BALUDARRI WETLAND

WETLAND PLAN OF MANAGEMENT

2010

Sydney Metropolitan CATCHMENT MANAGEMENT AUTHORITY

PARRAMATTA CITY COUNCIL

Project Identification

Name of the proposal:	**Baludarri Wetland** **Wetland Plan of Management**
Local government area:	**Parramatta**
Client:	**Parramatta City Council**
Report **prepared by:**	Australian Wetlands **Applied Ecology Pty Ltd**

Date	Revision	Prepared by:	Reviewed by
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1. INTRODUCTION

This document has been designed to provide best management practices and strategies to assist Council in better managing the reserve's assets, to increase biodiversity values and assist in the management of threatened and significant species and vegetation communities on site. The preparation and contents of this Wetland Plan of Management are in accordance with the requirements of the Local Government Act, 1993, and the Local Government (General) Regulation, 2005 for the contents of Plans of Management. Under the terms of the Local Government Act 1993 Parramatta City Council is required to prepare management plans for community lands in their care and control. The term 'community land' includes both public parks and bushland reserves. This report is also designed to fulfill Council's obligations under the Threatened Species Act 1993 and Environment Planning & Assessment Act 1979. The Baludarri Wetland POM will be reviewed on an as-needs basis. It is envisaged that this will be required to be done after 5 years.

1.1 What Is A Plan Of Management?

Council is required under the Local *Government Act 1993* to prepare a Plan of Management for Community land. The purpose of a Plan of Management is to identity the needs of an area, propose actions and to guide Council as owner of Community land in the future management of Baludarri Wetland. The purpose of the Baludarri Wetland Plan of Management is to enable Council to manage and conserve biodiversity values and passive recreational uses.

1.2 Land To Which This Plan Of Management Applies

This Plan of Management applies to Baludarri Wetland, which is approximately 2.3 hectares in area and located approximately 1.4kms north east of the Parramatta CBD.
Land within the reserve is owned by Parramatta City Council. Consequently, this Plan of Management has been prepared in accordance with the requirements of the Local *Government Act 1993*.
Key features of Baludarri Wetland include:

- **Coastal saltmarsh**, which is listed under the Threatened Species Conservation (TSC) Act 1995 as an Endangered Ecological Community (EEC).
- **Freshwater wetlands,** within the definition of freshwater wetlands on coastal floodplains, which is listed as EEC under the TSC Act.
- **Migratory bird habitat** protected under Federal Government inter governmental agreements (CAMBA JAMBA ROKAMBA) All migratory bird species listed in the annexes to these bilateral agreements are protected in Australia as matters of national environmental significance under the Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Act 1999.
- **Mangrove community (heritage listed)**
- **Other remnant native (and exotic) vegetation**

1.3 Objectives Of This Plan Of Management

Objectives of this Wetland Plan of Management for Baludarri Wetland are to:

- Establish a sound and balanced approach to the management of Baludarri Wetland while providing a flexible framework within which Council can respond to current needs and opportunities, as well as to future directions and pressures;
- Establish a framework to guide day-to-day and long-term decision-making regarding the management of the reserve; and
- Meet Council's obligations under local, state, national and international legislation.

1.3.1 Local Government Act 1993

The Local Government Act 1993 outlines requirements for the classification and management of community land (sections 35 and 36[1]). The Act requires that all community land owned by councils be the subject of a plan of management. Community land is defined as land that should be kept for the use of the general community, and cannot be sold; nor can it be leased for more than 21 years. The minimum requirements under the Local Government Act are that a plan of management must:

Table 1 Requirements of the Local Government Act 1993

Requirement	Addressed in this report
Categorise the land	Section 1.4.1
Contain objectives and performance targets of the plan	Section 6. Tables 3 to 21
Specify the means of achieving the objectives and performance targets	Table 4 to 21. Management issues, actions and timeframes for Zones 1 to 13 encompassing all of Reserve.
Outline how Council intends to measure and assess the objectives and performance target	As above
Permitted future uses of the land. (Section 36(3A)(b)	Planned developments and improvements to Baludarri Wetland, based on consultation with the community and Reserve users, and are shown on the Management Map Set. The scale and intensity of permitted uses should generally be consistent with the scale and intensity of current use, and as specified by Council in

Requirement	Addressed in this report
	license agreements. Increased use of the Reserve for recreational activities, such as community events, will only be permitted where damage to the Reserve and inconvenience to local residents is minimised.
Leases, licenses and other estates that can be granted.(Sections 46 to 47F)	In respect of community land in general, a lease, license or other estate may only be granted within Baludarri Wetland for: a) short-term casual purposes, However, the use or occupation of community land for these short-term casual purposes is permitted only if the activity does not involve erecting a permanent building or structure.

Table 2 Ownership and management of Baludarri Wetland

Classification	Community Land Lot and DP (multiple. Refer Figure 3)
Categorisation	Natural Area Watercourse (section 36M)
Owner	Parramatta City Council (NSW Maritime-Mangrove community)
Manager	Parramatta City Council
Zoning	6A Public Open Space
Area (ha)	2.49 ha
Public purpose	Open space

1.4 Background

Parramatta is Australia's second oldest settlement, established on the 2nd of November 1788. The surrounding area was used to farm crops for the new colony as the poor soils around Port Jackson would not support staple food crops. By the late 1850's Parramatta was the main metropolis of NSW placing considerable pressure on the natural environment. The River foreshore also became the site for heavy industry, resulting in extensive soil contamination which still has a major impact on the estuary today.

The Parramatta Local Government Area (LGA) straddles the junction between the physiographic regions of the Hawkesbury Sandstone Hornsby Plateau and the Wianamatta Shale Cumberland Lowlands. Quaternary alluvium follows the many creek lines. As a consequence of the diversity of the underlying geology and topography and climatic variations, there are a number of soil landscapes over the Parramatta LGA. These soil landscapes support 8 broad remnant vegetation communities. Six of these vegetation communities are recognised as being of high conservation significance under the Threatened Species Conservation Act (1995). Parramatta's diversity has markedly declined since the arrival of non-Indigenous people over 200 years ago. The continuous forests that existed from coast to mountains have largely been cleared, initially for farming and more recently for housing and industry. The remaining bushland in Parramatta is accordingly a patchwork of largely unconnected reserves. In all, Council manages 326 hectares of remnant vegetation including wetlands, 158 hectares of remnant canopy trees and 11 different vegetation or ecological communities (eight of State or national significance) (PCC, SOE 2007-8).

1.4.1 LOCATION AND SETTING

Baludarri Wetland is located immediately west of James Ruse drive on the northern bank of the Parramatta River (Figure 1 below). The site is bounded by:

- Thomas Street to the north;
- James Ruse Drive to the east;
- Pemberton Street to the west, and
- The Parramatta River to the south.

Figure 1 Location of Baludarri Wetland

1.4.2 ZONING AND SURROUNDING LANDUSE

Under the terms of the Parramatta LEP 2001 land in Baludarri Wetland is owned by Parramatta City Council and Maritime NSW. The unusual shape of Baludarri Wetland is created by the existing land tenure. In Figure 3 below only property in public ownership has the lot and DP numbers visible. Existing zoning is 6A Public Open Space and 2E Residential (Figure 2 below). Surrounding zoning is 9(a) Proposed open space, 2A Residential and 4 Employment. Baludarri Wetland forms part of the very fragmented riparian corridor along the Parramatta River. It abuts residential housing along the northern boundary but is buffered to some degree by the degraded but undeveloped Zone 4 land to the west and the Parramatta River and 9(a) lands to the south and south-west.

Figure 2 Zoning LEP 2001

Figure 3 DP and Lots Baludarri Wetland

For the purposes of SEPP-19, urban bushland is defined as: land on which there is vegetation which is either a remainder of the natural vegetation of the land or, if altered, is still representative of the structure and floristics of the natural vegetation. Baludarri Wetland is classified as community land-public open space, and the remnant bushland therein is afforded protection under the terms of SEPP-19.

1.4.3 TOPOGRAPHY, GEOLOGY AND SOILS

The study area is located on a level to gently undulating alluvial floodplain originally formed by the ancient river system draining the Wianamatta Group Shales of the Cumberland Lowlands and sits within the floodplain of the Parramatta River. The Cumberland Plain is a low, undulating plain underlain by horizontally bedded sediments of the Wianamatta Group, mainly Bringelly Shales. These shales are generally composed of claystones, siltstones and carbonaceous shales with sparse sandstone lenses. The sediments were laid down in a coastal alluvial plain during the middle Triassic (200Ma). Toongabbie Creek and its tributaries, which drain the south west area of the Upper Parramatta River catchment, flow through Bringelly Shales.

The Soil Landscapes of Sydney 1:100000 (9130) indicates that Baludarri Wetland is underlain by Wianamatta Group Ashfield Shale. The terrestrial soil landscape is part of the Blacktown Soil Landscape (Unit). The soils of the Blacktown unit are described as shallow to moderately deep, with red and brown podzolics on crests, upper slopes and well-drained areas, and yellow podzolics and soloths on lower slopes and in areas of poor drainage (Chapman and Murphy 1989).

The majority of the Baludarri Wetland is within the 1 in 100 year flood zone. Local relief in the reserve is generally one to two metres (excluding batters at reserve north/west boundaries), with slope gradients averaging less than three metres. Historic land use of the Reserve was primarily for agricultural purposes, probably grazing, and this is evidenced by formal drainage lines and the profusion of extant pasture grasses. Sydney Environmental and Soil Laboratory (SESL) Pty Ltd investigated the area which is now recreated saltmarsh in 2007. They found that the natural soil horizon was generally overlaid with approximately 0.7m of anthropogenic fill. Below the fill is a peaty layer underlain by coarse consolidated river sands.

1.4.1 Hydrology

Baludarri Wetland abuts the Parramatta River along its southern boundary. The Parramatta River is the main tributary of Sydney Harbour (Port Jackson). The river is tidal to the Charles Street Weir in Parramatta, some 19 km upstream of the commencement of the river at Balmain, or approximately 30 km from Sydney Heads. The spring tidal range at Parramatta is 11% greater than that at the Heads. The river begins at confluence of Toongabbie Creek and Darling Mills Creek west of Parramatta and travels in an easterly direction to its confluence with the Lane Cove River. The total catchment area of the river is approximately 130 km² (Department of Natural Resources, 2007).

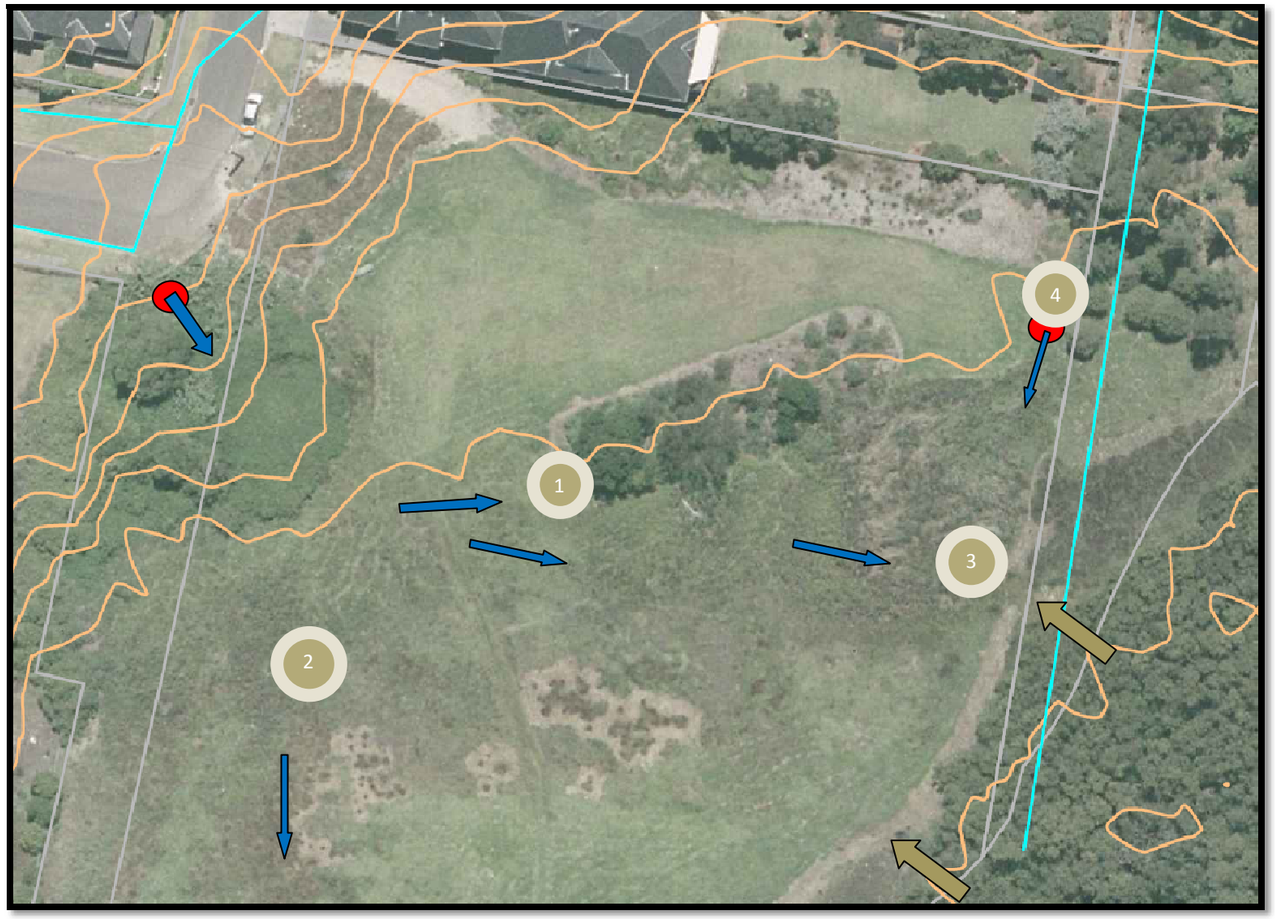
Port Jackson has been identified as the most contaminated waterway on the eastern seaboard. Extensive areas of the estuary have sediments containing high concentrations of a large range of metallic and organic contaminants. The Parramatta River is mantled in these contaminated

sediments at concentrations in excess of their ecological response levels (ERL) values i.e. at levels where adverse biological responses may be expected (Birch and Taylor 2002).

SESL (2007)site investigations concluded that electrical conductivity (EC) levels in the natural peaty soil layer (below the ~ 0.7m of anthropogenic fill) indicate that tidal influences could still occur and/or did occur and that the highly organic and permeable nature of natural site soils, despite compaction from the overburden, would allow exchange of water with the River.

West and north of the salt and freshwater interface along the river are two stormwater outlets that feed the freshwater wetland. These outlets service a typical impervious suburban catchment of 1.7 hectares. The eastern outlet invert is approximately 100mm below existing levels. Sediment and gross pollutants have deposited at the outlet and stormwater discharge scours and braids directly to the freshwater wetland through a substantial weedy sediment plug (see Figure 4 overleaf). Water quality testing has not been undertaken at the site.

Figure 4 Surface water flows Baludarri Reserve



SURFACE WATER

FRESHWATER FLOW DIRECTION

STORMWATER OUTLET

TIDAL WATERS

The western outlet is located at the edge of the road reserve within an extensive weed plume. Water discharges from the outlet and enters the freshwater wetland in a southerly direction. The immediate settling area contains a thick and extensive stand of Typha and water braids across the surface to two formalised drainage lines flowing south and east and one natural flow path that ends at the recreated saltmarsh where fresh and saline water mix. The eastern flowing drainage line appears to have been established when land use was primarily agricultural to drain the site (see Figure 5 right). During high rain events the stormwater sheets across the reserve south of the outlets (pers. comm. Graeme Phipps, 2009)

Tidal influence at the reserve has been mapped (mean high tide levels) and is illustrated in Map PE12/06 (Appendix C). Anthropogenic fill and historic landuse has reduced the area with observable tidal influence, however, wash from the rivercat unnaturally inundates the terrestrial zones. The recreated saltmarsh has a constant low input of freshwater from baseflows from the freshwater wetland and is inundated by saline waters during high tide.


Figure 5 Baludarri Wetland 1943


Figure 6 River Cat wash (southern area)


Figure 7 Recreated saltmarsh at low tide

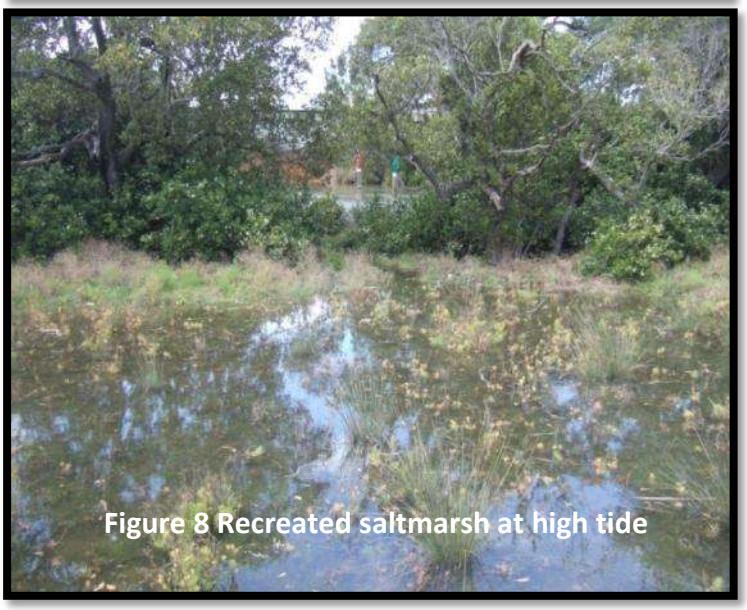
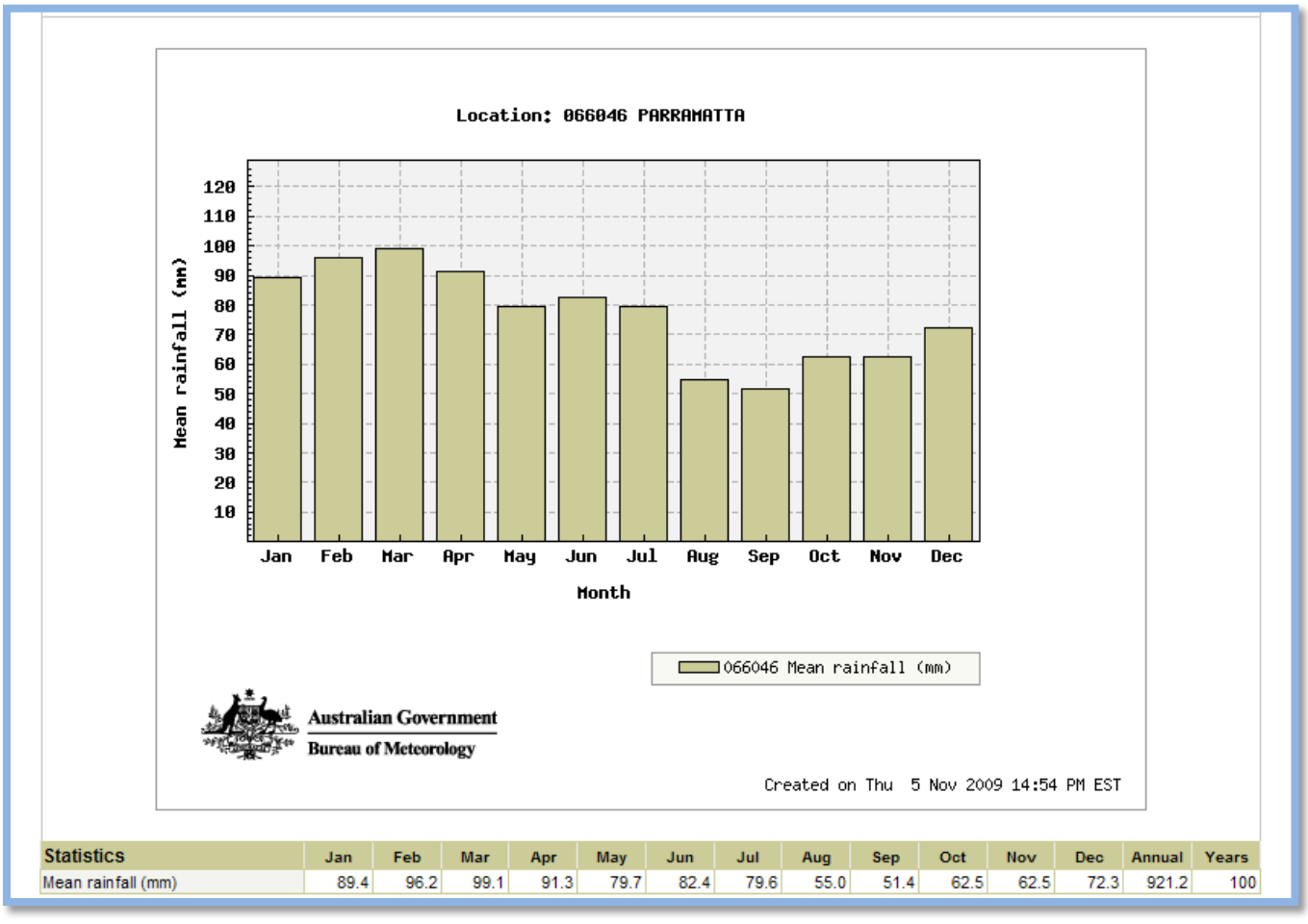


Figure 8 Recreated saltmarsh at high tide

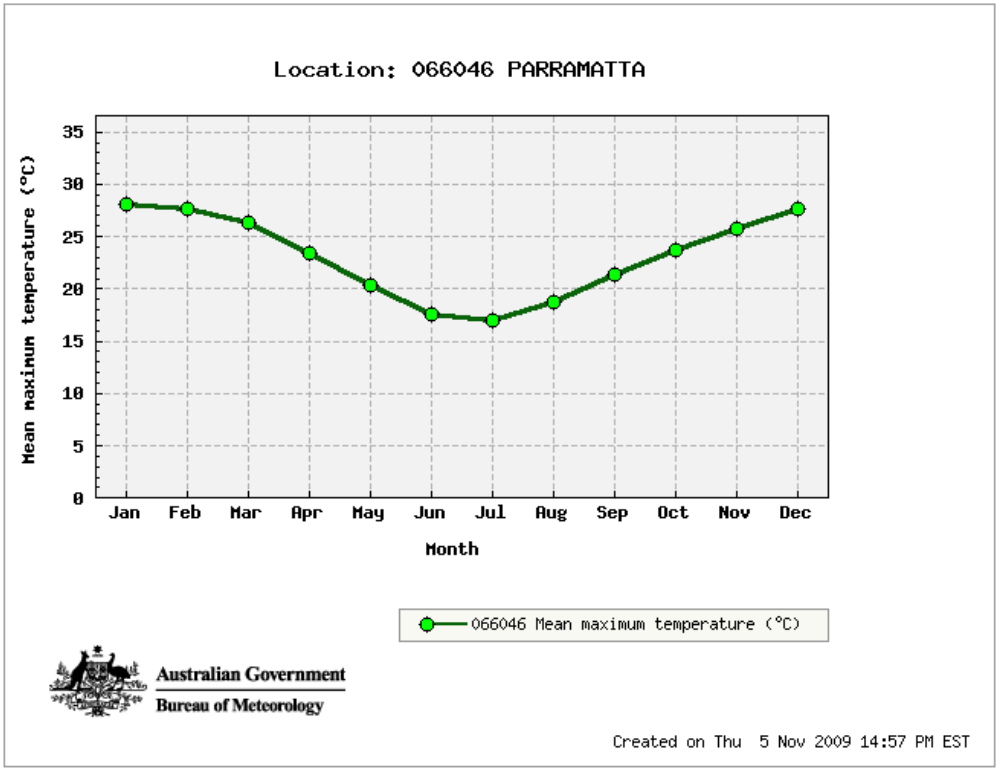
1.4.2 Climate

Climatic data was obtained from the nearest meteorological station at Parramatta (records from 1966 (rainfall)and 1956 (temperature) to 2009). Meteorological records indicate a yearly average maximum temperature of 23.1 and a yearly mean minimum temperature of 10.9°C. Mean annual rainfall is 921.2mm, with the number of days having a rainfall event greater than or equal to 1mm being 41.6 days. Mean number of days with rainfall events greater than or equal to 10mm is 12.7 days. Number of days with very heavy rain (greater than or equal to 25mm) is 4.9 days. Rainfall is lower in August and September, with the wettest period during February and March (Australian Bureau of Meteorology 2009).



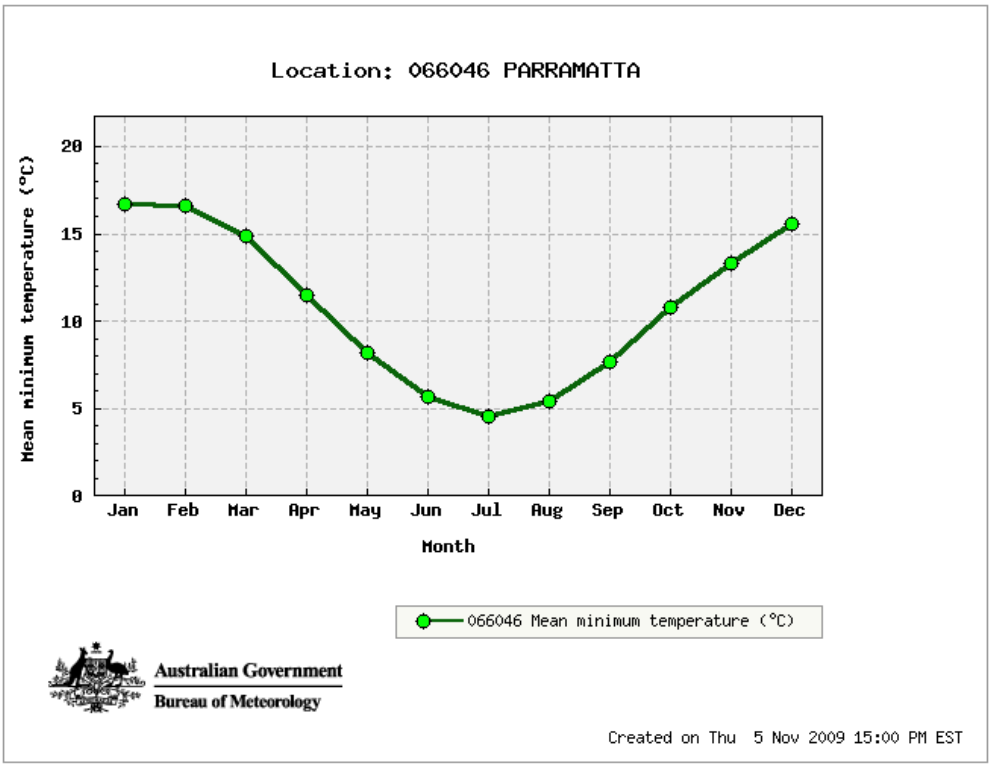
Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Mean rainfall (mm)	89.4	96.2	99.1	91.3	79.7	82.4	79.6	55.0	51.4	62.5	62.5	72.3	921.2	100

Figure 9 Mean annual rainfall Parramatta



Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Mean maximum temperature (°C)	28.1	27.7	26.4	23.4	20.3	17.5	17.0	18.7	21.4	23.7	25.8	27.6	23.1	40

Figure 10 Mean maximum temperature Parramatta (BOM 2009)



Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Mean minimum temperature (°C)	16.7	16.6	14.9	11.5	8.2	5.7	4.5	5.4	7.7	10.8	13.3	15.6	10.9	40

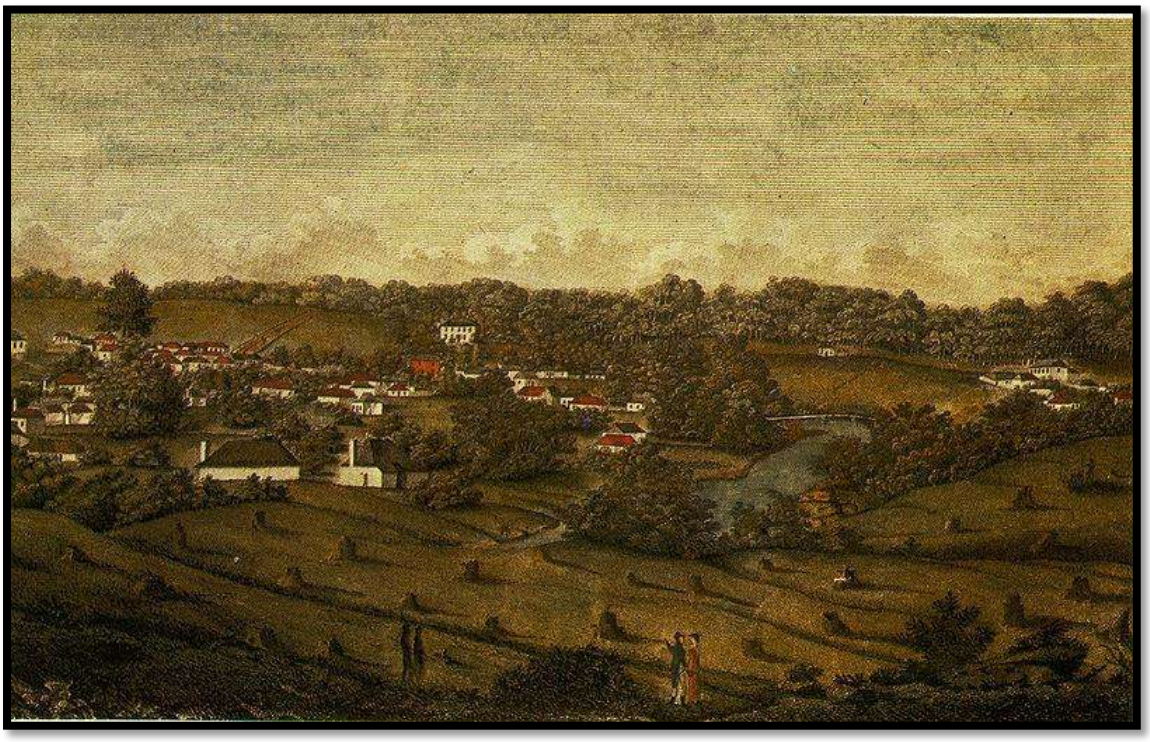
Figure 11 Mean minimum temperature Parramatta (BOM 2009)

1.4.3 Indigenous History

The head of the Parramatta River was home to the Burramatta (or Burramattagal), a clan of the Darug people whose name means eels ("burra") and a place, usually a water place ("matta"), or 'the place where eels lie down to breed'. Pre-European Parramatta would have been a place rich in a variety of food types and this combined with a warm temperate climate made it ideal for continuous settlement. The rich wealth of indigenous heritage items within the LGA has been studied extensively and it is accepted that there was a continuous aboriginal settlement in the LGA for at least 30,000 years prior to European settlement.

The first encounters between the foreigners in boats and the river people in February 1788 were friendly, with laughter and mimicry on both sides. The lives of the Burramatta clan changed forever the following November when armed marines built an earthwork fort at Parramatta. This action displaced the family of the Burramattagal elder Maugoran and his wife Gooroobera, who were forced to move down the river to The Flats, near Meadowbank. In April 1789 there was a smallpox epidemic, which Bennelong said killed half the Indigenous population. There were some friendly contacts between the Darug and the settlers at Parramatta, with several Aboriginals including Ballooderry (or Baludarri-after whom the wetland is named) bartering fish with the officers and settlers in June 1791. Baludarri was befriended by Governor Phillip and assisted with translation during expeditions further west. In July 1791 some of the convicts destroyed Baludarri's canoe and he speared a man near Kissing Point as payback. For this he was outlawed, to Phillip's disappointment. Without the use of his canoe, he would have found it very difficult to feed himself and his family. He died a few months later, possibly from small pox, and was buried in the Governor's garden at Sydney.

Figure 12 Engraving of Parramatta in 1812 by Phillip Slanger, in *Illustrated History of New South*



Wales, Flower C. (1981) Rigby Sydney

By most accounts, the hostilities which developed near the outer settlements were instigated by the convicts and the soldiers. Between Parramatta and Kissing Point, and west to Toongabbie, spearings in retaliation were not uncommon.

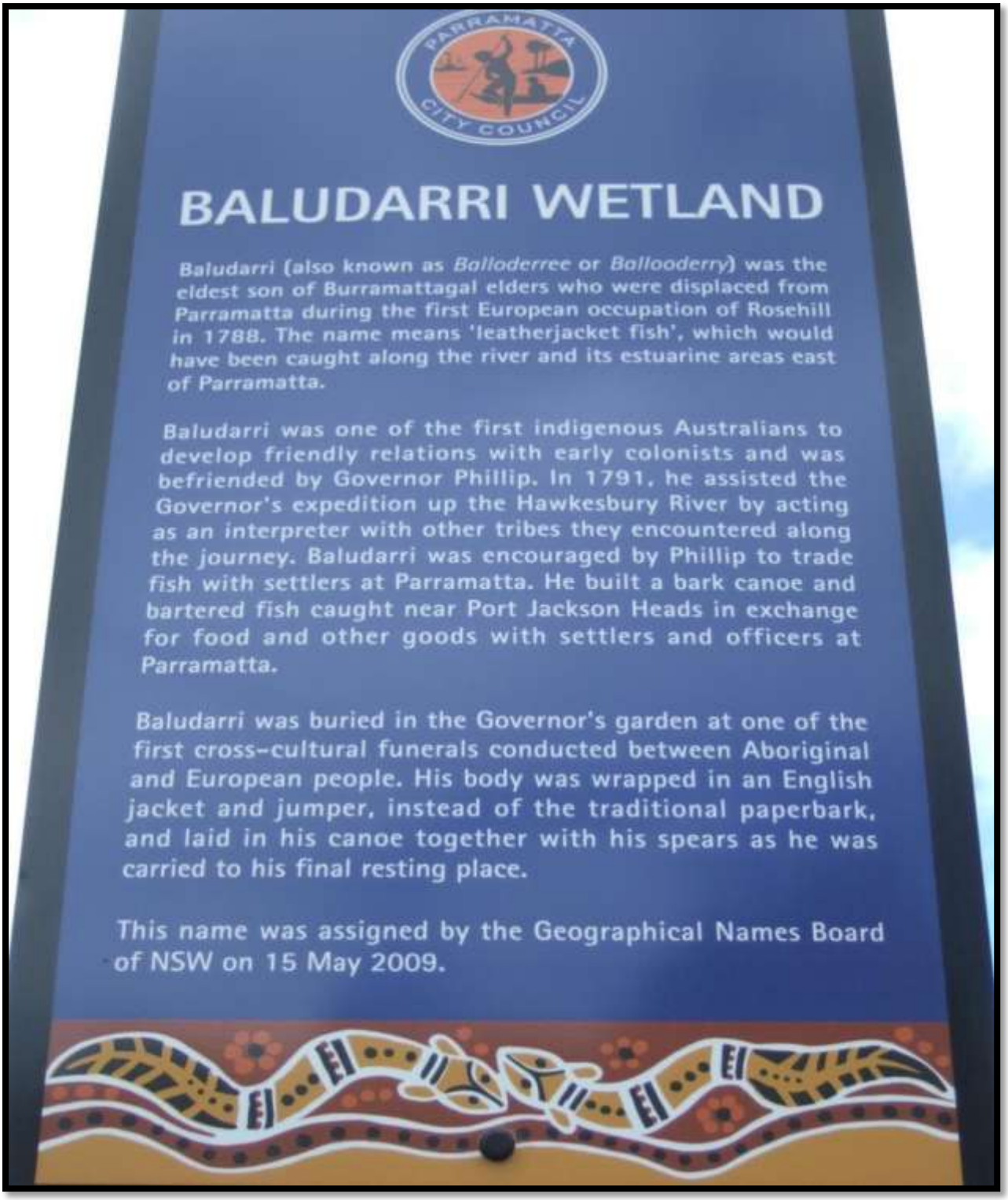
By 1800 the conflicts around Parramatta had developed to the stage where Governor King issued a proclamation allowing any Aboriginal west of Parramatta to be shot on sight. George Caley, who collected botanical specimens for Joseph Banks, suggested that the hostilities began when convict shepherds lost some of their sheep and, in fear of being punished, blamed the Darug people. Accordingly, "war was declared" and when the Darug retaliated a state of panic gripped the settlers living in western Sydney for over a year.

Hostilities around Parramatta continued until Macquarie's time, often led by Tedbury, Pemulwuy's son. Macquarie initiated a series of actions which were to dramatically impact on the local Aboriginal people, and it resulted in Parramatta and Government House becoming the centre of Aboriginal European interactions until Macquarie departed. In 1814, on the advice of the missionary William Shelley, he set up the Parramatta Native Institution to "civilise, Christianise and educate" Aboriginal children, and this was followed by the introduction of the annual feast, which continued at Parramatta until the 1830s.

Following the punitive expeditions in 1816 and the subsequent conciliatory attempts by Macquarie in rewarding 'friendly' Aboriginals, the Darug demonstrated their attitude towards the new relationship when Nurragingy, Merimeri and their entire clans visited the Governor and Mrs Macquarie at Parramatta on 12 January 1817. They were entertained but it was pointed out that they were uninvited. Of course, from the perspective of the local Darug owners of this area, it was the Europeans who were the uninvited guests on their land. (J.L.Kohen, 2002.)

History records that Bidgee Bidgee and a few other Kissing Point Aboriginals received blankets at Parramatta in 1834 and 1836. The journal entries of Samuel Marsden at around this time probably refer to an aboriginal named Bidgee Bidgee (who seems to have died in 1837) when Marsden wrote that:
"..from Sydney to Parramatta all along the north side of the river, there is but one original Native, the rest are all dead; thou they were very numerous in these districts."

Figure 13 Baludarri Wetland Signage



1.4.4 Cultural Heritage Items-European And Indigenous

The draft LEP Heritage map sheet 010 shows one environmental heritage item at Baludarri Wetland. This item is the wetlands on the Parramatta River which are of local significance. They are also listed under Schedule 2- Heritage items of local significance as item 429. Item 507, outside the reserve boundary, is the Boundary Stone at James Ruse Drive – under Bridge (north bank of River) and this is of State significance .

Figure 14 Baludarri Wetland -Heritage map 010 Draft LEP 2009 (PCC)

No indigenous or European cultural heritage items are recorded for the site. A search of AHIMS database found that no aboriginal items or places are recorded for the site (see Appendix D). The location on the floodplain combined with European past uses of the site including clearing and filling make it unlikely that items of European or indigenous heritage would /will be found. An archaeological report was prepared for the test pit excavations for saltmarsh recreation at the reserve by Archaeological &Heritage Management Solutions Pty Ltd in November 2006. The potential for the site to contain heritage items is classed as negligible due to “catastrophic flooding in 1864 and 1890”. Shell middens are identified as the most likely items to be on site but only below the fill level.

1.5 Bushcare

A bushcare group was formed approximately three years ago that meets in the reserve for workdays on a monthly basis. Combined with the professional bush regenerators and support from Parramatta City Council considerable improvement to the percentage of native cover within the reserve has been achieved. The bush regenerators began work in December 2005 and the volunteers began working in the reserve in 2006. Efforts thus far have been concentrated in the northern part of the reserve removing a considerable amount of woody and herbaceous weeds from the considerable weed plumes that occur on site and replanting with appropriate native species.

Figure 15 Aerial photographs of Baludarri Wetland (1943 at left top, 1978 at right top, 2005 at left bottom, 2009 at right bottom)

Figure 16 Bushcare volunteers prepare for terrestrial planting (photographs courtesy of PCC)

Pemberton Street Reserve from the Corner of Pemberton & Broughton Streets

21 January 2006 Well before the start

3 March 2007 After about three months work by contractors and volunteers

22 March 2008 A year later

Figure 17 Three years progress (photos courtesy of Neil McGrath and PCC).

Figure 18 Before saltmarsh expansion works April 2007 (photograph courtesy of PCC)

Figure 19 Saltmarsh reclamation 2007 (photographs courtesy of Neil McGrath and PCC)

1.6 Community Consultation

Community consultation was seen as integral to implementing the Wetland Plan of Management. The bushcare group volunteers, adjoining property owners and residents, and cyclists were all seen as key stakeholders with valuable input into the vision of future uses of the reserve and observations and knowledge regarding the history of the reserve. The bushcare volunteers were contacted by phone and email, and 75 flyers were letterboxed to adjoining streets (see Appendix B). Two community meetings were held on site. Both meetings were held out-side of typical working hours to maximise attendance, eight and four community members attended the two meeting respectively. Past and potential future uses of the reserve were discussed and the general consensus was the reserve had a special conservation significance for local residents and that enhancement of existing biodiversity values was seen as a priority.

