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Revision History

Rev. No.	Date Changed	Modified By	Details/Comments
03	2013	Integrated Planning	• References to DCP No.1 and LEP 2004 changed to Council's DCP and LEP 2013. • Document reformatted.
02	2008	Integrated Planning	Amended title of Appendix One (inserted the words "for the")
01	12/12/05	LMC^2 Consulting Group	▪ Amend title and contents page of Appendix 1 to *Vegetation Recommendations for Lake Foreshore,* to reflect its contents Water Cycle Management Guidelines ▪ Amend practice note referred to in *Landscape Practices* to read Practice Note 7. ▪ Remove duplication of species and their maintenance. ▪ Remove section on Species Selection, as this Appendix 3 is repetitive with other information in the document.
Master	22/03/04	LMC^2 Consulting Group	Master Document - adopted by Council on 22 March 2004

Summary

Suggests appropriate foreshore stabilisation treatment and construction techniques to assist landowners and managers.

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1 INTRODUCTION

This document is intended to assist landowners and managers to determine which foreshore stabilisation treatment and construction techniques suit their situation. The Guidelines are a support document to Council's Local Environmental Plan (LEP) and Development Control Plan (DCP).

Council's DCP defines foreshore stabilisation treatments as *Lakefront Area Development* and a development application is required before undertaking any works associated with this form of development.

Lakefront Area Development means development which is carried out within 6 metres of the deed high water mark of Lake Macquarie, its tributaries and estuaries and includes a jetty, slipway, boat ramp, pontoon, wharf, groyne or similar structure that may extend over or under the water and includes foreshore stabilisation treatments.

Lake Macquarie is a large coastal estuarine lake with an overall length of some 22 kilometres in the north-south direction and 10 kilometres in width. The lake covers an area of approximately 110 square kilometres and has a catchment area of 605 square kilometres. The foreshore is approximately 170 kilometres long and has many bays and peninsulas. The maximum depth of the lake is approximately 11 metres with an average depth of 8 metres. Swansea Channel connects Lake Macquarie to the Pacific Ocean. This single and constricted channel limits tidal interchange.

The lake and foreshore areas support a wide range of habitats and uses, including recreation, nature conservation, urban development, such as residential, commercial, marinas and industrial and rural activities. Because of these uses and associated foreshore vegetation clearance, reclamation, earthworks and construction, the ecology of the lake foreshore has been highly modified.

Foreshore and stream bank erosion and resulting impacts on the lake are a major concern for the community and Council.

With funding from Council and the Lake Macquarie Premiers Taskforce, a Lake Improvement Program has trialed a number of 'soft' and 'hard' engineering and landscape treatments in an attempt to combat this problem.

The Guidelines use these trials as a basis to provide general information for typical situations where stabilisation and rehabilitation is required. The general aim is to re-establish a 'stable', and preferably a natural, foreshore around the lake and along its tributaries.

2 EROSION PROCESSES AND PROBLEMS

The erosion processes that are likely to affect a particular site will depend on prevailing conditions. There can be considerable variation in the type and extent of erosion within relatively short distances along the foreshore.

The three main processes causing foreshore erosion around the lake are:

- wind generated waves,
- boat waves, and
- wind generated currents.

In some localised situations, dredging of creek and drain outlets may also contribute to foreshore erosion. Modifying the natural foreshore can amplify these processes.

Stream bank erosion in tributaries usually occurs as a result of vegetation clearing, current scour, wind generated waves and boat waves.

The key factors that affect the rate or levels of erosion are:

- Wave height - due to wind speed, duration, fetch length, wind direction.
- Lake or streambed slope and beach slope,
- Water depth,
- Beach width,
- Beach material – grain size, material type (granular, clay, rock),
- Presence of vegetation or structural elements,
- Activities associated with the use of the area.

Foreshore erosion can result from removal of native vegetation including seagrasses, development or construction activities, built elements, such as retaining walls, boat ramps and slipways, and boat and wind generated waves.

Foreshore erosion needs to be considered in the context of the lake as a dynamic process. Increased erosion often occurs during storm events or where some disturbance, usually human induced, has caused instability to the foreshore. Following such events the lake will re-establish equilibrium and may result in further erosion.

While foreshore erosion rates have not been quantified, it is understood that at some locations the foreshore has retreated in the order of many metres.

The consequences of foreshore erosion are:

- Adverse aquatic ecological impacts, such as smothering of near shore seagrass.
- Fragmentation and reduction of foreshore habitats.
- Localised degradation of water quality.
- Reduction of tree cover and foreshore vegetation communities.
- Loss or reduced access along the foreshore for recreational uses.
- Potential loss of public and private land.
- Increased maintenance and stabilisation costs for Council and landowners.
- Reduced aesthetics especially due to ad hoc erosion protection works and a reduction in the natural character of the site.

