9.0 Waterway Access and Facilities for Boat Users

Recreational boating is extremely popular in Port Stephens and is an important contributor to the local economy. The provision of adequate and safe facilities for boat users is therefore essential. As discussed in **Section 3.0**, both the residential and tourist populations of towns adjacent to Port Stephens and regional centres such as Raymond Terrace and Medowie are growing rapidly. While current statistics regarding the number of boat users in Port Stephens are not available, it can be assumed that as the local population and number of tourists increase, there will be a corresponding increase in the number of boat users and pressure on waterway access facilities. In an assessment of future demand patterns in the Great Lakes LGA, Jelliffe Environmental Pty Ltd (2003:8) concluded that 'a doubling in the pool of boats can be expected to occur between 2020 and 2030' based on a population growth rate of 2 per cent per annum. The assessment also noted that the 'Baby Boomer' generation is likely to migrate to coastal areas as they retire over the next few decades. Boating is likely to be a popular activity for this group, further contributing to the pressure on waterway facilities.

The location and management of boat ramps and jetties was identified as a major community concern during the preparation of the Port Stephens – Myall Lakes Estuary Management Study (Umwelt 2000b), as well as during community consultation for the current Plan. The crowding of the Little Beach Boat Ramp and car park, and its difficulty to use during windy conditions, is the most commonly voiced concern.

A survey of 45 boat ramp users (Little Beach, Shoal Bay, Salamander Bay, Soldiers Point, Lemon Tree Passage and Karuah) was undertaken for the Estuary Management Study and provides a snapshot of boat ramp users and their opinions. The main findings were as follows:

- 40 per cent of the respondents resided in the Port Stephens LGA, but 20 per cent were from the Newcastle LGA, and 17 per cent were from Sydney. The remainder were from elsewhere in the Hunter region;

- most ramp users interviewed participated in recreational boating on a weekly basis (not necessarily at weekends);

- 51 per cent of respondents were using a runabout type boat, up to 7.5 metres long, with a further 26 per cent having a runabout or speedboat up to 12.5 metres long;

- the areas of Port Stephens that were nominated as popular for recreational boating were Nelson Bay (11 per cent), Pacific Ocean (10.2 per cent), Salamander Bay (9.5 per cent), and Shoal Bay (8.9 per cent);

- boat users were mainly using the waterway for fishing, with a low proportion nominating sightseeing; and

- respondents explained their choice of ramp in terms of proximity to their home (or holiday residence). The poor condition of or lack of access to alternative ramps was also nominated.

As indicated by the above survey, the type of watercraft utilised influences demand for facilities. The NSW Maritime Authority estimates that 60-70 per cent of boats on Port Stephens are trailer boats rather than in-water boats (C. Dunkley, NSW Maritime Authority, email July 2005). Factors such as a general increase in affluence, and the availability of more affordable and improved models have all resulted in a relative increase in the number of trailer boat users. Again, this results in pressure on waterway facilities but also introduces the need for adequate dry boat storage.

Many Port Stephens waterway facilities, in addition to those at Little Beach, are already overcrowded during peak periods (although capacity for normal off-peak periods is generally adequate). A long term strategy is therefore urgently required to reduce current congestion, as well as to plan for at least a doubling of demand on facilities required by boat users over the coming decades.

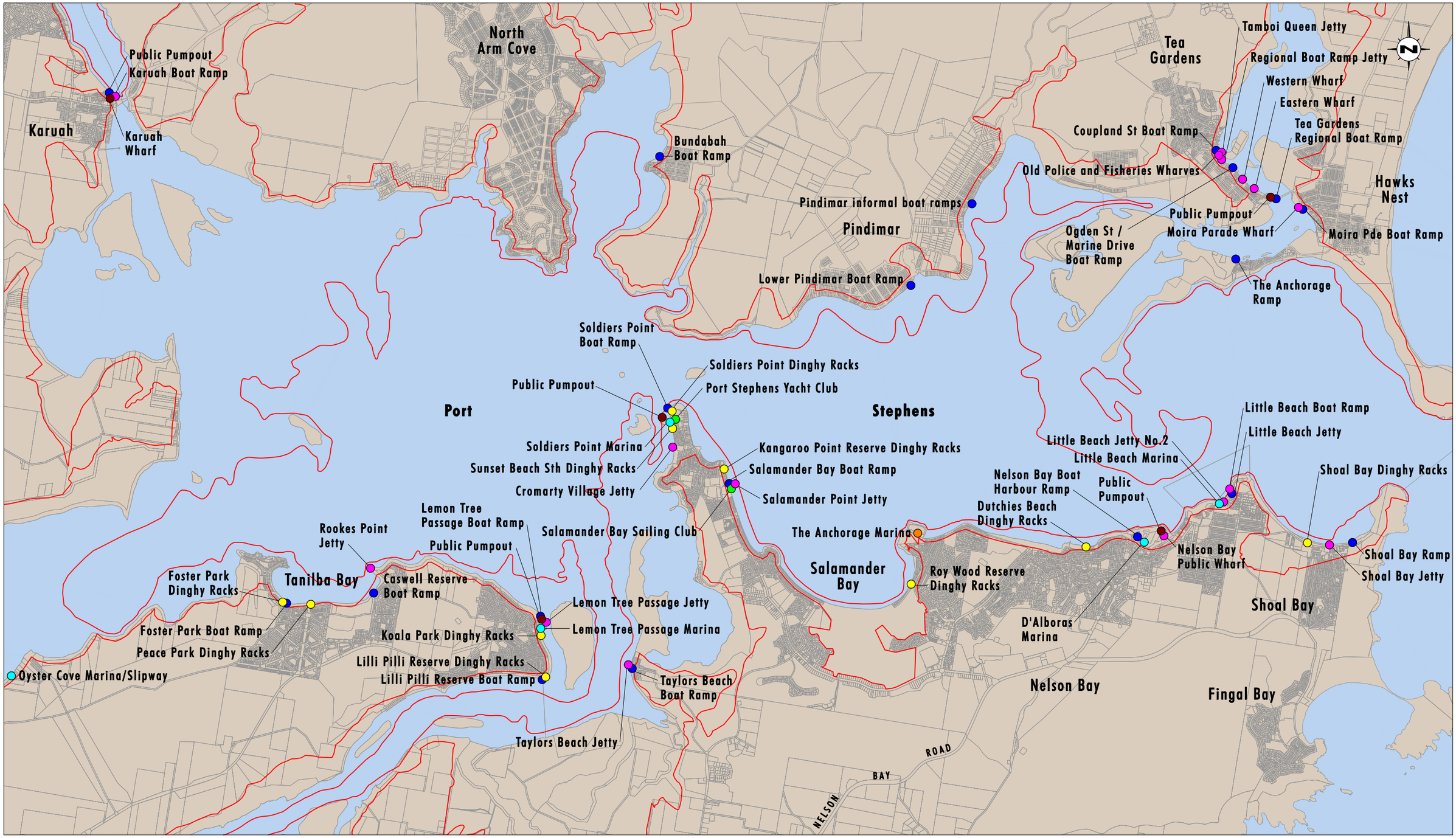
For the purposes of this study, waterway facilities include boat ramps, jetties, dinghy racks, marinas, pump-out facilities, as well as reserves which are suitable for boat based users.

Two major assessments of the waterway access facilities in Port Stephens have previously been undertaken. Patterson Britton & Partners Pty Ltd (PB&P) (1997) undertook an assessment of the wharves and jetties within the Port Stephens LGA, and Jelliffe Environmental Pty Ltd (2003) undertook an assessment of existing waterway access facilities in the Great Lakes LGA (from Karuah to Bulahdelah) and suggested a long term management strategy. The following sections include information extracted from these studies.

Figure 9.1 shows the location of waterway access facilities and other facilities utilised by boat users in Port Stephens. Each of these facilities is also listed in the **Foreshore Inventory**.

9.1 Boat Ramps

The majority of the public boat ramps in Port Stephens are owned and managed by Port Stephens and Great Lakes Councils. **Table 9.1** provides a summary of existing facilities and **Figure 9.1** shows their location.



Source: LPI NSW (2000), Great Lakes Council (2006), Port Stephens Council (2006)
Note: Seaward study area boundary defined by -2 metre (AHD) contour.

Legend

- Study Area
- Boat Ramp
- Club
- Dinghy Rack
- Jetty/Wharf
- Marina
- Marina/Slipway
- Pumpout

FIGURE 9.1

Existing Waterway Facilities

File Name (A3): R01_V2/2034_044.dgn

Table 9.1 – Existing Port Stephens Boat Ramps

Facility	Location/Management Zone	Description	Associated Facilities	Issues/Constraints	Owner/Manager
Shoal Bay Boat Ramp	Eastern end of Shoal Bay Road. Management Zone A1	One lane reinforced concrete ramp that projects across the beach face.	Unsealed car park.	Popular with jet skiers. Craft use the beach on either side of the ramp as a holding area. Often exposed to wind and swell conditions that make it difficult to launch/land. Requires upgrade/maintenance.	Port Stephens Council
Little Beach Boat Ramp	Little Beach - eastern end of Little Beach Management Zone A1	Three lane reinforced concrete ramp, grooved. High usage.	Little Beach Jetty, sealed car park (with through traffic), reserve, amenities, fish cleaning facilities.	Dangerous during westerly winds and numerous accidents have occurred requiring ambulance attendance. Car park and ramp congested during peak periods. Surrounding area identified as Sanctuary Zone within Port Stephens – Great Lakes Marine Park (Draft Zoning 2006).	Port Stephens Council
Nelson Bay Boat Harbour Ramp	Nelson Bay - within boat harbour (western side), adjacent to d'Albora Marina Management Zone A1	One lane reinforced concrete ramp with grooved surface.		Used by NSW Maritime and not available for public use in normal circumstances. Very limited parking.	Department of Lands (declared Crown land in 1996)/NSW Maritime Authority
Salamander Bay Boat Ramp	Seaview Crescent, Soldiers Point Management Zone A3	One lane reinforced concrete boat ramp.	Car park on Soldiers Point Road.	Steep ramp subject to high wave action. Limited manoeuvring area.	Port Stephens Council

Table 9.1 – Existing Port Stephens Boat Ramps (cont)

Facility	Location/Management Zone	Description	Associated Facilities	Issues/Constraints	Owner/Manager
Soldiers Point Boat Ramp	Soldiers Point, Everitt Park, north-western tip of Soldiers Point Management Zone A3	Two lanes wide. Constructed from a grooved reinforced concrete slab which extends down to mean low tide level. Protected from waves with a westerly fetch by a small offshore breakwater.	Sealed car park, amenities, small picnic area, fish cleaning table.	Car park overcrowded during peak periods. Adjacent beach used as holding area. Potential to be upgraded to regional facility.	Port Stephens Council
Taylors Beach Boat Ramp	Taylors Beach - western end of Taylors Beach Road Management Zone B1	One lane reinforced concrete ramp.	Taylors Beach Jetty, unsealed car park.	Jetty forms groyne that protects boat ramp from westerly and north-westerly wind waves. Erosion/deposition consequences along adjacent shoreline.	Port Stephens Council
Lemon Tree Passage Boat Ramp	Lemon Tree Passage - Cook Parade, at the eastern end of Kooindah Park Management Zone B3	Two lane reinforced concrete ramp.	Lemon Tree Passage Jetty, reserve, amenities, sealed car park, fish cleaning facilities.	Potential to be upgraded to regional facility.	Port Stephens Council
Lilli Pilli Boat Ramp, Lemon Tree Passage	Beach Road, Lemon Tree Passage	One lane unsealed ramp.	Unsealed car park and small picnic area.	Local use. Suitable for high tide use only.	Port Stephens Council
Caswell Reserve Boat Ramp, Mallabula	Fairlands Road, Mallabula	One lane concrete ramp.	Unsealed car park, reserve, public amenities.	Poor condition. Suitable for high tide use only. Contributes to foreshore erosion.	Port Stephens Council
Foster Park Boat Ramp, Tanilba Bay	Peace Parade, Tanilba Bay	One lane concrete ramp.	One lane concrete ramp.	Suitable for high tide use only.	Port Stephens Council

Table 9.1 – Existing Port Stephens Boat Ramps (cont)

Facility	Location/Management Zone	Description	Associated Facilities	Issues/Constraints	Owner/Manager
Karuah Boat Ramp	Karuah – upstream from the Pacific Highway Bridge, on the western bank of the Karuah River Management Zone D	A two lane grooved reinforced concrete ramp that extends down to mean low tide level.	Immediately adjacent to Karuah Wharf. Car parking provided at the eastern end of Memorial Drive.	Launch and retrieval operations from the ramp can be difficult when north-westerly winds and ebb tide conditions coincide. Potential to be upgraded to regional facility.	Port Stephens Council
Allworth Boat Ramp	Allworth Management Zone D	Concrete ramps and concrete sleepers.	Unsealed car park.	Appropriate for the size of community and the general level of usage.	Great Lakes Council
Bundabah Boat Ramp	Bundabah Management Zone E	Gravel ramp to a gently sloping sandy mud beach. Used by local community.	Adjacent unsealed car parking area.	Tide goes out over 100 m making the ramp unsuitable other than during a few hours either side of high tide. Ramp is below standard. Car park is flooded at higher tides.	Great Lakes Council
Lower Pindimar Boat Ramp	South Pindimar – northern end of Curlew Street Management Zone E	One lane concrete/gravel ramp.	Ample parking along road reserve.	Allows direct access to the beach during low tide, and allows for launching of most trailerable craft around 2 hours either side of high tide. High usage. A new jetty has been proposed adjacent to the boat ramp. This could provide access to the Port Stephens ferry service.	Great Lakes Council
Pindimar informal boat ramps	North Pindimar – Warri Street and Wombo Street Management Zone E	This area is characterised by shallow waters and a gently sloping sandy bed. Boat launching is only possible at higher tides.		Kyah Street Road Reserve (between Bulga Street and the water's edge) and Lot 29 Bulga Street have been identified by the local community as a suitable location for the development of a boat ramp, car parking area and community park.	Great Lakes Council

Table 9.1 – Existing Port Stephens Boat Ramps (cont)

Facility	Location/Management Zone	Description	Associated Facilities	Issues/Constraints	Owner/Manager
Tea Gardens Regional Boat Ramp	Tea Gardens – Marine Drive, immediately upstream and west of the 'Singing Bridge' Management Zone F3	A multiple lane ramp suitable for large craft.	Car park, washdown and fish cleaning facilities and a loading pontoon on a jetty.	Exposed to winds from the NE and river currents. Limited beaching area. Traffic direction from Marine Drive to Myall Street is one way and causes some traffic conflicts.	Great Lakes Council
Ogden Street/Marine Drive Boat Ramp (Police Station Ramp)	Tea Gardens – Ogden St/Marine Drive, near the Police Station Management Zone F3	Two lane concrete launching ramp. Heavily used by both the local community and visitors. Offers protected launching and a large beach landing area.	Fish cleaning table. Unsealed car park area.	Limited parking and proximity to residential dwellings. The presence of powerlines makes the ramp dangerous for vessels with masts.	Great Lakes Council
Coupland Street Boat Ramp	Tea Gardens – Coupland Street. Management Zone F3	Gravel ramp accessed from the grass road reserve.		Mainly used by locals and by owners of boats moored in the adjacent area.	Great Lakes Council
Moira Parade Boat Ramp	Hawks Nest – Moira Parade Management Zone F3	Two lane concrete ramp that accesses deep water.	Car park (unsealed), playground, toilet facilities, fish cleaning table.	Exposed to southerly weather and currents. Has defective drop off at one side resulting in trailer wheels becoming caught during low tide launching. The ramp could also be extended to allow for larger vessels during low tide.	Great Lakes Council
The Anchorage Ramp	Winda Woppa –- Corner of Jacaaba Street and The Anchorage Management Zone F2	A single lane concrete ramp with concrete sleepers extending into deeper water.	Car park 150 m to the west.	Well protected from tidal currents and suitable for medium to small trailerable craft. High usage. Proximity to residential dwellings results in some conflicts particularly with regard to noise at night time.	Great Lakes Council

9.1.1 Southern Shoreline of Outer Port (Management Zones A1, A2, A3 and B1)

Four public boat ramps service the Tomaree Peninsula between Shoal Bay and Soldiers Point. This area supports the highest residential populations as well as the most popular tourist destinations in Port Stephens. The ramps are not evenly distributed along the foreshore with no ramp available between Little Beach and Soldiers Point (Salamander Shores). Little Beach is the most utilised ramp along this shoreline. This facility provides quick access to the open ocean, as well as to the sandy bays and clear waters of the outer port. The associated reserve and public amenities are utilised heavily by boaters who tend to return to the area to use the amenities and picnic/barbecue facilities. The facility becomes extremely overcrowded during peak periods. This, along with the fact that the use of the ramp can be difficult during certain conditions, has led to a number of accidents and near misses. The expansion of this facility is not an option. The carrying capacity of the associated car park is not adequate, and the environmental impact to the surrounding aquatic ecology cannot be justified (although options to improve the safety of the facility should be investigated). The fact that a Sanctuary Zone has been identified in the surrounding area (draft Marine Park Zoning 2006) also has the potential to constrain any expansion to the Little Beach facilities.

