production Area 3 discharge volumes will peak in the first week of May (week 39), at a calculated exchange rate of 81 ML per day, and will continue to decrease after harvest. The final harvest will be completed in June (Week 43) at the conclusion of Production Area 3.

Summation of the total daily volume exchanged and released as part of harvesting, for all Production Areas, indicates a peak in daily discharge in February (weeks 25 and 26), at approximately 204ML, as shown in Figure 4.12.

Based on the above operating procedures, the proposed average daily water exchange over the growing season for the Guthalungra prawn farm will be 2.7%. This rate of exchange is 30% below the industry standards of 4 - 5 % exchange averaged over the growing season. This reduction reflects the water management improvements achieved in recent years amongst leading growers in the industry, and the expected benefits to result from good quality water drawn from Abbot Bay.

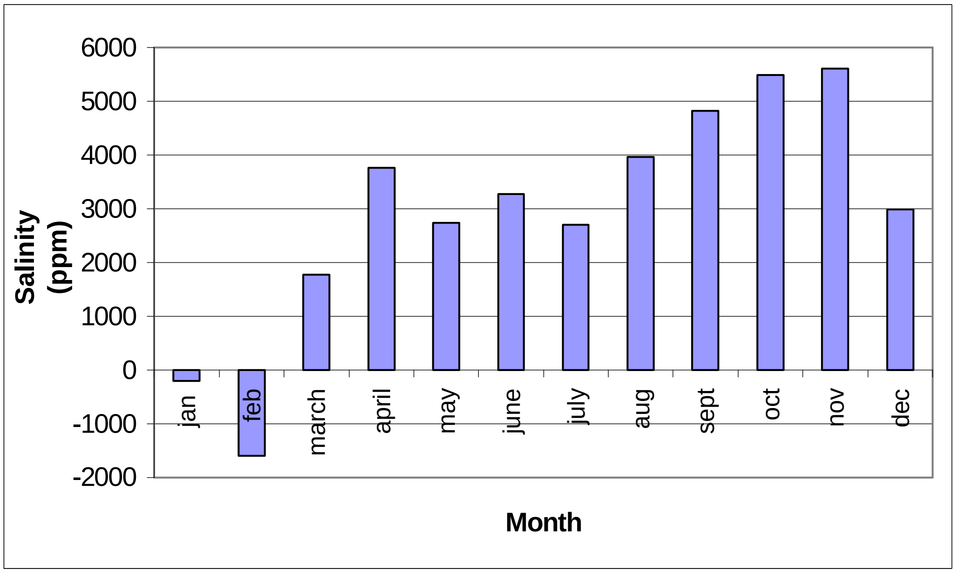

Figure 4-12
Daily Total Discharge rates each week indicating peaks in discharge volume (August to June)

The peak exchange volume of 200ML/d was a key input into the water quality modelling undertaken by the CRC for Reef Research, and for the design of the disposal pumping system and pipeline.

The ponds will be filled during August when water temperatures (23°C) are suitable for stocking post larval *Penaeus monodon*. The prawns have a growing season of 180 days in which time they will grow from <1gm to up to 25 gm. The stocking program in the ponds will be staggered over the months of August, September, October, November and December, so that prawns will be harvested in March, April, May and June of the following year. Maximum discharge will occur during the months of February and March (see Figure 4-12). All discharge figures include harvest discharge waters. From June to August the ponds will lay fallow, then dried and ripped in preparation for the next season.

4.2.3 Methods to Minimise Nutrients and Total Suspended Solids Concentrations

The principal strategies for improving the quality of disposal water include waste avoidance (e.g. food management), waste minimization (e.g. minimization of exchange rates), waste recycling (waste water recycling) and waste water treatment (e.g. settlement ponds). Refer to the Environmental Protection (Water) Policy S.15, and the ANZECC guidelines, Volume 2, Appendix 1.

A review study was undertaken for Pacific Reef Fisheries by Ken Hartley and Associates to determine if there were any viable potential wastewater techniques that can economically be adopted by the prawn farm industry to treat the discharge waters (see Appendix E). The conclusions of this study indicated that FCR's were the key element to reduce nutrient concentrations in discharge waters and that conventional treatment systems, such as sand or coarse media filters, were found to be not viable economically.

a) Feeds and Feeding Practices

There is little evidence of improvements in N retention by *P. monodon* in pond systems over the last few years. Briggs and Funge–Smith (1994) in a study of N budgets in shrimp ponds in the early 1990's found a similar percentage N retained by *P. monodon* to a study by Preston *et al.*, (2000) in the late 1990's (21% and 22% respectively). Most studies of the nutritional requirements of shrimp have been performed under controlled, laboratory conditions. Little information exists on the dietary requirements of shrimp in outdoor pond environments where natural food provides a supplementary feed source. (Tacaon, 1996). Feed formulations are, therefore, likely to be over-formulated and there is scope for lowering the protein levels in feeds.

There is also scope for the improvement in the water stability of feed and hence in the reduction of leaching of DON compounds by improved processing and exclusion methods. In addition, there is potential to reduce feed wastage. There is an urgent need to develop food demand sensing systems for shrimp aquaculture which are more effective and cheaper to operate than feed trays.

The proposed operation farm will adopt a partial harvest strategy which will reflect the methods currently used at the Pacific Reef Fisheries Alva Beach farm. Partial harvests will be carried when the biomass in a pond reaches a level of 3500kg to 5000kg. Partial harvests will be carried out by trap harvesting within the pond. Normally 1000kg to 1500 kg will be removed which allows the remaining prawns to continue growing to the 4000kg to 5000kg biomass. This process may be repeated one or two times to give total yields of up to 6 tonnes. Prawn size at which initial partial harvest occurs will depend on stocking density and survival (e.g. 400 000 x 70% survival = 18 to 21g for first partial harvest). The ponds will then be fully harvested by draining.

The advantage of partial harvest is that the food conversion efficiency is enhanced. As prawns grown larger, their food efficiency decreases (John Moloney, Pacific Reef Fisheries Farm Manager, pers.comm). Removal of these larger prawns will reduce food wastage and enhance the food conversion rate of the remaining smaller prawns within the ponds. This in turn should reduce the level of feeding required and the nitrogen inputs into the ponds. This partial harvesting also ensures no more than 30kg of feed will be fed to a pond in any day. Pacific Reef Fisheries is also encouraging technology transfer with prawn farm managers from South East Asia including employee exchange.

One trial underway during the 2002 – 2003 season at the Alva Beach prawn farm involves the use of feeding trays to monitor feed consumption. Previously, the trays have been set up to hold a feed ration comparable to that fed to prawns in the pond on a daily basis. If this feed were consumed from the feeding tray, the daily feed ration for the prawns in the pond would increase. This year's feeding strategy also uses feeding trays as a monitor for prawn consumption. The feeding ration to the ponds is similar to that used previously. However, extra food is now being added to the feeding tray. Should this food not be consumed from the feeding tray, the daily ration for the prawn food is reduced until the food from the feeding tray is eaten. To date, there has been an improvement in water quality as a result of this practice. The FCR's and growth rate of prawns determined for this season will be available in June, 2003.

Improvements in disposal water quality will also result from ongoing research into feed quality. Pacific Reef Fisheries is committed to feeding the best quality; digestible prawn feed on the market to its stock. There has been an ongoing FRDC funded fishmeal replacement research project which has been underway for some years however there has been limited commercial uptake from this work. Early adoption of the advancements made by this research, and the continued use of the best quality feed commercially available will be an important part of the ongoing improvement in environmental management of the proposed operation. Pacific Reef Fisheries does not have the resources to fund large scale diet formulation trials. Rather whole industry dietary research will be supported and Pacific Reef Fisheries will continue to implement rigorous feed management practices including visual monitoring and recording of feed consumed.

b) Seeding ponds

In the past fertilizer has been used to "seed" production ponds at the start of the season. Vegetable dyes have been used extensively to replace the fertilizer at the Pacific Reef Fisheries Alva Beach farm. It is estimated that up to 20 tonnes/yr of fertilizer may have been required at Guthalungra for this purpose on the proposed farm. This change in management practice will therefore result in a considerable reduction in the Nitrogen load input to the operation to the farm.

c) Minimal Water Exchange Systems

Chris Robertson (DPI, 2000) has noted significant improvements in pond management techniques, such as increases in yields, growth rates and survivals, in the Queensland prawn farming industry over the last ten years. On an industry wide basis, pond water exchange rates (averaged over an entire farm basis) have generally reduced from approximately 8-10% per day to less than 4 % per day over the growing season.

Pond managers could attribute such improvements to gains in quality of post-larvae and feed, but also to an increased understanding of water quality and algae bloom management. This has resulted from a shift in emphasis of exchanging water on a timetable basis to that of 'only when necessary'.

The health of the pond algal bloom is also an important aspect of maintaining water quality. Pond managers have recognized that major water exchanges, which change pond salinity or temperature for example, can disrupt the algal bloom (e.g. cause a change in cell density or species diversity) and potentially stress the prawn and hinder growth. Management of a healthy and stable algal bloom helps minimise significant changes in water quality (Stafford, 1999). Farmers can therefore develop pond management methods that minimise water exchange over time once they are accustomed to water quality of a farm site. This is best achieved by recirculation of pond waters through settlement ponds.

Various recirculation strategies have been adopted by Queensland farmers in the past, ranging from 10% recirculation to 100% recirculation. Chris Robertson (Queensland DPI) has investigated total recirculation in a prawn farm in Cairns in the wet tropics of North Queensland (Robertson, pers comm.). The 130 day grow out phase in a paired (2.7 ha each) pond system established harvested tonnages of 5.2 tonnes in the recirculation pond system and 4.3 tonnes in the flow through pond system. Harvested prawns of 14 grams were recorded from both pond systems.

Pacific Reef Fisheries (Alva Beach) currently grows only 8 % of prawns at this size or smaller because larger prawns attract a better market price. The TN loading calculated for the recirculation system was 0.53kg/ha/d and 0.92kg/ha/d for the flow through system. Total nitrogen concentrations in the recirculation system exceeded 5mg/L on occasions. These TN concentrations can potentially be toxic to aquatic animals, including prawns, if a substantial component of TN concentrations are ammonia.

This study has demonstrated that small scale recirculation can be carried out in the wet tropics of Queensland. The feasibility of full scale recirculation in a dry tropical environment is likely to be significantly less, however, due to the added complication of higher net evaporation, and more rapid declines in water quality that would result. Nevertheless this work does demonstrate the potential for reuse under appropriate conditions on a small scale. This study suggests that recirculation is possible and as such recirculation where possible will be carried out at Guthalungra. There has been reports that a prawn farm (>20 ha) in FNQ has undertaken full reticulation this season. This strategy has been unsuccessful with the ponds requiring drainage early in the season because of high prawn moralities.

The proposed prawn farm will be designed and constructed to enable recirculation of water within each Production Area. At Guthalungra, which is situated in the dry tropics, salinity has the potential to retard the growth of the prawns. Average annual coastal rainfall ranges between a minimum of 1015mm at Bowen and a maximum of 3813mm at Innisfail (Climatic Averages – Australia 1988). The evaporation rates at Bowen are high with peak rainfalls during January and February. For example, in Figure 4.13, it can be seen that evaporation rates in March, April and May increase salinities by between 2 and 3 ppt whilst evaporation rates in October, November and December salinities will increase between 3 and 5 ppt. Incoming waters from Abbot Bay will be between 38 and 39 ppt, so with additional monthly evaporation rates, salinities can will rise rapidly. Thus any recirculated waters will be in the order of 40 ppt and above.

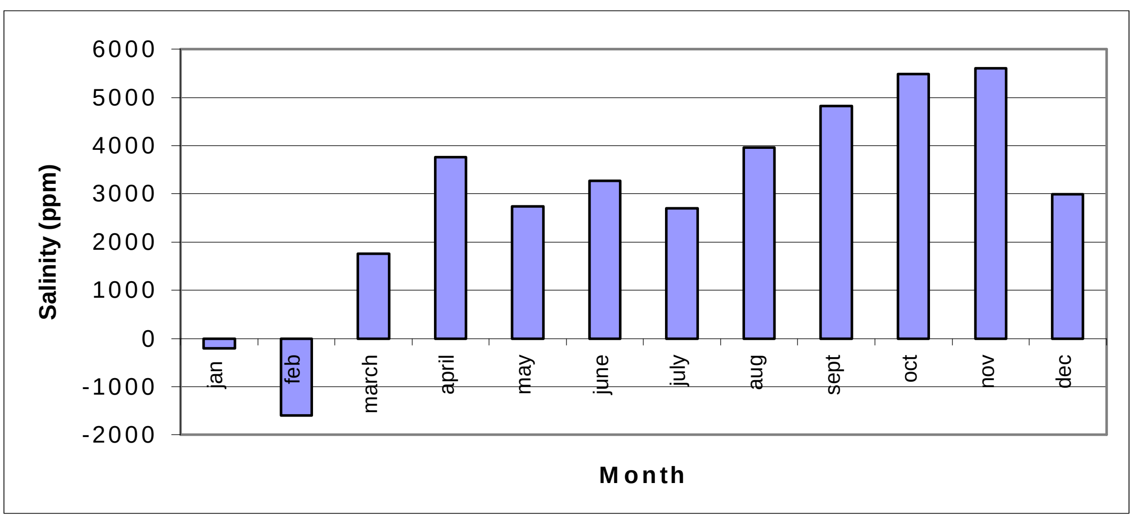

Figure 4-13
Monthly Grow-out Pond Salinity Variations (no rainfall)

Salinities above 42 ppt slow the growth of prawns, with the optimum salinity for prawn growth at being approximately 25 ppt. It is difficult to predict volumes of water and re-circulation rates, which in the case of the proposed farm will depend heavily upon climatic conditions. By way of example, the increase in salinity of pond water for November (0.5% daily exchange) and April (4% daily exchange) is shown in Figure 4-14.