3 WATER LEVELS

Water level changes in the lake occur as a result of tidal movement and major storm events. Tidal movement in the lake is restricted due to the narrow ocean entrance at Swansea. The maximum tidal range in the lake is approximately 0.2 metres. Flood inundation of foreshore areas may occur during major storm events. The 1% AEP design water level for the lake is 1.38 metres AHD with an extreme design water level of 2.63 metres AHD. The actual levels reached during any particular storm event are influenced by a combination of prevailing ocean levels, catchment rainfall and rain falling directly on the lake surface.

4 SELECTING A SUITABLE TREATMENT

The following steps should be considered when intending to undertake works associated with a foreshore stabilisation treatment.

STEP ONE

Carry out a Site Analysis

STEP TWO

Seek advice from a Qualified Engineer

STEP THREE

Discuss your intentions with Council

STEP FOUR

Select a suitable Foreshore Stabilisation Treatment

STEP FIVE

Lodge a Development Application with Council

Note - A sample site analysis sheet is contained in Appendix Three. This will assist in identifying matters that may be relevant to the decision making process.

Consultation with the land owner and the Office of Environment and Heritage is recommended prior to design works commencing. Approvals from other state authorities may also be required.

Soft engineering approaches that protect or enhance the natural state of the lakes foreshore *are preferred*. Heavily engineered systems may be required in exceptional cases where active erosion requires treatment as a last resort.

5 FORESHORE STABILISATION TREATMENTS

Foreshore stabilisation treatments can take several forms depending on the situation and purpose.

Soft engineering approaches that protect or enhance the natural state of the lakes foreshore are preferred stabilisation treatments. Heavily engineered systems may be required where exceptional circumstances have resulted in active erosion and these treatments are used as a last resort.

Generally, 'soft' treatments include creation of a beach in combination with vegetation establishment to stabilise beach material. Periodic beach nourishment may be required to replace eroded material as the beach adjusts to the dynamic requirements of the foreshore.

'Hard' treatments include seawalls, revetments, groynes, breakwaters and sills. Seawalls and revetments are shore stabilisation treatments that are used to retain and armour the shoreline. Treatments like groynes, breakwaters and sills are essentially beach stabilisation treatments used to reduce the loss of beach/foreshore material.

The actual design of the required structure can be complex. Each design is usually site specific. Consequently, some judgement is required to meet specific site objectives and the physical site constraints. The following is an overview of each of the treatments.

5.1 SOFT TREATMENTS

5.1.1 BEACHES

These are a preferred option and suit most conditions in Lake Macquarie.

Beaches are an effective means of dissipating wave energy. They are also areas of habitat and can support a range of invertebrate species.

Natural sand sorting will occur along the foreshore with larger particles likely to remain on the beach in normal and more severe conditions, with fine material being transported off shore.

It is expected that under severe conditions, erosion of beach material will occur and repairs may be required following storm events.

In the coastal situation, the dunal system forms an integral part of the beach and supplies large quantities of sand to the beach during periods of erosion. This component is missing on lake beaches.

Where there is no beach or only a minimal beach area, consideration should be given to recreating a beach.

The design slope of the beach will depend upon the grading of the material used and the local wave environment. The grain size of beach material has a direct relationship with the slope of a beach. The steeper the grade the coarser the material required.

As a general guide, the ratio of vertical height (V) to horizontal distance (H) of a beach using:

- Coarse sand is IV:20H, and
- Pebbles (20-45mm) is 1V: 8H.

Grades of naturally formed beaches around the lake have grades of between 1V: 6H up to 1V: 12H.

It is expected that the action of waves will modify the designed grade. Overfilling the beach during construction allows natural processes to establish the beach and reduces the need for early maintenance.

Where erosion is a minor problem, topping the beach up with more beach material may be appropriate. The replacement material may need to be different to the existing material, such as coarse sand or small pebbles rather than fine sand.

The following should be considered before undertaking a beach nourishment project:

- Prevailing site conditions and the use of the area.
- The amount of erosion and the state of the foreshore.
- Slope of any existing beach.
- Grain size distribution of the existing beach material.
- The location of a suitable quantity of suitable beach material.
- The volume of material required.

Imported beach material should, where possible, match the existing site material by maintaining a similar:

- Colour range,
- Surface texture,
- Particle shape, and
- Particle size range, with a bias towards the larger size ranges.

