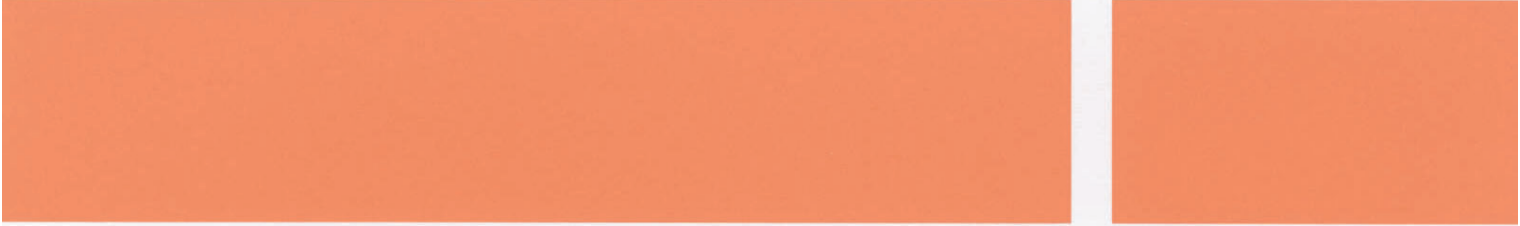



**WARRINGAH COUNCIL  
PITTWATER COUNCIL**



# **NARRABEEN LAGOON FORESHORE REHABILITATION PLAN**

**Issue No. 3  
SEPTEMBER 2003**



**Patterson Britton  
& Partners Pty Ltd**  
consulting engineers

# WARRINGAH COUNCIL PITTWATER COUNCIL

## NARRABEEN LAGOON FORESHORE REHABILITATION PLAN

### Issue No. 3 SEPTEMBER 2003

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# EXECUTIVE SUMMARY

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This report comprises a Foreshore Rehabilitation Plan for Narrabeen Lagoon, with the aims of improving bank stability and extending areas of stabilised bank where possible; extending and re-establishing foreshore areas with vegetation indigenous to the northern beaches area; and, enhancing riparian habitat. These objectives are considered in conjunction with the high recreational values placed on the Lagoon.

The specific sites investigated in this study, which exclude private foreshores, are shown in **Figure ES1**, except Sites 4, 6, 7, 11, 12, 19-21, 25 and 26 are not included. Of the remaining 19 sites, 14 are in Warringah (5, 8-10, 13-18, 22-24, 28), with 5 in Pittwater (1-3, 27, 29).

Based on a review of background information and site inspections, the dominant mechanism causing erosion of the Lagoon foreshore is found to be wind generated wave action, exacerbated by anthropogenic influences such as:

- offshore deepening due to dredging which has led to greater wave energy reaching the shore;
- reclamation of areas of foreshore (*sometimes with steep side slopes*) that are not in equilibrium with the prevailing wave energy and/or lack vegetative protection;
- trampling due to public foreshore access;
- loss of offshore seagrass meadows (*particularly in dredged areas*) that can attenuate waves and currents; and,
- boat wash.

The locations with the most severe erosion are found to be at Wimbledon Park and Berry Reserve. A summary of erosion mechanisms for each site is provided in **Table ES1**. In order to ameliorate the identified shoreline erosion, as well as provide habitat benefits where possible, seven bank stabilisation methods are selected for application in the Lagoon, namely:

1. Trial macrophyte plantings compared to a control site with no treatment:
  - a. Planting only;
  - b. Planting behind a wave barrier;
  - c. Natural recruitment (*no planting*) behind a wave barrier; and,
  - d. Planting and using mulch, behind a wave barrier.
2. Planting of macrophytes on a bench protected by coir fibre logs, woody habitat and/or rocks;
3. Regrading and planting of macrophytes and other vegetation on the flatter slope, with jute matting and offshore sediment/wave barrier;
4. Use of access boardwalks, platforms and/or ramps to reduce trampling damage;
5. Installation of a low level wall to retain the back-beach berm and provide seating and access;
6. Flattened slope with rock groynes at planform ends, sand nourishment, and seating and access as per Method 5; and,
7. Periodic nourishment.

Suitable locations for each design are summarised in **Table ES1**.