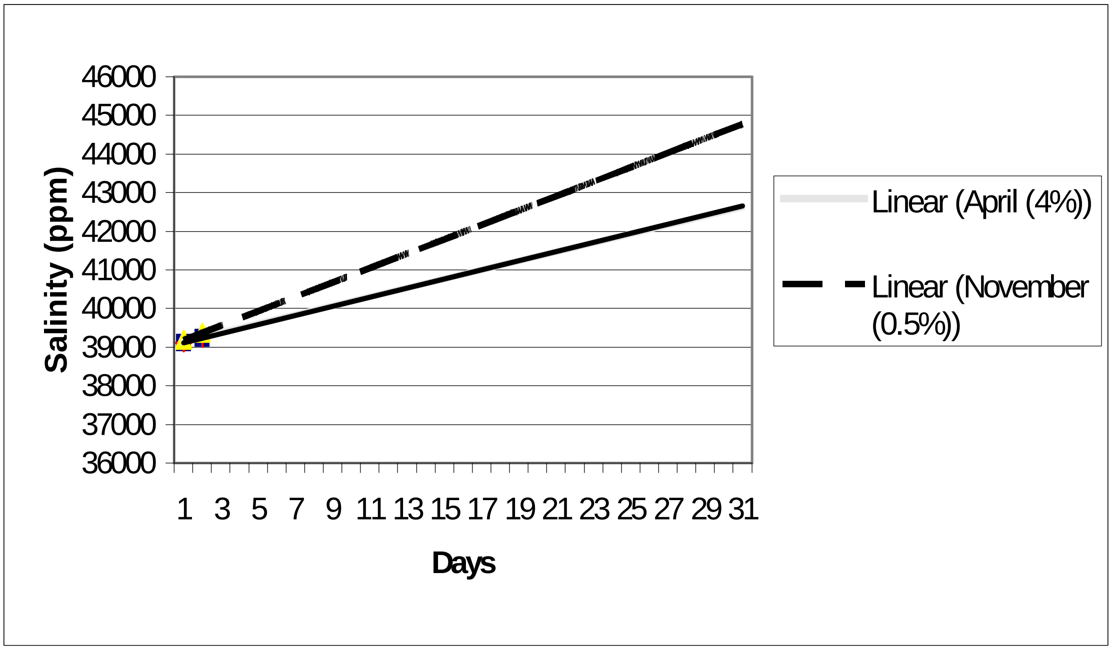

Figure 4-14
Extrapolated salinity increases in grow out ponds during November and April based upon daily water exchanges of 0.5% in November and 4% in April

In November, salinity will increase from 39 ppt to 45 ppt based upon no rain whilst in April with higher daily exchange rates, the salinity will increase from 39 ppt to 43 ppt when there is no rain. Rainfall events will reduce the salinities in the ponds and assist in pond management. Rainfall should occur during the summer months of December through to March, however even in some of these months, evaporation losses are greater than average rainfall (Figure 4-15).

Subject to satisfactory levels of other water quality parameters, it is recommended that recirculation should be undertaken when salinities are less than 35 ppt and stopped when salinities reach 38 ppt.

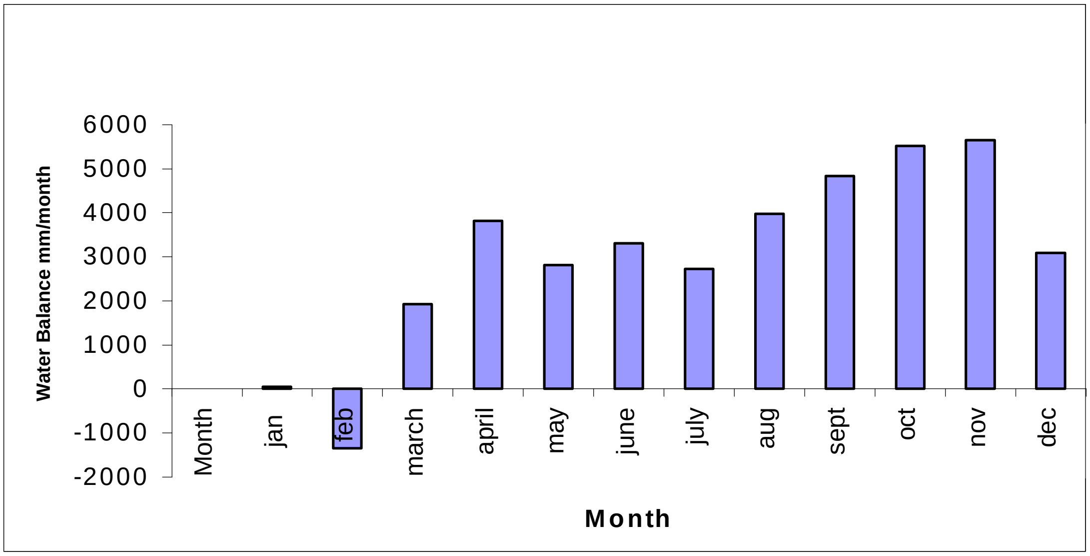

Figure 4-15
Monthly evaporation rates less rainfall at Bowen

d) Bio-remediation

Bio remediation in settlement ponds may assist in improving water quality. To date, there has been much speculation on the success of bio-remediation, however there is little documented evidence of the success of this approach. The discharge waters contain suspended material, primarily algae; refractory dissolved organic nitrogen and ammonia. The capture of nitrogen is likely to occur either when the algae is ingested by a predator or when the soluble fraction e.g. of ammonia is uptaken by plant material e.g. algae, macro-algae or seaweed. The soluble fraction of phosphorus similarly could be taken up by plant material.

The conclusions of a Queensland Department of Primary Industries trial in 2001 (Paul Palmer, DPI Bribie Island Research Station, pers. comm) with banana prawns stocked in growout ponds in five separate ponds were:

- That the growth of prawns stopped after three months;
- Predation of the prawns was high;
- There was no improvement in water quality (Paul Palmer, Bribie Island Research Station pers. comm);
- The potential exists for the husbandry of others animals e.g. rabbit fish, milkfish in settlement ponds. Quantification of growth rates and water quality improvements still has to be established for these species.

Another possibility is the cultivation of seaweed and macroalgae. Preston *et al.*. (2001) achieved high plant growth rate in their studies but plant harvests were too infrequent. Improved management and ponds designed specifically to facilitate plant harvest, should be able to result in improved the efficiency of this strategy.

While the plants grown in settlement ponds in their CSIRO study were the result of natural recruitment and had limited commercial value, an attractive alternative is to deliberately seed and grow plants with commercial markets. For example the seaweed *Gracileria*, used in production of agar for food and pharmaceuticals, has been successfully grown in prawn farm effluent in Australia (Jones *et al*. 2001) and overseas. However, because plants contain low N levels, substantial quantities of plant material need to be removed. For example 1.3 tonnes (wet eight) of plant material removed from the treatment pond contained only 9.1 kg N.

The final pond construction will be occurring over a number of years. During the preceding years, a number of government and industry research programs are planning to undertake trails to assess potential bio-remediation species and their effectiveness. Successful research outcomes will be incorporated in to the ponds in Guthalungra.

e) Constructed Mangrove Wetlands

A DPI study on constructed mangrove wetlands to improve prawn farm wastewater was concluded in Year 2001. The results of the initial two year data set could not categorically conclude that there was a general improvement in prawn farm discharge (Robertson, DPI, pers. comm.). Longer term studies are still required coupled with an economic assessment of the potential to harvest the mangrove wood. This work is ongoing and the industry awaits the results.

f) Other potential mechanisms

Preston *et al*.. (2000) suggests there are other potential mechanisms for nutrient control in prawn farm wastewater. These are discussed below.

Denitrification: This is a bacterial conversion of NO_3 (nitrate) to N_2 (molecular nitrogen), subsequently dissipated to the atmosphere. This, together with commercial recovery (see below) is the best possible destination for waste N since the end product is completely benign. Currently, denitrification efficiency in prawn ponds – and, presumably, treatment ponds – is very low (Burford, CSIRO, unpublished data).

To promote denitrification, several conditions must exist, including the availability of sufficient sites with appropriate redox potential, a source of organic carbon, adequate levels of nitrate, and lack of denitrification-inhibiting compounds. Further research is needed to gain a better understanding of how these factors limit denitrification in treatment ponds. T; this may allow the design of treatment systems with improved denitrification rates.

Volatilisation of ammonia: Ammonia in seawater exists in two forms, NH_3 and NH_4^+; the proportion of each depends on a number of factors, the most important being pH. Only non-ionised ammonia (NH_3) is volatilised. Ammonia volatilisation is therefore enhanced by high pH levels, and is also increased by aeration and wind. Volatilisation rates equivalent to about 0.25 to 0.5 kg N/ha./d have been recorded from experimental catfish ponds (freshwater, presumably non-aerated) when Total Ammonia Nitrogen concentration was 1 mg/L. This suggests that volatilisation is probably a significant, although not major, contribution to loss of N from prawn treatment ponds.

Incorporation into animal biomass (non-commercial): Extensive populations of naturally-seeded biota developed in all the ponds studied. These were principally filter-feeders (eg bivalves, barnacles, tube-worms), deposit feeders (eg chironomid larvae), or fish (eg mullet). Even without deliberate harvesting, most of the nutrients contained in these organisms will be completely removed from the discharge stream and the marine environment. For example, insect larvae metamorphose and fly away; and when the pond is drained at the end of the season, filter-feeders will die and be consumed by birds or other terrestrial carrion feeders. Fish if not harvested, can return to the marine environment when the pond is drained.

4.2.4 Description of Intake and Discharge

The intake and discharge of waters will be from Abbot Bay. Discharge waters will be released only via the discharge pipeline to Abbot Bay. There will be no capacity for overflow from the ponds. This is described in more detail in Section 4.1.

4.3 Construction Strategy

4.3.1 Works and Structures

The project will be constructed over 4 years to optimise the construction process, to allow time for resourcing of farm operations, and to ensure that most works are carried out in the driest months of the year.

Preliminary construction timetables and corresponding stage plans for the project are attached as Appendix B. The main elements of the stages of each year's construction are detailed below.

- Year 1 Construction Activities
  - Construction of the discharge water and intake water pump and pipeline systems;
  - Construction of the access track from Coventry Road to the Intake Pump Station;
  - Site clearing for 91 ha. Stage 1 ponds, Water Settlement Pond 1, seawater storage and administration / workshops / feed storage area;
  - Construction of earthworks to form ponds, storages, settlement ponds, channels, drains and administration area foundations;
  - Upgrading of main access road to the site;
  - Upgrading of power supply to the site, including connection of power to the intake pump station;
  - Construction of administration building, machinery workshops, the processing facility, and the fuel storage;
  - Construction of the first stage freezer unit and feed storage shed;
  - Construction of House No. 1;
  - Construction of the bypass floodway to the raw water storage dam;
  - Installation of Stage 1 re lift and re use pumps and pipelines;
  - Construction of the domestic wastewater, potable water treatment (including dam upgrade) and processing wastewater treatment systems.

- Year 2 Construction Activities

  - Clearing for 56 ha. Stage 2 ponds, Water Settlement Pond 2 and associated works;
  - Earthworks for growout ponds and settlement ponds;
  - Construction of the second stage of the freezer unit and feed storage shed;
  - Construction of House No. 2;
  - Installation of Stage 2 re lift and re user pumps and pipelines.

- Year 3 Construction Activities

  - Site clearing for 56 ha. Stage 3 ponds;
  - Earthworks for growout pond and associated works;
  - Construction of bypass floodway;
  - Construction of the sludge drying beds.

- Year 4 Construction Activities

  - Site clearing for 56 ha. Stage 3 ponds and Settlement Pond 3;
  - Earthworks for ponds, Settlement Pond and associated infrastructure;
  - Installation of Stage 3 re lift and re use pumps and pipelines;
  - Construction of the third stage of the freezer unit and feed storage shed; and
  - Construction of House No. 3.

4.3.2 Ocean Intake and Discharge Pipelines

a) Ocean Pipelines

The discharge pipeline will consist of a single 1000mm diameter field jointed HDPE pipe, extending approximately 500m offshore. The intake system will consist of dual 1000mm HDPE pipes extending approximately 300m offshore. Longitudinal sections for the proposed pipelines are shown in Figure 4-16, and a plan view is shown in Figure 4-2. From the intake pump station seaward to the low water mark, both the discharge and intake pipelines will be located in the same trench.

The proposed construction sequence for the land sections of the pipelines will involve using a bulldozer to push spoil from the pump station seaward (“benching”). Spoil will be stockpiled on the beach area to minimise disturbance of the dune system. Some of the spoil material may be used to form a working platform on the shore line, to enable trenching to continue over a greater range of tides. The area of disturbance across the primary dune will be approximately 50m wide, allowing for battering of earthworks, and to provide a working area alongside the pipe trench. Benching will continue down until seawater ingress makes further earthworks using this technique not feasible.

Further excavation below the benched level will be undertaken using a hydraulic excavator. Assuming initial levelling to –1.0m AHD, a further 2m of trench excavation will be required. To ensure trench stability in the sandy conditions, benching battering of the trench will be undertaken. Should stability to be difficult to achieve by this method, shoring will be used.

Trench excavation will commence from the pump station and progress seaward. For about the first 80m (Ch 5058 to Ch 5140) only the two 1000mm diameter intake pipelines will be located in the trench. This will require a trench width of approximately 5m to allow room for compaction around the pipes. In this section, the discharge pipeline will be located at a higher level than the intake pipes. The discharge pipeline will be laid above the inlet pipelines and covered during the backfilling operation.

From Ch (Chainage) 5140 to about Ch 5200 (across the beach) all the pipes will be laid at a level to provide at least 2m cover over the top of the pipes. Trench excavation will be by hydraulic excavator and all three pipes will be laid in the same trench, which will be approximately 7m wide.

De-watering of the trench area will be undertaken using conventional multiple spear point de-watering techniques. Sandy conditions at the site should lend themselves to spear-point installation, however significant amounts of seawater will need to be pumped and discharged.

The amount of de-watering required will be reduced by staged trench excavation and backfill. It is expected that approximately 20m of the pipeline will be laid each day in this fashion. Construction using this technique will continue seaward until de-watering of seawater becomes impractical.