Figure 20 Community days

2 LITERATURE REVIEW

2.1 Local And Regional Planning Instruments And Reports

2.1.1 Parramatta City Council Biodiversity Plan 2003

The Parramatta Biodiversity Plan was developed as a framework and a guide for the conservation and enhancement of biodiversity in the Parramatta LGA. Under the Charter for all NSW Councils (Local Government Act 1993), Councils must undertake their activities in line with Ecologically Sustainable Development (ESD) principles. Conservation of biodiversity is a key principle of ESD. The Plan is applicable to the Parramatta LGA only but was developed within the context of wider frameworks including neighbouring councils, Western Sydney and Sydney Harbour Catchment local government areas. As such it is a tool to guide Council in its own activities and in its dealings with other organisations who may have an impact on biodiversity in Parramatta.

The following principles underpin the Biodiversity Plan 2003:

- Apply a precautionary approach where there is a chance that a plan or activity may lead to irreversible biodiversity consequences.
- Conserve biodiversity within a regional context.
- Integrate and balance biodiversity conservation and management activities with broader environmental, social and economic considerations.
- Maintain and enhance existing biodiversity (no net loss).
- Minimise natural area fragmentation and promote corridor linkages whilst recognising the different habitat requirements of individual species.
- Give a high priority to the conservation and recovery of threatened species, populations and communities.
- Reduce the level of negative biodiversity impacts and threatening processes.
- When restoring ecosystems, aim to represent those ecological communities and systems originally existing at that site.

The Biodiversity Plan contains an inventory of environmental values, including species lists, of the remnant natural areas within the LGA.

The Wetland Plan of Management for Baludarri Wetland fulfils several of the key priority objectives of the Biodiversity Plan insofar as it seeks to enhance habitat for federally protected migratory birds, enhances and seeks to recreate natural communities occurring on site prior to European settlement, and increases the biodiversity and social and aesthetic values of the site.

2.1.2 Natural Areas Plan Of Management Parramatta City Council 2006

The Natural Areas Plan of Management (NAPOM) is a revised series of generic plans of management prepared by Parramatta City Council to comply with the requirements of the Local Government Act 1993, which introduced new requirements on all Council's to ensure the appropriate management of Council owned community land and that the community is actively involved in decisions affecting its management and use. The NAPOM is a strategic planning tool to guide the management of areas categorised as 'Natural Area'. Natural areas are categorised broadly into five categories within NAPOM. Baludarri Wetland, for the purposes of the NAPOM would be classified as:

"Primary Corridors
Linear reserves along our creeks containing remnant riparian bushland or fragmented remnants with revegetation, and often, large mown areas. These corridors link to core areas of bushland and the Parramatta River corridor, for example, Ponds/Subiaco Creek reserves that link to the core area of Galaringi/Cox Park " (pg 8).

And sub-categorised as:

Wetland
The Local Government (General) Regulation 1999 (as amended in 2005) states that land should be further subcategorised as Wetland under Section 36 (5) of the Act if:
'the land includes marshes, mangroves, backwaters, billabongs, swamps, sedgelands, wet meadows or wet heathlands that form a waterbody that is inundated cyclically, intermittently".

This Plan of Management does not cover community land categorised as 'Natural Area' that has a specific Plan of Management, for example, Lake Parramatta Reserve. In areas of conflict between a generic Plan of Management and a specific Plan of Management, the specific plan will have precedence. Where Council has declared an 'area of cultural significance' within a 'Natural Area' and a specific plan has not been adopted, this Plan of Management will cover all Natural Areas listed until they have an adopted specific plan. This Wetland Plan of Management, once adopted, will supersede the provisions of the NAPoM.

2.1.3 Parramatta River Foreshore Plan 2009 – 2016

The aims of Parramatta River Foreshore Plan 2009 (PRFP) is to revise and update the current Parramatta River Foreshores Reserves Concept Plan and Management Strategy and develop a prioritised action / implementation plan to consistently guide the future management and development of the Parramatta River Foreshore over the next 20 years. The PRFP lists threatening processes, restraints and opportunities for providing better access, better educational opportunities, producing better environmental outcomes, and enhancing heritage and recreational assets. The Plan contains specific actions for managing the foreshore, sources of funding, responsibility, and links to Parramatta's Vision Statement .

The following are a selection of specific issues from the PRFP that have direct linkages to the Wetland Plan of Management for Baludarri Wetland. The map and actions from the PRFP are provided in Figure 22.

- "*The few remnants of native vegetation communities along the banks of the river are currently recognised within Council's Biodiversity Plan and State of the Environment Report, but still need to be managed in an appropriate manner."*

The Wetland Plan of Management seeks to enhance current management practices on site.

- *"Past emphasis in open space management on structured recreation facilities and maintaining a mown and tidy appearance compromised natural values".*

The Wetland Plan of Management recommends that "mown and tidy appearance" be restricted to the zone north of the watercourse only, all other zones are to have natural values enhanced.

- *"Areas of saltmarsh have been lost over time and are often situated between mangrove and maintained grass interfaces and are significantly threatened by weed invasion."*

The Wetland Plan of Management recommends incremental reclamation of saltmarsh in the zones now presently dominated by pasture grasses.

- *"Stormwater runoff from increased urban areas has increased sedimentation, levels of nutrients and dispersal of litter."*
- *"An increase in the amount of hard surfaces and stormwater piping from residential, commercial and industrial areas, has added to the flow and water quality issues of the river."*

The Wetland Plan of Management recommends that constructed treatment wetlands be incorporated near end of pipe to improve water quality entering the natural freshwater wetland and Parramatta River.

- *"There is little interpretation of the values and interests of the river corridor for visitors."*

The Wetland Plan of Management recommends that interpretive signage be installed at the limit of the recreational zone.

2.1.4 PARRAMATTA RIVER ESTUARY DATA COMPILATION AND REVIEW STUDY

The Estuary Management Manual recommends an eight step process in order to to implement an Estuary Management Plan. In accordance with this policy, the Parramatta River Estuary Management Committee (PREMC) was established in 2006. The Data Compilation Study (Cardno Lawson Treloar 2008) report represents the second step in the estuary management process, incorporating some preliminary assessment of the compiled data. The data compilation study identified 672 data sources of which 402 were directly referenced. The main findings of the Data Compilation Study are categorised under the following processes headings:

- Catchment Characteristics (including climate and land use)
- Urban Stormwater, Hydrology and Flood Behaviour
- Bathymetry and Estuary Sediments
- Hydrodynamics
- Water Quality

- Ecology
- Human Usage and Recreation
- Cultural Heritage, Values and Significance.

The conclusions of the study were that the Parramatta River Estuary is a highly modified system, but it retains a level of functionality despite the wide range of uses and the human impacts throughout the catchment and waterway. The interactions amongst the processes are complex and the ongoing recognition of these interactions through the management phase of the estuary management process will be vital to ensure that the value of the estuary is maintained and enhanced.

2.1.5 Other Environmental Planning Instruments

Sydney Regional Environmental Plan No 28--Parramatta - Reg 4

The objectives for the Harris Park precinct are compatible with strategies and actions proposed for Baludarri Wetland. These objectives include:

(a) to conserve the significance of heritage items, their settings, historic subdivisions, conservation areas, identified views and sites of national significance, and to facilitate the preservation of those areas and sites and their presentation as an important cultural tourist attraction,

(b) to maintain the role, and improve the amenity of, Harris Park Precinct as an important residential area close to the Parramatta City Centre, providing a range of different housing types and supporting land uses,

(c) to protect and enhance the unique visual qualities of the Parramatta River by ensuring that development along the foreshore is of a scale and character in keeping with its foreshore location, and to maximise public access to, and use of, foreshore land,

(d) to maintain existing commercial and industrial areas and encourage low to medium-rise buildings that are compatible with surrounding residential land uses,

(e) to achieve environmental management best practice that protects and promotes the natural assets of the Harris Park Precinct,

(f) to improve the environmental performance of development in a way that minimises energy and resource use and noise, odour, dust, water, soil, air quality and contamination impact,

(g) to protect and enhance local and regional biodiversity, maximising the extent and integrity of aquatic and natural land areas, in particular, the Parramatta River and Clay Cliff Creek corridors

Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005 (Harbour REP) covers all the waterways of the Harbour, the foreshores and entire catchment. It establishes a set of planning principles to be used by councils for the preparation of planning instruments, for the hydrological catchment of the Harbour. It also zones the waterways into nine different zones to suit the differing environmental characteristics and land uses of the harbour and its tributaries. The Harbour REP includes a range of matters for consideration by consent authorities assessing development within

the Foreshores and Waterways Area of the Plan. These are aimed at ensuring better and consistent development decisions and include such issues as ecological and scenic quality, built form and design, maintenance of views, public access and recreation and working harbour uses. The REP includes provisions relating to heritage conservation and wetlands protection and provides planning controls for strategic foreshore sites. Baludarri Wetland primarily falls within the Wetland Protection Area as illustrated in Figure 21 below.

Figure 21 Wetland protection area (Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005 Wetlands Protection Area Map)

The Harbour REP identifies 'wetlands protection areas' comprising wetland habitats (which include mangroves, seagrasses, saltmarshes, sedgelands, wet meadows and mudflats) and a 40 metre buffer zone to address movement, growth and seasonal variation.

The Harbour REP requires consent for certain types of development on land within a wetlands protection area that may have a detrimental impact on a wetland. These provisions list a set of matters that are generally aimed at preserving and protecting the Harbour's wetland habitats, which are to be considered by the consent authority when assessing an application for such development.

Parramatta Local Environment Plan 2001 provides the planning objectives applying to parcels of land. The document outlines which types of development legally require Development Consent to be granted by Council including any stipulated objectives and controls cover zoning, height, floor space ratios, landscaping, overshadowing, and heritage and conservation areas. Baludarri Wetland occurs on 6A Public Open Space Zone. The zone objectives are:

(a) to identify public land owned or managed by the Council or other public authorities and used for open space and public recreational purposes, and

(b) to enable development of land for open space and recreational purposes, and

(c) to enable ancillary development or related uses which will encourage the enjoyment of land zoned for recreational purposes, and

(d) to enhance, restore and protect the natural environment.

Figure 22 Baludarri Wetland Parramatta River Foreshore Plan 2009

2.2 Management Of Baludarri Wetland

2.2.1 Waterways Restoration –Parramatta River Bush Regeneration Final Report February 2008 – February 2009

This report has been prepared for Parramatta City Council and summarises the bush regeneration performed by Toolijooa Environmental Restoration at George Kendall Reserve, Frog Pond Reserve, Gas Works Bridge and the unnamed reserve at Pemberton Street (now Baludarri Wetland) in accordance with the Parramatta River Foreshores Bush Regeneration Contract. The time period covered in this report is February 2008 – February 2009 covering the entire thirteen months of the contract. The report states that "Pemberton St Reserve contains the largest intact saltmarsh remnant of the four sites within the contract and as such is one of the largest, if not the largest area of saltmarsh within the Parramatta LGA. For the purpose of the contract, the site has been divided into six separate management zones." Weed control is the primary objective of the contract and the several treatments using applicable methods have been undertaken across the reserve.
Management recommendations and identified issues include:

- Wash from boat traffic on the river is eroding the riverbanks in places that would normally be covered in saltmarsh. Particularly damaging seems to be the 'River Cat' ferry.
- Mangroves are encroaching on saltmarsh remnants with young mangroves constantly taking root.
- Adult mangroves are shading out saltmarsh species in many areas. Perhaps some areas could be identified for trial removal of selected mangroves for the establishment and consolidation of some saltmarsh remnants.
- Many freshwater plants are invading the saltmarsh – particularly *Typha orientalis* encroaching into *Juncus krausii* - due to increases in freshwater runoff from stormwater drains. Very high flows of stormwater have been observed, particularly from the outlet at the eastern end of zone 2. Freshwater runoff from stormwater drains has also proven to be a source of weed seed and freshwater that is impacting on the saltmarsh behind the *Juncus krausii* patch in zone 3.
- There is evidence of rabbit grazing on revegetation plants throughout the site
- The large pile of green waste accumulated during saltmarsh reclamation works is infested with *Anredera cordifolia, Cestrum parqui* and *Solanum mauritianum.*
- Zone 2 has seen high levels of natural regeneration of wetland species including *Carex appressa* and *Juncus krausii.* Emergent specimens of these were carefully slashed around using brushcutters, with the distance between specimens gradually being decreased through higher recruitment levels.
- Soil compaction across the creek line needs to be closely monitored, especially if more excavation works are to be undertaken. Further excavation works in zone 4 (upstream of the previously excavated area) is likely to successfully increase the extent of the saltmarsh area. Timing of this excavation works is again critical – previous excavation works has shown that in the cooler months of the year, just prior to king tides, is optimal.
- Connectivity in zone 2 between native sedge species should be further enhanced by continuing with careful slashing between specimens. There is also scope for possible infill planting between existing species.
- Small infestations of alligator weed *Alternanthera phyloxeroides* should be monitored for signs of regrowth and spread, and treated again as is necessary.

The report list the treatments applied for each zone, revegetation works and future management recommendations. This Wetland Plan of Management encompasses and builds upon these recommendations.

2.2.2 A Wetland Prioritisation Technique For The Smcma Area: Smcma Wetland Management Strategy (Stage 1) (Schaeper Et Al, 2007)

This manual developed an assessment technique for prioritization of wetlands for rehabilitation as part of the Sydney Metropolitan CMA's Catchment Action Plan. The process began with collating existing maps of the extent of wetlands in the SMCMA. A number of methodologies to assess wetland condition were reviewed to determine a suitable desktop assessment for wetlands in the SMCMA area. The assessment framework that was developed included the following steps:

1. Wetlands are ranked based on a set of values criteria.

2. Wetlands are ranked based on a set of threats criteria.

3. High condition wetlands are identified based on high values and low threats – this information is used to prioritise the wetland for rehabilitation works.

4. Consideration will be given to the representativeness of wetland types.

5. Projects will be sought for priority wetlands, that protect, maintain and improve the condition of these wetlands.

6. Project feasibility will be assessed based on biodiversity outcomes, value for money, longevity of benefits, and consistency with other projects in the catchment.

7. A project prioritization list will be created based on feasibility and wetland priority, and used as a decision making tool for allocation of funding for rehabilitation works.

The methodology was tested on eight wetlands in the SMCMA region, all listed in the Directory of Important Wetlands in Australia. This method is similar to that described in the NSW Draft MER (DECC, 2008), which provides generalized methods for use throughout NSW. Australian Wetlands recently used a modified version of the NSW MER in an assessment of the health and rehabilitation potential of freshwater wetlands in the Tuggerah Lakes catchment. The modifications were aimed to tailor the methodology for specific local conditions and closely followed the steps given above.

There are a number of key stages in the process that will be applied to the development of this Wetland Plan of Management for Baludarri Wetland. These include the identification of wetland values and threats, and the development of project concepts that will provide biodiversity outcomes, value for money, and longevity of benefits. Baludarri Wetland has already been identified as a poorly represented type of wetland and rehabilitation of this site is considered consistent with whole of catchment strategies.

3 THREATENED SPECIES AND ENDANGERED COMMUNITIES – SCIENTIFIC DETERMINATIONS

Five endangered ecological communities occur on coastal floodplains (see Figure 23 below) in the Sydney Bioregion.

These communities are:

- Coastal saltmarsh
- Swamp schlerophyll forest
- Freshwater wetlands
- Swamp oak floodplain forest, and
- River flat eucalypt forest

Remnant coastal saltmarsh occurs within the Reserve and these remnants have been considerably enhanced by reclamation works to remove imported fill from the intertidal zones. A regenerating freshwater wetland naturally occurs on site and with grazing pressures removed and bush regeneration works this freshwater wetland is increasing in terms of natural recruitment of species indicative of the EEC and providing habitat for migratory birds.

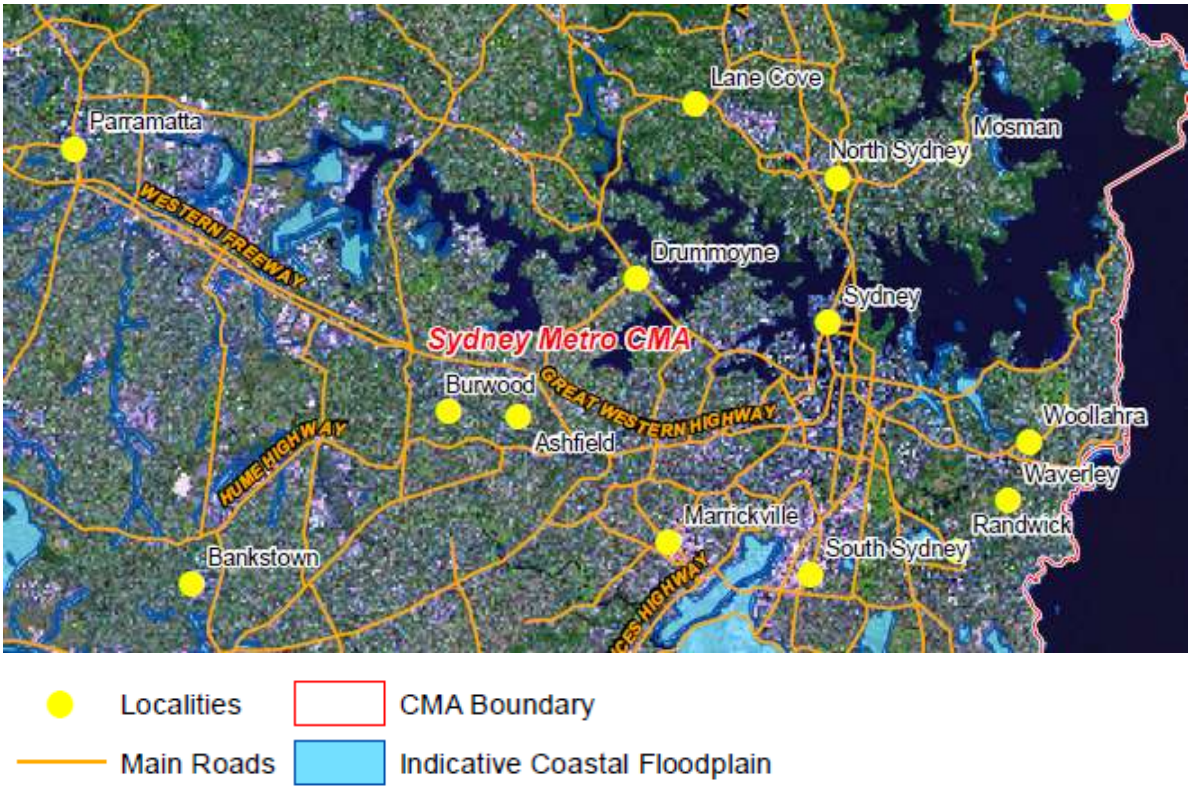


Figure 23 Guide to indicative areas (in aqua) where coastal floodplain communities are likely to occur (DECC indicative EEC map series – Sydney)

3.1 Coastal Saltmarsh In The Nsw North Coast, Sydney Basin And South East Corner Bioregions - Endangered Ecological Community Listing Nsw Scientific Committee - Final Determination

Final Determination

The Scientific Committee, established by the Threatened Species Conservation Act, made a Final Determination to list the Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions, as an Endangered Ecological Community in Part 3 of Schedule 1 of the Act. Listing of endangered ecological communities is provided for by Part 2 of the Act.

The Scientific Committee found that:

1. Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions is the name given to the ecological community occurring in the intertidal zone on the shores of estuaries and lagoons including when they are intermittently closed along the NSW coast. Coastal saltmarsh has been recorded from sites along the NSW coast. (NSW North Coast, Sydney Basin and South East Corner Bioregions).

Table 3 Characteristic vascular plant species of Coastal Saltmarsh are:

Baumea juncea	*Isolepis nodosa*
Juncus kraussii	*Samolus repens*
Sarcocornia quinqueflora	*Selliera radicans*
Sporobolus virginicus	*Suaeda australis*
Triglochin striata	*Zoysia macrantha*

The total list of species is larger, with many species present in low abundance or at few sites. A more extensive list of species is provided by Adam *et al.* (1988). The sediment surface may support a diversity of both micro-algae and macro-algae.

3. Communities with similar floristic composition, but with a different fauna, are found supratidally on exposed headlands (Adam *et al.* 1988). These headland communities and those of inland saline areas are not included within this Determination of the Coastal Saltmarsh Ecological Community.

4. Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions provide habitat for a diverse invertebrate fauna, which includes both marine (crabs and molluscs) and terrestrial (insects and spiders) elements. During tidal flooding a number of fish species utilise saltmarsh habitats. Grazing by macropods may occur between tidal events. Some coastal saltmarshes provide important high tide roosts for migratory wading birds, and a range of other

birds also utilise coastal saltmarsh as habitat. Diversity of macrofauna in mangrove forests adjacent to saltmarsh has been found to be greater than in mangroves that do not border saltmarsh (Yerman & Ross 2004)

5. Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions is frequently found as a zone landward of mangrove stands. Occasional scattered mature *avicennia marina* trees occur through saltmarsh at some sites, and *avicennia* (and less frequently *aegiceras corniculatum*) seedlings may occur throughout saltmarsh. In brackish areas dense stands of tall reeds (*phragmites australis, bulboschoenus* spp., *schoenoplectus* spp., *typha* spp.) may occur as part of the community.

6. West *et al.* (1985) estimated the total area of coastal saltmarsh in NSW was approximately 5700 hectares distributed in fragmented patches mostly less than 100 hectares. Since this estimate, further reduction and fragmentation have occurred.

7. Species composition within Coastal Saltmarsh varies with elevation. *sarcocornia quinqueflora* dominates at lower, and hence more frequently flooded, levels than *sporobolus virginicus* which dominates the mid saltmarsh, while *juncus kraussii* and *baumea juncea* are upper saltmarsh species. There is also geographic variation, with much more extensive stands of *sporobolus virginicus* being found in northern NSW, and conversely more extensive *sarcocornia quinqueflora* stands in the south. Coastal Saltmarsh in southern NSW is generally more species rich than further north, with *austrostipa stipoides, gahnia filum, limonium australe and sclerostegia arbuscula* forming a characteristic southern suite of species. A number of other species with restricted distribution in Coastal Saltmarsh include *distichlis distichophylla* (endangered), *halosarcia pergranulata* subsp. *pergranulata, wilsonia backhousei* (vulnerable) and *wilsonia rotundifolia* (endangered).

8. Saltmarshes are globally threatened, and many of the threatening processes identified by Adam (2002) operate in NSW including infilling, modified tidal flow, weed invasion, damage by domestic and feral animals, human disturbance, altered fire regimes and climate change. Climate change impacts on saltmarshes include sea level rise, increased sea temperatures, changes in hydrology, and increases in the frequency and intensity of extreme events such as storms, droughts and floods. Adaptation strategies need to be considered in the planning of rehabilitation activities. The prevention of additional stress may improve the ability of saltmarshes to respond to climate change (Bergkamp and Orlando 1999). Reducing pollution, avoiding vegetation removal and protecting wetland biological diversity and integrity are important activities that maintain and improve the resiliency of saltmarsh ecosystems under changed climatic conditions (Kusler and Burkett 1999). Another important strategy is preventing the fragmentation of existing saltmarsh systems and maintaining buffer zones that allow for landward vertical migration of saltmarshes if sea level rise exceeds the rate of vertical sediment accretion.

9. Historically, substantial areas of saltmarsh have been infilled for roads and aerodromes and for residential, recreational, waste disposal, industrial and agricultural purposes. With increased recognition of the ecological value of saltmarshes, the threat of further large-scale reclamation is less, but smaller scale infilling still occurs (Harty and Cheng 2003).

10. Patterns of tidal flow have been restricted by artificial structures in many NSW saltmarshes (Williams and Watford 1997), while discharge of stormwater alters salinity regimes, increases nutrient levels and facilitates the spread of *phragmites* and weeds.

11. In recent decades there has been widespread invasion of saltmarsh in southeast Australia by mangroves (Mitchell and Adam 1989, Saintilan and Williams 1999, 2000). The factors driving mangrove invasion are still unclear. The mangrove invasion limits the use of saltmarshes by birds that would normally make use of this habitat and has been a factor in their decline (Saintilan 2003, Straw 1999, 2000).

12. A large number of weed species occur in NSW saltmarshes (Adam 1981, Adam *et al.* 1988). In terms of change to the community structure and function, the most serious weed is *Juncus acutus*; other major weeds include *Baccharis halimifolia, Cortaderia selloana* and *Hydrocotyle bonariensis*. The upper saltmarsh zone may be dominated by introduced annuals or shortlived perennials, including *Parapholis incurva, Plantago coronopus* and *Polypogon monspeliensis*.

13. Damage to saltmarshes by recreational vehicles, including four wheel drives, is widespread, and deep wheel ruts persist for many years even after exclusion of vehicles. Use of BMX and mountain bikes is increasing, and even saltmarshes within conservation reserves have been seriously damaged (Adam 2002).

14. Grazing and trampling by domestic stock and feral herbivores occurs at a number of sites. Stock grazing has been shown to substantially change the vegetation composition and structure (Adam 1990), while on muddy substrates trampling can cause loss of plant cover and modify drainage patterns.

15. Saltmarshes have frequently been used for casual rubbish dumping and are at risk from waterborne pollution - including oil and chemical spills, both from shipping and road accidents, and catchment runoff of nutrients and agricultural chemicals.

16. Upper saltmarsh stands dominated by *Juncus kraussii* and *Baumea juncea* have high flammable fuel loads. While the natural incidence of fire in saltmarshes is likely to have been low, a number of saltmarshes have been burnt in recent years. The recovery of these sites is relatively slow and the long-term impacts of burning are uncertain.

17. Global warming and increased relative sea level are likely to pose an increasing threat to the survival of many areas of Coastal Saltmarsh (Adam 2002, Hughes 2003).

18. Coastal Saltmarsh occurs in a number of conservation reserves including the Ramsar listed sites at Towra Point and Kooragang Island Nature Reserves. Reserve status, however, does not confer protection from mangrove and weed invasion, recreational vehicles, pollution, fire or sea level rise without active management.

19. In view of the above the Scientific Committee is of the opinion that the Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival cease to operate.

3.2 Freshwater Wetlands On Coastal Floodplain Endangered Ecological Community Listing Nsw Scientific Committee - Final Determination

The Scientific Committee, established by the Threatened Species Conservation Act, made a Final Determination to list the Sydney Freshwater Wetlands in the Sydney Basin Bioregion as an ENDANGERED ECOLOGICAL COMMUNITY on Part 3 of Schedule 1 of the Act. The listing of Endangered Ecological Communities is provided for by Part 2 of the Act.

The Scientific Committee found that:

1. Sydney Freshwater Wetlands is the name given to the plant community characterised by the assemblage of species listed in paragraph 2 that is restricted to freshwater swamps in swales and depressions on sand dunes and low nutrient sandplain sites in coastal areas. All sites are within the Sydney Basin Bioregion.

2. Sydney Freshwater Wetlands is characterised by the following assemblage of species.

- *Banksia robur*
- *Baumea articulata*
- *Baumea juncea*
- *Baumea rubiginosa*
- *Callistemon citrinus*
- *Casuarina glauca*
- *Cladium procerum*
- *Eleocharis sphacelata*
- *Empodisma minus*
- *Gahnia clarkei*
- *Gahnia sieberiana*
- *Gleichenia dicarpa*
- *Goodenia paniculata*
- *Hakea teretifolia*
- *Hypolepis muelleri*
- *Lepironia articulata*
- *Leptocarpus tenax*
- *Leptospermum juniperinum*
- *Lomandra longifolia*
- *Ludwigia peploides subsp. montevidensis*
- *Melaleuca linariifolia*
- *Melaleuca nodosa*
- *Melaleuca quinquenervia*
- *Melaleuca styphelioides*
- *Persicaria decipiens*
- *Persicaria strigosa*
- *Philydrum lanuginosum*
- *Phragmites australis*

- *Pteridium esculentum*
- *Restio tetraphyllus*
- *Schoenus brevifolius*
- *Triglochin procerum sensu lato*
- *Typha orientalis*
- *Villarsia exaltata*
- *Viminaria juncea*
- *Xanthorrhoea resinifera*

3. The total species flora and fauna list for the community is considerably larger than that given in 2 (above), with many species present in only one or two sites or in very small quantity. In any particular site not all of the assemblage listed in 2 may be present. Invertebrate species may be restricted to sediments for example. At any one time, propagules and seeds of some species may only be present in the soil seed bank with no above-ground individuals present. The species composition of the site will be influenced by the size of the site, recent rainfall or drought conditions and by its recent disturbance history. The community includes vertebrates and invertebrates, many of which are poorly known.

4. Sydney Freshwater Wetlands are a mosaic community with considerable variation due to fluctuating water levels and seasonal conditions. Characteristic vegetation is sedges and aquatics *particularly Eleocharis sphacelata, Baumea juncea, Baumea rubiginosa, Baumea articulata, Gahnia sieberiana, Ludwigia peploides* subsp*. montevidensis* and *Persicaria* species. There may be considerable areas of open water particularly where drainage conditions have been altered. There may be patches of emergent trees such as *Melaleuca quinquenervia* and shrubs.

5. Sydney Freshwater Wetlands are restricted to freshwater swamps in swales and depressions on sand dunes and low nutrient sandplain sites in coastal areas. These areas are generally on the sands of the Warriewood and Tuggerah Soil Landscapes (Chapman & Murphy 1989). Coastal Swamp Forest eg. *Eucalyptus robusta* and swamp on alluvium with a saline influence is not covered by this Endangered Ecological Community Determination.

6. Sydney Freshwater Wetlands are or have been known to occur in the local government areas of Lake Macquarie, Wyong, Gosford, Pittwater, Warringah, Woollahra, Waverley, Botany, Rockdale, Randwick, Sutherland and Wollongong- but may occur elsewhere in the Sydney Basin Bioregion.

7. Sydney Freshwater Wetlands were formerly particularly extensive in the Sydney Eastern Suburbs and Kurnell area. Occurrences have been reported to include Jewells Swamp, Wallarah wetland, Budgewoi wetlands, Porters Creek wetland, Wyong Golf Course, Tuggerah Oxbow, Bateau Bay; Iluka Lagoon; Everglades Lagoon Umina, Deep Creek Warringah, Dee Why Lagoon, Lachlan Swamps, Centennial Park, Botany Swamps at Eastlakes, La Perouse, Kurnell, Potter Point, Bundeena and Marley Lagoons and Coomaditchy Lagoon, but the ecological community may also occur elsewhere.

8. Sydney Freshwater Wetlands include vegetation described in Benson & Howell (1994), Adam & Stricker (1993) and Chafer (1997).

9. Disturbed remnants are considered to form part of the community described under this determination where the natural soil and associated seedbank is partially intact. At some sites changes to hydrology or drainage may be required to assist regeneration.

10. Sydney Freshwater Wetlands has been extensively cleared and filled for recreational purposes - playing fields, car parks, roads eg Marton Park Kurnell. Remnants are threatened with illegal filling with commercial, industrial and residential waste, dumping and burning of stolen vehicles, sand extraction and clearing for urban development. Threats include urban runoff associated with proximity to urban and agricultural areas, weed invasion e.g. Cortaderia selloana, Ludwigia peruviana, Salvinia molesta, Eichhornia crassipes; off-road vehicles and trail bikes, and introduced deer affecting Marley and Jibbon Lagoons in Royal National Park by grazing and trampling.

11. Small areas of Sydney Freshwater Wetlands have been reported to occur in Wyrrabalong, Royal and Botany Bay National Parks.

12. Animal species of conservation significance which may occur in Sydney Freshwater Wetlands are Australasian Bittern, *Botaurus poiciloptilus,* Wallum Froglet, *Crinia tinnula*, Green and Golden Bell Frog, *Litoria aurea,* and Large Footed Myotis, *Myotis adversus*.

13. In view of the small size of existing remnants, and the threat of further clearing, disturbance and degradation, the Scientific Committee is of the opinion that the Sydney Freshwater Wetlands in the Sydney Basin Bioregion are likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival or evolutionary development cease to operate and that listing as an endangered ecological community is warranted.

3.3 Recovery Of Endangered Ecological Communities At Baludarri Wetland

DECCW has developed a total of 8 strategies to help recover **Coastal Saltmarsh** in the NSW North Coast, Sydney Basin and South East Corner Bioregions Each of these strategies has a number of priority actions within it.

1. ***Seed collection*** *Collect seed for NSW Seedbank. Develop collection program in collaboration with Botanic Gardens Trust (BGT) - all known provenances (conservation collection). Investigate seed viability, germination, dormancy and longevity (in natural environment and in storage).*
2. ***Community and land-holder liaison/ awareness and/or education*** *Enhance the capacity of persons involved in the assessment of impacts on this EEC to ensure the best informed decisions are made. Liaise with landholders and undertake and promote programs that ameliorate threats such as weeds, grazing and human disturbance.*
3. ***Habitat management: Feral Control*** *Undertake weed control for Bitou Bush and Boneseed at priority sites in accordance with the approved Threat Abatement Plan. Undertake control of feral pigs and horses at key sites.*

4. ***Habitat management: Ongoing EIA - Advice to consent and planning authorities*** *Prepare identification and impact assessment guidelines and distribute to consent and determining authorities.*
5. ***Habitat management: Site Protection (eg Fencing/Signage)*** *Identify and prioritise other specific threats and undertake appropriate on-ground site management strategies where required.*
6. ***Habitat Protection*** *(inc vca/ jma/ critical habitat nomination etc) Use mechanisms such as Voluntary Conservation Agreements to promote the protection of this EEC on private land. Consider inclusion of unencumbered crown land into a conservation reserve*
7. ***Research*** *Determine location, species composition and threats to remaining remnants to assist with prioritising restoration works.*
8. ***Survey/Mapping and Habitat assessment*** *Collate existing information on vegetation mapping and associated data for this EEC and identify gaps in knowledge. Conduct targeted field surveys and ground truthing to fill data gaps and clarify condition of remnants*

Action 2 (community education and adjacent landholder liaison), Action 3 (control of feral animals and exotic weeds - for Baludarri Wetland –rabbits) and Action 5 (fencing and signage) are deemed extremely applicable to the ongoing management of Baludarri Wetland. All other actions have LGA-wide applications.

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DECCW has developed a total of 9 strategies to help recover **Freshwater wetlands on coastal floodplains**. Each of these strategies has a number of priority actions within it.

1. ***Seed collection*** *Collect seed for NSW Seedbank. Develop collection program in collaboration with BGT - all known provenances (conservation collection).Investigate seed viability, germination, dormancy and longevity (in natural environment and in storage).*
2. ***Community and land-holder liaison/ awareness and/or education*** *Liaise with community to improve recognition of values and encourage landholder participation in site management including weed control. Liaise with landholders and undertake and promote programs that ameliorate threats such as grazing and human disturbance.*
3. ***Habitat management: Feral Control*** *Undertake control of feral pigs and horses at identified key sites.*
4. ***Habitat management****:* ***Ongoing EIA*** *-* ***Advice to consent and planning authorities****. Prepare identification and impact assessment guidelines and distribute to consent and determining authorities.*
5. ***Habitat management: Site Protection (eg Fencing/Signage)*** *Identify and prioritise other specific threats and undertake appropriate on-ground site management strategies where required.*
6. ***Habitat management: Weed Control*** *Undertake weed control for Bitou Bush and Boneseed at priority sites in accordance with the approved Threat Abatement Plan and associated PAS actions.*

7. ***Habitat Protection*** *(inc vca/ jma/ critical habitat nomination etc) Use mechanisms such as Voluntary Conservation Agreements to promote the protection, particularly from threats such as grazing, of this EEC on private land. Investigate acquisition of property that contains this EEC to complement and expand on existing areas reserved.*
8. ***Monitoring*** *Collate existing information on vegetation mapping and associated data for this EEC and identify gaps in knowledge. Conduct targeted field surveys and ground truthing to fill data gaps and clarify condition of remnants.*
9. ***Research*** *Determine location, species composition and threats to remaining remnants to assist with prioritising restoration works. Undertake research into environmental flows with a view to the restoration of natural flow regimes.*

Action 2 (community education and adjacent landholder liaison), Action 3 (control of feral animals- for Baludarri Wetland – dogs and rabbits), Action 5 (fencing and signage) and Action 8 (monitoring) are deemed extremely applicable to the ongoing management of BaludarriWetland. All other actions have LGA-wide applications.

3.4 Bonn Convention, Jamba, Camba And Rokamba

The Bonn convention or "Convention on the Conservation of Migratory Species of Wild Animals" has 49 countries as States Parties to the Convention. Australia signed the Convention in 1979 and it entered into force in September 1991. JAMBA, CAMBA and ROKAMBA provide an important mechanism for pursuing conservation outcomes for migratory birds, including migratory shorebirds. All migratory bird species listed in the annexes to these bilateral agreements and the BONN convention are protected in Australia as matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999.*

JAMBA and CAMBA The first two bilateral agreements relating to the conservation of migratory birds were formed with the Government of Japan in 1974 and the People's Republic of China in 1986. The JAMBA and CAMBA agreements list terrestrial, water and shorebird species which migrate between Australia and the respective countries. In both cases the majority of listed species are shorebirds.

Both agreements require the parties to protect migratory birds by:

- limiting the circumstances under which migratory birds are taken or traded;
- protecting and conserving important habitats;
- exchanging information; and
- building cooperative relationships.

The JAMBA agreement also includes provisions for

Migratory species and ECBC Act status of migratory birds observed at Baludarri Wetland:

Great Egret -EPBC Act Listing Status
Listed marine as *Ardea alba*
Listed migratory –
CAMBA as *Egretta alba,*
JAMBA as *Egretta alba*

Latham's Snipe -EPBC Act Listing Status
Listed marine as *Gallinago hardwickii*
Listed migratory –
Bonn as *Gallinago hardwickii,*
CAMBA as *Gallinago hardwickii*,
JAMBA as *Gallinago hardwickii*,
ROKAMBA as *Gallinago hardwickii*

cooperation on the conservation of threatened birds. Australian government and non-government representatives meet every two years with Japanese and Chinese counterparts to review progress in implementing the agreements and to explore new initiatives to conserve migratory birds.

ROKAMBA In April 2002, Australia and the Republic of Korea agreed to develop a bilateral migratory bird agreement similar to the JAMBA and CAMBA. The ROKAMBA agreement was signed in Canberra on 6 December 2006. The agreement entered into force on 13 July 2007. The ROKAMBA formalises Australia's relationship with the Republic of Korea in respect to migratory bird conservation and provides a basis for collaboration on the protection of migratory shorebirds and their habitat.

A dedicated bird survey of Baludarri Wetland has not been undertaken and sightings have been opportunistic. The list of two protected migratory species utilising the Reserve is probably understated and it is recommended that bird surveys be undertaken as a priority.

