NSW DEPARTMENT OF
PRIMARY INDUSTRIES

NSW North Coast Sustainable Aquaculture Strategy-Land Based Aquaculture

Readers' Note

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

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

Updated versions of this document can also be found at the above web address.

Site selection

NSW North Coast Sustainable Aquaculture Strategy
Land-based Aquaculture
August 2000

A NSW Government Initiative

North Coast Sustainable Aquaculture Strategy

A NSW Government initiative of NSW Fisheries, Department of Urban Affairs and Planning, Department of State and Regional Development, Environment Protection Authority, Department of Land and Water Conservation, National Parks and Wildlife Services and NSW Agriculture to encourage sustainable aquaculture in New South Wales

Table of Contents

.

1. Importance of site selection

1.1 The most critical step

For the long-term sustainability of an aquaculture enterprise, it is good investment sense to select an environmentally sound, low risk site at the outset. Site selection is the first and generally most critical step in establishing a sustainable aquaculture facility. Poor site selection can lead to failure. With pond culture, factors such as water supply quality and reliability, soil characteristics and topography can influence all further construction and operational decisions. It must be emphasised that a site that has access to an abundant supply of good quality water is key to a successful aquaculture enterprise.

Sound principles for the selection of aquaculture sites include:

- aquaculture must be permissible within the landuse zones
- environmentally sensitive areas should be avoided
- aquaculture should be compatible with nearby land uses
- site specific investigations should indicate that the site is fundamentally suitable for an aquaculture operation.

The appropriate location of an aquaculture facility is one of the most effective environmental management tools available to an applicant. While operational and market considerations are important factors, a high priority must be given to environmental characteristics of the location. Appropriate site selection can avoid or reduce many problems inherent to aquaculture, and:

- reduce the need for technically based environmental mitigation measures and costly ongoing management and monitoring measures
- result in substantial savings in establishment and operation
- reduce levels of public scrutiny and community concerns
- streamline the approval processes.

Information on the availability of potential sites can be obtained from real estate and stock and station agents. In addition, advice should be sought from NSW Fisheries and the Department of State and Regional Development (DSRD) as to whether they are aware of any potential sites. These agencies can also give advice on the general advantages and disadvantages of locating in particular regions or catchments.

1.2 A tiered approach to site evaluation

A systematic and rigorous approach to site selection based on the "locational principles" in the **Project Profile Analysis** is recommended.

At the time of site selection, the community as well as environmental factors should be considered. Potential conflicts with neighbours should be avoided. Options for reducing or preventing conflicts should be considered at the out set including the adequacy of separation distances between the ponds and other facilities and nearby houses. The surrounding existing or likely future land uses should be compatible with aquaculture. For example, it is important to consider early in the process whether a potential site is likely to be adversely affected by near-by agricultural pesticide use or if the aquaculture farm and the 24 hour operation of its pumps and other machinery is likely to adversely affect adjacent residents.

In undertaking an evaluation of various locations for aquaculture development, all relevant legislation, plans and government policies should be considered in the selection of preferred sites eg in relation to river and estuary flows regimes, water allocation, floodplain management, vegetation management, zoning, heritage strategies, biodiversity protection.

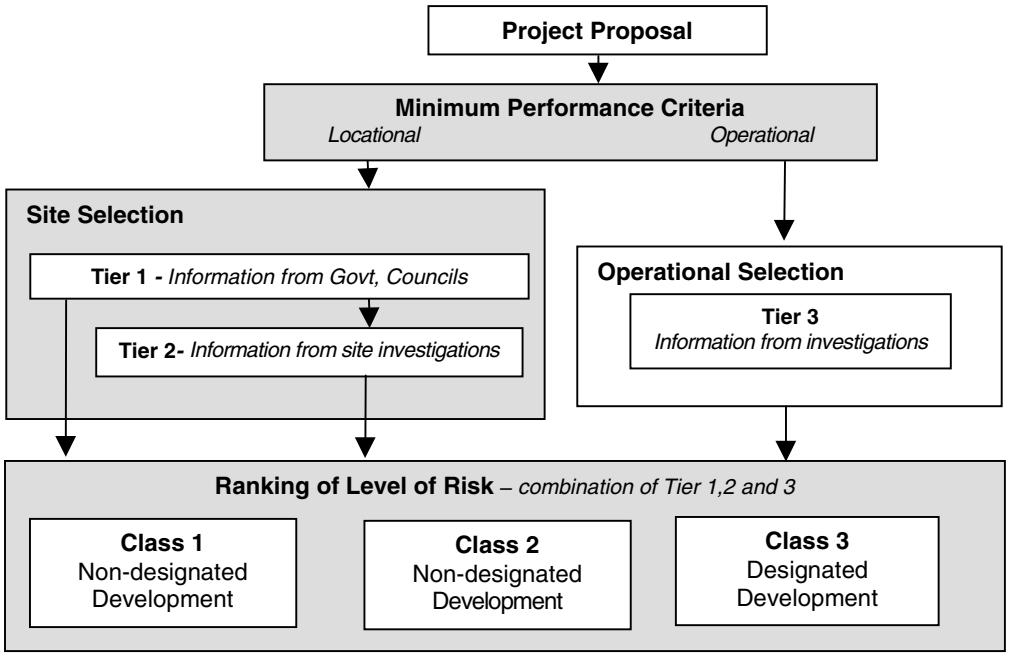
In general, the selection of a site should be based on a thorough knowledge of local and regional hydrology, geology, topography, ecology, climate and weather. While recognising that environmental factors are not the only factor in selecting a site, it is critical that when assessing alternative sites, environmental constraints and the long term costs (associated with environmental management and monitoring) are weighted with other factors such as land and construction costs.

To aid in this process, an assessment framework based on a series of "sieves" has been established to provide a mechanism for determining the likely level of environmental risk associated with any particular site. It includes three locational "sieves":

- The **Minimum Performance Criteria** provides the first environmental sieve for selecting sites and project characteristics. These must be met in order for the project to proceed.
- The **Tier 1** and **Tier 2** Site Selection Criteria in the Project Profile Analysis provides the next two environmental sieves to determine the acceptability of risks.

The Minimum Performance Criteria and Tier 1 criteria are based on information readily available in maps and other sources held by government agencies and accessible usually via a visit or a telephone call. Tier 2 criteria are dependent on information that will result from site investigations necessary to determine the suitability of the site for aquaculture. This assessment is intended firstly for the use for potential investors when considering alternative sites and secondly by approval authorities when deciding the level of risk associated with a project on the site and for determining the level of assessment.

Figure 3. "Sieves" in Project Profile Analysis



The Tier 1 and Tier 2 criteria and other issues that will need to be assessed on their merits are discussed in the *Site Selection* section of the AIDP. The Tier 1 and Tier 2 criteria are used to rank the level of risk associated with locating an aquaculture enterprise in a particular area and to establish the level of assessment (See *Project Profile Analysis*).

1.3 Minimum Performance Criteria

The Minimum Performance Criteria include locational criteria that land-based aquaculture proposals must meet to be permissible development within the North Coast Region.

Minimum Site Location Requirements

1 Zoning under environmental planning instrument
   (1) Pond-based aquaculture- within areas zoned for rural purposes
   (2) Tank-based aquaculture-within areas zoned for rural purposes or zoned for industrial purposes.

2 Tidal boundary for estuarine pong-based aquaculture
   Within an area that is not more than 1 kilometre from a tidal stream or no more than 1 kilometre from the upper tidal limit (identified in the NSW Coastal Policy) of the tidal stream.

3 Elevation Australian Height Datum (AHD)
   (1) Estuarine Pond-based aquaculture-within an area that is above 1 metre AHD and below 10 metre AHD.
   (2) Tank-based aquaculture and freshwater pond-based aquaculture – within an areas that is above 1 metre AHD.
   Note: AHD for areas may be sourced in the Acid Sulfate Soils Risk Maps published by the Department of Land and Water Conservation

4 Landform exclusion zones (high acid sulfate soils risk areas)
   Not within ASS risk codes EsO, EcO, EuO or Em shown on Acid Sulfate Soils Risk Maps published by the Department of Land and Water Conservation.