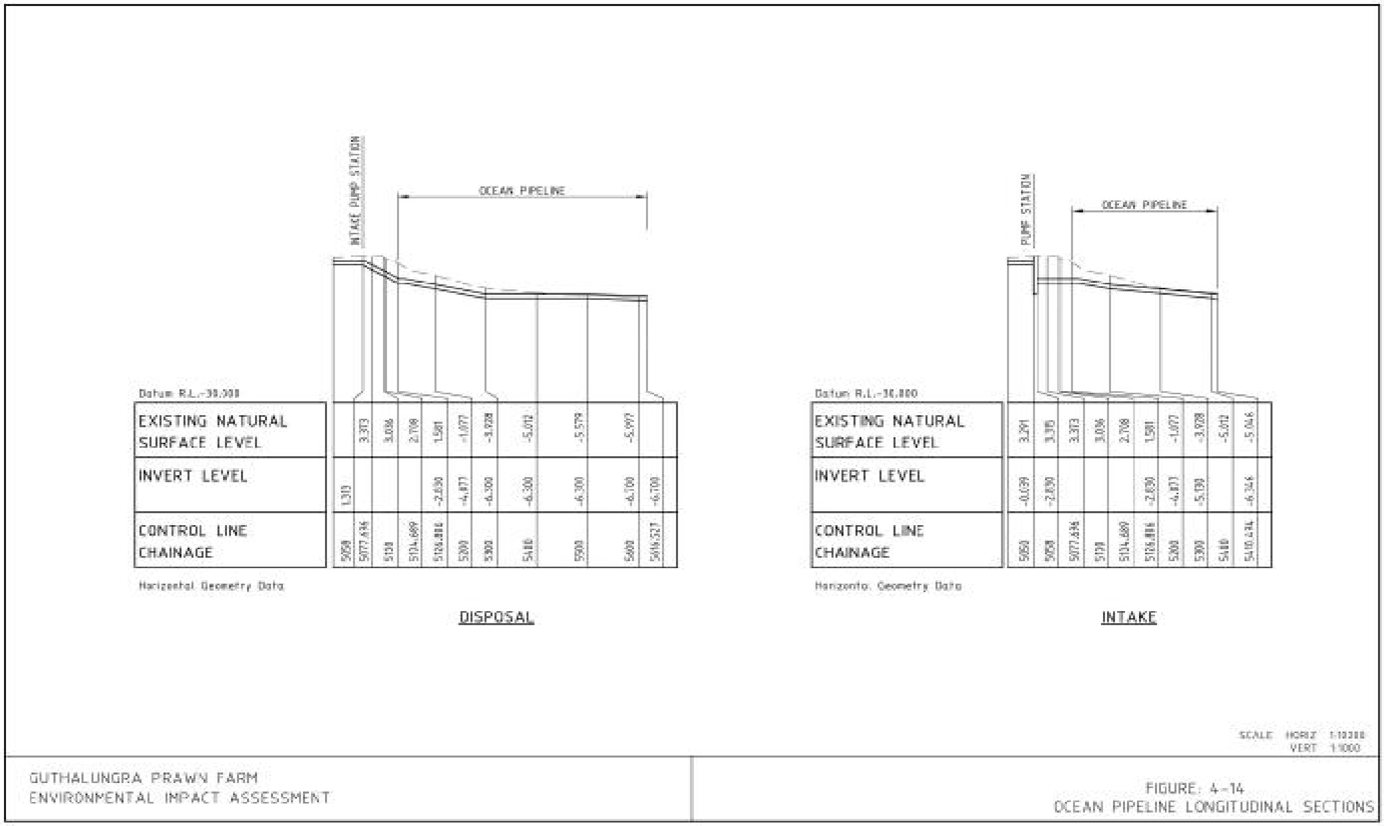

Figure 4-16
Ocean Pipeline Longitudinal Sections

Upon completion of pipeline installation, the primary and secondary dunes will be replaced and stabilised with jute matting or sugar cane mulch before replanting with local provenance species. The laying of the pipework and the re-profiling of the sand dune is expected to take about four weeks.

Beyond the low water mark the pipelines will diverge and sea-based excavation techniques will be used. For the purposes of concept design, this divergence point has been assumed to be Ch 5200. Excavation below the low water mark will be undertaken using a cutter-suction dredge.

The pipeline construction sequence will involve:

- Excavation of the trench along the full pipeline route. The trench will be slightly over-excavated to allow some incidental filling during the construction period;
- Whilst trench excavation is occurring, the pipeline will be welded on-shore. This will be done with the pipe aligned along the land-based pipeline route (i.e. perpendicular to the shoreline);
- The pipeline will be progressively towed out to sea. Pre-fabricated anchor blocks will be fixed to the pipe at the shore line as the pipeline is towed out. The pipeline will be sealed and will float;
- When positioned over the trench, the pipeline will be sunk by controlled release of air;
- Minor re-alignment of the pipeline or adjustment of bedding level will be undertaken to position the pipeline in the trench;
- Backfilling of the trench will occur relatively quickly via natural sand movement.

The above process is a proven technique for ocean pipeline installation in Australia.

b) Intake Screen

The intake screen will be pre-fabricated on land, including the concrete base pad, and lowered over the ends of the intake pipes from a barge. Anchor blocks will be positioned around the outlet pipe, onto which the foundation paid will be lowered and anchored.

It is expected the sea-based construction activities will take approximately two months to complete.

c) Intake Pump Station

The intake pump station will consist of an 8.5m diameter concrete wet well, with a floor level of approximately –5.3m AHD, or 8.7m deep.

The wet well will be constructed prior to the intake pipeline installation. It will be a caisson type construction, which involves the following construction sequence:

i) A concrete annulus typically 1.5m high is either pre fabricated and transported to the site, or is constructed on site;
ii) Soil is excavated from within the annulus and the structure lowered until level with ground surface;
iii) The annulus is extended by another 1.5m "lift" and the above process repeated until the full height is achieved;
iv) The floor of the wet well is reinforced and concreted and other internal concrete work completed.

It is expected that approximately six “lifts” will be required to produce the full caisson.

The intake pipes will be connected by removing part of the wet well wall at the time of pipeline installation. The join between the pipelines and the pump station wall will be re-concreted, and will incorporate weep flanges on the HDPE pipes to provide an effective seal.

Relatively little aboveground infrastructure will be required at the pump site, including a gantry crane, power / meter box and power transformer (11KV:415V). The area will be fenced with a 3m high security fence.

d) Rising Main Pipelines

Both the intake water and discharge water rising mains will consist of 1 000mm diameter field - jointed HDPE pipes. Between the intake pump station and the main farm area, the pipes will be laid side by side in the same trench, typically with 0.5m depth of cover. The trench bed width will typically be 3.0m wide. The depth of cover will vary according to ground conditions and acid sulphate status, with 0.5m cover maintained where ground conditions are suitable.

The pipelines will follow the natural surface contours across the coastal dune system, with air valves at high points for air expulsion.

Pipes will be installed in accordance with manufacturer’s specifications. Typically, this will involve backfilling and compacting around the pipes in 150mm thick layers. It is expected that excavated material will be suitable for use as backfill over most of the pipeline length. Where it is not suitable, backfill will be imported. All excess fill material will be removed from the pipeline route.

The pipeline will be constructed during the dry season to ensure ground conditions are optimal. It is expected that conventional excavation and laying techniques will be possible over the full length of the pipeline except in some sections across the mud flats (Ch 300 to Ch 900, and across lower lying areas between Coventry Road and the Intake Pump Station).

Between Coventry Road and the Intake Pump Station the pipeline route crosses several areas of land that are subject to regular inundation. Geotechnical testing also indicates that acid sulphate soils are likely to be encountered in these areas, particularly at lower depths. To minimise the risk of encountering acid sulphate soils, and to reduce the volume of material to be managed if acid soils are exposed, the pipelines will be constructed in embankment, as part of the access track required in this area. Appendix B shows the proposed longitudinal section of the pipeline and typical cross sections.

These investigations also indicated that areas near the edge of these mud flats immediately to the north of the proposed growout ponds may be difficult to excavate due to wet subgrade material. Trafficability using conventional of equipment is likely to be difficult. In such conditions a temporary working platform will be constructed using imported clay soil, underlain with geo-fabric to provide stability. This platform will be removed following construction.

Pipe cover in this section of the pipelines will be reduced to 0.3m, and any Acid Sulphate Soils will be handled in accordance with the Acid Sulphate Soils Management Plan.

The pipeline will traverse several environmentally sensitive areas. Measures proposed to mitigate any impacts are discussed in Section 7.0.

4.3.3 Excavation

a) Site Clearing

The existing site is predominantly vegetated with light scrub. Each stage will be cleared at the commencement of each year by chaining, windrowing and burning.

b) Earthworks

The general construction sequence will be as follows:

i) Stripping of topsoil will be undertaken using self elevating scrapers. Topsoil will be stripped to a depth of approximately 100mm and stockpiled for subsequent re-spreading. Stripping of topsoil will be carried out progressively to minimise the amount of exposed area.

ii) Bulk excavation of soil will be undertaken mostly using self elevating scrapers. Where ground conditions are difficult or where extra mixing of soil is desirable, material may first be pushed out by bulldozers for pick up and transportation by scrapers.

Geotechnical investigation has indicated that the clay soils at the site are suitable for bank and liner construction. Nevertheless some variability across the site has been identified, including the possibility of a sand layer along a depression system running through the Stage 2a works. Other sand lenses may be encountered. When this occurs sands will be excavated and mixed with heavy clays won from other parts of the development. This material will be used as bulk fill. Where sandy sub-grade conditions extend below the design excavation depth, excavation will continue down until suitable material is exposed, or excavated to 1.0m below finished pond floor level, whichever is the shallowest. Backfilling with clay material will be undertaken to 0.5m below finished floor level, with compaction to bulk fill standards.

Cut and fill will be balanced by sequentially constructing rows of ponds that run across the natural gradient of the site, moving material directly from areas of cut to fill. This will minimise the amount of temporary stockpiling and hence double handling of material that will be necessary.

If wet soil conditions are encountered (for example after heavy rainfall or due to localised high groundwater), material will be either temporarily stockpiled to allow drying, or will be mixed with drier material. Groundwater levels are not expected to effect construction, and hence de- watering of the site is not expected to be necessary.

Excavation of drainage lines may also be undertaken using hydraulic excavators.

iii) Placement of fill will be carried out directly from the scrapers. Material will be run out in approximately 200mm thick layers. Where the material is lumpy or does not flow easily, bulldozers or graders will be used to even out layers and ensure the necessary layer thickness.

iv) Compaction of fill will occur to a certain degree, by trafficking provided by scrapers and bulldozers. To ensure design compaction densities are achieved, however, it is expected that vibrating sheep-foot rollers will be required. Where necessary, water trucks will be used to maintain optimum moisture contents.

Clay lining material will be constructed using selected clay fill. Selected clay fill will be defined as the clays or sandy clays known to exist at the site (Shallow Profile 1 and Profile 2 soils as described by Douglas Partners), free from significant rocks or organic matter. Compaction will be to a minimum dry density ratio of 98% standard, at a moisture content of between 1% dry to 2% wet of optimum, as specified by Douglas Partners.

Embankment bulk fill will be compacted to 95% Standard at a moisture content of between 1% dry to 2% wet of optimum.

Testing for compaction will be undertaken by a suitably qualified geotechnical consultant, in accordance with AS 3798. It will typically include:

- Floor Lining: 1 test per 200mm layer per 2,500m^2;
- Embankment Lining: 1 test per 200mm layer per 100m of embankment length;
- Embankment Bulk Fill: 1 test per 200mm layer per 200m of embankment length.

The general construction technique for construction of lined embankments is shown in Figure 4-17.

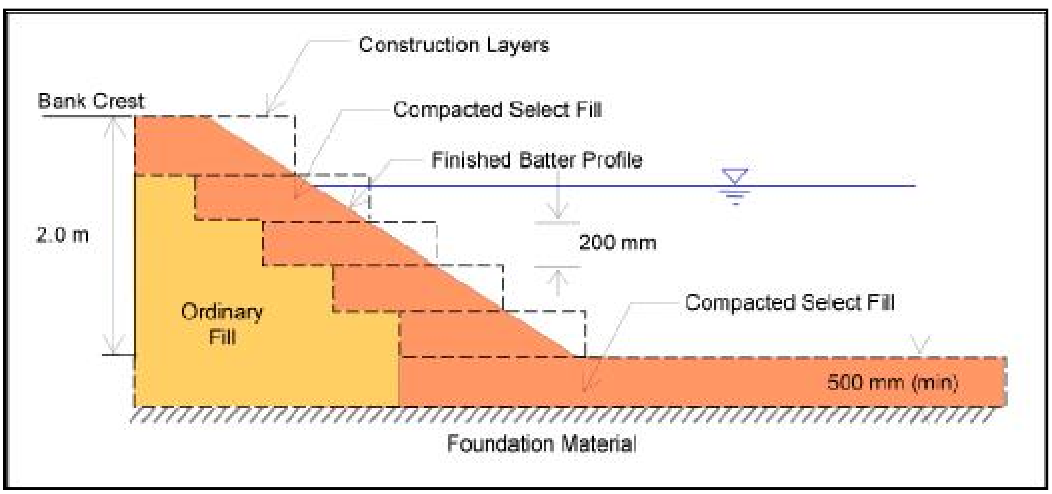

Figure 4-17
Lined Embankment Construction Technique

The inner batter of the embankment will be lined by placement and compaction of layers to the specified standards. The minimum width of this layer will be limited by the width of the construction equipment used (typically 3m), requiring forming and trimming of the inner batter upon completion of the bulk earthworks.

Lining layers will be lightly scarified prior to placement of the next layer to avoid lamination within the finished bank.

v) Earthworks trimming will be carried out using graders. This will include levelling and grading of the pond floors, forming and trimming of batters and grading of access tracks and berms.

vi) Re topsoiling of outer bank batters will be undertaken using hydraulic excavators and tip trucks. Topsoil will be placed on outer batters to a thickness of approximately 100mm and tamped in place by excavators.

vii) Placement of rip rap on inner batters will be undertaken using hydraulic excavators. Rip rap will be graded rock with nominal D50 = 75mm. This technique has proven very successful at Pacific Reef Fisheries, farm at Ayr.

viii) Gravelling of access tracks will be undertaken, with final grading and trimming using graders. Fine Crushed Rock will be used with nominal D50 = 20mm.

ix) Forming of drains and channels will be undertaken using hydraulic excavators or scrapers. Channel pads will be constructed as bulk fill, and excavated to the required profile and longitudinal gradients. Channels will be lined with HDPE lining to eliminate the potential for seepage or erosion.

Drains will be lined with 0.5m thick compacted clay. Drains in cut will be lined by firstly over excavating by 0.5m and subsequently backfilling with compacted clay to provide the required lining depth. Compaction densities will be achieved using self propelled sheep- foot rollers working up the face of the drain batter. Density testing will be to the same frequency as specified for pond floors.

Drains in fill will be lined in an identical fashion to embankments, by building up in 200mm thick layers.

x) Floodway earthworks will be carried out using elevated scrapers. Topsoil will be initially stripped and stockpiled and subsequently re-spread over the floodway batters and floor.

Modelling of the proposed earthworks has been undertaken to determine preliminary design levels that result in a balance between cut and fill across the site. Volume estimates are shown in Table 4-2. These estimates correspond to the floor levels shown in Appendix B.

Further refinement of the design levels to optimise the cut and fill balance will occur as part of detailed design. Any significant changes are expected to be minimal however, given the very small change in level required to significantly change the cut/fill balance. The initial modelling indicates that the cut/fill balance is within 10% of the total fill volume.

Table 4-2
Preliminary Earthworks Volumes

Construction Stage	Total Cut (m^3)	Total Fill Vol (m^3)	Excess of Cut Over Fill (m^3)
Stage 1	2018500	2056375	-37875
Stage 2a	1382000	1326650	55350
Stage 2b	933000	971650	-38650
Stage 3	1084000	1148250	-64250
Total	5417500	5502925	-85425

- Includes 15% compaction factor
- Includes 20% compaction factor.

Excess material from any one year's construction will be stockpiled for use in the subsequent year.

c) Growout Pond Structures

A range of minor structures will be constructed including pond inlet pipes, pond outlet structures, access culverts, pump pads and flow control structures. These will be installed after completion of the earthworks.