Figure 24 The great Egret at Baludarri Wetland 2009

4 FLORA AND FAUNA OF BALUDARRI WETLAND

4.1 Fauna Of Baludarri Wetland

Common Name	*Scientific Name*	Aust wetlands	Toolijooa	PCC staff	Bush care
AVES					
Australian Hobby	*Falco longipennis*		√		
Australian Pelican	*Pelecanus conspicillatus*				√
Australian Raven	*Corvus coronoides*	√	√		√
Australian Wood Duck	*Chenonetta jubata*				√
Black-faced Cuckoo Shrike	*Coracina novaehollandiae*				√
Black Shouldered Kite	*Elanus axillaris*			√	√
Brown Goshawk	*Accipiter fasciatus*		√		
Brown Quail	*Coturnix ypsilophora*				√
Blackbird*	*Turdus merula*	√			
Bulbul*	*Pycnonotus jocosus*	√			
Channel-billed cuckoo	*Scythrops novaehollandiae*				√
Chestnut-rumped Heathwren	*Hylacola pyrrhopygia*	√			
Common Koel	*Eudynamys scolopacea*				√
Crested Pigeon	*Ocyphaps lophotes*				√
Crimson Rosella	*Platycerus elegans*				√
Darter	*Anhinga melanogaster*		√		√
Dollar Bird	*Eurystomus orientalis*				√
Double-barred Finch	*Taeniopygia bichenovii*	√	√		
Eastern Rosella	*Platycercus eximius*				√
Eastern Spinebill	*Acanthorhynchus tenuirostis*				√
Eastern (purple) Swamphen	*Porphyrio porphyrio*				√
Eastern Whipbird	*Psophodes olivaceus*				√
European Goldfinch*	*Carduelis carduelis*				
Flycatcher	*Sp?*		√	√	
Galah	*Eolophus roseicapillus*				√
Glossy Ibis	*Plegadis falcinellus*		√		
Golden-headed Cisticola	*Cisticola exilis*		√		
Great Egret	*Ardea alba*	√	√	√	√
Grey Butcherbird	*Cracticus torquatus*				√

Common Name	*Scientific Name*	Aust wetlands	Toolijooa	PCC staff	Bush care
Grey fantail	*Rhipidura fuliginosa*				√
House Sparrow*	*Passer domesticus*				
Indian Myna*	*Acridotheres tristis*	√			√
Laughing kookaburra	*Dacelo novaeguineae*				√
Leaden flycatcher	*Myiagra rubecula*	√			
Latham's Snipe	*Gallinago hardwickii*	√			
Little Black Cormorant	*Phalacrocorax sulcirostris*				√
Little Corella	*Cacatua sanguinea*				√
Little Wattlebird	*Anthochaera chrysoptera*				√
Magpie-lark (Pee wee)	*Grallina cyanoleuca*	√			√
Masked Plover	*Vanellus miles*				√
New Holland Honeyeater	*Phylidonyris novaehollandiae*		√		√
Noisy miner	*Manorina melanocephala*				√
Nutmeg Mannikin*	*Lonchura punctulata*				
Pied Cormorant	*Phalacrocorax varius*				√
Pied Currawong	*Strepera graculina*				√
Rainbow Lorikeet	*Trichoglossus haematodus*	√			√
Red browed finch	*Neochmia temporalis*	√	√		√
Red-rumped Parrot	*Psephotus haematonotus*				√
Red wattlebird	*Anthochaera carunculata*	√			√
Restless Flycatcher	*Myiagra inquieta*				√
Richard's Pipit	*Anthus novaeseelandiae*				√
Royal Spoonbill	*Platalea regia*		√		
Sacred Ibis (Australian White Ibis)	*Threskiornis molucca*	√	√		√
Sacred Kingfisher	*Todiramphus sanctus*			√	√
Silver Gull	*Larus novaehollandiae*				√
Silvereye	*Zosterops lateralis*	√			√
Spangled Drongo	*Dicrurus bracteatus*		√		
Spotted Pardalote	*Pardalotus punctatus*		√		√
Spotted turle-dove*	*Streptopelia chinensis*	√			
Sulphur-crested cockatoo	*Cacatua galerita*	√			√
Superb Fairy-wren	*Malurus cyaneus*	√		√	√
Welcome Swallow	*Hirundo neoxena*				√

Common Name	*Scientific Name*	Aust wetlands	Toolijooa	PCC staff	Bush care
White-bellied Sea-Eagle	*Haliaeetus leucogaster*		√		√
White-browed scrub-wren	*Sericornis frontalis*				√
White-faced Heron	*Egretta novaehollandiae*	√	√		√
White-plumed honeyeater	*Lichenostomus penicillatus*				√
Willie wagtail	*Rhipidura leucophrys*	√			√
REPTILES AND AMPHIBIANS					
Blue-tongue lizard	*Tiliqua scincoides*			√	
Delicate or Garden skink	*Lampropholis delicata*	√			
Common froglet	*Crinia signifera*	√			
MAMMALS					
European Rabbit*	*Oryctolagus cuniculus*	√		√	

*introduced species ☐ JAMBA/CAMBA/ROKAMBA/BONN

Fauna sightings at Baludarri Wetland are opportunistic only. No flora or fauna survey of the Reserve has been undertaken. It is very likely that species utilising the reserve are very under stated. Microchiropteran bat surveys, targeted frog surveys and bird surveys are likely to increase the lists of species of local, state and federal conservation significance utilising the Reserve. Bird surveys should be timed to maximise migratory bird sightings.

4.2 Flora Of Baludarri Wetland

Table 4 Flora identified by AW

NATIVE SPECIES		NON-NATIVE SPECIES	
SPECIES NAME	**COMMON NAME**	**SPECIES NAME**	**COMMON NAME**
Acacia falcata	Hickory	*Acetosa sagitatta*	Turkey Rhubarb
Acacia longifolia	Sydney Golden Wattle	*Ageratina adenophora*	Crofton Weed
Acacia parramattensis	Parramatta Green Wattle	*Agrostis capillaris*	Creeping Bent
Aegiceras corniculatum	River Mangrove	*Alternanthera philoxeroides*	Alligator Weed
Alismata plantago-lanceolata	Water Plantain	*Anagalis arvensis*	Scarlet Pimpernel
Alocasia brisbanensis	Cunjevoi	*Anredera cordifolia*	Madeira Vine
Avicennia marina var australasica	Grey Mangrove	*Arauja sericifera*	Moth Vine
Bolboschoenus caldwellii	Clubrush	*Arundo donax*	Giant reed grass
Breynia oblongifolia	Breynia	*Atriplex prostrata*	Orache (saltbush)
Bursaria spinosa	Blackthorn	*Bidens pilosa*	Cobblers pegs
Carex appressa	Sedge	*Brassica sp*	Mustard seed
Casuarina glauca	Swamp Oak	*Briza minor*	Quavery Grass
Centella asiatica	Centella	*Bromus catharticus*	Prairie grass
Commelina cyanea	Scurvy Weed	*Capsella bursa-pastoris*	Shepherds purse
Cyperus difformis	Sedge	*Cardiospermum grandiflorum*	Balloon Vine
Dianella revoluta	Purple Flag Lily	*Cestrum parqui*	Green Cestrum
Epilobium billardieranum ssp not determined	Willow Herb	*Chamaesyce hirta*	Asthma Weed
Eucalyptus amplifolia	Cabbage Gum	*Cinnamomum*	Camphor Laurel

NATIVE SPECIES		NON-NATIVE SPECIES	
		camphora	
Eucalyptus deanei	Deane's Gum	*Conyza sp*	Fleabane
Eucalyptus punctata	Grey Gum	*Coriandrum sativum*	Coriander
Eucalyptus saligna	Sydney Blue Gum	*Cotoneaster sp*	Cotoneaster
Eucalyptus sp.1		*Cynodon dactylon*	Couch
Eucalyptus tereticornis	Forest Red Gum	*Cyperus eragrostis*	Umbrella Sedge
Euchiton sphaericus	Cudweed	*Digitaria ciliaris*	Finger grass
Glochidion ferdinandi	Cheese Tree	*Ehrharta erecta*	Panic Veldt Grass
Hakea sericea	Bushy Needlebush	*Euphorbia peplus*	Petty spurge
Hydrocotyle peduncularis	Pennywort	*Festuca elatior*	Tall Fescue
Imperata cylindrica	Blady Grass	*Foeniculum vulgare*	Fennel
Isolepis inundata	Spike Rush	*Fumaria bastardii*	Bastard's fumitory
Juncus kraussii	Sea Rush	*Galium aparine*	Cleavers
Juncus usitatus	Common Rush	*Hedera helix*	English Ivy
Kennedia rubicunda	Dusky Coral Pea	*Hydrocotyle bonariensis*	Kurnells Curse
Lobelia alata	Coast Lobelia	*Isolepis prolifer*	Sedge
Lomandra longifolia	Spiny Mat Rush	*Jacaranda mimosifolia*	Jacaranda
Melaleuca sieberi	Sieber's Paperbark	*Lactuca serriola*	Prickly Lettuce
Melaleuca styphelioides	Prickly Leaved Paperbark	*Lantana camara*	Lantana
Omalanthus populifolius	Bleeding Heart Tree	*Ligustrum lucidum*	Large leaved Privet
Oplismenis aemulus	Basket Grass	*Ligustrum sinense*	Small leaved Privet
Persicaria lapathifolium	Knotweed	*Lobularia maritima*	Sweet Alice/ Alyssum
Pittosporum revolutum	Pittosporum	*Lolium sp*	Rye Grass
Pittosporum undulatum	Sweet Pittosporum	*Lonicera japonica*	Japanese Honeysuckle
Plectranthus parviflorus	Cockspur Flowers	*Medicago polymorpha*	Medic
Samolus repens	Creeping Brooklime	*Modialla carolianum*	Mallow

NATIVE SPECIES		NON-NATIVE SPECIES	
Sarcocornia quinqueflora	Glasswort	*Morus alba*	Mulberry
Schoenus apogon	Fluke Bogrush	*Northoscordum borbonicum*	Onion Weed
Schoenus paludosus	Bogrush	*Olea europaea ssp. Africanus*	African Olive
Suaeda australis	Austral Seablite	*Oxalis sp*	Oxalis
Syncarpia glomulifera	Turpentine	*Paspalum dilatatum*	Paspalum
Tetragonia tetragonoides	Warrigul Cabbage	*Pennisetum clandestinum*	Kikuyu
Themeda australis	Kangaroo Grass	*Phyllostachys aurea*	Fishpole (Golden) Bamboo
Triglochin microtuberosum	Water Ribbons	*Piptatherum miliacea*	Rice millet
Triglochin striatum	Arrow Grass	*Plantago lanceolata*	Plantain
Typha orientalis	Cumbungi	*Polycarpon tetraphyllum*	Four leaved Allseed
		Ranunculus repens	Creeping Buttercup
		Rubis fruticosis aggregate	Blackberry
		Rumex grandifolia	Large leaved Dock
		Rumex obtusifolia	Small Dock
		Schinus areira	Peppercorn Tree
		Senecio madagascariensis	Fireweed
		Senna pendula	Smooth Senna
		Sida rhombifolia	Paddys lucerne
		Solanum linnaeanum	Apple of Sodom
		Solanum mauritianum	Wild Tobacco
		Solanum nigrum	Blackberry nightshade
		Sonchus oleraceus	Milk Thistle

NATIVE SPECIES	NON-NATIVE SPECIES	
Indicative Species (DECCW ID guidelines 2008) Coastal Saltmarsh Freshwater Wetlands	*Spergularia marina*	Sand Spurry
	Stellaria media	Chickweed
	Stenotaphrum secundatum	Buffalo Grass
	Taraxacum officinale	Dandelion
	Tradescantia albiflora	Trad
	Verbena bonariensis	Purple top
	Veronica sp	Speedwell
	Viccia sp	Vetch
	Zantedeschia elliottiana	Calla Lily

This list is not exhaustive and follow up surveys are highly recommended. Species distribution by management zone are available in Appendix A.

5 RESULTS/RECOMMENDATIONS

5.1 Key Actions

Nineteen key actions/strategies were identified for Baludarri Wetland. These are summarised in Table 5 below. Actions were prioritised to provide a balance between best cost/benefit outcome, ecological outcomes and community aspirations for the site. However "priority" is subjective and can be determined using differing parameters that are generally justifiable depending on the criteria adopted. The site was divided into management zones (Figure 25 below) and each action was refined to zone specific actions (see section 5.2).

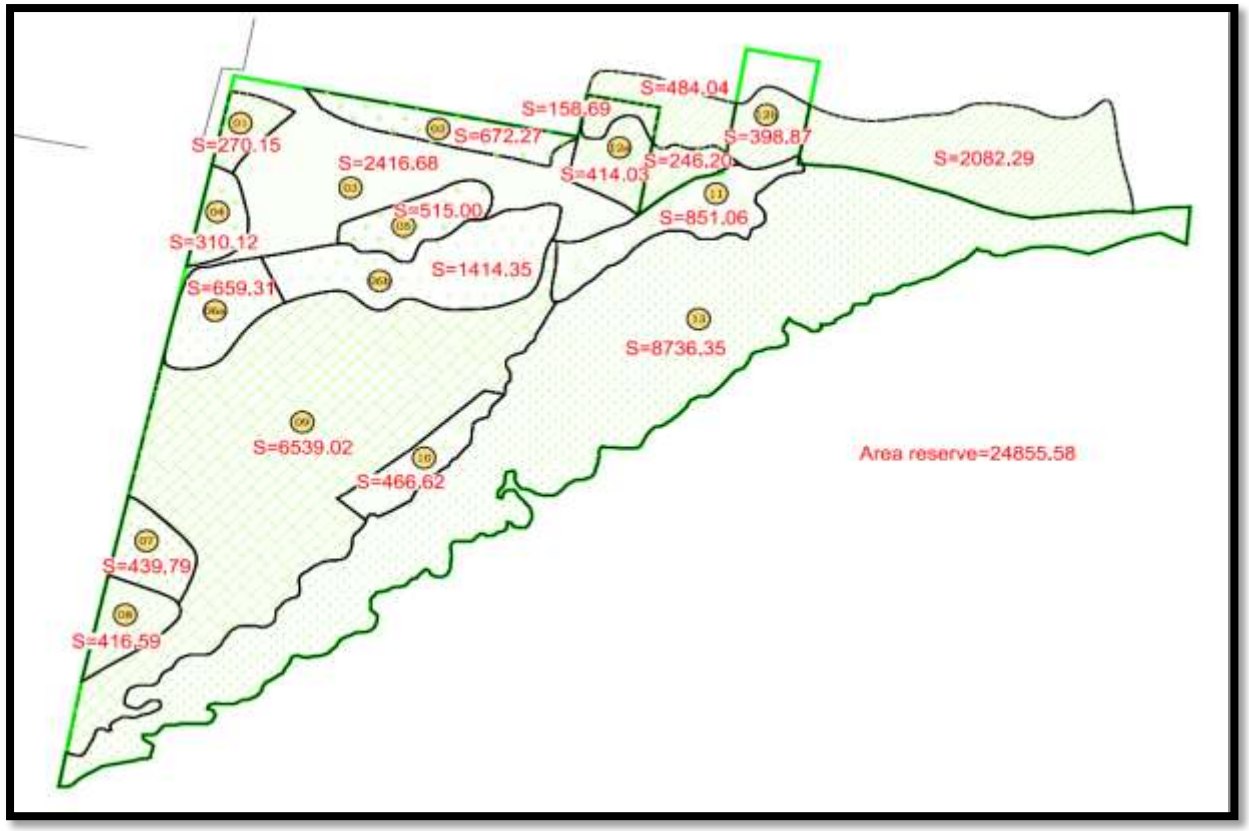


Figure 25 Reserve areas (m2) by zone

REFERENCES

Table 5 Key Actions/strategies

STRATEGY	PRIORITY	GOALS AND OBJECTIVES
Community support and involvement	1	**Education**-highlight the presence of migratory species and EEC's. Include behavioural change-management of domestic animals, garden escape plants, garden refuse, littering and fire. Continue support and encourage the activities of the local bushcare group.
Establishment of "no go" zones	2	**Establish fauna refuge in wetland areas** -many of the more uncommon species that use the site become disturbed by the presence of people, bicycles, dogs and other disturbances. Exclusion of any of these disturbances will improve the quality of the habitat available, and will result in an increase in the use of the area by migratory birds, uncommon species and may facilitate the reintroduction of uncommon wetland plant species.
Management of migratory bird habitat	3	**Correct timing of works** -activities that affect the integrity of the wetland need to be timed for when the birds are not likely to use it, and should allow a sufficient lag time for plants to establish before the next annual migration. Maintenance of wetland areas and management of disturbing impacts such as people, bikes, dogs etc are vital actions in preserving the habitat function of the reserve.

STRATEGY	PRIORITY	GOALS AND OBJECTIVES
Weed control through management of propagules-slashing and mowing	4	**Control exotic plants rather than eradicate them**-prevent any of the exotic plants flowering and setting seed, thus preventing the establishment of further propagules for reinfestation of surrounding areas.
Re-creation of saltmarsh	5	**Increase area of saltmarsh**- will require topographic survey and careful management of levels to ensure an appropriate hydrological regime is created.
Revegetation	6	**Increase the diversity of native plants in the area.** Increase the complexity of vegetation community. Stabilisation of soil surface to prevent erosion.
Erosion control	7	**Soil stabilisation post weeding**-Placement of logs and rock piles to reduce the potential for erosion on steeper slopes or where there is evidence of prior scouring and to increase the diversity of refugia and microhabitats available for small faunal species. Mulch as required exposed soils.
Weed removal	8	**Removal of exotic herbs, grasses, climbers and woody weeds** aims to enhance existing native vegetation, reduce the spread of weeds and create additional space for planting.

STRATEGY	PRIORITY	GOALS AND OBJECTIVES
Stormwater management to improve water quality	9	**Improve water quality**-remove gross pollutants through installation of GPT's or similar at the two outlets. Design and construction of a treatment wetland to create habitat, manage water quality and flow regimes through the wetland area.
Management of open space recreation area	10	**Manage access-establishment of a "no whip/no mow" zone** will support the establishment of vegetation and the development of faunal communities in sensitive areas. This can be through positioning of logs and/or rocks, either in a continuous wall or in a manner that shows indicative edge for the mown area
Feral animal control	11	**Rabbit removal** Group programmes achieve the best results and lowest long-term costs as rabbits are removed from a wider area. Options for integrated control of rabbits include: • fumigation of warrens • fencing • destruction of warren systems • removal of rabbit harbour Ripping warrens and destroying harbour assist in long term rabbit control by making it difficult for rabbits to find readymade shelter. A reputable feral animal control contractor should be engaged to complete this work.

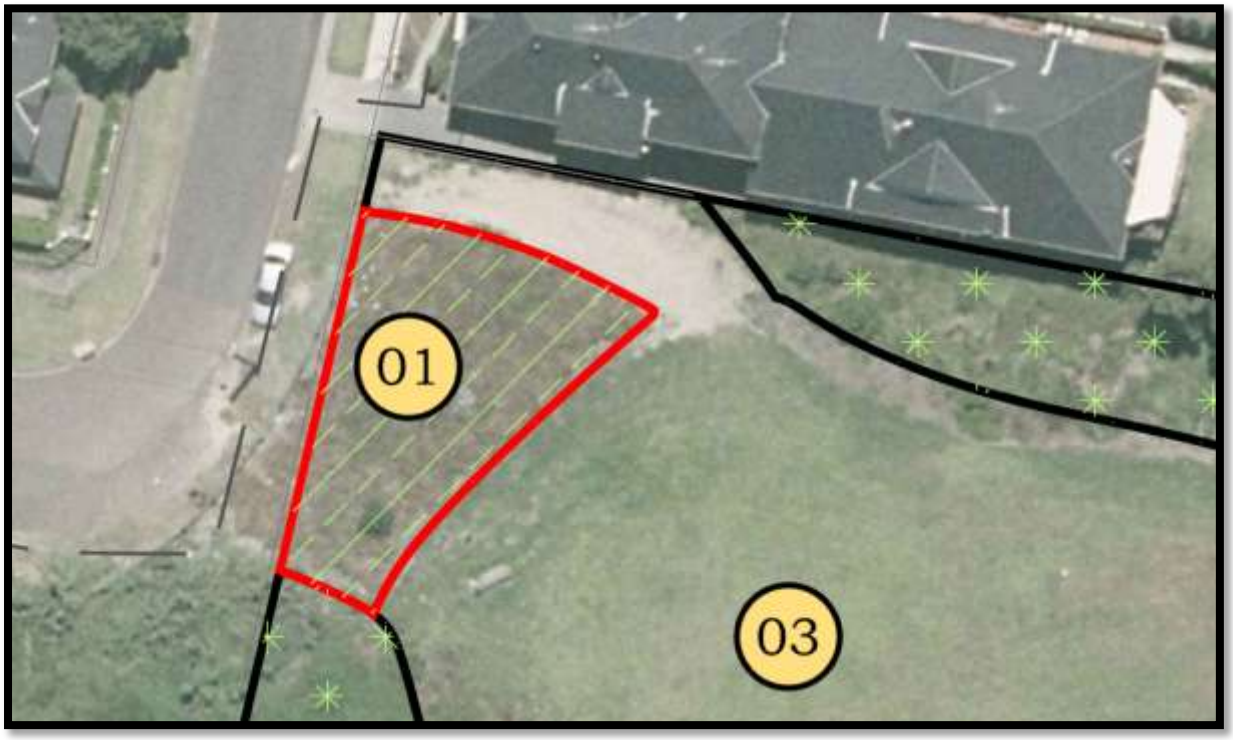
STRATEGY	PRIORITY	GOALS AND OBJECTIVES
Litter collection-Mangroves	12	Clear litter from mangrove forest area.
Fauna	13	**Commission fauna survey**-to ascertain which species are utilising the site. The wetlands provide potential habitat for a range of vulnerable species, including migratory birds, frogs and microbats, which may be in the area. Species inventory will guide habitat enhancement elements for extant fauna (eg nest boxes, microhabitats)
Public education- signage	14	**Install signage** Use of informative signage in conjunction with exclusion zones to explain values of the habitat conserved in the reserve
Monitor progress of rehabilitation program	15	**Quantify progress**
Consolidation of boundary areas .	16	**Work with local residents** in adjoining properties to manage weed plants in their yards. This may involve general education programs, offers of incentives or assistance to manage their invasive weeds
Staged removal of Onion Weed (*Nothoscordum borbonicum)*	17	**Manage Onion weed through mulching and planting with native species to outcompete the weed. Isolated flower removal with associated herbicide treatment Staged excavation of topsoil in areas with high density infestations. can be used to control this weed, and may be**

STRATEGY	PRIORITY	GOALS AND OBJECTIVES
		conducted in conjunction with the formation of saltmarsh extension. Removal of flowers before seed is set can reduce the rate of spread. The plant does not respond favourably to spraying, and potentially successful herbicide sprays are not suitable for use around wetlands due to their extreme toxicity.
Monitoring mangrove health	18	Monitor at regular intervals, especially after peak flow periods associated with king high tides and major storm events.

5.2 Identification Of Management Zones

5.2.1 Zone 1 (Planted Slope Adjacent To Roadway)

Figure 26 Zone 1



Zone Area : 270m2

Description of zone

Entry to the reserve is from Pemberton Street via an informal vehicular access track which runs along the northern edge of Zone 1. The zone comprises a steeply sloping section of stabilised road embankment which has been capped with crushed sandstone due to the presence of broken bonded asbestos pieces and planted out with native trees, grasses and scrambler vines. While these plants are all native, some of them are not from the local area. A good surface cover has been established and is important for maintaining stability on the slope. A range of weeds are also present in this area, with some woody weeds (Cotoneaster sp) and a diverse array of annuals and other herbs (see Appendix A).

Figure 27 Kangaroo Grass (*Themeda australis*) dominates the embankment in zone 1

Assessment of vegetation and habitat value

All of the trees and shrubs planted in the area are comparatively young (around 3-5 years). At this age the shrubs are starting to provide good foraging and refuge habitat for small birds, although proximity to the road and adjoining houses increases the area's exposure to domestic animals such as cats and dogs. The dense understorey of Dusky Coral Pea and herbaceous weeds also provides foraging for birds and refugia for small reptiles, such as lizards, which can be heard moving away in the undergrowth.

The primary value of the vegetation in this area is for soil stabilisation, and the main habitat value is for foraging and temporary refuges for small animals and birds.

Threatening processes

The main threatening processes for this area are weed encroachment from adjoining management zones (eg. Zone 4), erosion from road runoff, littering, illegal dumping along roadside edge and disturbance by domestic animals.

Table 6 Action Table: Zone 1

ZONE 1 TERRESTRIAL PLANTING	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
Strategy: Revegetation This zone is contaminated with broken bonded asbestos pieces and was remediated by capping with crushed sandstone in 2005/2006 As such, there is little likelihood of any native seedbank, and diversity of the existing native vegetation could be increased through planting of additional low species. Goals for this zone include increasing the diversity of native plants in the area, increasing the complexity of vegetation community, stabilisation of soil surface to prevent erosion. (see Appendix F for detailed planting notes)	low - medium	**Year 1:** Prepare soil and plant groundcover species and shrubs. Maintain plantings. **Year 2:** Maintain plantings, replant where necessary, prepare soil and plant grasses and herbs. **Year 3:** Maintain plantings, plant supplementary species **Year 4:** Maintain plantings, replant where necessary, and plant supplementary species **Year 5:** Maintain plantings	$ 660	n/a	Natural Resource Officer (NRO)	Revegetation- capital and operational
Strategy: Weed removal of herbs and grasses	medium	**Year 1:** Hand weed or spot	$3/m^2 Primary	$2/m^2	NRO	Bush regeneration:

ZONE 1 TERRESTRIAL PLANTING	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
Removal of exotic herbs and grasses in this area aims to enhance existing native vegetation and create additional space for planting. Hand pull or crown herbs and grasses, although this may not be effective for Kikuyu and other vegetatively reproducing grasses. Alternative treatment methods include spot spraying, although this is best used in areas where weeds are in patches or clumps, rather than scattered throughout the area. Areas where weeds are hand removed can be planted immediately. Plant areas after weed dieback, and mulch or use weed suppression mats. Use of plant guards will improve establishment success. Extension of the planted area into adjacent areas should commence within several years, and this will become the primary goal from this stage.		spray and plant **Year 2:** Hand weed and supplementary planting **Year 3:** Follow-up weeding and extend planting to adjoining areas (eg. Zone 4) **Year 4:** Follow-up weeding and continue consolidation planting. **Year 5:** Final stages of consolidation, ongoing maintenance weeding	treatment $500	Secondary treatment $350		weed removal Operational

ZONE 1 TERRESTRIAL PLANTING	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
(see Appendix F for detailed weed control notes)						
Strategy: Erosion control Consideration needs to be given to management of soils on steep slopes and along creek banks. Weed removal should be staged, and soils may need some further consolidation. Use of logs and rock piles to create habitat for frogs and reptiles can be extended for use as erosion control structures: placement of logs and rock piles should therefore consider potential for erosion on steeper slopes or where there is evidence of prior scouring.	medium - high	**Throughout project:** Monitor for early signs of sheet or rill erosion as these are the most likely forms of erosion on the site. Use of brush matting and/or mulch in between plantings can reduce the erosive potential of stormwater flows. Native brush with seed can provide additional revegetation outcomes through direct seeding. Management of actual erosion can be achieved through a number of soft engineering options, including jute matting, coir log installation,	Supply & install jute matting $3.80/m2 $450	n/a	NRO	Habitat creation/erosion control Capital-grant funding

ZONE 1 TERRESTRIAL PLANTING	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
		timber edged terracing, sandbagging, etc. Selection of an appropriate erosion control method may need further consultation.				
Strategy: Community support and involvement	High	**Throughout the project:** Carry out a community awareness program highlighting the presence of threatened species in the saltmarsh EEC. Provide education on the role that residents can play in maintaining these environmental treasures, including management of domestic animals, garden escape plants, garden refuse, littering and fire. This should include "community days" and printed material letterbox	In kind $15000	Low	Education Officer Bushcare Officer	Operational

ZONE 1 TERRESTRIAL PLANTING	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
		drops.				
Strategy: Access	Medium	Support and encourage the activities of the local bushcare group.	$300	NA	NRO	Capital
Strategy: Regulation	High	Provide safe access into the reserve via construction of stairs		NA		Capital
		Install regulatory sign at the reserve entrance to deter illegal use of the reserve (off-leash dog walking, dumping, anti-social behaviour)	In kind	In kind	NRO	
		Increase Ranger patrols of site				
Flora and Fauna Survey (whole of reserve)	Med-high	**Undertake Spring and Summer surveys.**	$6000	NA	PCC	Capital (or could be done internally)

5.2.2 Zone 2 (Planted Border Along Residential Boundary)

Figure 28 Zone 2

Zone area: 672m2

Description of zone

The northern boundary of the reserve abuts residential housing. Part of this boundary has been extensively weeded, planted and mulched. Selection of plant species was based on native shrubs and groundcovers that provide good cover and habitat without reaching a great height, thereby preventing interference with views from neighbouring properties. Unfortunately, like Zone 1, some of the plant species selected may not be local native species (Appendix A).

Figure 29 Terrestrial plantings are establishing well in Zone 2

Assessment of vegetation and habitat value

The planted trees, shrubs and groundcover in this area are around the same age but better established than those in Zone 1, probably due to better soil and water conditions. Shrubs are well established, providing good food and shelter for birds, reptiles and invertebrates. A dense foliage cover of Dianella sp provides extensive ground layer foraging and refuge habitat for small birds and reptiles, with bright flowers for pollen and fleshy fruit for frugivores. Some taller shrubs are located near the residential boundary wall, and these provide a more complex vegetation structure. The greater complexity of vegetation in this area creates more habitat niches, and provides for a wider range of insects and animals.

Threatening processes

The main threatening process in this zone is the introduction of weed propagules from neighbouring properties (for example illegal dumping of garden refuse) and adjoining management zones. Establishment of non-endemic native species may potentially become a problem at a later date. However, at this time, they are providing good foraging and refuge habitat.

Table 7 Action Table: Zone 2

ZONE 2 TERRESTRIAL PLANTING	PRIORITY	DETAILS	~INITIAL CAPITAL COST	~ONGOING COST	RESPONSIBILITY	WORKS TYPE
Strategy: Weed removal of woody weeds A large number of woody weeds have been removed from this area, and there are high density woody weed infestations in adjoining areas. This increases the potential for reintroduction of these weeds to this zone, and this will require ongoing maintenance to prevent significant reinfestation by these species.	low – medium	**Throughout project:** Maintenance weeding may involve hand pulling of seedlings or cut stump and paint using Roundup Bi-active®or similar glyphosate herbicide for larger saplings (stem diameter greater than 1cm).	$3/m2 See below	$3/m2	NRO	Weed control operational
Strategy: Weed removal of herbs and grasses Removal of exotic herbs and grasses in this area aims to enhance existing native vegetation	medium	**Year 1:** Hand weed or spot spray and plant **Year 2:** Hand weed and supplementary planting **Year 3:** Follow-up	Primary treatment $400.00	Secondary treatment $270	NRO	Revegetation capital

ZONE 2 TERRESTRIAL PLANTING	PRIORITY	DETAILS	~INITIAL CAPITAL COST	~ONGOING COST	RESPONSIBILITY	WORKS TYPE
and create additional space for planting. Hand pull or crown herbs and grasses where appropriate. Alternative treatment methods include spot spraying, although this is best used in areas where weeds are in patches or clumps, rather than scattered throughout the area. Areas where weeds are hand removed can be planted immediately. Plant areas after weed dieback, and mulch or use weed suppression mats. Use of plant guards will improve establishment success. Extension of the planted area into adjacent areas should commence within several years, and this will become the primary goal from this stage.		weeding and extend planting to adjoining areas (eg. Zone 12a) **Year 4:** Follow-up weeding and continue consolidation planting. **Year 5:** Final stages of consolidation, ongoing maintenance weeding				

ZONE 2 TERRESTRIAL PLANTING	PRIORITY	DETAILS	~INITIAL CAPITAL COST	~ONGOING COST	RESPONSIBILITY	WORKS TYPE
(see Appendix F for detailed weed control notes)						
Strategy: Revegetation This zone forms the interface between the reserve and the adjoining residential areas. Goals for this zone include management of vegetation to retain sight lines in residential premises, increasing the diversity of native plants in the area, increasing the complexity of vegetation community, stabilisation of soil surface to prevent erosion. Surface treatment following planting should include supplementary mulching in the existing mulched areas. (see Appendix F for detailed	medium	**Year 1:** Prepare soil and plant groundcover species and shrubs. Maintain plantings. **Year 2:** Maintain plantings, replant where necessary, prepare soil and plant grasses and herbs. **Year 3:** Maintain plantings, plant supplementary species **Year 4:** Maintain plantings, replant where necessary, and plant supplementary species **Year 5:** Maintain	Supply & install plants hiko$ 1.65 $550 Supply & install organic leaf litter mulch $2.63/ m2 $880		NRO	Revegetation capital

ZONE 2 TERRESTRIAL PLANTING	PRIORITY	DETAILS	~INITIAL CAPITAL COST	~ONGOING COST	RESPONSIBILITY	WORKS TYPE
planting notes)		plantings				
Strategy: Community support and involvement Carry out a community awareness program highlighting the presence of threatened species in the saltmarsh EEC. Provide education on the role that residents can play in maintaining these environmental treasures, including management of domestic animals, garden escape plants, garden refuse, littering and fire. Support and encourage the activities of the local bushcare group	high	**Throughout the project**	In kind	low	Education Officer Bushcare Officer	Operational

5.2.3 Zone 3 Recreational Area (Grassed Meadow Area)

Figure 30 Zone 3

Zone area: 2417m2

Description of zone

This zone incorporates a large open area that is used by locals for dog walking and other activities. Most of the vegetation in this zone comprises a mixture of exotic grasses and herbs. A full species list was not recorded for this area due to difficulties in identification of grasses without well developed inflorescences. Current management of the reserve includes irregular slashing of this area.

Assessment of vegetation and habitat value

There is little habitat value for the vegetation in this zone. As a complete groundcover it provides some stability for the soil surface, although the area is flat and there is little evidence of potential for erosion. Seeding grasses and herbs provide food resources for birds, insects, reptiles and frogs, but this is poor quality food from non native plants.

Threatening processes

The area provides a continuous source for weed propagules to other parts of the site. Management activities for this zone need to give consideration to reducing the level of impact from these seed sources.

Figure 31 Zone 3 extends southward to the tree and drainage line

Table 8 Action Table: Zone 3

ZONE 3 Recreational Area	PRIORITY	DETAILS	~INITIAL CAPITAL COST	~ONGOING COST	RESPONSIBILITY	WORKS TYPE
Strategy: Weed control through management of propagules The recommendations for this part of the reserve are to control exotic plants rather than eradicate them. The area constitutes passive open space recreation, and is best managed by keeping the area mown or slashed regularly. This will prevent any of the exotic plants flowering and setting seed, thus preventing the establishment of further propagules for reinfestation of surrounding areas.	medium	**Throughout project:** Mow or slash open space to the edge of the adjoining zones. The "no mow/no whip" limit should be clearly delineated using rocks or logs. These do not need to form a continuous wall but do need to provide a clear alignment for machinery. Convict hewn sandstone blocks would be ideal for this purpose, and are reportedly available.	Supply and install rocks "bollards" $1200		Parks	Operational
Strategy: Management of open space recreation The main purpose of the reserve is to conserve the saltwater/transitional/ freshwater wetlands and supporting ecosystems and to provide for passive recreation (eg. for birdwatching, walking). Passive recreation	high	**Throughout project:** Mow/slash/whip at regular intervals, eg. During spring and summer mow at least monthly, and during autumn and winter mow bi-monthly to control development of weed		$4500 pa	PCC	Operational

Table 8 Action Table: Zone 3

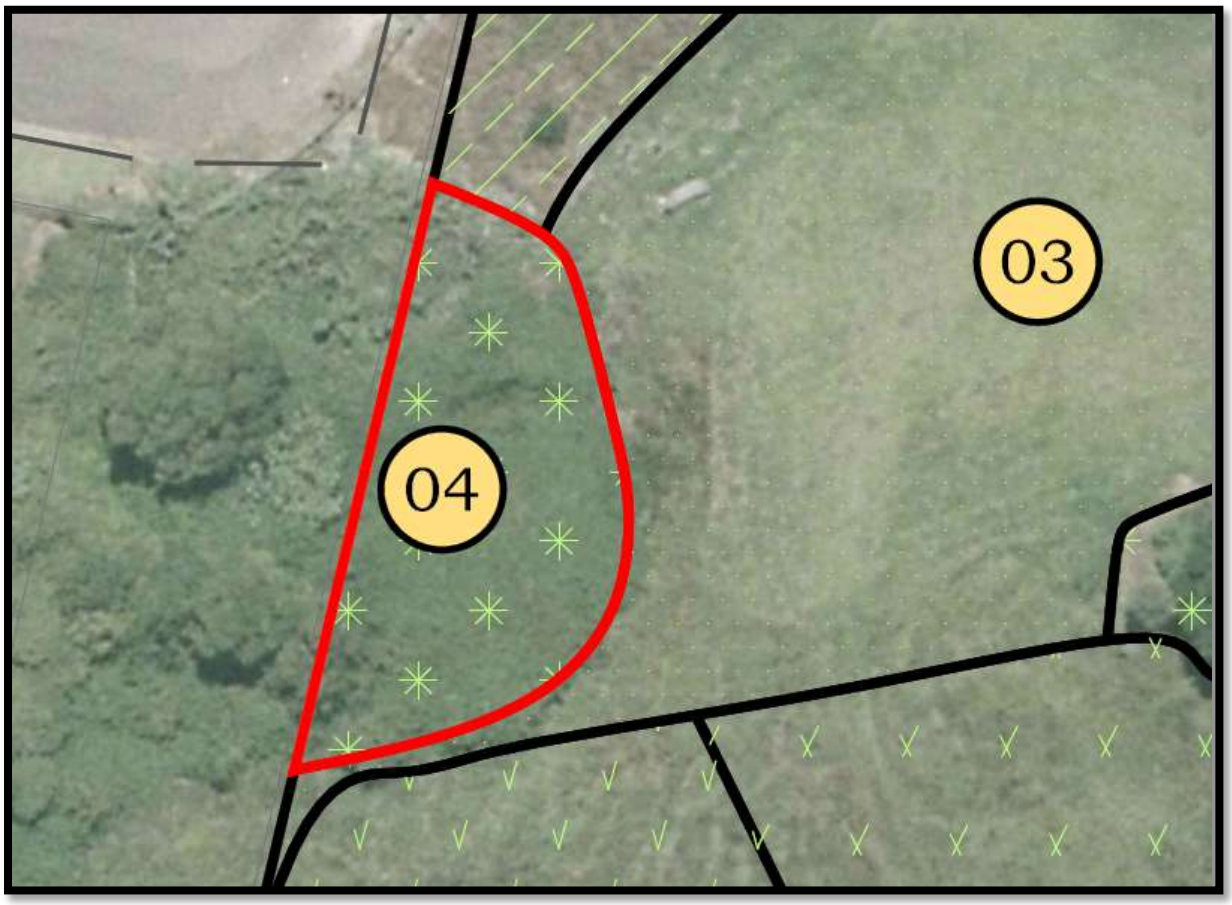
ZONE 3 Recreational Area	PRIORITY	DETAILS	~INITIAL CAPITAL COST	~ONGOING COST	RESPONSIBILITY	WORKS TYPE
activities should be cited in areas that are not likely to cause any adverse impact on local wildlife.		propagules. Monitor and mow more often to prevent development of seed.				
Strategy: Establishment of "no go" zones Many of the more uncommon species that use the site become disturbed by the presence of people, bicycles, dogs and other disturbances. Restriction of any of these disturbances to defined areas (eg boardwalks, walking tracks) will improve the quality of the habitat available, and may result in an increase in the use of the area by migratory birds, uncommon species and may facilitate the reintroduction of uncommon wetland plant species. If required fencing can be used to manage access to wetland areas of the reserve. Provision of maintenance access to the wetland areas of the reserve needs to be considered.	high	**Year 1:** Construct boardwalk to manage access to wetland areas. 	Boardwalk materials vary considerably in costs.			

Table 8 Action Table: Zone 3

ZONE 3 Recreational Area	PRIORITY	DETAILS	~INITIAL CAPITAL COST	~ONGOING COST	RESPONSIBILITY	WORKS TYPE
Strategy: Public education Use of informative signage in conjunction with boardwalk construction will explain the purposes of the boardwalk, as well as the values of the habitat conserved in the reserve. By establishing a link between the reserve and endangered species, local residents will be encouraged to become emotionally and/or practically involved with activities in the reserve.	high	**In conjunction with other activities in this zone** – best installed along with fencing	Up to $400 per sign			

5.2.4 Zone 4 (High Density Weed Area Near Road)

Figure 32 Zone 4



Zone area: 310m2

Description of zone

This area is immediately below the corner of Pemberton St, and has a dense cover of woody and herbaceous weeds. The weed infestation extends beyond the boundary of the reserve into the neighbouring block of land. The land surface is steeply sloping, and an informal drainage line from the road corner appears to flow along the fence line, before joining the main drainage outlet. Due to the dense weed cover in this area the exact alignment of the surface drainage and the piped stormwater drainage is not clear. There are no native plant species growing in this zone (see Appendix A)

Figure 33 Stormwater outlet high on the batter discharges nutrients and water to the well established weed plume

Assessment of vegetation and habitat value

The absence of native species in the zone is indicative of the value of the vegetation. It has no potential as part of a process of native plant rehabilitation for the reserve. At this stage, the main value for the existing vegetation is for stabilisation of soils on the steep bank, and through habitat provision.

Despite the absence of native plant species, the vegetation in this area provides a range of nesting, foraging and perching habitats. Many of the canopy species are older, and provide good feeding and roosting habitat for birds, and the dense canopy foliage provides ideal nesting habitat for birds that nest in the crown of the tree. A number of these trees (eg. Camphor Laurel, Small Leaved Privet) develop dense crops of small berries, providing an ample food source for a wide range of birds, bats, possums and insects. The dense understorey forms ideal refuge habitat for smaller birds and reptiles, and provides a range of food resources for these animals and a diverse array of invertebrates which, in turn, become a food resource for other animals in the local food chain. Replacement of weed species with natives should involve a staged process.

Threatening processes

The main threats for this zone are from poorly managed stormwater inputs. Poor quality stormwater favours the establishment and growth of exotic plants over native species. Uncontrolled discharge of stormwater has high erosive potential, and this needs to be managed on the steep slope for this area. Use of this area for a stormwater treatment/management process should be considered.

In its current configuration, and despite its habitat value, the dominance of highly invasive weed species in the zone constitutes a threatening process for other parts of the reserve. As a result, development and implementation of an ecologically sound management plan is essential to ensure that this degrading impact is managed, reduced and ultimately removed.