The use of larger sized beach aggregate may negatively affect the use, aesthetic appeal and habitat of the beach

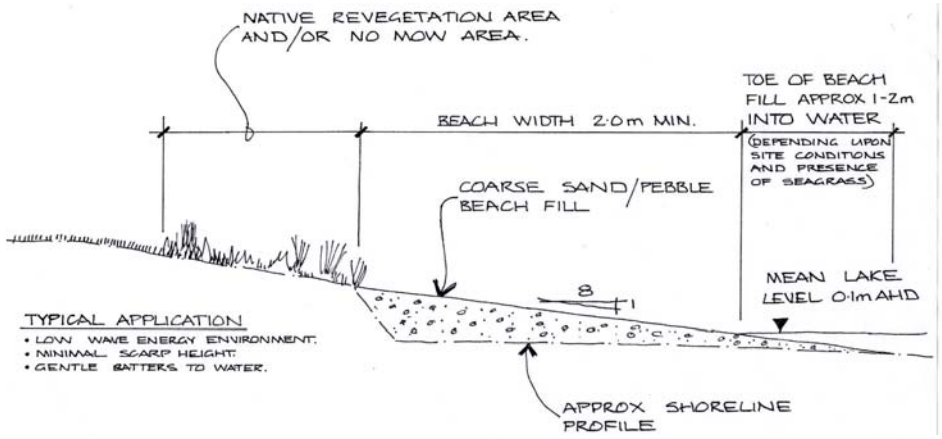

Figure 1 - Example of a Typical Beach Fill

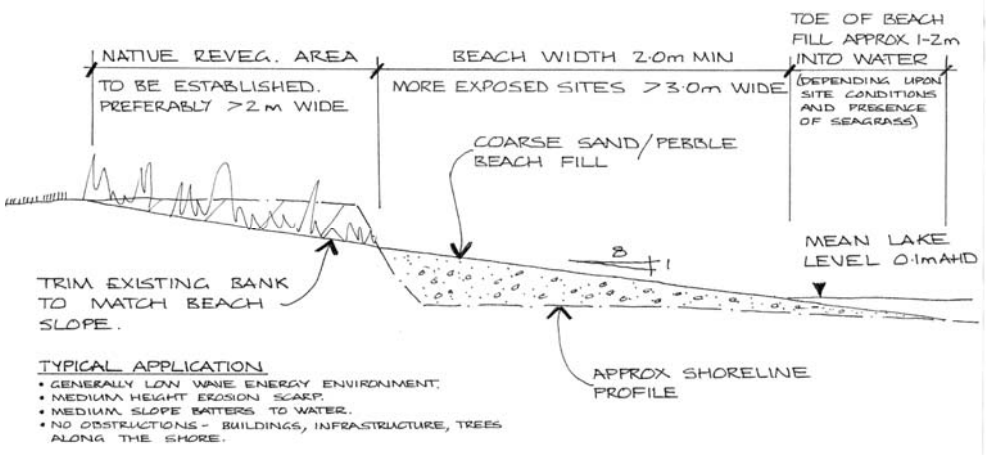

Figure 2 - Example of a Typical Beach Fill

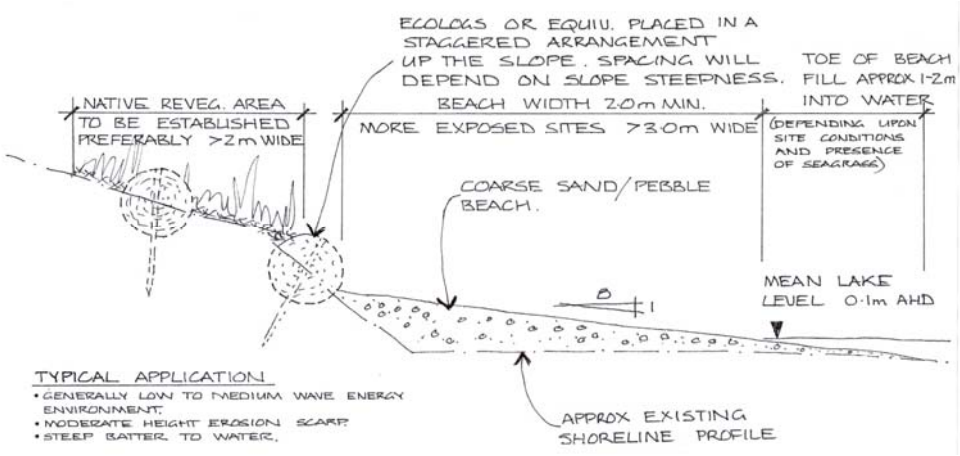

Figure 3 - Typical Beach using Coconut Fibre Log Fill

5.1.2 5.1.2 VEGETATION

- **Reinstatement or rehabilitation of foreshore vegetation is highly encouraged.**
- **Removal of native foreshore vegetation is highly discouraged.**

The establishment of vegetation on a site is the most effective means of preventing soil erosion. A good cover of vegetation protects the soil surface by:

- Reducing the erosive forces of water,
- Reinforcing the soil with plant roots,
- Reducing the velocity of surface run-off, and
- Catching dislodged soil particles before they move from the eroded site.