Wherever possible, pre cast concrete components will be used to reduce costs and minimise construction timeframes.

d) Power Supply

The proposed development will be powered by electricity drawn from the state power grid. A 66 kV power line is located several kilometres south of Guthalungra township.

It is proposed that a branch line be constructed to connect this supply to the farm, with a 66 kV to 15 kV transformer located at the property boundary on Coventry Road.

When fully developed, the project will consume approximately 23,900MWhr of power each year.

The main components of this demand are:

- Pond aeration: 11,230MWhr/annum;
- Freezers: 1,100MWhr/annum;
- Processing: 770MWhr/annum;
- Workshops / Housing: 250MWhr/annum;
- Water Intake Pumping: 4,000MWhr/annum;
- Re-lift Pumping On-form: 600MW/annum.

Power requirements will vary throughout the year according to areas stocked and processing activities. The peak power months will be January to April, and the estimated peak power requirement will be approximately 5.6 MW.

Power will be reticulated around the farm to supply pond aerators and pumps. Supply lines for individual ponds will be laid below ground. Main supply and pump power lines will be overhead.

The intake pump station will require 1,150 kW at peak operating load. It is proposed that the existing Guthalungra to Cape Upstart 11kV power line be upgraded to provide this capacity. The location of this line is shown in Figure 4-18.

From this line to the pump station, the supply line will be laid underground adjacent to the intake / disposal pipelines to minimise environmental and visual impacts.

An 11 kV / 415 V transformer will be located on the ground adjacent to the pump station. This transformer will be housed in a 3m x 3m x 3m higher cement block shed, located on the concrete pad to be constructed for the pump station. The transformer and shed will be constructed in accordance with standard designs and as such, it will include drainage collection and sump to minimise the risk of environmental damage should leakage from the transformer occur.

Discussions have been held with the local power retailer, Ergon, regarding infrastructure upgrade requirements and cost sharing. Ergon have indicated that they see no technical problems with the required upgrades.

Power supply will be reticulated to ponds and pump stations concurrently with the structures work. Supply to individual ponds for aeration will be via underground cable. Higher voltage power to pump stations will be via overhead lines.

e) Miscellaneous Works

The water supply, water treatment and wastewater treatment systems will be constructed in the first year. Upgrading of the raw water dam will also be carried out in the first year, using material borrowed from the Settlement Pond 1 earthworks.

The three domestic residences and administration / laboratory facility will be single storey slab-on-ground type construction, utilising brick veneer or concrete block type construction and iron roofs. The buildings will be constructed in full accordance with local building regulations and standards.

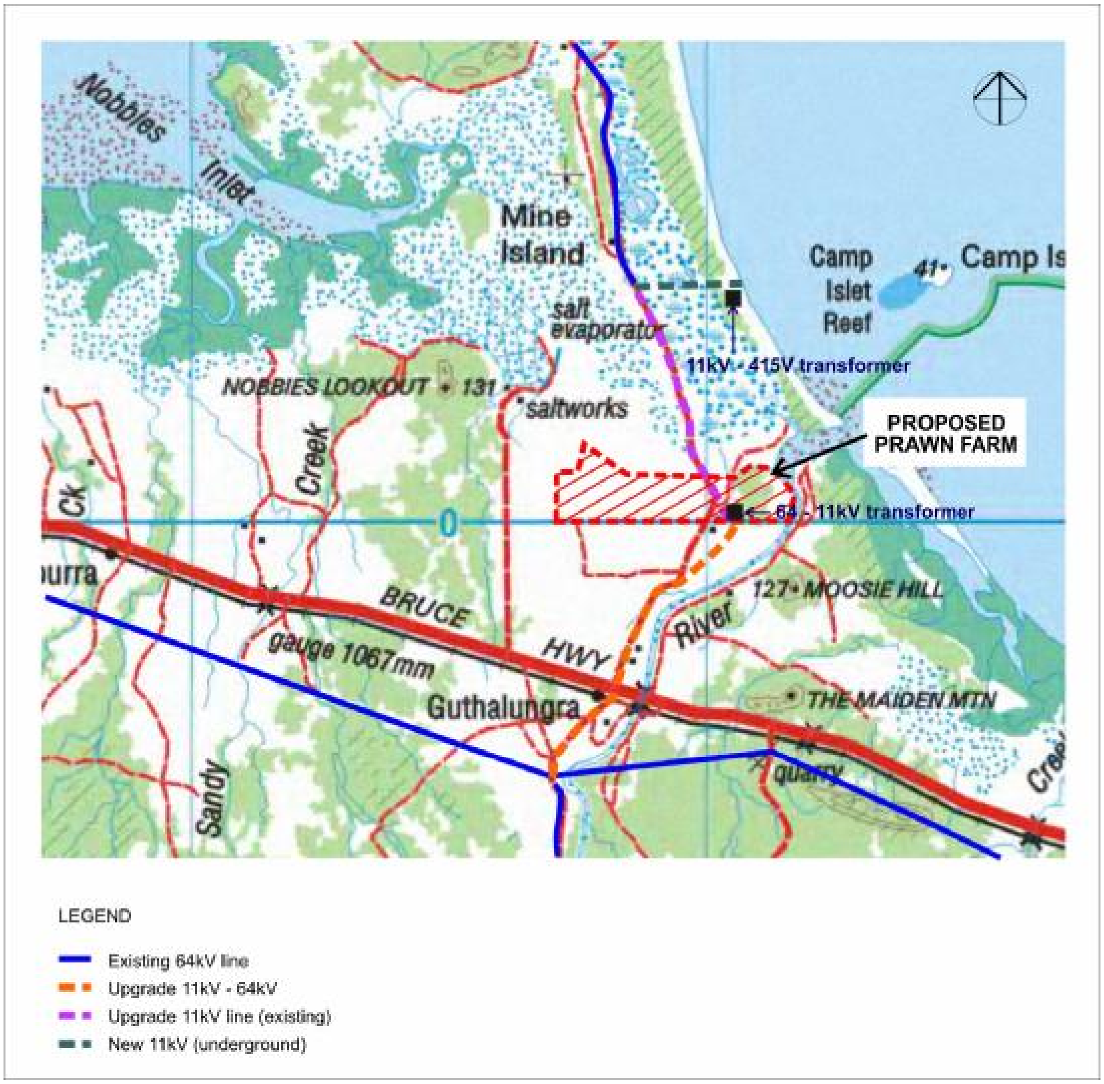

Figure 4-18
Power Supply Line Locations

f) Sediment and Stormwater Control

Refer Section 9.

4.3.4 Detailed Description of works for each stage

Refer Section 4.1, 4.2 and 4.3.

4.3.5 Construction Methods for Intake

Refer Section 4.3.

4.4 Operating Features

4.4.1 Site Management Arrangements

Figure 4-19 and Figure 4-20 shows the proposed management structure for Pacific Reef and the Guthalungra proposal.

The following highlights the responsibilities of the key management positions:

a) General/Executive Manager

Day to day management of the business, leadership for the whole organisation, implementation of the corporate vision and mission.

b) Production Manager

Overall responsibility for production pond output, processing and the general operation of both the Alva Beach and Guthalungra farm; staff leadership, optimising efficiency, technical leadership, research and innovation, and environmental management.

c) Farm Manager

Responsibility for pond output, particularly achieving optimal production and staff management.

d) Husbandry Manager

Responsible for optimal output from 50ha of pond production, management of staff, technical leadership.

e) Environmental Technician

Responsible for environmental monitoring, data collection, management and interpretation, supervision of trials, environmental leadership and training.

f) Pond Manager

Day to day management of around 25ha of ponds including feeding, harvesting, maintenance and water quality monitoring.

g) Pond Technician

Senior hand providing management support to the Pond Manager, responsible for undertaking all pond duties.

h) Farm Hand

Undertakes pond duties required to efficiently produce a crop of prawns.

i) Casual Farm Staff

See Farm Hand. Casual staff will be employed as necessary for up to six months of the year primarily for feeding and harvesting and general pond duties.

j) Maintenance Manager

Responsible for the maintenance of machinery, maintenance contracts, provides leadership in purchasing and management and operation of machinery, and manages a team of maintenance staff.

k) Processing Manager

Overall management of the processing facilities, product quality, output, freezer facilities and staff.

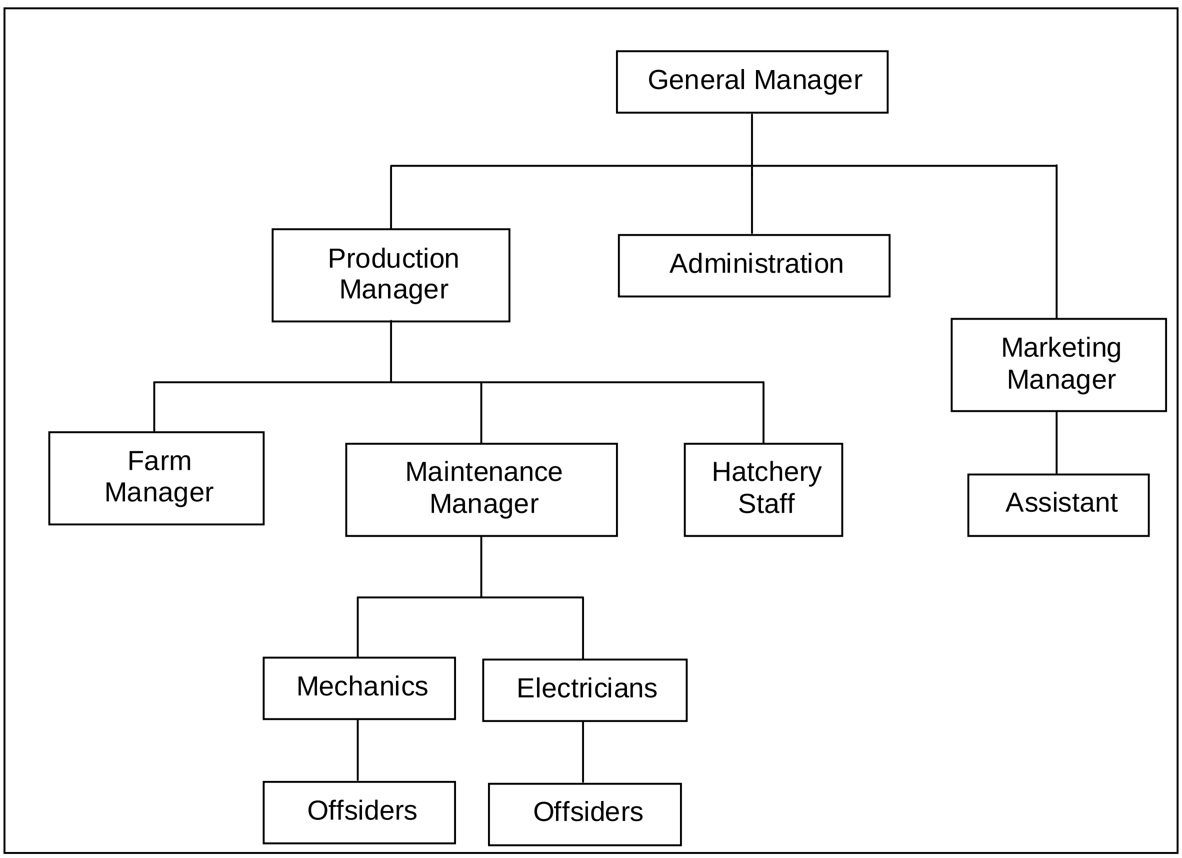

Figure 4-19
Guthalungra Site Management Structure

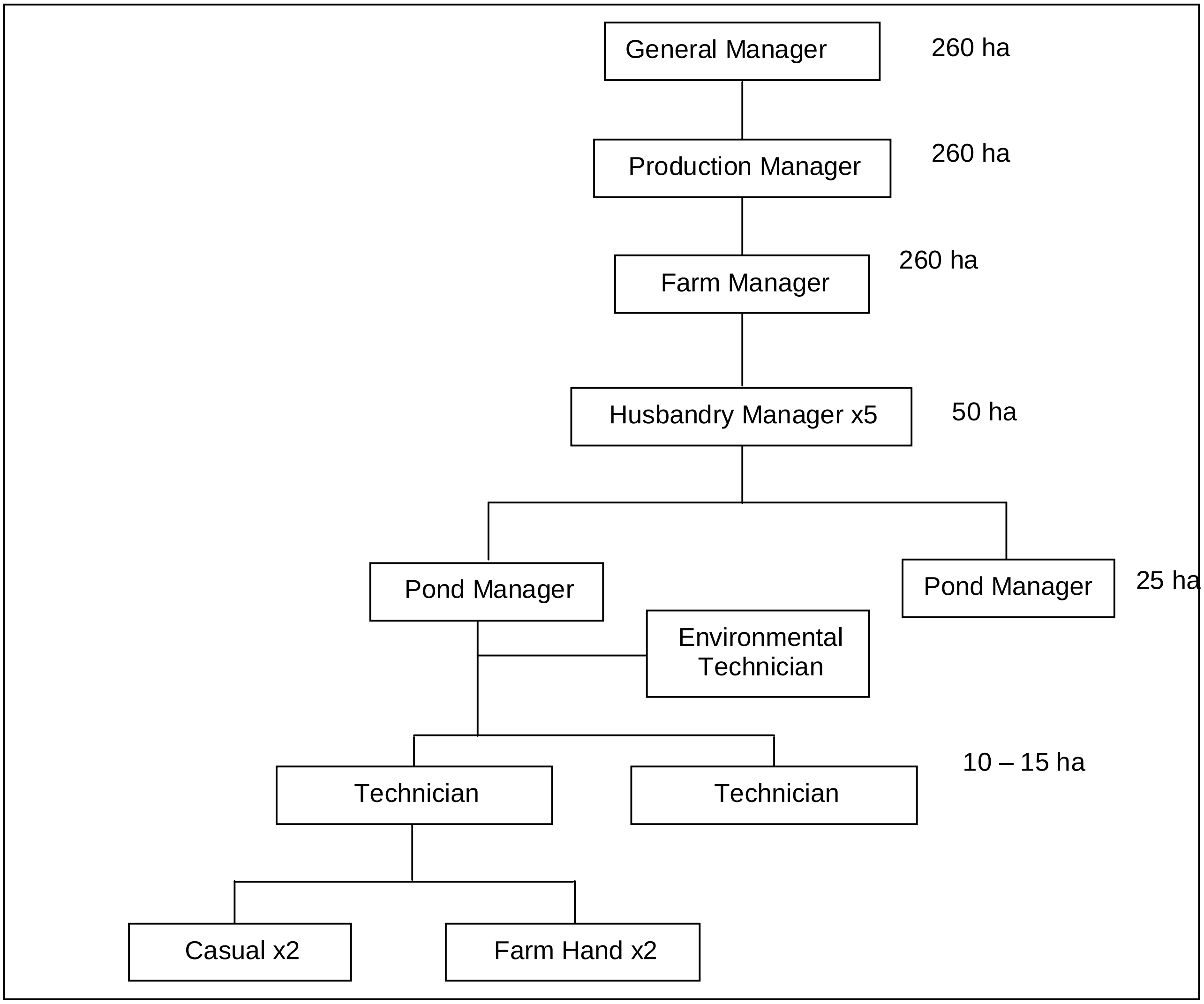

Figure 4-20
Guthalungra Production Structure

4.5 Operation of the Project

4.5.1 Specific Activities – Farming Prawns

The Guthalungra development will predominantly produce black tiger prawns. Other species, including other penaeid species, are being considered however only as potential aquaculture candidates. Pacific Reef may investigate alternative species for aquaculture, such as mud crabs or reef fish in future however the current proposal is for the production of penaeid prawns and more specifically black tiger prawns.

