Site Selection

Hunter and Central Coast Sustainable Aquaculture Strategy
Land Based Aquaculture

A NSW Government Initiative

Hunter and Central Coast Sustainable Aquaculture Strategy

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

Site Selection

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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 Department of Primary Industries (DPI) 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 outset 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 e.g. in relation to river and estuary flow regimes, water allocation, floodplain management, vegetation management, zoning, heritage strategies, biodiversity protection.

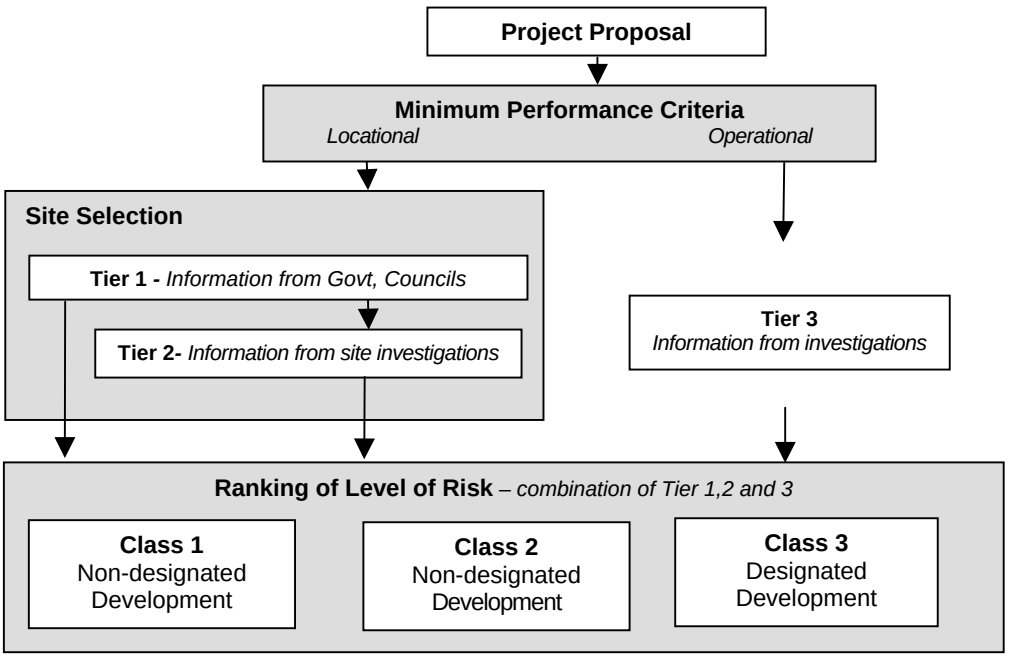
In general, the selection of a site should be based on a thorough knowledge of local and regional hydrology, geology, topography, ecology, climate and weather. While recognising that environmental factors are not the only factor in selecting a site, it is critical that when assessing alternative sites, 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. Locational "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 this section of the strategy. 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 Hunter and Central Coast Region.

Minimum Site Location Requirements

Zoning under local environmental planning instrument

1. Pond based aquaculture - Within zones listed in Column 2 of Zoning Table.
2. Tank based aquaculture - Within zones listed in Column 3 of Zoning Table.
3. Estuarine pond based aquaculture must be located within the green areas on the Estuarine Aquaculture map for the particular estuary.
4. 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 Williams River and the Hawkesbury Nepean catchments. 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 of the Lower North Coast, Hunter and Central Coast 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 and river flow environmental objectives were released in October 1999 for all catchments within the strategy area. For each catchment a printed booklet is available setting out the interim environmental objectives and associated information. The title of each of the booklets is *Guidelines for Water Quality and River Flow Interim Environmental Objectives, ... Catchment.* The catchment names are listed below. You can order a printed booklet for a specific catchment by telephoning Pollution Line on **131 555** or access the documents on the EPA's website at www.epa.nsw.gov.au/ieo.