Littoral and riparian vegetation also acts as a habitat corridor and creates aesthetically pleasing areas that encourage recreation and use.

Foreshore erosion is reduced where a good cover of native vegetation exists in association with a naturally formed beach. Many foreshore areas now support highly modified vegetation communities with scattered native trees and exotic grass understorey.

Aquatic vegetation, especially seagrasses, is also a significant vegetation community providing a major ecological component to the lake. Seagrasses occur as a band around the lake stretching from approximately 2 to 3 metres from the foreshore out to deeper water. Seagrass provides habitat for aquatic fauna, and catches and stabilises bottom sediments adjacent to the foreshore.

Naturalised environments can provide long-term benefits; reduced maintenance costs energy savings and increased areas of riparian habitat. However, returning the foreshore to a more natural state takes time to properly establish and can initially be a more expensive option.

Establishing a naturalised foreshore is facilitated through two main processes.

Passive Naturalisation

Passive naturalisation occurs when mowing ceases and the area is allowed to naturally regenerate. The process works best where there is an existing source of native seed. Some limited intervention may be required to control excessive weed growth until a native understorey establishes.

Active Naturalisation

Is required where there is no native species present. The area to be naturalised needs to be prepared, planted, mulched and maintained until healthy establishment of native species occurs.

Matters to consider when revegetating include:

- Species selection,
- Planting densities,
- Site preparation, and
- Maintenance.
- Adjacent land and foreshore uses.
- Views and aesthetics.

Appendix One provides a discussion and recommendations for sites where revegetation works are an integral part of the project. A plant list for suitable foreshore and stream bank species is shown in Appendix Two.

5.1.3 WRACK MANAGEMENT

Wrack is the build up of debris, including seagrasses and other material, on the foreshore. Organic wrack build up is an important part in providing a first line of defence against wave energy. It also is understood to provide habitat for bacteria, invertebrates, crustaceans and small fish and forms part of the ecology of the lake.

Due to the importance of this material to the biological and physical processes of the lake, removal of wrack is not encouraged, unless it is causing severe odour or use concerns.

5.2 HARD TREATMENTS

Revetment treatments will suit most needs on the Lake Macquarie foreshore.

It is unlikely that seawalls, groynes, breakwaters or sills would be required or approved to address erosion problems associated with individual private properties.

Hard foreshore stabilisation treatments can be either ‘rigid’ or ‘flexible’. The materials used in the structure will be dictated by the site and the nature of its use.

5.2.1 REVETMENTS

Revetments are smaller scale seawalls and are designed to dissipate wave energy and protect the foreshore from currents and smaller wave conditions.

They can be constructed as either ‘rigid’ cast in-place concrete treatments or ‘ flexible’ articulated treatments using rock rubble or interlocking precast concrete units. An advantage of the flexible revetment treatments is that it can tolerate settlement or movement without failing.

Sloped rock rubble revetments are an affective way of absorbing and dissipating wave energy, reducing wave run-up, over-topping and scour.

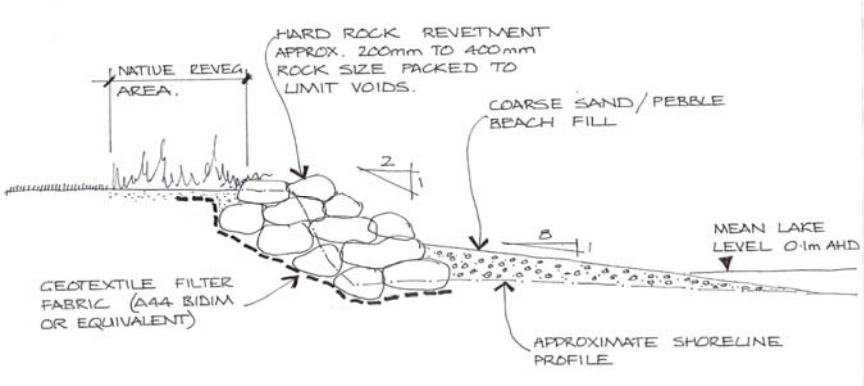

Figure 4 - Revetment for low to moderate wave action.