The relatively short length of the Shoal Bay Boat Ramp means that the size of the boats that utilise it is restricted. Its single lane also restricts the volume of usage. Expansion of this ramp is constrained by the important aquatic habitat in the area (seagrass), the impact the structure has on the natural littoral drift along Shoal Bay Beach, and the area available for parking, manoeuvring and other facilities. This ramp is favoured by people with smaller craft such as jet skis.

Salamander Bay Boat Ramp is a steep single lane ramp with very limited manoeuvring and parking space. It is also subject to high wave activity in certain conditions. Upgrade and expansion of this ramp is constrained by the very limited access and space available in the area.

Soldiers Point Boat Ramp is a three lane ramp that is limited by the lack of a loading/unloading facility (e.g. jetty or pontoon). Despite other limitations (e.g. access and parking space), it is considered that there is potential for this ramp to be expanded and improved so that it fulfils the requirements of a regional scale ramp. Council is currently preparing the *Soldiers Point Boating Infrastructure and Foreshore Management Plan* which will guide the design and construction of improved facilities.

As discussed in **Section 9.0**, there are currently no detailed statistics regarding the volume and timing of usage of each boat ramp. The installation of classified traffic counters at each facility during a peak period and a non-peak period would therefore provide useful information regarding usage of facilities. Long term management action could then be based on a sound understanding of waterway access requirements.

More evenly distributing the usage of waterway facilities around Port Stephens, particularly around the southern shoreline, is considered to be the optimal short term management option to reduce congestion at Little Beach. Distributing use would involve expanding some facilities and encouraging the use of the range of available facilities. The strategy would involve:

- upgrading the Shoal Bay Boat Ramp and formalising the associated car park. Encouraging the use of this facility by motorised sports craft (jet skiers) and other small motorcraft. The upgrade should also consider the needs of the commercial fishers who utilise this ramp (seasonal);

- encouraging boaters away from Little Beach to other facilities such as Soldiers Point and Lemon Tree Passage Boat Ramps. Encouraging picnickers and other users of the Little Beach Reserve to other reserves along the southern shoreline, e.g. Bagnalls Beach Reserve, reserves at Lemon Tree Passage such as Beach Road Reserve and Kooindah Park;

- encouraging passive watercraft users such as wind surfers and kayakers to use the western end of Bagnalls Beach to launch their craft (there is a firmer substrate at this end of the beach and relatively less seagrass);

- upgrading Salamander Bay Boat Ramp to make a more user friendly local scale boat ramp and an alternative ramp to use during winter/westerly conditions. NSW Maritime Authority has suggested attaching a pontoon to the adjacent jetty (Matt Davis, pers. comm. July 2006);

- upgrading Soldiers Point Boat Ramp to a regional scale facility;

- upgrading Taylors Beach boat ramp to make a more user friendly local/tourist facility;

- upgrading and standardising all signage at all boat ramps. These will provide instructions regarding the efficient use of the boat ramp, general regulations, and information about alternative facilities; and

- disseminating information about the range of waterway facilities available throughout Port Stephens through Council and community news letters, advertising in the local media, producing appropriate tourist information (tourist information centres, Council and tourism websites).

Figure 9.2 shows suggested management actions to improve waterway access in Port Stephens.

9.1.1.1 Tilligerry Peninsula (Management Zones B2, B3 and C1)

There are currently four public boat ramps along the foreshore of the Tilligerry Peninsula. These, particularly the Lemon Tree Passage facility, are suitable for more intensive use and so could take some of the pressure from the Tomaree Peninsula ramps. The following strategy is proposed:

- upgrade the Lemon Tree Passage facility to a regional scale facility (see **Figure 9.2**);

- upgrade the Lilli Pilli boat ramp (Lemon Tree Passage) to make a more user friendly local scale facility;

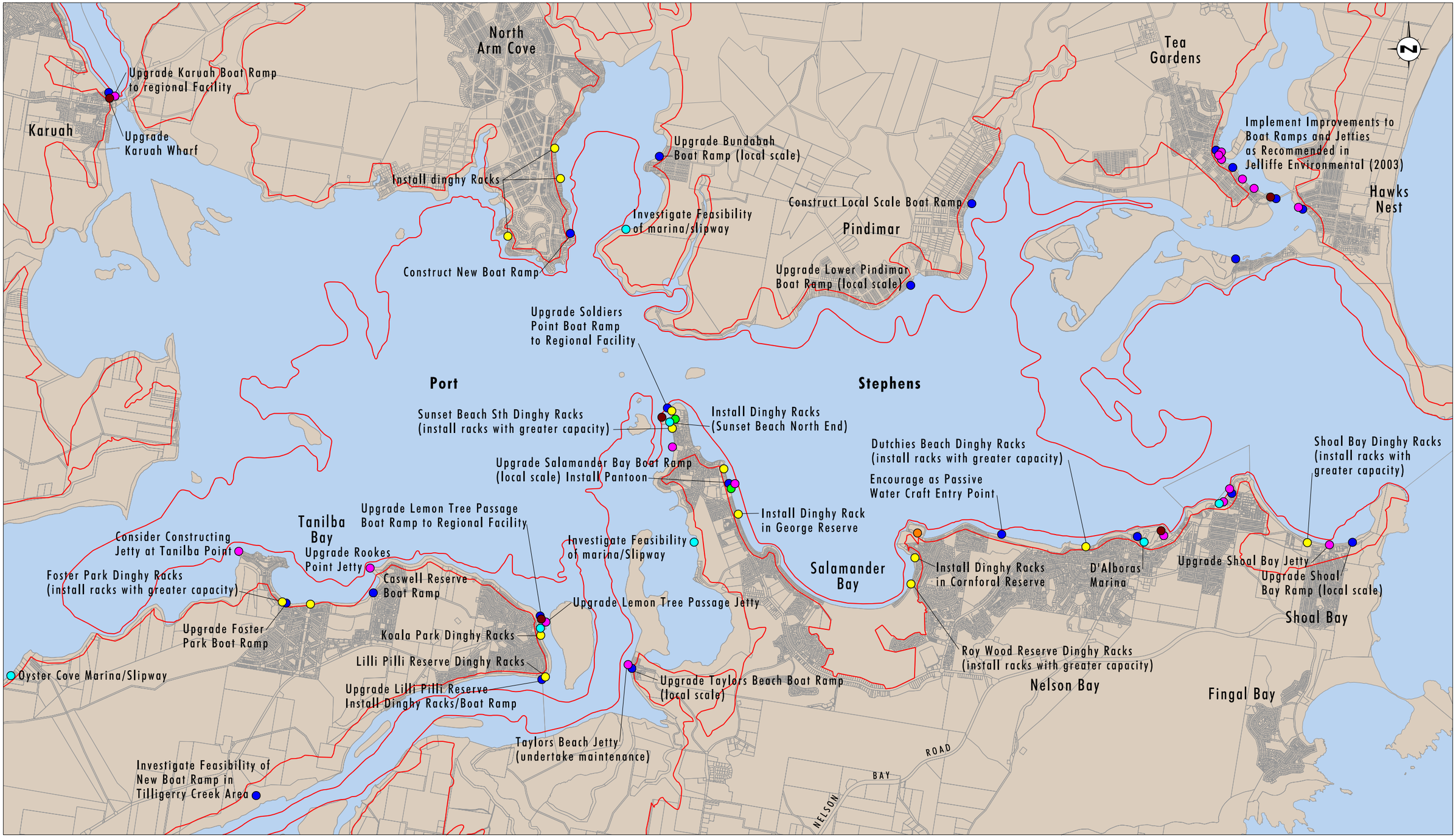
- remove Caswell Reserve Boat Ramp;

- remove informal boat ramps along the Tanilba Bay foreshore;

- upgrade Foster Park boat ramp, Tanilba Bay to make a more user friendly local/tourist facility;

- upgrade and standardise all boat ramp signage (as above); and

- disseminate information about the range of waterway facilities available throughout Port Stephens (as above).



Source: LPI NSW (2000), Great Lakes Council (2006), Port Stephens Council (2006)
Note: Seaward study area boundary defined by -2 metre (AHD) contour.

Legend

- Study Area
- Boat Ramp
- Club
- Dinghy Rack
- Jetty/Wharf
- Marina
- Marina/Slipway
- Pumpout

FIGURE 9.2

Identified Management Action For Waterway Facilities

A long term option for waterway access in the Inner Port is from land formerly utilised for oyster farming along Tilligerry Creek. The land formerly used by Shepherds Oyster Farm is one potential location.

9.1.1.2 Karuah River (Management Zone D)

The Karuah boat ramp is suitable for more intensive usage by local residents, residents of the nearby regional centres of Raymond Terrace, Medowie and even Newcastle, as well as tourists. This facility provides excellent access to the Karuah River and the inner port and it is suggested that it be upgraded to a regional facility.

The Allworth boat ramp provides adequate access to the local residents of the upper Karuah River.

9.1.1.3 Northern Shoreline (Management Zone E)

The majority of the northern shoreline is undeveloped and the waterway access in each of the villages either consists of an informal ramp or small basic ramps that require upgrading and maintenance. The shoreline and waterway access facilities are generally utilised by local residents. There are very few public facilities that would attract tourists or day trippers. The main management strategy for the waterway access facilities in this area involves constructing/upgrading local scale facilities in each foreshore village (see **Figure 9.2**). The adequacy of these facilities should be reviewed at least every five years as the population in these areas increases.

North Arm Cove

The majority of the foreshore of North Arm Cove is privately owned. Residents in the foreshore allotments therefore have direct access to the water and utilise private ramps (many of which are unauthorised). There are no public boat ramps or jetties in the area. Non waterfront residents generally utilise boat ramps in other towns or informal private facilities in the area.

Public Reserve 521 Cove Boulevarde has been identified as the most suitable location for both a boat ramp and jetty (Jelliffe Environmental 2003:32) (see **Figure 9.2**). There is both support and opposition amongst North Arm Cove residents for such facilities. The need for a public jetty is considered less urgent.

Bundabah

The Bundabah boat ramp is a local scale facility consisting of a gravel ramp and unsealed car park. Its location is shown on **Figure 9.1**. The entire facility is currently below standard. Jelliffe Environmental (2003:63) recommended that the ramp be upgraded (to a single land concrete ramp), the adjacent drainage issues be addressed, and the car park be improved and formalised.

North Pindimar and South Pindimar

The only formal boat ramp in this area is located at the eastern end of Curlew Street in Lower Pindimar. This can only be utilised around high tide because the gently sloping beach results in the tide receding over 150 metres from shore. The majority of users of this concrete ramp are local. There is ample parking in the adjacent road reserve.

At Pindimar, informal ramps are located at the ends of Warri Street and Wombo Street. Again, these can only be utilised around high tide. The parking is inadequate in these areas.

This area of the foreshore is popular with swimmers and so there is some potential for accidents to occur (Jelliffe Environmental 2003:22-26).

The Kyah Street road reserve and Lot 29 Bulga Street, Pindimar have been identified as a potential site for a community park with boating facilities (a concrete boat ramp), car parking area and a safe swimming area (Jelliffe Environmental 2003:23, 26) (see **Figure 9.2**).

9.1.1.4 Tea Gardens, Winda Woppa and Hawks Nest (Management Zones F2 and F3)

Tea Gardens

The village of Tea Gardens services the numerous recreational boat users and tourists visiting the Port Stephens area, and this forms a substantial component of the area's economy. It is well positioned to service both sea going vessels and those visiting the Myall Lakes area (although the Myall River to the north of the town is shallow and so the size of boats entering this area is restricted).

The regional boat ramp is located at Tea Gardens and consists of a multi-lane ramp that is suitable for the launching of large and small craft (see **Figure 9.1**). There are two other boat ramps within Tea Gardens. The Odgen Street/Marine Drive Ramp (Police Station Ramp) is a two-lane ramp heavily used by both locals and visitors, and the Coupland Street Ramp is a gravel ramp generally only used by locals.

These facilities experience overcrowding in peak periods, trailer parking is particularly critical during these times. There are no major issues associated with these ramps, although the Regional Boat Ramp at Tea Gardens is exposed to river currents and NE winds, and traffic conditions in the area occasionally cause problems. The Police Station Ramp is in close proximity to local residences and the presence of powerlines poses a danger to vessels with masts.

Jelliffe Environmental (2003:39-63) made recommendations with regard to the boat ramps in Tea Gardens. These generally involve improvements to each ramp's associated facilities and are detailed in **Section 12.0**.

Winda Woppa

The Anchorage Ramp, at the corner of Jacaaba Street and The Anchorage, Winda Woppa is suitable for the launching of medium to small vessels. It is a single lane concrete ramp and is well protected from tidal currents. Its proximity to residences causes some inconvenience. Jelliffe Environmental (2003:36-37) recommended a minor upgrade to this ramp.

Hawks Nest

Access from the Myall River to Hawks Nest is provided by the Moira Parade Boat Ramp. The two-lane concrete ramp accesses deep water. No specific management action is required.

9.1.2 Jetties

The jetties along the Port Stephens foreshore are used by recreational fishers, recreational boaters (as a holding point for boats using adjacent ramps), commercial fishing and charter operators, public ferries, and tourists utilising them as vantage points.

The majority of public jetties along the Port Stephens foreshore are owned by Port Stephens or Great Lakes Councils. Each jetty is described in **Table 9.2**. **Figure 9.1** shows their location. An assessment of the facilities within the Port Stephens LGA was undertaken

in 1997 (Patterson Britton & Partners Pty Ltd (PB&P) 1997). Jelliffe's (2003) *Waterways Facilities Management Strategy* assessed the jetties located along the northern shoreline. The observations and recommendations made in these reports are incorporated below.

Table 9.2 – Port Stephens Jetties

Facility	Location	Description	Associated Facilities	Issues/ Constraints	Owner/ Manager
Shoal Bay Wharf	Shoal Bay – intersection of Shoal Bay and Tomaree Roads, midway along Shoal Bay Beach Management Zone A1	A timber wharf and reinforced concrete extension. Suffering decay. Major remaining function is a vantage point for tourists and for recreational fishing.	None.	Berthing at the wharf often dangerous due to exposure to ocean swell conditions and large open fetches.	Port Stephens Council
Little Beach Jetty (1)	Little Beach – eastern end of Little Beach Management Zone A1	Timber jetty that is tailored toward providing access to the emergency response equipment shed used by the NSW Maritime and the NSW Fire Brigade. Also used as an embarkation point for estuary and offshore fishing charter operations and ecotourism exhibitions, and holding point for the adjacent boat ramp.	Little Beach Boat Ramp.	Water depths less than 1.5m at low tide restrict the type of boat that can use the jetty at low tide. Exposed to westerly winds which can cause problems for berthing and mooring.	NSW Maritime / Port Stephens Council
Little Beach Jetty (2)	Little Beach – western end of Little beach Management Zone A1	Timber jetty	Swimming area.	Provides disabled access to swimming area. Exposed to westerly winds.	Port Stephens Council
Nelson Bay Public Wharf	Nelson Bay – within boat harbour Management Zone A1	Can be accessed from the eastern breakwater.	Marina, etc.	None.	Port Stephens Council
Salamander Bay Jetty	Soldiers Point Road, Salamander Bay Management Zone A3	Substantial timber jetty.	Salamander Bay Boat Ramp.	Exposed to high waves in certain conditions.	Port Stephens Council

Table 9.2 – Port Stephens Jetties (cont)

Facility	Location	Description	Associated Facilities	Issues/ Constraints	Owner/ Manager
Taylors Beach Jetty	Taylors Beach – western end of Taylors Beach Road Management Zone B1	Timber jetty with concrete encased piling. Predominantly used by local recreational boat owners as holding point for adjacent boat ramp, also a tourist vantage point. Not used by charter vessels.	Taylors Beach Boat Ramp.	Use limited by shallow water depth. Can only service small craft and can only be used as a berthing point when water levels are above mid-tide level. Boats using the beach have been damaged during windy conditions when blown onto pockets of loose rock.	Port Stephens Council
Cromarty Village Jetty	Soldiers Point – Sunset Beach	Substantial timber jetty with private marina at seaward end.	None.	Landward end is for public use.	Private/Port Stephens Council
Lemon Tree Passage Jetty	Lemon Tree Passage - Henderson Park, adjacent to Lemon Tree Passage Tidal Baths Management Zone B3	Timber jetty forms the perimeter of the Lemon Tree Passage Tidal Baths. Predominantly used by the general public, occasionally used by charter vessel operators. Not used by local professional fishermen.	Lemon Tree Passage Boat Ramp.	Shallow water depths restrict use of jetty by large vessels at low tide.	Port Stephens Council
East and West Public Wharves	Tea Gardens - between Maxwell St and Charles Street Management Zone F3	Eastern wharf is timber decked with external timber piles. Western wharf is decked with plywood and sealed with asphalt. Used by a range of different private craft and commercial operations, and the ferry service to Port Stephens.	Ferry landing pontoon and bridge at western end. Grassed pedestrian area adjacent to western wharf. Car parking area.	Lack of fresh water supply. Submission made to allow limited vehicular access to western wharf.	Great Lakes Council

Table 9.2 – Port Stephens Jetties (cont)

