4.0 DESIGN OF MARINA STRUCTURES AND FACILITIES

The ultimate environmental performance of a properly sited coastal marina depends on the marina design, construction and operation. Guidelines for the design of marinas are currently available in Australia. 'Australian Standard AS3962-1991, Guidelines for Design of Marinas' details appropriate design and engineering standards for marinas in Queensland. However, given the World Heritage status of the GBRMP, and the sensitivity of marine ecosystems in the Park, engineering and design criteria which may meet these standards may still have unacceptable environmental consequences in the Marine Park. Subsequently, in some situations and environments the designer's job may require stricter, novel or more 'environmentally friendly' alternatives which minimise effects on the Park, as much as possible. **It should be stated here that the guidelines outlined in this section are in no way prescriptive or mandatory by law and compliance with the guidelines does not necessarily guarantee the acceptability of a development.** The following design notes are included as a helpful guide to developers as many specific approvals are the responsibility of State and Commonwealth authorities apart from GBRMPA. They have been included however because even if the marina design, construction and operation are in accordance with these standards, there is still potential for impact on the marine environment. Marina developments need to be judged on a case-to-case basis. However, it is hoped that more knowledge of the environmental implications of engineering and design recommendations as spelled out in these guidelines, will assist designers, developers and operators achieve sound, economical marina developments with acceptable environmental impacts.

The layout of marina land facilities is usually determined by the physical constraints of the particular location and the need to enable efficient material and activity flow paths. It is recommended that a land to water area ratio of between 50:50 and 40:60 be adopted for preliminary planning of a marina development, depending on the extent of shore-based facilities to be provided. However, financial viability of land/water ratio must also be carefully considered as the 'real estate' created by reclamation in many marina developments is the principal financial asset of the development.

4.1 Basin

In the design of a marina basin, the following should be considered:

Minimise vertically faced structures.

• Vertically faced structures lead to reflection of wave energy, causing confused seas and high wave energy within the berthing area.

Seek expert advice in marina basins exposed to ocean wave energy.

• Basins exposed to ocean wave energy may be subject to longer period oscillations and resonance (seiche).

Design of the basin must facilitate adequate flushing of the marina.

• Adequate flushing of a marina is necessary for maintaining the water quality of the marina basin and adjacent waterway. Natural circulation near the site should be maintained whenever possible. Poorly flushed marinas can become stagnant and permit the concentration of pollutants from the marina facility and boats. The settling and accumulation of organic material and fine sediments can result in decreased dissolved oxygen levels and shoaling within the marina basin.

Give consideration to the diversion of streams and creeks to high flushing zones.

• Adjacent streams or creeks should not be allowed to discharge into the marina basin as they may cause water quality problems.

Minimum depth of the basin should not be less than 2.5 m at MLWS.

• It is recommended that the minimum depth within the mooring basin (at MLWS) should be no less than the maximum draught of moored craft plus half the predicted wave height plus tolerance of 0.3 m or 0.5 m for seabed conditions comprising soft material or rock respectively, plus allowance for siltation. As a general rule, these factors sum to at least 2.5 m as a minimum during MLWS.

Maximise tidal exchange and mixing in the basin; minimise backwaters and current constrictions.

The configuration of a marina basin may enhance or hinder flushing rates. Open marinas located on existing channels will generally have the same flushing rate as the channel. Marina basins with excessively deep or dead-end areas that have lower than natural rates of exchange tend to accumulate potential pollutants or require inordinate periods of time for flushing and organic decomposition. Semi-closed marinas or marinas with dredged basins should be designed to maximise tidal exchange and mixing within the marina. Marina basin design features that promote flushing include:

Ensure channel depths eliminate 'sills' ponding deep basin areas.

• Basin depths that are not deeper than the open water or channels to which the basin is connected and never deeper than the marina access channel. Basin and channel depths should gradually increase toward open water. Dredging of natural channel sills for larger marinas should be avoided.

Provide two openings, or partial walls on one side.

• Two openings at opposite ends of the marina to establish flow-through currents.

Minimise 'dead' water by creating curved surfaces.

• Basins with few vertical walls and gently rounded corners or circular or oval shaped basins. Even bottom contours, gently sloping toward the entrance with no pockets or depressions.

Minimise long reaches where water flows are restricted.

• For rectangular marinas, the length to breadth ratio should be in the range of 0.5-3.0 to promote good mixing characteristics; for similar reasons, entrances should be centrally located.

4.2 Entrance Channel

Entrance channel width should conform with AS3962-1991.

While the width of entrance channels is clearly dependent on many factors, AS3962-1991 states that the channel should be the greatest of 20 m, or, the length of the longest boat to use the marina plus 2 m, or 5 times the beam of the broadest monohull to use the marina. For marina basins of say 200 to 300 berths the entrance channel should have a minimum navigable width of 30 to 50 m in unexposed conditions.