5 Flood liability
   (1) Not within an area subject to flooding in the case of high risk species (having regard to the probable maximum flood level)
   (2) High risk species are species designated as high risk species in the relevant Aquaculture Industry Development Plan (eg barramundi)

6 Conservation exclusion zones
   Not within:
   (a) Areas dedicated or reserved under the National Parks and Wildlife Act 1974; or
   (b) Aquatic reserves or marine parks (other than areas designated as general use zones), or
   (c) Vacant Crown land (other than areas used only for access to water provided under a licence).

2. Water issues

2.1 Water quality objectives

The NSW Government through its Water Reform Program is committed to ensuring the long-term health of the NSW Waterways. This program includes the introduction of a better balance in the sharing of water between users and the environment and reducing the stress on rivers and aquifer systems. Improved water quality and flow regimes are prime objectives for healthier waterways.

The Government has developed a two part complementary process for setting environmental objectives for individual catchments. One part involves an independent inquiry by the Healthy Rivers Commission in individual catchments to recommend longer-term environmental objectives and management strategies. This has occurred in the Clarence Catchment. The other involves the development of interim environmental objectives to guide river management planning with the involvement of Water Management Committees for each catchment. For each catchments, water quality objectives and river flow objectives have been developed. The most relevant of these areas for aquaculture are the estuarine and uncontrolled stream areas. Interim water quality objectives were released in October 1999 (see Table 12).

Table 12. North Coast Catchments with Interim Water Quality Objectives

River catchment, estuary and adjacent coast line	Town water supply catchments	Waterways affected by urban development	Regulated streams	Uncontrolled streams	Estuaries
Bellinger River & Coffs Harbour		x		x	x
Brunswick River		x	Yankee Creek below Mullumbimby Power Station	x	x
Camden Haven & Hastings River		x		x	x
Macleay River	Fattorini, Malpas, Puddledock Dams	x	Oaky River	x	x
Manning River	Bootawa Dam	x		x	x
Nambucca River		x		x	x
Richmond River	Emigrant Creek + Rocky Creek Dams	x	Iron Pot and Eden Creeks below Toonumbar Dam	x	x
Tweed River	Clarrie Hall Dam	x		x	x

Water quality objectives for estuaries

For all estuaries the water quality objectives included protection of aquatic ecosystems, visual amenity, recreation (primary/secondary contact) and aquatic food (cooked) and commercial shellfish production. The river flow objectives included maintaining wetland and floodplain inundation, manage groundwater for ecosystems, minimise effects of weirs and other structures, maintain or rehabilitate estuarine processes and habitats and maintain natural flow variability.

Ongoing water quality problems occur in estuaries from the nutrients and other contaminants in stormwater and sewage outflows as well as release of highly acidic waters from acid sulfate soils areas. In particular dredging and drainage works on the floodplain continue to result in disturbance of acid sulfate soils with resultant water quality problems. The Shellfish Quality Assurance Program conducts regular monitoring of estuarine water quality as part of actions to support commercial shellfish production.

Water quality objectives for uncontrolled streams

The water quality objectives for uncontrolled streams included the protection of aquatic ecosystems; visual amenity; recreation – primary and secondary contact; water supply – livestock, irrigation, homestead, domestic drinking water and aquatic food (cooked). The river flow objectives included:

- Protection of natural low flows and ponds in dry times
- Protection of important rises in water levels
- Maintain wetland and flood plain inundation
- Mimic natural drying in temporary waterways
- Maintain natural flow variability
- Manage groundwater for ecosystems
- Minimise effects of weirs and other structures.

2.2 Water supply issues

An abundant supply of good quality water available on a permanent basis is essential for land based aquaculture. In evaluating a potential water supply, seasonal changes in quantity and quality must be considered. The cost of purchasing water as well as supplying it to the site may be a major limiting factor to the economic feasibility of a particular site. Pumping costs can be high and should be minimised. Options for gravity flow on a site should be maximised, as it is efficient and cheap. This should be kept in mind when evaluating a site and layout options.

(a) Water quality suitable for aquaculture

In evaluating the acceptability of a water supply, consideration could be given to whether the supply is reliable and:

- Free of organic, agricultural or industrial pollution (pesticides, heavy metals)
- Free of suspended particles - need to check particulates -composition (organic and inorganic), size, concentration, likely seasonal variation
- Relatively constant temperature - need to check temperature range (daily and seasonal variations)
- For estuarine farms, relatively constant salinity range - need to check tidal and seasonal salinity, pH and alkalinity variation
- Free of pathogens, trash fish and other undesirable aquatic organisms.

For the production of healthy fish and the maintenance of good water quality on the farm, the source water to be used in the ponds should meet the criteria set down in the ANZECC Water Quality Guidelines (1992) for protection of aquatic ecosystems and the protection of human consumers of fish and other aquatic organisms. The guidelines give levels of physico-chemical parameters that would be required to maintain a viable natural aquatic community. The ANZECC Guidelines[1] also provide guidance relating to levels of organic contaminants that may cause tainting of the products.

[1] *Australian Water Quality Guidelines for Fresh and Marine Waters*, National Water Quality Management Strategy, Australian and New Zealand Environment and Conservation Council, Canberra

Table 13. Water Quality Indicators for Aquatic Ecosystem

Based on EPA's Guidelines for River, Groundwater and Water Management Committees (1999)

Water quality indicator	Criteria	Comment
Total phosphorus	Rivers and estuaries : 10-100ug/L Lakes & reservoirs: 5-50 ug/L EPA recommendation interim level for estuaries and coastal lakes: 10-20ug/L	Understanding the different forms of P (eg the proportion of P in water that is available for plant growth) is important in managing unfavourable plant/algae response.
Total Nitrogen	Rivers and estuaries : 100-750ug/L Lakes & reservoirs: 100-500 ug/L Current range for estuaries and coastal lakes: 150-300ug/L	Understanding the different forms of N is important in managing of different situations.
Chlorophyll-a	Bays and estuaries : 1-10ug/L Lakes & reservoirs: 2-10 ug/L	
Turbidity	Estuaries and coastal lakes <5 NTU Increase in suspended solids should be limited. <10% change in seasonal mean NTU EPA notes that 5-20 NTU typical in fresh water	Common water quality descriptors < 5 NTU – low turbidity & high clarity 5-25 NTU medium turbidity 25-50 NTU high turbidity >50 NTU very high turbidity
Clarity	For waters deeper than 50% of the euphotic depth, the euphotic dept should not change by more than 10% for an established seasonal norm.	For water shallower than 50% of the euphotic depth, the maximum reduction in light at the sediment bed should be < 20%
Salinity (EC)	Freshwater: < 1500 uS/cm Non-degradation of current levels	
Dissolved oxygen	> 6mg/L or 80-90% saturation, being determined over at least 24 hours (or few days) to establish the diurnal range in concentration)	
pH	Fresh water: 6.5-9.0 Marine waters: < 0.2 pH unit change	Change of more than 0.5 pH units from the natural seasonal maximum or minimum should be investigated
Temperature	< 2^{o}C change in natural temperature levels	
Chemical contaminants	See ANZECC (1992) Guidelines [3]	Waters should be free of pollutants in amounts or combinations that are toxic to humans, animals, plants and other organisms.

If the water supply does not meet these criteria, then an assessment should be made of the potential effect of non-compliance with the parameters is likely to have on the selected species at all stages of the life cycle, eg. an animal may be able to live and grow in pH of 6.0, but the eggs and larvae may not survive.

In some waterways, the water quality may meet the criteria for protection of the aquatic communities, but not meet the guidelines for human health eg. arsenic may be found at levels of 50ug/l for protection of aquatic communities, but only 0.2ug/l for human health. The reason behind the different standards is the potential bioaccumulation of some of the contaminants in the organisms. This can potentially increase low levels of contaminant to levels that can cause health concerns in people consuming the product.