Figure ES1: Site numbering adopted in this study (based on WBM, 2001)



**Table ES1: Erosion mechanisms and suitable bank stabilisation methods for sites investigated in this study**

Site	Likely Erosion Mechanisms	Erosion Severity	Stabilisation Method	Comments
1	Wind waves exacerbated by dredging, reclamation and lack of vegetation	3	1, 2, 3	Method 2 would be employed where there are fringing trees, while Method 3 could be used as alternative in other areas where land-take was acceptable. This is also a suitable site for trial plantings ( <i>Method 1</i> ). The aim is to create continuous benches of macrophytes ( <i>where they are currently fragmented</i> ) in specific areas that will not detract from recreational usage. Plant additional <i>Casuarina glauca</i> landward of existing stands. Exclude mowing near foreshore vegetation. Control or remove weed growth ( <i>Figure 26 and Figure 27</i> ).
2	Wind and boat waves exacerbated by dredging and reclamation; and trampling	3	2, 3	Constrain access to sandy beach area by employing Method 2 ( <i>or Method 3 where land-take acceptable between trees</i> ) in other areas and generally increasing vegetation density. Maintain/promote woody habitat in waterway. Plant additional <i>Casuarina glauca</i> landward of existing stands. Exclude mowing near foreshore vegetation. Control or remove weed growth ( <i>Figure 28</i> ).
3	Wind and boat waves exacerbated by dredging, reclamation and lack of vegetation; and trampling	5	2, 4, 6	Focus access to area stabilised by Method 4 or 6 at end of current road, with additional optional platforms or boardwalk. If macrophytes were planted, this would restrict pedestrian access, and terrestrial fencing would potentially be required to enforce the limited access. Fence to prevent vehicle access off road, and provide small carpark. Plant additional <i>Casuarina glauca</i> landward of existing stands and generally increase overstorey and understorey vegetation density in park. Exclude mowing near foreshore vegetation ( <i>Figure 28</i> ).
5	Wind and boat waves exacerbated by dredging	1	none	There is potential to replicate planting methods following trials at other sites to determine the best method for establishment of Phragmites if necessary. Discourage recreational boating landing and access to the island, eg with signage ( <i>Figure 28</i> ).
8	Wind and boat waves exacerbated by dredging (but probably accreting over long term)	1	none	There is potential to replicate Phragmites planting methods following trials at other sites if required. Discourage recreational boating landing and access to the island, eg with signage ( <i>Figure 29</i> ).
9	Wind and boat waves exacerbated by dredging and reclamation; trampling; and streamflow	3	2, 4	Plant macrophytes where absent. Area of exposed soil and roots replaced with platform, delineated with terrestrial and foreshore vegetation. Also monitor second smaller access area ( <i>Figure 29</i> ).
10	Wind and boat waves exacerbated by dredging and reclamation; trampling; and streamflow	2	2 + options	Plant macrophytes where absent. Area of exposed soil and roots at southern end of seawall replaced with optional platform ( <i>delineated with terrestrial and foreshore vegetation</i> ), or the grouted stone wall could be extended, or macrophytes planted ( <i>Figure 29</i> ).