Entrance channels should be straight; aligned into prevailing winds; and not in an area of shoaling.

The entrance channel should be as straight as possible and follow an existing natural channel if available. The entrance channel should also be aligned in the direction of prevailing winds to promote mixing. The entrance should not be located in areas of shoaling as increased maintenance dredging is required and sills between the marina and open water can form causing reduction in flushing.

Mark channels in compliance with Commonwealth and State Departments of Transport requirements.

In the interests of safety, channels must be properly marked, both approaching and inside the marina and in compliance with Commonwealth and Queensland Department of Transport (Marine and Ports Division) requirements.

4.3 Fairways

Preferred fairway width is 1.75L.

To minimise manoeuvring accidents, it has been found that minimum fairway widths between rows of berths in well protected waters should be the greater of 20 m or L + 2 m (where L is length of longest boat in marina). The preferred width is 1.75L.

4.4 Berthing Facilities

Marina layout must attempt to accommodate present and likely future boating requirements.

Marina designers should carefully plan the layout of berths. While boat sizes 25 years hence may not be forecast with any certainty, for the initial 'loss' of a few berths, the marina's future suitability might be enhanced. The layout can affect operational efficiency, convenience to boat owners, security, safety and the comfort of owners working or living on board.

The following floating design features are desirable:

Water area for turning = 2.25L.

- Turning areas should be provided, particularly adjacent to fuelling berths and dead-end channels. Water area for turning, entering and leaving berths should be 2.25 times the length of the longest boat (minimising chance of collision).

Berths at right angles to walkway.

- Berths should be orientated at right-angles to the walkway (maximises numbers, reduces manoeuvring difficulties).

Fingers symmetrically opposite.

- Berths should be arranged so that, wherever possible, fingers are symmetrically located on opposite sides of the walkway (reduces manoeuvring difficulties).

Smaller berths closer to shore.

- Smaller berths should generally be located closer to the shore (more easily manoeuvred into and out of).

Berth access close to marina office.

• Access to berths should be close to the marina of fice (for security reasons).

Berths for hire and bare boat charter craft should allow greater tolerance for inexperienced drivers.

Careful consideration should also be given to the allocation of berths for hire and bare boat charter craft in the marina. In general, hire boats are used more frequently, and by less experienced people than privately owned boats at the marina. Berths for these boats should be readily accessible to the open waterways so as to minimise manoeuvring within the marina. They should also be wider to accommodate inexperienced drivers.

Marina berths may be fixed or floating.

Marina berths may be **fixed**, i.e. piled jetty, or **floating**, i.e. pontoon type. Fixed moorings usually consist of piled walkways (jetties) and mooring piles. One boat moored between a pair of mooring piles is a typical arrangement. Floating moorings are usually pontoons arranged to provide walkways to vessels. These walkways may be located by means of guide piles or cables/chains (attached to anchor blocks), allowing free vertical movement. The boats are moored in either single or double berths, separated by finger pontoons. In areas of high tidal range, floating berths are clearly advantageous, whilst fixed berths are more acceptable in reduced tidal ranges.

Effective (design) berth widths and lengths for fixed moorings are:
(Wb) = B + 1.0 m
(Wdb) = $B_1 + B_2$ + 1.5 m
(Lb) = L + 2.0 m

An allowance should be made in the design of craft berths for manoeuvring (taking account of cross currents) and also clearances when moored. Craft may be moored in both single and double berths. The effective (design) berth widths and lengths for fixed moorings are as follows:

Single Berth width (Wb) = B + 1.0 m
Double Berth width (Wdb) = $B_1 + B_2$ + 1.5 m
Berth length (Lb) = L + 2.0 m

Suggested berth dimensions for floating berth are :
(Wb) = B + 0.6 m
(Wdb) = Wb1 + Wb2
(Lb) = L + 1.0 m

As with fixed berths, clearances are required for craft in floating berths (refer Figure 5). The beam requirement is not as high, however, because the craft's beam at the waterline is generally smaller than the maximum beam, and craft on floating berths can be more tautly moored than in fixed berths where some slack is provided in mooring lines to account for tidal variations. The suggested berth dimensions for floating berths are:

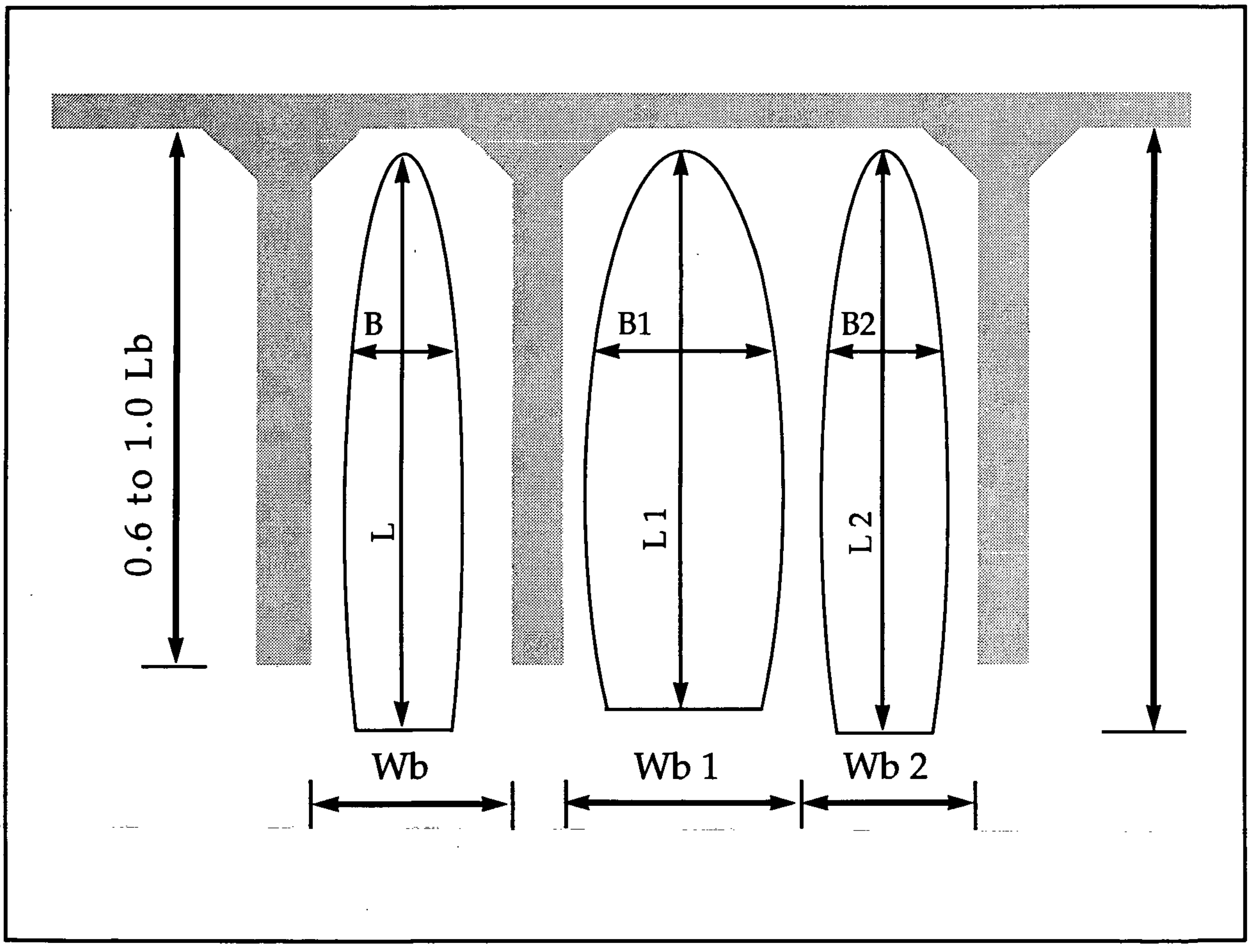
Single Berth width (Wb) = B + 0.6 m
Double Berth width (Wdb) = Wb1 + Wb2
Berth Length (Lb) = L + 1.0 m

4.5 Walkways

Recommended walkway widths given in Table 4.1.

Walkway widths depend on likely usage levels, length of walkway and the extent of ancillary services mounted on the walkway. The walkway should be wide enough to allow two-way pedestrian traffic with barrows. Marinas with live-aboard patronage will be expected to comply with AS1170 Version 2 loading standards. Where walkway lengths exceed 150 m, the minimum widths should be increased by 0.5 m for every 100 m of length over 150 m. Table 4.1 provides recommended walkway widths.

Figure 5. Floating berth dimensions



Optimum finger length is 0.8 Lb.

Fingers have lower levels of usage; hence the width may be reduced to provide passage of only one person at a time. The length of the fingers should fall between 0.6 times the berth length and 1.0 times the berth length, however the optimum appears to be 0.8 Lb. This is sufficiently long to enable boarding and securing of the boat. Shorter fingers may be subjected to oscillations from short period wave action, and may also require provision of additional free-standing mooring piles.

Fendering is required along walkways of both fixed and floating structures.

It is usual to provide fender (or buffer) strips along the edges of walkways and fingers. Fendering is needed along walkways for two reasons. Firstly it should prevent vessels getting under fixed structures, and secondly it will reduce the damage in the event of a collision. The latter applies to both fixed and floating structures.

A 'tee' should be incorporated at the end of each walkway.

A 'tee' should be incorporated into the end of each walkway to prevent wave buffeting of boats berthed at the distal end of the walkways. This area should be used for temporary mooring only.