Table 14. Metal Contaminant Indicators

Indicator	Aquatic Community		Human Health	Potable
	Fresh water	Marine water		
Arsenic	50.0	50.0	0.02	50.0
Beryllium	4.0	NR	0.1	
Nickel	15-150	15	100	100

(b) Estuarine water supply

Tidal exchange

The *Estuarine Aquaculture Maps* identify sites adjacent to waterways that tend to have water quality satisfactory for a water supply source. Careful consideration needs to be given the potential for high levels of freshwater runoff likely to affect salinity, sediment levels, pH, alkalinity and other water quality characteristics. More detailed investigations should be undertaken to determine if there is good tidal exchange and circulation and if the water quality is able to recover quickly to consistent good water quality following rain events.

Preferred location: Tidal flushing time of < 15 days

Tidal amplitude

Water intake sites should be in an area of good water ventilation. Channels which have an exchange due to tidal action of greater than 30 days are considered to have poor exchange. Poorly ventilated areas may be adversely and significantly impacted by adjoining floodgates and land runoff. An indirect measure of ventilation is tidal amplitude. Tidal amplitude is defined as:

MHWN - MLWN

where MWHN = Mean High Water Neap, and
MLWN = Mean Low Water Neap.

This attribute uses tidal plane analysis sheets derived from recording stations situated on the river systems. The data is administered by Manly Hydraulic Laboratories in Sydney. Generally tidal amplitude will diminish further up river systems and where restriction to tidal movement occurs such as narrow/shallow channels and sand bars. Sites with a tidal amplitude of less than 100mm should undergo a full assessment prior to making a decision that the site is suitable in the long term.

Preferred location: Tidal amplitude > 300 mm

Access

The site selection process requires consideration of whether the potential inlet sites will require a change to the estuary channel eg require sump or deepening or other disturbance of the bed of the estuary.

Preferred location: Require no deepening of the estuary for pumping station

Adjacent land and water uses

Sites down stream of land uses likely to result in poor water quality should be avoided, eg downstream of sewage treatment works, town storm water overflows, near heavy agricultural pesticide use or high levels of recreational boating activities.

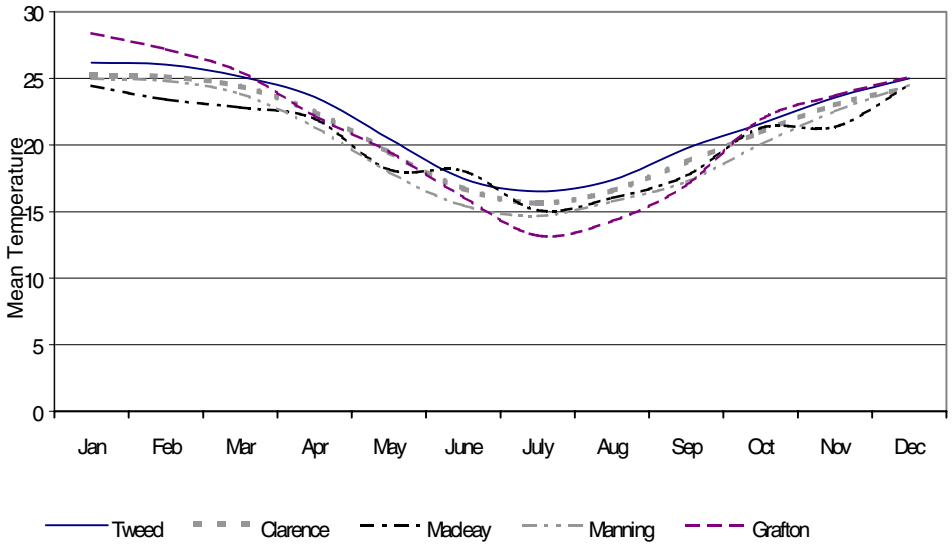
Consideration should also be given to whether the location of inlet and outlet sites are likely to affect the water quality or flows of other water users, in particular whether any changes in water quality are likely to affect oyster growers, aquatic ecosystems and recreational users up stream and down stream of any discharge site.

Preferred location: Not affected by poor water quality or likely to affect other users with poor water quality

(c) Water temperature

Water temperature is a key limiting factor in the selection of species and the location of aquaculture facilities.
Pond/tank freshwater supply

Figure 4. Average Monthly Water Temperature



Water for freshwater fish farms can be drawn from sources such as streams, on-site dams, underground bore water or town supply providing the relevant permit/entitlement can be obtained. Most streams are now under an embargo, which means that water entitlement in most catchments must be purchased from another water user usually an irrigator. For advice on the availability of entitlements, contact the local stock and station agents or consult *Waterexchange.com* on the likely availability of water in the catchment.

In some areas, while access to groundwater is generally embargoed, there are some groundwater aquifers that are not yet under an embargo. In these areas the current level of water usage is relatively small and the environment is not degraded. For these water resources, water licences may be obtained from the Department of Land and Water Conservation by application. It is essential that the ground water supply be evaluated for reliability of flow, demands of other competing users, vulnerability, depth and cost of access and quality.

Preferred location: Irrigation licence approved or available for water extraction

Reliability of supply in dry periods is a critical issue in assessing alternative sites. In some systems, water may only available during high flows (when water quality may carry high levels of sediment). For projects with restricted access, an on-site storage and settlement system should be considered.

Preferred location: No access restrictions based on flows in normal conditions

In addition it is preferable for water pumps to be located in stretches of rivers where modifications are not required to the rivers bed or banks in order to install a pump system which will have reliable access to water.

Preferred location: Require no deepening of the river for pumping station

It should be noted that a water licence is required to install a pump, construct a levee, divert the river flow or install a bore or piezometer. A licence must also be obtained for the containment of more than 10% of overland flows across a site. However because of rainfall variability, any venture using rain run-off as the major supply (ie. catchment and storage in a reservoir on the farm) should seriously estimate the water budget and storage requirements and consider establishing a contingency back-up water supply in the case of extended dry conditions. Under the new Water Act, a licence may be required for a change of use from irrigation to aquaculture.

(d) Potable water for processing and other purposes

As well as having a reliable supply of quality water for the pond/tanks, it is also essential that there is a reliable supply of potable water for processing, purging and employee uses. The quantity required will depend on the nature of the operation. The water must meet "potable" drinking water standards set out in the National Drinking Water Standards.

Preferred location: Existing reliable potable water or access to mains water

(e) Multiple use of recycled freshwater pond/tank or processing water

When selecting a site, the potential for multiple use of the water on the farm or by a neighbouring water user should be considered. There could be significant economic and environmental benefits, if a multiple use approach is taken. While water should be recycled and re-used a number of times in ponds/tanks within the farm, it is recommended that other water uses (such as hydroponics, horticulture or irrigated agriculture) be integrated with the operation to allow for regular exchange of water. In some cases it may be possible to on-sell/ transfer the recycled water to neighbouring water users. Any irrigation schemes associated with aquaculture should be seen as a substitute for "raw" water and not as wastewater disposal schemes.

(f) Avoid drinking water catchment

Sites within an identified drinking water catchment area (eg land mapped or nominated as "special or protected areas" by the County Council or water supply authorities) should be avoided.

Preferred location: Site not within a prescribed drinking water catchment

SURFACE WATER ACCESS RULES

Riparian Rights

Riparian Rights only apply to landholders with river frontage. Currently water can only be extracted without a licence for stock and domestic purposes to water up to 4 hectares of land. This water is not available for commercial aquaculture production. It is a subsistence right. If the product using this water is to be sold, a water licence should be obtained. This right has been reviewed as part of the new Water Act review and is to be limited to small volumes generally less then 2 megalitres equating to normal house and stock drinking use.

On-Farm Dams

The Dams Policy applies to all landholders who have a right to harvest up to 10 % of runoff from their properties without a water license, metering or charging. Water under the policy can be used for any purpose including aquaculture. The policy applies to dams constructed on hillsides and 1st and 2nd order streams, but not on permanent flowing streams. The 1st and 2nd order streams are defined by the blue lines on the 1:25,000 topograhic maps. The amount of runoff varies with rainfall and maps are available from DLWC for the various regions. Using a self-assessment kit, landholders simply take the harvestable right contour line near their property and multiply it by the area of their property to calculate dam capacities.