The Guthalungra operation will produce only market size prawns. There will not be a hatchery facility for prawns located at Guthalungra. Processing and freezing will be undertaken on site.

Following is a simplified description of the prawn farming process taken from Australian Prawn Farming - The Industry and its Issues. Duncan P.F. & Marsden G.E, Queensland Department of Primary Industries 2000. It provides a summary of the principles of prawn faming, only the grow-out and harvesting sections are applicable to Guthalungra.

Prawn farming involves three stages:

- Broodstock collection and spawning

  In Australia, prawn larvae are not captured from the wild as in some Asian and South American countries. Instead of capturing thousands of individual larvae or juvenile prawns from the wild, one mature prawn is captured and taken to a hatchery where it is induced to spawn between 200,000 and 1,000,000 eggs. From these eggs a greater proportion of larvae survive to commercial size than in the wild. Use of hatcheries maximises the contribution from each prawn.

  Around 3500 mature female prawns (broodstock) were used by the entire Australian prawn industry in 1997-98. This is equivalent to 350 kg or 1.75 % of the large black tiger prawns that are caught and sold frozen to the fish markets. The yield from these 3500 broodstock was 1554 tonnes, representing an efficient use of a natural resource (Lobegieger, 2000).

  Progress has been made recently in the development of methods that enable the rearing of broodstock in captivity. This process, which maintains the whole life cycle (Figure 4-21) on the farm, reduces the demand for wild-caught broodstock and increases control over the reproduction cycle thereby providing a more reliable supply of larvae.

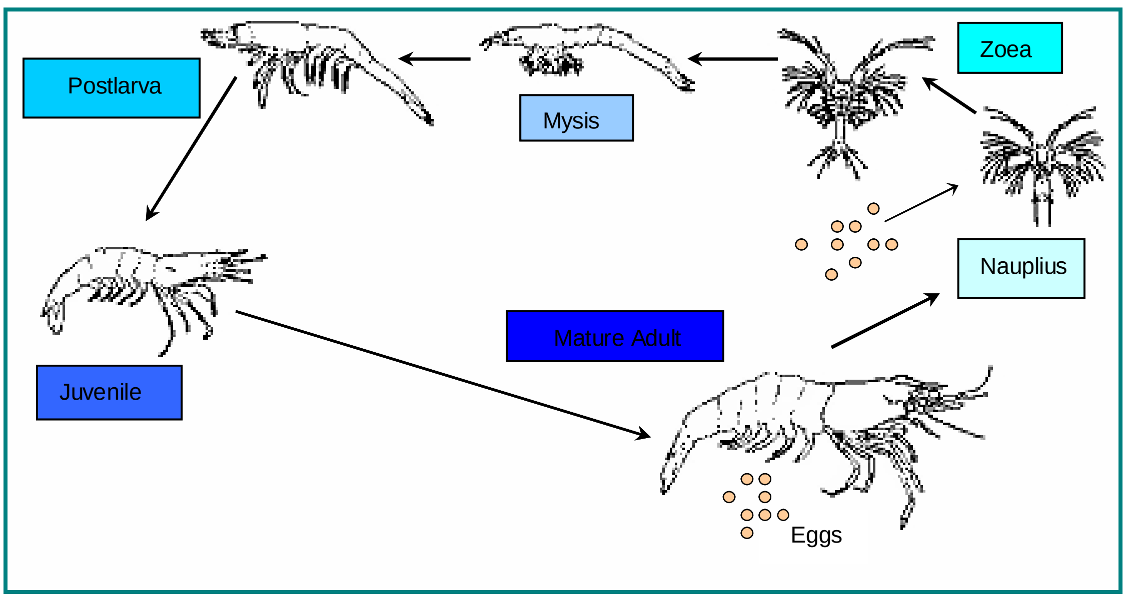

Figure 4-21
The life cycle of Penaeid prawns showing the main developmental stages.
(Modified from Rothlisberg & Staples, 1992)

- Larval production
  Broodstock are taken to indoor facilities called hatcheries. Here the broodstock are induced to spawn eggs that hatch within 14 hours. After hatching the larvae are grown in tanks at high densities for about 1 month until they reach postlarvae stage 15, approximately 12mm in length. The postlarvae (PL15s) are harvested and stocked directly into outdoor growout ponds.
- Growout and harvest
  Growout ponds are usually about one hectare in area and 1.5m deep. They are typically constructed on clay soils, which have good water retention properties, although sandy soils can be used in conjunction with waterproof pond liners.

Depending on the species being stocked, ponds are filled with either seawater or brackish water from estuaries or rivers. Small amounts (relative to agriculture crops) of fertiliser are added prior to stocking the prawns to increase micro algae in the water (bloom). The algae are present naturally in coastal waters but are maintained in the pond at relatively high concentrations. The algae species give the ponds their characteristic green or brown colour but are not the same as those that cause toxic blooms and fish kills.

The manipulation of algal blooms within ponds is an essential management tool to help control water quality. As a plant the algae produce oxygen during daylight hours and use up nutrients (waste products) produced by the prawns. Algal blooms also provide shading, which encourages light sensitive prawns such as black tiger prawns to feed during the day, and also limits the growth of aquatic weeds on the pond bottom. Healthy algal blooms can be maintained through periodic water exchange. Without dilution the algal blooms can become too thick and 'crash' (die and sink to the bottom) causing deterioration in water quality.

Prawns stocked as post-larvae reach one gram in about three weeks. After about 18 weeks (depending on factors such as temperature and stocking density) they reach marketable size of between 25 and 35 grams. North of Townsville up to two crops per year are possible, whereas further south, where growth is slower due to lower water temperatures, only one crop per year is grown.

Specially formulated pellets are fed to the prawns up to five times daily. Feed conversion ratios (kg of feed to produce kg of prawns) range from 1.6:1 up to 2.7:1, depending on management and species. Excessive feeding is expensive and can lead to water quality problems. Overfeeding can occur because the pellet is designed to sink so that prawns can find it on the pond bottom. It is difficult to observe the quantities of uneaten food so methods have been developed to give practical estimates of food consumption allowing feeding rates to be adjusted daily.

Water exchange rates may vary from 0 to 20% of the total pond volume and are highest by the end of the growout cycle (i.e. when the total weight of prawns in the pond is highest). Average daily water exchange for the crop cycle is about 5%. Water exchange depends on water availability and pond water quality and some farms are now experimenting with low, or nil water exchange.

To harvest black tiger prawns, ponds are usually partially or completely drained. The prawns are captured in nets attached to the outlet pipes and delivered immediately to the processing sheds on site. Also partially harvesting of the crop during the season is now becoming a more commonplace practice.

Specific Activities – Guthalungra

The specific activities undertaken at Guthalungra are outlined below.

4.5.2 Timing and schedule for operation of the project

The timing and schedule for the operation of the project is discussed in greatest detail in Section 4.2.2. During the construction phase of the farm (4-years) each unit (3) will be stocked and managed to ensure that production across the farm occurs over the entire growing season (Aug through June). On completion of the third unit, the management of the farm will change and at full capacity the farm will be managed as three discreet farms, each with its own supply, production and treatment systems. Each farm will be stocked en-mass at three different times of the growing season ie early, mid-season and late stocking.

This will ensure the most efficient use of staff and equipment. However it is contingent on having the freezer and processing capacity in place to cope with bulk of the product being harvested and processed in a relatively short space of time.

As the farm is located in the dry tropics production will cease at the end of June and stocking recommence in August.

4.5.3 Intake and waste discharge and estimated volumes

Figure 4-12 shows the anticipated water intake and discharge profile for the operation. The Excel spreadsheet calculations are listed in Appendix D. The maximum discharge is 200ML/d which includes harvest waters.

4.5.4 Expected chemical, biological and physical characteristics of discharge waters

The discharge waters will have low concentrations of both soluble and organic nutrients. There will be no hormones or antibiotics residues in any discharge waters as these will not be used on the farm. The discharge waters will have no human pathogens typically found in non-disinfected sewage discharge effluents.

The bulk of the organic matter will be algal cells. Low concentrations of ammonia, refractory organic nitrogen and phosphorus will be in the discharge. These concentrations are described more fully below Total Nitrogen concentrations are predicted to be 2mg/L or less; Total Phosphorus concentrations 0.3mg/L or less, Total Suspended Solids 30mg/L or less and Chlorophyll a 30ug/L or less.

The discharge waters will have salinities 2-3 ppt higher then the receiving waters.

4.5.5 Freshwater and/or groundwater requirements

Freshwater availability is limited on site. For this reason the facility has been designed to minimise the use of freshwater in the production process. Freshwater usage is discussed in detail in Section 4.1.1 and 4.1.5.

4.5.6 Management of water flows and water quality in/through ponds

Incoming water flows to each individual pond are controlled by means of a valve on the intake pipe, discharge water flows are controlled with a monk or culvert designed to limit the depth of water in the pond. Typical inlet and outlet structures are shown in Appendix B.

The amount of water used in the operation of the ponds is dictated by a number of factors, for example:

- Quality of the incoming water;
- Biomass in the pond;
- Health of the algal bloom;
- Feeding rate for optimum growth;
- Stage of production;
- Dissolved oxygen concentration;
- Pond water salinity.

Therefore water flow rates through individual ponds will vary depending on a number of factors. The Guthalungra operation has been designed on the basis that the average exchange rate over the entire farm at full capacity over the growing season will be around 2.7% per day over the season, (Refer to Section 4.2.2). This is considerably lower than the industry average and will be achieved through a number of initiatives introduced to the Guthalungra operation including:

- Pond biomass and feed control (capping);
- High levels of aeration;
- Availability of high quality incoming water from Abbot Bay;
- Improved feed efficiency;
- Rigorous pond water quality monitoring;
- Flow monitoring and buffering discharge "spikes" by storing water for release;
- Reduced stocking density;
- Water re-use.

4.5.7 Water recirculation and reuse opportunities

Refer to Section 4.2 for a further discussion of recirculation opportunities.

Recirculation is being trialled by Queensland Department of Primary Industries Researchers in Cairns. Some success has been achieved in the treatment and recirculation of prawn pond discharge. The Guthalungra farm has been designed to allow for recirculation to take place.

It should be noted that the relatively high evaporation rates experienced in the dry tropics limits the ability to fully recirculate water on the Guthalungra prawn farm. The capacity to recirculate has been designed into the farm. Each of the three treatment areas will be able to discharge into the pond water supply system.

Trials will be undertaken to optimise the water reuse on the farm.

4.5.8 Waste treatment methods and facilities

Discharge waters from the grow-out ponds will drain to water treatment systems, with each production area being serviced by an independent treatment area. The treatment system consists of two main elements:

- Primary sedimentation areas;
- Settlement ponds.

The primary treatment area is designed to allow sedimentation of the coarse fraction of suspended solids. A Hydraulic Retention Time (HRT) of approximately 8 hours will be provided. Each primary sedimentation area will have two ponds. At regular intervals, one sediment pond will be drained and the material in the pond collected and taken to another pond where drying can be completed.

Water will discharge from the sedimentation area into settlement ponds, where further sedimentation and biological treatment will occur. Settlement ponds have been sized to provide a minimum of 48 hours HRT under peak discharge conditions.

As discussed above, it will be possible to raise the water level to 5.0m AHD to provide additional treatment to accommodate periods when water quality issues occur on the farm. Settlement Ponds will be clay lined and will incorporate rip-rap protection on inside batters.

4.5.9 Treatment Systems

The prime method of treating the discharge stream will be through the use of primary sedimentation ponds followed by settlement ponds. The respective areas required for treatment are listed in Table 4-1.

Water after discharge from the growout ponds will pass along earthen channels before entering one basin of two primary sedimentation basins built in parallel. These primary sedimentation basins will be 3m deep and are designed to hold water for 8 hrs at maximum flow. The principle aim of the basins is to capture much of the larger organic and inorganic floc material, which forms much of the sludge in ponds when deposited. Robertson (2001) for example, reported long settlement drains with baffle or silt traps are used on some aquaculture farms to assist in sedimentation and biological filtration of effluent to enable recirculation of pond waters.

Preston *et al.* (2001) found that the physical settlement of organic matter e.g. uneaten food, prawn faeces and moults, phytoplankton, and zooplankton in prawn farm ponds was of limited benefit because bacterial action in the sediment will mineralise nutrients contained in this organic matter, resulting in the nutrients being returned to the water in dissolved form. Direct measurement of NH_3 fluxes from the sediment in a settlement pond indicated that up to 3.8kg N $ha^{-1}.d^{-1}$ was being released from the sediment as ammonia (M.A. Burford, unpublished data). Preston *et al.* (2001) concluded that the effectiveness of physical settlement as an N-removal process will therefore be improved by regularly removing settled deposits for land-based storage and treatment.

Sedimentation ponds or drains can be used to reduce the amount of particulate material in the water column and minimise the build up of sludge in biological treatment ponds further downstream (e.g. settlement ponds, bioremediation ponds and constructed mangrove wetlands). For example, Teichert – Coddington *et al.* (1999) reported that 6 hours of residence time in settlement ponds removed 88% of TSS and 31% of total nitrogen from the final harvest water from shrimp ponds in Thailand.

In laboratory scale experiments, Jones *et al.* (2001) found that within 12 hours, prawn farm effluent from a Gold Coast prawn farm recorded the following reductions in TN, TP and TSS.

Table 4-3
Percentage reductions in nutrients and biological material of prawn farm effluent via settlement (Jones *et al.* (2001))

Parameter	% reduction
TN	25
TP	30
TSS	55

Burford and with other co-researchers (e.g. Pearson (1998), Williams (2001), Jackson and Preston (2001), Longmore (2001), Preston, Gilbert and Dennison (2002)) have extensively studied the fate on nitrogen in prawn farms. They found based on N processing in shrimp ponds, the major pathways of N cycling can be summarized in the following way: dietary N enters the pond system as DON (Dissolved Organic Nitrogen) or ammonium. In the case of ammonium, it is released by shrimp gill excretion, rapidly assimilated by the phytoplankton, and also to some extent by bacteria and produced principally by re-mineralization of detritus in the sediment. In contrast DON, is produced from shrimp feed and faeces and is only slowly utilized by the microbial community. The result is an accumulation of DON over the shrimp growth season.