Figure 34 A vast array of sizeable gross pollutants within Zone 4

Table 9 Action Table: Zone 4

ZONE 4 HIGH DENSITY WEEDS	PRIORITY	DETAILS	~INITIAL CAPITAL COST	~ONGOING COST	RESPONSIBILITY	WORKS TYPE
Strategy: Weed removal of woody weeds and climbers Management aims for this zone are to remove a large source of weed seeds in patches with consideration of habitat and replace with effective natives that provides stability on the slope and good habitat for a range of faunal groups. Following removal of weeds, it will be possible to locate the discharge point for the stormwater drainage network from nearby residential areas. Cut and paint medium sized woody weeds and Balloon Vine, hand pull Madeira Vine taking care to collect all vegetative propagules, cut and paint or spray Lantana. Some species will require stem injection for effective treatment (eg. larger plants of Small and Large Leaved Privet, Camphor Laurel). Pile vegetative material on site to provide habitat for lizards, invertebrates and small	medium	**Year 1:** Treat Arundo donax grass at top of slope; plant and jute mat or mulch to stabilise soils. Begin treatment of vines, especially Madeira Vine. Fell larger trees. **Year 2:** Remove lantana and vines from lower slope, cut and paint remaining woody weeds unless this may destabilise soils on the slope. Plant and stabilise with mulch, brush matting or jute matting as appropriate. **Year 3:** Follow up weed removal especially vines. Remove any remaining weeds and vines, treat ground cover weeds. Additional planting to stabilise area.	Primary treatment $1500 Or clear and grubbing and weed disposal $2000	Secondary treatment $930 per treatment	NRO	Weed control operational

Table 9 Action Table: Zone 4

ZONE 4 HIGH DENSITY WEEDS	PRIORITY	DETAILS	~INITIAL CAPITAL COST	~ONGOING COST	RESPONSIBILITY	WORKS TYPE
birds. Take care to ensure that all weed propagules have been removed. (See Appendix F for further information on woody weed treatment)		**Year 4:** Follow up weeding. **Year 5:** Maintenance weeding.				
Strategy: Weed removal of herbs and grasses Spraying should be conducted during autumn and winter when the wildlife is less active, and more likely to have found overwintering shelters. Only use Roundup Biactive® around possible frog habitat locations, or around waterways. (See Appendix F for further information on spraying and hand removal of herbs and grasses)	medium – high	**Year 3:** Spray, crown or hand pull groundlayer weeds, mulch and plant to stabilise soils. **Year 4:** Follow up weeding. **Year 5:** Maintenance weeding.	0.50/ m2 herbicide spray $155 per treatment	0.50/ m2 herbicide spray	NRO	Operational
Strategy: Erosion control Consideration needs to be given to management of soils on steep slopes and along creek banks.	high	**Throughout project**	As item 1 Supplementary Treatment		NRO	Capital/ grant

Table 9 Action Table: Zone 4

ZONE 4 HIGH DENSITY WEEDS	PRIORITY	DETAILS	~INITIAL CAPITAL COST	~ONGOING COST	RESPONSIBILITY	WORKS TYPE
Weed removal should be staged, and soils may need some further consolidation. Use of logs and rock piles to create habitat for frogs and reptiles and can be extended for use as erosion control structures: placement of logs and rock piles should therefore consider potential for erosion on steeper slopes or where there is evidence of prior scouring.			Supply and install Rocks: $1200 Supply and install Coir logs: $1000			
Strategy: Revegetation This zone forms the interface between the reserve and the adjoining road reserve and associated areas. Goals for this zone include stabilisation of soil surface to prevent erosion, management of vegetation to retain sight lines in residential premises, increasing the diversity of native plants in the area, increasing the complexity of	high	**Year 1:** Prepare soil and plant groundcover species and shrubs. Maintain plantings. **Year 2:** Maintain plantings, replant where necessary, prepare soil and plant grasses and herbs. **Year 3:** Maintain plantings, plant supplementary species	Stabilisation Supply & install jute matting $3.80/m2 $1000 Supply & install plants hiko$ 1.65 $2050	low	Senior project officer-waterways strategy	Capital/grant

Table 9 Action Table: Zone 4

ZONE 4 HIGH DENSITY WEEDS	PRIORITY	DETAILS	~INITIAL CAPITAL COST	~ONGOING COST	RESPONSIBILITY	WORKS TYPE
vegetation community. Surface treatment following planting should include supplementary jute matting and/or installation of coir logs in steeper areas. (see Appendix F for detailed planting notes)		**Year 4:** Maintain plantings, replant where necessary, and plant supplementary species **Year 5:** Maintain plantings	Supply & install organic leaf litter mulch $2.63/ m2 $710			
Strategy: Stormwater management to improve water quality The bulk of surface flows through this area are generated in a highly urbanised catchment. As such, they generally carry a high nutrient and sediment load and this can have an adverse effect on the freshwater wetlands and the saltmarsh. Options for treatment include installation of a gross pollutant trap (GPT) such as a Pratten Trap, which functions as an end of pipe structure to remove bulk solids from the stormwater before it enters the reserve itself. These are easy to install and maintain, and can be quickly retrofitted to existing pipes and	high	**Best completed in Year 2** in conjunction with weed control activities: Identifying a suitable location for a retrofitted GPT will be largely dependent on locating the pipe and/or headwall first. Some modification, stabilisation or other repairs may be necessary. An appropriately qualified professional should be consulted.	Varies on device chosen $5000+	medium	Catchment Management Engineer	Operational

Table 9 Action Table: Zone 4

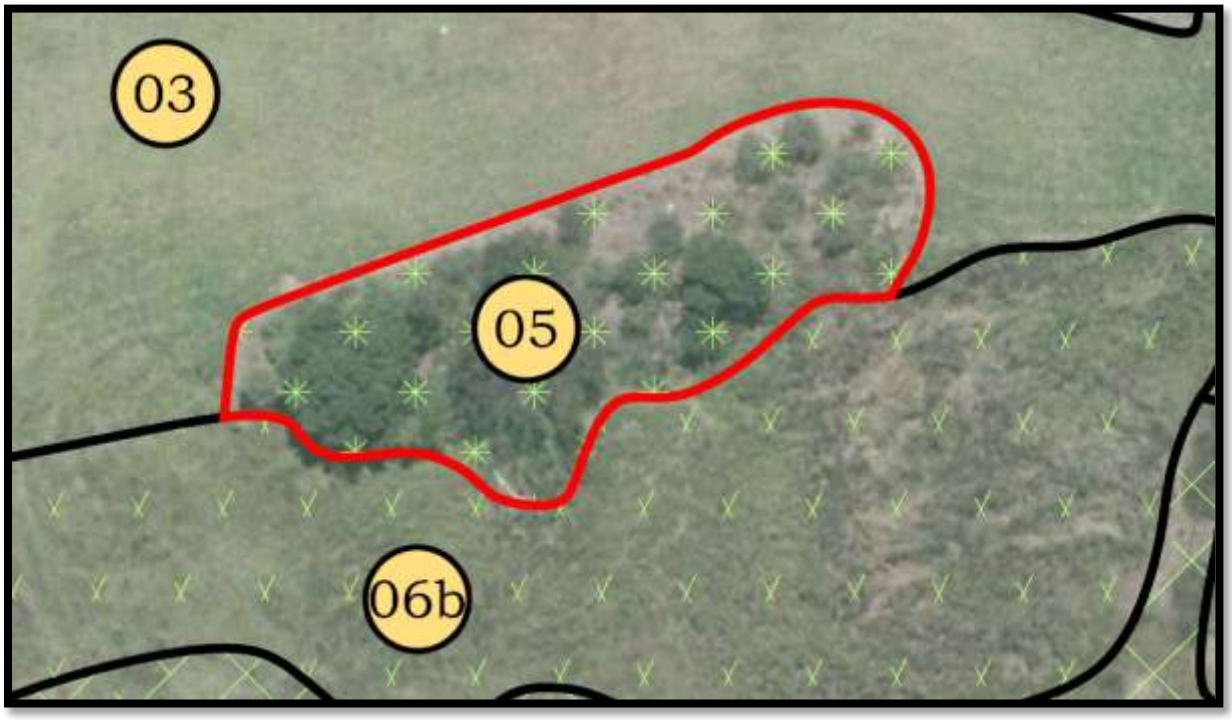
ZONE 4 HIGH DENSITY WEEDS	PRIORITY	DETAILS	~INITIAL CAPITAL COST	~ONGOING COST	RESPONSIBILITY	WORKS TYPE
headwalls. (see Section 9 for a review of GPT options)						
Strategy: Monitor progress of rehabilitation program Establish a series of permanent monitoring points (photo-points and transects and/or quadrats).	high	**Monitor every 6 months** for duration of the project.	In kind	low	NRO or Bushcare officer	Operational
Strategy: Public education Carry out a community awareness program that highlights the presence of threatened species in the saltmarsh EEC. Support this with informative signage in the reserve itself.		**Throughout the project**	Low-medium	low	Education Officer	Operational
Strategy: Community support and involvement Support and encourage the activities of the local bushcare group. Provide education on the role that residents	high	**Throughout the project**	Low-medium	low	Bushcare Officer	Operational

Table 9 Action Table: Zone 4

ZONE 4 HIGH DENSITY WEEDS	PRIORITY	DETAILS	~INITIAL CAPITAL COST	~ONGOING COST	RESPONSIBILITY	WORKS TYPE
can play in maintaining these environmental treasures, including management of domestic animals, garden escape plants, garden refuse, littering and fire.						

5.2.5 Zone 5 (Terrestrial Planting Near Freshwater Channel)

Figure 35 Zone 5



Zone area: 515m2

Description of zone

A range of tree and shrub species have been planted in this area. These are providing a good vegetative barrier between the adjacent wetland channel and the exotic grasses in Zone 3. The ground has a good mulch cover in between, reducing the need for management of weeds in this area. These plantings appear to be around 3-5 years old, the same age as those in Zones 1 and 2. Species selection will ultimately provide a good canopy cover, with a reasonable shrub layer as well. Some of the species planted, however, do not appear to be local endemic species.

Figure 36 Tree species establishing in buffer zone to wetland

Assessment of vegetation and habitat value

Non endemic tree species have the potential to provide good habitat, but as they are not an original component of the pre-existing vegetation their value in a restoration process is reduced. Since an average restoration process is never straightforward, however, their value may be greater as part of a staged process.

The age of the plants reduces their current habitat value. Canopy species are not old enough to provide nesting hollows, nor are the crowns sufficiently well developed to support many nesting and foraging birds. This growth stage will begin to be reached over the next 5 years, and as the trees mature their capacity to provide good habitat will increase as well. There is sufficient diversity among the tree species that a range of niche habitats should develop, increasing the diversity of species that will fill them. Among the shrub layer species, many are acacias. These are good colonisers, improving the local soil conditions to favour the establishment of other native species, and at the same time they provide nectar and seeds for many birds and insects. The bright yellow flowers in particular are attractive to butterflies.

Threatening processes

The main threat for this zone is weed encroachment from Zone 3, and this needs to be managed on a continuing basis.

Table 10 Action Table: Zone 5

ZONE 5 TERRESTRIAL PLANTING	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
Strategy: Weed removal of herbs and grasses Removal of exotic herbs and grasses in this area aims to enhance existing native vegetation and create additional space for planting. Hand pull or crown herbs and grasses where appropriate. Alternative treatment methods include spot spraying, although this is best used in areas where weeds are in patches or clumps, rather than scattered throughout the area. Areas where weeds are hand removed can be planted immediately. Plant areas after weed dieback, and mulch or use weed suppression mats. Use of plant guards will improve establishment success. Extension of the planted area into adjacent areas should commence within several years, and this will become the primary goal from this stage.	medium	**Year 1:** Hand weed or spot spray and plant **Year 2:** Hand weed and supplementary planting **Year 3:** Follow-up weeding and extend planting to adjoining areas (eg. Zone 12a) **Year 4:** Follow-up weeding and continue consolidation planting. **Year 5:** Final stages of consolidation, ongoing maintenance weeding	$3/m2 Primary treatment $460	$2/m2 Secondary treatment $200	NRO	Operational

Table 10 Action Table: Zone 5

ZONE 5 TERRESTRIAL PLANTING	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
(see Appendix F for detailed weed control notes)						
Strategy: Revegetation This zone provides an informal barrier between the open space and wetland areas of the reserve. Goals for this zone include management of vegetation to retain sight lines in residential premises, increasing the diversity of native plants in the area, increasing the complexity of vegetation community, stabilisation of soil surface to prevent erosion. Surface treatment following planting should include supplementary mulching in the existing mulched areas. (see Appendix F for detailed planting notes)	medium	**Year 1:** Prepare soil and plant groundcover species and shrubs. Maintain plantings. **Year 2:** Maintain plantings, replant where necessary, prepare soil and plant grasses and herbs. **Year 3:** Maintain plantings, plant supplementary species **Year 4:** Maintain plantings, replant where necessary, and plant supplementary species **Year 5:** Maintain plantings	Supply & install plants hiko $ 1.65 $1300 Supply & install organic leaf litter mulch $2.63 /m2 $400	low	NRO	capital

Table 10 Action Table: Zone 5

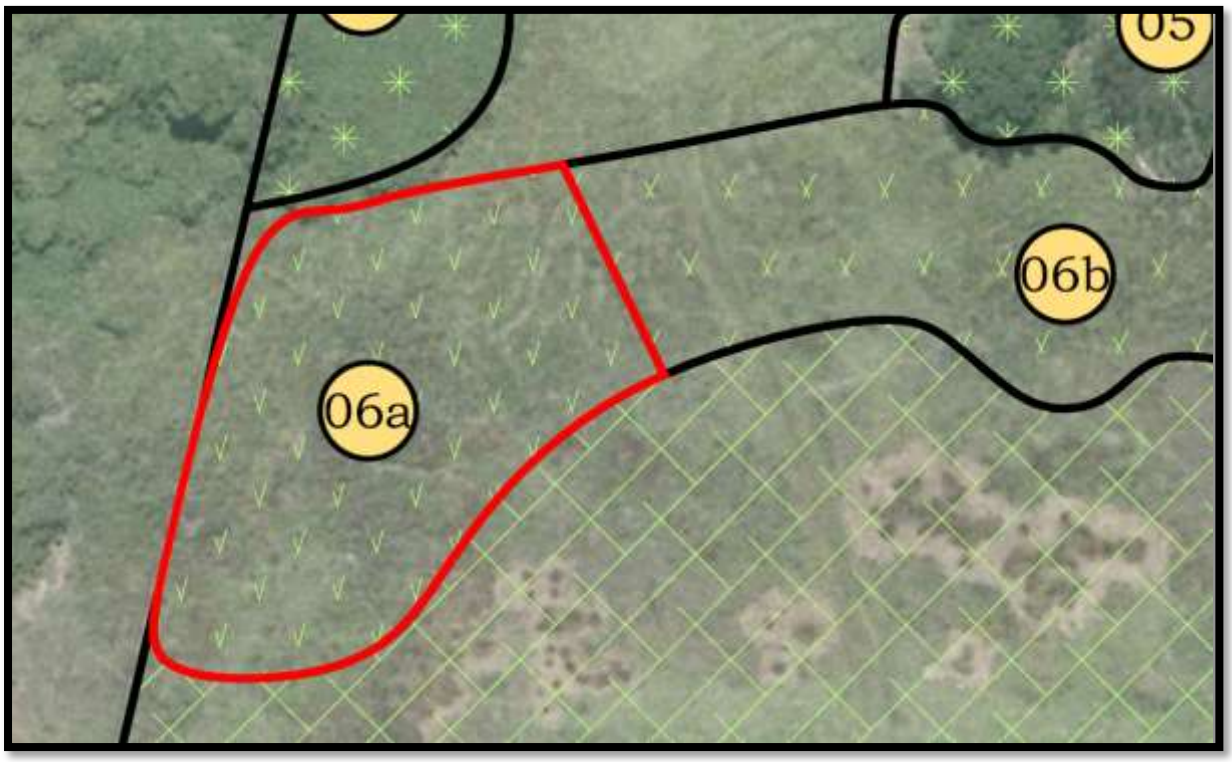
ZONE 5 TERRESTRIAL PLANTING	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
Strategy: Management of open space recreation area Establishment of a "no whip/no mow" zone will support the establishment of vegetation and the development of faunal communities in the area. This can be through positioning of logs and/or rocks, either in a continuous wall or in a manner that shows indicative edge for the mown area in the adjoining Zone 3. Incorporating this with formal fencing can provide dual outcomes – management of access and provision of habitat.	high	**Year 1:** clearly identify boundaries of "no whip/no mow" zone **Year 2:** monitor effectiveness of the boundary marking **Year 3:** fencing should be established by this time.	Supply and install rocks $232/m3 $1200	n/a	PCC	capital
Strategy: Enhance refugia Install nest/roost boxes for microbats and birds (see section 8 for details of nest boxes)	medium	Ascertain which species are likely to use the reserve and install appropriately sized nest and roost boxes.	Supply and install $100 per box	Low-volunteer monitoring and inspections	PCC	Operational
Strategy: Community support and	high	**Throughout the project**	In kind	low	PCC	Operational

Table 10 Action Table: Zone 5

ZONE 5 TERRESTRIAL PLANTING	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
involvement Support and encourage the activities of the local bushcare group. Provide education on the role that residents can play in maintaining these environmental treasures, including management of domestic animals, garden escape plants, garden refuse, littering and fire.						

5.2.6 Zone 6a (Freshwater Wetland Area)

Figure 37 Zone 6A



Zone area: 659m2

Description of zone

This zone includes the discharge point(s) from the road and stormwater drainage network. The result of the stormwater input and the topography has been the creation of a freshwater wetland. At this stage the exact location of the drainage discharge point is unclear. There is no tidal influence on this part of the site, and the wetland is exclusively fed by freshwater inputs from higher in the localised catchment. This catchment area includes fully developed residential housing of medium density, including small blocks of flats (6 to 8 units) with single houses on urban housing blocks (the "quarter acre block"). As urban stormwater, the runoff includes high levels of nitrates (and other NOx), phosphates and fine sediment particles. This favours the establishment and growth of exotic plant species, although the wetland itself includes mainly native plants. While the wetland gives some treatment to the stormwater through existing natural processes, there may be issues associated with quality of the stormwater discharged to the receiving environment (Parramatta River).

Assessment of vegetation and habitat value

Dense stands of *Typha, Juncus* and *Carex* species form a good quality natural wetland. While there is not a huge diversity of species in the wetland, the comprehensive cover is indicative of a well

established wetland ecosystem. There are some weeds invading the wetland, with blackberry, onion weed and a number of exotic grasses causing noteworthy problems.

While there are some weeds in the wetland, this zone still provides good quality habitat for a number of faunal groups. A range of bird species have been recorded in the area, including a sighting of Latham's Snipe during recent field work by AW staff. Frog calls were heard, and Pobblebonks were identified as present in the zone, and numerous small to medium sized lizards were sighted or heard.

Figure 38 *Carex appressa* in foreground. *Typha* at back.

Threatening processes

Key threatening processes for this wetland zone are stormwater quality, quantity and flow regime, and weed invasion, especially from Zone 4. Poor water quality can cause dieback or death among the existing wetland species in more extreme scenarios, while continuous inputs of high nutrient loaded water will favour exotics to replace these lost native species. Unregulated flows can damage wetlands, causing erosion and channelisation, creating openings for weeds to become established. High flow events can carry weed propagules into the wetland area, ready for establishment in the more favourable conditions.

Table 11 Action Table: Zone 6A

ZONE 6A Freshwater Wetland	PRIORITY	DETAILS	~INITIAL COST PER ANNUM	~ONGOING ANNUAL COST	RESPONSIBILITY	WORKS TYPE
Strategy: Weed removal of herbs and grasses Removal of exotic herbs and grasses in this area aims to enhance existing native vegetation and create additional space for planting. Hand pull or crown herbs and grasses where appropriate. Alternative treatment methods include spot spraying, which is best used in areas where weeds are in patches or clumps. Use on Roundup Bi-Active® around wetland areas. Areas where weeds are hand removed can be planted immediately. Plant areas after weed dieback, mulch or use weed suppression mats in drier areas around the margins only. Use of plant guards will improve establishment success. Extension of the planted area into adjacent areas should commence within several years, and this will become the primary goal from this stage. (see Appendix F for detailed weed control notes)	medium	**Year 1:** Hand weed or spot spray and plant **Year 2:** Hand weed and supplementary planting **Year 3:** Follow-up weeding and extend planting to adjoining areas (eg. Zone 4) **Year 4:** Follow-up weeding and continue consolidation planting. **Year 5:** Final stages of consolidation, ongoing maintenance weeding	$3/m2 Primary treatment $1000	$2/m2 Secondary treatment $600	NRO	Operational

Table 11 Action Table: Zone 6A

ZONE 6A Freshwater Wetland	PRIORITY	DETAILS	~INITIAL COST PER ANNUM	~ONGOING ANNUAL COST	RESPONSIBILITY	WORKS TYPE
Strategy: Revegetation This zone includes the main freshwater wetland area on site, and provides habitat for a range of threatened and uncommon species. Goals for this zone include management of vegetation to maintain the integrity of the wetland, provide management of stormwater impacts, improve the health of the wetland, increase the complexity of vegetation community, and provide stabilisation of soil surface to prevent erosion. Best outcomes for this wetland area could be achieved by treating stormwater before it enters the wetland, and managing the hydrological regime by constructing a formalised outlet to manage water levels, especially during extended dry periods. (see Appendix F for detailed planting notes)	medium	**Year 1:** Prepare soil and plant groundcover species and shrubs. Maintain plantings. **Year 2:** Maintain plantings, replant where necessary, prepare soil and plant grasses and herbs. **Year 3:** Maintain plantings, plant supplementary species **Year 4:** Maintain plantings, replant where necessary, and plant supplementary species **Year 5:** Maintain plantings	Supply & install plants hiko $ 1.65 $1320	low	NRO	capital

Table 11 Action Table: Zone 6A

ZONE 6A Freshwater Wetland	PRIORITY	DETAILS	~INITIAL COST PER ANNUM	~ONGOING ANNUAL COST	RESPONSIBILITY	WORKS TYPE
Strategy : Erosion control In its current configuration this wetland area is exposed to direct effects from storm event flow surges, which have high erosive potential. Management of vegetation in the adjoining Zone 4 may cause changes in the hydraulic regime for this zone. The effects of this are best managed by diverting stormwater into a designated stormwater management structure (see below, and see concept design sheets Appendix C).	high				NRO	
Strategy: Management of stormwater Main stormwater impacts, in addition to erosion potential, include high nutrient loadings, toxic compounds including hydrocarbons, and sediment deposition. Each of these have the potential to have a serious degrading impact on the wetland, either through smothering (sediments), poisoning (toxicants) or by favouring the establishment and growth of exotic species over natives (high nutrient	high	As a guide only for works at both outlets and constructed habitat enhancement wetlands: design for construction $15000-$20000, Construction $60,000-$80,000	$75000-$100000	$1000	Catchment Management Engineer	

Table 11 Action Table: Zone 6A

ZONE 6A Freshwater Wetland	PRIORITY	DETAILS	~INITIAL COST PER ANNUM	~ONGOING ANNUAL COST	RESPONSIBILITY	WORKS TYPE
loads). Most Australian native plants are adapted to a relatively low nutrient environment, and suffer under high nutrient regimes. We recommend design and construction of a treatment wetland to manage water quality as well as flow regimes through the wetland area. (see concept design sheets Appendix C)						
Strategy: Management of migratory bird habitat AW staff sighted two Latham's Snipes leaving this wetland area on a recent site visit. Their location and the time of year suggest that these migratory birds use this as a stopover spot after returning from their annual migration to the northern hemisphere. The site is unlikely to support populations for an extended period, but is nearby to important migratory waders' summer habitat. These birds often rest at nearby sites before continuing to their final destination. The lack of interim stopover sites may affect their capacity to reach the more permanent site. Thus this reserve has a vitally	very high	**Throughout the project lifetime**	N/A	N/A	NRO	Operational

Table 11 Action Table: Zone 6A

ZONE 6A Freshwater Wetland	PRIORITY	DETAILS	~INITIAL COST PER ANNUM	~ONGOING ANNUAL COST	RESPONSIBILITY	WORKS TYPE
important role for the maintenance of this and similar species. Activities that affect the integrity of the wetland need to be timed for when the birds are not likely to use it, and should allow a sufficient lag time for plants to establish before the next annual migration. Maintenance of wetland areas and management of disturbing impacts such as people, bikes, dogs etc are vital actions in preserving the habitat function of the reserve.						
Strategy: Management of general fauna habitat A number of uncommon bird species were sighted during recent visits by AW staff. This suggests that, in addition to migratory birds, a number of other important species potentially use the site. The freshwater wetland provides potential habitat for a range of vulnerable species that may be in the area. Historic fauna survey data is available and has been supplemented by informal observations recorded in	medium	May require additional funding Full surveys of fauna and flora before and after significant works provide an effective tool for monitoring.	See Table 5 page 72			

Table 11 Action Table: Zone 6A

ZONE 6A Freshwater Wetland	PRIORITY	DETAILS	~INITIAL COST PER ANNUM	~ONGOING ANNUAL COST	RESPONSIBILITY	WORKS TYPE
an ad hoc manner. Since the last survey considerable restoration works have been conducted on the reserve, improving the quality of the habitat on offer. To gain a full appreciation of the value of the site as fauna habitat we recommend that a full fauna survey is conducted in the area.						
Strategy: Establishment of "no go" zones Many of the more uncommon species that use the site become disturbed by the presence of people, bicycles, dogs and other disturbances. Restriction of any of these disturbances will improve the quality of the habitat available, and will result in an increase in the use of the area by migratory birds, uncommon species and may facilitate the reintroduction of uncommon wetland plant species. Fencing can be used to manage access to wetland areas of the reserve. Provision of maintenance access to the wetland areas of the reserve needs to	high	**Year 1:** Construct fencing to manage access to wetland areas.	As previous for this action (Table 7)			

Table 11 Action Table: Zone 6A

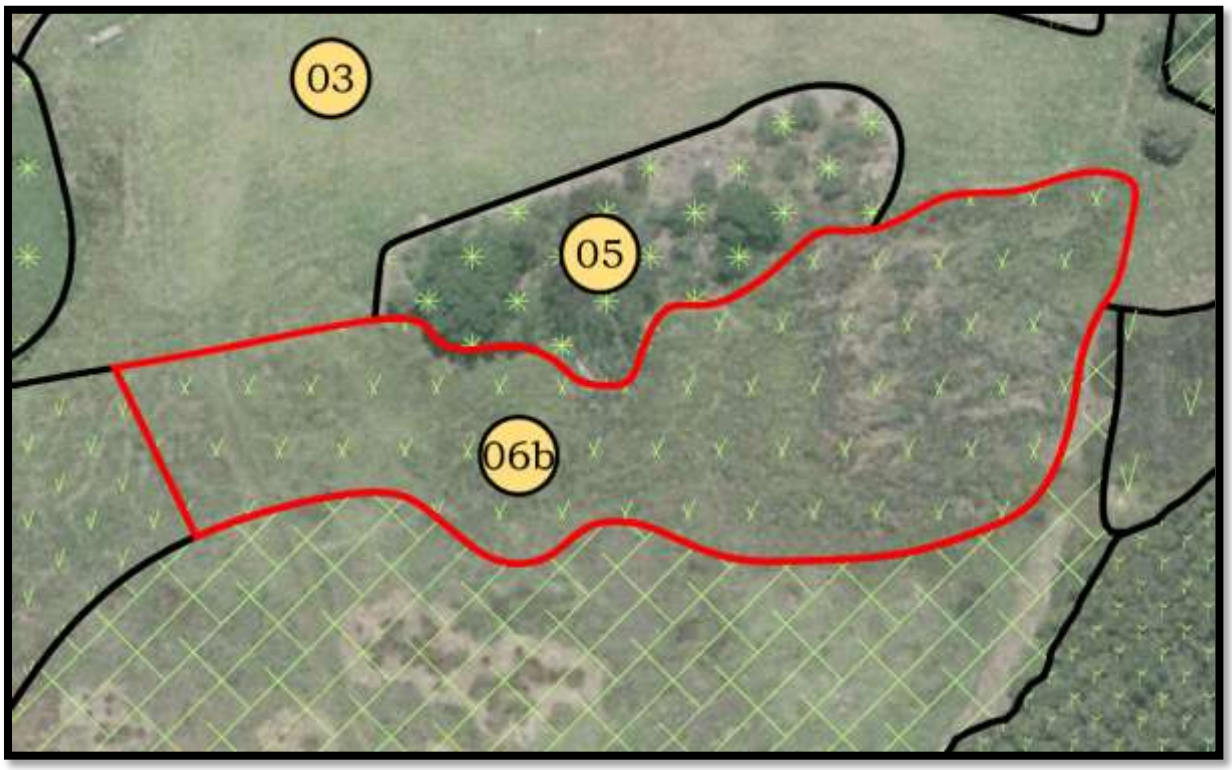
ZONE 6A Freshwater Wetland	PRIORITY	DETAILS	~INITIAL COST PER ANNUM	~ONGOING ANNUAL COST	RESPONSIBILITY	WORKS TYPE
be considered.						
Strategy: Monitor progress of rehabilitation program Establish a series of permanent monitoring points (photo-points and transects and/or quadrats).	high	**Monitor every 6 months** for duration of the project.	In kind	Low	NRO	operational
Strategy: Community support and involvement Support and encourage the activities of the local bushcare group. Provide education on the role that residents can play in maintaining these environmental treasures, including management of domestic animals, garden escape plants, garden refuse, littering and fire.	high	**Throughout the project**	In kind	Low	NRO	operational
Seed collection	Low-med	Collect seed for NSW Seedbank. Develop collection program in collaboration with	low	low	DECCW	Operational(could be undertaken by volunteers

Table 11 Action Table: Zone 6A

ZONE 6A Freshwater Wetland	PRIORITY	DETAILS	~INITIAL COST PER ANNUM	~ONGOING ANNUAL COST	RESPONSIBILITY	WORKS TYPE
		DECCW and Botanic Gardens Trust				once program established)

5.2.7 Zone 6b (Freshwater Wetland Channel)

Figure 39 Zone 6B



Zone area: 1414m2

Description of zone

Immediately downstream of Zone 6a is the wetland channel. This channel conveys most of the freshwater from the wetland to the nearby Parramatta River. It has the appearance of a constructed channel that was built for this purpose. Over time, the channel may have become partially blocked, causing this water to spread over the adjacent flat land as well. Evidence of significant weed removal from the area can be seen along the banks of the channel. The channel appears to be permanently wet, with some areas deeper than others, to a maximum depth of around 300mm of water. There are small areas of open water interspersed with an array of aquatic plants. This provides a range of freshwater habitats within the channel. The lower parts of the channel are becoming significantly impacted with weeds. Zonation in the vegetation indicates that there is a transition from freshwater to brackish over the length of the channel, with most of the saline influence contained to the lowest section. Typha is forming an effective transitional zone between the freshwater drainage and the tidally influenced saltmarsh at the downstream end.

Figure 40 Zone 6B Freshwater wetland channel

Assessment of vegetation and habitat value

There is a range of aquatic plants growing in and around the freshwater channel, providing different food and habitat resources. These are utilised by frogs, birds and lizards, and may also be accessed by microbats (outside the current study). *Typha* sp. and *Juncus kraussii* are forming an effective transitional zone between the freshwater drainage and the tidally influenced saltmarsh at the downstream end.

Threatening processes

The current composition of the vegetation in the channel is most likely to be affected by weed encroachment, with additional potential effects from poor quality stormwater and some possible effects from fluctuating water levels in the Parramatta River. These impacts may include wave-driven inflows associated with the River Cat, generalized flooding associated with peak storm events, and long term impacts from sea level rise, and a consequent rise in the levels of Parramatta River.

Table 12 Action Table: Zone 6B

ZONE 6B Freshwater Drainage Channel	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
Strategy: Weed removal for woody weeds Considerable work has been completed to remove woody weeds from this zone; however, some have been retained for management purposes in the past. As part of an ongoing management plan these need to be killed, and replaced with native shrubs suited to the environment for stability. High density woody weed infestations in adjoining areas increases the potential for reintroduction of these weeds to this zone, and this will require ongoing maintenance to prevent significant reinfestation by these species.	medium	**Throughout project:** Maintenance weeding may involve hand pulling of seedlings or cut stump and paint using Roundup Bi-active®or similar glyphosate herbicide for larger saplings (stem diameter greater than 1cm).	$3/m2 Primary treatment $2150	$2/m2 Secondary treatment $1300	NRO	operational
Strategy: Weed removal of herbs and grasses Removal of exotic herbs and grasses in this area aims to enhance existing native	medium	**Year 1:** Hand weed or spot spray and plant **Year 2:** Hand weed and	Weed control included		NRO	operational

ZONE 6B Freshwater Drainage Channel	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
vegetation and create additional space for planting. Hand pull or crown herbs and grasses where appropriate. Alternative treatment methods include spot spraying, which is best used in areas where weeds are in patches or clumps. Use on Roundup Bi-Active® around wetland areas. Areas where weeds are hand removed can be planted immediately. Plant areas after weed dieback, mulch or use weed suppression mats in drier areas around the margins only. Use of plant guards will improve establishment success. Extension of the planted area into adjacent areas should commence within several years, and this will become the primary goal from this stage. (see Appendix F for detailed weed control notes)		supplementary planting **Year 3:** Follow-up weeding and extend planting to adjoining areas (eg. Zone 4) **Year 4:** Follow-up weeding and continue consolidation planting. **Year 5:** Final stages of consolidation, ongoing maintenance weeding	item 1 Supply & install plants hiko $ 1.65 See below			

ZONE 6B Freshwater Drainage Channel	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
Strategy: Management of stormwater Main stormwater impacts, in addition to erosion potential, include high nutrient loadings, toxic compounds including hydrocarbons, and sediment deposition. Each of these have the potential to have a serious degrading impact on the wetland, either through smothering (sediments), poisoning (toxicants) or by favouring the establishment and growth of exotic species over natives (high nutrient loads). Most Australian native plants are adapted to a relatively low nutrient environment, and suffer under high nutrient regimes. We recommend design and construction of a treatment wetland to manage water quality as well as flow regimes through the wetland area. (see concept design sheets Appendix C)	high	As per table 11: guide only for works at both outlets and constructed habitat enhancement wetlands: design for construction $15000-$20000, Construction $60,000-$80,000	$75000-$100000	$1000	Catchment Management Engineer	

ZONE 6B Freshwater Drainage Channel	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
Strategy: Revegetation This zone includes part of the main freshwater wetland area on site, and provides habitat for a range of threatened and uncommon species. Goals for this zone include management of vegetation to maintain the integrity of the channel and wetland upstream, provide management of stormwater impacts, improve the health of the wetland, increase the complexity of vegetation community, and provide stabilisation of soil surface to prevent erosion. (see Appendix F for detailed planting notes)	medium	**Year 1:** Prepare soil and plant groundcover species and shrubs. Maintain plantings. **Year 2:** Maintain plantings, replant where necessary, prepare soil and plant grasses and herbs. **Year 3:** Maintain plantings, plant supplementary species **Year 4:** Maintain plantings, replant where necessary, and plant supplementary species **Year 5:** Maintain plantings	Supply & install plants hiko $ 1.65 $2640		NRO	Revegetation operational
Strategy : Erosion control In its current configuration this wetland channel may be exposed to direct effects from storm event flow surges, which have high	high	**As per Table 11**: guide only for works at both outlets and constructed habitat enhancement wetlands: design for construction	$75000-$100000	$1000	Catchment Management Engineer	

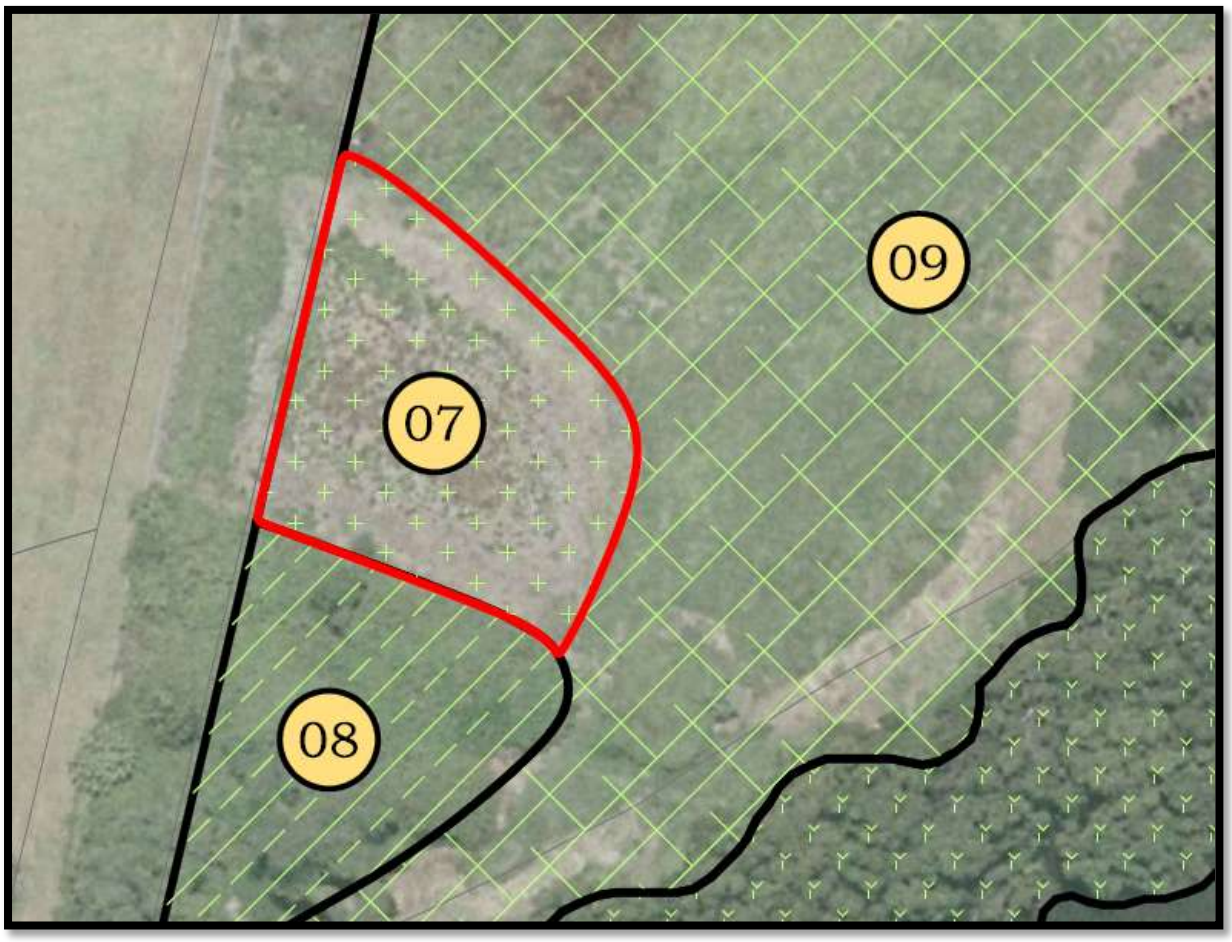
ZONE 6B Freshwater Drainage Channel	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
erosive potential. Management of vegetation in the adjoining Zone 4and 6a may cause changes in the hydraulic regime for the channel. The effects of this are best managed by diverting stormwater into a designated stormwater management structure (see below, and see concept design sheets Appendix C).		$15000-$20000, Construction $60,000-$80,000				
Strategy: Management of fauna habitat (birds, frogs, microbats) A number of uncommon bird species were sighted during recent visits by AW staff. This suggests that, in addition to migratory birds, a number of other important species use the site. The freshwater wetland provides potential habitat for a range of vulnerable species, including frogs and microbats, which may be in the area. Historic fauna survey data is available and has been supplemented by informal observations recorded in an ad hoc	medium – high	**Undertake Spring and Summer surveys.**	$6000	NA	PCC	Capital (or could be done internally)

ZONE 6B Freshwater Drainage Channel	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
manner. Since the last survey considerable restoration works have been conducted on the reserve, improving the quality of the habitat on offer. To gain a full appreciation of the value of the site as fauna habitat we recommend that a full fauna survey is conducted in the area.						
Strategy: Monitor progress of rehabilitation program Establish a series of permanent monitoring points (photo-points and transects and/or quadrats).	high	**Monitor every 6 months** for duration of the project.	In kind	In kind	NRO	operational
Strategy: Community support and involvement Support and encourage the activities of the local bushcare group. Provide education on the role that residents can play in maintaining these environmental	high	**Throughout the project**	In kind	In kind	Bushcare officer	operational

ZONE 6B Freshwater Drainage Channel	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
treasures, including management of domestic animals, garden escape plants, garden refuse, littering and fire.						

5.2.8 Zone 7 (Terrestrial Planted Mound)

Figure 41 Zone 7



Zone area: 440m2

Description of zone

This area contains the overburden cut from the saltmarsh reclamation zone. This cut is the imported fill used historically to raise the level of the tidal areas of the site and prevent incursion of saline water. SESL (2007) concluded that the imported fill was not contaminated and was probably of local origin. Native plants growing on this mound do not include a diverse array of species. The mound was planted in a spiral pattern in 2007 and key species used were Dianella, Kangaroo Grass and Plume Grass which has been a favoured food source of the rabbits (The Dichelachne has since been destroyed through foraging by rabbits).