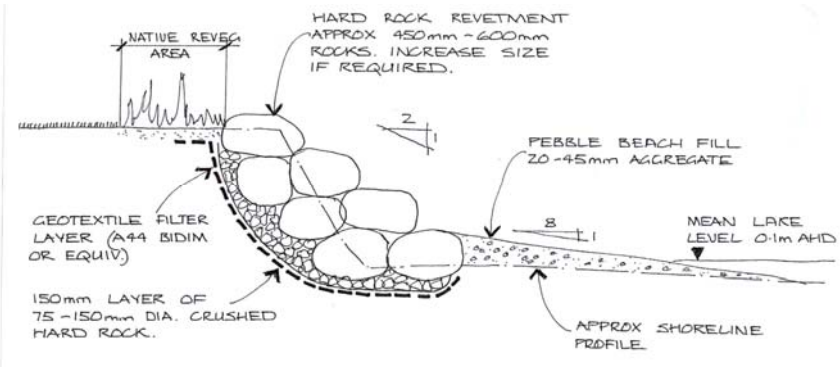

Figure 5 - Revetment for high wave action.

Where a sloped rock rubble revetment is used:

- The lake side face should be 1V:2H (being vertical height to horizontal distance).
- The thickness of more than one rock is required to allow for wave energy dissipation and to reduce scour. Rock sizes of between 200mm to 400mm are effective in most situations.
- A layer of geotextile, or a gravel drainage layer, is required between the natural ground and the rocks to prevent leaching of fine particles, and the subsequent undermining of the structure.

When selecting stone for a rock rubble revetments, the following should be considered. The stone needs to be:

- Sound, durable and hard.
- Free from lamination and weak cleavages and not disintegrate under the action of water and air exposure, or handling and placing.
- All stone should be angular with the greatest dimension not more than 3 times the smallest dimension.

5.2.2 SEAWALLS

Seawalls are usually large structures designed to resist the full force of waves up to a design Annual Recurrence Interval (ARI). Depending on the location and use of the site, seawalls are constructed from reinforced concrete and/or hard rock rubble.

Seawalls can have a number of profiles to dissipate or reflect wave energy. These include vertical or near vertical, sloping, convex – curved, concave – curved, re-entrant, or stepped.

Vertical or near vertical faces are generally less effective against wave attack as severe scour can occur at the base of the wall through water turbulence. Vertical surfaces also reflect wave energy off shore causing increased wave turbulence that may lead to bed profile changes. Problems can also occur adjacent to these structures.

Figure 6 - Photograph of seawall at Swansea Foreshore

5.2.3 GROYNES

Groynes are narrow structures constructed at a right angle to the foreshore. The main purpose of a groyne is to intercept and trap sand transported by long shore drift and to retard erosion of existing beaches.

Groynes are constructed from rock rubble, timber, steel or concrete and can be impermeable or permeable.

In some instances, small-scale groynes may be necessary where a strong long shore drift affects the site.

5.2.4 BREAKWATERS

There are two types of breakwaters -shore-connected and off shore breakwaters.

Shore-connected breakwaters are structures to create calm water areas for boat mooring and handling, such as a harbour, anchorage or basin. In many cases, they are constructed from rock rubble. Precast concrete units are used in some situations.

Offshore breakwaters are structures designed to protect the foreshore from wave action. They are generally constructed parallel to the foreshore and work by reducing the wave energy that reaches the shore on the lee of the breakwater. Offshore breakwaters are generally constructed from rock rubble. Other methods, such as timber and floating units can be used. The wave and site conditions and uses will determine the scale of the structure.

5.2.5 SILLS

Sills are generally parallel to the foreshore and submerged below low water level. Their main purpose is to provide a physical barrier to retard the rate of off shore sand movement and will cause some incoming waves to break at the sill. The discontinuity in the bed levels caused by the sill allows a perched beach to form landward of the sill. Beaches formed in this manner are generally wider and more elevated or perched, than surrounding beaches.

Sills are usually constructed as rubble mound structures using hard quarry rock.

Aesthetically, a sill may be more acceptable than an off shore breakwater but a major disadvantage of the sill is the potential hazard to navigation and swimmers.

6 APPENDICES

6.1 APPENDIX ONE - VEGETATION RECOMMENDATIONS FOR THE LAKE FORESHORE

Discussion/recommendations:

The following discussion is provided as recommendations for rehabilitation of native vegetation associated with the lake foreshore.

Plant Selection and Installation

Plant selection and installation is very important for successful rehabilitation of the lake foreshore.

Planting at higher densities and with a broader range of species will:

- Enhance plant survival,
- Increase the root mass and depth, and
- Allow a more diverse ecosystem to develop.