Burford's *et al.* (2000, 2001) research has shown that much of the ammonium in P. monodon ponds is produced in the sediment, particularly in the sludge zone. They estimate that continual removal of sludge during the growout season would result in a 60% reduction in ammonium fluxes from the sediment.

In contrast to ammonium, much of the DON appears to be produced directly from shrimp feeds and feeding processes and is not readily utilized by the natural biota. Therefore it is likely that improvements to feeds and feeding practices are more likely to significantly reduce DON concentrations in ponds.

To minimise the potential for the re-mineralization of much of this settled material, the sedimentation ponds have been designed to be emptied and dried on a frequent and rapid basis. Clean out would occur on a minimal monthly basis and more rapidly as experience dictates. The accumulated sludge material will be removed, thus reducing the nutrient load to the settlement ponds and eventual discharge to Abbot Bay.

4.5.10 Source of Nutrients and Discharge Water Quality

The predicted annual total feed for the project is 2987 tonnes, based upon a Feed Conversion Ratio (FCR) of 1:1.8. The total nitrogen contribution to the ponds will be 187 tonnes based upon a nitrogen component in the feed of 6.25% (pers. comm, Ridley Feeds). Briggs and Funge - Smith (1994) and Jackson et al. (2002) estimated that the total nitrogen exported from prawn ponds without treatment during a grow out season as a percentage of the total input was between 35% to 57%. That is, between 43% and 65% of the Total Nitrogen stayed within the ponds, was lost by volatization, or was taken out by prawn biomass.

Assuming 35% of the total nitrogen input is exported from the ponds at Guthalungra, this would be the equivalent of 65 tonnes based upon the given feeding rates for the project. The use of treatment systems will reduce this load. The proposed treatment system is predicted to remove 30% (Jones *et al.,* 2000) of the initial 65 tonnes in the sedimentation ponds i.e. 20 tonnes thus reducing the load to 45 tonnes. A further 20% reduction in the settlement ponds would remove another 9 tonnes. A residual load of 36 tonnes would be discharged.

This load would correspond to a daily loading rate during the discharge period (287 days) of 0.48 kg/ha/d. The discharge period will be from the first week in September thorough to the second week in June.

Alternatively, if it is assumed that 57% of the total nitrogen input is exported from the ponds at the proposed site, this would be the equivalent of 107 tonnes based upon the given feeding rates. The treatment system is predicted to remove 30% in the sedimentation ponds i.e. 31 tonnes reducing the load to 76 tonnes. A further 20% reduction in the settlement ponds would remove an additional 15 tonnes. A residual of 61 tonnes would be discharged. This load would correspond to a daily loading rate during the discharge period (287 days) of 0.82kg/ha/d. These calculations are displayed in Table 4-4.

Table 4-4
Nitrogen Mass Balance based on Feed Inputs and Treatment Streams

Total Nitrogen Load at FCR of 1:1.8 (tonnes) in to the Grow Out Ponds	Percentage Nitrogen Exported from Pond Systems without treatment (%) (tonnes exported from ponds in brackets)	Treatment Stream Reduction – Sedimentation ponds (% capture) (tonnes remaining in discharge stream in brackets)	Treatment Stream Reduction – Settlement ponds (% capture) (tonnes remaining in discharge stream in brackets)	Daily discharge rate over the discharge period (287 days) (kg/ha/d)
187	35 (65)	30 (45)	20 (36)	0.48
187	57 (107)	30 (76)	20 (61)	0.82
187	45 (84)	30 (59)	20 (47)	0.63

4.5.11 Nutrient Discharge Composition

Total nitrogen and total phosphorus are typically found in low concentrations in prawn farm discharges when compared with other forms of discharge e.g. sewage or feedlot effluent. The bio-available form of nitrogen in the prawn farm discharge is ammonia, which will be in the order of 25% of the bio-available fraction of the total nitrogen component (Jackson *et al*. (2002)). Ammonia concentrations in the discharge should range between 0.10 to 0.50mg/L. Significantly, the conceptual modelling developed by the Western Australia EPA (1992) for seagrass and nutrient interactions focuses only on additional dissolved nutrients and not total nitrogen and phosphorus because of the question of the bio-availability of the inorganic component. The dissolved organic nitrogen (DON) fraction of the prawn farm discharge is refractory and will break down after a period of about 7 or so days (Burford and Pearson, 1998). These DON concentrations should range also between 0.10 to 0.50mg/L. Essentially much of this material will have left the area and be highly diluted before there should be any biological break down and uptake of this material. The algal material in the discharge is likely to be a source of fish food for fish larvae within the region.

Total phosphorus is also likely to be predominately in the organic form as a component of total suspended solids.

Even though the organic component of the discharge is likely to be high and not readily bio-available; the water quality dispersion modelling undertaken by the CRC for Reef Research used conservative Total Nitrogen and Total Phosphorus concentration described below.

Likely total nitrogen concentrations in the discharge waters over the growing season to meet the daily discharge rates in discussed above are displayed in Table 4-5. To meet a daily discharge of 0.51kg/ha/d, total nitrogen concentrations in the discharge waters may vary between 0.6mg/L and 1.5mg/L. Using a conservative constant discharge total nitrogen concentration of 2mg/L would give the equivalent of 0.81kg/ha/d. As a point of reference, the modelling of discharge concentrations and dispersion in Abbot Bay were based on a constant discharge total nitrogen concentration of 2mg/L or 0.81kg/ha/d.

Table 4-5

Calculated daily discharge rate over the discharge period (kg/ha/d) for each grow out pond based on a twenty four week grow out season (note – four weeks of no exchange), percentage weekly water exchange rates and various discharge TN concentrations after treatment.

Week	%	TN (mg/L)	TN (mg/L)	TN (mg/L)
1	0.5	0.6	0.6	2
2	0.5	0.6	0.6	2
3	0.5	0.6	0.6	2
4	0.5	0.7	0.7	2
5	2	0.7	0.7	2
6	2	0.7	0.7	2
7	2	0.7	0.7	2
8	2	1	1.5	2
9	4	1	1.5	2
10	4	1	1.5	2
11	4	1	1.5	2
12	4	1.2	2	2
13	6.5	1.2	2	2
14	6.5	1.2	2	2
15	6.5	1.2	2	2
16	6.5	1.5	2	2
17	9	1.5	2	2
18	9	1.5	2	2
19	9	1.5	2	2
20	9	1.5	2	2
Daily discharge rate over the discharge period (287 days) (kg/ha/d)		0.51	0.71	0.81
Total Nitrogen Discharged (tonnes)		35.2	51.4	55.6

4.5.11.1 Total Suspended Solids and Total Phosphorus Discharge Loads

Total phosphorus concentrations are typically 10% of that of total nitrogen concentrations. In this instance, total phosphorus concentrations can be expected to vary between 60 to 200µg/L. Seasonal loadings would between 3.5 and 5.5 tonnes based upon performance of the treatment system. This corresponds to a daily load of between 0.05 and 0.08 kg/ha/d. TSS concentrations are usually between 10 and 30mg/L in discharge waters. Based upon these discharge concentrations, seasonal loadings would be between 2980 and 5410 tonnes of suspended material. A daily load of between 11.5 and 34 kg/ha/d may be expected. Chlorophyll a concentrations will be a component of the TSS component and the removal processes for chlorophyll in algal cells will be similar to that of TSS.

4.5.12 Pond Discharge Quality during Normal Operation and Drain Harvesting

It is expected that there will be little difference in pond effluent quality between normal operation and during drain harvesting. Elevated concentrations of TN have been factored in the pond farm operation during the latter stages of the prawn farm operation for the months of February, March and April when feeding is higher and ponds are harvested. The large numbers of pond exchanges will substantially dilute nutrient concentrations from harvest waters before ongoing treatment in the sedimentation and settlement ponds.

4.5.13 Water quality management and control

A variety water quality management and control procedures will be put in place at Guthalungra. The following provides a summary of some of the techniques that will be employed:

- Discharge buffering capacity - The farm has been designed to include considerable water discharge holding capacity (refer to Section 4.1);
- Management and Control Farm Releases - Discharges will be timed to ensure maximum dilution in the bay coinciding with appropriate tidal flows and offshore water movement;
- Aeration - Aerators will be utilised to ensure adequate water quality in production ponds and treatment facilities;
- Accurate Flow Data - Pacific Reef will have accurate measurements of discharge flow from the farm;
- Reduction of Water Use - The amount of water exchanged from the ponds will be minimised as a result of increased aeration and tight feed management;
- Lined ponds - The ponds at Guthalungra will be lined with rock to reduce the erosion of the pond walls and suspension of earth. Trials are currently underway at the Pacific Reef farm at Alva Beach to assess the use of (plastic) lined ponds; lined ponds may enable the removal of sludge from the pond during production (or the incorporation of central drains). The use of plastic liners is as yet unproven in the prawn industry. Organic material will be removed from the pond bottom at the end of the crop;
- Feed Cap - Pacific Reef utilise a feed cap, i.e. the biomass of the pond is maintained through partial harvests (trapping and drain) to ensure that no more than 30 kg of feed is fed per feed time to a pond;
- High Quality Feed - Pacific Reef is committed to feeding the best quality, most digestible prawn feed on the market;
- Feed Management - Pacific Reef will continue to implement rigorous feed management practices including visual monitoring and recording of feed consumed;
- Partial Harvests - More prawns will be harvested utilising traps that selectively remove the larger prawns. In this way less water will be discharged;

- Seeding ponds - In the past the industry has used fertiliser to "seed" production ponds at the start of the season. This will not occur at Guthalungra, instead vegetable dyes will be used extensively to replace the fertiliser;
- Re-use - Pacific Reef is committed to implement the findings of on-farm trials and to re-use discharge water wherever possible;
- Daily Monitoring - Water quality parameters will be collected continuously across the farm to ensure that the response to water quality issues in both the ponds and the discharge system occurs immediately;
- Environmental Manager - Dedicated environmental officers will have responsibility for mitigation trials and environmental monitoring. The farm managers will be in direct control of water discharges;

4.5.14 Monitoring of Capacity of Settlement Ponds

Water will drain from grow out ponds to the settlement ponds via gravity (except for part of Production Area 1, which may be pumped), and from the settlement ponds to the Outfall Pump Station via the Main Outfall Drain. The total capacity of the water treatment system at normal operating depth (4.0m AHD) including both settlement ponds and Sedimentation Areas, will be approximately 1000ML. This can be increased to 1500ML by increasing the storage level to 5.0m AHD. The design crest level of the Settlement banks will be RL 6.0m AHD, providing a maximum possible storage of approximately 2000ML.

It is expected that the operating level will usually be maintained at approximately 4.0m AHD throughout the season, to maintain optimum water conditions in the settlement ponds. Diurnal variations around this mean level will occur, depending on the water exchange and pond harvesting activities taking place. Operating at this level will provide approximately 1000ML of buffer storage before overtopping of confining banks could occur. This equates to approximately 5 days exchange during the peak season.

Water levels in the settlement ponds will be monitored by staff during daytime working hours, when all releases from ponds will occur.

Pond outlet flow rates will be matched with inflow rates and outfall pumping capacity to maintain stable water levels. Outlets from settlement ponds to the Main Outfall Drain will be overshot type, minimising the potential for excessive short term increases in pond water level due to variability in inflow rates. Water levels in the Main Outfall Drain will be maintained at less than 3.5m AHD by adjusting both the outfall pumping rate and the release rate from the ponds.

4.5.15 Pipeline Pigging

Intake and discharge pipeline systems will be cleaned by "pigging". The two intake pipelines supplying the intake pump station will be reverse-pigged by passing a pig from the pump station back along the pipelines, exiting at the ocean intake structure. A removable pig launcher will be used within the pump station, and intake pipelines will be cleared consecutively. A total of approximately 700m of 1000mm diameter intake pipe will be cleaned in this way.

Cleaning of the pipework within the pump station will be carried out by back-launching pigs from the pumping manifold.

The intake pipeline rising main will be cleaned by pigging from the pump station to the seawater storage, a distance of approximately 5120m. One of the intake pumps will be used to supply water for this operation.

The discharge pipeline will be cleaned via pigs launched in the pipeline adjacent to the intake pump station.

A pig launcher will be located at this point, supplied with water from one of the intake pumps. Pigs will be pumped back to the discharge pump station from this launcher (approx. 5080m). At the discharge pump station, provision will exist to enable the pig to pass into the final section of the intake pipeline rising main, exiting in the seawater storage.

Pigging of the section of discharge pipeline seaward from the intake pump station (approx. 540m) will be via the pig launcher adjacent to the intake pump station.

The processes described above will result in the generation of waste material scoured from the pipes during pigging. Pigging of both the discharge and intake lines will be undertaken at the end of growing season. The rates of accumulation of marine growth inside the pipelines are not known with certainty, and will depend on a range of environmental factors. It is assumed that a 5mm thick layer of marine growth occurs within the pipes in a typical year, approximately 9m^3 of waste material would be deposited in the marine environment each year as a result of pigging of the ocean pipelines. Approximately 72m^3 of material would be deposited in the seawater storage.

It is expected that cleaning will be required annually, to keep the degree of fouling to a manageable level. The design of the infrastructure has therefore been based on the need to gain ready access for cleaning purposes.

The material will be primarily barnacles and some organic material. There will be only small quantities of seaweed and macro-algae, as the light climate within the pipes will limit plant growth. For pipes seaward of the intake pump station (both discharge and intake) this material will be deposited on the seabed at the end of the pipelines.

Material generated by pigging both the discharge and intake pipelines inland from the intake pump station will be deposited in the seawater storage.

4.5.16 Processing

Also refer to Section 4.1.5 – Processing and Potable Water.

All processing will be carried out on site in purpose built facilities. The facilities will be constructed to process around 1600 tonnes of production over a relatively short period. The majority of stock will be harvested over six months from January to July. Around 300 tonnes of product will be sold as fresh either cooked or green, and the remainder will be frozen cooked or green. Freezer capacity will be available for about 900 tonnes of product.

The following processing activities will be undertaken:

A grading, cooking and packing plant will be constructed on-site. The plant will conform to all relevant health and food safety regulations. Freezing and refrigeration facilities will be established on-site for product storage and ice making.

Immediately after harvest the prawns will be transported to the cooking and packing facility. Prawns are emptied from harvest cages directly into the hopper of the grading machines. Prior to entering the grading machine, the prawns will pass over a manual sorting table where inert material is removed.