Figure 42 The planted mound at left has a dense cover of Dianella and Kangaroo grass

Assessment of vegetation and habitat value

It is unlikely that minimally impacted native vegetation could be established on this part of the site given the origins and nature of the soils. By establishing and maintaining native plant species in this zone, the potential for introduction of native plant propagules to other parts of the site is increased, and the opportunity for weeds decreased.

Together the Dianella and Kangaroo Grass provide a dense vegetation cover for the mound, stabilizing soils and reducing exposure to weeds. The dense groundcover provides good basking and foraging habitat for reptiles, and good refuge and foraging habitat for transient/migratory birds.

Table 13 Action Table: Zone 7

ZONE 7 Terrestrial Planting "Mound"	PRIORITY	DETAILS	INITIAL CAPITAL COST	ONGOING COST	RESPONSIBILITY	WORKS TYPE
Strategy: Weed removal of herbs and grasses Removal of exotic herbs and grasses in this area aims to enhance existing native vegetation and create additional space for planting. Hand pull or crown herbs and grasses where appropriate. Alternative treatment methods include spot spraying, although this is best used in areas where weeds are in patches or clumps, rather than scattered throughout the area. Areas where weeds are hand removed can be planted immediately. Plant areas after weed dieback, and mulch or use weed suppression mats. Use of plant guards will improve establishment success. Extension of the planted area into adjacent areas should commence within several years, and this will become the primary goal from	medium	**Year 1:** Hand weed or spot spray and plant **Year 2:** Hand weed and supplementary planting **Year 3:** Follow-up weeding and extend planting to adjoining areas (eg. Zone 12a) **Year 4:** Follow-up weeding and continue consolidation planting. **Year 5:** Final stages of consolidation, ongoing maintenance weeding	$3/m^2 Primary treatment $660	$2/m^2 Secondary treatment $440	NRO	Capital and operational. Possibility for volunteer input.

Table 13 Action Table: Zone 7

ZONE 7 Terrestrial Planting "Mound"	PRIORITY	DETAILS	INITIAL CAPITAL COST	ONGOING COST	RESPONSIBILITY	WORKS TYPE
this stage. (see Appendix F for detailed weed control notes)						
Strategy: Revegetation This zone forms a protective cover for the spoil excavated during construction of the saltmarsh extension area. Goals for this zone include management of vegetation to retain sight lines in residential premises, increasing the diversity of native plants in the area, increasing the complexity of vegetation community, stabilisation of soil surface to prevent erosion. Surface treatment following planting should include supplementary mulching.	medium	**Year 1:** Prepare soil and plant groundcover species and shrubs. Maintain plantings. **Year 2:** Maintain plantings, replant where necessary, prepare soil and plant grasses and herbs. **Year 3:** Maintain plantings, plant supplementary species **Year 4:** Maintain plantings, replant where necessary, and plant supplementary species **Year 5:** Maintain plantings	Plants $1400 Mulch $570		NRO	Capital and operational. Possibility for volunteer input.

Table 13 Action Table: Zone 7

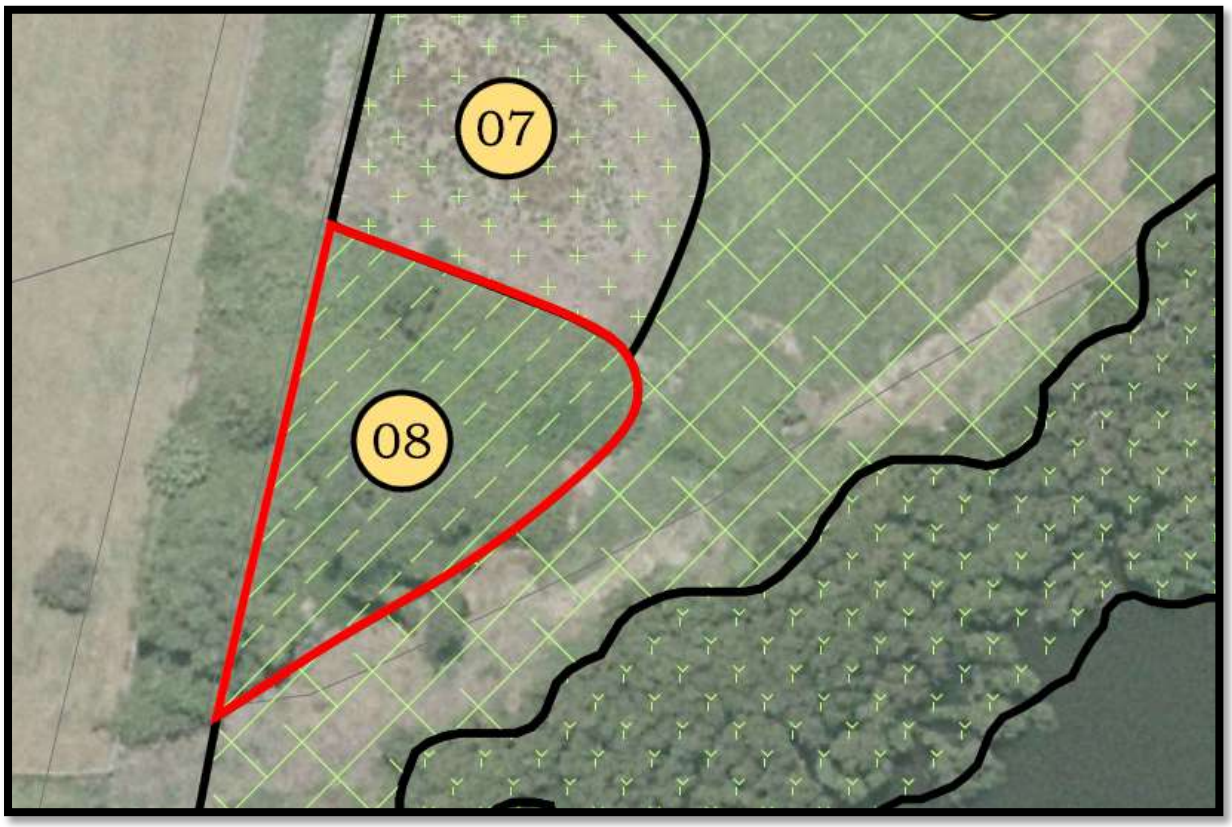
ZONE 7 Terrestrial Planting "Mound"	PRIORITY	DETAILS	INITIAL CAPITAL COST	ONGOING COST	RESPONSIBILITY	WORKS TYPE
(see Appendix F for detailed planting notes)						
Strategy: Erosion control Given the general topography of the area, the likelihood of severe erosion is minimal; however, there is some potential for movement of soil from the mound to the surrounding area. This mound is formed from spoil from the saltmarsh construction area. These soils have been described as silty clay loam, and were originally used as fill for the whole site. They have been excavated and mounded on site, and the mound planted and mulched. A reasonable vegetation cover has become established in the area, and care must be taken to maintain this cover during weed control activities.	low	Monitor at regular intervals and after severe storms. If signs of erosion are detected, remedial action may be required. This may include jute matting, brush matting, coir log installation, or mulching.	N/A			
Strategy: Community support and involvement	high	**Throughout the project**	In kind	In kind	Education officer	Operational

Table 13 Action Table: Zone 7

ZONE 7 Terrestrial Planting "Mound"	PRIORITY	DETAILS	INITIAL CAPITAL COST	ONGOING COST	RESPONSIBILITY	WORKS TYPE
Support and encourage the activities of the local bushcare group. Provide education on the role that residents can play in maintaining the reserve, including management of domestic animals, garden escape plants, garden refuse, littering and fire.						

5.2.9 ZONE 8 (HIGH DENSITY WEED AREA ON SOUTHWESTERN BOUNDARY)

Figure 43 Zone 8



Zone area: 417m2

Description of zone

This zone includes most of the southwestern corner of the site, and comprises a range of woody, herbaceous and climbing weed species. A number of these weed species have been identified as highly invasive (Appendix A). There were no native plants recorded in the area. The land is gently sloping with drainage mainly directly to Parramatta River. Some runoff potentially passes through this part of the site from the adjoining land.

Assessment of vegetation and habitat value

The absence of native species in the zone is indicative of the value of the vegetation. It has no potential as part of a process of native plant rehabilitation for the reserve. The only potential value for the vegetation in this zone is as habitat.

Despite the absence of native plant species, the existing vegetation provides a range of nesting, foraging and perching habitats. Many of the canopy species are older, and provide good feeding and roosting habitat for birds, and the dense canopy foliage provides ideal nesting habitat for birds that nest in the crown of the tree. A number of these trees (eg. Camphor Laurel, Small Leaved Privet) develop dense crops of small berries, providing an ample food source for a wide range of birds, bats, possums and insects. The dense understorey forms ideal refuge habitat for smaller birds and reptiles, and provides a range of food resources for these animals and a diverse array of invertebrates which, in turn, become a food resource for other animals in the local food chain. Saltmarsh has been identified as of value particularly for the high diversity of invertebrate species it supports. The availability of good refuge habitat adjacent to existing saltmarsh areas on the site gives this area additional habitat value. This should be considered in the development of a staged removal process.

Threatening processes

Main threats for this area are minimal; instead it constitutes a potential source of propagules for a number of highly invasive weed species. This forms a threatening process for the other zones in the wetland reserve. However, the saline waters in this part of the estuary prevent the successful establishment of most of these weed propagules along the river bank.

Table 14 Action Table: Zone 8

ZONE 8 High density weed SW boundary	PRIORITY	DETAILS	INITIAL COST	ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
Strategy: Weed removal of woody weeds and climbers Management aims for this zone are to remove a large source of weed seeds and replace with effective native that provides stability on the slope and good habitat for a range of faunal groups. Cut and paint medium sized woody weeds and Balloon Vine, hand pull Madeira Vine taking care to collect all vegetative propagules, cut and paint or spray Lantana. Some species will require stem injection for effective treatment (eg. larger plants of Small and Large Leaved Privet, Camphor Laurel). Pile vegetative material on site to provide habitat for lizards, invertebrates and small birds. Take care to ensure that all weed propagules have been removed. (See Appendix F for further information on woody weed treatment)	high	**Year 1:**. Begin treatment of vines, especially Madeira Vine. Stem inject larger trees. **Year 2:** Remove lantana and vines, cut and paint remaining woody weeds unless this may destabilise soils. Plant and stabilise with mulch, brush matting or jute matting as appropriate. **Year 3:** Follow up weed removal especially vines. Remove any remaining weeds and vines, treat ground cover weeds. Additional planting to stabilise area. **Year 4:** Follow up weeding. **Year 5:** Maintenance weeding.	$5/m^2$ Primary treatment $2100	$3/m^2$ Secondary treatment $1300	NRO	operational

Table 14 Action Table: Zone 8

ZONE 8 High density weed SW boundary	PRIORITY	DETAILS	INITIAL COST	ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
Strategy: Weed removal of herbs and grasses Spraying should be conducted during autumn and winter when the wildlife is less active, and more likely to have found overwintering shelters. Only use Roundup Biactive® around frog locations, or around waterways. (See Appendix F for further information on spraying and hand removal of herbs and grasses)	medium – high	**Year 3:** Spray, crown or hand pull groundlayer weeds, mulch and plant to stabilise soils. **Year 4:** Follow up weeding. **Year 5:** Maintenance weeding.				
Strategy: Erosion control Consideration needs to be given to management of soils on steep slopes and along creek banks. Weed removal should be staged, and soils may need some further consolidation. Use of logs and rock piles to create habitat for frogs and reptiles can be extended for use as erosion control structures: placement of logs and rock piles should therefore consider potential for erosion on steeper slopes or where there is evidence of prior	high	**Throughout project**	$100 supply and install coir log (2.8m) $1000	0	NRO	Capital

Table 14 Action Table: Zone 8

ZONE 8 High density weed SW boundary	PRIORITY	DETAILS	INITIAL COST	ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
scouring.						
Strategy: Revegetation Immediately following primary weeding this zone will require replanting. An appropriate mix of local native small trees, shrubs and groundlayer species should be used for revegetation works in this area. Goals for this zone include stabilisation of soil surface to prevent erosion, management of vegetation to retain sight lines in residential premises and open woodlands for birds of prey, increasing the diversity of native plants in the area, increasing the complexity of vegetation community. Surface treatment following planting should include mulching. Use of tree guards will reduce grazing impacts from rabbits. (see Appendix F for detailed planting notes)	high	**Year 1:** Prepare soil and plant groundcover species and shrubs. Maintain plantings. **Year 2:** Maintain plantings, replant where necessary, prepare soil and plant grasses and herbs. **Year 3:** Maintain plantings, plant supplementary species **Year 4:** Maintain plantings, replant where necessary, and plant supplementary species **Year 5:** Maintain plantings	Plants $2750 Mulch $1100		NRO	Operational and capital

Table 14 Action Table: Zone 8

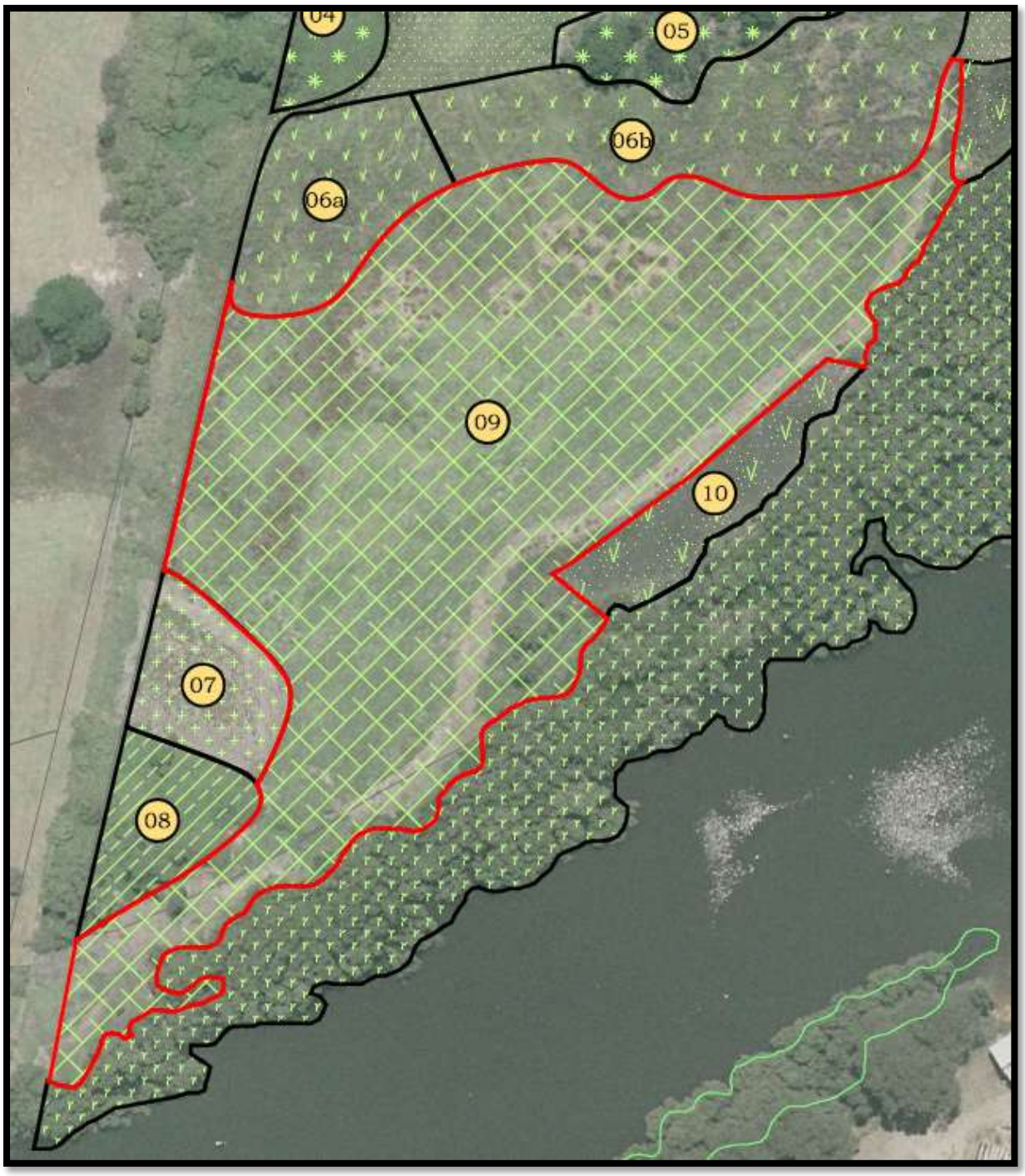
ZONE 8 High density weed SW boundary	PRIORITY	DETAILS	INITIAL COST	ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
Strategy: Management of general fauna habitat A number of uncommon bird species were sighted during recent visits by AW staff. This suggests that, in addition to migratory birds, a number of other important species potentially use the site. The dense weed infestation includes a complex vegetation structure that potentially provides habitat for a range of bird, animal and invertebrate species that may be in the area. These organisms rely on the protection of the dense vegetation, and complete removal of this may adversely impact them. A staged removal, in conjunction with dense planting of replacement species will help to protect them. To gain a full appreciation of the value of the site as fauna habitat we recommend that a full fauna survey is conducted in the area.	medium – high	May require additional funding Full surveys of fauna and flora before and after significant works provide an effective tool for monitoring.	$6000	NA	NRO	Consultancy fees or inhouse operational
Strategy: Monitor progress of rehabilitation program	high	**Monitor every 6 months** for duration of the project.	Low-medium	low	PCC/volunteers	operational

Table 14 Action Table: Zone 8

ZONE 8 High density weed SW boundary	PRIORITY	DETAILS	INITIAL COST	ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
Establish a series of permanent monitoring points (photo-points and transects and/or quadrats).						
Strategy: Community support and involvement Support and encourage the activities of the local bushcare group. Provide education on the role that residents can play in maintaining these environmental treasures, including management of domestic animals, garden escape plants, garden refuse, littering and fire.	high	**Throughout the project**	In kind	In kind	Bushcare officer Education officer	operational

5.2.10 Zone 9 (Ephemeral Freshwater/Saltmarsh Transition Zone)

Figure 44 Zone 9



Zone area: 6539m2

Description of zone

This zone forms much of the open space in the reserve. It is bordered by the freshwater wetland zones in the north and the saltmarsh and mangrove zones in the south. The vegetation ranges from

freshwater tolerant sedges such as *Juncus usitatus* and *Carex* sp, with a range of exotic herbs and grasses to more salt tolerant sedges with a similar mix of weeds. Current management techniques reportedly include very occasional slashing , spraying and hand weeding to encourage the spread of natives and control weeds.

Figure 45 Transitional zone

Assessment of vegetation and habitat value

This area provides an interesting transitional zone between the dedicated freshwater wetland and the estuarine influenced saltmarsh areas. Its current topography means that it is mostly influenced by the freshwater wetland, but during high flow events on the river this area is potentially inundated. The mixture of native and exotic vegetation is such that restoration to wholly native species is possible, but potentially expensive and time consuming. Alternative treatment methods may include regular spot spraying and re-seeding or supplementary planting.

Transitional ephemeral wetlands such as this have a major role as invertebrate habitat. By providing an extensive range of niches, a diverse array of invertebrate species is able to breed and feed in the area. This in turn provides food for a number of significant species, including transient and migratory wetland birds, microbats and frogs. Other birds and reptiles can also utilise the food resources for the area. The mixed sedgeland provides seed for small birds, reptiles and insects, and refuge habitat for reptiles, frogs and small birds.

Threatening processes

The presence of a number of prolific exotic weeds, including onion weed, forms a major threat to the continuing integrity of the existing native vegetation. This area is most likely to be affected by small changes in sea levels associated with climate change, or flooding from more widely fluctuating rainfall patterns. There is also potential for bank erosion associated with increased use of the river for transport, especially as a result of increased demands for the river cat journeys.

Table 15 Action Table: Zone 9

ZONE 9 TRANSITIONAL EPHEMERAL WETLAND ZONE	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
Strategy: Weed control through management of propagules The recommendations for this part of the reserve are to control exotic plants rather than eradicate them. The area constitutes passive open space recreation, and is best managed by keeping the area mown or slashed regularly. This will prevent any of the exotic plants flowering and setting seed, thus preventing the establishment of further propagules for reinfestation of surrounding areas.	medium	**Throughout project:** Mow or slash open space to the edge of the adjoining zones. The “no mow/no whip” limit should be clearly delineated using rocks or logs. These do not need to form a continuous wall but do need to provide a clear alignment for machinery. Convict hewn sandstone blocks would be ideal for this purpose, and are reportedly available.		$15200 pa	Parks	operational
Strategy: Management of open space recreation The main purpose of the reserve is to conserve the saltwater/transitional/ freshwater wetlands and supporting ecosystems and to provide for passive recreation (eg. for birdwatching, walking). Passive recreation	high	**Throughout project:** Mow/slash/whip at regular intervals, eg. During spring and summer mow at least monthly, and during autumn and winter mow bi-monthly to control development of weed	N/A	$4500	Parks	operational

Table 15 Action Table: Zone 9

ZONE 9 TRANSITIONAL EPHEMERAL WETLAND ZONE	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
activities should be cited in areas that are not likely to cause any adverse impact on local wildlife. Access for the purposes of maintenance (ie. bushcare, bush regeneration, planting, etc) should be timed for periods that are least likely to disturb birds or animals.		propagules. Monitor and mow more often to prevent development of seed.				
Strategy: Staged removal of Onion Weed (*Nothoscordum borbonicum)* Onion weed dominates the vegetation in this area, and reproduces primarily by producing numerous bulblets in association with its main underground bulb. These bulblets become separated from the mother plant when the soil is disturbed, and rapidly grow to produce new plants. It is also a prolific seeder and can spread rapidly by seed as well. Removal of flowers before seed is set can reduce the rate of spread. The plant does not respond favourably to spraying, and	medium	Timing for the staged removal by excavation should be in conjunction with creation of saltmarsh extension areas (see below)	Additional costs to saltmarsh reclamation will include treating excavated spoil so it can be reused on site. This could include stockpiling away from wetland areas and spraying, or composting under black plastic to sterilize bulblets.		PCC	operational

Table 15 Action Table: Zone 9

ZONE 9 TRANSITIONAL EPHEMERAL WETLAND ZONE	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
potentially successful herbicide sprays are not suitable for use around wetlands due to their extreme toxicity. Staged excavation of topsoil in areas with high density infestations can be used to control this weed, and may be conducted in conjunction with the formation of saltmarsh extension.						
Strategy: Potential for creation of saltmarsh This zone is immediately adjacent to the area excavated for the creation of saltmarsh. The technique used in the adjoining zone has been very successful, and could be utilised in parts of this zone as well. Excavation of imported fill to the original level (or an adjusted level that compensates for compression) of the underlying peat soils creates suitable conditions for passive establishment of saltmarsh species. The existing saltmarsh areas provide a good source of plant propagules for a number of species, resulting in a saltmarsh that is quite diverse.	medium	May require additional funding; and careful management of levels to ensure an appropriate hydrological regime is created.	$15000	NA	NRO	Capital

Table 15 Action Table: Zone 9

ZONE 9 TRANSITIONAL EPHEMERAL WETLAND ZONE	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
This attracts many species of insects, which in turn feeds many species of birds, reptiles, frogs, microbats, and is potential food for fish and other organisms in the nearby river.						
Strategy: Management of general fauna habitat A number of uncommon bird species were sighted during recent visits by AW staff. This suggests that, in addition to migratory birds, a number of other important species potentially use the site. This area consists of a mixture of sedges and weed grasses and herbs. As ephemeral marsh it provides habitat for a range of invertebrate species, which in turn feeds a range of birds, frogs and microbats. To gain a full appreciation of the value of the site as fauna habitat we recommend that a full fauna survey is conducted in the area.	medium – high	May require additional funding Full surveys of fauna and flora before and after significant works provide an effective tool for monitoring.	$6000	NA	NRO	Study-External consultancy or could be done in house
Strategy: Feral animal control (eg. Rabbits)	high	No warrens were observed on	Main costs will be		NRO	Operational

Table 15 Action Table: Zone 9

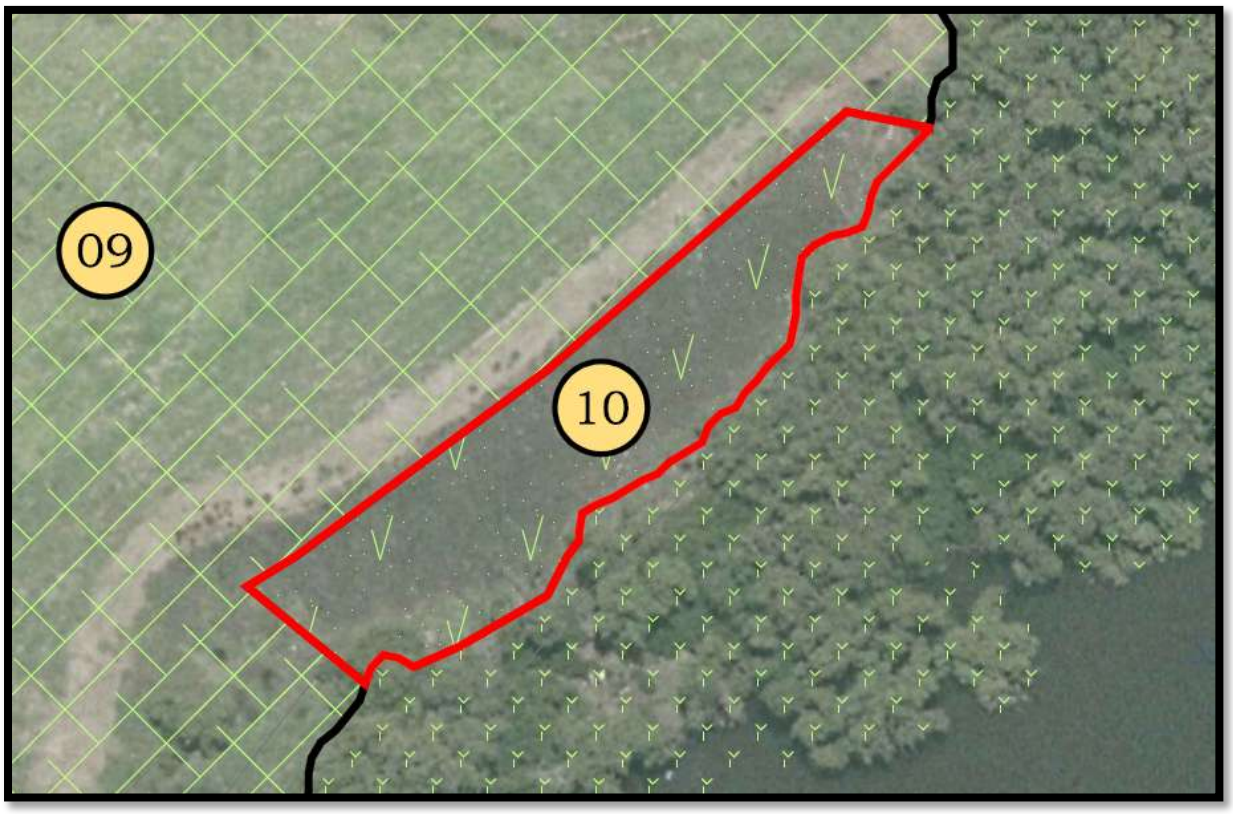
ZONE 9 TRANSITIONAL EPHEMERAL WETLAND ZONE	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
For a rabbit control programme to be successful, an integrated approach is vital. Shooting, baiting or fumigating without follow-up warren or harbour destruction will leave ready-made homes for young migrating rabbits from surrounding areas. The aim of any rabbit control programme should be to achieve local eradication and to prevent re-infiltration. Group programmes achieve the best results and lowest long-term costs as rabbits are removed from a wider area. Options for integrated control of rabbits include: • fumigation of warrens • fencing • destruction of warren systems • removal of rabbit harbour Ripping warrens and destroying harbour assist in long term rabbit control by making it difficult for rabbits to find readymade shelter. A reputable feral animal control contractor should be engaged to complete this work.		site, however dense weedy areas are providing rabbit refugia. Removal of weeds are dealt with throughout the action tables. Liaison with adjoining landholders is critical to the success of an eradication program. Community education regarding the dumping of domestic rabbits should also be integrated into community education programs.	associated with formulating and then implementing an intergrated programme with adjacent landholders			

Table 15 Action Table: Zone 9

ZONE 9 TRANSITIONAL EPHEMERAL WETLAND ZONE	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
Strategy: Monitor progress of rehabilitation program Establish a series of permanent monitoring points (photo-points and transects and/or quadrats).	high	**Monitor every 6 months** for duration of the project.	In kind	In kind	NRO	operational
Strategy: Community support and involvement Provide education on the role that landholders can play in effective management of feral animals and plants, helping to protect the environmental values of the reserve.	high	**Throughout the project**	In kind	In kind	Education officer Bushcare officer	operational

5.2.11 Zone 10 (Reconstructed Saltmarsh Zone)

Figure 46 Zone 10



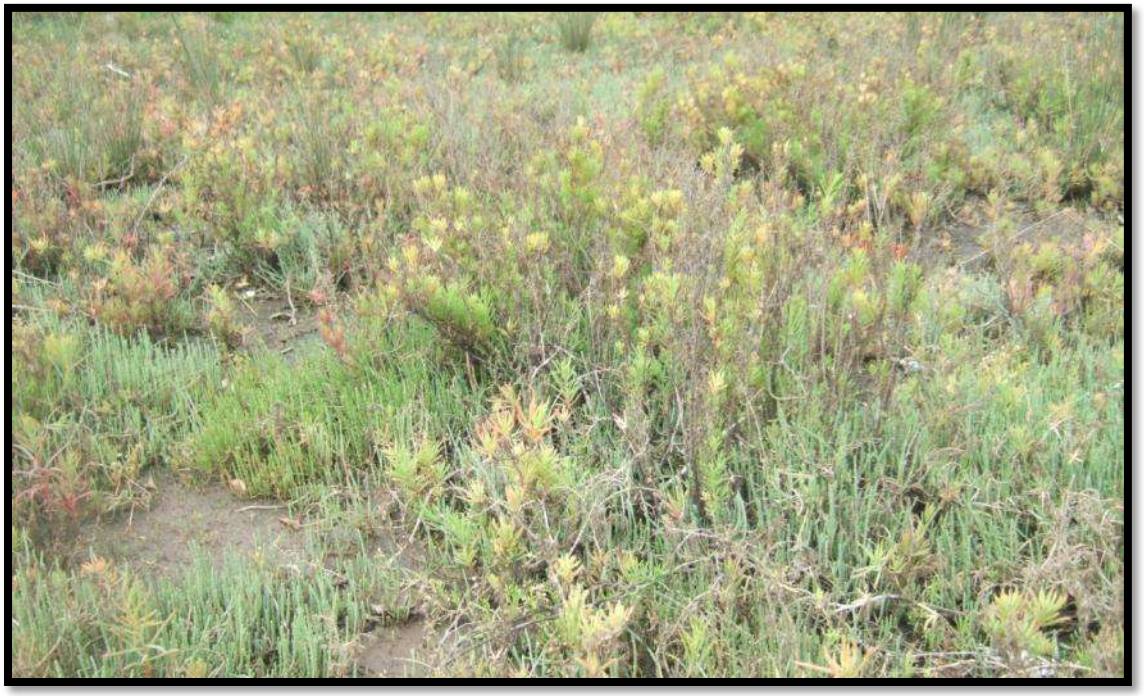
Zone area: 467m2

Description of zone

A smaller area of the transitional ephemeral wetland has been modified to create (or recreate) saltmarsh. The level of the bank has been lowered so that it is inundated at high tide, with several centimeters of water. This level of inundation is fairly short-lived, thereby creating conditions that are ideal for the development of saltmarsh. The earthworks were completed around 2 years ago, with some planting of saltmarsh species undertaken as part of the project but the majority of saltmarsh species have been allowed to re-introduce at their own pace. In the short period of time since, a diverse range of saltmarsh species have become established (Appendix A).

Figure 47 Recreation of saltmarsh has been very successful

Figure 48 Natural recruitment has resulted in a healthy cover of typical saltmarsh species in this zone



Assessment of vegetation and habitat value

The vegetation in this zone is typical of good quality saltmarsh (Table 21), and is indicative of the level of plant propagules available in the area. Dominant species include several succulents, *Sarcocornia quinqueflora* and *Suaeda australis*. While saltmarsh vegetation tends to be less diverse than other vegetation types, this is offset by the highly diverse invertebrate fauna. This provides food for numerous birds and microbats, as well as an extension to the normal habitat for a number of aquatic or semi-aquatic species including fish, frogs and larger invertebrates.

Threatening processes

The potential for saltmarsh habitat is defined by the frequency, duration and depth of inundation associated with tidal movement in the rest of the estuary. Changes to this as a result of sea level rise, or changes in aspects of the river's hydrology (such as flooding, change in salinity associated with storm flows) have the potential to detrimentally affect the health and extent of the saltmarsh. This area is particularly susceptible to the adverse effects of wave action generated by the river cat. As well, mangrove invasion of existing or potential saltmarsh habitat has been identified as a key threatening process.

Table 16 Action Table: Zone 10

ZONE 10 CONSTRUCTED SALTMARSH	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
Strategy: Weed management strategies Common weed plants in Sydney estuarine saltmarsh include Buffalo Grass (*Stenotaphrum secundatum*), Asparagus fern (*Asparagus asparagoides*), Kikuyu (*Pennisetum clandestinum*), Alligator Weed (*Alternanthera philoxeroides*), Saltbush (*Atriplex hastata*). Best practice management techniques for each species should be determined, and care taken to prevent the establishment of any potential weed problem. Identify and seek approvals to selectively cull mangroves encroaching on saltmarsh	medium	**Throughout the project**	N/A	$6080 pa	PCC I&I NSW	
Strategy: Hydrological management Although climate change impacts are not easily predicted, it is likely that wetlands will be affected through a number of processes, including sea level rise, increased sea temperatures, changes in hydrology, and	high	Monitoring on a regular basis, especially after king high tides or major storm events in the catchment. May require additional funding	$15000	medium	PCC DECCW SMCMA	Monitoring estuary-wide

Table 16 Action Table: Zone 10

ZONE 10 CONSTRUCTED SALTMARSH	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
increases in the frequency and intensity of extreme events such as storms, droughts and floods. An important adaptation strategy is to prevent the fragmentation of existing wetland systems and buffer zones that allow for landward vertical migration of wetlands if sea level rise exceeds the rate of vertical sediment accretion. A small shift in sea level could result in a significant change in the distribution of saltmarsh. As well, waves force water onto the bank, and elsewhere have been responsible for major erosion problems. This can exacerbate the effects of sea level rise for saltmarsh as a small variation in water level can alter the suitability of potential or actual habitat. Too low and it becomes regularly inundated, shifting the balance toward establishment of mangroves. Too high and the saltmarsh may suffer from drought impacts and terrestrial plant encroachment. A gently sloping bed for the saltmarsh can provide						

Table 16 Action Table: Zone 10

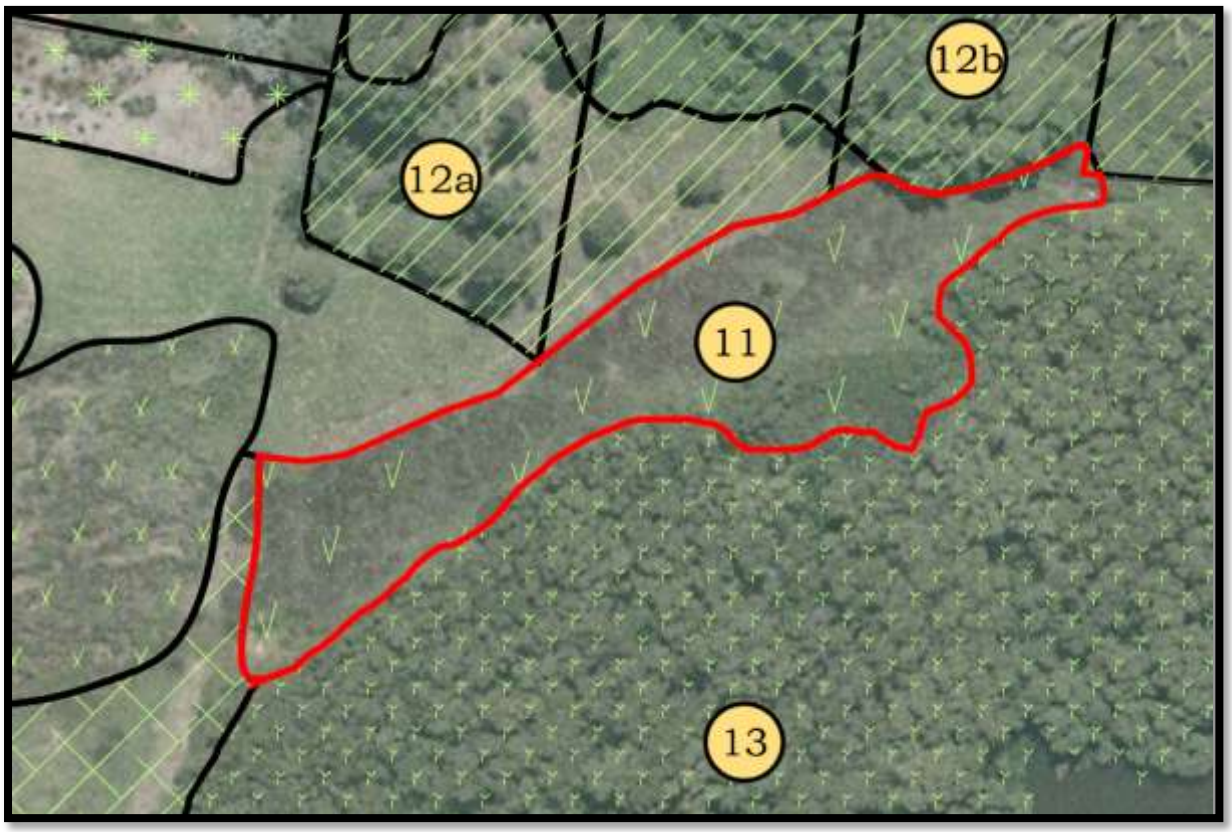
ZONE 10 CONSTRUCTED SALTMARSH	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
small variations in levels that will accommodate changes in sea levels over a period of time. Consideration should be given to consolidation of saltmarsh areas at the reserve through construction of an extension area that joins the sedge saltmarsh in Zone 11 with the previously constructed saltmarsh in Zone 10.						
Strategy: Erosion control The actions of waves associated with the rivercat have the potential to cause major erosion impacts in the new saltmarsh area. Construction of a low berm along the river side of the saltmarsh aims to protect the establishing seedlings from wave action. The berm should be constructed to remove energy from the wave action but also be low enough to allow fish passage. Alternatives include a runnel for fish passage and to dewater the saltmarsh , or creation of a permeable barrier.	medium	Monitor regularly, especially after king high tides and after heavy rainfall If erosion becomes a problem, consult a suitably qualified professional	Low-medium ~$1000	N/A	NRO	Consultation and operational

Table 16 Action Table: Zone 10

ZONE 10 CONSTRUCTED SALTMARSH	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
Strategy: Monitor progress of rehabilitation program Establish a series of permanent monitoring points (photo-points and transects and/or quadrats).	high	**Monitor every 6 months** for duration of the project.	Low-medium $500	Low $200	NRO	operational
Strategy: Community support and involvement Support and encourage the activities of the local bushcare group. Provide education on the role that residents can play in maintaining this EEC, including management of domestic animals, garden escape plants, garden refuse, littering and fire.	high	**Throughout the project**	In kind	In kind	Bushcare officer Education officer	operational

5.2.12 Zone 11 (Established Sedge Saltmarsh)

Figure 49 Zone 11



Zone area: 851m2

Description of zone

Towards the northern end of the mangroves is an area of well established saltmarsh dominated by *Juncus kraussii*. It forms the buffer between the freshwater wetland channel and the mangroves along the river's edge. *Juncus kraussii* is tolerant of a range of salinities, as well as *Samolus repens* and many of the other plants in this area.

Assessment of vegetation and habitat value

The vegetation in this saltmarsh section differs from that in Zone 10. It is dominated by *J. kraussii* and *Samolus repens*, whereas the saltmarsh plants in Zone 10 are mainly succulents. The result in this area has a dense understorey cover of sedges, with occasional patches of other saltmarsh plants interspersed. The ground level is slightly higher, so that the area is inundated less frequently, which has resulted in the different mix of plant species present.

The dense cover provided by the sedges gives good refuge habitat to a number of small birds and reptiles, as well as numerous invertebrate species. These invertebrates provide a food resource for frogs and microbats, as well as reptiles and birds. The thick bed of sedges provides a number of hydraulic benefits as well. The erosive potential of waves acting on the bank is reduced by the

sedges, which provide a physical buffer that slows the wave and reduces its potential energy. The sedges also provide almost complete foliage cover, reducing the amount of soil surface exposed to potential erosive impacts.