- Gosford and Northern Beaches Lagoons Catchments
- Hunter River Catchment
- Karuah River and Great Lakes Catchments
- Lake Macquarie and Tuggerah Lakes Catchments

More localised numerical targets for nutrients and turbidity have not been refined for many water bodies of the State. Until this is achieved, more generic objectives will need to be employed. It is recommenced that general "trigger" values that have been derived for particular water body types in NSW be used. These are values that can be used as an indication of the levels above which adverse effects might be expected. In the absence of rigorously derived and agreed local objectives, these can be used as a proxy for in-stream water quality objectives (see Table 12).

Table 11. Water quality trigger values for water body types in NSW

Water body type	TP	TN	FRP	NH4 -N	NOx-N
	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)
Upland River	20	250	15	13	15
Lowland River	50	500	20	20	40
Estuary	30	300	5	15	15

Land based aquaculture facilities such as trout farms have the potential to contribute significant nutrient loads to waterways. It is important that aquaculture facilities are designed and managed to minimise pollutant concentrations and loads in all discharges so that water quality objectives can be met and maintained in receiving waters. In some areas, high nutrient loads might lead to unacceptable deterioration in water quality. In these cases alternative sites should be pursued.

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 assessing 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 (2000 Version soon to be released by the Commonwealth) 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.

Table 12. 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 depth 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, e.g. 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

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

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 13. 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 *Aquaculture Land Suitability Maps* identify sites adjacent to waterways that tend to have water quality satisfactory for an estuarine water supply source. Careful consideration needs to be given to 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, e.g. downstream of sewage treatment works, town storm water overflows, near heavy agricultural pesticide use or high levels of recreational boating activities.

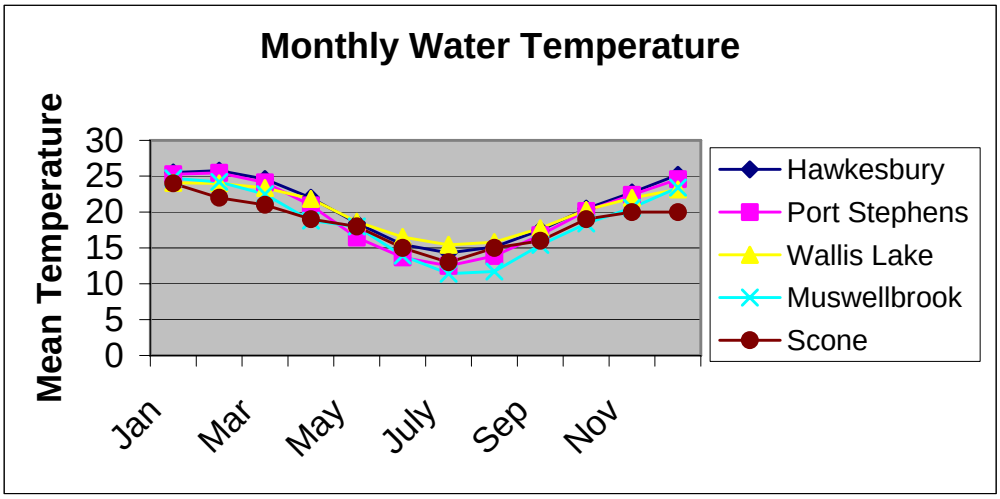
Consideration should also be given to whether the location of inlet and outlet sites are likely to affect the water quality or flows of other water users, in particular whether any changes in water quality are likely to affect oyster growers, aquatic ecosystems and recreational users up stream and down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

Figure 4. Average Monthly Water Temperature



d) Pond/tank freshwater supply

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 www.*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 Infrastructure, Planning and Natural Resources by application.

Preferred location: Irrigation licence approved or available for water extraction.