The grading machines will be capable of sorting the prawns into six size categories before directing into separate bins. The prawns will either be cooked or packed at this stage. Product required for cooking will be manually moved to the cookers. Cooking is undertaken by boiling in brine for less than three minutes. The cooked product is then plunged into sub zero brine for chilling, then removed and packed.

The packing used depends on customer requirements and whether the prawns are cooked or green, or are to be sold frozen or fresh.

Product that is to be frozen is passed through an IQF system then packed in heavy-duty plastic bags, and sealed in a waxed card container (a variety of sizes are used) before being blast frozen. The cartons are stacked on a pallet and stored at around - 25^{o}C in the freezers.

Fresh cooked and green product is packed in heavy-duty plastic bags, then placed into Styrofoam boxes with ice, marked for size and sealed. The standard Styrofoam box will hold approximately 17.5kg of produce and 1.5kg of ice. A conveyor will move these boxes to a stacking area where the sizes will be sorted onto pallets for storage in the cool rooms.

The processing facility will utilise grading machines that will have a capacity of 3 tonnes per hour and processing from harvesting to packaging is expected to take a maximum of three hours with a maximum daily throughput of around 25 tonnes.

4.5.17 Hygiene Management

Pacific Reef has a HACCP based quality program in place at the existing prawn farm at Alva Beach, Ayr. A similar system will be adopted at Guthalungra. A Food Safety Plan has been prepared, and the Australian Quarantine and Inspection Service undertake regular audits for export certification. Similar systems will be established at Guthalungra.

4.5.18 Estimated size of the operational workforce and accommodation requirements

The operational workforce is detailed Section 7.10 and in the Guthalungra Prawn Farm Business Plan (Confidential Report).

The accommodation requirements are detailed in Section 7.10.

4.5.19 Scale drawings and (for vegetation) maps on the operating phase of the project

Design drawings are provided in Section 4.1 and Appendix B. Vegetation maps are provided in Appendix M.

4.5.20 Species Farmed

Guthalungra prawn farm has been designed to farm penaeid prawns. The principal production species at Guthalungra will be black tiger prawns *Penaeus monodon* other penaeids may be grown after trials have been undertaken include *Penaeus esculentis*, the brown tiger prawn, and *Penaeus merguiensis*, the banana prawn. The black tiger prawn is better suited than the banana prawn to the environmental condition at Guthalungra and a more viable commercial proposition. The brown tiger is commercially unproven at this stage. Small quantities of banana prawns may be grown.

Other species that may be reared on the farm are mud crab, *Scylla serrata* and barramundi, *Lates calcarifer*, as well as other species such as mangrove jack, oysters, *Artemia spp*., barramundi cod, coral trout, grouper, and mullet. Some of these species may be used individually or collectively to enhance wastewater treatment (e.g. milkfish, mullet) i.e. for the purpose of nutrient removal.

Table 4-6 below outlines the species that may be produced at Guthalungra in addition to penaeid prawns at some point in the future. The current EIS has been prepared on the basis that penaeid prawns will be the sole commercial crop and *Penaeus monodon* will constitute the majority of that crop.

Table 4-6
Potential Aquaculture Species – Guthalungra

Common Name	Scientific Name	Purpose	Global/Australian Culture Status	Pacific Reef Status
Mud crab	*Scylla serrata*	Commercial Production	Commercial/Experimental	Experimental - Commercial techniques used overseas are unlikely to be commercially viable in Australia. Pacific Reef will undertake trials to determine the commercial viability of mud crabs
Barramundi	*Lates calcarifer*	Commercial Production	Commercial	Commercial - No short term plans for commercial production
Mangrove jack	*Lutjanus spp.*	Commercial Production	Experimental	Experimental - No short term plans to undertake trials
Coral Trout	*Plectropomus leopardus*	Commercial Production	Experimental	Experimental - No short term plans to undertake trials
Barramundi cod	*Cromileptes altivelis*	Commercial Production	Experimental	Experimental - No short term plans to undertake trials
Estuary cod	*Epinephelus coioides*	Commercial Production	Experimental	Experimental - No short term plans to undertake trials
Mullet	*Mugil cephalus*	Bioremediation	Commercial	Experimental - No short term plans to undertake trials
Milkfish	*Chanos chanos*	Bioremediation	Commercial	Experimental - Milkfish may be trailed

4.5.21 Species Farming Details - *Penaeus monodon*

Guthalungra has been designed and will be constructed to produce *Penaeus monodon*. Refer to Section 4.4 – Species Farmed.

4.5.21.1 Source of Juveniles

Guthalungra will be established as a "production only" farm. Pacific Reef is considering sites and properties for the establishment of hatcheries in the vicinity of Bowen. Until a dedicated hatchery is established, post larvae will be purchased from licensed hatcheries in Queensland.

Samples of all stock purchased from commercial hatcheries will be health tested by QDPI prior to stocking in the production ponds.

4.5.21.2 Stocking Rates

Lower stocking rates will simplify pond management, reduce feed costs, improve Feed Conversion Ratios (FCRs), reduce stress, and improve survival. Stocking rates in the Australian industry vary widely from 8 to 40 prawns per m^2 depending on management techniques.

This project will initially be based on a stocking rate of 28 post larvae per m^2. This rate will be refined during the first few years of operation. Based on a survival rate of 80% to maturity and harvest the estimated yields per annum over the development of the farm increase to 1660 tonnes as shown in Table 4-7.

Table 4-7
Guthalungra Production and Feed Consumed

	2004/05	2005/06	2006/07	2007/08
Ha of pond production	91	147	203	260
Total Yield (tonnes)	581	938	1296	1660
Total feed used (tonnes)	1045	1690	2330	2990

Assumes an average body weight at harvest of 28.5 g and 28 PL/m2 stocking and 80 % survival.

4.5.21.3 Genetically Modified Stock

Pacific Reef will not farm any genetically modified stock.

4.5.22 Management processes and controls to avoid disease

A disease management plan will be developed, see Section 9.

The management plan will be based on the General Principles of Health Management in Aquaculture prepared by Queensland Department of Primary Industries (Lobegeiger 1997) The following outlines the action that have/or will be undertaken by Pacific Reef to ensure adequate disease management:

- Site Selection
  - Ensure a suitable temperature range for the aquatic species to be farmed;
  - Ensure freedom from noxious agents in the soil, water and air;
  - Ensure an adequate distance from neighbouring farms so as to prevent cross contamination;
  - Ensure that weather (rain/sunshine/wind) and environmental conditions (tides, waves, cyclones) are not serious threats.
- Water Source
  - Ensure reliability of supply to meet expected farm/hatchery requirements throughout an entire year;
  - Ensure high quality at all times and back-up storage for times of adverse weather;
  - Need water free of noxious agents, predators and parasites, and not draw on outlet water of a neighbouring aquaculture facility or seafood processing plant.
- Farm/Hatchery Structures
  - Use only non-toxic and non-traumatic structures to enclose the aquatic animals (soil, tanks, cages, nets etc);
  - Design the farm/hatchery as several physically separate sub units (ponds, tanks, etc) to reduce cross contamination and manage disease emergencies;
  - Ensure all inlet/outlet structures, ponds, tanks and air/water lines can be drained, disinfected and dried effectively;

- All structures, tanks, and surfaces must withstand cleaning processes and disinfectant chemicals;
- Ensure that pumps, aerators, etc have fail-safe back up systems (or duplicated systems) to prevent deterioration of environmental (water) conditions.

• Imported Aquatic Animals and Quarantine

- Introduce animals from disease-free farms or sources only, after appropriate health testing and disease-free certification by a reputable veterinary laboratory; disinfect eggs or larvae where appropriate;
- In grow-out facilities only introduce young juvenile animals; special care is needed with the introduction of adult animals;
- Quarantine (isolate) all animal introductions from the rest of the farm for an appropriate period of time;
- Apply appropriate preventative treatments for parasites to all introduced animals while still in quarantine.

• Hygiene

- Disinfect eggs or larvae prior to use where appropriate;
- Keep separate different species, batches, ages and sizes;
- Exclude all unwanted aquatic animals from the ponds/tanks prior to stocking;
- Maintain all tanks, ponds, net cages, walkways, drains and equipment in a clean condition at all times;
- Operate the farm/hatchery as several physically separate sub units (ponds, tanks, etc) to reduce cross contamination;
- Farm/hatchery workers should work from the youngest animals to the oldest each day, or have separate work teams for the different age classes on the farm/hatchery;
- Farm/hatchery workers must be provided with appropriate facilities to disinfect foot wear and hands when moving from one sub unit of the facility to another, and at the end of each working day;
- Clean and disinfect all transport tanks between batches;
- Allocate separate equipment to specific ponds, tanks or systems or clean and disinfect before use in different ponds, tanks or systems to prevent transfer of infection;
- Clean, disinfect and sundry tanks, cages, ponds and structures between batches or at least once each year;
- Remove sick and dying animals as soon as practical and treat in a quarantine section or dispose of appropriately, so there is no contamination of the farm animals or aquatic environment;
- Dispose of farm wastes appropriately so there is no contamination of the farm animals or aquatic environment;
- All visitors, particularly other aquaculture operators, should disinfect footwear and hands before entering the farm/hatchery.

• Husbandry and Management

- Stock at an appropriate density to avoid stress and to ensure adequate nutrition, oxygenation and waste removal.

- Water Quality

  - Screening of intake waters to prevent the entry of macro-aquatic animals from the incoming water;
  - Ensure adequate water flow and/or aeration at all times to optimise water quality;
  - In facilities where water is supplied in series (not recommended), the youngest aquatic animals must be upstream;
  - Minimise faecal and waste food accumulation;
  - Monitor and record water quality on a regular basis.

- Nutrition

  - Feed a recommended ration which is appropriate to the farmed aquatic animal and its age and reproductive state;
  - Ensure that the feed is not a means of transmitting infectious diseases;
  - Ensure that the feed is always fresh, of high quality and is stored in a manner to maintain its quality;
  - Ensure that the feed is always of sufficient quantity;
  - Ensure that the feed is in an appropriate form and size for the age of the animal being fed.

- Handling

  - Use only low-stress, non-traumatic procedures;
  - Minimise the number of procedures done at any one time;
  - Minimise the frequency of procedures done on aquatic animals;
  - Use only humane procedures and use anaesthetics if appropriate;

- Chemical use

  - Ensure all farm/hatchery workers are aware of the hazards of the chemicals used, and that they have training on the storage, use and handling of the chemicals used and are provided with appropriate protection gear.

- Chemical use

  - Ensure all farm/hatchery workers are aware of the hazards of the chemicals used, and that they have training on the storage, use and handling of the chemicals used and are provided with appropriate protection gear.

- Animal Welfare:

  - Consider the welfare of the aquatic animal at all times to minimise or avoid any pain, distress or suffering; use anaesthetics if appropriate;
  - Consider appropriate, humane methods of slaughter.

- Health Monitoring and Control

  - Record all introductions and disposals of aquatic animals; include their source or destination;
  - Record all outbreaks of sickness and deaths;
  - Measure and record growth rates;
  - Monitor the health and parasite status of a sample of the animals at regular intervals;
  - Maintain appropriate instruments, preservative solutions and specimen transport boxes for specimen collection and transport for laboratory diagnosis or health examinations;
  - Use preventative dips to control parasites and secondary bacterial infections where appropriate and record;
  - Minimise or eliminate the need for prophylactic antibiotic use by appropriate management and the use of vaccines where available.

- Disease Outbreaks

  - Isolate any infection associated with sickness/deaths to affected ponds and tanks only;
  - Prevent bird, animal, vehicle and human vectors from spreading disease through the farm/hatchery;
  - Farm/hatchery workers should work on the healthy animals each day before they have any contact with the sick ones;
  - Obtain veterinary laboratory assistance to determine the cause(s) of any losses; always attempt to get a diagnosis;
  - Collect sick specimens of affected aquatic animals for laboratory examination where appropriate/requested;
  - Collect and destroy by an appropriate method all dead aquatic animals each day at frequent intervals;
  - Chemicals and therapeutics are to be used only on the advice of an aquaculture veterinarian, and withdrawal times must always be observed;

- Disease Emergencies

  - Prepare a contingency plan to handle the diagnosis of a ‘declared disease’ on the farm/hatchery; this should include:
  - A plan and ability to completely isolate each pond, tank, sub unit or system to prevent transfer of disease by water, bird, animal or human to other farms and the aquatic environment;
  - A capacity to disinfect an entire pond, tank, cage, sub unit or system;
  - A capacity and an appropriate method to destroy, collect and dispose of large numbers of aquatic animals in a safe manner;
  - Records to allow tracing the origin and disposal of any affected group of aquatic animals.

4.5.23 Further Preventative Measures

Further to those measures outlined in Section 4.4 above, Pacific Reef will manage the ponds to ensure that potential sources of stress are minimised, some of the measures that will be adopted include:

- Adequate pond water exchange to maintain appropriate physico-chemical parameters;

- Adequate levels of aeration;
- Monitoring of pond water quality and substrate conditions will be undertaken;
- Monitoring of growth rates, feed conversion, specific growth rates undertaken regularly;
- Strict regulation of pond biomass and feeding rate;
- Extensive training program for staff particularly water quality, stock handling and response procedures;
- Reduced stocking rates (see above);
- Screening of stock for diseases;
- Purchase of certified disease free post larvae;
- Feed rates capped, and feeding optimised through thorough monitoring;
- Records of all introductions and disposal of prawns, including their source and destination, will be maintained;
- Health monitoring will be undertaken on a regular basis;
- Records of all disease outbreaks and parasite infections will be maintained;
- Screens in position to prevent escape stock;
- Facility in place to isolate individual ponds or sections of the operation.

4.5.23.1 Remedial Action

Reporting of disease outbreaks will be undertaken as required by Queensland Fisheries Service and Great Barrier Reef Marine Park Authority. Any therapeutant that may be used in the treatment of farm stock will be used under their instructions of a qualified vet.

4.5.23.2 Chemical Use

The only drugs and chemical substances to be used in the prawn farming operation will be those authorised by the National Registration Authority, prescribed by a veterinarian, or those substances that have been declared “Exempt from Registration” and their use shall be in accordance with the label’s specifications. Pacific Reef will not routinely use antibiotics in the production of prawns at Guthalungra.

Following is a summary of the drug and chemical approvals for aquaculture in Australia (Pers. Comm. Tiina Hawkesfoord, QDPI 21.01.2003), most not relevant to prawn farming and their use is not envisaged at Guthalungra the list is reproduced here for information purposes:

Drugs fully registered for use by aquaculture industries in Australia:

- AQUI-S Aquatic Anaesthetic (AQUI-S New Zealand Ltd, active constituent: Isoeugenol);
- Chorulon, Chorionic Gonadotrophin 5000 IU and 1500 IU (Intervet);
- ANGUILLVAC – Vibriosis C Vaccine (Tasmanian DPIWE);

Minor Use Permits approved by the NRA:

- Anaesthetics
  Benzocaine MUP issued on 18 January 2002 until 31 December 2003 for use as a sedative/anaesthetic and prescribed by registered veterinarians to aquaculture farmers producing finfish and/or abalone to Aquatic Diagnostic Services International. PER4904
- Antifungals
  Trifluralin MUP for 6 months issued 4 June 2002 until 31 January 2003 for the treatment of fungal infections in prawn hatcheries.