Facility	Location	Description	Associated Facilities	Issues/ Constraints	Owner/ Manager
Tambo Queen Jetty	Tea Gardens – Marine Drive Management Zone F3	A wooden structure with a floating pontoon on the downstream side. A public structure but has been used more recently as a home base for a commercial operation. The jetty is useful for the boarding and landing of larger craft, but the pontoon is too high for easy boarding from smaller vessels.	None.	Lack of potable water supply (critical lack of watering points at Tea Gardens noted). Usage would increase if pontoon was lowered.	Great Lakes Council
Old Police and Fisheries Wharves	Tea Gardens – Marine Drive, between Hough Street and Iluka Street Management Zone F3	Twin narrow wooden structures separated by approximately 5.4 m. Originally used by Fisheries and Police boats but no longer formally used. Public access now prohibited due to state of disrepair.	Nearby car parking area.	Development proposals being considered by Council.	Great Lakes Council
Regional Boat Ramp Jetty	Tea Gardens – Marine Drive Management Zone F3	Timber jetty with pontoon adjacent to boat ramp.	Boat ramp.	None.	Great Lakes Council
Moira Parade Wharf	Hawks Nest – Moira Parade Management Zone F2	A relatively new public wharf. Provides the only access to the town of Hawks Nest from the Myall River. Suitable for a range of craft.	Boat ramp.	None.	Great Lakes Council
Karuah Wharf	Karuah – upstream from the Pacific Highway Bridge, on the western bank of the Karuah River Management Zone D	Timber jetty on concrete piles. Primarily used by boat users using the adjacent boat ramp. Occasionally used by charter boat operators.	Immediately adjacent to Karuah Boat Ramp. Car parking provided at the eastern end of Memorial Drive.	In a serious state of disrepair.	Port Stephens Council
Allworth Jetty	Allworth Management Zone D	Wooden jetty.	Unsealed car park.	Appropriate for the size of community and the general level of usage.	Great Lakes Council

9.1.2.1 Southern Shoreline of Outer Port (Management Zones A1, A2, A3 and B1)

There are public jetties located at Shoal Bay, Little Beach and within Nelson Bay Harbour. The Shoal Bay Jetty is in a poor state of repair. PB&P (1997) suggested two options: demolish the existing jetty and build a new jetty at the eastern end of the beach adjacent to the Shoal Bay Boat Ramp; or undertake a major upgrade of the existing jetty. It is suggested that the existing jetty be repaired and upgraded for the following reasons:

- the jetty is a focus for recreational activities. The existing location of the jetty in front of the shopping village means that the jetty is heavily used as a vantage point by tourists and people who use the local shops and cafes. People often make their purchase and then walk along the foreshore and jetty;

- the jetty is ideally situated for use by commercial waterway recreation operators and fishing and charter operators;

- the car parking facilities at the eastern end of the beach does not have the capacity for large numbers of vehicles that are not utilising the boat ramp; and

- the construction of a jetty at the eastern end of the beach would impact significant seagrass beds.

The Little Beach jetties are heavily used. They should be maintained to a high standard for both safety and aesthetic reasons (see **Figure 9.2**). The area in which the jetties are located is within a sanctuary zone of the Port Stephens-Great Lakes Marine Park (Draft Zoning 2006) which does not allow any form of recreational fishing. Recreational fishing from this jetty and the adjacent beach is currently a popular activity.

The jetty within Nelson Bay Harbour is used by the Newcastle and Port Stephens Game Fishing Club, by various fishing and charter operators and by the general public. No specific management action is required. Similarly, there is no specific management action required for the relatively new Salamander Bay Jetty.

A new jetty adjacent to the Soldiers Point Boat Ramp is currently being investigated by Port Stephens Council (see the *Soldiers Point Infrastructure and Foreshore Management Plan* (in progress)).

Taylors Beach Jetty is used as a holding point for boaters using the adjacent boat ramp and as a tourist vantage point. PB&P (1997) recommended some minor structural maintenance and additional safety requirements. These suggestions have been adopted as a management action in the current Plan. The foreshore erosion and accretion associated with this structure is discussed in **Section 10.2.5**.

9.1.2.2 Tilligerry Peninsula (Management Zones B2, B3 and C1)

The Lemon Tree Passage Jetty and Rookes Point Jetty are the only public jetties along this section of the foreshore, following the removal of the Rudd Reserve Jetty. PB&P (1997) suggested a number of additional safety requirements for the Lemon Tree Passage Jetty but its basic structure was found to be adequate. The Lemon Tree Passage Boat Ramp has been identified as being suitable for upgrade to a regional facility. Upgrades to the jetty would be incorporated into such a facility (see **Figure 9.2**).

The Rookes Point Jetty is a very small structure that is in need of maintenance. The adjacent car park and access road also require maintenance. The facility is generally only used by local residents.

PB&P (1997) suggested that a jetty at Tanilba Point would be welcomed by Port Stephens commercial charter operators who believe that it would be an ideal mid-trip destination for tourists wanting to explore the port. Such a facility would also provide a focus for recreational activities in this section of the port. This suggestion has been adopted as a management action.

9.1.2.3 Karuah River (Management Zone D)

The Karuah Jetty, adjacent to the Karuah Boat Ramp is in a poor state of repair. Like Soldiers Point and Lemon Tree Passage, Karuah has been identified as a suitable location for a regional boat ramp facility. Improvements to the Karuah Jetty would be incorporated into such a facility.

There is no specific management action required for Allworth Jetty which is considered adequate for its usage level.

9.1.2.4 Northern Shoreline (Management Zone E)

There are no public jetties along this section of the foreshore, although there are numerous private jetties in the North Arm Cove and Pindimar areas. Many of the private structures are not authorised. This issue is discussed further in **Section 10.5.1**. A public jetty at Lower Pindimar, adjacent to the existing boat ramp, has been suggested by Jelliffe (1997).

9.1.2.5 Tea Gardens, Winda Woppa and Hawks Nest (Management Zones F2 and F3)

There are six public jetties along the Tea Gardens foreshore. An assessment of each structure was undertaken by Jelliffe (2003) and a management strategy for each facility suggested. The Moira Parade Jetty at Hawks Nest is relatively new and no management action is required.

9.1.3 Dinghy Racks

Table 9.3 lists the location and adequacy of dinghy storage facilities around the foreshore. The table also notes locations which do not currently have dinghy racks but require such facilities. The location of existing dinghy racks is shown on **Figure 9.1**. Suggested management actions are shown on **Figure 9.2**. Where replacement racks are required, it is suggested that vertical racks are used. These generally have a larger capacity per unit area occupied. The visual impact of these racks should be considered during placement.

Table 9.3 – Dinghy Racks

Location	Capacity/Comments	Recommendations
Shoal Bay (central area)	2 dinghy racks – capacity of approximately 6 and 20. Visually obtrusive and inadequate capacity.	Replace with larger dinghy rack. Place in visually unobtrusive location, e.g. western end of central reserve.
Dutchies Beach	1 dinghy rack – capacity of approximately 15. Inadequate capacity	Replace with larger dinghy rack or install an additional rack.
Cornford Reserve, Corlette (Salamander Bay)	No facilities. Numerous dinghies moored in bay.	Install dinghy rack in visually unobtrusive location.
Roy Wood Reserve, Salamander Bay	2 dinghy racks – capacity of approximately 25 each.	Install additional dinghy racks.
George Reserve, Salamander Bay	No facilities. Numerous dinghies stacked in this reserve and foreshore reserve behind beach.	Install dinghy rack in visually unobtrusive location.
Reserve immediately east of Kangaroo Point, Soldiers Point	1 dinghy rack – capacity of approximately 8.	No specific recommendations.
Soldiers Point (Boat Ramp area)	1 dinghy rack – capacity of approximately 8.	Move rack to location which does not impinge on picnic/recreation area (see *Soldiers Point Infrastructure and Foreshore Management Plan* (in progress)).
Sunset Beach (north end), Soldiers Point	No facilities. Numerous dinghies stacked in this reserve.	Install dinghy rack in visually unobtrusive location.
Sunset Beach (south end), Soldiers Point	1 dinghy rack – capacity of approximately 6.	Replace with larger dinghy rack or install an additional rack. Place in visually unobtrusive location.
Taylors Beach Reserve	No facilities. Numerous dinghies stacked in this reserve.	Install dinghy rack in visually unobtrusive location.
Lower Tilligerry Creek Reserve, end of Crawley Avenue and Blanch Street (Lemon Tree Passage)	No facilities. Numerous dinghies stacked in these locations.	Install dinghy rack in visually unobtrusive location.
Lilli Pilli Boat Ramp Area, Lemon Tree Passage	1 dinghy rack – capacity of approximately 8.	Replace with larger dinghy rack or install an additional rack. Place in visually unobtrusive location.

Table 9.3 – Dinghy Racks (cont)

Location	Capacity/Comments	Recommendations
Koala Park, Lemon Tree Passage	1 dinghy rack – capacity of approximately 8.	No specific recommendations.
Peace Park, Tanilba Bay	1 dinghy rack – capacity of approximately 6.	No specific recommendations.
Foster Park, Tanilba Bay	1 dinghy rack – capacity of approximately 6. Inadequate capacity.	Replace with larger dinghy rack or install an additional rack. Place in visually unobtrusive location.
Casuarina Park, Eastslope Way, North Arm Cove	No facilities. Numerous dinghies stacked in this reserve.	Install dinghy rack in visually unobtrusive location.
Waters Street Reserve, North Arm Cove	No facilities. Numerous dinghies stacked in this reserve.	Install dinghy rack in visually unobtrusive location.
Heroes Bay Reserve, North Arm Cove	No facilities. Numerous dinghies stacked in this reserve.	Install dinghy rack in visually unobtrusive location.
Bundabah Boat Ramp Area	No facilities.	Install small dinghy rack in visually unobtrusive location.
Kyah Street, North Pindimar	No facilities. Numerous dinghies stacked in this reserve.	Install dinghy rack in visually unobtrusive location.

9.1.4 Marinas, Slipways and Aquatic Clubs

Port Stephens is one of the state's most popular waterways for recreational boating, fishing and watersports. There are numerous commercial and recreational clubs that revolve around these popular activities. **Table 9.4** summarises the marinas and aquatic clubs around the foreshore. **Figure 9.1** shows their location.

Table 9.4 – Marinas and Aquatic Clubs

Marina/Aquatic Club	Location	Description	Comments/Issues
Little Beach Marina (and slipway)	Little Beach (western end)	Commercial operation that provides berths for recreational craft, slipway, fuelling facilities.	Potential water pollution source.
d'Albora Marina (and slipways)	Nelson Bay – within boat harbour	Commercial operation that provides 150 berths for recreational craft, as well as 22 berths for commercial fishing vessels. Slipways and fuelling facilities.	Potential water pollution source. Expansion planned.
The Anchorage Marina	Corlette Beach – southern end of Corlette Beach	Commercially operated marina with 90 berths, fuelling facilities.	Potential water pollution source.
Lemon Tree Passage Marina (and slipway)	Lemon Tree Passage – at mouth of Tilligerry Creek	Provides 34 berths, slipway, fuelling facilities.	Potential water pollution source.
Soldiers Point Marina (and slipway)	Soldiers Point – Sunset Boulevarde	90 berth marina, slipways, fuelling facilities.	Potential water pollution source.
Oyster Cove Marina (and Slipways)	Oyster Cove	Slipways.	Potential water pollution source.
Salamander Bay Sailing Club	Seaview Crescent, Soldiers Point	Clubhouse, boat ramp, beach.	Parking restricted due to lack of space.
Port Stephens Yacht Club	Ridgeway Ave, Soldiers Point	Clubhouse, lookout.	New premises are planned behind the Soldiers Point Boat Ramp Car Park.
Karuah Motor Yacht Club	Karuah Waterfront, off Pacific Highway	The club currently uses a former oyster shed on former Oyster Lease 73-406 on the western bank of the Karuah River, downstream of the Karuah Bridge. The Club has made submissions to the Department of Lands for a long term lease. A decision is yet to be made. The Club has also submitted a tender to lease a less preferable alternative site, in case the original submission is refused.	The site on the western bank of the Karuah River and downstream of the Karuah Bridge is the optimal site. The Club would make a positive social and economic contribution to the local economy.

The major issues associated with the slipways in Port Stephens are potential water quality impacts if not properly managed. The major issue associated with marinas is an under-supply of berths.

Water Quality

Concern has been expressed about the environmental impacts existing slipways are having on the Port Stephens waterway. The existing slipways are generally located within marinas. An audit of each slipway is proposed and a strict timetable for non-complying slipways to conform with environmental regulations is suggested.

There is also a national voluntary environmental accreditation system for marinas. The Clean Marinas – Australia Program has been established by the Marina Association of Australia (MAA) with the objective of reducing pollution in Australia's waterways. There is a three step accreditation process:

- The Pledge. A statement of intention to improve environmental management systems.
- Self-Assessment. The marina works through a series of checklists.
- Certification. When the marina is satisfied that it meets the qualifications for certification, the MAA will visit and verify that the marina is clean.

The MAA lists the benefits of certification as: it minimises the potential for environmental fines and prosecutions; it improves company image and increases customer patronage; it increases confidence with the government, community, neighbours, etc; it delivers short and long term cost savings; and it improves environmental conditions for everyone.

Under-Supply of Marina Berths and Dry Storage Areas

Boat owners and marina operators have reported that there are not enough marina berths available in Port Stephens, particularly during large events such as the Game Fish Competition (Matt Davis, NSW Maritime Authority, email May 2006). As discussed in **Section 9.0** the number of recreational boats on Port Stephens is likely to continue to increase as the tourist and residential population grows and the affluent 'Baby Boomer' generation retires.

Cromarty Bay has been suggested as a potential long term location for a marina if the oyster industry leaves the area. A Special Purpose Zone has been identified in the Draft Marine Park Zoning Plan (2006) for this area. Oyster Cove may also be a long term option for the location of a marina.

There are no marinas currently servicing the northern shoreline of Port Stephens. There is certainly a need for such a facility and it is recommended that investigations for a suitable site commence immediately. Options include Tea Gardens and the Bundabah/Fame Cove area.

A dry storage area on the southern and northern side of Port Stephens is also desirable. The increase in the number of smaller trailer boats using Port Stephens is amenable to this type of storage. Investigations for suitable sites should commence immediately. Suggested locations include Tilligerry Creek (former oyster lease areas), the Salamander Bay industrial area, Oyster Cove, Tea Gardens, and Karuah. The feasibility of dry storage areas within existing marinas should also be considered.

It is assumed that any new marina in Port Stephens would incorporate a slipway and that such a facility would be designed to minimise environmental impacts.

9.1.5 Moorings

Mooring areas are located in many areas adjacent to the southern shoreline, in Tilligerry Creek, Big Swan Bay, Karuah River, Heroes Bay, North Arm Cove, Lower Pindimar, Pindimar, and in the lower section of the Myall River (see **Figure 9.1**).

Emergency moorings are located at:

- Shoal Bay;
- Lemon Tree Passage (mouth of Tilligerry Creek);
- Winda Woppa; and
- Tea Gardens.

Public moorings are located at:

- Nelson Bay (3); and
- Fame Cove (3).

All of the mooring areas are located in areas where seagrass beds are known to occur. The impact of anchors on aquatic habitat should be considered. The NSW Maritime Authority will release a Mooring Management Plan for Port Stephens in 2007.

9.1.6 Pump-Out Facilities

Pump-out facilities within Port Stephens are located at:

- Karuah Public Wharf;
- Lemon Tree Passage Jetty;
- Anchorage Marina, Corlette;
- d'Albora Marina, Nelson Bay;
- Nelson Bay Public Wharf;
- Soldiers Point Marina; and
- Tea Gardens Wharf.

There are adequate pump-out facilities in Port Stephens (Estuary Management Committee pers. comm. April 2006), although their level of usage could be improved. It is suggested that the facilities be serviced regularly and that their adequacy be reviewed every five years.

9.1.7 Foreshore Reserves Utilised by Boaters

The foreshore reserves and beaches which are most commonly utilised by boat based people for picnicking and recreation are:

- Shoal Bay. This is a popular place to anchor for the day and/or to access the cafes and shops of Shoal Bay village;

- Little Beach. This is also a popular area to anchor in. Additionally, boat users return to Little Beach in the middle part of the day to access the reserve facilities and café;

- Soldiers Point. This is also the venue for yacht/boat races;

- Fame Cove. This is a very popular anchoring location. Boaters are attracted to the area for its natural beauty and undeveloped nature; and

- Tea Gardens. This area provides easy access to cafes, shops and other facilities.

These areas become overcrowded during peak periods. More even distribution of usage is considered necessary and, as for boat ramps, the provision of information about alternatives is considered to be the most effective way to do this (through signage, tourist information and local media and newsletters).

Locations which are appropriate for more intensive usage by boat based people are:

- Conroy Park, Corlette;

- Western Salamander Bay (Wanda Beach);

- Taylors Beach Reserve;

- Lemon Tree Passage;

- Tanilba Bay (Peace Park and Foster Park);

- Karuah River (Longworth Park); and

- South Pindimar (Curlew Ave foreshore Reserve).

Specific management action required to facilitate this usage in each area is contained in **Section 12.0**.