It is essential that the stream water quality be evaluated for reliability of flow, demands of other competing users, cost of access, salinity, and other water quality parameters. With ground water supply, reliability of flow, demands of other competing users, vulnerability, salinity, depth and cost of access and quality should be evaluated. 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 (i.e. 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.

e) 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.

f) 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.

g) Avoid drinking water catchment

Sites within an identified drinking water catchment area (e.g. 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 solely for domestic uses. 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 than 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 licence, 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 topographic maps. The amount of runoff varies with rainfall and maps are available from DIPNR 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 in the Hunter - Central Coast area currently have surface water licence embargoes. No increase in licensed entitlements are available under Sections 10, 13A, 18F, 20B, 20CA or 20L of the Water Act. Much of the aquaculture development is occurring through diversification of existing water licences. Water Management Plans, currently being prepared by Water Management Committees, will establish rules for access to water. Any new application to use water from river extraction can only occur where the volume has been purchased on the water trading market.

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, and
- Conservation of water resources.

GROUNDWATER WATER ACCESS RULES

Under Section 116 of the Water Act, anyone using a bore or well must have a groundwater licence. Currently, the alluvial aquifers in the Hunter Catchment, with the exception of Wollombi Brook, are embargoed, and therefore no new water licence applications can be made. The Tomago-Tomaree-Stockton sandbed aquifer system has been nominated for an embargo, with the endorsement of the Tomago-Tomaree Groundwater Management Committee.

Any proposed use of groundwaters in areas possessing acid sulfate soils will need considerable environmental assessment to convince the DIPNR that such extraction will not lower groundwater tables leading to an acid sulfate water issue. The department will generally require a full assessment of any proposed works affecting land mapped as having either vulnerable groundwaters, or significant potential for acid sulfate soils.

Table 14. 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 DIPNR 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 DIPNR has published groundwater vulnerability maps for the Hunter Valley and the Tomago-Tomaree aquifers. No vulnerability maps cover the aquifers of the Central Coast. These groundwater vulnerability maps identify areas where areas could be considered to be high risk in terms of location of ponds.

Technical advice from recognised consultants or the DIPNR should be sought on the suitability of sites and potential impacts on groundwater.

Preferred location: No underlying 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 to the potential for aquaculture ponds seepage putting the groundwater at risk, the groundwater could also 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 design: So ponds/raceways/tanks not flood liable
– Freshwater above PMF
– 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 DIPNR and Local Council.

Preferred location: No potential for flood management measures to effect passage of flood waters or neighbouring 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 areas adjacent to creeklines and waterways often have a high potential to contain Aboriginal sites. With indigenous species, there should be capacity to have at least 50 metres distance between the ponds/tanks and the waterways. With barramundi the set back is required for both grow-out and effluent culture units.

Preferred location: All ponds > 50 metres from the top of the high bank.

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

Preferred location: Estuarine ponds must be on land located within the green areas on the Estuarine Aquaculture Maps.

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. NSW Agriculture Advisory Bulletin No. 14 *Landform and soil requirements for biosolids and effluent reuse* (NSW Agriculture, 1998) contains further information on landform assessment and requirements for effluent reuse.

Table 15. Landform Requirements for Irrigation Systems

	Limitation			Restrictive Feature
	Slight	Moderate	Severe	
Slope for				Excess runoff and erosion risk
• surface or underground	<1	1-3	>3	
• 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 for 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 Infrastructure, Planning and Natural Resources (DIPNR). In many cases, DIPNR 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, particularly those 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 organophosphate, carbamates and synthetic pyrethroids should be avoided. Pesticide use in the Hunter and Central Coast catchments is likely with beef and dairy (dips), vines, fruit trees, horticulture crops, maize, potato, soy bean and weed control.

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 could subside under load once ponds are filled. In addition, the effect of "loading" and "unloading" of these types of muds can lead to pond wall instability and leakages.

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. In some areas, site and soil characteristics will be unsuitable for receiving irrigation water from aquaculture facilities. In these cases alternative sites and/or approaches might need to be pursued. NSW Agriculture Advisory Bulletin No. 14 *Landform and soil requirements for biosolids and effluent reuse* (NSW Agriculture, 1998) contains further information on landform assessment and requirements for effluent reuse.