- Antiparasitics
  Formalin MUP was approved on 9 May 2001 for 12 months for use in prawn aquaculture for the Australian Prawn Farmers Association. Expired

A federally sponsored project is currently underway to obtain minor use permits for a number of chemicals for aquaculture industries throughout Australia.

4.5.23.3 Management Processes and Controls to Avoid Escape

The water discharge system has been designed in such a way that prevents the escape of livestock to the ocean. All pond discharge culverts will be screened of appropriately sized mesh (2mm for first 3 months of production and then 9mm thereafter). Additionally, the discharge waters leaving the treatment ponds will be screened (9mm) and waters will pass through a number of pumps before being pumped 4.5 km out to sea. This will help to destroy stock that may have escaped to the discharge system.

It is not intended to net the ponds. A number of strategies will be adopted to ensure that bird interference is managed (refer to section 7.2.14).

4.5.23.4 Water Transfer between Species from Different Ponds

There is no intention to transfer water between commercially produced species at Guthalungra.

4.5.24 Feed and Feeding Methods for each Species

Black Tiger Prawns *Penaeus monodon.*

4.5.24.1 Amount of Feed

The following Tables 4-8, 4-9, 4-10 and 4-11 provide an indication of the amount of food that will be fed seasonally and at each stage of the development of the operation:

Table 4-8
Farm Feed Consumption (tonnes) – Production Season 2004/05 (91ha)

% Stock	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05	May-05	Jun-05	Total
10	0.7	4.4	11.4	19.8	23.5	40.0	4.8					
25		1.8	11.0	28.4	49.5	58.7	100.0	11.9				
25			1.8	11.0	28.4	49.5	58.7	100.0	11.9			
25				1.8	11.0	28.4	49.5	58.7	100.0	11.9		
15					1.1	6.6	17.1	29.7	35.2	60.0	7.2	
100	**0.7**	**6.2**	**24.2**	**61.1**	**113.6**	**183.3**	**230.1**	**200.3**	**147.1**	**71.9**	**7.2**	**1045.7**

Table 4-9
Farm Feed Consumption (tonnes) – Production Season 2005/06 (147ha)

% Stock	Aug-05	Sep-05	Oct-05	Nov-05	Dec-05	Jan-06	Feb-06	Mar-06	Apr-06	May-06	Jun-06	Total
10	1.2	7.1	18.4	32.0	37.9	64.6	7.7					
25		3.0	17.8	45.9	80.0	94.8	161.5	19.3				
25			3.0	17.8	45.9	80.0	94.8	161.5	19.3			
25				3.0	17.8	45.9	80.0	94.8	161.5	19.3		
15					1.8	10.7	27.6	48.0	56.9	96.9	11.6	
100	**1.2**	**10.1**	**39.1**	**98.7**	**183.4**	**296.1**	**371.6**	**323.6**	**237.7**	**116.2**	**11.6**	**1689.2**

Table 4-10
Farm Feed Consumption (tonnes) – Production Season 2006/07 (203ha)

% Stock	Aug-06	Sep-06	Oct-06	Nov-06	Dec-06	Jan-07	Feb-07	Mar-07	Apr-07	May-07	Jun-07	Total
10	1.6	9.8	25.4	44.2	52.4	89.2	10.6					
25		4.1	24.6	63.4	110.5	131.0	223.0	26.6				
25			4.1	24.6	63.4	110.5	131.0	223.0	26.6			
25				4.1	24.6	63.4	110.5	131.0	223.0	26.6		
15					2.5	14.7	38.1	66.3	78.6	133.8	16.0	
100	**1.6**	**13.9**	**54.0**	**136.3**	**253.3**	**408.8**	**513.2**	**446.9**	**328.2**	**160.4**	**16.0**	**2332.7**

Table 4-11
Farm Feed Consumption (tonnes)–Production Season 2007/08 (260ha) and Ongoing

% Stock	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Total
10	2.1	12.6	32.5	56.6	67.1	114.3	13.6					
25		5.2	31.4	81.2	141.5	167.7	285.7	34.1				
25			5.2	31.4	81.2	141.5	167.7	285.7	34.1			
25				5.2	31.4	81.2	141.5	167.7	285.7	34.1		
15					3.1	18.9	48.7	84.9	100.6	171.4	20.4	
100	**2.1**	**17.8**	**69.2**	**174.5**	**324.5**	**523.6**	**657.3**	**572.4**	**420.4**	**205.5**	**20.4**	**2987.7**

4.5.24.2 Source of Feed

There is one Australian manufacturer of prawn feed and numerous overseas suppliers. Feed will be sourced from a number of different producers. The feed is usually delivered by semi-trailer to the farm. The pelleted feed is delivered in 20 to 25 kg bags, up to 1 tonne loaded on to pallets. Fork lifts are used to load the pallets into the food stores.

4.5.24.3 Feed Conversion Ratio

The average feed conversion ratio for the entire crop is expected to be less than 1.8. Experience at the Pacific Reef Ayr operation would suggest that 1.6 is becoming more the norm, however 1.8 has been used to calculate food consumption. The Queensland industry average is currently around 2 (Lobegeiger, 2000).

4.5.24.4 Feed Profile

The following information has been provided by Ridley Aqua-Feed. It provides a summary profile of prawn diets produced by one manufacturer (Table 4-12) Diets produced by other manufacturers are broadly similar.

Table 4-12
Feed Analysis

	Starter	Grower	Finisher
Crude protein (min)	43%	41%	40%
Crude fat (min)	6%	6%	6%
Crude fibre (max)	3%	3%	3%
Ash (max)	13%	13%	13%

The Ingredients will be prime quality steam-dried fishmeal, squid meal, squid liver meal, antioxidant-treated marine and vegetable oils, oilseed meal, flour, phospholipids, vitamins and minerals. The particle size of the feed is shown in Table 4-13.

All diets will include a complete vitamin premix containing highly stable and available forms of vitamins C and E.

Table 4-13
Particle Size

Product Name	Pellet Size (mm) Dia-Length
Starter Crumble #1	1.2 – 1.6 mm
Starter Crumble #2	1.6 – 2.2 mm
Starter Pellet #2P	1.6 / 2 – 3 mm
Starter Pellet #3	2.2 / 2 – 3 mm
Grower Pellet #1	2.2 / 3 – 4 mm
Grower Pellet #2	2.2 / 5 – 6 mm
Finisher Pellet	2.2 / 7 – 8 mm

4.5.24.5 Feed Quality

The Australian feed manufacturer Ridley Aqua-Feed is certified under AS/NZS ISO 9002: 1994 and HACCP 9000:1996 standards.

Feed that is imported into Australia requires authorisation from the Australian Quarantine and Inspection Service (AQIS).

4.5.24.6 Feed Storage

Feed will be stored in a dedicated central feed store located near to the administration and processing facilities. A central storage centre will allow better management, tracking and rotation of stock. The facility will be sealed and designed to prevent entry by birds, rodents or theft.

4.5.24.7 Feeding Method

Feed will be distributed to the ponds via blowers positioned on purpose built vehicles. The feed consumption of the ponds stock is assessed using feed trays. The trays are checked after each feed and the subsequent feeds amended accordingly. Pond stock is sample weighed monthly to determine FCRs and other growth parameters.

There are a number of reasons why the feeding rate of stock in the ponds will vary, e.g. water temperature, age of stock, pond condition etc. The following Table 4-14 provides a broad indication of feeding rates:

Table 4-14
Commercial Feeding Table

Ave. Body Weight (grams)	Daily Feed Rate (% Body Wt)	Feed Type	Feeds per Day	Time after Feeding to Check Rates (hrs)
PL15 to PL 35	35 – 25	Starter 1	4	2.5
0.2 – 2.0	20 – 16	Starter 1/2P	4	2.5
2 – 4	10 – 6	Starter 2/2P	4	2.5
4 – 7	6.0 – 4.5	Starter 3	5	2
7 – 10	4.5 – 4.0	Grower 1	5	2
10 – 18	4.0 – 3.5	Grower 2	5	1 - 2
> 18	3.5 – 2.0	Finisher	5	1 - 2

* Use only as a guide. Adjust according to appetite and feeding activity of prawns.

Source Ridley Aquafeeds

4.5.25 Chemicals & Fuel

The only chemical added to the processing waste is chlorine to disinfect processing wastewaters prior to discharge to the settlement ponds. No other chemicals are added the ponds. No other chemicals will be used to clean water supply or discharge pump and pipeline systems.

Chlorine may be used to disinfect ponds after the removal of stock. Chlorinated water remains in the ponds where it is aerated fully to remove the chlorine prior to release. Chlorine will be stored in a dedicated area (refer to Appendix B) in an enclosed building, locked and identified, with the capacity to retain 1.25 times the volume of chemical stored should spillage occur.

The existing Pacific Reef prawn operation at Alva Beach utilises a number of detergents or cleaning fluids for use in the processing plant. Pacific Reef have Material Safety Data Sheets (MSDS) and AQIS approvals for the following chemicals:

- Butcher Foam;
- Sanitize;
- Trapclean;
- Phosclean.

These solutions may be used at Guthalungra. A processing operations manual will be developed for Guthalungra which will be similar to the existing Alva Beach manual.

Up to 5 000 litres of diesel and 5 000 litres of petrol will be stored in dedicated tanks in an area near to the administrative centre of the farm. The tanks will be located in dedicated, bunded areas constructed of concrete an appropriate distance from buildings and other structures. The two bunded areas will be capable of holding 1.25 times the volume of fuel stored.

During construction up to 10 000 litres of diesel will be stored in a temporary tank to service the construction vehicles. Again this temporary concrete structure will be bunded to hold 1.25 times the capacity of the tank.

4.5.26 Pollutants and Waste

The major wastes are low concentrations of algae and nutrients in discharge waters from the prawn farm. Discharge quantities and wastes are discussed in Section 4.2 and Section 4.5. The generation of solid wastes from the site are minimal. Air emissions are minor. Waste management is described in more detail in Section 7. 6.

4.5.27 Noise

Noise predictions indicate that construction works are not likely to generate significant acoustic impacts at nearby sensitive receiver locations, providing the recommended daytime working hours are adhered to. Construction works, may however, be audible for part of the works.

A noise model for the operation of the proposed Guthalungra Prawn farm was established to estimate the likely noise levels during general farming activities and during the post-harvest maintenance activities. The predicted noise levels showed that operation of the proposed facility is not likely to generate noticeable noise levels at the nearest sensitive receiver, located approximately 2000m east of the proposed processing area and the nearest pond.

Using the conservative estimate of existing background noise levels within the area of 35 dB(A) during the day and evening and 30 dB(A) during the night, the following prawn farm operational noise levels, when measured at nearest sensitive receivers to the site, are considered reasonable:

- LAMAXadj, T : 40 dB(A), between 7 am - 10 pm; and
- LAMAXadj, T : 33 dB(A), between 10 pm - 7 am.

4.5.28 Light Levels

Lights will be mounted on the perimeter fence and used for night time security. Buildings will have external light for safety at night. It is proposed to fit high efficient full cut off flood lights which use less energy and provide full compliance with the requirements of AS 4282 – 1997 ‘’Control of Obtrusive Effects of Outdoor Lighting”.

All outside building lights will be fitted with anti glare shields and have all light controlled below the horizontal to meet the requirements of AS 4282 – 1997 ‘’Control of Obtrusive Effects of Outdoor Lighting”. No external lights are proposed for the pump station.

4.5.29 Emissions

Emissions from the site will be minimal. All vegetation will be mulched on site. Dust generation will be controlled by watering of any worked areas during construction. During operation, odours associated with the ponds will be similar to those of the local mangroves, beach and ocean. There will be no air emissions from the pump station. Ergon will supply mains power and back up generators will also be installed on site. Subsequently no air emissions will be generated on site from this source except on the occasions the generators are required.

The processing facility will involve the processing (sorting, cooking, refrigerating and freezing), of prawns. The processing facility including cold room will be enclosed during processing. The prawns are initially sorted then cooked. There is little odour associated with these activities; particularly as the prawns are cooked whole and there is little waste generation. The time taken between harvesting and processing is only 15 minutes, so maximum freshness, texture and flavour in maintained.

There will be no discernable odours associated with discharge waters.

4.5.30 Traffic Transportation

Based on the current and projected turning volumes and AUSTROADS Part 5 – Guide to Traffic Engineering Practice – Intersections at Grade, the intersection will not need any remedial works associated with the proposed development. The intersection has already been designed for the surrounding land uses and 100kph speed limit.

The traffic impacts of the proposed development on the State Controlled Road Network are negligible. The intersection will not require remedial works as it has already been designed in accordance with Austroads Part 5 – Intersections at Grade with right turn pockets and deceleration lanes. The intersection would operate with significant spare capacity in the future. The intersection has adequate sight distances and safety should not be an issue. No pavement works will be required based upon the Equivalent Standard Axles calculations.

4.5.31 Confidential Information

Cultural Heritage and the Business Plan are confidential documents completed for this study. The Pacific Reef, Ayr Prawn Farm – Processing Operations Manual has been used to prepare sections of this EIS. This document is confidential.

The Guthalungra Terms of Reference cites further information that should be provided but which may be confidential. The following list is reproduced from the TOR and the information requirement addressed:

Economic feasibility, including costs of development, and ongoing maintenance, insurances, cash flow projections, and other operational costs.

Refer to the Guthalungra Prawn Farm Business Plan.

Decommissioning and Rehabilitation Costs

It has been estimated that the cost of fully decommissioning and rehabilitating the site after complete construction would be in the vicinity of $2.5 million. This based upon draining ponds and backfilling, levelling then seeding. This estimate is based upon $10,000 per ha which is a unit commonly used within the mining industry.

Capacity of proponents to satisfactorily develop the project.

Refer to Section 1.

Estimated Market Size

Refer to the Guthalungra Prawn Farm Business Plan and Ruello (2002).

Location

Refer to Section 1.

Purchase Price

The land at Guthalungra is freehold and owned by Pacific Reef, the purchase price of the land is not relevant to this study.

Estimated losses due to climatic conditions, natural and human induced hazards

Refer to Section 6.2 (Climate) and Section 6.4 (Beach Erosion).

Commercial and Government fees

Refer to Section 14.2.

Financial Assurances

Not Applicable.

Joint Venture Arrangements

Not Applicable.

Foreign Investment Review Board Issues

Not Applicable.