9.1.8 Current Management

The majority of waterway access facilities are managed and maintained by Port Stephens Council and Great Lakes Council. Both Councils carry out intermittent inspections of each facility. Broad assessments of facilities have also been commissioned by the Councils, e.g. PB&P (1997) and Jelliffe (2003). Through these assessments and inspections both Councils are aware of the pressure on existing facilities and a general long term strategy to manage waterway access requirements has been identified. A more detailed and precise strategy could be established with reliable statistical information obtained from classified traffic counters. Funding is the key requirement to progress the maintenance, upgrades and construction of new facilities.

9.1.9 Identified Management Action

General recommendations have been suggested throughout the preceding sections. A prioritised list is summarised in **Table 9.5**. Detailed management actions for individual waterway access facilities are contained in **Section 12.0**.

Table 9.5 – Management Action for Waterway Access Facilities

Relevant Management Zone	Identified Management Action
Whole of foreshore	Install classified traffic counters at all boat ramps during a peak and off-peak period.
Whole of Foreshore	Upgrade and standardise all signage at boat ramps (include directions to alternative facilities).
Whole of Foreshore	Disseminate information about the range of waterway access facilities (and reserves easily accessible by boaters) available around Port Stephens.
Whole of Foreshore	Implement recommendations with regard to dinghy racks (see **Section 9.1.3**).
Whole of Foreshore	Investigate a suitable site for a new marina (and slipway) and dry boat storage site on both the southern side and northern side of Port Stephens.
A1/A2/A3	Investigate suitable location for additional boat ramp.
A1/A2/B1/C2	Undertake environmental audits of all marinas and slipways. Enforce a strict compliance timetable.
A1	Upgrade Shoal Bay Boat Ramp.
A1	Upgrade the Shoal Bay Jetty.
A2	Encourage the use of Bagnalls Beach by passive watercraft users.
A3	Upgrade Salamander Bay Boat Ramp to more user friendly local scale facility.
B1	Upgrade Soldiers Point Boat Ramp to a regional scale facility (as per *Soldiers Point Infrastructure and Foreshore Management Plan* (in progress)).
B1	Upgrade Taylors Beach Boat Ramp to more user friendly local scale facility.
B1	Construct jetty at Soldiers Point (as per *Soldiers Point Infrastructure and Foreshore Management Plan* (in progress)).
B1	Undertake structural maintenance on Taylors Beach Jetty as recommended in PB&P (1997).
B1/B2/C2/D	Investigate former oyster leasees in Cromarty Bay, Tilligerry Creek, Oyster Cove and Karuah for boat ramp/marina/slipway dry boat storage locations.
B2	Upgrade Lilli Pilli Boat Ramp to more user friendly local scale facility.
B3	Upgrade Lemon Tree Passage Boat Ramp to a regional scale facility. Incorporate upgrade to Lemon Tree Passage Jetty.
C1	Upgrade Foster Park Boat Ramp to more user friendly local scale facility.
C1	Remove Caswell Reserve Boat Ramp.
C1	Remove informal/unauthorised boat ramps along Tanilba Bay foreshore.
D	Upgrade the Karuah Boat Ramp to a regional scale facility. Incorporate upgrade to adjacent Karuah Jetty.
E	Construct a local scale boat ramp at North Arm Cove.
E	Upgrade the local scale boat ramp at Bundabah.
E	Construct a local scale boat ramp at Pindimar.
F2/F3	Undertake improvements to boat ramps and jetties at Tea Gardens, Winda Woppa and Hawks Nest as recommended in Jelliffe (2003).

9.1.9.1 Standards and Guidelines

All new facilities and work on existing facilities should be undertaken in accordance with the Australian Standards for the Design of Maritime Structures (DR02536). These and other relevant standards and guidelines are clearly summarised in the NSW Maritime Authority's *Engineering Standards and Guidelines for Maritime Structures*. Some of these include:

- Boat Launching Ramps – Guidelines (NSW Public Works Department 1985);
- Australian Standard Design for Access and Mobility (AS1428); and
- Australian Standard Piling – Design and Installation (AS2159).

9.1.9.2 Possible Funding Sources

Minor Ports Program

The Department of Lands' Minor Ports Program provides for the maintenance and upgrading of government owned maritime infrastructure associated with minor ports and river entrances, including Nelson Bay Boat Harbour.

Contact: Department of Lands Minor Ports Unit. Phone: 49205059

Maritime Infrastructure Program

The objective of the Maritime Infrastructure Program is to 'assist in providing waterways infrastructure for the benefit of the boating community and the marine sector on NSW waterways'. It is jointly funded by the NSW Maritime Authority and proponents such as boating and marine organisations and local and state governments.

A grant application must be submitted with written support from key stakeholders.

Contact: NSW Maritime Authority (Hunter Inland). Phone: 49842133

10.0 Foreshore Stability

The issues of inundation and wave runup, sea level rise, foreshore erosion and foreshore protection structures have been addressed in this section.

10.1 Inundation and Wave Runup

Inundation and wave runup in Port Stephens have been addressed in the documents outlined in Manly Hydraulics Laboratory (MHL) (1993, 1997, 1998c, 2002a, and 2002b).

Manly Hydraulics Laboratory (1997) examined the nature and extent of flooding around the Port Stephens foreshore. The following information has been extracted from this report.

Flood levels are influenced by a combination of the water level in the port and the wave climate at the foreshore. These two factors, are, in turn, influenced by a number of factors. The water level in Port Stephens is influenced by: ocean level, local wind set-up, bathymetry, catchment runoff from rainfall, and rain falling directly into Port Stephens. The port has two types of wave climates – wind waves and ocean waves. Wind waves are influenced by local wind conditions (speed and direction) and bathymetry. Ocean waves are influenced by offshore wave climate, water level in Port Stephens, wave refraction and diffraction, and bathymetry. At any particular location around the foreshore the extent of flooding depends on the combination of port water level, wind waves, ocean wave activity, the inshore bathymetry and the presence of any foreshore structures. When the waves reach the shoreline they break and expend their remaining energy as wave runup. The level of wave runup is the final factor which impacts on the design flood level for any foreshore development (MHL 1997:1-2).

MHL (1998c) used the results from MHL (1997) to estimate wave runup and determine design foreshore flood levels at 42 selected sites around the Port Stephens foreshore. The report notes that wind waves can affect foreshore water levels in all embayments no matter what their orientation; that ocean waves tend to only impact the eastern embayments of Port Stephens; and that the highest wave setups are caused by easterly winds which push water directly into Port Stephens. The calculations took sea level rise estimates into consideration (based on International Panel on Climate Change (IPCC) (1996) data). IPCC has since revised its best estimates of sea level rise twice (IPCC 2001 and IPCC 2007) (see **Section 10.1.1**). Lord *et al* 2005 presented analysis indicating that the sea level scenarios presented by IPCC 2001 would make what are now rare high water levels commonplace. This work did not target Port Stephens specifically, but did discuss the implications of higher sea levels for depths and frequency of inundation across a range of low lying urban and natural areas along the NSW coast.

WMA (2002a) assessed a range of management options available to reduce the impacts of flooding on the Port Stephens foreshore. These included flood modification methods (measures that modify a flood's physical behaviour), property modification measures (measures that modify land use and development controls on the foreshore), and response modification measures (measures that inform the community's response to flood hazard).

WMA (2002b) sets out a prioritised list of management actions, including a recommendation to 'Prepare a Development Control Plan for the foreshore lands affected by flooding and other coastal hazards'.

10.1.1 Climate Change and Sea Level Rise

The Port Stephens foreshore, as the interface between a tidal waterway that is also subject to ocean and wind waves, and a highly valued terrestrial landscape, has responded and will continue to respond to variations in other aspects of environmental condition and processes, including:

- sea level rise due to ice melt and thermal expansion;
- changes to wave climate and wave runup;
- changes to storm surge;
- changes to sea temperature; and
- changes to rainfall seasonality and intensity.

The potential impact of these changes on foreshore stability, siltation, shoal formation, ecological processes and community facilities/amenity is an important issue for foreshore managers. Climate change and particularly sea level rise, has significant implications for the investment and policy decisions required to maintain ecological system resilience and to maintain the functionality of community infrastructure (e.g. jetties and break walls for recreation and tourism, but also to maintain the integrity of stormwater outlets and sewage reticulation systems and to support continuity of ecological functions).

DECC has responsibility for advising the NSW community about the best available climate change science. Current DECC technical and policy advice is based on the range of sea level scenarios presented by IPCC 2007, adjusted in response to further regional scale analysis (e.g. by McInnes *et al* (CSIRO) 2007, Church *et al* 2005, 2006 and research commissioned at the University of NSW). The results of these more recent studies have shifted DECC's conclusions about the most likely sea level rise scenario for the central east coast to the higher end of the IPCC 2007 range.

For planning purposes, DECC 2008 is now recommending a sea level projection of 40 cm above the 1990 mean sea level by 2050 and 90cm above the 1990 mean sea level by 2100. The most recent research results from Church *et al*, analysing actual sea level change using highly reliable satellite data, indicate that these estimates are reasonable.

Predicting the specific risk associated with climate change and sea level rise on local scale sections of the Port Stephens shoreline is complex. The data available for this project was not adequate for detailed local planning to be undertaken. The recent Department of Planning LiDAR study, which provided a first pass assessment of the vulnerability of estuarine shorelines on the Central Coast, included some of Port Stephens Council, but did not extend to the Port Stephens waterway.

A review of climate change and sea level rise hazards, leading to an understanding of the vulnerability of the Port Stephens foreshore to these processes (using the best available estimates of sea level rise to predict potential inundation and shoreline recession), is a priority for Port Stephens and Great Lakes Councils. PSC is currently working towards a climate change preparedness and adaptation study, due for completion in the second half of 2009.

This will ensure that potential impact of process hazards on high value infrastructure, and on the foreshore characteristics that are valued by the community, are properly understood and adaptive measures can be put in place to minimise risk.

As quality local scale information becomes available, actions within the Port Stephens Foreshore Management Plan will be reviewed.

In the interim, the design flood levels of Port Stephens have taken estimates of sea level rise into consideration, these levels have, in turn, been used in the structural design guidelines for foreshore protection structures (see **Section 10.5**).

10.2 Foreshore Erosion

Community consultation undertaken by WMA (2002a) identified the fact that foreshore erosion was a major concern to many Port Stephens residents. The water levels and wave conditions determined in the flood studies (MHL 1997, 1998c) were used during the investigations of foreshore erosion for the current Plan.

Foreshore erosion is recession of the shoreline as a result of sediment movement caused by wind, waves and currents. Shoreline erosion has been identified as a significant issue in the Outer Port of Port Stephens for many decades and there are anecdotal reports of the Jimmys Beach/Yacaaba Headland being breached by storm waves at the end of the nineteenth century. Erosion of the foreshore is also an issue in the inner port. The Tanilba Bay foreshore and the banks of lower Tilligerry Creek are of particular concern to local residents.

Numerous foreshore protection structures (retaining walls) have been built by both residents and the Port Stephens and Great Lakes Councils. Many of the private structures are unauthorised, and the majority of structures are not designed or constructed according to accepted coastal engineering standards. All structures below MHWM require Council, Department of Lands and MPA approval, generally for maintenance as well as construction (see **Section 10.4**).

Previous studies and community feedback indicated that the following locations were of concern with regard to foreshore instability and/or foreshore protection structures:

- Shoal Bay (previous investigations reviewed only, see **Section 10.2.1**);
- Sandy Point and Corlette Beach (subject of field investigation, see **Section 10.2.2** for summary of results and **Reference Document** for detailed results);
- Salamander Bay (subject of field investigation, see **Section 10.2.3** for summary of results and **Reference Document** for detailed results);
- Soldiers Point (subject of field investigation, see **Section 10.2.4** for summary of results and **Reference Document** for detailed results);
- Taylors Beach (subject of field investigation, see **Section 10.2.5** for summary of results and **Reference Document** for detailed results);
- Lemon Tree Passage and Lower Tilligerry Creek (subject of field investigation, see **Section 10.2.6** for summary of results and **Reference Document** for detailed results);
- Tanilba Bay (previous investigations reviewed only, see **Section 10.2.7**);
- Karuah (subject of brief inspection, see **Section 10.2.8**);

- Carrington/Tahlee (subject of field investigation, see **Section 10.2.9** for summary of results and **Reference Document** for detailed results);

- North Arm Cove (subject of field investigation, see **Section 10.2.10** for summary of results and **Reference Document** for detailed results);

- Pindimar and Lower Pindimar (subject of field investigation, see **Sections 10.2.11** and **10.2.12** for summary of results and **Reference Document** for detailed results); and

- Jimmys Beach (previous investigations reviewed only, see **Section 10.2.13**).

The above areas are shown on **Figure 10.1**. Detailed field investigations were undertaken by SMEC (2006). This document forms the Foreshore Stability section of the **Reference Document**. Current and recommended management actions are discussed in **Sections 10.4** and **10.5** (extracted from SMEC (2006)). Identified management actions are also detailed in **Section 12.0**.

10.2.1 Shoal Bay

Shoal Bay suffers from a long term erosion problem resulting in a steep scarp at the back of the beach (see **Figure 10.1**). This scarp effects visual and recreational amenity in the area. There is also a potential risk to infrastructure. Physical processes in Shoal Bay and their management have been addressed in a number of studies (MHL 1998a, 1998b, 1999, Geomarine 1994, Laxton 1997).

The white sandy beach of Shoal Bay has experienced ongoing erosion over several decades. It is likely that this sediment movement is simply part of the continuous adjustment processes of a dynamic sedimentary environment. Historic plans refer to Shoal Bay as the 'Bay of Shifting Sands' (MHL 1998a:2). The erosion has led to the degradation of beach amenity and a perceived threat to infrastructure. MHL (1998a:21) explained the sediment transport processes occurring in Shoal Bay as follows:

> There is some sediment supply from the offshore shoals which moves onto the beach at the eastern end of the beach under low ocean swell conditions. The rate of this supply is variable depending on weather conditions and has not been accurately quantified. The sand is then moved alongshore from east to west under the action of waves and currents. The alongshore transport potential from time to time exceeds the sand supply to the eastern end and this deficit is made up by erosion of the beach area. At the western end of the beach, sand is deposited on the beach face and across the flat nearshore zone. During stormy periods sand is moved offshore at the western end of the beach and deposited in the deep channel adjacent to Nelson Head or redistributed under the action of tidal currents across the tidal shoals towards the entrance.

The above process was probably occurring well before European settlement. Problems have arisen as development and infrastructure has been established over a dynamic environment.

MHL (1998a) also concluded that the three stormwater outlets along Shoal Bay caused only localised erosion, with no permanent offshore loss of sand.

MHL (1998b) defined the immediate erosion threat (immediate impact line) to the Shoal Bay shoreline as the 'the landward limit of the back beach erosion escarpment following a severe storm event at present'. This line is shown on **Figure 10.1** and indicates that sections of Shoal Bay Road and beachfront structures are at risk.

The 50 year impact line is also shown on **Figure 10.1**. This allows for '50 years of recession and storm erosion landward of the present dune crest'. The line indicates that existing commercial and residential development is not at risk but that the majority of Shoal Bay Road

Source: LPI NSW (2000), Great Lakes Council, Port Stephens Council
Note: Seaward study area boundary defined by -2 metre (AHD) contour.

0 1.0 2.0 3km
1:70 000

Legend

- Study Area
- Foreshore Structures
- Foreshore Erosion
- (B3) Management Zones
- Photo

FIGURE 10.1

Areas With Foreshore Stability Issues

File Name (A3): R01_V2/2034_015.dgn

and beachfront structures would be lost without some level of protection works or implementation of a management strategy in that period.

The effect of sea level rise was also considered by MHL (1998b). For a midterm scenario of sea level rise (0.19 metre over the next 50 years) and in the absence of beach management works, it was recommended that an additional allowance of 2 metres landward of the 50 year impact line be made.

MHL (1998b) also undertook a stability assessment of the back beach area of Shoal Bay. It was found that special foundations may be required for a distance of up to 13 metres landward of the projected erosion scarp (impact lines). This offset takes into account the *zone of slope adjustment* ('the portion of the foreshore landward of the vertical erosion escarpment that would slump to the natural angle of repose of the dune sand following the erosion during the design storm event') (MHL 1998a:30).

Significant coastal inundation in the Shoal Bay area is unlikely provided the current dune levels are maintained.

MHL (1999) explored a number of erosion management options including structural engineering options such as groynes and offshore breakwaters, as well as soft engineering options. On the basis of an assessment of each option that considered current land use, aesthetic and ecological factors, recreational amenity, social and economic factors, and a risk analysis, it was concluded that a gradual and ongoing beach nourishment program (on an as required basis) would be the most effective way of managing the dynamic shoreline. The effectiveness of previous foreshore protection strategies such as timber revetment walls, rock walls, groynes and beach nourishment programs was also taken into consideration during the assessment. For example, previous large scale nourishment programs probably resulted in the overfilling of the beach, resulting in higher sand loss rates and a steeper beach face. The recommended management strategy requires the placement of smaller sand volumes regularly and involves trucking sand from the beach berm at the western end of the beach to the central and eastern end of the beach as required.

This strategy has been successfully implemented over recent years and will continue into the foreseeable future.

10.2.2 Sandy Point and Corlette Beach

Early last century a channel was dredged on the northern side of Corrie Island to improve the navigability of the Myall River entrance. The original entrance had been to the south of Corrie Island and to the north of a peninsula known as Myall Point. The dredging of the channel caused the deterioration of Myall Point and the point was eventually breached by gales in the 1920s. Today the area comprises subaqueous and inter-tidal sand shoals known as Paddy Marrs Bar.