Table 4.1 Recommended walkway widths

	Minimum	Preferred
Primary Walkway	2.4 m	3.0 m
Secondary Walkway	1.8 m	2.0 m
Finger	0.75m	1.0 m
Fuel Berth Finger	2.4 m	3.0 m
Access Gangway	1.2 m	-

4.6 Reclamations

Reclamation not to cover natural MLW. Reclamation crossing MLW may be broken and bridged.

Reclamation works are not to cover the natural location of the GBRMP boundary (MLW), but that line may be bridged. MLW is not a standard tidal plane and must be calculated by an approved method.

Contact GBRMPA for further information on defining MLW and GBRMPA boundaries.

Where a marina is proposed at a site where MLW forms the boundary of the Great Barrier Reef Marine Park, reclamation over this point would result in alteration of the GBRMP boundary. Except for trivial instances (which generally must be judged on legal advice for each case) the boundary of the GBRMP cannot be altered without the approval of both houses of the Commonwealth Parliament.

4.7 Piers and Pilings

Moored wooden structures can impact water quality within the marina basin through the leaching of wood preservatives. Potential impacts can be avoided or reduced by:

Consideration should be given to the most appropriate materials to be used for wetted surfaces.

- Using alternative materials such as concrete-filled, steel-reinforced PVC, plastics or other non-conventional materials.
- Using highly refined (grade one) creosote that contains less tar, or alternative preservatives such as chromated copper arsenate (CCA salt) to minimise chemical leaching.

Design and place structures to minimise impacts on aquatic habitats.

In addition, the use of solid structures should be avoided in order to minimise habitat loss by allowing adequate water circulation. The marina designer should also minimise structure width to allow for maximum sunlight penetration. Docks and piers should be elevated as high as possible and orientated in a north-south rather than an east-west direction. These designs will avoid excessive shading of aquatic habitats.

Mooring pile 0.9 times the berth length from the walkway.

For ease of berthing and protection of craft when moored, the mooring pile should be located approximately 0.9 times the berth length from the walkway.

4.8 Breakwaters

For fixed breakwaters use design features to enhance flushing rates.

Breakwaters can be fixed or floating. Fixed breakwaters can interfere with currents and reduce the flushing rate within the marina, resulting in reduced water quality and increased shoaling. Solid breakwater design should therefore include consideration of natural current and sediment flow, wave patterns and overall flushing characteristics. Circulation can often be maintained by providing openings in solid breakwaters, at both ends of fixed breakwaters or between the fixed breakwater and shore.

Design for a category 4 cyclone. Incorporate allowance for sea level rises.

Breakwaters and protective works should be designed to withstand a category 4 cyclone, and incorporate allowance for sea level rise as predicted to result from the 'Greenhouse Effect' (refer Section 3.5).

Sloping riprap structures are preferred for breakwater construction.

Sloping riprap structures are preferred for fixed breakwater construction. If the land margin needs stabilisation, a sloping riprap wall with underlying filter cloth is preferred - these have the advantages of maximising habitat niche creation, economy, reduction of wave reflectance problems and minimisation of sedimentation.

Floating breakwaters have a number of advantages over fixed breakwaters but are only effective for sheltered sites.

The alternative to fixed breakwaters are floating breakwaters. Although floating breakwaters are only effective for wavelengths shorter than twice the width of the breakwater and are not effective on open coasts, they offer certain advantages over fixed breakwaters as follows:

- construction cost is nearly independent of water depth;
- they can be used where soft or unstable bottom precludes the use of fixed structures;
- they can be easily relocated if necessary (i.e. reversible impact);
- they can minimise potential interference with fish migration and shoreline processes and can reduce benthic habitat modification; and
- they can be used in areas of high tidal range where high breakwater walls would provide unaesthetic visual effects.

4.9 Fuelling Facilities

Locate fuelling facilities leeward of marina with respect to prevailing winds and leeward of exits.

The location of a fuelling facility is a critical decision with respect to safety. It should be located to be easily accessible by visiting and passing boats, without access through the main berthing area. The facility should be located to leeward of the marina with respect to the prevailing wind in the boating season and to leeward of exits to permit safe evacuation of boats in the event of fire. They should preferably be in the area of greatest flushing in order to minimise water quality impacts.

Ensure easy access to the fueling facility and the emplacement of the safety precautions.

When planning a fuel berth, the following points should be considered in order that a good balance between maximum benefit and potential environmental impacts are achieved:

- access to fuel berth by boats in marina and visiting boats;
- access of fire fighting vehicles to fuel berth;
- provision of adequate fire fighting equipment;
- lighting of berth (for safety and security);
- provision of fuel spillage protection devices to be kept on site;
- size of fuel storage tanks;
- flexible fuel supply lines from shore to berth as approved by the Department of Transport;
- automatic fuel cut-off valves and refuelling by authorised personnel only;
- location of bowsers on shore in preference to on pontoon;
- proximity to marina office;
- fuel facilities should have back pressure automatic shut-off nozzles;
- any fuel transfer systems operating within or across the intertidal zone should use vacuum operated pumps, dry break couplings or drip trays;
- provision for reporting and dealing with all spills; and,
- security against vandalism and unauthorised use.