13	Wind and boat waves exacerbated by dredging, reclamation and lack of vegetation; and trampling	4	2, 4, 5 + runoff control	Maintain existing beach near Tramshed, with back-beach berm wall ( <i>Method 5</i> ). Provide ramp/skid for foreshore access ( <i>Method 4</i> ) at Kayak Club. Plant macrophytes between access areas. Constrain market stalls and vehicles. Divert runoff and control sheet erosion near Narrabeen St. Plant additional <i>Casuarina glauca</i> landward of existing stands. Exclude mowing near foreshore vegetation. Control or remove weed growth ( <i>Figure 28</i> ).
14	Wind waves exacerbated by dredging, reclamation and lack of vegetation; and trampling	4	2, 3	Maintain existing beaches to allow foreshore access in high use areas, with macrophytes planted in between. Investigate integrity of treated pine seawall near the Boatshed. Enhance saltmarsh vegetation and delineate access ( <i>eg with woody habitat</i> ) at Scout Hall. Plant additional <i>Casuarina glauca</i> landward of existing stands. Exclude mowing near foreshore vegetation. Control or remove weed growth ( <i>Figure 28 and Figure 30</i> ).
15	Wind waves exacerbated by dredging, reclamation and lack of vegetation; and trampling	2	5 + option	Maintain access to existing sandy beaches. Minor macrophyte planting may be undertaken ( <i>Method 1 or 2</i> ). Construct back-beach berm wall ( <i>Method 5</i> ) or regrade westernmost beach. Investigate substrate quality. Plant terrestrial trees and control weeds. There is potential to replicate planting methods following trials at other sites to determine the best method for establishment of Phragmites if necessary. ( <i>Figure 31</i> ).
16	Wind waves	1	none	There is potential to replicate Phragmites planting methods following trials at other sites if required.
17	Wind waves and minor trampling	1	none	As above
18	Wind waves and minor trampling	1	none	As above
22	Streamflow and trampling	2	2, 5	Construct back-beach berm wall in heavily accessed area in Middle Creek with vegetation planted in surrounds. Undertake bush regeneration and increase density of terrestrial vegetation, including planting <i>Casuarina glauca</i> on bare riparian fringes. Reinstate damaged bollard in car park ( <i>Figure 32</i> ).
23	Wind and boat waves	1	none	Maintain sandy beach for recreational access. Undertake bush regeneration. There is potential to replicate planting methods following trials at other sites to determine the best method for establishment of Phragmites if necessary, where they will not interfere with recreational access ( <i>Figure 32</i> ).
24	Wind and boat waves	1	none	There is potential to replicate Phragmites planting methods following trials at other sites if required.
27	Wind waves	1	1	Employ Method 1 to increase macrophyte density at small exposed beach. Continue bush regeneration. Do not expand access within sanctuary or to surrounding bushland ( <i>Figure 27</i> ).
28	Wind and boat waves exacerbated by lack of vegetation; and streamflow	2	2, 4	Plant macrophytes on bench or construct platform as option in heavily accessed area at tip of Middle Creek with vegetation defining the approach. Undertake bush regeneration and increase density of terrestrial vegetation, including planting <i>Casuarina glauca</i> on bare riparian fringes. There is potential to replicate planting methods following trials at other sites to determine the best method for establishment of Phragmites if necessary; however, streamflow would inhibit establishment in Middle Creek ( <i>Figure 32</i> ).
29	Wind waves (including longshore component), and streamflow	2	7 + options	Sand nourishment should be used to retain the current beach character. Foreshore aquatic vegetation could be planted as an option in isolated pockets if desired. Groynes could be installed to hold beach sediment, but were not considered to be as economical as periodic renourishment ( <i>Figure 33</i> ).