Increased planting densities will improve the chance of establishment and to allow the new plants to out-compete weeds and provide each other with some support and shelter. For example, ground covers/grasses should be planted in the order of 100 plants per square metre.

Ensuring that proper site preparation and use of appropriate fertilisers, soil modifiers, water absorbing materials, mulch (not deeper than 200mm) and in some cases shelter will also enhance the chances of plant establishment.

One of the aspects that has been highlighted as a contributing factor in the poor establishment is the use of non endemic species and plants grown outside the local area, away from a coastal/foreshore environment. It is suggested that endemic species, many of which are identified in Appendix Two, be used in foreshore planting.

The wholesale removal of existing vegetation, which is often introduced grasses, to plant native species may not be warranted in every situation. Introduced grasses can provide a stable transition from a beach to the land. Where an erosion scarp of up to 200mm has formed, grasses assist in holding the bank in place and may be adequate in limiting further erosion.

Where scarps are higher, such as greater than 250mm the shallower root depth and/or root mass of the grass does not hold the bank, undermining by wave action may continue and the bank collapses taking the grass cover with it. In this instance, native species with a longer root base may be more suitable.

Planting should occur as soon as possible after the construction of the foreshore stabilisation treatment. Delaying the planing leaves the foreshore vulnerable to erosion.

Planting in areas used for private land/water based recreation will require greater consideration to ensure damage through trampling does not result. Grouping or limiting planting areas and improving the growth of the grass component in active area will provide a better overall result.

Maintenance

Ongoing care of the plants, including replanting, watering, weed control, shelter control, restricting pedestrian access, is an essential factor in plant establishment.

Where vegetation, especially native species is used as a major component of the foreshore stabilisation treatment, it is vital that the planting succeeds. Follow up maintenance is necessary to limit costs associated with repeated planting.

6.2 APPENDIX TWO - NATIVE SPECIES FOR FORESHORE AREAS

Table 1 - Local Native Species Suitable for Streambank Planting

	Common Name	Botanical Name	Growth Form	Conditions	Position	Notes
AQUATIC	Water Plantain	Alisma plantago-aquatica	Erect, emergent herb to 1 m tall	Wet-damp	In water - waters edge	Tubers are edible
		Ludwigia peploides	Herb with creeping or floating vegetative stems, and erect flowering stems to 50 cm tall	Wet, ponds and creeks	In water	Yellow flower
	Swamp Lily	Ottelia ovalifolia	Submerged plant with floating leaves	Wet, ponds and slow-moving water	In water	Attractive white flowers
	Water Ribbons	Triglochin procerum	Submerged, tufted herb	Wet, permanent creeks	In water	Widespread and common; small, green fruits are edible
	Tall Spike-rush	Eleocharis sphacelata	Large rush to 2 m tall	Wet, standing water	In water	Forms extensive colonies
	Leafy Twig-rush	Cladium procerum	Erect, leafy sedge 1-1.5 m high	Edge of freshwater swamps on the coast	In water	
	Jointed Twig-rush	Baumea articulata	Sedge 1-2 m tall	Swamps	In water	Attractive plant with large, drooping inflorescence
GROUND COVERS	Native Violet	Viola hederacea	Creeping herb forming carpets	Moist and shady	Bank slope to floodplain	
	River Buttercup	Ranunculus inundatus	Small herb	Marshy, periodically inundated	Waters edge	
	Swamp Pennywort	Centella asiatica	Creeping herb	Marshy, clay or sandy soils	Top of bank to floodplain	