Figure 50 *Juncus kraussii* dominates this zone

Threatening processes

Key threatening processes for this saltmarsh include changes to the frequency, duration and depth of tidal inundation. Changes to this as a result of sea level rise, or changes in aspects of the river's hydrology (flooding, dilution, pollution) have the potential to detrimentally affect the health and extent of the saltmarsh. Additional impacts may occur from the freshwater wetland channel that discharges through the saltmarsh. Increases in discharge volume and rates, and changes to the water quality can have an adverse affect on saltmarsh vegetation.

Table 17 Action Table: Zone 11

ZONE 11 SALTMARSH SEDGELAND	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
Strategy: Weed management strategies Common weed plants in Sydney estuarine saltmarsh include Buffalo Grass (*Stenotaphrum secundatum*), Asparagus fern (*Asparagus asparagoides*), Kikuyu (*Pennisetum clandestinum*), Alligator Weed (*Alternanthera philoxeroides*), Saltbush (*Atriplex hastata*). Many common terrestrial weeds are adversely affected by high salt levels, and are eliminated from saltmarsh areas. Best practice management techniques for each species should be determined, and care taken to prevent the establishment of any potential weed problem. Identify and seek approvals to selectively cull mangroves encroaching on saltmarsh	medium	**Throughout the project**	N/A	$1000	PCC I&I NSW	Operational
Strategy: Hydrological management An important adaptation strategy is preventing the fragmentation of existing wetland systems	high	Monitoring on a regular basis, especially after king high tides or major storm events in the	medium	Medium $600pa	PCC DECCW	Monitoring estuary-wide

Table 17 Action Table: Zone 11

ZONE 11 SALTMARSH SEDGELAND	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
and buffer zones that allow for landward vertical migration of wetlands if sea level rise exceeds the rate of vertical sediment accretion. This is very important in this part of the reserve as the area is part of the freshwater/saline transitional wetland system. A small shift in sea level could result in a significant change in the distribution of saltmarsh to freshwater wetland. As well, waves force water onto the bank, and elsewhere have been responsible for major erosion problems. This can exacerbate the effects of sea level rise for saltmarsh as a small variation in water level can alter the suitability of potential or actual habitat. Too low and it becomes regularly inundated, shifting the balance toward establishment of mangroves. Too high and the saltmarsh may suffer from drought impacts and terrestrial plant encroachment. A gently sloping bed for the saltmarsh can provide small variations in levels		catchment. May require additional funding			SMCMA	

Table 17 Action Table: Zone 11

ZONE 11 SALTMARSH SEDGELAND	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
that will accommodate changes in sea levels over a period of time. Consideration should be given to consolidation of saltmarsh areas at the reserve through construction of an extension area that joins the sedge saltmarsh in Zone 11 with the previously constructed saltmarsh in Zone 10.						
Strategy: Erosion control This area currently has the potential for erosion from the freshwater drainage channels and the wave impacts from the river. Effective hydraulic management of the freshwater channels is important. Construction of a low berm along the river side of the saltmarsh may be required to protect the saltmarsh from wave action.	medium	Monitor regularly, especially after king high tides and after heavy rainfall If erosion becomes a problem, consult a suitably qualified professional	Low-medium (See table 16)	N/A	nro	Consultation and operational
Strategy: Management of migratory bird habitat AW staff sighted two Lathams Snipes leaving	very high	**Throughout the project lifetime**	Low-medium	Low	NRO	operational

Table 17 Action Table: Zone 11

ZONE 11 SALTMARSH SEDGELAND	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
the adjoining wetland area. The site is unlikely to support populations for an extended period, but is nearby to important migratory waders' summer habitat. This reserve has a vitally important role for the maintenance of this and similar species. Activities that affect the integrity of the wetland need to be timed for winter when the birds are not likely to use it, and should allow a sufficient lag time for plants to establish before the next annual migration. Maintenance of wetland areas and management of disturbing impacts such as people, bikes, dogs etc are vital actions in preserving the habitat function of the reserve.						
Strategy: Management of general fauna habitat A number of uncommon bird species were sighted during recent visits by AW staff. This suggests that, in addition to migratory birds, a	medium – high	May require additional funding Full surveys of fauna and flora before and after significant works provide an effective	$6000	na		

Table 17 Action Table: Zone 11

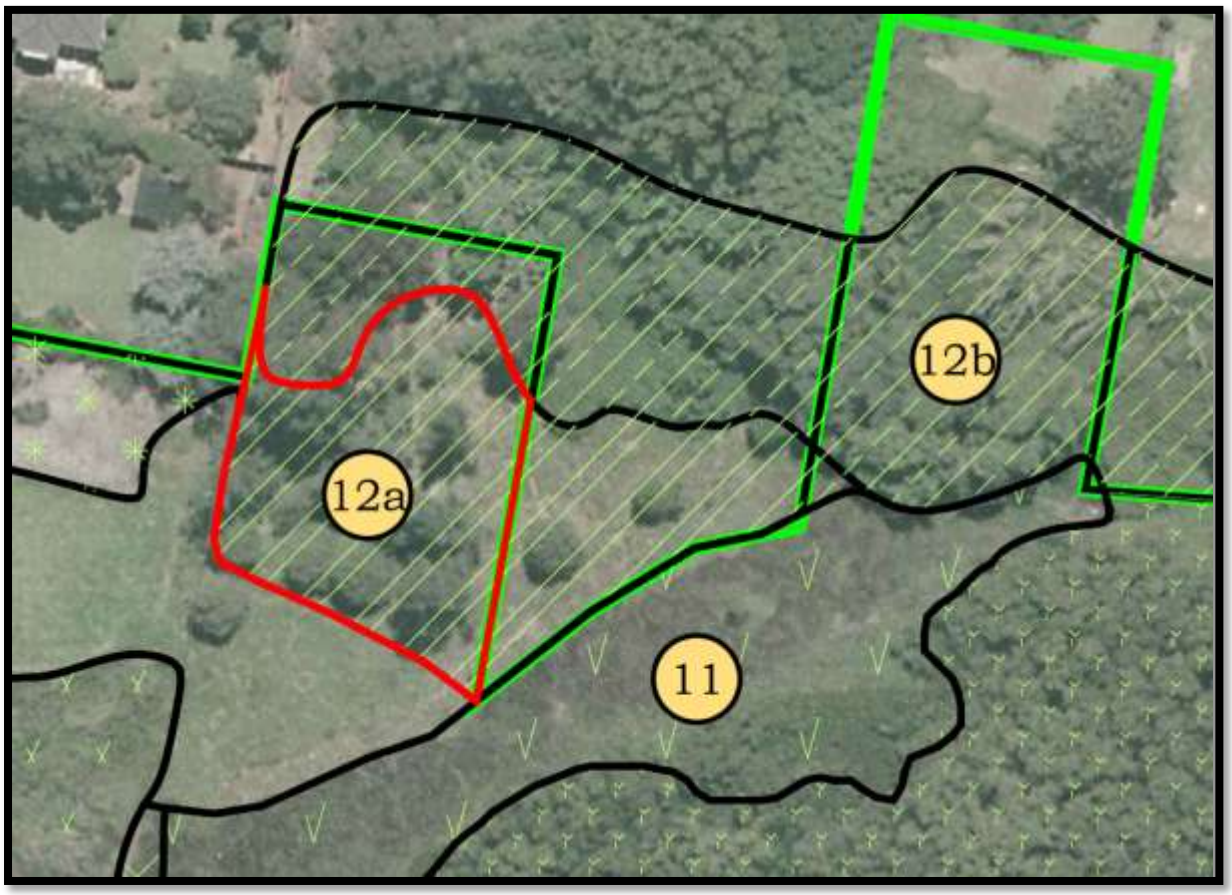
ZONE 11 SALTMARSH SEDGELAND	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
number of other important species potentially use the site. This area consists of a mixture of sedges and weed grasses and herbs. As ephemeral marsh it provides habitat for a range of invertebrate species, which in turn feeds a range of birds, frogs and microbats. To gain a full appreciation of the value of the site as fauna habitat we recommend that a full fauna survey is conducted in the area.		tool for monitoring.				
Strategy: Monitor progress of rehabilitation program Establish a series of permanent monitoring points (photo-points and transects and/or quadrats).	high	**Monitor every 6 months** for duration of the project.	In kind	In kind	NRO	operational
Strategy: Community support and involvement Support and encourage the activities of the local bushcare group.	high	**Throughout the project**	In kind	In kind	Bushcare officer Education Officer	operational

Table 17 Action Table: Zone 11

ZONE 11 SALTMARSH SEDGELAND	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
Provide education on the role that residents can play in maintaining this EEC, including management of domestic animals, garden escape plants, garden refuse, littering and fire.						
Seed collection	Low-med	Collect seed for NSW Seedbank. Develop collection program in collaboration with DECCW and Botanic Gardens Trust	low	low	DECCW	Operational(could be undertaken by volunteers once program established)

5.2.13 Zone 12a (Bush Regeneration In Terrestrial Weed Zone)

Figure 51 Zone 12A



Zone area: 414m2

Description of zone

There is a small area of terrestrial vegetation adjoining the northern end of the saltmarsh in Zone 11 which consists of an area that has previously been significantly weed infested. The western boundary of the zone is formed by the shallow drainage channel from the residential area immediately above this part of the reserve. This formalized channel drains into the main drainage channel, but only actually flows intermittently. There was little observable or apparent base flow but the current bed configuration retains some water, and some macrophytes; however, most of the vegetation in the channel is exotic.

A large part of this has had many of the woody weeds removed and replaced with a mixture of eucalypts, casuarinas and callistemons (Table 23). Some of these are now fairly mature; in other parts of the zone there is ongoing bush regenerations works being completed by contractors. Woody weeds have been removed and the remaining understorey has a mixture of native and exotic grasses and herbs.

Figure 52 Trees planted by adjacent landholders (pers comm Neil McGrath) are reaching maturity

Figure 53 Drainage line with outlet in foreground and established plantings to right

Assessment of vegetation and habitat value

The planted canopy trees and shrubs are 5-8 years old and are beginning to achieve a dense canopy cover that provides good foraging and refuge habitat for birds and insects. Smaller birds are able to nest in this canopy as well. The shrubs are mature and provide a good annual crop of food for birds, small marsupials, reptiles and insects. Mature remnant eucalypts are reaching an age where they may begin to develop hollows in the near future.

Threatening processes

Much of the adjoining area (Zone 12b) is densely weedy, providing a ready source of weed propagules. Some of the area is located on sloping ground, and over-clearing may result in active erosion. Much of the groundlayer vegetation is exotic, and treatment of this should consider the potential for erosion. The adjoining Zone 3 also provides a ready source of weed propagules for grass and herb species.

Table 18 Action Table: Zone 12A

ZONE 12A: BUSH REGENERATION AREA & SECONDARY DRAINAGE CHANNEL	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
Strategy: Weed removal of woody weeds and climbers Management aims for this zone are to remove a large source of weed seeds and replace with effective native that provides stability on the slope and good habitat for a range of faunal groups. Cut and paint medium sized woody weeds and Balloon Vine, hand pull Madeira Vine taking care to collect all vegetative propagules, cut and paint or spray Lantana. Some species will require stem injection for effective treatment (eg. larger plants of Small and Large Leaved Privet, Camphor Laurel). Pile vegetative material on site to provide habitat for lizards, invertebrates and small birds. Take care to ensure that all weed	high	**Year 1:** Treat Arundo grass at top of slope; plant and jute mat or mulch to stabilise soils. Begin treatment of vines, especially Madeira Vine. Stem inject larger trees. **Year 2:** Remove lantana and vines from lower slope, cut and paint remaining woody weeds unless this may destabilise soils on the slope. Plant and stabilise with mulch, brush matting or jute matting as appropriate. **Year 3:** Follow up weed removal especially vines. Remove any remaining weeds and vines, treat ground cover weeds. Additional planting to stabilise	$3/m2 Primary treatment $650	$2/m2 Secondary treatment $420	NRO	operational

ZONE 12A: BUSH REGENERATION AREA & SECONDARY DRAINAGE CHANNEL	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
propagules have been removed. (See Appendix F for further information on woody weed treatment)		area. **Year 4:** Follow up weeding. **Year 5:** Maintenance weeding.				
Strategy: Weed removal of herbs and grasses Spraying should be conducted during autumn and winter when the wildlife is less active, and more likely to have found overwintering shelters. Only use Roundup Biactive® around possible frog locations, or around waterways. (See Appendix F for further information on spraying and hand removal of herbs and grasses)	medium – high	**Year 1:** Hand weed or spot spray and plant **Year 2:** Hand weed and supplementary planting **Year 3:** Follow-up weeding and extend planting to adjoining areas **Year 4:** Follow-up weeding and continue consolidation planting. **Year 5:** Final stages of consolidation, ongoing maintenance weeding	$3/m2 Primary treatment $1200	$2/m2 Secondary treatment $800	NRO	Operational

ZONE 12A: BUSH REGENERATION AREA & SECONDARY DRAINAGE CHANNEL	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
Strategy: Revegetation This zone forms the interface between the reserve and the adjoining residential areas. Goals for this zone include stabilisation of soil surface to prevent erosion, management of vegetation to retain sight lines in residential premises, increasing the diversity of native plants in the area, increasing the complexity of vegetation community. Surface treatment following planting should include supplementary jute matting and/or installation of coir logs in steeper areas. (see Appendix F for detailed planting notes)	high	**Year 1:** Prepare soil and plant groundcover species and shrubs. Maintain plantings. **Year 2:** Maintain plantings, replant where necessary, prepare soil and plant grasses and herbs. **Year 3:** Maintain plantings, plant supplementary species **Year 4:** Maintain plantings, replant where necessary, and plant supplementary species **Year 5:** Maintain plantings	Supply & install jute matting $3.80/m2 $400 Supply & install plants hiko $ 1.65 $1320 Supply & install organic leaf litter mulch $2.63/ m2 $550	Low Water requirements will be dependant on prevailing weather conditions	PCC	Capital/operational
Strategy : Erosion control In its current configuration this wetland area is	high	Grant funding may be required for this action	See below	low	PCC	Capital /operatio

ZONE 12A: BUSH REGENERATION AREA & SECONDARY DRAINAGE CHANNEL	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
exposed to direct effects from storm event flow surges, which have high erosive potential. Management of vegetation in this zone may cause changes in the hydraulic regime for the adjoining saltmarsh in Zone 11. The effects of this are best managed by diverting stormwater into a designated stormwater management structure (see below, and see design concept drawing set) Localised erosion following weed removal is best managed through replanting, brush matting, and mulching. More serious erosion can be managed with jute matting, coir logs or sandbagging.						nal
Strategy: Management of existing drainage channel A drainage channel with a small residential subcatchment passes through this part of the site. There is virtually no base flow through this channel, and it only carries water during storm events. In its current configuration	high	Additional funding may be required for this action	Supply and install geofab liner $180 Supply and install riprap for scour protection - rocks 250-300 mm $232	low	PCC	Capital/grant

ZONE 12A: BUSH REGENERATION AREA & SECONDARY DRAINAGE CHANNEL	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
damp and wet areas are retained in the channel bed, forming potential habitat for frogs. For this to function effectively as habitat it needs to be kept undisturbed. We recommend that a “no whip/no mow” zone be established so that a buffer 2-3 metres wide is retained around this and other waterways on site. In addition, this channel can be modified to form a wetland swale, providing good quality habitat across a greater area, as well as some treatment of urban runoff before it reaches the saltmarsh, mangroves, and Parramatta River. (See concept design sheets Appendix C)			/m3 $1800 Supply and install coarse gravel $180 /m3 $1370 Backfill gaps with ameliorated soil 11/ m2 $400 Plants for swale/channel $240			
Strategy: Management of stormwater	high	Grant funding may be required	$75000-$100000	$1000	Catchm	

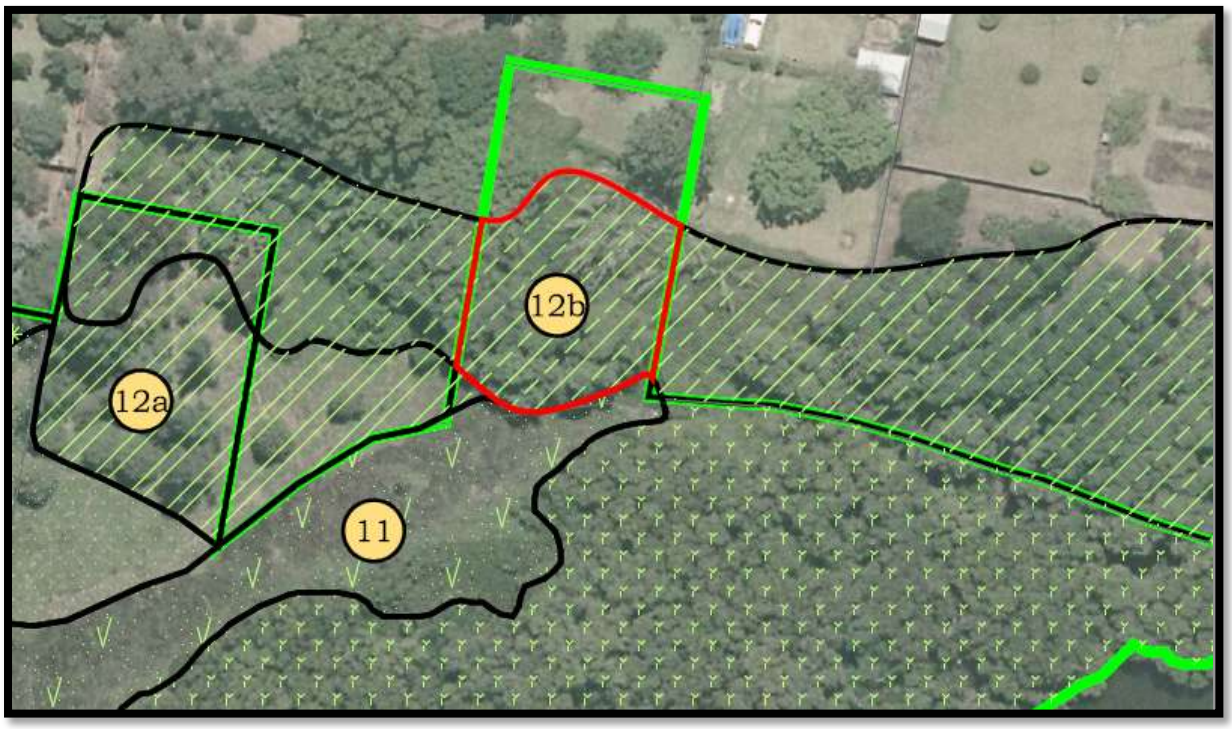
ZONE 12A: BUSH REGENERATION AREA & SECONDARY DRAINAGE CHANNEL	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
Main stormwater impacts, in addition to erosion potential, include high nutrient loadings, toxic compounds including hydrocarbons, and sediment deposition. Each of these has the potential to have a serious degrading impact on the saltmarsh area downstream. We recommend design and construction of a treatment wetland to manage water quality as well as flow regimes through the wetland area. (see concept design sheet Appendix C)		for this action. As a guide only for works at both outlets (this zone and zone 6a) and constructed habitat enhancement wetlands: design for construction $15000-$20000, Construction $60,000-$80,000			ent Management Engineer	
Strategy: Management of general fauna habitat A number of uncommon bird species were sighted during recent visits by AW staff. This suggests that, in addition to migratory birds, a number of other important species potentially use the site. The dense weed infestation includes a complex vegetation structure that potentially provides habitat for a range of bird,	medium – high	May require additional funding Full surveys of fauna and flora before and after significant works provide an effective tool for monitoring.	$6000	NA	PCC	Capital (or could be done internally)

ZONE 12A: BUSH REGENERATION AREA & SECONDARY DRAINAGE CHANNEL	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
animal and invertebrate species that may be in the area. These organisms rely on the protection of the dense vegetation, and complete removal of this may adversely impact them. A staged removal, in conjunction with dense planting of replacement species will help to protect them. To gain a full appreciation of the value of the site as fauna habitat we recommend that a full fauna survey is conducted in the area.						
Strategy: Monitor progress of rehabilitation program Establish a series of permanent monitoring points (photo-points and transects and/or quadrats).	high	**Monitor every 6 months** for duration of the project.	In kind	In kind	NRO	operational
Strategy: enhance refugia Install nest/roost boxes for microbats and	medium	Ascertain which species are likely to use the reserve and install appropriately sized nest	Supply and install $100 per box	Low-volunteer monitorin		Operational

ZONE 12A: BUSH REGENERATION AREA & SECONDARY DRAINAGE CHANNEL	PRIORITY	DETAILS	~INITIAL COST	~ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
birds (see section 8 for details of nest boxes)		and roost boxes.		g and inspections		
Strategy: Community support and involvement Support and encourage the activities of the local bushcare group. Provide education on the role that residents can play in maintaining these environmental treasures, including management of domestic animals, garden escape plants, garden refuse, littering and fire.	high	**Throughout the project**	In kind	In kind	Bushcare officer	operational

5.2.14 Zone 12b (Dense Weed Zone On Steep Slope Above Mangroves)

Figure 54 Zone 12B



Zone area: 399m2

Description of zone

Immediately above and adjacent to Zone 12a is a densely weed covered section that has not been weeded. It includes areas of steeply sloping bank above sections of saltmarsh and mangrove. This area in particular is susceptible to the re-infestation from the adjoining residential yards, which are frequently filled with the same weeds as those found in this part of the reserve. Limiting the weeds downstream of the slope has been through lack of salt tolerance in areas that are periodically or frequently inundated.

Figure 55 Very heavy weed infestation on north eastern boundary

Assessment of vegetation and habitat value

Unfortunately, many woody weeds and shrubs provide good foraging, nesting and refuge habitat for a range of native birds, insects and reptiles. In areas like this one, the only effective habitat available is the dense weed infestation. There were no native plants recorded in this zone (Appendix A) and despite this there were a number of native birds sighted.

Threatening processes

The main threatening processes for this area are the high potential for erosion, especially following any removal of woody weeds. Additional impacts include the ongoing re-infestation by weeds from adjoining properties and the availability of weed propagules from this site to other parts of the reserve. Removal of the weed canopy from the lower sections of the slope will increase light penetration to the inner margins of the mangroves, and may facilitate the reestablishment of saltmarsh in this area.

Table 19 Action Table: Zone 12B

ZONE 12B: DENSE WEED ZONE	PRIORITY	DETAILS	INITIAL CAPITAL COST	ONGOING COST	RESPONSIBILITY	WORKS TYPE
Strategy: Weed removal of woody weeds and climbers Management aims for this zone are to remove a large source of weed seeds and replace with effective native that provides stability on the slope and good habitat for a range of faunal groups. Following removal of weeds, it will be necessary to manage the stormwater impacts to prevent erosion and sedimentation in the saltmarsh and mangrove areas nearby. Cut and paint medium sized woody weeds and Balloon Vine, hand pull Madeira Vine taking care to collect all vegetative propagules, cut and paint or spray Lantana. Some species will require stem injection for effective treatment (eg. larger plants of Small and Large Leaved Privet, Camphor Laurel).	high	**Year 1:** Treat Arundo grass at top of slope; plant and jute mat or mulch to stabilise soils. Begin treatment of vines, especially Balloon Vine. Stem inject larger trees. **Year 2:** Remove lantana and vines from lower slope, cut and paint remaining woody weeds unless this may destabilise soils on the slope. Plant and stabilise with mulch, brush matting or jute matting as appropriate. **Year 3:** Follow up weed removal especially vines. Remove any remaining weeds and vines, treat ground cover weeds. Additional planting to	$5/m2 Primary treatment $2000	$3/m2 per treatment Secondary treatment $1200	NRO	Operational

ZONE 12B: DENSE WEED ZONE	PRIORITY	DETAILS	INITIAL CAPITAL COST	ONGOING COST	RESPONSIBILITY	WORKS TYPE
Pile vegetative material on site to provide habitat for lizards, invertebrates and small birds. Take care to ensure that all weed propagules have been removed. (See Appendix F for further information on woody weed treatment)		stabilise area. **Year 4:** Follow up weeding. **Year 5:** Maintenance weeding.				
Strategy: Weed removal of herbs and grasses Hand pull, crown or spray herbs and grasses. Mechanical methods are preferred over spraying, although this is suitable for larger areas or for weeds that are difficult to treat manually. Spraying should be conducted during autumn and winter when wildlife is less active, and more likely to have found overwintering shelters. Only use Roundup Biactive® around possible frog habitat, or around waterways. (See Appendix F for further information on spraying and hand removal of herbs and	medium – high	**Year 3:** Spray, crown or hand pull groundlayer weeds, mulch and plant to stabilise soils. **Year 4:** Follow up weeding. **Year 5:** Maintenance weeding.	Included in Item 1		NRO	Operational
			AND/OR			
			Spray 0.50/m2 $200	Spray 0.50m/2 $200	PCC	operational

ZONE 12B: DENSE WEED ZONE	PRIORITY	DETAILS	INITIAL CAPITAL COST	ONGOING COST	RESPONSIBILITY	WORKS TYPE
grasses)						
Strategy: Erosion control Consideration needs to be given to management of soils on steep slopes and along creek banks. Weed removal should be staged, and soils may need some further consolidation. Use of logs and rock piles to create habitat for frogs and reptiles and can be extended for use as erosion control structures: placement of logs and rock piles should therefore consider potential for erosion on steeper slopes or where there is evidence of prior scouring. Branches from trees that have been cut and painted or stem injected can be used to construct check dams on some sections of the bank. This provides effective erosion control	high	**Throughout project**	Supply and install 2.8m coir log $100 $1000	Low	nro	Capital/operational

ZONE 12B: DENSE WEED ZONE	PRIORITY	DETAILS	INITIAL CAPITAL COST	ONGOING COST	RESPONSIBILITY	WORKS TYPE
on medium slopes (to around 30°), and steeper slopes with very cohesive soils. Slopes with a greater fall than this will require further erosion control management, such as installation of coir logs, sand bags, jute matting or soil confinement mats. Very steep slopes may require construction of a rock or log retaining wall.						
Strategy: Stormwater management The bulk of surface flows through this area are generated in a highly urbanised catchment. These can carry a high nutrient and sediment load and this can have an adverse effect on the saltmarsh and mangrove communities. There are no formalised drainage channels through this part of the site; however, informal channels will develop, resulting in greater erosion damage. The best outcomes are achieved when stormwater is directed into the soil, rather	high	**Best conducted in** conjunction with weed control activities: An appropriately qualified professional may need to be consulted.	See above	Low	PCC	Capital/operational

ZONE 12B: DENSE WEED ZONE	PRIORITY	DETAILS	INITIAL CAPITAL COST	ONGOING COST	RESPONSIBILITY	WORKS TYPE
than moving quickly across the soil surface. Use of plants, berms, surface stabilisation can facilitate this.						
Strategy: Revegetation This zone forms the interface between the reserve and the adjoining road reserve and residential areas. Much of it is on a steep slope, with existing cover comprising mainly exotic species. A staged planting program needs to be conducted in conjunction with a stages weed removal program. Use only local native species that are appropriate for this type of environment. Goals for this zone include stabilisation of soil surface to prevent erosion, management of vegetation to retain sight lines in residential premises, increasing the diversity of native plants in the area, increasing the complexity of vegetation community. Surface treatment in conjunction with the	high	**Year 1:** Prepare soil and plant groundcover species and shrubs. Maintain plantings. **Year 2:** Maintain plantings, replant where necessary, prepare soil and plant grasses and herbs. **Year 3:** Maintain plantings, plant supplementary species **Year 4:** Maintain plantings, replant where necessary, and plant supplementary species **Year 5:** Maintain plantings	Supply & install jute matting $3.80/m2 $1500 Supply & install plants hiko$ 1.65 $2650	Low	PCC	Capital/operational

ZONE 12B: DENSE WEED ZONE	PRIORITY	DETAILS	INITIAL CAPITAL COST	ONGOING COST	RESPONSIBILITY	WORKS TYPE
planting program will be necessary to minimise erosion, especially in steeper areas. (see Section # for detailed planting notes)						
Strategy: Management of general fauna habitat A number of uncommon bird species were sighted during recent visits by AW staff. This suggests that, in addition to migratory birds, a number of other important species potentially use the site. The dense weed infestation includes a complex vegetation structure that potentially provides habitat for a range of bird, animal and invertebrate species that may be in the area. As well, many microbat species feed on invertebrates in and around canopy vegetation. The saltmarsh area provides habitat for invertebrates, and is a ready source of food for the bats. Many of these organisms rely on the dense vegetation for foraging, nesting and refuge	medium – high	**Undertake Spring and Summer surveys.**	$6000	NA	PCC	Capital (or could be done internally)

ZONE 12B: DENSE WEED ZONE	PRIORITY	DETAILS	INITIAL CAPITAL COST	ONGOING COST	RESPONSIBILITY	WORKS TYPE
habitat, and complete removal of this may adversely impact them. A staged removal, in conjunction with dense planting of replacement species will help to protect them. To gain a full appreciation of the value of the site as fauna habitat we recommend that a full fauna survey is conducted in the area.						
Strategy: Consolidation of boundary areas Work with local residents in adjoining properties to manage weed plants in their yards. This may involve general education programs, offers of incentives or assistance to manage their invasive weeds.			In kind	In kind	PCC residents	operational
Strategy: Monitor progress of rehabilitation program Establish a series of permanent monitoring points (photo-points and transects and/or quadrats).	high	**Monitor every 6 months** for duration of the project.	In kind	In kind	NRO	operational

ZONE 12B: DENSE WEED ZONE	PRIORITY	DETAILS	INITIAL CAPITAL COST	ONGOING COST	RESPONSIBILITY	WORKS TYPE
Strategy: Public education Carry out a community awareness program that highlights the presence of threatened species in the saltmarsh and mangrove EECs. Support this with informative signage in the reserve itself.		**Throughout the project**	Low-medium Signage $400 per sign	In kind	Education officer	operational
Strategy: Community support and involvement Support and encourage the activities of the local bushcare group. Provide information on the role that local residents can play in maintaining these environmental treasures, including management of domestic animals, garden escape plants, garden refuse, inappropriate access and use, littering and fire.	high	**Throughout the project**	In kind	In kind	Bushcare officer	operational

5.2.15 Zone 13 (Mangroves)

Zone area: 8736m2

Description of zone

Figure 56 Zone 13

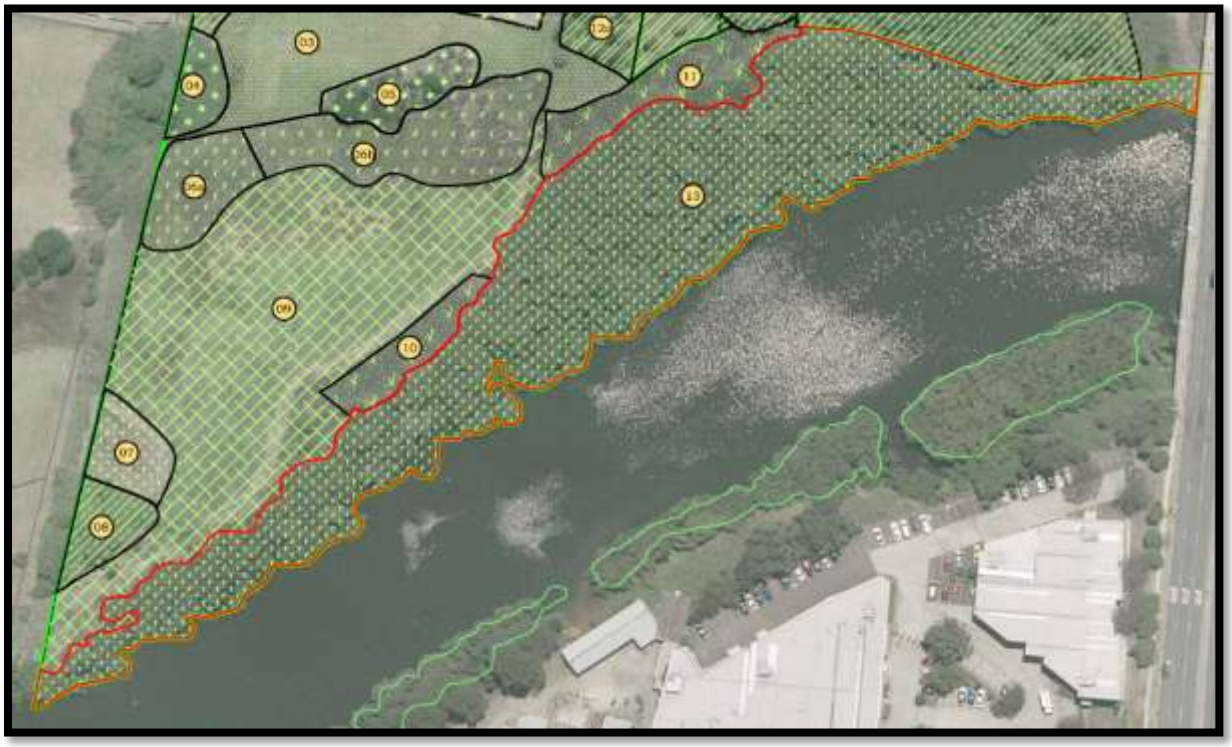


Figure 57 Two species of Mangroves fringe the River

The entire bank region of the reserve includes an extensive stand of mangroves. This zone is owned by NSW Maritime. Both Sydney based species of mangroves are present, including the Grey Mangrove (*Avicenna marina* var *australasica*) and the River Mangrove (*Aegiceras corniculatum*). This is a healthy mixed stand that has a fairly low level of weed invasion, although there is minor evidence of dieback among some of the older mangroves.

Assessment of vegetation and habitat value

Mangroves are widely recognized as important for nutrient cycling in estuaries, as well as providing breeding grounds for fish and feeding grounds for young fingerlings. For this reserve the mangrove stand is currently providing a degree of protection from wave erosion for the river bank. A number of birds and insects are adapted to life in the mangroves, and several more generalist species of birds were sighted using this habitat.

Threatening processes

Key threatening processes for this stand of mangroves include changes in water quality, especially sedimentation, erosion of the channel, and significant changes in water levels in the estuary – for example, through sea level rise.

Figure 58 River-borne gross pollutants deposited in the mangroves

Table 20 Action Table: Zone 13

ZONE 13 MANGROVES	PRIORITY	DETAILS	INITIAL COST	ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
Strategy: Weed management The mangrove forest is predominantly Grey Mangrove (*Avicennia marina* var *australasica*) with River Mangrove (*Aegiceras corniculatum*). A number of weeds in the immediate area have the capacity to invade the drier parts of the mangroves, and compete for areas that would otherwise be saltmarsh or mangrove recruitment zones. Main weed species that are potential problems include *Atriplex hastata, Asparagus asparagoides* and *Stenotaphrum secundatum*. These are best managed by removal before they become a significant problem	medium	Throughout project	N/A monitor		NSW Maritime	Operational
Strategy: Erosion control/streambank management Mangroves have an important role in the protection of shorelines from erosion	high	Regular monitoring, especially after peak flow events, such as those associated with king high tides and major storm events.	In kind Volunteer monitoring by		PCC and NSW Maritime	

Table 20 Action Table: Zone 13

ZONE 13 MANGROVES	PRIORITY	DETAILS	INITIAL COST	ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
caused by wave action. As well they are important for filtration of pollutants from runoff and management of siltation in the waterways. The mangroves along the shore of this part of the Parramatta River form an intact stand of mangroves and provide a good barrier to erosion of the bank. Maintaining the integrity of this barrier will become increasingly important as the frequency of the rivercat journeys is increased, with subsequent increase in the impacts from wave action. Monitoring is important, and stabilising early erosion sites vital to maintaining the integrity of the mangrove stand, saltmarsh and the rest of the reserve.			Bushcare members			
Strategy: Litter collection The presence of litter in estuarine systems detracts from the visual amenity of an area and can harm humans (eg broken glass, used needles) or animals (which eat,	high	**Immediately:** Clear litter from mangrove forest area. **Ongoing:** Regular monitoring, especially after	Medium	$1500-$2000 pa	PCC and NSW Maritime	Operational

Table 20 Action Table: Zone 13

ZONE 13 MANGROVES	PRIORITY	DETAILS	INITIAL COST	ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
become entangled in, or are suffocated by, the litter). Floating litter may aid in the movement introduction of animals and plants which may become pests. Toxic substances can leach out of litter affecting animals and plants. Toxic substances leach out of cigarette butts, for example, and can kill small animals. Animals also mistake butts for food. Plastics pose a particular threat due to their durability and their ability to float.		peak flow events, such as those associated with king high tides and major storm events – this will inform a suitable regime for ongoing maintenance cleaning. Best strategy is for litter to be collected by hand on a regular basis. There is an existing buildup of litter in the northeastern part of the site, and this requires a full cleanup. This could be a community blitz in association with the bushcare activities or Clean up Australia Day. OH&S is important in this type of project. Once the area has been cleared of litter, regular monitoring should be conducted to establish a suitable ongoing maintenance regime for management of litter on site.				
Strategy: Monitoring mangrove health	high	Monitor at regular intervals, especially after peak flow periods associated	In kind		NSW	

Table 20 Action Table: Zone 13

ZONE 13 MANGROVES	PRIORITY	DETAILS	INITIAL COST	ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
Key factors in the maintenance of mangrove health are regular tidal flushing and management of water quality from surrounding catchments. Major issues are siltation and poisoning as a result of exposure to toxic leachates that can be generated from landfill areas or mobilised river sediments (eg. as a result of increased activities by the rivercat).		with king high tides and major storm events.	Monitor		Maritime PCC DECCW I&I NSW	
Strategy: Public education Carry out a community awareness program that highlights the presence of threatened species in the saltmarsh and mangrove EECs. Support this with informative signage in the reserve itself.	medium	**Throughout the project**	In kind	In kind	Education officer	operational
Strategy: Community support and involvement Support and encourage the activities of	high	**Throughout the project**	In kind	In kind	Bushcare officer	operational

Table 20 Action Table: Zone 13

ZONE 13 MANGROVES	PRIORITY	DETAILS	INITIAL COST	ONGOING COST PER ANNUM	RESPONSIBILITY	WORKS TYPE
the local bushcare group. Provide information on the role that local residents can play in maintaining these environmental treasures, including management of domestic animals, garden escape plants, garden refuse, inappropriate access and use, littering and fire.						