4.10 Amenities

Specialist requirements for marinas larger than 200 berths or dedicated to racing.

Recommendations for the planning of marina facilities, with particular reference to amenities are given below. The values quoted are for a typical commercial operation of moderate size, say 200 craft. Club facilities and marinas berthing a significant number of racing yachts would demand a greater number of the particular amenity.

Toilet blocks should be provided at convenient points. Recommendations for marina toilet facilities are given in Table 4.2.

Table 4.2 Toilet block requirements

Item	Ratio (per marina berth) Male and Female
Toilets	1 per 50 people
Urinals	1 per 75 people
Wash basins	1 per 50 people
Showers	1 per 75 people
Deep Sinks	one at each block

Amenities should be close to berths and easily accessible by disabled persons.

The range of amenities which are provided at a marina will depend upon the size of the marina and requirements of the clients. Marinas with more than 50 pens should provide rest rooms with showers, basins and toilets convenient to the pens.
It is usual that toilets and showers are provided, however, laundry, locker and similar facilities may be worthy of consideration. No berth should be in excess of 300 m from an amenities block. Access and ease of use by disabled persons should be incorporated in the design and location of amenities buildings.

4.11 Waste Treatment and Disposal Facilities

Onshore pump-out facilities will be required for `designated developments'.

For marinas which are **designated developments** in Queensland, the provision of sewage pump-out facilities onshore will become a condition of development consent.

Assess appropriate marina onshore wastewater collection systems.

Three types of onshore marina wastewater collection systems are available: marina-wide systems, portable/mobile systems, and slip side systems. Marina-wide wastewater collection systems include one or more centrally located wastewater pump-out installations. Vessels requiring the wastewater pump-out services would dock at the pump-out installation and a flexible hose would be connected to a wastewater fitting in the deck of the vessel. These units pump to an onshore holding tank (or truck) or to an onshore wastewater collection and treatment system. Portable/mobile systems are similar to marina-wide systems except that the pump-out stations are mobile. The mobile unit includes a positive displacement pump and a small storage tank. Slip side systems provide continuous wastewater collection facilities at each slip. In general, there are two types of slip side systems, each with modifications available to customise the system. Pump-out systems use an on board grinder pump to transport wastes to a main sewer. Vacuum systems use differential pressure to transport wastewater from each slip to a central collection tank from which wastewater may then be pumped to a sewer or hauled to a wastewater treatment plant. Both types of systems can also handle bilge water discharged from boats if the flow rates do not exceed a specified rate. The system may be used on either floating or fixed docks.

Sewerage system connections are preferred.

Larger projects, that is, marinas with more than 50 pens, should have sewage pump-out facilities unless all users are short-term transients. These can be conveniently placed adjacent to refuelling points. Pump-out and public facilities should preferably be connected to a sewerage treatment system.

Septic systems require a minimum drain field setback of 35 m from surface water.

With marina-connected septic systems, the problem of chemicals from onboard holding systems may be solved by using two septic systems in series for both marina and pump-out use (thus increasing residence time). A minimum drain field setback of 35 m from surface waters is recommended.

Live-aboards cannot discharge directly.

Note that it is GBRMPA policy that any sewage discharge into the Marine Park receives tertiary treatment (nutrient removal). Live-aboard vessels will therefore not be permitted to use direct flow toilets onboard.

4.12 Administrative Areas

Administration centre should have a good view over entire marina.

The extent and sizing of administration areas depends on the size of the marina, extent of shore-based activities and whether offices for government authorities are to be provided. The administration centre should command a good view over the entire marina for safety considerations and client management.

4.13 Maintenance Areas

Maintenance area should allow for one boat per 25 craft.

As a guide, allow enough area for maintenance of one average sized boat per 25 craft at the marina. This will vary depending on craft types and the rate of fouling. For initial planning, provision of 5% of total land area for maintenance is reasonable. Maintenance areas should be located above high tide mark to avoid contamination of incoming tidal water.

Maximise landward length of the slip.

The landward length of the slip should be maximised to permit as many boats as possible to be slipped simultaneously. Tandem cradles assist in this regard and are favoured. Transverse slipping of smaller boats can increase slipway utility.

Slipway gradient of 1:15 is preferred.

Slipway gradients of 1:10 to 1:15 have been found to be the practical limits for most situations. In general, a gradient of 1:15 is preferred (the steeper gradients are useful for small boats only).

Paving design must allow for very high point loads.

In the design of slipways, hardstand and maintenance areas, the paving design must allow for very high point loads. Such loads are generated beneath the wheels of fork lift trucks (as used in dry stacks), hardstand cradles (for small boats and cruisers), under keel chocks, slipway rail supports, parallel boat lifts and straddle transporters.