The loss of Myall Point triggered widespread changes in the Outer Port, including the erosion of Jimmys Beach (see **Section 10.2.13**) on the north side of the Port and unprecedented erosion of Sandy Point and eastern Corlette Beach on the southern side of the Port. Ocean swell now refracts over the low sand shoals of Paddy Marrs Bar and impinges onto the southern shoreline in the Sandy Point area. This has resulted in the construction of numerous seawalls and groynes, and the loss of the once sandy shoreline (see **Figure 10.1**).

The seawalls and groynes around Sandy Point have not been constructed in accordance with sound coastal engineering principles and the majority of them are unravelling. The vertical walls, apart from presenting a public hazard due to their height and lack of safety rail, are being undermined and will collapse in due course. The groynes are entirely inadequate

in providing any foreshore protection (see **Reference Document** for details) and should be removed.

It is recommended that the existing seawalls and revetment be reconstructed to a standard design (see **Section 10.5.2**).

The eastern end of Corlette Beach has also suffered considerable erosion and rock has been dumped there to halt this process. This area could be rehabilitated by the construction of a suitable revetment (see standard guidelines in **Section 10.5.1**) which could be buried in sand nourishment material sourced from the very large volume of sand that has accumulated against the marina breakwall at the western end of the beach. The benefits of transferring this sand include: obviating siltation of the stormwater outlet at the western end of the beach; obviating siltation of the Anchorage Marina; obviating the loss of good beach sand from the southern shore of the Outer Port; and rehabilitation of a valuable public beach. The sand could easily be transferred using mechanical shovels and trucks.

10.2.3 Salamander Bay

There is a perception that there is an erosion problem along sections of the Salamander Bay foreshore.

The NSW Public Works Department (1987) has undertaken tidal current measurements within Salamander Bay as well as a physical model study of tidal flows in Port Stephens, and the Manly Hydraulics Laboratory (1997) has undertaken a wave climate inundation study for the foreshore. The studies found that both flood and ebb tidal currents in the bay were weak and, generally, were less than 0.2 m/s. Such currents, without superimposed wave stirring, would not be competent in transporting sand. While the Bay is exposed to north-westerly winds, the fetches are short and there is little opportunity for the generation of large waves along the foreshore.

Investigation undertaken during the current study found that, while there is some undermining, the signature of natural foreshore recession is weak and there does not appear to be any assets at threat. Many of the foreshore structures (seawalls) along this bay are poorly designed and constructed. A summary of the results of the field investigations in this area are contained in **Sections 10.2.3.1** to **10.2.3.3**. The detailed results are contained in the **Reference Document**.

10.2.3.1 North-eastern Foreshore

The eastern section of Salamander Bay foreshore is protected by rock revetment (see **Figure 10.1**). This revetment protects the reclamation and foreshore walkway of a public reserve (Cornford Reserve) and appears sound and effective in protecting this asset from wave action.

A sloping sandy beach with grassed area behind extends between this revetment and Mambo Wetland. The grassed strip narrows in front of residences between Roy Wood Reserve and Mambo Wetland so much that the foreshore public reserve cannot be distinguished from private residences. Wave inundation is a risk to these properties. This problem has arisen because the alignment of the subdivision has intersected the natural curvature of the bay. Additionally, some of these houses have floor levels that are below the calculated 1 per cent AEP design level for wave runup. The low walls constructed to protect residences from inundation in this area do not appear to be having any adverse impact on neighbouring properties or the beach. The establishment of vegetative ground cover in front of these walls would improve amenity and also provide an added level of foreshore protection. This area is particularly prone to the impacts of sea level rise, any alterations or new development in this area should take this into consideration.

The flooding which has previously affected these residences was originally thought to be associated with the restricted water flows beneath Foreshore Drive between Mambo Wetland and the bay (the natural outlet of the wetland was replaced by concrete pipes when Foreshore Drive was constructed). Hydrological investigations, however, found that the cause of the flooding was associated with the narrowing of a channel further up in the Mambo Wetland catchment.

10.2.3.2 Mambo Wetland Foreshore

The shoreline of Mambo Wetland is also eroding (see **Figure 10.1**). There is evidence that this is being made more severe by vehicles using the area to illegally launch boats. There is also some evidence of erosion along the shoreline of Joe Redman Reserve where the roots of foreshore trees have been undercut.

Further effort is required to prevent vehicles entering this area. Council should continue to ensure that there is a vegetated strip along the foreshore of landscaped public reserves (see **Appendix 4**). Foreshore protection structures are not required along this section of the foreshore (see **Figure 10.2**). Further discussion regarding the appropriate location of foreshore protection structures is contained in **Section 10.5.2**.

10.2.3.3 North-western Foreshore

Numerous seawalls have been constructed in front of waterfront residences of western Salamander Bay (west of Joe Redmond Reserve and west of Bob Cairns Reserve) (see **Figure 10.1**). These include vertical timber and brick walls, as well as rock/brick/concrete fill placed on the immediate shoreline. All of these appear to be maintaining unauthorised reclamation of public reserve. Additionally, at least two private boat ramps extend across the foreshore reserve. The area between the foreshore and these residences is now very narrow. Members of the public are unlikely to access these sections of foreshore due to intimidation by the 'private' appearance of the strip. Access is also hampered by the structures built across the foreshore reserve (see **Section 8.3** for discussion regarding public access to the foreshore).

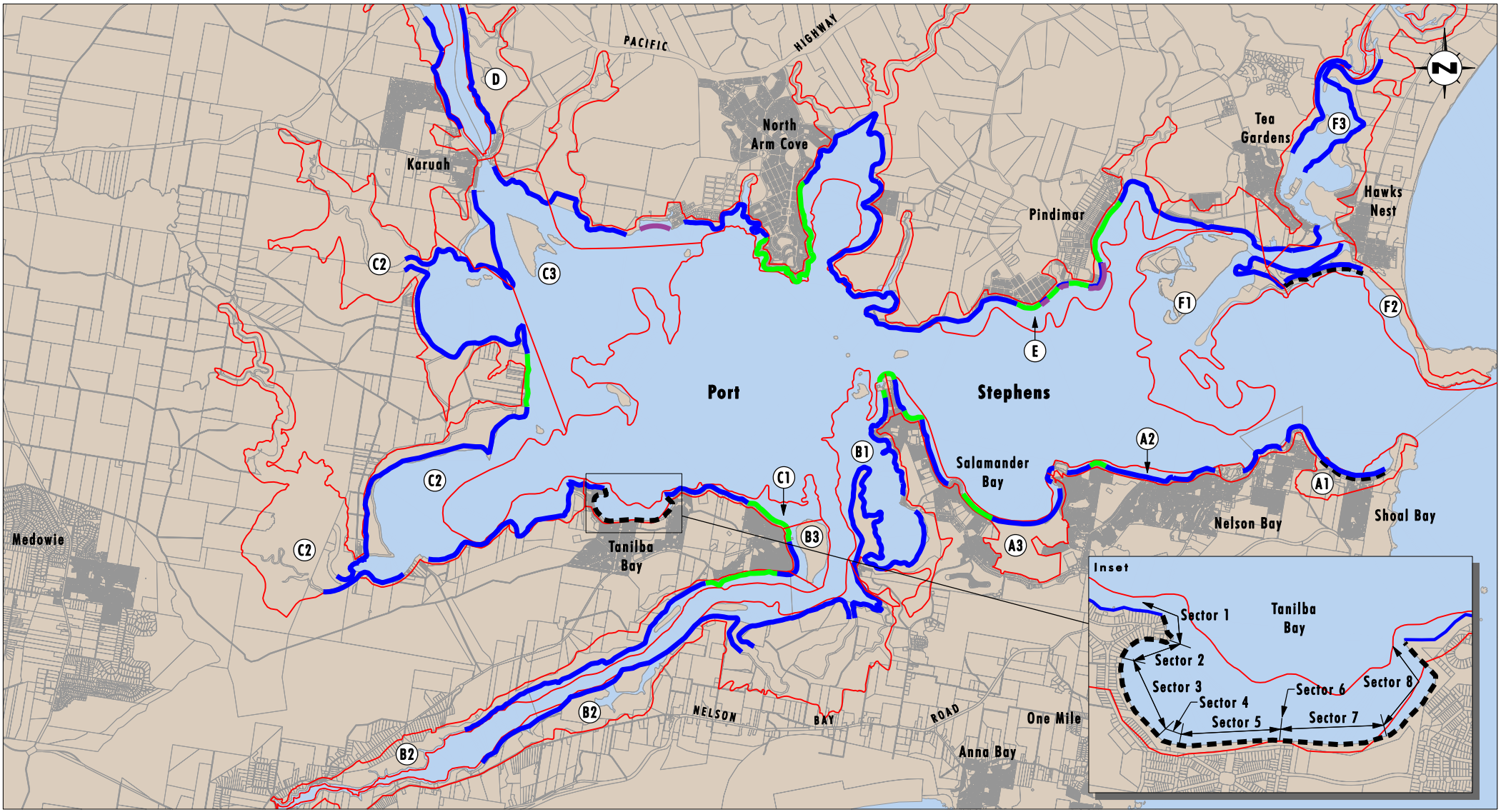
The existing retaining walls (vertical seawalls) have not been designed or constructed in accordance with sound coastal engineering practice, although they do not appear to be having an adverse impact on neighbouring properties. The appropriate management of existing foreshore structures is discussed in **Section 10.5.1**.

No long term erosion signature was evident along the gently sloping foreshore of Bob Cairns Reserve. Foreshore protection structures are not considered appropriate for this area.

Wanda Head has been encircled by major rock revetment. Immediately landward of this revetment is a public pathway/cycleway which provides easy access around the entire headland. A small rock groyne has been constructed immediately adjacent to the revetment at the northern end of the beach. This is entirely ineffective and should be removed.

10.2.4 Soldiers Point

Similar to Salamander Bay, there is a perception that there is an erosion problem along some sections of the Soldiers Point foreshore. This area was the subject of field investigations during the current study. The following sections summarise the results of these investigations.



Source: LPI NSW (2000), Great Lakes Council, Port Stephens Council
Note: Seaward study area boundary defined by -2 metre (AHD) contour.

0 2.0 4.0 6km
1:120 000

0 0.5 1.0 1.5km
1:30 000
(Inset Scale)

Legend

- Study Area
- Management Strategy Currently Being Impemented (Subject of Previous Studies)
- Areas Where Foreshore Structures Should Be Rehabilitated/Removed
- Areas Where Foreshore Structures Should Not Be Authorised
- Areas Where "Soft" Engineering Solutions are Feasible
- (B2) Management Zones

FIGURE 10.2

Suggested Management of Foreshore Stability Issues

File Name (A4): R01_V2/2034_016.dgn

10.2.4.1 Wanda Beach

Wanda Beach, on the eastern shoreline of Soldiers Point (see **Figure 10.1**), is characterised by a sloping sandy beach with a sloping grassed area (public reserve) behind. There does not appear to be any signature of erosion at this beach, other than a minor change in the shape of the beach where stormwater outlets occur. No foreshore protection structures have been built along this section, nor is there a need for them.

Seawalls and rock revetment have been constructed in front of the Soldiers Point Sailing Club and Salamander Shores, where the Salamander Bay Boat Ramp and Jetty are located. Some concern regarding erosion of the shoreline to the north of this area has been previously voiced. The area is characterised by a sloping sandy beach with a narrow grassed area (including public reserve) between the beach and foreshore residences. No long term erosion signature was noted here and no foreshore structures have been constructed.

Foreshore structures should not be authorised or constructed along this section of the foreshore (see **Figure 10.2** and **Section 10.5.2**).

10.2.4.2 North of Kangaroo Point

The Kangaroo Point development is founded on a bedrock headland and there is no process signature of long term erosion in this area. While various seawalls and groynes have been constructed at Kangaroo Point, it does not appear that there is any significant erosion threat to residential development. Nevertheless, reclamation has taken place and some protection of that reclamation has been put in place to provide protection from the occasional storm waves from the north-east.

The vertical seawall structures and groynes have not been built according to sound coastal engineering standards and many have been illegally constructed on public reserve. **Section 10.5.1** discusses the appropriate management of such structures.

10.2.4.3 Northern Tip of Soldiers Point

The northern tip of Soldiers Point (in the vicinity of the Soldiers Point Boat Ramp) has been protected with rock revetment (see **Figure 10.1**). Previous attempts have also been made to retain sand on the small beach between the boat ramp and the Soldiers Point Marina. The loss of sand is probably due to the Soldiers Point Marina blocking wave energy. The floating pontoons act as an effective breakwater for the seas generated over the south-south-west fetch (L Nielsen pers. comm. March 2006). Prior to marina construction the wind waves would have pushed sand northward along the beach toward the boat ramp. Currently, wave energy created by winds from the north-west pushes sand southward and there is no mechanism to push it back.

This area is currently the subject of detailed investigations being undertaken by Council. Recommendations regarding improvements to the existing rock revetment and amenity of the adjacent beach will be contained in the final *Soldiers Point Infrastructure and Foreshore Management Plan*.

10.2.4.4 Sunset Beach

The north-western tip of Soldiers Point (Sunset Beach) (see **Figure 10.1**) is lined with foreshore protection structures (vertical seawalls) that protect narrow areas of reclamation. These structures appear to have been constructed on public reserve and the resulting 'private' appearance of this reserve discourages public access. The appropriate management of existing foreshore protection structures is discussed in **Section 10.5.1**.

10.2.5 Taylors Beach

The obliqueness of the wave direction to the Taylors Beach foreshore alignment (see **Figure 10.1**) results in the southerly transport of littoral drift (see **Reference Document**). This is evidenced by the significant accumulation of sediment on the northern side of Taylors Beach Jetty (groyne). This entrapment has starved the foreshore to the south of the jetty of sediment, and exacerbated erosion of the public reserve in this area. Rock revetment has consequently been placed along this foreshore.

The jetty/groyne has provided good protection from foreshore erosion on the northern foreshore of Taylors Beach but starved the southern foreshore of beach sand. Replacement of this structure with a piled jetty would release this large volume of sand and replenish the southern foreshore with sand. However, in time, the sandy foreshore would continue to erode. Such a situation could be alleviated with the construction of a number of groynes along the foreshore. On the other hand, foreshore erosion in this area threatens only public reserve and a number of mature trees. It is therefore recommended that the jetty/groyne remain and the existing rock revetment be improved. Improvement works should include an increase in the number of access ways across the revetment to the beach.

10.2.6 Lemon Tree Passage

10.2.6.1 Kooindah Park Foreshore

Some foreshore erosion has occurred along the north-eastern foreshore of the Tilligerry Peninsula (see **Figure 10.1**). This erosion is caused by locally generated wind waves and, possibly, a slight increase in mean sea level (see **Reference Document**). The existing rock revetment is not designed or constructed in accordance with sound engineering practice and is unravelling. The revetment is also unsightly (see **Section 7.2.5**), inhibits access to the intertidal zone, and is a risk to public safety.

This minor erosion process could be solved through the placement of shallow nearshore rock revetment in the form of headlands around trees and other assets that may require protection. This would result in the development of small sandy embayments.

10.2.6.2 Lower Tilligerry Creek

Erosion along the northern bank of the lower Tilligerry Creek (see **Figure 10.1**) is probably caused by a combination of the removal of mangroves and resultant wind wave activity, as well as a more long term process affecting the full depth of the Tilligerry Creek channel. The majority of the existing foreshore protection structures along this area have not been constructed in accordance with sound engineering practices and pose a threat to public safety. They are also visually obtrusive (see **Section 7.2.5**) and inhibit access to the intertidal zone. All existing foreshore protection structures, including a number of private ramps and access ways, are constructed illegally on public reserve.

The Tilligerry Creek Catchment Management Plan (EarthTech 2006:66) recommends the re-establishment of mangroves (coppiced to maintain water views), the removal of existing foreshore protection structures, and a local community education campaign to provide information about the importance of mangroves and appropriate bank stabilisation methods.

The findings of the current study (see **Reference Document**) indicate that rehabilitation rather than removal of existing foreshore protection structures in this area would address both the physical processes and management issues affecting this section of the foreshore (see **Section 10.5.1**).

10.2.7 Tanilba Bay

WP Geomarine (1997) investigated the cause of the erosion that had been affecting Tanilba Bay (see **Figure 10.1**) over many decades and subsequently provided management recommendations in the *Tanilba Bay Erosion Management Study*.

WP Geomarine (1997) noted that net littoral flow in the bay is west to east, and that three out of four seasons are characterised by predominantly westerly and north-westerly winds. Additionally, the littoral processes at the western and eastern ends are strongly influenced by waves diffracted around Rookes Point and Sunrise Point headlands. Without any management action or worsening of the erosion processes, it was predicted that the shoreline would recede approximately 10 metres in the eastern and central parts of the bay over the next 50 years.

For the purposes of the study, the foreshore of the bay was divided into eight sections. In addition to global erosion caused by wind waves, local processes affecting each of these sections were identified.

In Sector 1, the Sunrise Point area, wave refraction has caused boulders to be exposed in this area. An inclined rock revetment conforming with the existing land slope was recommended.