Planting would be dominated by *Phragmites australis* at a density of 2-3 plants/m<sup>2</sup>, either from nursery stock, seed collection, or transplanted from numerous Lagoon sources. Other potential macrophyte species could be used in the rehabilitation. This would be part of reinstating some of the less well represented communities or specific significant species for vegetative diversity.

After planting it would be necessary to maintain the vegetation to ensure successful establishment and growth. The recommended establishment phase for plantings is 52 weeks, with intensive monitoring and maintenance tasks required primarily during the first 6 to 12 weeks, depending on the time of year that plantings are undertaken and prevailing climatic conditions.

Throughout the planting establishment period, maintenance should include, but not be limited to the following:

- watering;
- weeding;
- pest and disease control;
- replanting;
- rubbish/debris removal; and
- where trials are undertaken, measurement of plant growth.

Costs of the seven proposed Lagoon rehabilitation works are provided in **Table ES2**.

**Table ES2: Cost estimates for individual proposed Lagoon rehabilitation works**

Stabilisation Method	Cost	Comments
1a – Trial macrophyte plantings – planting only	\$550/site	Each trial area 50m <sup>2</sup> (10m longshore and 5m crossshore). Does not include maintenance and monitoring.
1b – Trial macrophyte plantings – planting behind a sediment fence wave barrier	\$800/site	As per 1a. Add \$350/site if using a woody habitat wave barrier ( <i>wood freely sourced</i> ). Add \$350 per site if using a large sandstone rock boulder wave barrier.
1c – Trial macrophyte plantings – natural recruitment behind a sediment fence wave barrier	\$400/site	As per 1b.
1d – Trial macrophyte plantings – planting behind a wave barrier and using mulch	\$1150/site	As per 1b. Nearby seagrass wrack collected and used as mulch.
2 – Planting of macrophytes on a protected bench of coir fibre logs	\$1800/site	Area 9m longshore and 5m crossshore, with 0.4m average depth of bench. Does not include maintenance and monitoring. Add \$150 if using woody habitat or rock for wave protection.
2 variation – Planting of macrophytes on coir fibre logs directly against bank	\$750/site	Areas as above, with 0.3m from top of bank to bed. Does not include maintenance and monitoring.
3 – Planting of macrophytes on a flattened slope with matting and offshore sediment/wave barrier	\$4250/site	Area 25m longshore and 5m crossshore. Does not include maintenance and monitoring.
4 – Platform	\$21000/platform	Platform area 25m <sup>2</sup> .
4 – Ramp/Skid	\$17000/skid	Ramp/skid area 24m <sup>2</sup> .
5 – Back-beach berm wall – keystone type system	\$7500/site	Wall 25m long and 0.5m high. Cost similar for timber.
6 – Beach with rock headlands/groynes at platform ends and back-beach berm wall	\$22,000/site	Beach 18 m longshore and 18m crossshore. Back-beach wall assumed to be keystone type as per Method 5.
7 – Periodic nourishment	\$2,200 per event	Assume undertaking work during Narrabeen Lagoon Entrance Clearing Operations. Therefore, do not include cost of site establishment and disestablishment; environment protection; or excavation, stockpiling and dewatering.

The costing of an overall integrated strategy is given in **Table ES3**. This overall strategy is estimated to cost about \$165,700 if fully implemented, excluding maintenance and monitoring of plantings. There would also be scope to continue planting macrophytes on a bench (*or use an alternative planting method*) over an additional distance of about 360m after assessment of the success of the initial plantings.

**Table ES3: Costing of overall rehabilitation strategy for Narrabeen Lagoon (excluding maintenance)**

Item	Cost
Basic trial plantings 1a, 1b, 1c and 1d ( <i>two of each</i> ), covering 80m of bank, with 1 control site	\$5,800
Method 2 ( <i>coir log plantings with or without bench</i> ) over distance of 250m ( <i>mainly at Sites 1 and 13</i> )	\$43,500
Method 3 ( <i>plantings on regraded slope</i> ) over distance of 45m	\$7,650
Platforms ( <i>Method 4</i> ) at Site 9 and 1 additional site ( <i>eg Site 3, 10 or 28</i> )	\$42,000
Ramp/skid ( <i>Method 4</i> ) at Site 13	\$17,000
Back-beach berm walls ( <i>Method 5</i> ) at Sites 13, 15 and 22 <sup>1</sup>	\$22,500
Beach with rock headlands and back-beach berm wall ( <i>Method 6</i> ) at Site 3	\$22,000
Periodic nourishment ( <i>Method 7</i> ) during entrance clearing operations at Site 29	\$2,200
Planting of <i>Casuarina glauca</i> landward of existing stands or on bare riparian fringes	\$2,990
TOTAL	\$165,700

In terms of Local Government Areas, the total of \$165,700 can be separated into costs of \$104,910 for Warringah Council and \$60,730 for Pittwater Council, as itemised in **Table ES4** and **Table ES5** respectively.

**Table ES4: Costing of overall rehabilitation strategy for Narrabeen Lagoon (excluding maintenance), for Warringah Council LGA**

Item	Cost
Method 2 ( <i>coir log plantings with or without bench</i> ) over distance of 200m ( <i>mainly at Site 13</i> )	\$34,800
Method 3 ( <i>plantings on regraded slope</i> ) over distance of 45m ( <i>Site 14</i> )	\$7,650
Platform ( <i>Method 4</i> ) at Site 9	\$21,000
Ramp/skid ( <i>Method 4</i> ) at Site 13	\$17,000
Back-beach berm walls ( <i>Method 5</i> ) at Sites 13, 15 and 22 <sup>1</sup>	\$22,500
Planting of <i>Casuarina glauca</i> landward of existing stands or on bare riparian fringes	\$1,960
TOTAL	\$104,910