Maintenance area drainage should include a collection pit.

Careful attention must also be paid to drainage and disposal of stormwater and wash down wastes. Disposal facilities are required to take used sump oil, hull scrapings and other wastes associated with maintenance areas. Maintenance area drainage should therefore include a collection pit from which waste can be removed and bunds around the area to divert external stormwater. Where possible, remove marine growth and paint by mechanical means.

Wastewater disposal may require specific licenses.

Options for wastewater disposal include: pump out pit contents for disposal at an approved site; connect to sewer if contaminants are not harmful to the treatment system (a ***trade waste permit is required***); and discharge to waters after treatment to an acceptable standard (a ***discharge licence is required***) (refer 'Sewage Discharges into the Great Barrier Reef Marine Park, GBRMPA 1993').

Provision should be made for regular cleaning of slipways.

Wastewater from slipways also need to be contained and disposed of, although this is difficult. Slipways should be regularly cleaned by sweeping or vacuuming and the solids removed. Traps may be able to be installed at the lower end to collect wastes which can also be regularly removed.

4.14 Boat Launching Facilities

Boat launching ramp needs should be identified.

Boat launching ramps are required at most marina facilities for the launching and recovery of hire boats, transient craft, dinghies, boats for sale and for deliveries from manufacturers. The need for such facilities should first be identified.

The following guidelines cover the principles of planning and design which may be modified to suit the scale, scope and particular purpose of the marina ramp. Separate ramps for different purposes may be indicated.

Desirable features are:

Boat launching ramps should have the following characteristics:

Locate away from sensitive areas.

- Locate boat ramps away from sensitive areas such as seagrass beds or shellfish beds. Preferred areas are shorelines without wetland vegetation and adjacent to waters with adequate navigation depths.

Recommended slope 1:10. Recommended widths 4.0 m (single) and 3.7 m (multiple).

- To reduce risk of accident, ramp slope should be 1:10 (recommended) and not exceeding 1:8. For ease of use, lane width minimums are 4.0 m (single lane) and 3.7 m (multiple lanes).

Align perpendicular to predominant waves.

- The effect of waves, currents and boat wash should be minimised. The ramp should be aligned perpendicular to the predominant waves so that the boat is not moved sideways during launching and retrieval.

Examine existing amenity of proposed area.

- In general, boat launching facilities should not be located where the ramp activities will have an adverse effect on the existing amenity of the area or where there will be conflict with other activities of the marina.

Adequate water depth at ramp toe.

- Adequate water depths at the toe of the ramp at low water should allow all tide boat launching.

Boarding jetties of 15 m length.

• Boarding jetties or pontoons should be not less than 15 m in length for all water levels.

Car manoeuvring areas to be provided.

• Sufficient area should be provided for approach ramps, manoeuvring cars and trailer parking areas.

Double width ramps recommended.

• Construction of single ramps should be avoided wherever possible. The additional cost of a double width ramp is relatively minor compared to the cost of constructing an additional lane at a later date.

Sufficient lighting.

• Provide minimum lighting for ramp usage.

Indicate ramp lanes by painted lines.

• Ramp lanes should be indicated by painted lines, not kerbs which may cause problems during manoeuvring of boat trailers.

A grooved surface using appropriate ratio cement.

• Deep, square-shouldered grooves moulded into the surface at an angle of 45 degrees to the ramp contours. Concrete used should be the equivalent of 35 Mpa, with slump of 80 mm, water/cement ratio of 0.45 and 20 mm minimum aggregate size.

Marine ways and hoists can be used to minimise shoreline alterations.

As an alternative to ramps, marine ways (dolly) and hoists can be used to minimise shoreline alterations. A marine way precludes the need for a pier or dredging at marinas with a gradual submarine slope and permits preservation of a vegetated fringe, while hoists require pier construction.

4.15 Air Quality

Facilities/activities involving releases into the air should be placed and controlled to avoid downwind air quality problems.

Air quality problems can arise from: vapours from volatile organic solvents used in degreasers, primers, thinners, paints and antifoulants; spray painting drift; dust from abrasive blasting, sanding, planing, wood shaving and sawdust. Paint, spray odours and dust fallout can be a very real nuisance to neighbours at the development, but can be controlled in a number of ways such as maintaining adequate separation distances between boat building/maintenance areas and neighbours; restriction on use of atomised spray guns which produce large amounts of overspray; enclosing workshops and provision of ventilation where appropriate; use of spray 'booths'; conduct of abrasive blasting during low wind conditions and minimisation of dust from sanding by use of suitable dust collectors or industrial vacuum cleaners.