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APPENDIX A FLORA

NATIVE SPECIES				**(nil)**	**(nil)**											
SPECIES NAME	COMMON NAME	AREA 1	AREA 2	AREA 3	AREA 4	AREA 5	AREA 6a	AREA 6b	AREA 7	AREA 8	AREA 9	AREA 10	AREA 11	AREA 12a	AREA 12b	AREA 13
Acacia falcata	Hickory		y													
Acacia longifolia	Sydney Golden Wattle	y	y											y		
Acacia parramattensis	Parramatta Green Wattle	y														
Aegiceras corniculatum	River Mangrove															y
Alismata plantago-lanceolata	Water Plantain							y								
Alocasia brisbanensis	Cunjevoi							y								
Avicennia marina var australasica	Grey Mangrove															y
Bolboschoenus caldwellii	Clubrush							y			y		y			
Breynia oblongifolia	Breynia		y													
Bursaria spinosa	Blackthorn								y							
Carex appressa	Sedge		y			y	y				y			y	y	
Casuarina glauca	Swamp Oak					y							y	y		
Centella asiatica	Centella							y								
Commelina cyanea	Scurvy Weed		y											y		
Cyperus difformis	Sedge										y					
Dianella revoluta	Purple Flag Lily		y			y			y						y	
Epilobium billardieranum	Willow Herb	y	y				y				y				y	

ssp not determined																
Eucalyptus amplifolia	Cabbage Gum					y										
Eucalyptus deanei	Deane's Gum													y		
Eucalyptus punctata	Grey Gum					y								y		
Eucalyptus saligna	Sydney Blue Gum					y										
Eucalyptus sp.1		y														
Eucalyptus tereticornis	Forest Red Gum													y		
Euchiton sphaericus	Cudweed															y
Glochidion ferdinandi	Cheese Tree					y									y	
Hakea sericea	Bushy Needlebush		y			y										
Hydrocotyle peduncularis	Pennywort													y	y	
Imperata cylindrica	Blady Grass		y			y										
Isolepis inundata	Spike Rush												y			
Juncus kraussii	Sea Rush					y		y			y	y	y			y
Juncus usitatus	Common Rush		y			y	y				y	y				y
Kennedia rubicunda	Dusky Coral Pea	y														
Lobelia alata	Coast Lobelia					y										
Lomandra longifolia	Spiny Mat Rush		y									y				
Melaleuca sieberi	Sieber's Paperbark								y							
Melaleuca styphelioides	Prickly Leaved Paperbark													y		
Omalanthus populifolius	Bleeding Heart Tree		y													
Oplismenis aemulus	Basket Grass		y													
Persicaria lapathifolium	Knotweed		y			y	y	y								
Pittosporum revolutum	Pittosporum		y													
Pittosporum undulatum	Sweet Pittosporum					y				y					y	
Plectranthus parviflorus	Cockspur Flowers		y			y		y								

Samolus repens	Creeping Brooklime						y				y	y	y		y	y
Sarcocornia quinqueflora	Glasswort											y				
Schoenus apogon	Fluke Bogrush							y								
Schoenus paludosus	Bogrush							y								
Suaeda australis	Austral Seablite											y	y			y
Syncarpia glomulifera	Turpentine													y		
Tetragonia tetragonoides	Warrigul Cabbage					y						y				y
Themeda australis	Kangaroo Grass	y							y							
Triglochin microtuberosum	Water Ribbons							y								
Triglochin striatum	Arrow Grass												y			
Typha orientalis	Cumbungi						y	y			y					
NON-NATIVE SPECIES																
SPECIES NAME	COMMON NAME	AREA 1	AREA 2	AREA 3	AREA 4	AREA 5	AREA 6a	AREA 6b	AREA 7	AREA 8	AREA 9	AREA 10	AREA 11	AREA 12a	AREA 12b	AREA 13
Acetosa sagitatta	Turkey Rhubarb	y			y										y	
Ageratina adenophora	Crofton Weed				y											
Agrostis capillaris	Creeping Bent			y		y		y								
Alternanthera philoxeroides	Alligator Weed							y								
Anagalis arvensis	Scarlet Pimpernel	y	y	y		y		y	y	y	y	y		y	y	
Anredera cordifolia	Madeira Vine				y					y						
Arauja sericifera	Moth Vine														y	
Arundo donax	Giant reed grass	y			y											
Atriplex prostrata	Orache (saltbush)									y		y				

Bidens pilosa	Cobblers pegs	y		y											
Brassica sp	Mustard seed			y						y				y		
Briza minor	Quavery Grass			y				y		y						
Bromus catharticus	Prairie grass	y	y	y	y	y			y	y	y			y		y
Capsella bursa-pastoris	Shepherds purse	y		y												
Cardiospermum grandiflorum	Balloon Vine									y				y	y	
Cestrum parqui	Green Cestrum				y				y	y					y	y
Chamaesyce hirta	Asthma Weed							y					y			
Cinnamomum camphora	Camphor Laurel				y											
Conyza sp	Fleabane			y				y	y		y				y	y
Coriandrum sativum	Coriander	y	y			y		y								
Cotoneaster sp	Cotoneaster	y														
Cynodon dactylon	Couch			y			y	y			y	y			y	
Cyperus eragrostis	Umbrella Sedge			y				y		y	y			y	y	
Digitaria ciliaris	Finger grass			y							y					
Ehrharta erecta	Panic Veldt Grass			y				y						y	y	y
Euphorbia peplus	Petty spurge	y	y	y										y	y	
Festuca elatior	Tall Fescue			y				y								
Foeniculum vulgare	Fennel										y					
Fumaria bastardii	Bastard's fumitory	y	y	y	y							y		y		
Galium aparine	Cleavers	y	y	y	y		y		y	y	y			y	y	
Hedera helix	English Ivy														y	
Hydrocotyle bonariensis	Kurnells Curse						y	y								
Isolepis prolifer	Sedge							y								
Jacaranda mimosifolia	Jacaranda														y	
Lactuca serriola	Prickly Lettuce			y		y		y	y						y	

Lantana camara	Lantana				y					y					y	
Ligustrum lucidum	Large leaved Privet				y										y	
Ligustrum sinense	Small leaved Privet				y			y							y	
Lobularia maritima	Sweet Alice/ Alyssum	y														
Lolium sp	Rye Grass			y			y									
Lonicera japonica	Japanese Honeysuckle		y		y		y	y								
Medicago polymorpha	Medic	y		y												
Modialla carolianum	Mallow									y		y		y		
Morus alba	Mulberry														y	
Northoscordum borbonicum	Onion Weed	y	y	y	y			y	y	y	y	y	y			
Olea europaea ssp. Africanus	African Olive									y					y	
Oxalis sp	Oxalis			y				y	y	y	y	y			y	y
Paspalum dilatatum	Paspalum			y												
Pennisetum clandestinum	Kikuyu			y			y			y	y					
Phyllostachys aurea	Fishpole (Golden) Bamboo														y	
Piptatherum miliacea	Rice millet	y	y	y			y	y	y		y	y			y	
Plantago lanceolata	Plantain	y		y	y			y		y	y	y	y	y	y	
Polycarpon tetraphyllum	Four leaved Allseed	y													y	
Ranunculus repens	Creeping Buttercup														y	
Rubis fruticosis aggregate	Blackberry		y		y			y	y		y				y	
Rumex grandifolia	Large leaved Dock	y			y		y				y					
Rumex obtusifolia	Small Dock			y	y	y	y	y		y	y			y	y	
Schinus areira	Peppercorn Tree									y						

Senecio madagascariensis	Fireweed	y		y		y		y			y					
Senna pendula	Smooth Senna				y	y									y	
Sida rhombifolia	Paddys lucerne	y	y	y						y						
Solanum linnaeanum	Apple of Sodom		y		y	y			y	y					y	
Solanum mauritianum	Wild Tobacco				y	y				y				y	y	
Solanum nigrum	Blackberry nightshade	y	y		y	y		y		y	y				y	
Sonchus oleraceus	Milk Thistle	y	y	y	y	y	y	y	y	y	y		y	y	y	
Spergularia marina	Sand Spurry											y				
Stellaria media	Chickweed									y						
Stenotaphrum secundatum	Buffalo Grass			y							y	y				
Taraxacum officinale	Dandelion	y	y	y							y				y	
Tradescantia albiflora	Trad													y	y	
Verbena bonariensis	Purple top	y	y		y		y	y	y	y	y			y		
Veronica sp	Speedwell	y		y										y		
Viccia sp	Vetch	y	y	y		y	y	y	y	y	y				y	
Zantedeschia elliottiana	Calla Lily							y								

APPENDIX B COMMUNITY FLYER

Parramatta City Council is preparing a Wetland Plan of Management with the assistance of Australian Wetlands. The Plan of Management outlines how Council will manage and improve the reserve with specific targets and actions, over a period of five years.

The Plan of Management will assess:

- Weed management
- Vegetation management
- Improving the habitat available for the native fauna
- Improving water quality
- Wetland and aquatic habitat management

COME FOR A LOOK AND SHARE YOUR FEEDBACK

If you have never visited the reserve before why not come down, have a walk through the wetland reserve and share your feedback with us.

Council officers and staff from Australian Wetlands will be on hand to answer questions, assist and show you around the Reserve.

Baludarri Wetland Reserve is a unique place. It contains significant trees and plants that are now uncommon in the Sydney area and provides habitat for threatened migratory birds.

Appendix C Management Map Set

BALUDARRI WETLAND

PARRAMATTA CITY COUNCIL

CONCEPTUALISATION FOR WETLAND MANAGEMENT STRATEGIES

Prepared for:
PARRAMATTA COUNCIL
PE00020

V0
Date: 11.06.10

LOCALITY *N.T.S.*

DRAWING No.	
PE00020/00	COVER
PE00020/01	LAYOUT
PE00020/02	GENERAL ARRANGEMENT
PE00020/03	MANAGEMENT ZONES & PROPOSED ACTIONS
PE00020/04	HABITAT - WETLANDS
PE00020/05	HABITAT - SALTMARSH
PE00015/06	CREEK RESTORATION
PE00015/07	CREEK RESTORATION DETAILS
PE00015/08	RESTORATION

CONCEPT ONLY -
NOT FOR CONSTRUCTION

BALUDARRI WETLAND
PLAN OF MANAGEMENT

Scale: 1/2000@A3

Reserve: Management plan

Management
Refer pages PE00020/ 02,03

Habitat improvement
Refer pages PE00020/ 04,05

Restoration
Refer pages PE00020/ 06

Data extracted from GIS data provided by the client and Australian Wetland ground truthing (October, 2009).
Coordinates system Map Grid of Australia Zone 56 using GDA94 datum, MGA-56.

Australian Wetlands
SYDNEY - BYRON BAY - GOLD COAST - SUNSHINE COAST

FINAL

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Conceptualisation **02/10 - ISSUE 3**
PARRAMATTA COUNCIL *AE PE00020/01*

BALUDARRI WETLAND PLAN OF MANAGEMENT

GENERAL ARRANGEMENTS

Location map

Existing/problematic

The Parramatta River catchment is a unique area with a high biodiversity value. The catchment's natural resources include bushland, rivers & creeks, wetlands, estuaries and cultural heritage. A total of 85 threatened species are found in the Cumberland sub-region, which the Parramatta River catchment lies within. There is also a wide diversity of aquatic species as well as regionally significant plants and animals throughout the catchment.

Water quality in the catchment is greatly impacted by stormwater runoff. In high rainfall events, large volumes of water enters rivers and creeks, transporting sediment, litter, nutrients, toxic chemicals, herbicides, pesticides, oils and grease, animal waste and sewage. The combined effect of this runoff over time is the degradation and pollution of local waterways as well as siltation and sediment contamination in the Parramatta River estuary.

Research into historical drawings and writings indicates that the significant stands of mangroves that now exist along the River were far fewer at English colonisation. The foreshores of the River were often sandy beaches and outcrops of rock, with extensive tidal flats around Homebush Bay. Excessive siltation of the river has enabled mangroves to thrive, often at the expense of more fragile vegetation communities such as salt marsh.

0 10 50 100m

Scale 1/2000 @A3

Data extracted from GIS data provided by the client and Australian Wetland ground truthing (October, 2009).
Coordinates system Map Grid of Australia Zone 56 using GDA94 datum, MGA-56.

Australian Wetlands

SYDNEY - BYRON BAY - GOLD COAST - SUNSHINE COAST

FINAL

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Conceptualisation **02/10 - ISSUE 3**

PARRAMATTA COUNCIL *AE PE00020/02*

BALUDARRI WETLAND PLAN OF MANAGEMENT

Management zone and proposed actions

ZONE	PRIORITY
ZONE 1: TERRESTRIAL PLANTING	
Community support and involvement	low
ZONE 2: TERRESTRIAL PLANTING	
Community support and involvement	low
ZONE 3: OPEN AREA (EXOTIC GRASSES)	
Management of open space recreation	medium
Establishment of "no go" zones	high
Public education	medium
ZONE 4: HIGH DENSITY WEEDS	
Weed removal of woody weeds and climbers	medium
Erosion control	high
Revegetation	high
Stormwater management to improve water quality	low
Monitor progress of rehabilitation program	medium
Community support and involvement	medium
ZONE 5: TERRESTRIAL PLANTING	
Management of open space recreation area	medium
Community support and involvement	high
ZONE 6A: FRESHWATER WETLAND	
Erosion control	medium
Management of stormwater	high
Management of migratory bird habitat	very high
Establishment of "no go" zones	high
Monitor progress of rehabilitation program	medium
Community support and involvement	medium
ZONE 6B: FRESHWATER WETLAND CHANNEL	
Management of stormwater	medium
Strategy : Erosion control	medium
Monitor progress of rehabilitation program	medium
Community support and involvement	medium
ZONE 7: TERRESTRIAL PLANTING	
Community support and involvement	medium
ZONE 8: HIGH DENSITY WEEDS	
Weed removal of woody weeds and climbers	medium
Erosion control	high
Revegetation	high
Monitor progress of rehabilitation program	low
Community support and involvement	medium
ZONE 9: EPHEMERAL TRANSITIONAL WETLANDS	
Management of open space recreation	high
Feral animal control (eg. Rabbits)	high
Monitor progress of rehabilitation program	medium
Community support and involvement	medium
ZONE 10: CONSTRUCTED SALTMARSH	
Hydrological management	high
Monitor progress of rehabilitation program	high
Community support and involvement	high
ZONE 11: SALTMARSH SEDGELAND	
Hydrological management	high
Management of migratory bird habitat	very high
Monitor progress of rehabilitation program	high
Community support and involvement	high
ZONE 12A: BUSH REGENERATION AREA &	
Weed removal of woody weeds and climbers	medium
Revegetation	high
Strategy : Erosion control	high
Management of existing drainage channel	medium
Management of stormwater	medium
Monitor progress of rehabilitation program	medium
Community support and involvement	high
ZONE 12B: HIGH DENSITY WEEDS	
Weed removal of woody weeds and climbers	medium
Erosion control	high
Stormwater management	high
Revegetation	high
Monitor progress of rehabilitation program	medium
Community support and involvement	vey high
ZONE 13: MANGROVES	
Erosion control/streambank management	high
Litter collection	high
Monitoring mangrove health	low
Community support and involvement	high

Australian Wetlands

SYDNEY - BYRON BAY - GOLD COAST - SUNSHINE COAST

FINAL

Conceptualisation **02/10 - ISSUE 3**

PARRAMATTA COUNCIL *AE PE00020/03*

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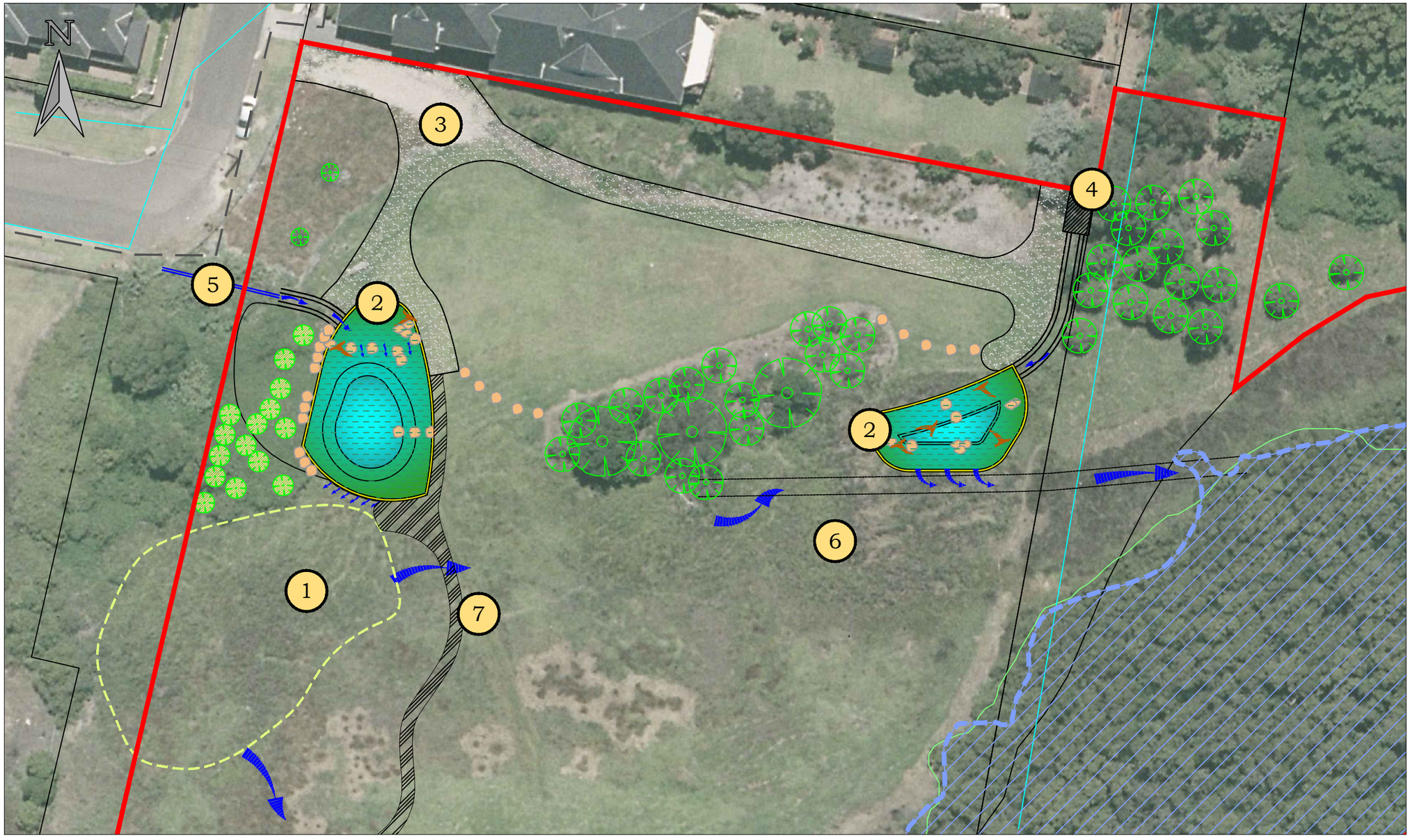
Data extracted from GIS data provided by the client and Australian Wetland ground truthing (October,2009).
Coordinates system Map Grid of Australia Zone 56 using GDA94 datum, MGA-56.

0 10 20 30 40 50 60m

Scale 1/1200 @A3



Habitat enhancement Wetlands

1- Existing wetland

Buffer zone to limit disturbance

2- Creation of new wetlands
Shallow area, -300mm deep
Deep area, -500mm to 1.00m deep
Rocks and logs for habitat
Rocks and logs for flow dispersion

3- Access way (3.50m wide, crushed sandstone)
Facilitate the maintenance
Delimit the mowing area

4- Bust existing pipe, build a GPT, form a planted swale to the wetland

5- form channel from apron of existing headwall (+ more shrubs on the embankment).

6- Weed management in accordance with species requirement

7-Raised boardwalk
Access over wetland area, possible viewing plateform

P1- Rocks (internal wetland berm)

P2- Created open water in wet area

P3- Wetland, deep and shallow area

P4- Soft terrestrial planted slope and log

Legend

- Reserve Boundary
- Max. water marks
- Flow path
- Proposed planted swale
- Periodically inundated area
- Existing tree
- Proposed wetlands
- Rocks and logs
- Proposed shrub

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REV.	ISSUE / AMENDMENTS	DATE
01	PRELIMINARY	13/10/09
02	ZONAGE	08/12/09
03	RAISED BOARDWALK-FINAL	15/02/10

DESIGNED DH
DRAWN DH
CHECKED AC

PROJECT
PARRAMATTA COUNCIL
BALUDARRI WETLAND
PLAN OF MANAGEMENT

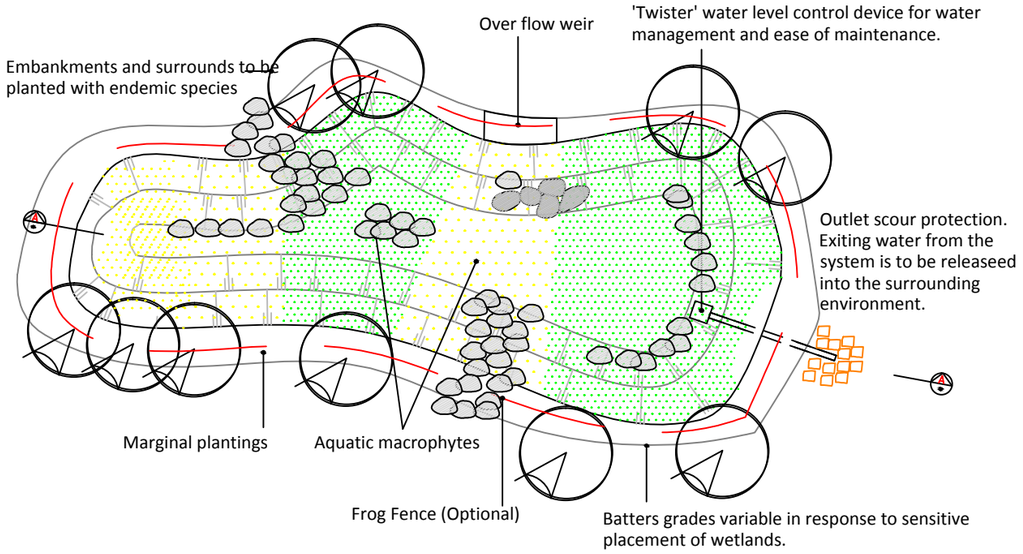
DRAWING
HABITAT ENHANCEMENT
PROPOSED WETLANDS

DWG No. **AE PE00020/04**
CAD FILE No. **PE00020.dwg**
REV. **03**

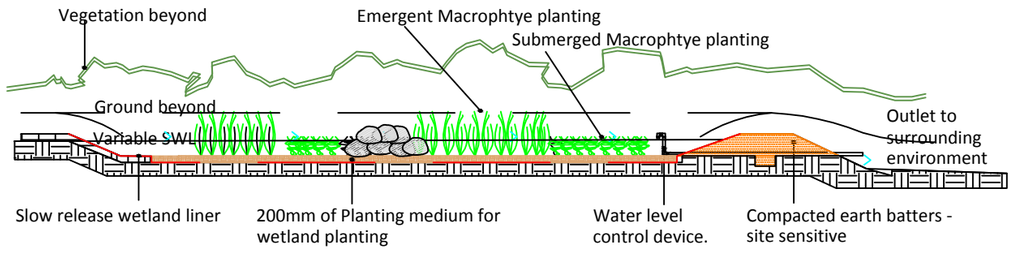
SCALE 1:750 @A3
DRAWING CREATED 08/12/09

Concept Plan for Habitat Wetland

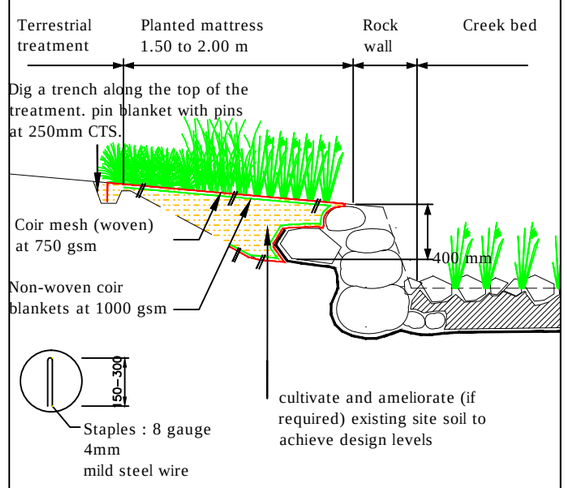
NOTES:
Plant material to be sourced from the existing site via 'slabbing' or from similar sites within 3klm with the the same hydrology and geology as the site.



Section AA-Concept Section for Habitat Wetland



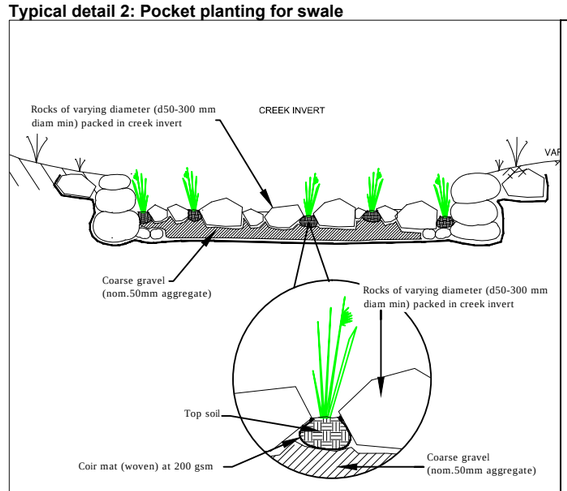
Typical detail 1: Ephemoral planted mattress with rock abutments



Ephemoral zone: non woven coir matting overlaid with coir mesh is to installed prior to backfilling and pinned into subsoil and firmly pushed into rock cavities.
Back fill with imported topsoil or conditioned site soil. Pull remaining matting and mesh over soil profile and pin down securely.
Plant through matting and mesh.

This planting strategy will provide stability for the planting substrate during high velocity "flashy flows". Coir fibre matting water holding capacity is in excess of 500% reducing the impacts of wetting and drying cycles on plant establishment. The product is entirely bio-degradable and will degrade in a time frame appropriate to plant establishment and recruitment.

Typical detail 2: Pocket planting for swale



Tubestock planted into rip rap reinforced swale sections needs to have planting medium protected from both dispersal during baseflow and complete dislodgement during high velocity flows during plant establishment phase. Creating a coir mat “nest” or “pocket” to bed down the topsoil prior to planting will assist with plant establishment. The coir mat should be pushed firmly into cavity before backfilling and trimmed at soil level.

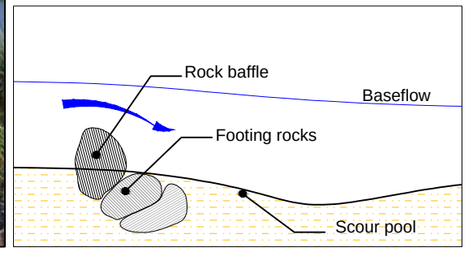

P5-Wetland, logs and planted bench


P6-Wetland built for frog habitat

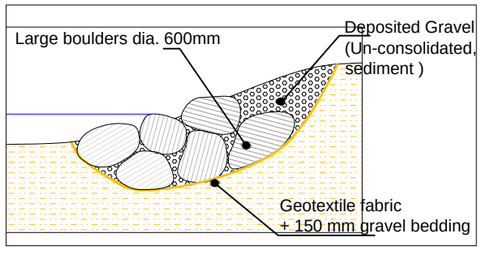

P7-Wetland, Rocks for habitat value


P8-Wetland, log after plants establishment
Refer p4.

Typical in-stream rock baffle



Typical Rock Bank Scour Protection



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REV.	ISSUE / AMENDMENTS	DATE
01	PRELIMINARY	13/10/09
02	ZONAGE	08/12/09
03	FINAL	15/02/10

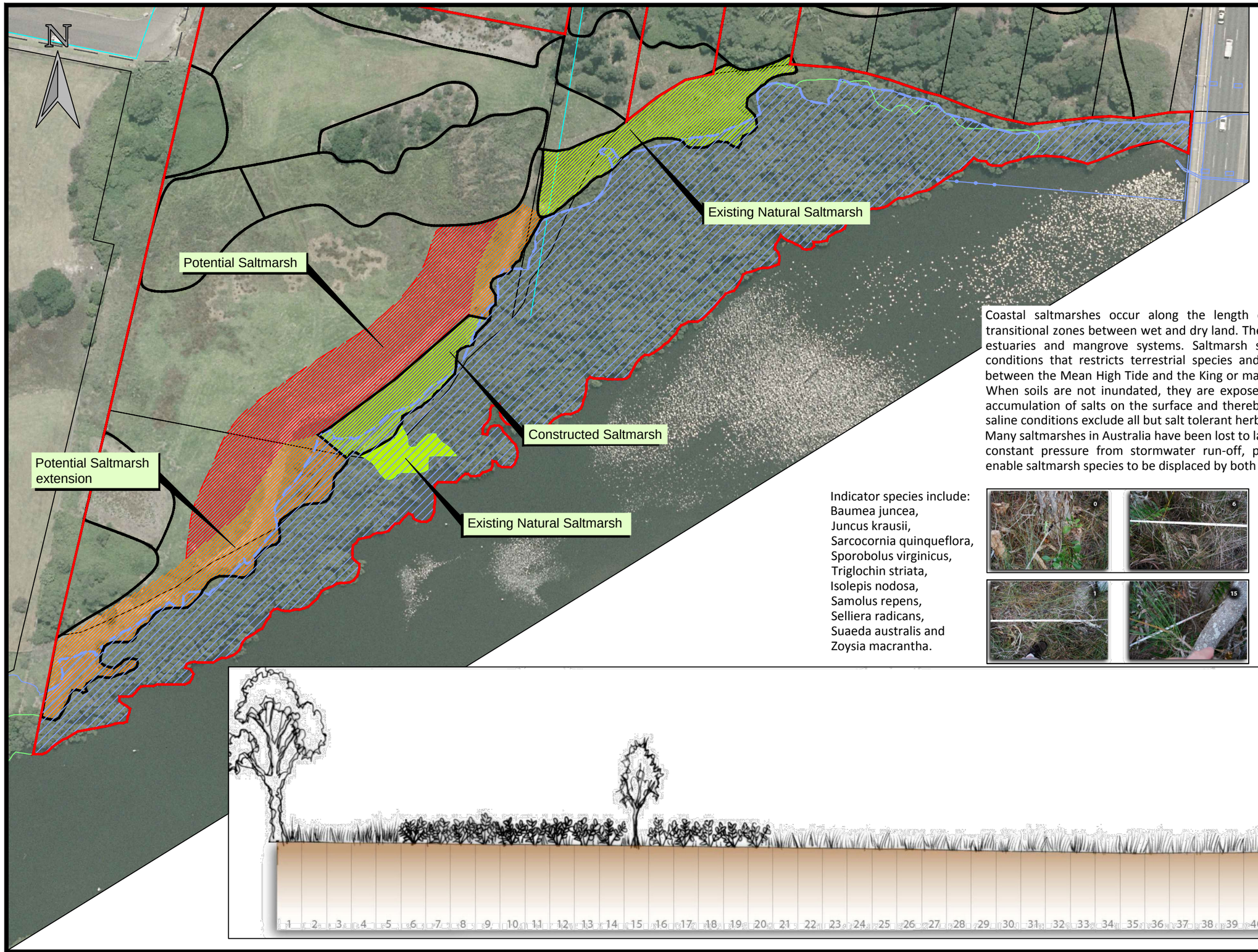
DESIGNED DH
DRAWN DH
CHECKED AC

PROJECT
PARRAMATTA COUNCIL
BALUDARRI WETLAND
PLAN OF MANAGEMENT

DRAWING
HABITAT ENHANCEMENT
WETLAND TYPICAL DETAILS

DWG No. **AE PE00020/05**
CAD FILE No. **PE00020.dwg**
REV. **03**

SCALE NTS @A3
DRAWING CREATED 08/12/09



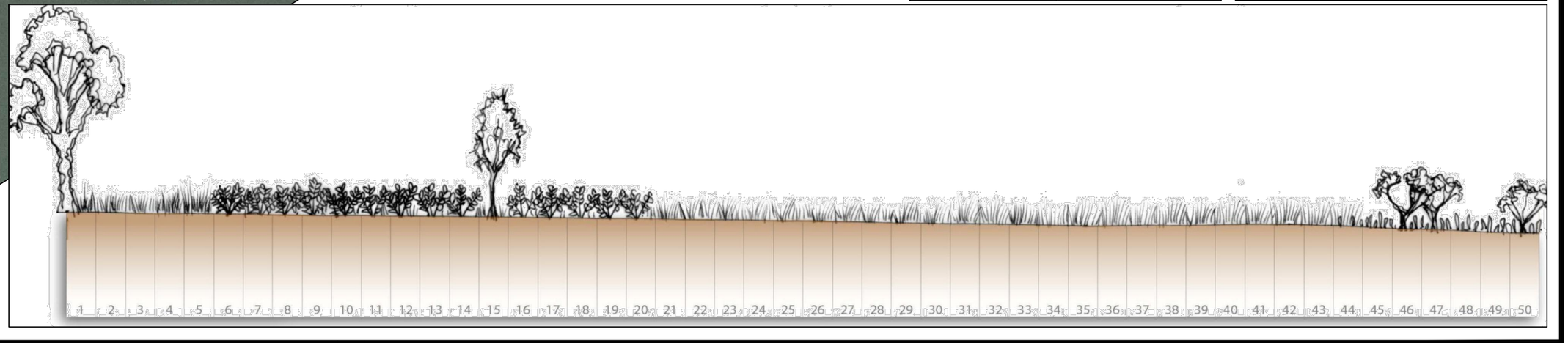
Reserve boundary

High tide mark

Vegetation zone
(refer to page PE00020/03)

Coastal saltmarshes occur along the length of the NSW coast. Saltmarshes occupy the transitional zones between wet and dry land. They are typically found in the upper tidal zone of estuaries and mangrove systems. Saltmarsh survives in a niche created by hyper saline conditions that restricts terrestrial species and even mangroves. Saltmarsh typically occure between the Mean High Tide and the King or maximum tide, and is only periodically inundated. When soils are not inundated, they are exposed to intense evaporation which results in the accumulation of salts on the surface and thereby creating hyper salines conditions. The hyper saline conditions exclude all but salt tolerant herbs, grasses and macrophytes.
Many saltmarshes in Australia have been lost to land reclamation initiatives and are under constant pressure from stormwater run-off, poor water quality and sedimentation, which enable saltmarsh species to be displaced by both mangroves and terrestrial species.

Indicator species include:
Baumea juncea,
Juncus krausii,
Sarcocornia quinqueflora,
Sporobolus virginicus,
Triglochin striata,
Isolepis nodosa,
Samolus repens,
Selliera radicans,
Suaeda australis and
Zoysia macrantha.



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01	PRELIMINARY	13/10/09
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03	FINAL	15/02/10

DESIGNED DH
DRAWN DH
CHECKED AC

PROJECT
PARRAMATTA COUNCIL
BALUDARRI WETLAND
PLAN OF MANAGEMENT

DRAWING
SALTMARSH MANAGEMENT

DWG No.
AE PE00020/06

CAD FILE No.
PE00020.dwg

REV.
03

SCALE
1:500 @A3

DRAWING CREATED
13/10/09

APPENDIX D AHIMS

Aboriginal Heritage Information Unit
43 Bridge Street Hurstville NSW
PO Box 1967, Hurstville NSW 2220
Tel: (02) 95856345 Fax: (02) 95856094
ABN 30 841 387 271
www.environment.nsw.gov.au

Your reference :[Unknown]
Our reference :AHIMS #28078

Australian Wetlands
175 Cranebrook Rd
Cranebrook NSW 2749

13 NOV 2009

Monday, 09 November 2009

Attention: Anne Carey

Dear Sir or Madam:

Re: AHIMS Search for the following area at As Per Attached lot & Dp List

I am writing in response to your recent inquiry in respect to Aboriginal objects and Aboriginal places registered with the NSW Department of Environment, Climate Change and Water (DECCW) at the above location.

A search of the DECCW Aboriginal Heritage Information Management System (AHIMS) has shown that *0* Aboriginal objects and Aboriginal places are recorded in or near the above location. Please refer to the attached report for details.

The information derived from the AHIMS search is only to be used for the purpose for which it was requested. It is not to be made available to the public.

The following qualifications apply to an AHIMS search:

- AHIMS only includes information on Aboriginal objects and Aboriginal places that have been provided to DECCW;
- Large areas of New South Wales have not been the subject of systematic survey or recording of Aboriginal history. These areas may contain Aboriginal objects and other heritage values which are not recorded on AHIMS;
- Recordings are provided from a variety of sources and may be variable in their accuracy. When an AHIMS search identifies Aboriginal objects in or near the area it is recommended that the exact location of the Aboriginal object be determined by re-location on the ground; and
- The criteria used to search AHIMS are derived from the information provided by the client and DECCW assumes that this information is accurate.

All Aboriginal places and Aboriginal objects are protected under the *National Parks and Wildlife Act 1974* (NPW Act) and it is an offence to destroy, damage or deface them without the prior consent of the DECCW Director-General. An Aboriginal object is considered to be known if:

- It is registered on AHIMS;
- It is known to the Aboriginal community; or
- It is located during an investigation of the area conducted for a development application.

If you considering undertaking a development activity in the area subject to the AHIMS search, DECCW would recommend that an Aboriginal Heritage Assessment be undertaken. You should consult with the relevant consent authority to determine the necessary assessment to accompany your development application.

Yours Sincerely

Freeburn, Shannon
Administrator
Aboriginal Heritage Information Unit
Information Systems and Assessment Section
Aboriginal Heritage Operation Branch
Culture and Heritage Division
Department and Environment, Climate Change and Water (DECCW)
Phone: 02 9585 6471
Fax: 02 9585 6094

List of Sites (List - Short)

Grid Reference Type = AGD (Australian Geodetic Datum), Zone = 56, Easting From = 316543, Easting to = 316896, Northing From = 6256365, Northing to = 6256671, Feature Search Type = AHIMS Features

Site ID	Site Name	Datum	Zone	Easting	Northing	Context	Site Features	Site Types (recorded prior to June 2001)	Recording (Primary)	Reports (Catalogue Number)	State Arch. Box No (for office use only)

No Site Recorded

Number of Sites : 0

Page 1 of 1

09/11/2009 11:23:31

APPENDIX E LEGISLATIVE CONTEXT

STATE GOVERNMENT LEGISLATION

Local Government Act 1993

Core Objectives For Management Of Community Land Categorised As Watercourse (36j)

The core objectives for management of community land categorised as watercourse are:

(a) To manage watercourses so as to protect the biodiversity and ecological values of the instream environment, particularly in relation to water quality and water flows, and (b) To manage watercourses so as to protect the riparian environment , particularly in relation to riparian vegetation and habitats and bank stability , and

(c) to restore degraded watercourses, and

(d) to promote community education, and community access to and use of the watercourse, without compromising the other core objectives of the category.

Threatened Species Conservation Act 1995

The Threatened Species Conservation Act aims to conserve threatened species, populations, ecological communities and their habitats; to promote their recovery; and manage the processes that threaten or endanger them. The NSW Scientific Committee established by the Act lists a number of threatened flora and fauna species under Schedules 1 and 2. Under Schedule 3 of the Act, plant communities considered to be at risk of extinction are listed as 'endangered ecological communities'.

The reserve contains two vegetation communities which are listed as ‘endangered’ under Schedule 1, Part 3 of the Act- Freshwater wetlands on Coastal Floodplain and Saltmarsh on Coastal Floodplain.

Noxious Weeds Act 1993

The Noxious Weeds Act 1993 aims to streamline administration and improve the implementation of noxious weed control. There is an increased emphasis on urban and environmental weeds. It encourages community co-operation, and promotes a co-ordinated approach to the control of noxious weeds throughout the State.

Noxious plants are nominated to the Minister of Agriculture by local government authorities. On listing, weeds are categorised according to the specific action required to control them. An amended Noxious Weeds Act came into effect 1 March 2006. The above criteria still apply, but changes have been made to the list of currently declared noxious weeds (increased from 42 to 86) and to the

"categories". The former W1, W2, W3 and W4 categories have been changed to "control classes" (CC) 1, 2, 3, 4 and 5.

Ten noxious plants are currently reported at Baludarri Wetland:

Table 21 Noxious weed of Baludarri Wetland

NOXIOUS WEED CLASS	SPECIES NAME	COMMON NAME
Class 1. Notifiable State Prohibited Weeds	nil	
Class 2. Notifiable Regionally Prohibited Weeds	nil	
Class 3. Regionally Controlled Weeds	*Cestrum parqui*	Green Cestrum
	Alternanthera philoxeroides	Alligator Weed
Class 4. Locally Controlled Weeds	*Anredera cordifolia*	Madeira Vine
	Arundo donax	Giant reed grass
	Cardiospermum grandiflorum	Balloon Vine
	Lantana camara	Lantana
	Ligustrum lucidum	Large leaved Privet
	Ligustrum sinense	Small leaved Privet
	Phyllostachys aurea	Fishpole (Golden) Bamboo
	Rubis fruticosis aggregate	Blackberry
Class 5. Notifiable Restricted Plants	*Oxalis sp*	Oxalis

State Environmental Planning Policy No 19 – Bushland In Urban Areas (Sepp 19)

SEPP-19 aims to protect and preserve bushland within the Sydney Metropolitan area, and in other areas of the State which nominate for inclusion under the terms of the Policy. For the purposes of SEPP-19, urban bushland is defined as:

> Land on which there is vegetation which is either a remainder of the natural vegetation of the land or, if altered, is still representative of the structure and floristics of the natural vegetation.

Clause 6 (1) of the Policy states that "A person shall not disturb bushland zoned or reserved for public open space purposes without the consent of Council" and further, Clause 7 (2) states that "a public authority shall not disturb bushland for a purpose referred to in Clause 6 (2) unless it has first had regard to the aims of the Policy". Further, Clause 9 requires that where development is to be carried out on land which adjoins bushland protected by *SEPP-19*, the Consent Authority (usually Council) must consider the need to retain any bushland on the land, and the impact of the proposed development on the adjacent, protected bushland.

Baludarri Wetland is classified as community land, and the remnant bushland therein is afforded protection under the terms of SEPP-19.

Rural Fires Act 1997

The Rural Fires Act 1997 replaces the Bush Fires Act 1949. Section 63 of the Act makes the land holder responsible for managing any fire hazard on the land which may be a threat to adjoining property. The Act applies to both public and privately owned land. As Baludarri Wetland is a public reserve, Parramatta City Council has a legal responsibility to ensure that the reserve poses a minimal threat to adjoining property. The reserve is surrounded by development on one side, so that the maintenance of suitable fire breaks and the monitoring of litter loads in this area will necessarily be part of the reserve management program. Further, if and when fire is used as an ecological management tool, precautionary measures must apply.

Pesticides Act 1999

The Pesticides Act 1999 became fully operational on 1 July 2000. The Act introduces new provisions to significantly improve the management of pesticides use in NSW. It also aims to reduce the risks associated with the use of pesticides to human health, the environment, property, industry and trade, and to promote collaborative and integrated policies for the use of pesticides. Note that the generic term ‘pesticides’ includes bactericides, baits, fungicides, herbicides, insecticides, lures, rodenticides and repellents (EPA 2000).

Of particular significance for bushland managers is the extension of responsibility for actions undertaken by field operators. Section 111 provides that any person who causes or permits, by act or omission, another person to commit an offence under this Act may also be guilty of that offence.