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

Table 16. Soil requirements for irrigation systems

Property	Limitation			Restrictive Feature
	Slight	Moderate	Severe	
Exchangeable sodium percentage (ESP, 0-40 cm)	< 5	5 - 10	> 10	Structural degradation and waterlogging
Depth to top of seasonal high water table (m)	> 3	0.5 - 3	< 0.5	Wetness, risk to groundwater
Depth to bedrock or hardpan (m)	> 1	0.5 - 1	< 0.5	Restricts plant growth, excess runoff, waterlogging
Excessive drainage	highly structured soils, sandy loams, other soils		fine to coarse sands	Risk to groundwater from nutrients
Poor drainage	poorly structured clay loams, other soils		Hardpans, poorly structured clays	Potential for restricted plant growth and runoff

SOIL 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 adsorption 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 Hunter and Central 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 2ha of native vegetation is to be cleared, generally a consent will be required from DIPNR.

Recent vegetation mapping undertaken for the Lower Hunter and Central Coast Regional Environment Management Strategy provides information to assist in identifying important vegetation communities. Regional Vegetation Management Committees are currently being established to prepare Regional Vegetation Management Plans for the Hunter and Central Coast. These plans, when prepared, will outline requirements with regard to the regulation, management and conservation of native vegetation. The vegetation mapping and the Regional Vegetation Management Plans (once prepared) will assist in identifying vegetation communities of importance.

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.

Preferred location: Species indigenous to the catchment and if not, then consistent with the Department of Primary Industries 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 habitats.

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 1995* and the *Fisheries Management Act 1994* include lists of threatened species, population and ecological communities and critical habitats that are protected under these Acts. The DEC maintains a GIS database of information on the flora and fauna of NSW - *Atlas listing of Fauna and Flora Records in NSW* (Contact: Data Licensing Officer (02) 9585 6684).A search of the *Atlas of NSW Wildlife* (which only contains species and not populations or communities) may be undertaken for the study areas to provide an early warning of the occurrence of threatened wildlife species, on or near the site. The *Atlas of NSW Wildlife* does not, however, 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. Department of Primary Industries should be contacted to determine if any threatened species, populations or communities 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 impact on 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

Impacts on 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 Myall Lakes National Park (including Corrie Island and Little Broughton Island Nature Reserves) and Kooragang Nature Reserve are the only listed Ramsar Wetlands in the Hunter and Central Coast Region. However it should be noted that **Important Wetlands In Australia** (Briggs) list Barrington Tops Swamps, Myall Lakes, Port Stephens Estuary, Wallis Lakes and adjacent estuarine islands and Shortland Wetlands Centre. Your local council should be consulted as it may have also identified wetlands within its area that are considered to be of high local conservation value.
- ***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).

- ***Critical Habitat*** declared under Part 3 of the *Threatened Species Conservation Act 1995*.
- ***Protected areas*** which include all lands managed by the DEC and protected under the *National Parks and Wildlife Act 1994* such as National Parks (including marine park extensions e.g. Bouddi National Park), Nature Reserves, Historic Sites, Aboriginal Areas, Karst Conservation Areas, State Recreation Areas and Regional Parks.
- ***Wilderness Areas*** declared under the *Wilderness Act 1987*.
- ***World Heritage Area*** of the Barrington Tops National Park which is part of the Central Eastern Rainforest Reserves World Heritage Area. This World Heritage property includes all major protected areas of rainforest in north east NSW and south east Queensland. Please note that a project does not need to be in or adjacent to a World Heritage Area to have an impact e.g. development in a catchment of World Heritage Area could significantly alter water quality and quantity in the World Heritage Area.
- ***Marine Parks***: At present there are no marine parks in the Hunter and Central Coast region. A marine park in the Port Stephens area is under investigation by the Marine Parks Authority. The zoning of marine parks permits aquaculture 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:*** Fly Point – Halifax Park Aquatic Reserve, Port Stephens (approximately 80 ha) is the only aquatic reserve in the Hunter and Central Coast Region. This popular diving and snorkelling site includes seagrass, kelp, sand and rocky reef habitats on the ledges at Fly Point and the bomboras at Halifax Park which contain overhangs and crevices inhabited by many different fish. 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 impact on 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 long periods to resolve.