4.16 Parking

Assessment of parking requirements should include:
- **craft usage patterns**
- **public usage of other marina services**
- **alternative parking possibilities**
- **special parking for disabled persons**
- **access special areas for large vehicle**
- **parking for cars and attached trailers.**

A large portion of the land area associated with a marina may be required for car parking (refer also to AS3962-1991). Where land is not readily available, it has to be purchased or reclaimed. This can amount to a major cost in a marina development. In assessing the number of car parking spaces required, the following factors should be considered (together with any others which might apply to a given development):

- size and type of craft at berths likely to use the marina (this relates to crew/passenger numbers and maintenance requirements);
- frequency of use of the various types of craft (to establish a base parking demand);
- likely usage patterns of craft during public holidays and summer periods (to establish peak parking demand);
- location of marina site and adjacent areas for passive recreation, tourism, etc by the public;
- provision of adequate car parking for other marina services and special use areas, such as repair facilities, ferry and charter services, restaurants, shops, sailing clubs, dry storage or for boat launching ramp facilities;
- availability of overflow parking in surrounding streets or nearby areas during peak periods; an
- delivery areas should be provided adjacent to marina walkaways.

Provide parking for people with a disability.

Parking spaces should be made available for persons with a disability (refer AS1428). These spaces should be wider than normal (at least 3.7 m) and should be identified as being reserved for people with a disability. They should be located close to the land based buildings and comprise at least 1% of the available parking spaces. Allowance should be made for people with a disability to cross kerbs and other obstructions.

Provide for (and separate from the public) large and commercial vehicles.

Allowance should be made where the projected activities of the marina require access for large vehicles, (e.g. delivering sail or power boats, and cranage). Wherever possible, delivery and maintenance vehicle traffic should be kept separate from car park areas and circulation roads.

Minimum parking requirements detailed opposite.

Assessment of each aspect of the marina development is necessary, and appropriate car parking requirements need to be assigned. Parking may be allocated using the following minimum provisions:

- 0.6 parking spaces per wet berth
- 0.2 parking spaces per dry storage berth
- 0.5 parking spaces per marina employee
- 0.2 parking spaces per swing mooring licensed to the marina

Parking area design should consider many factors:

Provide separate areas for car parking only.

• Provide separate areas for 'car only' parking, and provide sufficient car and trailer parking to meet projected demands for normal usage.

Allow for drive-through parking spaces.

• Design drive-through parking spaces for ease of manoeuvring car and trailer combinations.

Locate parking close to the ramp or provide a loading zone.

• Locate parking as close as possible to the ramp such that all parking spaces are no more than 200 m away. If this is not possible a loading zone should be provided close to the rigging and wash areas.

Allow emergency vehicle access.

• Provide easy access for emergency vehicles to 'high risk' areas such as workshops.

Avoid large asphalted areas through use of green areas.

• Avoid large asphalted expanses through the use of green areas. Green areas in the form of strips or islands may be used as a means of controlling traffic and trailer parking areas.

Grass trailer parking areas.

• Experience has shown that grass can withstand trailer loads without undue damage and therefore it is recommended that all trailer parking areas be grassed.

Provide overflow grassed parking areas.

• Provide overflow grassed parking areas wherever possible.

Route parking runoff via landscaped areas.	• Encourage runoff from paved areas to nourish adjacent site landscaping, rather than piping the runoff away from the site.
Ensure a high standard of architectural treatment.	• Undertake a high standard of architectural treatment (both structural and landscape) in order that the car parking area does not detract from the visual appeal of a marina.
Clearly signpost parking controls.	• Parking areas will be enhanced if a set of rules for traffic are adopted and clearly signposted.
Design in accordance with local council regulations.	• Design parking in accordance with local council regulations.
Plan sufficient flexibility to cope with future demand.	• The boat launching facility should, if possible, be designed and located such that future land and water based expansions to the launching ramp may be possible as a result of increased demand.

4.17 Commercial Facilities

Appropriate balance of commercial facilities should be considered.	Appropriate commercial facilities are often essential to the financial viability of a marina. They can also complement the marina and in turn the marina activities often add value to commercial developments.

4.18 Revetment Design

Place revetments as far upland as possible.	Breakwaters or revetments are used to absorb and reflect wave energy away from the marina and to protect boats within the marina basin. Revetments should be situated as far upland as possible and provide access ways over wetlands to avoid shallow intertidal areas.
Use sloping revetments where possible.	Sloping revetments (stair-step or sloped 45° or less) and vegetated revetments provide better habitat and protection for juvenile fish and are preferable to vertical walls, where feasible. If vertical walls are necessary, they should contain weep holes covered with a filter cloth.

Assessment of a suitable design should include hydrographic and geotechnical surveys.

Solid breakwaters can reduce water circulation and affect water quality. Design of these structures should therefore include consideration of natural current and sediment flow, wave patterns and overall flushing characteristics. Additional items which should be considered in the design of a breakwater include: tidal range; water depths; stability of the structure (permissible damage levels); overtopping; availability of suitable rock or use of concrete armour; and foundation stability.

4.19 Aesthetics

Use sloping riprap walls for land margin stabilisation.