Extraction Licences from rivers

All catchments from the Tweed to the Hastings currently have surface water licence embargoes. There are no new Surface Water Licences under sections 10, 13A, 18F, 20B, 20CA or 20L of the Water Act available with the exception of a special exemption for aquaculture and town water supplies. The embargo exemption for aquaculture allows new licences up to 200 ML's to be issued (Note the most common aquaculture licence application on the North Coast presently is 60 Megalitres). These licences will have access conditions that will generally limit access to higher flows. DLWC is currently using the stressed rivers assessment to determine access rules. In the future water management plans being prepared by Water Management Committees will provide the parameters. Enterprises needing licences above 200 ML will need to be bought on the water trade.

The Manning Catchment currently is not embargoed except for two small areas in the Dingo-Caparra catchment and the Gloucester River above Gloucester. Apart from these areas new licences are available. Most aquaculture in this area is developing from diversification through using existing water licences.

2.3 Groundwater

The NSW State Groundwater Protection Policy (1998) should be consulted on the principles and issues to be considered relating to groundwater, for example

- Groundwater quality and vulnerability
- Threats and protecting the resource
- Conservation of water resources

.

GROUNDWATER WATER ACCESS RULES

Under section 116 of the Water Act, anybody using a bore or well must have a groundwater licence. Currently there are no groundwater embargoes on the North Coast.

- However, embargoes are currently being considered in the Stuarts Point near Kempsey and in some sections of the Altonsville Groundwater Management Area.
- Similarly, because of the ecological and acid sulfate soil issues in the Maria River area near Port Macquarie, the Department will generally require a full assessment for any proposed works affecting groundwater. See Table 15
- Similarly, bores on floodplains over acid sulfate soils will need considerable environmental assessment to convince the DLWC that the groundwater extraction is not going to lower the water table leading to an acid sulfate water issue.

Table 15. Assessment regime for groundwater

Situation	Site Selection Assessment required
In areas where groundwater is not vulnerable because of the depth, overlying geology and where there are no obvious sources of contaminants and no ASS present (as indicated in DLWC Maps)	**No assessment** necessary
In areas which have groundwater of "low" value which may be vulnerable and where there are no obvious sources of contaminants	**A Professional Opinion** is required in relation to the nature of the groundwater resource and the risk the development places on the resource
In areas where there may be a potential risk to groundwater or the environment	**A Desk Study** is required showing the nature of groundwater resource, pollution risk, effect of any barriers to pollution flow, either natural or engineered. Calculations showing level of environmental risks based on existing knowledge of the site
In areas where the desk study indicate that there are potential risks to the environment.	**Limited Site Studies** are required with soil and water testing to establish a baseline and to confirm the characteristics of the resource and to determine the likely effectiveness of barriers or other possible measures (natural or engineered) to protect the resource.
In areas where there are significant risks to quality groundwater as indicated by the desk study or the limited site studies	**Extensive Site Studies** are required with soil and water testing and modelling of the groundwater flows and quality to predict the likely effectiveness of the barriers and other design and planning options to prevent degradation of the resource.

(a) Groundwater vulnerability

The quality of the underlying groundwater should not be put at risk by the pond management, in particular where the saline ponds are underlain by fresh water aquifers. Groundwater that may be used for drinking or irrigation supply must be protected from contamination. Of particular concern is the potential contamination of groundwater by nitrogen compounds, salts, chemical contaminants and microorganisms.

The DLWC has published groundwater maps for some areas on the North Coast that identify areas where the groundwater is of good quality and may be vulnerable to contamination from various landuses. These areas could be considered to be high risk in terms of location of ponds. Technical advice from recognised consultants or the DLWC should be sought on the suitability of sites and potential impacts on groundwater.

Preferred location: No underlining potable or high quality fresh groundwater within 3 metres

Where there are risks to groundwater from saline ponds because of the proximity or the vulnerability, the site evaluation should be based on the principles set out in National Water Quality Management Strategy: Guidelines for Groundwater Protection in Australia (ARMCANZ & ANZECC 1995). During the site selection process, baseline groundwater chemistry may need to be established so that monitoring can determine if future deterioration of groundwater quality is occurring as a result of the project.

(b) Groundwater and ASS

In areas where there is acid sulfate soils, the management of groundwater is critical in minimising the generation and export of acid into the ponds or neighbouring environment. Preferably the project should lead to no increases in the generation of acid either from the disturbance of acid sulfate soils or the lowering of the groundwater levels. It is critical that there is a clear understanding of the likely implications to any change to the groundwater in terms of acid generation and appropriate measures built into the project to mange the acid generated.

Preferred location: No lowering of the groundwater levels in ASS areas

(c) Groundwater and pond security

In addition the potential for aquaculture ponds seepage putting the groundwater at risk, the groundwater could put the successful operation of the aquaculture ponds at risk. Sites with high groundwater are high risk for pond construction and management. It can be difficult to build the ponds and maintain the integrity of the walls where there is high or rising groundwater. If ponds are built in these areas, they may not be able to be adequately drained and dried, steps which are necessary for efficient pond management.

Preferred location: Not located in areas of high groundwater.

2.4 Surface hydrology issues

(a) Tidal issues

When assessing potential sites, the potential increase in the tidal flow and subsequently the tidal prisms in the estuaries and creeks from the inlet/outlet flows should be considered. In addition, consideration should be given to whether the construction and operation of the aquaculture ponds is likely to result in changes in the tidal inundation patterns on nearby land or wetlands.

(b) Flooding issues

Sites that are flood prone should be avoided. If unavoidable, then a detailed risk assessment should be undertaken. As well as the risk to the investment from flooding of ponds, tanks, plant and equipment and the loss of stock, these sites pose a potential risk to the environment if there is an escape of non-indigenous fish species, disease or nutrient enriched waters.

Preferred location: Site not flood liable – Freshwater above PFM
– Estuarine above 1:100

In addition the construction of banks, levees or above ground ponds which are likely to affect flood flows patterns can pose an increased risk to neighbours and possibly the catchment flood mitigation controls. Prior to the selection of a flood prone site, an analysis of the catchment flooding implications should be undertaken and discussed with DLWC and Local Council.

Preferred location: No potential for flood management measures to effect passage of flood waters or neigbouring properties

(c) Stormwater issues

In addition to flooding impacts, consideration should be given to the effect on local stormwater issues. The sites within a stormwater drainage passage can result in problems for management and maintenance of the facilities as well as local flooding problems for neighbouring properties. It is preferable that there is no major stormwater drainage across to the site. If unavoidable, there should be sufficient space to design measures to manage the flows so as not to affect neighbouring properties or ecosystems.

Preferred location: Not located on a local stormwater drainage channel

(d) Waterway protection

The site should provide for adequate setback or separation between the facility and any natural waterbodies so as to avoid disturbance of riparian vegetation, to allow for natural hydrological processes and to avoid accidental contamination during storm events if there is an incident. It should be noted that in many areas, Aboriginal heritage items are more likely to be located within 200 metres of waterways. With indigenous species, there should be capacity to have at least 50 metres distance between the ponds/tanks and the waterways. With barramundi and other high security species, a set back of 500 metres distance is required for both grow-out and effluent culture units.

Preferred location: All ponds > 50 metres from the top of the high bank (except for high security species which should be 500 metres setback)

3. Elevation and topography

(a) Elevation

For estuarine ponds, the height above sea level of land is a good indicator of a number of important factors such as:

- Land above 2 m AHD is less likely to contain acid sulfate soils and land below 1 m AHD is likely to have significant acid sulfate soils issues.
- Ponds on land located higher than 10 m AHD will involve expensive pumping costs
- Tidal and flooding inundation is likely to occur on land below 1 m AHD
- Ponds on land below 1 m AHD are likely to have problems with draining and drying and ASS.