Sector 2, the section of foreshore between Swan Road and Sunrise Point, consists of many vertical seawalls constructed on private land. The beach profile is flat and is composed of mud and pebbles. The reflection of the waves from the vertical walls has resulted in the loss of the sandy beach that previously characterised this area WP Geomarine recommended that rocks be dumped in front of the seawalls (removal of the seawalls was not proposed due to opposition by property owners) at a minimum slope of 1 in 1.5. Sand nourishment was then recommended. It was considered that the reduction in wave reflection would encourage sand to remain on the beach.

Sector 3, the western section of the foreshore is unaffected by foreshore structures. The beach and profile were found to be in a healthy condition with ample sand.

Sector 4 (the stormwater outlet area near the intersection of Tanilba Avenue and Peace Parade), Sector 5 (the central section of the bay) and Sector 6 (the stormwater outlet area at the end of President Wilson Walk) were found to be degraded. The original sandy beach has eroded away. The stormwater outlets at each end of this section were found to be the cause of erosion here. Strong flow through the outlets directed a strong flow perpendicular to the coast, obstructing local littoral drift. The littoral flow material was directed offshore and formed a shoal offshore of the outlets. This section is affected by both westerly and easterly waves (and so westerly and easterly littoral drift) and the outlets affected both of these, resulting in severe erosion.

The preferred management option was a wooden fence and gravel flow barrier constructed around the stormwater outlets. These would disperse flow and reduce the velocity of flow, and allow littoral material to flow around the structures and along the shoreline. Beach renourishment was then recommended for this section. A sloping revetment structure (dumped rock) was also recommended as a second layer of defence. It was advised that this be covered as much as possible with nourished sand to prevent erosion on either side of it.

The recommended works in Sectors 5 and 6 have since been undertaken by Port Stephens Council (Brad Sutton, Port Stephens Council, pers. comm. April 2006).

Sector 7, the Tilligerry Habitat foreshore, was assessed as being in reasonable condition. The dune system in this area was destroyed by a storm in 1994 and some sand renourishment works (large quantities of sand pushed up from tidal flats) were undertaken during the 1990s. This section was assessed as being a priority because of threats to the Tilligerry Habitat. It was considered that sand renourishment in Sector 5 would have a positive influence on Sector 7. It was recommended that this be monitored and if there were no signs of improvement (or a big storm occurred) nourishment in this sector should also be undertaken.

Strong flow from a creek between Sectors 7 and 8 (eastern section of bay) was found to form a barrier to littoral flow across this part of the bay, evidenced by an offshore shoal. The area east of the creek was found to be most affected because westerly winds and storms dominate this side of the bay. Additionally, the boat ramp in Sector 8 is obstructing the predominantly west to east littoral flow, resulting in local erosion east of the boat ramp. Council plans to remove this boat ramp in the near future.

10.2.8 Karuah

A brief inspection of the foreshore in front of the Karuah Aboriginal community (see **Figure 10.1**) indicated that the previous stabilisation works (gabion baskets) required maintenance. Associated landscaping of the foreshore area is also required and should include adequate and safe access to the waterway.

10.2.9 Carrington/Tahlee

The cause of the erosion along the Carrington/Tahlee foreshore (see **Figure 10.1**) has not been confirmed (see **Reference Document**). Wind waves may be responsible (the foreshore is exposed to a considerable southerly fetch) and the removal of oyster leases in the area may have changed the foreshore wave energy climate. Without management, the erosion may eventually impact foreshore infrastructure. It is recommended that rock revetment be placed here. The design specifications detailed in **Section 10.5.2** should be utilised.

10.2.10 North Arm Cove

The settlement of North Arm Cove (see **Figure 10.1**) is located on bedrock that underlays a silty sandy beach. While the threat to mature trees on the foreshore presents some evidence of foreshore recession, it would appear that the 'erosion problem' exists where the foreshore has been reclaimed. The reclamations have been protected with vertical seawalls.

The majority of the foreshore structures (vertical seawalls) along this shoreline have not been built to accepted coastal engineering standards and are unauthorised (see **Figure 10.1**). Many are difficult to traverse and may pose a threat to public safety. The continuous line of foreshore structures is also an eyesore from the perspective of both the water and opposite shorelines (see **Section 7.2.5**). The management of existing foreshore structures is discussed in **Section 10.5.1**.

10.2.11 Lower Pindimar

Foreshore recession in the Lower Pindimar area occurs where mangroves are absent from the nearshore zone (see **Figure 10.1**). The rock revetment and vertical timber retaining walls along the foreshore of the public reserve in the vicinity of the boat ramp are not designed or constructed in accordance with accepted coastal engineering standards. The rock rubble is visually unattractive and may pose a threat to public safety.

The seawalls and log groynes in front of reclamations undertaken by waterfront residents in Lower Pindimar are also not designed or constructed in accordance with coastal engineering standards. The log groynes are entirely ineffective as coastal protection works. Appropriate management of existing foreshore structures is discussed in **Section 10.5.1**. Mangroves in the nearshore zone should be allowed to regenerate (except in the boat ramp area) and perhaps coppiced to retain water views. A community education program should also be undertaken to provide information about the important foreshore stability role played by mangroves.

The western foreshore of the village of Lower Pindimar has a healthy beach profile with no foreshore protection structures. Foreshore structures should not be authorised or constructed along this section of foreshore (see **Section 10.5.2** and **Figure 10.2**).

10.2.12 Pindimar

The Pindimar foreshore is a depositional area, as attested by the mangrove stands in the area. The foreshore is well protected from wave action, being exposed to a narrow wind wave fetch to the south east.

While there does not appear to be a signature of long term foreshore erosion, there has been considerable reclamation undertaken (see **Figure 10.1**). This has been supplemented with *ad hoc* rock wall and groyne protection works. There are also several jetties crossing the foreshore in this area.

The majority of the foreshore protection structures along this section of the shoreline have not been designed or constructed according to accepted coastal engineering standards. **Section 10.5.1** discusses the management of existing foreshore structures such as these.

10.2.12.1 Orungall Point

The foreshore erosion in this area is caused by the removal of mangroves. This allows more wave energy to reach the shore, thereby causing erosion. Areas where the mangrove stands are intact retain healthy sand accumulation.

Many poorly designed and constructed seawalls are located along this section of the foreshore. **Section 10.5.1** contains a discussion regarding the management of such structures. The regeneration of mangroves in the nearshore zone would lessen the erosion threat in this area. A community education program should be undertaken to provide information about the important foreshore stability role played by mangroves.

10.2.13 Jimmys Beach

Patterson Britton and Partners (PBP) (2005:1) provide a summary of the previous management of the erosion of Jimmys Beach (see **Figure 10.1**).

Following severe erosion during storms in the 1980s, Great Lakes Council endorsed beach nourishment as the preferred management strategy. Beach nourishment was undertaken between 1983 and 1998 with material obtained from the Corrie Island channel. This material was found to have a smaller grain size than the native beach material, which resulted in a more rapid erosion and movement of material offshore and subsequently to the east under coastal processes. These nourishment campaigns placed a large amount of material on the beach every two to three years, resulting in the overfilling of the subaerial portion of the beach profile and corresponding higher loss rate.

The current management strategy involves placing smaller amounts of sand more frequently in an attempt to maintain the beach profile. The optimal method of doing this continues to be

evaluated. Recent nourishment proposals have focused on sand which has accumulated on a shoreline shoal at the eastern end of the beach.

10.3 Summary of Foreshore Stability Issues

10.3.1 Privately Built Foreshore Protection Structures

There are numerous privately built foreshore protection structures around the shoreline of Port Stephens. These vary from carefully constructed seawalls (constructed from various material including timber, brick, and rock) to dumped material. The type of dumped material noted around the foreshore includes building rubble, tyres, logs and rock.

All foreshore protection structures below MHWM require Department of Lands, Council and MPA approval for both construction and maintenance (see **Section 10.4**). Where the landowner has absolute water frontage they will require a licence from the Department of Lands. Private structures are not appropriate where they front Crown or Council reserve.

The majority of constructed seawalls around Port Stephens are unauthorised and not designed or constructed to accepted coastal engineering standards. The majority of the walls built by private land owners are vertical and rigid. Current engineering and environmental standards do not favour rigid vertical structures because:

- they restrict access across the foreshore and can pose a risk to public safety. Some seawalls are of a height that requires a safety rail, particularly in areas that are used by the public, e.g. Sandy Point. The majority of Council-built rock revetments also do not meet current coastal engineering standards;

- they reflect wave energy, often causing the erosion and disappearance of the beach in front of the wall;

- they can induce erosion on adjacent unprotected areas (and erosion around the ends of a seawall can lead to their collapse);

- scour at the base of a seawall can result in its catastrophic failure;

- they remove the natural intertidal habitat; and

- *ad hoc* design, location and materials have a detrimental impact on visual amenity and also have the potential to pollute the estuarine waterway (see **Section 7.2.5**).

Seawalls are not suitable for the protection of individual properties because of their tendency to induce erosion in adjacent areas. They are more effective in the long term when they are designed as continuous and uniform structures protecting all properties over the length of foreshore suffering erosion.

Locations where privately built structures are not only unauthorised (i.e. Development Consent has not been granted and they have not been authorised under the *Crown Lands Act 1989*) but are also illegally located on public reserve include:

- Sandy Point, Corlette;

- western Salamander Bay;

- Kangaroo Point area;

- Sunset Beach, Soldiers Point; and
- lower Tilligerry Creek, Lemon Tree Passage.

These locations are shown on **Figure 10.1**.

Locations where privately built structures have been built on private land but are generally unauthorised (i.e. without Development Consent) include:

- Sunrise Point, Tanilba Bay;
- North Arm Cove;
- Lower Pindimar (east); and
- Pindimar (including Orungall Point).

It is likely that many people who have constructed these seawalls were unaware that Development Consent and other approvals are required. Additionally, many current owners are likely to have purchased the property with the unauthorised foreshore structure already existing.

The management of these structures is discussed in **Section 10.5.1**.

10.3.2 Other Privately Built Foreshore Structures

In addition to seawalls, there are also a large number of unauthorised jetties and boat ramps around the foreshore. The majority of these are partly located on private land and partly on Crown land, and are concentrated in areas such as North Arm Cove and Pindimar. These are generally not affecting coastal processes or foreshore stability but their haphazard placement has a negative impact on the visual and recreational amenity of the areas, and can pose a risk to public safety by inhibiting access across the inter-tidal zone.

As for sea walls, any of these structures built on Crown land requires approval and/or licence from the Department of Lands as well as Council consent. Where structures are located below MHWM, approval from the MPA is also required. Details are provided in **Section 10.4**.

10.3.3 Council Built Foreshore Protection Structures

There are many Council-built rock revetment structures around the Port Stephens foreshore. Although flexible and sloping rock revetment is a preferred form of foreshore protection (because they absorb wave energy, minimise wave run-up and reflection, are easily maintained and repaired, and are able to adjust to differential settlement), a number of the existing structures do not meet accepted coastal engineering standards.

The major foreshore protection structures built by government bodies including Port Stephens and Great Lakes Councils are shown on **Figure 10.1** and discussed below:

- Western margin of Sandy Point. This consists of dumped rock. The rock is ineffective, unsightly and its unevenness may pose a danger to public safety. This revetment should be rehabilitated according to the structural design guidelines contained in **Section 10.5.2**.
- Eastern Salamander Bay (Cornford Reserve). This consists of rock revetment protecting reclamation and a foreshore walkway. The wall is sound and effective.

- Wanda Wanda Head. Wanda Wanda Head is encircled by sloping rock revetment that was built by American servicemen during WWII. The revetment is sound and effective.

- Soldiers Point Sailing Club and Salamander Shores (Salamander Bay). Sections of rock revetment and a timber vertical wall have been constructed in front of these facilities. The revetment is unsightly but currently effective.

- Soldiers Point. The northern tip of Soldiers Point is protected by rock revetment and a rock groyne. There is also rock revetment behind the small beach between the boat ramp and the marina. The revetment and groyne are not adequately designed and constructed and are now unravelling. The revetment is unsightly, hinders access to the foreshore and could pose a danger to public safety. The unravelling of the beach revetment has resulted in rocks and gravel covering the beach. The stability of the foreshore in this area is currently being addressed by Council in the document *Soldiers Point Infrastructure and Foreshore Management Plan* (in progress).

- Marys Bay, Soldiers Point. Rock has been placed around the northern margin of Marys Bay. The effectiveness of this action is currently being monitored.

- Taylors Beach. Rock revetment lines the Taylors Beach Reserve to the south of the Taylors Beach jetty/groyne. This revetment is poorly designed and constructed, unsightly, hinders access across the foreshore, and may pose a danger to public safety. This revetment should be rehabilitated according to the structural design guidelines contained in **Section 10.5.2**.

- Lemon Tree Passage (Kooindah Park). Rock revetment lines the Lemon Tree Passage foreshore reserve. This is poorly designed and constructed and is currently unravelling. The revetment is consequently ineffective, unsightly, hinders access across the foreshore and is a danger to public safety. This revetment should be replaced with shallow nearshore rock revetment in the form of headlands around trees and other assets that may require protection. These should be built in accordance with the structural design guidelines contained in **Section 10.5.2**.

- Tanilba Bay. Rock revetment along a section of central Tanilba Bay has recently been completed. Its effectiveness is currently being monitored. Rock revetment also lines Peace Park. This revetment is unravelling and is consequently ineffective, unsightly, and could pose a danger to public safety. This revetment should be reconstructed according to the structural design guidelines contained in **Section 10.5.2**.

- Karuah village area. The existing foreshore protection along the foreshore of the Karuah River requires maintenance.

- Lower Pindimar (east). Sections of rock revetment and timber retaining wall have been built along the eastern foreshore of Lower Pindimar. This is poorly designed and constructed and much of it is unravelling. The foreshore area is consequently unsightly and the uneven revetment may pose a danger to public safety. This revetment should be reconstructed according to the structural design guidelines contained in **Section 10.5.2**.

- Tea Gardens. The foreshore of Tea Gardens has been lined with seawalls and jetties for over one hundred years. The structures are suitable for the setting and are adequately maintained.

Identified management actions for Council-built foreshore protection structures are also detailed in **Section 12.0**.

10.4 Current Management

The Port Stephens estuary is highly environmentally constrained and any future development will need to ensure no negative impacts on the surrounding environment. Any development application on the foreshore will need the approval of Port Stephens council, the Department of Lands and the MPA.

While there is a rigorous authorisation process for foreshore structures (see **Section 10.4.1**), many of the existing structures built on both private and public foreshore land are unauthorised. Neither the Port Stephens nor the Great Lakes Council have a relevant DCP or standard guidelines that provide information about the appropriate location, design and construction of foreshore structures. Suggestions regarding the content of DCP/guidelines for foreshore stabilisation and protection are contained in **Section 10.5.5**.

10.4.1 Authorisation Process for Foreshore Structures

The current authorisation process for a foreshore protection structure such as a seawall is outlined in the following sections.

10.4.1.1 Consent Requirements from Port Stephens Council

Seawalls are defined as a form of retaining wall. Under some circumstances (prescribed in DCP 8) retaining walls can be considered as exempt development. However, they are not considered as exempt development for the purposes of DCP 8 where they are within a sensitive coastal zone location as defined under SEPP71 – Coastal Protection. The entire Port Stephens foreshore falls within the definition of a sensitive coastal zone location (i.e. 'land within 100 m above mean high water mark of the sea, a bay or an estuary').

Where retaining walls are not exempt development under DCP 8, a Development Application (DA) is required. A DA is also required for structures such as jetties and boat ramps. Integrated development requirements are also relevant, e.g. Department of Water and Energy (Part 3A Permit) (see **Section 10.3.1.3**) and Department of Primary Industries (Fisheries) (Section 205 *Fisheries Management Act 1994*).

Owner's consent to lodge a development application involving Crown land (i.e. a foreshore reserve or below MHWM) is required from the Department of Lands before an application is made to Council, or it is an invalid application.

Clause 8 considerations of SEPP71 are used by Council when assessing a DA for a foreshore structure. These considerations include: existing public access, the provision of public access, scenic qualities, ecological habitats, impact on coastal processes and hazards, and protection of Aboriginal culture.

Additionally, Clause 92 of the *Environmental Planning and Assessment Regulation 2000* requires the *Government Coastal Policy* (as defined in that clause) to be taken into consideration by the consent authority when determining DAs in the LGAs identified in that clause or on land to which the *Government Coastal Policy* applies (Port Stephens Council).

While not an integrated development requirement, concurrence is also required from the NSW MPA (under the *Marine Parks Act 2004*) for foreshore structures within the Port Stephens – Great Lakes Marine Park (in areas other than Wallis Lake and north of One Mile Beach).

10.4.1.2 Consent Requirements from Great Lakes Council

Foreshore structures within the Great Lakes LGA require development consent under Clauses 11 (Landform Modification) and 25 (Waterways) of Great Lakes LEP 1996.

As above, where structures are located within land the subject of SEPP71, Clause 8 considerations of SEPP71 are assessed by Council. Integrated development requirements are also relevant and concurrence from the NSW MPA is required.