The marina designer should aim to maximise vegetated landscaping. If the land margin needs stabilisation, a sloping riprap wall with underlying filter cloth is preferred. These have the advantages of maximising habitat niche creation, economy and reduction of wave reflectance problems. In some cases, stabilising walls have been successfully vegetated with mangrove plantings to provide strength and soften the visual intrusion of such walls.

4.20 Boat Clearances from Revetments and Quays

Allow 1.0 m clearance from boat stern to point of minimum depth on sloping revetment and a similar value from boat stern to quay wall.

The water area available for berths is strongly influenced by the revetment or quay wall treatment. Allow typically 1.0 m clearance from boat stern to point of minimum depth on sloping revetment and a similar value from boat stern to quay wall. Craft with transom hung rudders or deep skeg rudders may require greater clearance. For sloped revetments, the distance from the bank to the boat should be minimised. The further the boat from the bank, the longer the walkway and the more difficult the access.

4.21 Fixed Moorings

A wave height range of 0.5 m to 0.6 m is commonly adopted as the maximum for fixed mooring systems.

Mooring structures within a marina should be designed for the wave climate within the harbour, related to an appropriate return period. Moorings are often anchored using piles (a fixed mooring). A wave height range of 0.5 m to 0.6 m is commonly adopted as the maximum for fixed mooring systems. It is important to be aware that while the mooring system may not be damaged by loadings imposed by 0.5 to 0.6 m waves, the craft may suffer damage to mooring cleats or other fittings.

4.22 Floating Moorings

Floating moorings where wave height is less than 0.3 m, water depth is excessive, sea bed is unsuitable for pilings or establishment costs are prohibitive.

Floating mooring systems are generally used in harbours with small wave heights. A widely accepted practice for the design of wave protection in small craft harbours incorporating floating mooring systems has been that wave heights (within the harbour) should not exceed 0.3 m. Floating mooring systems are also used in sites with excessive water depths, unsuitable sea bed conditions, or prohibitive piling establishment costs.

Four major types:

The floating mooring uses an anchoring system of either:

Clump weight

- concrete or steel clump moorings consisting of a series of weights connected by chains and connected to the pontoons by anchor lines, usually with intermediate drag plates or weights to reduce shock loads;

Anchored

- commercial anchor systems;

Pile driven

- anchor piles driven into the sea bed and cut off at or near bed level, connected to the pontoons by anchor lines, also with intermediate drag plates or weights. This system is used where water depths make full length piles uneconomical; or

Auger moorings.

- screw or auger moorings.

Require periodic survey and major maintenance or repair in 15-20 years.

Screw and auger moorings require more maintenance than a piled system. Periodic servicing by divers is required. However, they have been shown to work effectively. The working life of floating structures is generally shorter than that of fixed structures, with major maintenance or replacement typically required within 15 to 20 years of installation.

4.23 Choice of Materials

Select materials for their resistance to degradation and compatibility with other materials.

The selection of materials for all structural, buoyancy and cladding elements of marinas should be given careful consideration. The environment is extremely aggressive at marinas fronting sea water. The factors which influence the selection of materials are exposure or vulnerability to:
attack by marine organisms (e.g. ship worms, barnacles, algae); tidal zone conditions; stress reversal or fluctuation; fatigue; corrosion; erosion; wear (e.g. at hinges due to constant movement); spillage of solvents; fire hazard; and electrolytic corrosion due to the connection of incompatible materials. Materials should be selected having regard to their compatibility with other materials to which they may be connected.

Adhere to Australian Standard Specifications for materials.

Australian Standards Specifications exist for the majority of construction materials and these should be used. The list is too large for inclusion in this document. Standards are obtainable from the Standards Association of Australia, 80 Arthur Street, North Sydney 2060.

Petroleum resistant polystyrene to be used in foam structures.

Foam structures should be made of petroleum resistant polystyrene foam rather than expanded bead foam - it lasts longer, has greater cohesion and better fouling resistance.

Minimise waterproofed areas.

Waterproofed (concrete/bitumen) areas should be minimised. Gravel or shell grit surfacing is an attractive alternative appropriate in many instances and has benefits of decreasing runoff velocity, increasing infiltration and allowing suspended solids to settle out of runoff water.

Avoid the use of antifouling paints wherever possible.

While wood preservative such as CCA are suitable, antifouling paints will not be approved for use on non-boat facilities in the GBRMP unless it can be shown that they do not release heavy metals into the water. If the use of creosote is necessary then use Grade 1 not 2 or 3.

4.24 Safety Requirements

Incorporate safety features into design.

A marina facility should be designed with consideration given to safety so as to reduce the risk of injuries and damage to life and property. If safety features are incorporated into the initial design of the marina it will ultimately facilitate site management and reduce safety hazards that otherwise arise due to poor planning. When planning the marina layout, the designer should ensure easy access for people with a disability is provided to all areas of the marina. Steps should be avoided wherever possible.