**Table ES5: Costing of overall rehabilitation strategy for Narrabeen Lagoon (excluding maintenance), for Pittwater Council LGA**

Item	Cost
Basic trial plantings 1a, 1b, 1c and 1d ( <i>two of each</i> ), covering 80m of bank, with 1 control site	\$5,800
Method 2 ( <i>coir log plantings with or without bench</i> ) over distance of 50m ( <i>mainly at Site 1</i> )	\$8,700
Platform ( <i>Method 4</i> ) at Site 3	\$21,000
Beach with rock headlands and back-beach berm wall ( <i>Method 6</i> ) at Site 3	\$22,000
Periodic nourishment ( <i>Method 7</i> ) during entrance clearing operations at Site 29	\$2,200
Planting of <i>Casuarina glauca</i> landward of existing stands or on bare riparian fringes	\$1,030
TOTAL	\$60,730

<sup>1</sup> It may be possible to regrade the berms, rather than constructing walls, particularly at Site 15. Costs for this option would then be lower.

General maintenance of planted areas (*including watering and weeding*), monitoring of trial areas, and general weed control in the Lagoon foreshore area is estimated to cost about \$31,500 in the first year. This can be separated into costs of \$17,590 for Warringah Council and \$13,730 for Pittwater Council.

A priority listing of the Lagoon rehabilitation works is given in **Table ES6**, ranked from the highest priority (*number 1*) to the lowest priority.

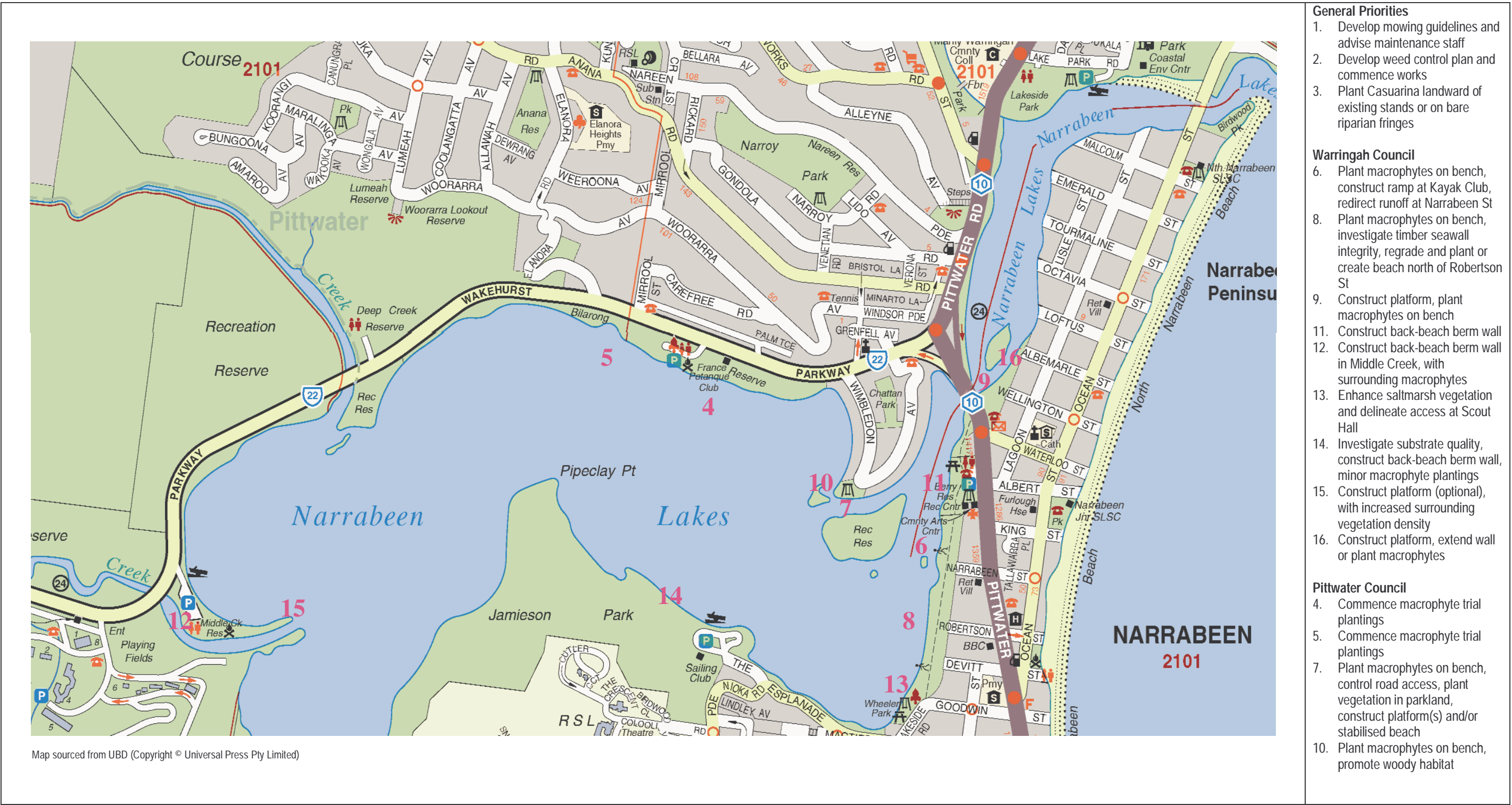
High priorities for Lagoon rehabilitation works include developing mowing guidelines and weed control plans, and planting *Casuarina glauca* landward of existing stands or on bare riparian fringes. With regard to specific sites, Bilarong Reserve, Berry Reserve and Wimbledon Park are considered to have the highest priority for commencing planting and undertaking other works.