10.4.1.3 Permit under Part 3A of the *Rivers and Foreshore Improvement Act 1948*

In the case of a proposed structure landward of the high water mark (within 40 metres), an application under Part 3A of the *Rivers and Foreshores Improvement Act 1948* is considered by the Department of Water and Energy. This legislation will be eventually replaced by the *Water Management Act 2000* which is being implemented over a period of time.

Once Development Consent has been obtained from Council the Department of Water and Energy uses Part 4 of the *Environmental Planning and Assessment Act 1979* (*EP&A Act*), to assess the permit application. The assessment is restricted to issues of bed and bank stability (e.g. will the structure deflect flow and effect bank stability in adjacent areas, etc), and whether the design is structurally sound (Vicki McBride, Department of Water and Energy, pers. comm. May 2006).

Public authorities (including local Councils) do not require a permit under Part 3A of the *Rivers and Foreshores Improvement Act 1948* to construct a foreshore structure.

10.4.1.4 Waterfront Licence (Crown land)

In the case of a proposed structure seaward of the high water mark (i.e. on Crown land), owner's consent to lodge a development application involving Crown land (i.e. foreshore reserve or below MHWM) is required from the Department of Lands before an application is made to Council, or it is an invalid application.

When assessing an application for a Waterfront Licence, the Department of Lands requires the Council DA, a Statement of Environmental Effects, plans of the structure, and a letter of concurrence from both the Department of Primary Industries (Fisheries) and NSW Maritime Authority. They are also required to either conduct a land assessment in accordance with the *Crown Lands Act 1989* or waive this requirement where the Minister is satisfied that the proposal is in the public interest. In making a decision regarding such structures, the Department of Lands refers to their *Crown Land Foreshore Tenures Policy (Non-Commercial Occupations)*, as well as to any relevant Council DCP or guidelines. The *Crown Land Foreshore Tenures Policy (Non-Commercial Occupations)* states that:

> The provision of practical and environmentally sensitive public access within the inter-tidal zone of Crown tidal waters and along the adjoining Crown foreshore will be a prime consideration in the management of these lands.

The Department of Lands also has a policy on Marinas and Waterfront Commercial Tenures. The intent of this policy includes encouraging the ongoing development and improvement of existing and new waterfront sites; and encouraging sound environmental management.

10.4.1.5 Concurrence from Marine Park Authority

Under the *Marine Parks Act 1997*, development consent under the EP&A Act, requires concurrence from the MPA.

10.4.2 Building Set-backs

Building setbacks (the distance between a building and a road, reserve, or waterway) for the Port Stephens LGA are provided in DCP PS10 (Building Standards and Notification Procedures). A performance measure for building setbacks is 'Public use of waterfront reserves is not discouraged or intimidated by the proximity of buildings'. This is clearly not being achieved along some sections of the Port Stephens foreshore (see **Section 8.3**) but is more a result of the seawalls and structures illegally built across waterfront public reserve than an inadequate setback distance.

The recommended setback of 4.5 metres to a waterfront reserve boundary and 20 metres where there is absolute water frontage is considered adequate from the point of view of foreshore stability. Where foreshore structures are necessary they should be designed so as not to impinge upon the existing setback distance.

Foreshore building lines vary between 12 to 35 metres along the foreshore within the Great Lakes LGA. Building lines are specified in Great Lakes Council's Building Line Register and on Building Line Maps. An application to vary the set building line is required for the construction of a boat shed or some houses. Existing building setbacks are considered adequate from a foreshore stability point of view.

10.5 Identified Management Action

10.5.1 Existing Foreshore Structures

10.5.1.1 Seawalls and Rock Revetments

While the majority of existing seawalls and rock revetments do not meet current coastal engineering standards, their large scale removal is likely to be very difficult for the following reasons:

- The costs involved would be very high because major engineering works would often be required to restore the natural foreshore profile, on top of the cost of structure removal.
- The complexities involved in identifying the individual/authority responsible for funding and undertaking such work is likely to be prohibitive.
- Individual private owners are likely to vigorously oppose the removal of foreshore structures.
- The removal of concentrations of foreshore structures (and foreshore rehabilitation) would need to be undertaken on a whole of foreshore (or section of foreshore) basis in order to effectively deal with the wider coastal processes. This would be a major and controversial undertaking.

It is therefore considered appropriate that a program of foreshore rehabilitation be commenced. The implementation of such a program would need to be administered by the relevant Council in partnership with the Department of Lands and MPA.

There are a number of ways this program could be implemented. It could be implemented when a new DA is submitted for an individual property. Development approval could require the rehabilitation/removal of foreshore structures where necessary. This is a piecemeal approach which would probably be most appropriate when addressing structures located on private land.

The program could also be implemented using a wholistic approach and would require the completion of the suggested rezoning/Estuary Foreshore DCP (refer to **Section 8.12.1**). Targeted sections of the foreshore could be identified as requiring improved public access and the associated works could include the extension of the walkway/cycleway system along with reconstruction of seawalls in accordance with standard coastal engineering principles. This approach would be suitable for publicly owned sections of the foreshore.

There are 'hard' and 'soft' engineering solutions for foreshore instability. Soft solutions protect or enhance the natural state of the foreshore (see **Section 10.5.3**). Hard solutions involve engineered structures. Sections of the Port Stephens foreshore which are considered more suited to soft treatment include:

- sections of the foreshore which do not have existing seawalls and other engineered foreshore protection structures;
- areas where the bank is relatively low and gently sloping; and
- areas where there is little or no erosion and areas of natural deposition, e.g. Pindimar, Orungall Point, Swan Bay.

Foreshore areas where soft foreshore protection treatments are a feasible management option are shown on **Figure 10.2**.

Sections of the foreshore where hard engineering solutions (seawalls) have been in place for many decades and where they line the majority of that section of shoreline are considered most suitable for continued hard engineering treatments. Those locations where rehabilitation of foreshore structures is considered necessary are shown on **Figure 10.2**.

Structural design guidelines for the rehabilitation of seawall structures around Port Stephens are provided in the **Reference Document** and are summarised here as follows:

Rehabilitation comprises converting the existing vertical walls to porous sloping (2:1 H:V) rock rubble revetments. This can be done simply by placing, on geo-textile, the requisite armour stone in a wedge in front of the wall (see Figure 3.1 in **Reference Document**). This can also be done if the wall is masonry (see Figure 3.2 in **Reference Document**).

In most cases, the wave action is relatively low. Based on the wave climate estimates in MHL (1997 & 1998), design breaking wave heights on the protected revetments would be around 0.9 m. Accordingly, this would require a revetment stone armour size of D_{50} = 420 mm (D_{min} = 380 mm; D_{max} = 450 mm) having W_{50} = 125 kg (W_{min} = 90 kg; W_{max} = 160 kg − see Appendix A). Requisite sizes for under-layers and granular fill (if required) are in Appendix A of the **Reference Document**.

10.5.1.2 Groynes

A number of privately built and Council built groynes are located around the foreshore of Port Stephens. The majority of these are ineffective, e.g. the privately built groynes at Sandy Point (see **Section 10.2.2**) and the small Council built groyne immediately south of Wanda Head (see **Section 10.2.3.3**). Groynes are not considered an appropriate erosion management tool in Port Stephens. They are generally ineffective against the types of processes occurring in the Port and where they are effective, the interruption of littoral flow (the basic effect of a groyne) means that adjacent areas are starved of sediment and so negatively impacted.

10.5.1.3 Private Jetties, Boat Ramps, etc

While there are many unauthorised jetties and boat ramps along the foreshore of Port Stephens, particularly the northern foreshore, their large scale removal is not considered feasible for reasons similar to those associated with seawall removal (see **Section 10.5.1.1**). However, these types of structures could be incorporated into the suggested program of foreshore rehabilitation. As discussed, the program would require detailed input from the Department of Lands (in relation to which structures are authorised/unauthorised, as well as the appropriateness of individual structures) and the MPA. Where structures are considered to be a risk to public safety, or have a detrimental effect on visual or ecological or any other foreshore value, they should be removed.

It is considered that the number of private structures around the foreshore of Port Stephens should be minimised in order to minimise impacts to the ecological, visual and recreational values of the foreshore. The provision of adequate public facilities would decrease the need for private ones.

10.5.2 New Foreshore Structures

The construction of any hard foreshore protection structures on previously unprotected sections of the foreshore should be undertaken as a last resort. The potential impacts on coastal processes, ecological habitats, public access and safety and visual amenity should be thoroughly assessed. Any new foreshore structures should also consider potential impacts on the adjoining Marine Park. Sections of the foreshore where it is considered foreshore structures would be inappropriate are shown on **Figure 10.2**. Foreshore protection structures in these areas are not necessary because:

- a long term erosion signature is not present; and
- the potential impacts on the recreational, scenic, and ecological values of the Port Stephens foreshore cannot be justified.

Where new foreshore protection structures are found to be necessary, the structural design guidelines contained in the **Reference Document** should be followed. These guidelines are outlined below.

Generally, new revetments should comprise rock rubble and be sloping, preferably not steeper than 2:1 (H:V). Suitable revetment schema for new structures against a natural bank and for reclamations is presented in Figures 3.3 and 3.4 of the **Reference Document**.

The revetment crest should be above that which would allow significant overtopping. The revetment crest levels can be assessed from the Manly Hydraulic Laboratory Report MHL880. The size of armour stone cannot be determined accurately without a nearshore/foreshore survey to determine existing levels. Nevertheless, for protected areas, such as Pindimar, Carrington, Lemon Tree Passage and Salamander Bay, where the crest levels should be around 2.5 m AHD, the armour stone size should be D_{50} = 420 mm (D_{min} = 380 mm; D_{max} = 450 mm) having W_{50} = 125 kg (W_{min} = 90 kg; W_{max} = 160 kg − see Appendix A). Requisite sizes for under-layers and granular fill (if required) are in Appendix A of the **Reference Document**.

For severely exposed areas, such as Sandy Point, more robust structures would be required. There the design wave height would be around 2.6 m, giving a revetment stone armour size of around D_{50} = 1.2 m (D_{min} = 1.1 m; D_{max} = 1.3 m) having W_{50} = 3.0 t (W_{min} = 2.2 t; W_{max} = 3.7 t − see Appendix A). Requisite sizes for under-layers and granular fill (if required) are in Appendix A. Requisite crest levels for a revetment here are indicated in MHL880 to be

around 2.4 m AHD. This appears low and it is recommended that this level be reviewed prior to finalisation of a design for the rehabilitation of the seawalls at Sandy Point.

10.5.3 Soft Engineering Options

Soft engineering approaches that protect or enhance the natural state of the estuary are preferred foreshore stabilisation treatments. Soft treatments appropriate to Port Stephens include the creation of a beach in combination with vegetation establishment, or reinstatement or rehabilitation of foreshore vegetation.

While this is the preferred approach, few locations on the Port Stephens foreshore are suitable (see **Figure 10.2**). The majority of areas which display erosion signatures and are amenable to soft engineering solutions have existing hard structures which would be difficult and costly to convert to a more natural profile and environment.

10.5.4 Community Education

Both Port Stephens and Great Lakes Councils should undertake a community education program that informs residents about the important ecological values of the foreshore and its vegetation. The program should cover issues such as:

- guidelines regarding the approval process for private jetties, boat ramps and other structures;
- the importance of keeping the foreshore free from litter;
- suggestions about what individuals can do to look after the foreshore;
- dog owners' responsibilities with regard to the use of dog litter bins;
- waterfront residents' responsibilities with regard to not imposing or impacting on foreshore public reserve;
- the importance of saltmarsh/mangroves and the legislation that protects it;
- the difference between a natural healthy foreshore and one that has been developed/altered;
- suggestions regarding appropriate foreshore stabilisation methods; and
- suggestions regarding appropriate foreshore plantings.

10.5.5 Foreshore Protection Guidelines/Content of DCP

Port Stephens and Great Lakes Councils, in consultation with relevant State government agencies, should develop standard guidelines (or a DCP or Policy) for the appropriate location, design and construction of foreshore structures. The guidelines should provide the following information:

- locations where foreshore protection structures (hard engineering solutions) are not appropriate and where they may be suitable (see **Section 10.5.2** and **Figure 10.2**);
- locations where soft treatments may be effective and instructions regarding their construction (see **Section 10.5.3**);

- structural design guidelines for the rehabilitation of existing foreshore protection structures (seawalls) (see **Section 10.5.1** and **Reference Document**);

- structural design guidelines for new foreshore protection structures (see **Section 10.5.2** and **Reference Document**);

- consideration of the safety and access across and along foreshore protection structures (particularly Council constructed revetment along public reserves); and

- guidelines regarding private jetties, boat ramps and other foreshore structures.

11.0 Water Quality

The *Port Stephens – Myall Lakes Estuary Management Study* (*Reference Document 2: Estuary Management Issues, Themes and Options for Port Stephens and Myall Lakes*) (2000) and *Port Stephens – Myall Lakes Estuary Management Plan* (2000) summarised the water quality issues affecting the Port Stephens estuary.

These studies concluded that water quality in the estuary is generally good. It generally satisfies ANZECC and EPA (now DECC) guidelines for the protection of aquatic ecosystems, secondary and primary contact recreation, and consumption of seafood. However, despite these generally positive assessments, the water quality of some parts of the estuary is considered to be at risk of degradation, or indeed have become degraded (e.g. Tilligerry Creek). The principle risks to water quality in Port Stephens are:

- urban stormwater (nutrients, biological pollutants (such as faecal coliforms), sediment, litter and chemicals);
- rural runoff (nutrients, biological pollutants, sediment);
- run-off from on-site wastewater treatment systems;
- drainage from oxidised acid sulphate soils; and
- point source discharges from marinas (and slipways) and municipal wastewater treatment plants.

It should be noted that the natural clarity of the Port Stephens waterway varies between the Inner and Outer Ports. The Outer Port is generally characterised by clear water that is regularly flushed by tidal processes. The water of the Inner Port is influenced by the Karuah River and other creek flows, is relatively shallow and so bottom sediments are often resuspended by wind waves, is flushed less regularly and so is naturally more turbid.

Port Stephens also contains the substantial groundwater reserves of the Tomago, Tomaree and Stockton Aquifers. These provide drinking water to the surrounding region and also support important wetland ecosystems. These areas can also contribute to flows into Port Stephens. The highly permeable nature of these aquifers means that they are vulnerable to contamination by sewage, industry and poor land use practices (PSC 2005:21).

The importance of good water quality in Port Stephens cannot be overstated. The conservation of a variety of ecological habitats, aesthetic values and the enjoyment of a clean and safe waterway all depend on satisfactory water quality. The economic viability of the Port Stephens fishing and aquaculture industries, as well as the rapidly expanding tourism industry, is also dependent on a healthy waterway.

11.1 Water Quality Monitoring

Port Stephens Council has water quality monitoring points at 49 locations as part of the Clean Waterways Program (EarthTech 2006:39). The objectives of this monitoring are to:

- protect public health by monitoring recreational water quality;
- increase baseline data of estuarine health; and
- identify pollution sources and inform strategies to improve the health of local waterways.

The monitoring results for the period May 2005 to May 2006 indicate that water quality continues to be satisfactory, with the exception of the following issues:

- faecal contamination, originating from dogs, in the Bagnalls Beach area; and
- faecal contamination, originating from on-site sewage systems, in Tilligerry Creek.

The management of faecal contamination at Bagnalls Beach was partly addressed in **Section 8.6** where it was suggested that all off-leash dog exercise areas located on the foreshore area be converted to on-leash exercise areas.

Contamination associated with on-site sewage treatment is discussed in **Section 11.4**.

11.2 Urban Stormwater

Urban stormwater is one of the most significant pressures on the water quality of Port Stephens. The stormwater and drainage system largely discharges untreated stormwater into the estuary (*Port Stephens State of the Environment Report 2005*). **Figure 11.1** shows the location of stormwater outlets around the foreshore of Port Stephens. Untreated stormwater can contribute litter, bacteria, fertilisers, heavy metals, sediments and nutrients to the estuary, affecting water quality as well as aquatic habitats such as seagrass and wetlands. In addition to the effects on the natural environment, the outlets themselves have a negative impact on the visual amenity of the foreshore (see **Section 7.2.4**). This is a problem common to the Australian coastline.