Preferred location: For estuarine ponds, land located between 2-10m AHD

(b) Landform

Preferably, the land should be relatively flat with few undulations or sloping gently. The slope of the land will influence the most economical dimensions for the ponds and the drainage system. It is preferable that the site will allow for the location of a water recycling dam below the growing ponds for ease of drainage and treatment and should be constructed so as not to cause scouring.

Greater emphasis need to be placed on the topography of the site for high security species with translocation concerns.

Preferred location: Slope should be : less than 2% (estuarine);or
less than 5% (freshwater).

The topography can also be an important factor if pond discharge water is to be used on site for irrigated crops. Attached is a table of characteristics to be considered in assessing site.

Table 16. Landform Requirements for Irrigation Systems

	Limitation			Restrictive Feature
	Slight	Moderate	Severe	
Slope for • surface or underground	<1	1-3	>3	Excess runoff and erosion risk
• sprinkler	<6	6-12	>12	
• trickle/microspray	<10	10-20	>20	
Flooding	None or rare	occasional	frequent	
Land form characteristics	Crests, convex slopes and plains	Concave slopes and footslopes	Drainage lines and incised channels	Erosion and seasonal water logging risks

4. Soil characteristics

4.1 Selecting sites if ponds or dams

(a) Soil characteristics

The soil characteristics of the site will influence construction costs as well as long-term maintenance and management costs. The availability of suitable soils will determine the type of embankment to be constructed and the construction methods. Advice on the suitability of soils for pond construction should be sought from appropriate authorities such as the soil specialists at the Department of Land and Water Conservation (DLWC). In many cases, DLWC may have available relevant soil survey information or maps to provide detailed information on the soil characteristics of particular sites. In other cases, some soil survey work may need to be undertaken to provide adequate Tier 2 evaluation information.

With high security species with translocation concerns, the assessment of the suitability of the soil for pond or dam construction is essential.

Preferred location: Soil clayey (soil/sand mix) with low erosion potential

As ponds and water storage/ recycling dams should be constructed of impervious soils to eliminate or reduce the loss of water by seepage, sites with clay or clay loam soil characteristics are ideal. Ponds can be constructed in sandy or other porous soils but the cost of lining the bottom and sides with clay will add a significant extra cost to construction. It is preferable that at the Project Profile Analysis Tier 2 evaluation phase, sufficient site data should be available to determine if there are likely to be any gravel or sand layers, rock strata and other soils characteristics that may interfere with water-holding qualities and hence add to the costs of construction.

When evaluating the site for saline pond culture in areas with highly permeable soil, the risks of infiltration of saline water into any underlying groundwater should be considered at the Tier 2 assessment. In areas where the underlying groundwater is fresh, the site should be considered to be high risk.

For sites with highly dispersive or flocculative soils, additional erosion controls and other measures to prevent dam wall failure through “tunnelling” will need to be factored into the costs. Dam liners are recommended.

(b) Soil contamination

The previous land use is also a risk factor that should be considered. If the land was previously used for crops, the soil should be tested for accumulated pesticide residues. Soil contaminated with agricultural chemicals should be avoided.

A review of pesticide use in the Clarence, Richmond, Brunswick and Tweed catchments indicated that a broad range of chemicals are being used mainly organophosphate, carbamates and synthetic pyrethroids (Smith & Associates 1995). An indication of the major pesticide users in the Clarence and Tweed are in the table below.

Table 17. Agricultural Pesticide Use in the Clarence & Tweed Study Area.

Industry	Total Active Ingredient used (kg/an)
Banana	3464
Beef and dairy (dips)	1080
Avocado	25195
Macadamia	66701
Maize	5059
Potato	4738
Soy bean	8163
Sugar cane	48587
Tea tree	2380
Weed control	Not available

Preferred location: No soil contamination from previous land uses or remediated so suitable for residential or animal occupation

(c) Acid sulfate soils

In estuary areas, high-risk acid sulfate soils (ASS) should be avoided on two counts. Firstly, the disturbance of the sulphidic material could result in the production of acid damaging to the aquaculture operations as well as to the surrounding environment. Secondly, sulphidic muds have poor load bearing characteristics and are could subside under load once ponds are filled.

The ASS Risks Maps provide details on the likely risks that acid sulfate soils are present given the broad range of soil characteristics. In addition these maps provide information on elevation and soil/landscape characteristics. The risk approach in the ASS Maps provides a useful tool for identifying areas where aquaculture ponds could be high risk, where the risks are more easily managed and areas where there is nil risk. Any likely sites on ASS soils should be evaluate using methods in the ASS Manual (ASSMAC).

Preferred location: Where there are no acid sulfate soils, or ASS Landform Process Class A with Landform Element class b, l, t, p, y or w

4.2 Soils for irrigating recycled water

If irrigation of recycled pond water or processing wastewater is proposed the suitability of the soil for crops or tree plantations should be considered. Factors such as fertility, permeability and slope should be taken into account in the context of the method of irrigation and the type of crop. All relevant soil characteristics should be fully established when designing an irrigation system.

Preferred location: For freshwater recycle systems, soil suitable for irrigated agriculture

SOILS SUITABILITY FOR IRRIGATION

Soil salinity

Soil salinity refers to the amount of dissolved salts in the soil solution. Soil salinity levels are usually determined by measuring the electrical conductivity (EC) of a soil suspension, which estimates the concentration of soluble salts in the soil. High concentrations of soluble salt in soil are not desirable for most plants and also affect land use and increase potential for soil erosion.

Soil sodicity

Soil sodicity refers to the amount of exchangeable sodium cations in the soil and is expressed in terms of exchangeable sodium (Na) percentage (ESP) or Sodium adsorption ratio (SAR). Dispersion is associated with sodicity levels. For practical purposes, soil or water sodicity is the measurement of sodium ions in soil or water relative to calcium and magnesium ions.

Cation exchange capacity

The cation exchange capacity (CEC) of a soil is the total number of cations it can retain on its adsorption complex at a given pH. CEC is a major factor controlling soil structure, nutrient availability for plant growth, soil pH and the soil's reactions to fertilisers, contaminants and other soil ameliorants. Soils with a low CEC may be improved by the addition of organic matter.

Exchangeable cations

The principle exchangeable cations in soil include Ca2+, Mg2+, K+, Na+ (exchangeable bases), and H+ and Al3+ (exchangeable acidity). It is common practice to measure the concentration of these five most abundant cations and express them individually as a percentage of the CEC.

Desirable levels of major soil cations for many plants

Cations	% of CEC
Calcium	65-80
Magnesium	10-15
Potassium	1-5
Sodium	0-1
Aluminium	<5

Source: NSW Agriculture and Fisheries (1989)

Soil nutrients

Soil nutrient concentrations should be determined before establishing an irrigation scheme, since they can influence the amount of additional nutrients that can safely be applied in the discharge or waste water. The composition of nutrients taken up by the crop may also be determined at key stages of crop growth to ensure that nutrient balance is maintained.

Soil phosphorus

Most unfertilised Australian soils contain less than 0.02% phosphorus. Much of it is immobilised in forms not readily available to plants such as organically bound P and insoluble mineral P. There are three main sinks for phosphorus within an irrigation area: soil adsorption, organic matter and plant uptake. Soil minerals can adsorb inorganic orthophosphate ions. The amount of P adsorbed at a given P concentration over a fixed period of time is known as phosphorus sorption capacity (PSC). The soil's capacity to immobilise available P depends on the concentration of hydrous oxides of iron and aluminium, and calcium carbonate and their relative surface areas. Soils high in such oxides tend to have high sorption strength.

Soil nitrogen

Nitrogen is the nutrient required in the largest amounts by a crop. The addition of N to soils in excess of the agronomic rate of N uptake at a crop site results in the potential for NO_3-N contamination because NO_3-N is not easily adsorbed by the soil particles and will move downward as water percolates downward through the soil profile.