Most vacant Crown Land on the Hunter and Central 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 proven. Department of Lands (DL) can provide information on those areas that are presently under 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 (DEC can provide relevant contacts) and local historical societies
iii) inspect existing heritage registers, databases or lists including :
- in LEPs and REPs for relevant heritage issues
- 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 DEC Aboriginal Heritage Information Management System,
- 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 Aboriginal sites
- Reference should be made to the *NSW Heritage Manual* 1996 for guidance on methodology for surveying, identifying and assessing the importance of any non-Aboriginals sites.

8.1 Aboriginal heritage

Aboriginal sites or items have been recorded across the landscape in the Hunter and Central Coast area. Other cultural values may also be associated with this landscape, such as traditional uses of an area, eg. a ceremonial area, a historic event or place, and/or contemporary values such as access to wild resources. Areas that are adjacent to creeklines and waterways often have a high potential to contain Aboriginal sites. A search should be undertaken of the DEC Aboriginal Heritage Information Management System (AHIMS) to determine whether any Aboriginal sites have been recorded on or adjacent to the proposed land. If the search of the AHIMS yields no sites, it does not necessarily mean that there are no sites present. The AHIMS is, nevertheless, an important first step. The State Heritage Inventory should also be checked as Aboriginal sites 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 sites.

The DEC charges a fee for each search of the AHIMS (Contact: 02 9585 6471). All search requests should clearly identify the land and state the reason for the request, i.e., to accompany an aquaculture application in accordance with the Hunter and Central Coast Sustainable Aquaculture Strategy. The results of the search will be forwarded along with advice on the level of Aboriginal heritage assessment required. In determining the appropriate level of assessment, the DEC considers a range of factors including:

- the results of the DEC Aboriginal Heritage Information Management System 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 DEC Aboriginal Heritage Information Management System also forward a letter of notification to the Aboriginal groups in the area. The DEC 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.

Under the Integrated Development Approvals (IDA) process the DEC 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 DEC 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.

A survey may need to be undertaken by an appropriately qualified and experienced heritage person in consultation with the relevant Aboriginal community group/s to identify and record any sites, places of cultural significance or other values that the place has to the Aboriginal community. The significance of any places or values that are recorded should be assessed, and appropriate management options developed. Places of high significance should be conserved in-situ wherever possible.

Preferred location: Site does not contain any recorded Aboriginal sites, places or values of significance to the Aboriginal community and if Aboriginal sites, places or values are present the project will not impact on these.

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 prominent vantage point (e.g. 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 and Department of Lands (if Crown Land may be involved in or adjacent a proposal) 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 Hunter and Central Coast. However because prime agricultural lands (i.e. 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 or fogging 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 5km from the target crops under prevailing winds.
- If prime agricultural land (e.g. class 1, 2 or 3), alternative use for agricultural production taking into consideration economic factors. It should be noted that for fresh water aquaculture, it is an advantage to have nearby potential users of discharge water e.g. for hydroponics, horticulture, orchards, vineyards or lucerne.
- 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 facilities associated estuarine aquaculture.

Preferred location: No inlet or outlet facilities 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 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 17. 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
- roadways, loading docks, carparks
- 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, Newcastle 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 labour 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?
- Proximity to processors?

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

11.3 Access and location for tourists

If an aquaculture facility is to be developed as a tourist attraction then site aspects such as ease of access, prominent location and integration with other tourist facilities or routes need to be considered. Local tourist authorities may be able to assist in identifying the tourism potential of a 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

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