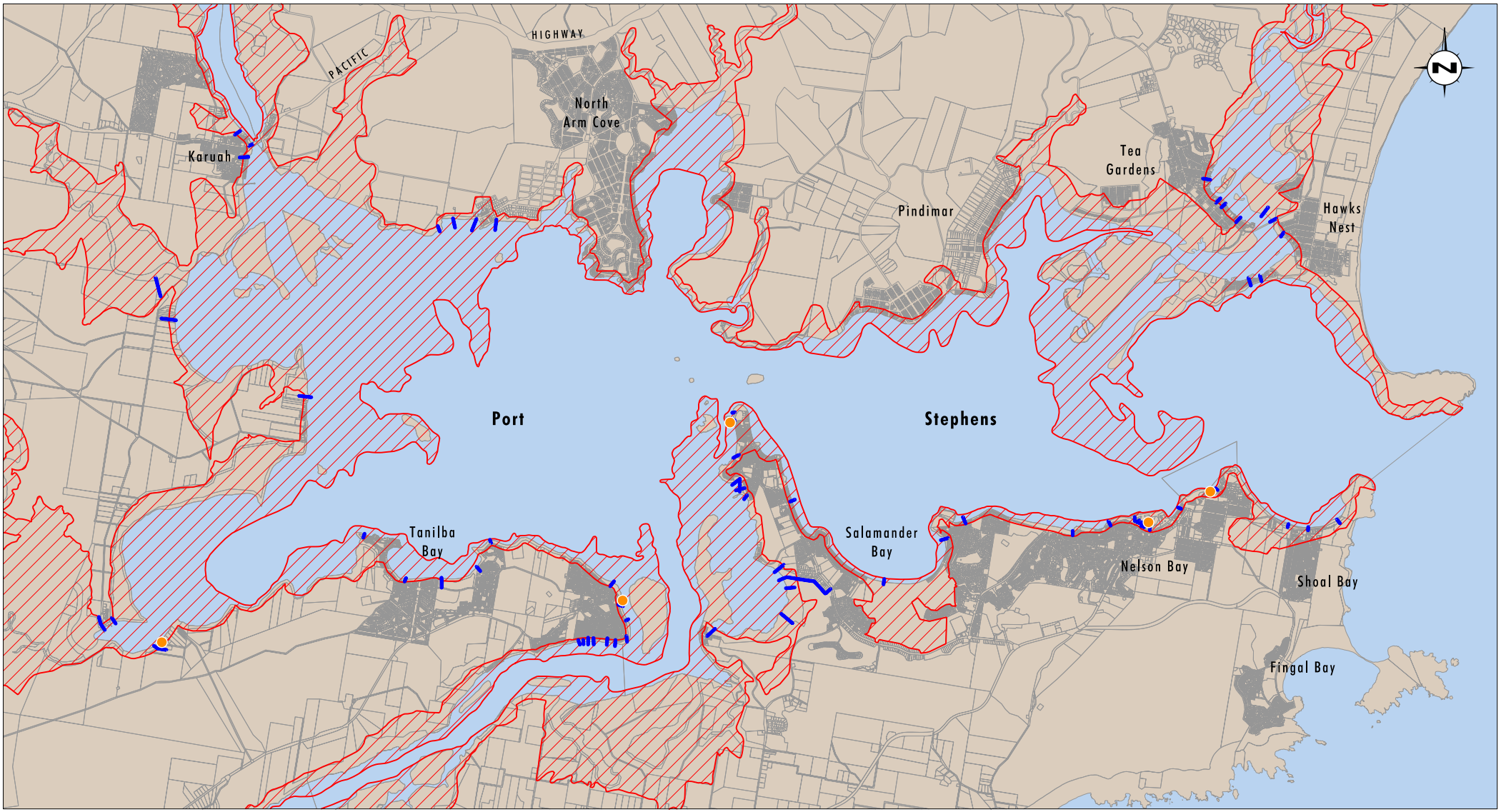
In recognition of the need to manage urban stormwater (and under the direction of the EPA (now DECC)), Port Stephens Council has produced an *Urban Stormwater and Rural Water Quality Management Plan (Stormwater Plan)* (2003). The rural areas adjacent to the Karuah River and Tilligerry Creek are included in the Plan.

The Plan identifies stormwater issues in the LGA and makes short-term (within 3 years) and long-term (planning horizon of between 25 to 30 years) recommendations that aim to mitigate the effects of stormwater. The sections most relevant to the current Plan are those which address the Karuah River Region, and Western End of the Port Stephens Estuary, Tilligerry Creek, and Tomaree Peninsula. Long term goals for these regions include:

- to meet ANZECC guidelines for ambient water quality parameters within receiving waters throughout the Port Stephens LGA for 90 per cent of samples;
- to maximise the value of riparian, terrestrial, foreshore, floodplain and wetland vegetation;
- to minimise the impacts of developments on receiving waters; and
- to minimise the impacts of stormwater on community health and safety.

Identified management options are detailed and site specific and include the installation of silt traps and litter baskets, and investigation into the design and construction of infiltration facilities. These recommendations continue to be effectively incorporated into Council's Forward Works Programs (see **Section 8.11.5**).

The management of stormwater on the northern foreshore is partly addressed in the *Tea Gardens, Hawks Nest and Bulahdelah Stormwater Management Plan* (Jelliffe 2000). The Plan notes that the majority of the Tea Gardens and Hawks Nest area rely on overland flow



Source: LPI NSW (2000), Great Lakes Council (2006), Port Stephens Council (2006)
Note: Seaward study area boundary defined by -2 metre (AHD) contour.

0 1.0 2.5 5.0km
1:100 000

Legend

- Study Area
- Marinas/Slipways
- Stormwater Drains

FIGURE 11.1

Potential Sources of Water Pollution

and infiltration. Potential stormwater pollution point sources were identified as the landfill site and industrial area at Tea Gardens (that eventually drain to a natural swamp and Pindimar Bay), and the golf course and caravan parks at Hawks Nest.

The stormwater management issues identified included water quality degradation which affects the oyster industry, loss of riparian vegetation, acid sulphate soils, and litter and floatable materials from urban areas. Identified management options included sewer ex-filtration programs, the installation of gross pollutant traps or wetlands in specific locations, and community education.

Community consultation identified stormwater as a major concern of some members of the North Arm Cove community. A stormwater management plan for the villages of North Arm Cove, Bundabah, Pindimar and Lower Pindimar is considered warranted. As noted below, the Great Lakes Council currently implements an Erosion and Sediment Control Policy, however, concerns continue to be raised about the erosion of new development sites in the North Arm Cove area.

11.2.1 Policy and Code of Practice for Erosion and Sediment Control

The Stormwater Plans also identify the impact of development sites on water quality in Port Stephens. Construction site erosion can lead to increased turbidity of stormwater and subsequent impacts on estuary conservation values. In addition to recommendations made in these plans, the management of erosion and sedimentation is addressed in the *Policy and Code of Practice for Erosion and Sediment Control for the Central Coast, Hunter, Karuah, Great Lakes and Manning Region LGAs*. The Policy applies to any activity that involves or could involve:

- disturbance of or placing fill on the soil surface, and/or changes to the contours of the land; and

- change in the rate and/or volume of runoff flowing over land, or directly or indirectly entering 'waters'.

In these instances, developers are required to prepare an Erosion and Sediment Control Plan (as part of their DA) which sets out methods for erosion control and site rehabilitation.

11.2.2 Water Sensitive Urban Design

In addition to Stormwater Management Plans, Councils are implementing Water Sensitive Urban Design (WSUD) principles. WSUD aims to sustainably manage the urban water cycle through the appropriate design of houses, streets and suburbs. The principles can also be applied to existing infrastructure through retrofitting.

11.2.3 Nelson Bay Harbour

Nelson Bay Harbour not only receives stormwater runoff from the most heavily developed part of the catchment, but also collects any spills from slipway/marina operations (including fuel, antifouling and sewage) and wastes from the Fishing Co-operative (Umwelt 2000b:1.8-1.11). The area also collects a large volume of litter which is left by visitors, or blows into the water from open skip bins and the surrounding foreshore reserves.

The harbour area is also relatively poorly flushed and there have been complaints about its water quality since its construction in 1986. Despite all these potential contaminants, the sandy beach within the harbour is frequently used for swimming/paddling. Umwelt (2000b:1.9-1.11) also undertook a preliminary feasibility investigation into options to improve water quality and flushing in Nelson Bay Harbour. It was found that the issue could

be addressed through better management of input pollutants (such as the controls discussed in Council's stormwater management plan), with improving water circulation within the harbour and flushing of the harbour with water from Port Stephens.

There is sufficient tidal energy available outside of the harbour to induce adequate flushing of Nelson Bay Harbour through the judicious design of pipe vents. Adequate designs could be completed only following more detailed field data acquisition of the tidal streams around the harbour.

Alternatively, the site is suited to the mechanical flushing out of poor water quality 'hotspots' from within the harbour using low-head, high-discharge pumps. It is considered that this could be achieved with reasonable pump operating and maintenance costs.

The recommendations identified as a result of the investigation were incorporated into the Port Stephens – Myall Lakes Estuary Management Plan (Umwelt 2000a:5.55). The recommendations that are still relevant are listed below:

- Form a working party of all stakeholders (Port Stephens Council, NSW Maritime, Department of Lands, Fishermens Co-operative and D'Albora Marina), to discuss management issues and find practical solutions.

- Employ a part-time caretaker/ranger to regularly clear gross pollutants from the waterway. The caretaker will also be responsible for visual monitoring of oil and grease slicks.

- Install additional litter bins on the western breakwater and boat harbour precinct.

- Prepare a protocol between the local Fire Brigade, NSW Maritime and the caretaker, for clean up of minor oil spills.

- Develop a program of regular control of vermin on the rock walls.

- Undertake a detailed analysis of water quality monitoring results to clarify compliance with the water quality parameters for primary contact recreation and protection of aquatic ecosystems.

- Regularly maintain gross pollutant traps and litter baskets on stormwater pits around the harbour.

- Negotiate with the Co-op and commercial fishermen about waste management and refuelling practices.

Any recommendations for best management practice in Nelson Bay Harbour should be forwarded to the Department of Lands to incorporate into commercial lease terms at the time of issue or renewal.

11.3 Rural Runoff

Water quality in the upper estuarine reaches of the Karuah River and Tilligerry Creek is affected by runoff from rural land.

11.3.1 Karuah River Catchment

The Karuah catchment supports intensive dairy and poultry farming. The *Karuah River Catchment Strategic Water Quality Monitoring Plan* (Marine Pollution Research Pty Ltd (MPR) 1999) identified these industries as major sources of pollution potential and made a number of recommendations regarding the auditing of effluent management systems and compliance with relevant guidelines.

The Catchment Assessment Program undertaken by Port Stephens Council in 1998 found that the majority of chicken farms in the Karuah River catchment followed good management practices with regard to the storage and utilisation of waste but that there was considerable potential for improved management. Further audits to ensure Best Management Practices are being implemented, are considered necessary for both this industry and the dairy industry in the Karuah catchment. The Great Lakes Council has prepared a Commercial Poultry Code which provides guidance for the planning, construction, operation and management of commercial poultry farms in the Great Lakes LGA (which includes the eastern side of the Karuah River). Each farm must also have an Environmental Management Plan that details how environmental impacts will be minimised.

In order to identify and appropriately manage all of the assets and potential threats to the Karuah River catchment, a Karuah River Catchment Management Plan should be prepared. Such a plan would address issues such as:

- the management of former and existing oyster leases;
- bank erosion;
- runoff from poultry and dairy industries;
- important wetland and riparian habitats; and
- waterway recreation.

11.3.2 Tilligerry Creek Catchment

While the primary water quality issue in Tilligerry Creek is faecal coliform originating from on-site wastewater treatment systems (see **Section 11.4**), farming activity adjacent to the waterway also has an impact. According to the Tilligerry Creek Catchment Management Plan (EarthTech 2006:38):

> The lack of riparian buffers has resulted in little filtration of runoff into the watercourse with animal waste and minor cropping products including fertiliser contributing to elevated nutrients that may trigger toxic algal blooms within the estuary.

Management recommendations that address these issues have been made in the Catchment Management Plan. These actions support those already set out in the Stormwater Plan.

11.4 On-Site Wastewater Treatment Systems

Many urban areas and villages around Port Stephens rely on on-site effluent disposal methods. These consist of septic tanks, aerated wastewater treatment systems (AWTS) and pump-outs. Martens and Associates (Martens) (1999) undertook a *Broad Scale Study of On-Site Effluent Disposal Suitability in the Port Stephens Council LGA*. Recommendations

were made for the management of both existing and future systems. Of note is the fact that the majority of the Tomaree Peninsula, Tilligerry Peninsula, western foreshore of Port Stephens and the Karuah River area were assessed as being 'generally unsuitable' or contained a 'significant risk' for on-site effluent management. This conclusion was based on the fact that these areas are:

- water catchment areas;
- flood prone areas;
- SEPP14 wetlands;
- areas with slopes in excess of 30 per cent;
- unstable sand dune areas;
- within 100 metres of a main drainage line; and/or
- areas of Aeolian, beach, estuarine, lacustrine and swamp soils.

Consequently, the majority of the Port Stephens foreshore is unsuitable for on-site effluent disposal. The estuarine soils which compose most of the foreshore of the Inner Port are prone to prolonged saturation (as a result of the high water table) and poor drainage. The soils of the northern shoreline are also often characterised by estuarine and swamp soils and so are generally unsuitable for on-site waste management systems (Martens & Associates 1999:17,49).

The Tilligerry Creek oyster harvesting zone was closed in 2005 after being found to have been affected by faecal contamination from septic tanks. A program of upgrading existing on-site septic systems is currently underway. While a reticulated sewage system in all Port Stephens urban areas would be optimal, the cost of such infrastructure currently appears prohibitive. Until such time as a reticulated system is possible, Port Stephens Council requires that all existing on-site systems in the Tilligerry Creek catchment be upgraded to a 'Wisconsin Mound System'. These provide an additional treatment (through physical, biological and chemical means as it filters down through aggregate and sand layers) to effluent that has already undergone primary or secondary treatment. The effluent that eventually reaches the natural soil is therefore of a higher standard.

The villages on the northern shoreline of Port Stephens are also currently unsewered. The Great Lakes Council's Onsite Sewage Management Strategy provides the framework to manage and regulate the impact of on-site sewage management systems; to regulate and monitor on-site systems; and coordinate system approval, monitoring and EA.

11.5 Acid Sulphate Soils

The oxidation of acid sulphate soils, leading to discharges of low pH water into the estuary, is another potential threat to the water quality of Port Stephens. The NSW Department of Land and Water Conservation (now DNR) produced acid sulphate soil risk maps for the state. Extensive areas of the hinterland of Port Stephens have been mapped as having a high risk of acid sulphate soils occurring near the surface. All bottom sediments in the Port Stephens estuary, wetlands and flood prone area have a high potential.

Strategic Guidelines for the Management of Acid Sulphate Soil in the Port Stephens and Anna Bay Catchments were prepared in 2000 (Environmental and Earth Sciences 2000).

These guidelines state that it is the uncontrolled lowering of the water table and excavation and disturbance of acid sulphate soils that represent the greatest environmental threat with regard to these soils.

Acid Sulphate Soils are managed through the Acid Sulphate Soils Policy in the Port Stephens LGA, and through the draft LEP and DCP – Acid Sulphate Soils in the Great Lakes LGA.

11.6 Point Source Discharges

Point source discharges into Port Stephens that require auditing by the relevant Council and, if required, actions to alleviate their environmental impact include:

- landfill sites (e.g. Tea Gardens Waste Depot, the former Salamander Bay Waste Depot, Lemon Tree Passage Waste Depot);
- slipways/marinas;
- golf courses;
- industrial estates;
- aquaculture industries; and
- fuel and stormwater systems at Williamtown RAAF base (a spill contingency plan should also be prepared for this base).

Specific management actions with regard to the above are contained in **Section 12.0**.

11.7 Groundwater

As discussed in **Section 11.0**, Port Stephens contains substantial groundwater reserves. These reserves provide drinking water, are essential to the ecological health of the Port Stephens estuarine wetlands, and to the water quality of the estuary as a whole. Contamination from sewage, industry and poor land use practices, as well as over-extraction is the greatest threat to these reserves (PSC 2003). The correct functioning of on-site sewage treatment systems and the appropriate management of point source discharges and agricultural land is extremely important in areas where the soil is sandy and the water table is close to the surface. The majority of the Port Stephens foreshore has these characteristics and must be managed accordingly.

11.8 Current Management and Identified Management Action

The current management of the various threats to water quality in Port Stephens has been discussed throughout **Sections 11.0** to **11.7**. The current plan recommends the continued implementation of:

- The Clean Waterways Program;
- Urban Stormwater and Rural Water Quality Management Plan (PSC);
- Tea Gardens, Hawks Nest and Bulahdelah Stormwater Management Plan (GLC);

- Policy and Code of Practice for Erosion and Sediment Control;
- WSUD Principles;
- Karuah River Catchment Strategic Water Quality Monitoring Plan;
- Recommendations arising from the Catchment Assessment Program (PSC);
- Commercial Poultry Code (GLC);
- Tilligerry Creek Catchment Management Plan;
- Twelve Mile Creek Catchment Management Plan;
- Broad Scale Study of On-Site Effluent Disposal Suitability in the Port Stephens Council LGA;
- Upgrading and monitoring of existing on-site sewage systems in the Tilligerry Creek catchment;
- On-Site Sewage Management Strategy (GLC);
- Strategic Guidelines for the Management of Acid Sulphate Soil in the Port Stephens and Anna Bay Catchments;
- Policies and LEP/DCP requirements with regard to acid sulphate soils; and
- Rehabilitation of Salamander Waste Depot.

Additionally, the following management actions should be considered:

- convert off-leash dog exercise areas located along the foreshore to on-leash exercise areas (see **Section 8.7**);
- prepare a Stormwater Management Plan for the villages of North Arm Cove, Bundabah, Lower Pindimar and Pindimar;
- ensure the Erosion and Sediment Control Policy is implemented in all developments adjacent to the foreshore;
- undertake environmental audits of all Port Stephens marinas and slipways;
- undertake environmental audits of industrial estates; and
- ensure that fuel and stormwater management systems at Williamtown RAAF are in place and effective.

All identified management actions that aim to improve water quality are also detailed in **Section 12.0**.