Organic matter

Organic matter has an important effect on soil fertility. Considered the "life blood" of productive soil, it is both living (microorganisms) and decaying matter. It plays a crucial role in improving soil structure, recycling and storing plant nutrients, holding water and buffering changes in acidity and alkalinity. The organic matter content in soil may range from 1-10% by weight, depending on the soil type, soil moisture content and type of vegetation grown. When land is cleared and cultivated, the organic matter content of the soil becomes depleted. Over time, fertility will become exhausted unless this organic matter is replenished. Around 75% of Australia's surface soils have less than 1% organic matter.

5. Local climate and air quality

The local climate can be an important factor in site selection.

Growing cycle

The seasonal variation in air and water temperature can have a significant impact on the growing cycle of many aquaculture species and should be considered in evaluating alternative sites within the North Coast region. (See Water Temperature)

Design and construction issues

The prevailing wind direction and air movement patterns along with the local topography should be considered as consistent air circulation assists in the aeration of the ponds. In evaluating sites, rainfall patterns including storm intensity, timing and frequency need to be considered in terms of their impacts on the design of ponds, dams, stormwater drains and flood management facilities. Seasonal climatic patterns including severe storm events should be considered in construction timetables as they could add significantly to the construction costs and environmental management measures for some sites.

Effect on environmental performance

Noise and odour impacts are likely to be more of an issue in areas that experience local temperature inversions, particularly where there are existing odour or noise issues from other industries. The existence of other industries with the potential for cumulative impacts in the air catchment should be considered at the site selection stage.

Effect on irrigation schemes performance

Temperature, humidity and wind patterns will affect plant growth, evapotranspiration or crop water use and hence will have a bearing on the design of irrigation schemes to use the discharged pond water. Ideally, a location where monthly evapotranspiration consistently exceeds net monthly rainfall provides the best climatic regime for effective irrigation schemes. High rainfall areas are acceptable, provided adequate storage is available

6. Ecological factors

6.1 Terrestrial ecology

The existing land use and vegetation on the site is an important factor in evaluating potential sites. Sites should be selected so as to minimise the need to clear native vegetation including native grasses. If more than 2 ha of native vegetation is to be cleared, generally an approval will be required from DLWC. Vegetation Plans are being developed for the North Coast Region that will identify vegetation communities of importance and develop protocols for clearing in the region.

Preferred location: No native vegetation present on the site or if present, no disturbance of the native vegetation is required

6.2 Aquatic ecology

The risks to native species within the catchment from the escape of stock or disease from the water exchange (estuarine only) or from flooding should be considered when selecting a location. These issues are considered in the Species Selection section. However they are also listed here as a site selection factor as the preferred species may have locational constraints. For example, there are restrictions on the growing of Murray Cod in the Clarence and Richmond River catchments so the sites in those catchments would not be acceptable.

Preferred location: Species indigenous to the catchment and if not, then consistent with the NSW Fisheries Translocation Policy

With estuarine sites, consideration should also be given to the likely risks to native aquatic species from the location of intake and outlet systems or from overtopping during flooding which could result in the escape of stock or release of disease. This could be a particular constraint if the site is near oyster farms or important fish nurseries or habitat.

Preferred location: No likely disturbance of mangroves or aquatic habitat.

6.3 Predators

The feeding, breeding, roosting or migratory activities of birds in the vicinity of potential sites should be evaluated for the potential for conflict with the management of the ponds. Sites near areas where predator birds congregate should be avoided as the long-term costs in terms of loss of fish or in mitigation measures can be very significant. (See *Planning and Design* section for a more detailed discussion on avoidance of predator problems and predator management). Water rats can also be nuisance predator.

Preferred location: Not adjacent to wetlands or other likely habitats of predator species.

6.4 Threatened species

In the Threatened Species Conservation Act and the Fisheries Management Act, there are lists of threatened species, population and ecological communities and critical habitats that are protected under these acts. The NPWS maintains a GIS database that lists recordings of the occurrence of threatened species in a particular region - *Atlas listing of Fauna and Flora*

Records in NSW (Contact: Data Licensing Officer (02) 9585 6684). A search of the NPWS Wildlife Atlas (which only contains species and not populations or communities) may be undertaken for the study areas to provide an early warning of the likely occurrence of threatened wildlife species, on or near the site. The Wildlife Atlas does not represent a comprehensive list of threatened species in an area and there may be unrecorded threatened species present. Councils may also have lists of species, population and ecological communities occurring in their local government areas as a result of studies undertaken in the preparation of local environment plans or other strategies. In addition Council may be aware of 8 Part Tests or Species Impact Statement (SIS) prepared by other applicants on nearby land which could provide useful data.

As with terrestrial ecology, consideration should be given to whether threatened aquatic species, populations or communities and their habitats are likely to be affected. NSW Fisheries should be contacted to determine if any threatened species, populations or comminutes have been recorded occurring in the particular estuary or river.

At the site selection stage, it may not be necessary to undertake a full 8 Part Test (necessary prior to lodging a Development Application to decide if a SIS is required), but the general issues in the 8 Part Test should be considered when evaluating different sites.

Preferred location:	No likely disturbance of threatened species, populations or ecological communities or their habitats or critical habitat listed under the Threatened Species Conservation Act or the Fisheries Management Act.

THE 8 PART TEST

The following factors must be taken into account in deciding whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitat:

a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction,

b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised,

c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed,

d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community,

e) whether critical habitat will be affected,

f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region,

g) whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process,

h) whether any threatened species, population or ecological community is at the limit of its known distribution.

6.5 Conservation sites

Sites of high conservation value should be avoided. Conservation sites include:

- ***Coastal Rainforest*** especially SEPP 26 – Littoral Rainforest and ***Wetlands*** especially SEPP 14 – Coastal Wetlands and any RAMSAR wetlands, riparian vegetation, mangroves, seagrass beds. Currently there are no listed Ramsar Wetlands in the North Coast Region. However it should be noted that **Important Wetlands In Australia** (Briggs) list Barrington Tops Swamps, Bundjalung National Park, Clarence River Estuary, Clybucca Creek Estuary, Crowdy Bay National Park, Everlasting Swamp, Lake Hiawatha and Minnie Water, Limeburners Creek Nature Reserve, Swan Pool / Belmore Swamp, The Broadwater, Upper Coldstream, Wallis Lake and adjacent estuarine islands and Wooloweyah Lagoon.
- **Habitat of Migratory Species** protected under CAMBA and JAMBA international agreements. The full list of species can be seen on the Internet. They include CAMBA species such as Cattle Egret Bubulcus ibis (Ardeola ibis), Great Egret (Egretta alba), Eastern Reef Egret (Egretta sacra), Glossy Ibis (Plegadis falcinellus), White-bellied Sea-eagle (Haliaeetus leucogaster) and Sarus Crane (Grus antigone) and JAMBA species such as Red-faced Cormorant (Phalacrocorax urile), Oriental White Stork (Ciconia ciconia boyciana), Japanese Crested Ibis (Nipponia nippon), White-tailed Sea Eagle (Haliaeetus albicilla albicilla), Steller's Sea Eagle (Haliaeetus pelagicus pelagicus), Goshawk (Accipiter gentilis fugiyamae) and Japanese Crane (Grus japonensis).
- ***NPWS protected areas*** including National Parks, Nature Reserves and Historic Sites, Aboriginal Sites.
- ***World Heritage Area*** of the Barrington Tops of the Central Eastern Rainforest Reserves, including Richmond Range, Nightcap Range, Iluka NR, Washpool & Gibraltar Range, New England, Hastings-Macleay, Barrington Tops. Please note that a project does not need to be in or next to a World Heritage area to have an impact eg development in a catchment of World Heritage area could significantly affects water quality and quantity in the World Heritage area.
- ***Marine Parks***: At present Solitary Island Marine Park which extends from Coffs Harbour to Arrawarra is the only marine park in the North Coast Region. A marine park at Cape Byron is under investigation by the Marine Parks Authority. Aquaculture is permitted in marine parks where it can be demonstrated that the activity is environmentally sustainable and does not impact adversely on the marine park environment or its flora and fauna. The zoning plan for each park, and the consultation process involved in its development, will determine where and when aquaculture (and any other similar activities) will be permitted.
- ***Aquatic Reserves:*** Julian Rocks Aquatic Reserve, Byron Bay (approximately 80 ha) is the only aquatic reserve in the North Coast Region and it provides protection for important sensitive fish habitat as well as providing unspoilt natural sites for recreation, eduction and research. Line fishing is permitted in the reserve though disturbance of marine vegetation or habitat is prohibited.