	Common Name	Botanical Name	Growth Form	Conditions	Position	Notes
		Hydrocotyle peduncularis	Creeping herb	Sheltered, marshy	Top of bank to floodplain	
	Scurvyweed	Commelina cyanea	Creeping herb	Moist, shady	Top of bank to floodplain	
	Swamp Goodenia	Goodenia paniculata	Small, tufted herb to 30 cm	Marshy conditions	Top of bank to floodplain	
	Rasp Fern	Doodia aspera	Small, erect fern with harsh fronds 20-40 cm high	Moist, shady	Bank to floodplain	Forms extensive colonies
TREES	Prickly-leaved Paperbark	Melaleuca styphelioides	Tree 6-15 m	Swampy places, fresh and brackish	Top of bank to floodplain	Lower catchment
	Narrow-leaf Paperbark	Melaleuca linariifolia	Small tree to 8 m	Marshy ground	Top of bank to floodplain	Lower catchment
	Node-fruited Paperbark	Melaleuca nodosa	Shrub or small tree to 6 m	Marshy ground	Top of bank to floodplain	Lower catchment
	Broad-leaved Paperbark	Melaleuca quinquenervia	Tree 8-12 m	Marshes	Top of bank to floodplain	Lower catchment
	Willow Bottlebrush	Callistemon salignus	Shrub 3-4 m	Moist and swampy ground	Top of bank to floodplain	Lower catchment
	Cabbage Tree Palm	Livistona australis	Tall palm	Rainforest gullies	Top of bank to floodplain	
	Water Gum	Tristaniopsis laurina	Small, spreading tree 4-10 m	Moist	Top of bank to floodplain	Upper catchment
	Grey Myrtle	Backhousia myrtifolia	Spreading shrub 3-4 m	Sheltered gullies	Top of bank to floodplain	Upper catchment
	Lilly Pilly	Acmena smithii	Shrub or tree	Moist	Top of bank to floodplain	Upper catchment
	Sandpaper Fig	Ficus coronata	Small tree 3-4 m	Moist	Top of bank to floodplain	Upper catchment
	Black Wattle	Callicoma serratifolia	Large shrub usually 4-5 m	Moist	Top of bank to floodplain	Upper catchment
	Cheese Tree	Glochidion ferdinandi	Shrub or tree usually 4-8 m	Moist	Top of bank to floodplain	Upper catchment

	Common Name	Botanical Name	Growth Form	Conditions	Position	Notes
	Rough-barked Apple	Angophora floribunda	Small to medium tree	Moist valleys with deep, alluvial soils	Top of bank to floodplain	Upper western parts of catchment in valleys of Watagan mountains
	Sydney Blue Gum	Eucalyptus saligna	Tall tree 30-50 m	Moist	Top of bank	Upper catchment
	Swamp Mahogany	Eucalyptus robusta	Tree 20-30 m	Swampy ground, fresh and brackish	Floodplain (and steep foreshore land)	Lower catchment
	Swamp Oak	Casuarina glauca	Tree to 20 m	Along boundary between fresh and brackish waters	Top of bank to floodplain	Lower catchment
LOW UNDERSTOREY	Swamp Water Fern	Blechnum indicum	Erect fern 50-150 cm	Swampy ground near the coast	Floodplain	
	Common Maidenhair Fern	Adiantum aethiopicum	Delicate fern 15-40 cm high	Damp, shady places	Bank to floodplain	Occurs in dense colonies
	False Bracken Fern	Calochlaena dubia	Soft fern to 1.5 m	Moist, shady conditions on sandy soils	Top of bank to floodplain	Forms dense colonies
	Spiny Mat-rush	Lomandra longifolia	Grass-like herb to 1 m	Wide range of habitats	Bank slope to floodplain (above high tide on foreshores)	Flowers / bases of new leaves are edible
	Tussock Rush	Juncus usitatus	Forms dense clumps to 1 m	Range of soils from moist to swampy sites	Bank slope and waters edge	
	Tussock Sedge	Carex appressa	Tussock to 1 m	Moist to waterlogged soils	Bank slope to floodplain	
	Saw-sedge	Gahnia clarkei	Forms dense thickets to 2.5 m	Damp and marshy sites	Bank slope to floodplain	
	Club-rush	Bolboshoenus caldwellii	Erect sedge 50-100 cm tall	Brackish water	Waters edge	
	Marsh Club-rush	B. fluviatilis	See above	Freshwater	Waters edge	
	River Club-rush	Schoenoplectus validus	Forms dense stands to 1.5 m or more	Freshwater	Waters edge	

Table 2 - Local Native Species Suitable for Foreshore Planting

	Common Name	Botanical Name	Growth form	Conditions	Position	Notes
GROUNDCOVERS	Sand Couch	Sporobolus virginicus	Creeping, perennial grass	Saline	From upper tidal range to above high tide	
	Coast Couch	Zoysia macrantha	Creeping, perennial grass	Saline-brackish	Above high tide	
	Samphire	Sarcocornia quinqueflora	Small herb to 30 cm	Saline, frequent inundation	Upper tidal range	Edible
	Austral Seablite	Suaeda australis	Spreading herb to 40 cm	Saline, frequent inundation	Upper tidal range	Edible
	Pigface	Carpobrotus glaucescens	Creeping herb	Saline	Above high tide	Succulent leaves and pink, daisy-like flowers
	Sesuvium	Sesuvium portulacastrum	Sprawling herb	Saline	Above high tide	Thick, glossy leaves and pink, star-shaped flowers
	Scurvyweed	Commelina cyanea	Creeping herb	Moist, shady, saline - fresh	Above high tide	
	New Zealand Spinach	Tetragonia tetragonioides	Robust, leafy, sprawling herb	Moist, saline	Above high tide	Leaves edible, preferably cooked
	Sea Celery	Apium prostratum	Scrambling herb	Saline, infrequent inundation	Above high tide	Superior substitute for parsley
	Creeping Brookweed	Samolus repens	Herb to 30 cm	Saline, infrequent inundation	Above high tide	
		Lobelia alata	Small herb with white to blue flowers	Marshy, brackish	Above high tide	Sharply angular stems, flowers white to sky blue
	Bacopa	Bacopa monnieri	Small, creeping herb	Marshy, brackish	Within tidal range	
		Selliera radicans	Creeping herb, forming dense carpets under Swamp Oak	Marshy, brackish	Above high tide	