**Table ES6: Priority listing of Lagoon rehabilitation works**

Priority	Site	Item
1	-	Develop mowing guidelines and advise maintenance staff
2	-	Develop weed control plan and commence works
3	1-3, 13-14, 22, 28	Plant <i>Casuarina</i> landward of existing stands or on bare riparian fringes
4	1	Commence macrophyte trial plantings
5	27	Commence macrophyte trial plantings
6	13	Plant macrophytes on bench, construct ramp at Kayak Club, redirect runoff at Narrabeen St
7	3	Plant macrophytes on bench, control road access, plant vegetation in parkland, construct platform(s) and/or stabilised beach
8	14	Plant macrophytes on bench, investigate timber seawall integrity, regrade and plant or create beach north of Robertson St
9	9	Construct platform, plant macrophytes on bench
10	2	Plant macrophytes on bench, promote woody habitat
11	13	Construct back-beach berm wall
12	22	Construct back-beach berm wall in Middle Creek, with surrounding macrophytes
13	14	Enhance saltmarsh vegetation and delineate access at Scout Hall
14	15	Investigate substrate quality, construct back-beach berm wall or regrade berm, minor macrophyte plantings
15	28	Construct platform ( <i>optional</i> ), with increased surrounding vegetation density
16	10	Construct platform, extend wall or plant macrophytes

The location of these works is shown in **Figure ES2**. Priorities 1, 2, and 3 are general recommendations and have no specific location. Priorities 4, 5, 7 and 10 apply to Pittwater Council, while the remainder apply to Warringah Council. The final priority for works would be confirmed following further monitoring.





**Figure ES2: Summary of prioritised rehabilitation works arising from the Narrabeen Lagoon Foreshore Rehabilitation Plan (numbers shown are priority ranks)**

It is recommended that, in general:

- woody habitat should be encouraged;
- a fauna survey and habitat mapping should be carried out;
- “no access” areas should be maintained around the foreshore for habitat;
- foreshore access should be maintained where required, and otherwise macrophytes should be planted in adjacent areas;
- the diversity of foreshore vegetation should be increased where opportunities allow it;
- the current designated 8 knot speed limit for power boating should be enforced;
- existing *Phragmites australis* areas should be maintained, as should other sections of shoreline vegetated by aquatic and terrestrial vegetation;
- acceptable foreshore treatments for private foreshores should be defined in a Development Control Plan or similar;
- private landholders should be encouraged to play a positive role in maintaining and enhancing foreshore vegetation; and,
- seagrass beds should be maintained and enhanced where possible.

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