Preferred location:	Not located adjacent to or with the potential to disturb conservation sites

7. Native title issues

An aquaculture proposal relating to Crown lands subject to a Commonwealth Native Title Claim/ NSW Aboriginal Land Claim Applications can not proceed until the claims are resolved. The Native Title Claims can take a long periods to resolve.

Most vacant Crown land on the North Coast is now under one claim or more. Generally, claims under the NSW Land Rights Act are granted unless an essential public use of the lands can be proved. The whole of the Clarence River estuary is presently under Native Title Claim.

Aquaculture applications that need to cross Crown land (subject to either of these claims) to gain access to water supply, should be avoided unless agreements can be made with the claimants. However, unless the works are likely to adversely affect the estuary, it could be expected that the claims would be unlikely to stop access across Crown land to waterways.

8. Heritage issues

If the land was previously cleared and used for agriculture it is less likely that heritage items will be located on the site. The heritage significance of any built and non-built items on the site should be considered at the site selection stage to reduce delays later associated with gaining approvals to change the heritage significance of an area. Generally a 2-step process should be followed if heritage items are suspected of occurring on the site:

Step 1: collate information from the following sources:

i) consult relevant heritage or historical research on the area
ii) consult with the local council, the Aboriginal community (through NPWS) and local historical societies
iii) inspect existing heritage registers, databases or lists including :
- in LEPs and REPs (North Coast REP has a heritage component)
- in Heritage Studies prepared by a local council
- on State Heritage Register for items protected under the Heritage Act or subject to Interim Heritage Orders or s.136 Orders.
- on the National Trust Register
- on NPWS Aboriginal Sites Register,
- in Shipwrecks Atlas (if affecting an estuary or its banks),
- on Register of the National Estate (Australian Heritage Commission).

Note: The Heritage Office maintains a computerised *State Heritage Inventory* with listings of items protected under the Heritage Act and LEPs and REPs that can be searched on www.heritage.nsw.gov.au.

Step 2: survey the area likely to be affected, to identify any items of potential heritage significance.
- Reference should be made to the *Aboriginal Cultural Heritage Standards and Guideline Kit* for guidance on methodology for surveying, identifying and assessing the importance any Aboriginals sites
- Reference should be made to the *NSW Heritage Manual* 1996 for guidance on methodology for surveying, identifying and assessing the importance any non-Aboriginals sites.

8.1 Aboriginal heritage

In certain areas, aboriginal heritage site or items are more likely to be located near waterways. For example in some areas, 90% of Aboriginal heritage items or sites are found within 200 metres of the foreshores of creeks and estuaries. A search should be undertaken of the NPWS Aboriginal Sites Register to determine whether any Aboriginal sites have been recorded on or adjacent to the proposed land. If the search of the Register yields no sites, it does not necessarily mean that there are no sites present. The Register is, nevertheless, an important first step. The State Heritage Inventory should also be checked as Aboriginal heritage items may also be protected under the Heritage Act. Early consultation with the local Aboriginal community and/or Land Council could also provide valuable information on the area and the likely occurrence of Aboriginal heritage sites or items.

The NPWS charges a fee of $35 for each search of the Register (Contact: (02) 95856471). All search requests should clearly identify the land and state the reason for the request, ie, to accompany an aquaculture application in accordance with the North Coast Sustainable Aquaculture Strategy. The results of the search will be forwarded via the relevant NPWS regional office along with advice on the level of Aboriginal heritage assessment required. In determining the appropriate level of assessment, the NPWS considers a range of factors including:

- the results of the Aboriginal Sites Register search,
- reference to general archaeological models relating to Aboriginal site locations within a given area, and
- the views of the local Aboriginal community.

Applicants should at the time of making a request with the NPWS Aboriginal Sites Register also forward a letter of notification to the Aboriginal groups in the area. The NPWS can advise of the relevant Aboriginal groups. This letter should include a copy of the relevant 1:25,000 topographic map clearly illustrating the area of the proposal and a brief description of works proposed. The letter should request notification of the presence of any Aboriginal sites on the property and further discussions with the group should Aboriginal sites be present which require active management.

Note: NPWS can require up to an additional 46 days to consult with Aboriginal communities, organisations or Land Councils after the development application has been lodged prior to issuing general terms of approval, if it is considered by NPWS that a relic or Aboriginal place is likely to be disturbed. As a result it is wise to consult the relevant Aboriginal communities early in the site selection and evaluation process to determine if there are any major constraints on the site relating to Aboriginal heritage issues.

On advice from NPWS, a survey may need to be undertaken by an appropriately qualified and experienced heritage expert to provide additional certainty that no sites are present or to identify and categorise any sites or items present. If any sites are identified, NPWS should be notified and discussions held with the local Aboriginal community to ascertain their archaeological and anthropological significance. Land containing sites of high significance should be avoided unless agreement can be reached with the relevant Aboriginal community and NPWS regarding the disturbance of the sites.

Preferred location:	Site does not contain any recorded Aboriginal sites and if Aboriginal heritage items are present the project will not affect the significance of these items

8.2 Non-aboriginal heritage

For non-Aboriginal heritage, if there are any potentially historic or cultural items on the site, the LEP and REP should be check along with the State Heritage Inventory and Heritage Commission lists (Commonwealth) and the National Trust register to determine if the item is already listed for protection.

If not, the heritage significance should be considered. It may be appropriate to engage an appropriately qualified and experienced heritage expert. If in doubt, council officers and/or the NSW Heritage Office should be contacted regarding the appropriate provisions for the identification, assessment and conservation of heritage items.

Preferred location:	Site does not contain any heritage items identified in LEP Maps and if present the project will not affect the significance of these items

9. Amenity issues

Conflicts commonly arises when there is a perception that the amenity of residents or recreational users is likely to be threatened by impacts such as poor water quality, highly visible industrial structures, odour from the management of sludges or dead fish or disturbance from noisy pumps or other activities.

In the evaluation of sites, the compatibility of aquaculture activities with surrounding existing or future land and water uses should be considered. For example in some areas

- there may be concerns that if aquaculture was located on a particular site, there could be risks to the heritage significance of the adjacent properties, buildings or sites.
- there could be concerns that the amenity of the area could be compromised from noise, air and water emissions.
- there could be concerns that the visibility of the sheds, ponds and other plant on the site could affect the visual quality of the landscape of the area.

Preferred location:	Site not overlooked by neighbours or from a major highway

These issues should be considered in the evaluation of sites. Potential site options for reducing or preventing conflicts should be considered, in particular, the range of management options to prevent off-site impacts.

Preferred location:	No residences within 400 metres of the ponds or pumps or 200 metres of tanks (if not in an industrial zone)

If there is likely to be conflict, consideration should be given to acquiring sufficient land to provide adequate on-site separation from nearby houses as it can help maintain good relationships with the neighbours in the longer term and will provide sufficient land for flexibility in management of the facility in the long term.

10. Strategic landuse planning issues

It is essential that discussions be held early with local council to understand the future strategic land use direction of the area. Sites in "stable" agricultural areas (or industrial areas for tank production) are preferable.

Preferred location: neighbouring land uses compatible with aquaculture

10.1 Future residential areas

Areas in transition from agriculture to rural residential or urban areas carry long term risks. For example, the long term viability of aquaculture should be questioned in relation to sites in areas where council has indicated that they are proposing an adjacent or overlooking residential land release area or adjacent to land where the land owner has or is applying to rezone the land for rural residential.

In these circumstances, careful consideration should be given to whether future conflicts could occur which could result in costly additional mitigation measures being required or pressure being brought to bear to encourage the aquaculture enterprise to move. It is preferable that the Council's long-term land use strategy be consistent with the long-term aspirations of the aquaculture enterprise on the preferred site.