	Common Name	Botanical Name	Growth form	Conditions	Position	Notes
LOW UNDERSTOREY	Swamp Lily	Crinum pedunculatum	Large perennial herb with thick leaves to 2 m long and large white flowers	Marshy, brackish	Above high tide	Crushed leaves rubbed on skin are antidote to marine stings
	Sea Rush	Juncus krausii	Forms dense clumps 1-2 m high	Saline water	Above high tide	
		Isolepis nodosa	Erect sedge, forming clumps to 70 cm	Moist, saline - brackish	Above high tide	Spikelets form dense globular clusters near top of stem
		Baumea juncea	Slender, erect sedge to 1 m	Slightly saline	Above high tide	
		Cyperus laevigatus	Erect sedge 40-60 cm tall	Saline	Within tidal range	
		Bolboschoenus caldwelli	Erect sedge 50-100 cm tall	Brackish	Within tidal range	
	Streaked Arrow-grass	Triglochin striata	Small, erect, grass-like herb	Brackish, with strong flow	Within tidal range	
	Kangaroo Grass	Themeda australis	Tufted grass to 1 m high	Steep foreshore land	Above high tide	
	Boobialla	Myoporum insulare	Scrambling shrub 50-150 cm high	Saline	Above high tide	
	Sydney Golden Wattle	Acacia longifolia	Shrub 3-4 m high	Steep foreshore land	Above high tide	Golden yellow flowers
TREES	Grey Mangrove	Avicennia marina	Small tree 2-5 m	Saline water	Within tidal range	Fruit fall in December and are dispersed by the tide
	Swamp Oak	Casuarina glauca	Tree to 12 m	Along boundary between fresh and brackish waters	Above high tide	Leaves are reduced to rows of small teeth on branchlets
	Coastal Banksia	Banksia integrifolia	Shrub or tree 6-16 m high	Saline	Above high tide	Underside of leaves is white
	Tuckeroo	Cupaniopsis anacardioides	Small to medium tree 3-10 m tall	Saline, from coastal headlands to littoral rainforest	Above high tide	

	Common Name	Botanical Name	Growth form	Conditions	Position	Notes
	Spotted Gum	Corymbia maculata	Tree to 30 m high	Steep foreshore land	Above high tide	Smooth, spotted bark

6.3 APPENDIX THREE - SITE ASSESSMENT PROFORMA

To be used as a guide with carrying out site inspection before design, development application, construction or maintenance activities take place.

GENERAL

Assessment Undertaken By: .....

Date: .....

Street Address/Location: .....

Suburb: .....

Weather Conditions: (on the day of the inspection)

.....

Site Sketch: (plan view)

SITE CONDITIONS

Infrastructure: (eg. sewerage, stormwater). Identify on Location Sketch.

.....

Structures: (eg. boat sheds, boat ramp, jetty, play equipment and garden shed).
Identify on Location Sketch.

.....

Recreation Uses:

Land Based: (eg. type, frequency of use)

.....

Water Based: (eg. type, frequency of use)

.....

FORESHORE CONDITIONS

General description: Including adjacent areas.

.....

Details: (eg. beach - width, slope, material, presence of rock platforms, scarp height, any constructed elements, length of eroded shoreline, length of unaffected shoreline).

.....

Orientation:

.....

Prominent Wind Patterns Affecting the Site: (consider seasonal changes. Identify on Site Sketch.

.....

Prominent Wave Patterns Affecting the Site: (consider seasonal changes and water uses) Identify on Site Sketch.

.....

Soils: (eg. type, natural, fill, acid sulfate soils).
Soil testing by qualified person may be required. Attach Geotech Report if necessary.

.....

Profile Sketch: (cross section)

Visual Aspects:

Consider views from the water, land and adjoining properties. Photographs are useful.

Photographs:

.....

.....

Vegetation Types: (Include Predominant Species, Significant Species or Habitats)

Onshore: .....

Offshore: .....

Condition: (eg presence of weeds, tree health, maintenance impacts)

.....