10.2 Agricultural land issues

Aquaculture is recognised as an increasingly important food production industry with potential to provide diversification for farmers on the North Coast. However because prime agricultural lands (ie class 1,2, 3 agricultural lands) are a limited resource, the use of these lands for aquaculture should be carefully assessed on its merits, taking into consideration the full implications given the socio-economic and environmental factors.

In the majority of circumstances, potential sites for pond culture (and some tank culture) will be currently under agricultural use. In evaluating these sites, consideration should be given to:

- The previous land use and the potential for soil contamination leaching into the ponds. If there were pesticides, fungicides, nemocides or herbicides used on the site or adjacent land, appropriate soil analysis should be undertaken early in the site evaluation process, as sites with significant soil contamination should be eliminated from further consideration.
- The compatibility with surrounding land use and potential for chemical contamination from the use of chemicals sprays. If there is to be regular chemical use especially involving aerial spraying adjacent or near a potential site, the site should be avoided. Reliance on neighbouring land to provide a buffer is not acceptable, as the neighbouring land use may change and result in incompatible adjacent landuses in the future. It should be noted that aerial pesticide spray drift can be detected up to between 1 and 5 Km from the target crops under prevailing winds.
- If cane land, the importance of the land in the strategic context should be considered. The continued production of cane on prime cane lands is important for the economic viability of the sugar mills. The cumulative removal of prime cane land from cane production is likely to have an impact on the industry as a whole. If the site is prime cane land, the local mill should be consulted regarding the compatibility of aquaculture with the future planning for the mill.

- If prime agricultural land (eg class 1,2 or 3), alternative use for agricultural production taking into consideration economic factors.
- The likelihood of the land being returned to agriculture or other viable land uses should the aquaculture enterprise fail. If the land is prime agriculture land then the practicality of returning the land to agriculture if aquaculture should fail or not be continued should be considered at the outset.

Preferred location: No pesticide spraying within 1km

10.3 Oyster growers and other water users

Good water quality is of great importance to all aquaculture enterprises. particularly those located in the waterway such as oyster farms or caged fin fish culture. These enterprises must be considered in the selecting of sites and the location of inlet and outlet facilties associated estuarine aquaculture.

Preferred location: No inlet or outlet facilties so as to affect the water quality of other water users especially oyster growers

10.4 Potential cumulative impacts

If similar industries cluster in a catchment, there is a likelihood of cumulative impacts arising. For example, if a number of industries or activities which discharge water with nutrients into a waterway, though the impacts of individual activities may not be significant, their combined impacts could be. Aquaculture like other industries will contribute to cumulative impacts. The likelihood of cumulative impacts occurring in sub-catchments or catchments should be anticipated and avoided.

Table 18. Potential Contributing industries/activities to cumulative impacts

Potential cumulative impact	Examples of Contributing industries/activities to cumulative impacts
Water quality - sedimentation	agriculture, urban development, storm water, forestry, estuarine aquaculture, road works
Surface water quality - nutrients	agriculture, sewage treatment & stormwater, manufacturing, estuarine aquaculture
Sub-surface water quality	agriculture, manufacturing, aquaculture, sewage treatment and the disturbance of ASS soils.
Water supply usage	agriculture, urban development, aquaculture, manufacturing industry
Disturbance of ASS	agriculture, urban development, estuarine aquaculture, road works, manufacturing industry
Aquatic diseases	aquaculture, fishery activities, stress from poor water quality especially ASS discharge
Land clearing – loss of vegetation & habitats	agriculture, urban development, forestry, aquaculture, road works
Noise & odour	agriculture, urban development, aquaculture, sewage treatment

11. Practical locational issues

11.1 Size of the site

Small sites can result in management problems that can ultimately put the sustainability of the aquaculture enterprise at risk. For a site to be acceptable for a fish farm, it should be large enough for current production needs plus for future expansion. Depending on the type of facility there should be adequate space for the following facilities to be laid out so that there can be efficient movement on the site:

- growing facilities: ponds and/or tanks
- spawning and/or hatchery facilities/ laboratory complex
- cold storage and packing and possibly processing sheds,
- water storage tanks/dams
- pond/tank water recycling and reuse facilities including storage dams
- waste management facilities – dead fish, sludges, processing waste water, sewage, etc
- management and staff facilities
- tourist facilities if relevant.

The site should be large enough to provide adequate distance between noise and odour generating activities such as pumps, ponds and waste storage areas, and any neighbouring residential or community areas. This should provide for the level of odour, dust or noise beyond the site boundary to be kept to an acceptable level. In some prominent locations, it may be desirable for allowance of sufficient space for landscaping along the boundary fence as a visual barrier.

11.2 Availability of services and other practical matters

Other important practical factors that must be considered include:

- Availability of electricity (3 phase in sufficient quantity and price) and its proximity to the site.
- Availability of vehicle access to the site and transport networks Does the site provide for safe truck entry and exit?
- Proximity of markets – are there local niche markets; are there efficient transport options to Sydney or Brisbane?
- Availability of a reliable source of stock, feeds, and other supplies. Is the site well located in terms of hatcheries?
- Availability of suitable manpower to operate the farm. Is the local TAFE offering training courses to increase the skill base?
- Ability to secure the site against poaching and sabotage?

Preferred location:	Access and services available or readily connected to the site

Reference Sources

Australian and New Zealand Environment and Conservation Council (ANZECC) 1992 *Australian Water Quality Guidelines for Fresh and Marine Waters*

Briggs, J D. and Leigh, J H. 1988 *Rare and Threatened Australian Plants (ROTAP),* Special Publication 14, NPWS, Canberra, ACT

Environment Protection Authority 1999 *Environmental Guidelines: Assessment, Classification & Management of Liquid & Non-Liquid Wastes* EPA, Sydney

Environment Protection Authority 2000 *Industrial Noise Policy*, EPA, Sydney

Environment Protection Authority 1997 *Environmental Management Guidelines for the Use and Disposal of Biosolids Products*, EPA, Sydney

Environment Protection Authority 1995 *Provisional Water Quality Investigations Manual: Preferred Methods for Sampling & Analysis* EPA, Sydney

Environment Protection Authority 1999 *Approved methods for the sampling and analysis of air pollutants in New South Wales* EPA, Sydney

Harden, G J. 1990 *Flora of New South Wales Volumes 1–4* University Press, Sydney

McDonald, R C, Isbell, R F, Speight, J G, Walker, J. & Hopkins, M S. 1990 *Australian Soil and Land Survey Field Handbook,* Inkata Press, Melbourne

Ministerial Council on Forestry, Fisheries and Aquaculture 1999. *National policy for the Translocation of Live Aquatic Organisms – Issues, Principles and Guidelines for Implementation.* Canberra. Australia.

Northcote, K H. 1979 *A Factual Key to the Recognition of Australian Soils*, CSIRO, Rellim Technical Publications, Glenside, SA

NSW Agriculture 1999 NSW Guidelines for Dairy Effluent Resource Management Elizabeth Macarthur Agricultural Institute Camden

NSW Fisheries 1994 *Introduction and Translocation Policy.* Sydney

NSW Fisheries 1999 *Policy and Guidelines Aquatic Habitat Management and Fish Conservation*. Sydney

NSW Government 1999 (draft) *Floodplain Development Manual, Sydney*

NSW Government 1990 *Coastline Management Manual Sydney*

NSW Government 1995 *Estuary Management Manual Sydney*

NSW OLMA 1995 *Environment, Planning and Development Manual for Aquaculture*. Commonwealth of Australia

NSW OLMA Aquaculture, Fishing and Related Industries Committee Inc.(1995) *The NSW Aquaculture Handbook.* Commonwealth of Australia

Stone Y, Ahern C R, Blunden B 1998 Acid Sulfate Soils Manual ASSMAC Wollongbar, NSW

York, A., Binns, D. & Shields, J. 1991 Flora and Fauna Assessment in NSW State Forests Survey Guidelines Procedures for Sampling Flora and Fauna for Environmental Impact Statements Forestry Commission of NSW