The shared liability (as identified) means that any occupier of land, person applying the pesticide (employee and/or employer), contractor or company directors may be liable for any damage caused by the inappropriate use of a pesticide.

The pesticides act was amended in 2005. As a requirement of the act a *Pesticides Notification Plan,* must be prepared. The plan must be prepared to satisfy the requirements of the Pesticides Regulation 1995, as amended 2005. All works must consider the requirements of the plan.

The plan must set out how Parramatta City Council will notify members of the community of pesticide applications it makes or allows to be made to public places that it owns or controls. The aim of the plan is to protect the rights of the Community's right to know about pesticide applications made outdoors in Council owned or controlled public spaces (including crown land).

Federal Government Legislation

Environment Protection And Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) provides for the protection of items of national environmental significance. It promotes Ecologically Sustainable Development by requiring that all consent authorities consider these principals when considering development applications. The Commonwealth Minister for the Environment must, by instrument published in the Gazette, establish a list of threatened species, threatened ecological communities and key threatening processes. Each list, as first established, contains only the species contained in Schedules 1, 2 and 3 of the Commonwealth Endangered Species Protection Act 1992, as in force immediately before the commencement of the EPBC Act.

The Act introduces a new assessment and approvals system for:

- Actions that have a significant impact on matters of national environmental significance
- Actions that have a significant impact on the environment of Commonwealth land
- Actions carried out by the Commonwealth Government

The EPBC Act commenced in July 2000 and replaces the Environment Protection (Impact of Proposals) Act 1974; Endangered Species Protection Act 1992; National Parks and Wildlife Conservation Act 1975; World Heritage Properties Conservation Act 1983; and Whale Protection Act 1980.

Migratory birds protected under the BONN convention, and the bilateral agreements - JAMBA/CAMBA/ROKAMBA- are listed in the annexes to these agreements and are protected in Australia as matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999.

Other Relevant Legislation For Bushland Reserves

Other policies and Acts relevant to the management of remnant bushland in the urban environment include:

- Environmental Planning and Assessment Act 1979;
- Heritage Act 1977;
- Protection of the Environment Operations Act 1997 (amends the Pollution Control Act 1970, Clean Waters Act 1970 and Soil Conservation Act 1938);
- Occupational Health and Safety Act 2000
- Poisons Act 1964;
- Public Health Act 1902; and

State Environmental Planning Policies (SEPPs).

7 APPENDIX F MANAGEMENT ACTIONS: BEST PRACTICE NOTES

Phytophthora cinnamomi

During any on-ground works care must be taken that the movement of soils and equipment on to the site or off the site do not introduce or spread weed propagules or harmful fungi and spores. Thoroughly clean vehicles and equipment to remove all adhering soil and plant debris before moving from one site to another. *Phytophthora cinnamomi* 's growth, reproduction and spread is favoured by free water in the soil or ponding on the water surface. Consequently, the movement of infested water and soil play a key role in the spread of this pathogen, and in contrast to other pathogens of natural ecosystems, human activity has played a significant role in the spread *of P. cinnamomi* in infested soil (http://www.cpsm.murdoch.edu.au). In NSW, strong evidence of *Phytophthora cinnamomi*-induced dieback has been identified in forest, woodland and heathland vegetation in the Catchment Management Authority (CMA) areas of Hawkesbury–Nepean, Hunter–Central Rivers, Northern Rivers, Southern Rivers and Sydney Metropolitan (McDougall & Summerell 2003; Daniel et al. 2006).Best management guidelines can be downloaded at http://www.sydney.cma.nsw.gov.au/our-projects/survey-and-management-of-phytophthora-cinnamomi-biodiversity.html

Standard Weed Control Techniques

Cut And Paint Method

This method is an effective way to remove woody weeds such as Privet and Mock Olive. It involves cutting the stem or trunk of the plant just above the ground level and applying non-residual glyphosate herbicide (such as Biactive Roundup®) to the cut area.

This weed removal technique can be used to clear large areas of woody weeds without affecting surrounding native vegetation, and can be utilised in primary, secondary and maintenance weeding.

Procedure:

1. Using secateurs, loppers or saw, cut the stem of the plant as close to the ground as possible;
2. Apply undiluted herbicide to the cut area using an applicator within 20-30 second of cutting before plant cell closes.

Stem Injection: Drilling And Frilling

Removing large weedy trees will involve drilling holes at 2 cm increments around the trunk of the trees, and filling the holes with herbicide. Caution must be taken when using this method to eradicate large trees, as dead tree material becomes brittle and could become a potential public/site safety risk. Poisoning prior to removal can mean that the cost of tree lopping and removal can be

reduced, as all leaf matter fall from the tree through poisoning, reducing the volume of waste requiring removal.

Procedure:

1. Using a cordless drill, drill holes into the trunk at a 45° angle and apply undiluted herbicide immediately into the drill holes.
2. Repeat this process at 2-5cm spacings around the trunk.

Frilling involves a similar procedure using a hammer and chisel, and can be used over waterways safely. It is also useful when there is difficult to access stems, or when it is not convenient to carry multiple spare batteries for a cordless drill.

Procedure:

1. Slots are chiseled using 15mm or 25mm wood chisels and cut at 45° angles into the trunk. Slots must completely penetrate the outer bark so that the herbicide reaches the meristematic tissue where it can be translocated throughout the whole plant. Undiluted herbicide is applied immediately into the holes.
2. Repeat this process at spacings that are 2-3 times the width of the chisel blade. This will allow re-treatment if required, without ringbarking the tree.

Scraping Method

Scraping is used to remove mainly exotic vines or weed species not easily eradicated using the cut and paint method or manual removal. The stem of the vine or plant should be scraped with a knife as close to the ground as possible. The scrape should be at least 20 cm long (or longer depending on the size of the plant) and undiluted herbicide applied to the exposed area.

Procedure:

1. Using a knife, apply a 20-100cm scrape along the main vines to expose the sapwood below the bark.
2. Apply undiluted herbicide to the scraped area immediately.

Manual Removal

Shallow rooted annuals, perennials, and juvenile plants can be removed by hand. This labour intensive but low impact method is principally used during primary, secondary and maintenance weeding. Hand tools are used to remove the root system of the weeds and minimise soil disturbance. This is the preferred method of weed removal within sensitive areas as no herbicides or machinery is required.

Many plants which will not regrow from their roots (eg many grasses) can be crowned: hold leaves and stems together, and use a knife to cut through all the roots below the 'crown'.

Herbicide Spraying

The use of herbicide can be used to successfully control large weed infestations. Repeated applications may be required to ensure complete weed eradication. Herbicide spraying is not recommended near remnant vegetation as herbicide drifts can affect non-target species. Protect native plants from treatment.

Extra precautions should be taken when spraying near watercourses, and this must be undertaken by a licensed EPA (Environmental Protection Authority) approved operator. Approval from the EPA may be required. Exercise caution when spraying as 'over spray' may have detrimental effects on surrounding plants, environment and public. Environmental control measures for applying herbicide include:

- Only a non-residual glyphosate herbicide should be used (e.g. Nufarm Weedmaster®, Biactive Roundup®). Refer to the instructions on the herbicide pack to determine the appropriate concentrations to apply to the weeds;
- Ensure that any staff member applying herbicide wears appropriate protective gear (i.e. overalls, covered shoes, gloves, glasses and mask);
- Apply herbicide sparingly using a spray pack with an appropriate applicator head and spray guard; and
- Do not spray herbicide on windy or rainy days, or when rain is forecast for subsequent days.

Consultation with the Parramatta City Council Naturak Resources Division should be undertaken prior to commencing any spraying to ensure that all matters of safety and regulations are adhered to. All herbicide use should be undertaken with a registered herbicide as specified on the herbicide product label or relevant off-label permit published by the Australian Pesticides & Veterinary Medicines Authority and in consultation with Parramatta City Council. Personnel must be qualified in the storage, transport and application of herbicide chemicals.

Developing A Weed Management Strategy

DECC has developed detailed guidelines for regeneration of vegetation in the Western Sydney region in the publication **"**Recovering Bushland on the Cumberland Plain: Best practice guidelines for the management and restoration of bushland" (2005). Techniques for treatment of pasture grasses and associated weed species in a mixed understorey are appropriate for use on the site, in particular the proposed conservation zone where exotic species are likely to suppress natural regeneration of the groundlayer and understorey. Selective weed control should be aimed at a staged reduction of pasture grasses to aid natural recruitment of native grass species present on site. The guidelines state that the following practices demonstrate how a combination of methods can achieve maximum weed control and survival of native species in situations where a native understorey is present:

- Where annual weeds are tall, apply herbicide using a 'wick wiper'
- Where it is required to control small privets, sida (paddy's lucerne) and other small woody species in native grasslands use garlon® at low concentrations.

- In areas of no or few native grasses, the use of the selective herbicide fusilade® to control exotic grasses will allow native herbs to survive.
- Bulbs such as watsonia in grassy native areas can be effectively controlled by a process of first whippersnipping back the grass and bulbs. Subsequent regrowth in the bulbs is at a faster rate than the native grasses, allowing discrete herbicide treatment of bulb leaves during times of active bulb growth.
- To prevent seed drop from grasses and herbaceous weeds in areas of native understorey, target the aerial parts using a hand-held flame thrower to consume the plant and scorch seed.
- Reducing weed levels by slashing or mowing (as outlined above) may be a useful interim measure.

Standard Planting Notes

Site Preparation

Weed Eradication

Weeds can be a major issue for the aquatic and terrestrial environments. The successful establishment of planted species is reliant on removing weeds and providing a weed free habitat over a lengthy period of time. Weed infestations are undesirable because they compete with and displace native species, and contribute to decline in native habitat health. Excessive growth of weeds or infestations can destroy natural habitats and are not easily eradicated. Weed invasions may inhibit or out-compete native plantings, particularly in new areas. Sites should be monitored for weeds on a regular basis and weed invasions must be managed.

Appropriate treatment methods exist for each species of weed plant, and accommodate habit, growth and dispersal processes (see Section #). It is important to remove only vegetative cover that is intended to be replaced by landscape treatment. At any stage in the works process, remove only the area of weeds that can be remediated within a workable timeframe. Existing native vegetation should be retained unless the proposed treatment cannot be achieved without its removal. Areas of potential conflict may include wetland areas and bank treatment areas.

Top Soil Preparation

Before doing any excavation, remember to ascertain the location of existing underground services. Obtain an analysis of existing soils to determine their suitability. Ameliorate existing soils as required. Regrade existing site soils and add 250mm imported top soil, if required. Compact soil layers lightly and uniformly using a mix roller (or similar) to a compacted depth of 150mm. Lightly water each layer with a fine mist spray prior to installing the following layer. Avoid differential subsidence and excess compaction to produce a planting surface that is void of branches and rocks greater than 50mm diameter and is of a smooth and even till.

JUTE MATTING INSTALLATION

Steep sloping banks, areas subject to high levels of disturbance from animals, humans, wind or rainfall/runoff should be stabilised. Using jute matting and/or coir logs are ideal for this; selection will depend on the degree of slope and disturbance. For most areas 750gsm jute matting is sufficient, unless the slope is very steep, or there is a significant level of erosion. Install jute matting to required areas after completion of weed eradication and top soil preparation. Peg using 300mm U pegs at 300mm centres along the edges and through the centre. Overlap adjacent sections by at least 200mm, with upstream sections over lapping downstream sections. Lay jute from top of bank to bottom.

Guidelines For Plant Installation

Guidelines for the selection of plant stock and related materials were provided in Rockdale Wildlife Friendly Design Guidelines – Phase 1 Report, which provided general guidelines for these items. Guidelines relating to the installation of plant material have been reproduced here:

- Plant material should be planted immediately after delivery, or stored in a protected location
- Plant installation should not proceed when air temperature exceeds 28°C, or drops to below 5°C, or in excessively windy weather, as adverse weather conditions will affect the successful establishment of plants
- Water plants well immediately before planting
- Set out plant materials as scheduled to locations and quantities shown on the approved plant layout drawings
- Planting holes for all plants are to be at least double the width and the same depth as the container
- Incorporate fertiliser and water storing granules into backfill at the manufacturers recommended rates
- Remove plant from tube (or pot) and gently tease out exposed roots
- Place plant in planting hole and backfill pit with soil so that the top of the plant rootball is at the same level as the surrounding soil
- Gently compact around plant with soil excavated from hole, and remove any debris detrimental to normal plant growth
- Form a small bowl around plantings by moulding topsoil and dispose of any excess excavated soil responsibly
- Stake, tie and mulch plants and water well immediately after planting
- The use of a plant guard is recommended. These are generally made from recycled plastics and are widely commercially available. Three bamboo stakes are positioned evenly around the plant in a triangle to hold the guard in place.
- Regular maintenance of plant guards is essential to prevent damage to the plant. Guards need to be removed when the plant has grown taller than the guard
- Use of plastic plant guards creates a warm, moist growing space for young plants. It also creates a barrier between the plant and the surrounding area, so that follow-up spraying of

weeds can be conducted with no harm to the plants. The space inside the guard also needs to be weeded to prevent choking of the plant

Source Lists Of Plant Species For Reserve Designs

The main habitat types represented with each of the target reserves were identified, and this provided a source list of plants for each of the reserves. A plant list was developed for each habitat type, and plants for the various treatment areas in the reserve should be selected from the list for the appropriate habitat. In this manner, the Baludarri Wetlands Management Guidelines aim to develop or recreate a previously existing habitat, rather than merely increasing the extent of the existing habitat quality.

Habitat types were ascertained from the Natural Vegetation of the Sydney 1:100 000 map sheet (Benson & Howell, 1994) and the Biodiversity Plan, Volume 1(PCC, 2003). Suitability of plant species and historic distributions were confirmed using Flora of New South Wales, volumes 1-4 (Harden, 1990-2007), the Field Guide to the Native Plants of Sydney (Robinson, 2004), and Waterplants in Australia (Sainty & Jacobs, 2004). The resulting lists are presented in Tables 23, 24 and 25.

Table 22 Plant species list for mangrove/saltmarsh.

SPECIES	COMMON NAME	BRIEF DESCRIPTION
TREES/SHRUBS		
Casuarina glauca	Swamp oak	Tree to 20m common in brackish marshes and estuaries, also brackish/freshwater creeks
Atriplex cinerea	Grey saltbush	Shrub to 1.5m, once common around Botany Bay, sand dunes
Avicennia marina var. *australasica*	Grey mangrove	Small stout tree to 6m, pioneer coloniser of shallow tidal waters
Melaleuca ericifolia	Swamp paperbark	Small rounded tree to 6m, corky bark, common in semi-saline swampy ground
GROUNDLAYER HERBS AND GRASSES		
Crinum pedunculatum	Swamp lily	Large fleshy perennial to 2m, common in swampy ground near brackish estuaries
Enchylaena tomentosa	Ruby saltbush	Low spreading shrub in salty places near the sea, uncommon in area
Isolepis nodosus (= I. nodosa)	Sedge	Erect sedge to 70cm with globular flower head; moist salty soil
Juncus kraussii	Sea rush	Tall coarse sedge in dense clumps on intertidal brackish estuaries
Leptinella longipes(= Cotula longipes)	Water buttons	Creeping herb in saltmarshes with yellow daisy flower
Lomandra longifolia	Mat rush	Hardy tufted perennial common in a wide range of habitats, including saltmarsh, swamps
Mimulus repens	Creeping monkey flower	Creeping herb on coastal lagoon margins with blue/purple flower
Phragmites australis	Common reed	Tall reed-like grass to 2m, common on margins of saltmarshes
Rhagodia candolleana	Seaberry saltbush	Spreading shrub to 1m, small thick glossy leaves, opportunistic on sandy seashores
Samolus repens	Creeping brookweed	Herb with erect upper stems to 30cm, common in saline conditions near estuaries
Sarcocornia quinqueflora	Samphire	Small erect succulent to 30cm forming dense colonies in saltmarshes
Senecio lautus ssp. *maritimus*	Coast groundsel	Sprawling perennial herb common on deeper sands near the sea, and saltmarshes
Sporobolus virginicus	Sand couch	Creeping perennial grass forming dense mats in saltmarshes and sand dunes, common
Suaeda australis	Austral seablite	Dense spreading herb to 40cm common in saltmarshes and estuaries with samphire

SPECIES	COMMON NAME	BRIEF DESCRIPTION
Tetragonia tetragonoides	Warrigal cabbage (New Zealand spinach)	Robust sprawling leafy herb common in moist places near the sea

Table 23 Plant species list for Freshwater Creeks and Brackish Swamps.

SPECIES	COMMON NAME	BRIEF DESCRIPTION
TREES		
Allocasuarina verticillata (=Casuarina stricta)	Drooping sheoak	Small tree to 10m, found on rocky areas near the sea, uncommon
Casuarina glauca	Swamp oak	Tree to 20m common in brackish marshes and estuaries, also brackish/freshwater creeks
Eucalyptus botryoides	Swamp bangalay	Medium tree to 30m, rough red bark, common on sandy soils near dune scrub
Eucalyptus robusta	Swamp mahogany	Medium tree to 25m, common on swampy creek and estuary margins
Melaleuca ericifolia	Swamp paperbark	Small rounded tree to 6m, corky bark, common in semi-saline swampy ground
Melaleuca quinquenervia	Broad leaved paperbark	Attractive tree 8-12m found in marshes and nearby forests
SHRUBS		
Acacia binervia	Coast myall	Shrub or small tree common in rocky places near coastal streams
Leptospermum juniperinum	Prickly tea tree	Dense compact shrub to 1.5m, dense thickets in marshy, sandy heath areas
Leptospermum laevigatum	Coastal tea tree	Shrub to 6m, common in dense scrubs behind sand dunes
Leptospermum polygalifolium	Lemon scented tea tree	Shrub to 2.5m, very common in moist woodland
Pittosporum revolutum	Rough fruit pittosporum	Shrub 1-3m, opportunistic in moist sheltered areas, widespread
Pittosporum undulatum	Sweet pittosporum	Large shrub 3-10m, opportunistic in moist disturbed areas especially with urban runoff
Rapanea variabilis	Mutton wood	Shrub to 3m, common in sheltered forests or gullies
Viminaria juncea	Golden spray	Erect leafless shrub to 3m, common in wet ground, dense yellow flowers in spring
GROUNDLAYER HERBS AND GRASSES		
Alternanthera denticulata	Lesser joyweed	Weakly sprawling herb, widespread in marshes and shallow waters
Baumea articulata	Jointed twigrush	Stout sedge 1-2m tall, uncommon in swamps, attractive drooping inflorescence
Baumea juncea	Twig rush	Slender rush to 100cm on spreading rhizome, common in freshwater seepages to saltmarsh

SPECIES	COMMON NAME	BRIEF DESCRIPTION
Bolboschoenus caldwellii	Clubrush	Erect sedge 50-100cm, common along creeks and in brackish swamps with *Phragmites*
Cyperus difformis	Sedge	Erect sedge 30-50cm, fairly common in disturbed marshy areas
Cyperus polystachyos	Sedge	Erect sedge 40-70cm, opportunistic coloniser of marshy ground near streams and swamps
Cyperus sanguinolentus	Sedge	Erect sedge to 40cm, common in damp grassland and disturbed marshy areas
Eleocharis sphacelata	Tall spike rush	Large rush to 2m, common in standing waters and forming dense colonies
Gahnia clarkei	Sword grass	Tall leafy sedge to 2.5m forming dense thickets on creek banks and marshes
Gahnia subaequiglumis	Saw sedge	Leafy sedge to 1m, found in open ground on the edge of swamps
Hemarthria uncinata	Mat grass	Creeping bright green grass forming dense colonies on marshy ground
Hypolepis muelleri	Harsh ground fern	Erect fern 30-100cm, common along creeks and in woodland swamps
Isolepsis inundata	Sedge	Small tufted sedge to 30cm, common in damp places
Juncus pallidus	Pale rush	Stout rush forming dense clumps to 1.5m, found in saltmarshes and freshwater swamps
Juncus usitatus	Common rush	Graceful rush forming dense clumps to 1m, common in disturbed moist to swampy soils
Persicaria decipiens	Spotted knotweed	Erect herb 0.5-1m, found in freshwater marshes and creeks, common in the area
Persicaria lapathifolia	Knotweed	Erect herb 1-2m, found in permanently wet ground beside streams and creeks
Philydrum lanuginosum	Woolly frogmouth	Tufted succulent herb to 1.5m, numerous yellow flowers, common in swamps and edges
Phragmites australis	Common reed	Tall reed-like grass to 2m, common on margins of saltmarshes
Restio tetraphyllus ssp. *meiostachyus*	Tassel cord rush	Elegant rush to 1.2m, found in sheltered coastal marshes, uncommon, but good stands present in Scarborough Park
Scaevola calendulacea	Scented fan flower	Robust prostrate herb forming dense mats on sandy dunes near the sea, blue flowers
Schoenoplectus validus	River Clubrush	Erect rush to 1.5m forming dense stands on the edge of freshwater streams, common
Schoenus melanostachys	Black bogrush	Erect sedge forming dense graceful

SPECIES	COMMON NAME	BRIEF DESCRIPTION
		clumps 60-200cm, common in wet sandy soils
Selliera radicans	Fan flower	Creeping herb forming dense carpets in brackish saltmarshes (not tidal)
Triglochin multifractum	Water Ribbons	

Table 24. Plant species list for Alluvial Woodland/ Estuarine Forest.

SPECIES	COMMON NAME	BRIEF DESCRIPTION
TREES		
Allocasuarina littoralis	Black She-oak	Shrub 3-6m, common in drier woodland, often on rocky ground
Allocasuarina torulosa	Forest She-oak	Small rounded tree to 8m, in high nutrient soils in moist situations
Angophora floribunda	Rough barked apple	Small to medium tree in moist deep alluvial soils, common in wet sheltered forests
Banksia integrifolia	Coastal banksia	Shrub 6-16m common in coastal scrub, on dune successions and beside estuaries
Casuarina glauca	Swamp Oak	Tree to 20m in brackish marshes and estuaries, or lining muddy creeks
Eucalyptus amplifolia	Cabbage gum	Medium tree in swampy flats, often on shale derived soils
Eucalyptus botryoides	Bangalay	Medium tree 20-30m, common inland of dune scrub and in littoral rainforest pockets
Eucalyptus crebra	Narrow leaf Ironbark	Tall tree 30m usually found in drier areas on clay soils on Cumberland Plain
Eucalyptus eugenoides	Brown Stringybark	Medium tree 15-25m common in moist clay soils near creeks and rivers
Eucalyptus fibrosa ssp *fibrosa*	Ironbark	Tall tree to 35m, common on well drained clay soils on Cumberland Plain
Eucalyptus haemastoma	Scribbly gum	Very hardy small tree to 15m, common on skeletal soils
Eucalyptus pilularis	Blackbutt	Tall tree to 40m with spreading crown, common in poor sandy soils
Eucalyptus punctata	Grey gum	Tall open crowned tree to 35m, smaller on poor soils, found in a wide range of soils and situations
Eucalyptus robusta	Swamp Mahogany	Medium tree 20-30m in swampy creek and estuary margins with groundcover of marsh plants
Eucalyptus saligna	Sydney blue gum	Tall tree 30-50m, common in wet woodlands with deep alluvial soils
Eucalyptus tereticornis	Forest red gum	Tall tree to 40m with smooth pale trunk, common in well drained grassy alluvial soils
Ficus macrophylla	Morton Bay Fig	Huge spreading tree to 50m, found in

SPECIES	COMMON NAME	BRIEF DESCRIPTION
		sub-tropical rainforest and moist gullies around Sydney Harbour
Ficus rubiginosa	Port Jackson Fig	Small tree 4-10m common in sheltered gullies, especially moister areas
Melaleuca linariifolia	Snow-in-summer	Small paperbark to 8m, abundant in marshy gullies and beside swamps
Melaleuca nodosa	Ball Honeymyrtle	Shrub to 6m common in forests near marshy ground
Melaleuca stypheliodes	Prickly leaved paperbark	Small tree 6-15m common in swampy places near creeks and estuaries
Notolea longifolia	Mock Olive	Small shrub 2-4m found in wetter sclerophyll and rainforest areas
Rapanea variabilis	Muttonwood	Small shrub 2-3m high, found in sheltered forests and gullies, common in area
Syncarpia glomulifera	Turpentine	Tall tree 40m+ common in moist, well drained soils throughout the area
SHRUBS		
Acacia binervata	Two veined hickory	Dense dark tree to 15m, found in moist coastal forests in near coastal areas
Acacia decurrens	Sydney Green Wattle	Handsome shrub to 10m, common in forests on Cumberland Plain on clay soils
Acacia elongata		Open shrub to 3m, common in colonies on damp ground
Acacia falcata	Sickle leaved wattle	Open shrub to 5m, common on clay soils on Cumberland Plain
Acacia floribunda	White sallow wattle	Dense rounded shrub to 3m (or taller), common along coastal creeks and rivers
Acacia implexa	Hickory wattle	Slender graceful shrub 4-10m found in moist gullies around Sydney and on clay soils
Acacia longifolia	Sydney golden wattle	Attractive shrub 3-4m, very common in moist forests and disturbed ground
Acacia parramattensis	Parramatta Green Wattle	Shrub to 8m found in woodland on sry shallow sandy or clay soils
Acmena smithii	Lily Pilly	Dense dark shrub smaller in exposed areas, common in gullies and rainforests
Backhousia myrtifolia	Grey myrtle	Spreading shrub to 4m found in dense colonies beside streams
Banksia ericifolia	Lantern Banksia	Rounded shrub 2-5m, abundant in heath and woodland, important food plant
Banksia spinulosa	Hair pin banksia	Erect rounded shrub to 2m, common in woodland with moist soils
Breynia oblongifolia	Breynia	Shrub 2-3m common in rainforest, moist gullies and along creeklines
Bursaria spinulosa	Blackthorn	Erect shrub 2-3m widely distributed,

SPECIES	COMMON NAME	BRIEF DESCRIPTION
		including along stream banks, can dominate
Dodonea triquetra	Common Hopbush	Soft shrub to 2m, common in forests and disturbed areas, good coloniser
Epacris stricta	Native fuchsia	Slender shrub to 1.5m, prolific flowers, common on rocky ground in woodland
Hakea teretifolia	Dagger hakea	Stiff prickly shrub to 1m, abundant in low moist coastal heaths
Kunzea ambigua	Tick bush	Tall shrub to 4m with dense foliage, good coloniser
Melaleuca ericifolia	Swamp Paperbark	Shrub to 6m, common on semi-saline swampy ground near estuaries
Melaleuca decora	White Feather Honeymyrtle	Shrub 6-20m, common on marshy ground especially on clay soils
Olearia microphylla	Bridal daisy bush	Shrub to 1.5m with dense fragrant flowers, fairly common in woodland
Omalanthus populifolius	Bleeding Heart Tree	
Pittosporum undulatum	Sweet Pittosporum	Shrub 3-10m common and widespread especially around creeklines
Polyscias sambuccifolia	Elderberry Panax	Erect shrub 2-3m common in sheltered woodland gullies
Trema aspera	Native peach	Tall shrub 3-5m, fairly common in moist forests along streams
Xanthorrhoea resinosa ssp resinosa	Grasstree	Grasstree to 2.5m, fairly common in the area in moist heathland
GROUNDLAYER HERBS AND GRASSES		
Aristida ramosa	Three awn Speargrass	Slender clumping grass 20-60cm tall, common in heath and woodland
Asplenium flabellifolium	Necklace fern	Small weak fern with trailing frond 10-20cm, common in moist sheltered situations
Austrodanthonia (Danthonia) tenuior	Wallaby grass	Erect grass with slender stems to 50-70cm, common on a range of soils and vegetation
Blechnum pattersonii	Strap Waterfern	Dark leathery fern with frond 20-50cm, common in rainforests and wetter areas
Carex appressa	Carex	Graceful sedge 70-100cm, common from moist forests to open swamps with standing water
Cladium procerum	Leafy Twigrush	Erect sedge1-1.5m found on the edges of freshwater swamps on the coast
Leptinella (Cotula) longipes	Waterbuttons	Creeping herb with fleshy divided leaves, found in slightly brackish marshes on coast
Cymbopogon refractus	Barbed wire grass	Tufted grass with tall wiry stems, fairly common on sandy or stony woodland soils
Cyperus difformis	Sedge	Erect sedge 30-50cm found in marshy

SPECIES	COMMON NAME	BRIEF DESCRIPTION
		disturbed places in Western Suburbs
Dianella caerulea producta	Blue flax lily	Tufted herb to 50cm, common in woodland on sandstone soils
Dianella longifolia var longifolia	Flax lily	Erect tufted herb to 1m, on clay and sandstone on Cumberland Plain
Doodia caudata	Small Rasp Fern	Erect or drooping fern 15-30cm, common in moist sheltered gullies
Echinopogon ovatus	Forest Hedgehog Grass	Slender grass 60-100cm, common in woodland on a range of soils, easily recognized by its dense tufted seed head
Entolasia marginata	Flag grass	Wiry grass in dense spreading tuft, common on rocky sandstone soils in woodlands
Gahnia clarkei	Saw Sedge	Tall leafy sedge to 2.5m common on marshy sites and creek banks
Hardenbergia violacea	False sarsaparilla	Attractive climber with rich purple flowers, common on bare rock and soil in woodlands
Hemarthria uncinata	Matgrass	Creeping grass 30-80cm tall, usually forming dense colonies on marshy ground
Imperata cylindrica	Blady grass	Erect grass to 1m, hardy and abundant in a range of conditions, thrives on margins of swamps and moist ground
Juncus kraussii	Sea Rush	Tall coarse rush 1-2m growing in dense clumps on the edges of brackish estuaries
Juncus usitatus	Common rush	Graceful rush forming dense clumps to 1m, common in disturbed moist to swampy soils
Kennedia rubicunda	Dusky Coral Pea	Robust twiner with large red pea flowers and stems 2-3m, abundant in sunny places
Kunzea ambigua	Tick Bush	Spreading shrub 2m common in heath and scrub where it colonised disturbed ground
Leucopogon juniperinus	Bearded Heath	Small dense prickly shrub to 1m, common understorey species on clay soils in forests
Lomandra longifolia	Mat rush	Hardy tufted perennial common in a range of habitats, including heath and woodland
Lomandra multiflora ssp multiflora	Many flowered Mat rush	Grasslike herb with flowers in dense clusters, common in heath and woodland
Microlaena stipoides	Weeping meadow grass	Slender grass 15-70cm, common in woodland on sandstone soils

SPECIES	COMMON NAME	BRIEF DESCRIPTION
Oplismenus imbecillus	Basket Grass	Small sprawling grass forming colonies in shady or wetter woodland areas
Pandorea pandorana	Wonga Wonga Vine	Tall vigorous woody climber common in many situations
Persicaria lapathifolium	Knotweed	Erect or drooping herb 1-2m found on permanently wet ground besides creeks and swamps
Pimelia linifolia	Slender Rice Flower	Graceful shrub to 50cm abundant in area in sunny places in heath and woodland
Poa sieberiana var sieberiana	Snow grass	Dense tussock grass with panicle 60-100cm tall, common on clay in Cumberland Plain
Themeda australis	Kangaroo grass	Slender tufted grass to 1m, once common throughout the area

Developing Vegetation Structure

Natural environments provide places for many different species to live, so if we are to replicate or perhaps even enhance such environments; a number of elements need to be considered. Typically there are five structural layers in native bush-land:

1. **Canopy:** large trees (e.g. gums) which due to their size provide resources to a vast array of animals.
2. **Under-story:** large shrubs (e.g. Acacias or Banksias) provide shelter as well as rich sources of nectar and insects.
3. **Small shrubs:** (e.g. Saltbush or Leucopogons) as for large shrubs, but typically with increased plant diversity.
4. **Ground cover:** the greatest natural plant diversity is typically seen in this layer, which contributes to a rich insect fauna and in turn the diversity of many vertebrate species. Unfortunately, it is also one of the layers that can disappear in a manicured or overly tidy garden.
5. **Leaf-litter:** is a layer that reduces the loss of moisture and harbours decomposers such as bacteria and fungi which return vital nutrients to the soil. A wide range of invertebrate species live in this zone and many birds, mammals, lizards and frogs forage here because of its rich offerings.

Figure 59. The more layers in the vegetation, the more potential habitats.

The greater the number of layers in the wildlife friendly habitat, the greater the number of potential habitats, or places to live, for native fauna (Figure 59).

Once a list of suitable plant species was selected for each treatment area, their density and arrangements were determined, based on the requirements of each species and the desired outcomes for the treatment area. Desired outcomes could include:

- Establishment of canopy trees for habitat and shade
- Establishment of understorey shrubs to enhance habitat components
- Establishment of groundlayer cover for control of erosion, or to enhance habitat components
- Rapid establishment of aquatic cover for control of erosion, treatment of water quality, or to enhance habitat components

Establishment Phase Maintenance

The establishment phase is important because juvenile plants need to be protected until they become tolerant of local conditions. This phase typically covers a 12 month period from the time of planting. The most important activities required during the establishment phase include:

- Watering;
- Monitoring of plant establishment and growth;
- Replanting;
- Weed control;
- Plant protection;
- Restriction of public access.

Monitoring Plant Growth And Replanting

Regular, long-term maintenance of plant species within the wetland is essential to ensure that the system functions as desired. The health of the plants should be visually inspected fortnightly during the first two months and monthly thereafter.

Plants may suffer from transplant shock, disease or from insufficient watering during the first 6 months following installation. Discolouration or wilted leaves indicate poor plant health and could be caused by inadequate watering, disease or lack of nutrients. Plants that have not grown since being planted or showing signs of discolouration in the leaves may require the application of fertilisers. If plant survival rates are below 90% or if plants have been predated or displaced during storm events replanting should be undertaken.

Weed Control

During storm events, there is a possibility that sediment may be mobilised, which can facilitate weed invasion. Weeds are undesirable as they compete with establishing plants for light, nutrients and space. It is preferable to manually remove weeds before their abundant growth requires herbicide application. Recent research has confirmed that glyphosate is detrimental to the survival of soil and litter macro-arthropods, and there are on-going implications for restoration processes in rainforests and other wetland forests (Nakamura et al, 2008).

- During the warmer months from late spring to early autumn, the site should be monitored fortnightly and weeded as required; and
- During the cooler months, from mid autumn to early spring, the site should be monitored and cleared of weeds on a monthly basis.

If an abundance of small weeds do germinate and manual removal is not feasible, herbicide treatment may be the most cost effective management strategy.

Protection From Predation

Some birds, macropods, possums and gliders, and sometimes people, are known to cause significant damage to seedlings, and it is important to minimise damage during the establishment phase. If seedlings are seriously damaged or removed the area should be replanted with larger plants, or clumps of well-established plants can be transplanted. Protection options include installation of guards, exclusion fencing, netting, scare tactics and distraction feeding.

Plant Replacement

Regular maintenance of plants is essential to ensure that the wetland system functions as desired. Plant health and coverage should be monitored on a monthly basis.

When To Replant

Additional plants should be installed if:

- Survival rates are below 90%;
- Plants have been predated upon or displaced by storm events; or
- Plants have been removed when sediment is removed.

Take care not to confuse plants in senescence ('hibernation') with those that are dead or unhealthy. Senescence generally occurs over the winter months. Although plants in senescence may appear dead or lose their foliage, they can be distinguished from dead or unhealthy plants by:

- Remnants of viable plant growth;
- Green shoots at the base of the plant; and
- A firmly anchored root system.

Replanting Techniques

The following list summarises the appropriate replanting technique:

1. Dig a hole twice the size of the plant root-ball using a shovel, hoe or hand tools;
2. Dig the plant in so that the top of the root-ball is slightly below or level with the surrounding soil surface;
3. Place a fertiliser tablet near the root-ball (optional); and
4. Back-fill the hole and firm down the surrounding soil to ensure that there is complete contact between the roots and soil; and that the plant is not easily dislodged.

APPENDIX G GROSS POLLUTANT TRAPS IN STORMWATER TREATMENT

Gross Pollutant Composition

Organic material – leaves, twigs and grass clippings – constitute the largest proportion of gross pollutant load (by mass) carried by urban stormwater (CRC-CH, 1997). This was observed across all urban land-use types. Vegetation, however, is not a major source of nutrients compared to other sources. The potential total phosphorus and total nitrogen loads from vegetation in stormwater are about two orders of magnitude lower than the loads measured in stormwater samples. However, because of its large volume, plant matter should be taken into account in the selection of gross pollutant traps, particularly where they could cause pipe blockages or habitat destruction.

Most of the litter analysed – by mass and frequency – comprised paper and plastics. These enter the drainage network as street litter from mainly commercial areas. Large quantities of food, drink and cigarette refuse were also found during the monitoring. Typically only 20 percent of the litter and less than 10 percent of the vegetation usually floats. This has implications for traps designed to catch only floating material.

Gross Pollutant Transport During Storms

Analysis of rainfall, discharge, gross pollutant concentration and gross pollutant load rate during a typical storm event show that:

• the composition of gross pollutants during events remains relatively constant compared to the concentration and load fluctuations

• gross pollutant concentrations are highest during the early stages of runoff, but most of the load is transported during times of high discharge

• the loads and concentrations of gross pollutants generated by a storm are similar to those generated by other storms occurring earlier on the same day

The large amount of gross pollutants suggests that stormwater channels are effective in transporting gross pollutants from urban areas. Not only do discharge and pollutant conditions in stormwater drains change and vary considerably, but so does the material carried. It may be any size, shape, density or hardness. Trapping systems should be geared to treat the maximum possible discharge, and to cope with multiple storms in a day.

Trapping Gross Pollutants

Methods for reducing gross pollutants in urban waterways can be grouped into two categories:

• Structural methods are traps placed in Side Entry pits in gutters, or installed inside stormwater channels to separate and contain gross pollutants

• Non-structural methods involve changing the attitudes and actions of the community (including business, industry and residents)

Increasing concern about the quantity of gross pollutants in urban waterways is leading to greater use of gross pollutant trapping devices. Although different types of trapping devices are now available, there is little information on their performance. This is the focus of the CRC`s second monitoring program. Two main characteristics determine the performance of a gross pollutant trap: trapping efficiency, and maintenance requirements. The trapping efficiency is defined as the proportion of the total mass of gross pollutants transported by stormwater that is retained by the trap. A low trapping efficiency means that gross pollutants pass through the trap and reach downstream waters. A poorly maintained trap will be inefficient at trapping pollutants, and is also a potential source of pollutants as trapped materials break down.

The first gross pollutant traps were built in the late 1970s using simple designs. More recent technologies have incorporated high-tech design and construction. Six trapping systems commonly used in Australia are described here, from those designed for the upper parts of catchments (e.g. SEPTs), to those intended for slow-moving waterways (litter booms) further down the catchment.

SIDE ENTRY PIT TRAPS (SEPTS)

Side entry pit traps (SEPTs) are baskets fitted below the entrance to drains from road gutters. When stormwater passes through the baskets to the drain, material larger than the basket mesh size (5-20 mm) is retained. This material remains in the basket until it is removed by a maintenance crew, typically every four to six weeks. SEPTs are intended to be used at many locations throughout an urban area, and can catch up to 80 percent of the litter in a catchment.

LITTER CONTROL DEVICE (LCD)

In the litter control device the baskets sit below the entry point of the inlet pipe. Water entering the basket flows out through the holes, while debris larger than the pore size is retained. As debris builds up, it reduces the pore sizes, allowing smaller material to be caught. Trapping efficiencies of 30 to 80 percent have been reported, depending on a monthly or weekly cleaning frequency.

TRASH RACK

Trash racks consist of vertical or horizontal steel bars – typically 40-100 mm apart – fitted across stormwater channels up to 10 metres wide. They are manually cleaned, usually monthly. When water passes through the trash rack, it retains material larger than the bar spacing. As material builds up behind the trash rack, finer material is collected. However, this frequently blocks the rack, causing overflows that carry collected pollutants downstream.

CONTINUOUS DEFLECTIVE SEPARATION (CDS)

The continuous deflective separation (CDS) device is installed in stormwater channels and works by diverting the incoming flow of stormwater and pollutants into a pollutant separation and containment chamber. Solids within the separation chamber are kept in continuous motion, and are prevented from 'blocking' the screen. Water passes through the screen and flows downstream. The

non-blocking screen ensures that all gross pollutants are retained except for flows that overflow the by-pass weir during large floods. Floating objects are kept in continuous motion on the water surface, while heavier pollutants settle into a containment sump from where they can be routinely removed.

GROSS POLLUTANT TRAP (GPT)

Gross pollutant traps (GPTs) consist of a large concrete-lined wet basin upstream of a weir. A trash rack is located above the weir. The decreased flow velocities in the wet basin encourage coarse sediments to settle to the bottom. Gross pollutants are retained by the trash rack – usually made from vertical steel bars – at the downstream end of the basin. The trash rack collects floating and submerged debris in the same way as conventional trash racks. Major and minor GPTs have been developed to accommodate small (2–50 ha) and large (50–500 ha) catchments. Both operate with the same principles.

FLOATING DEBRIS TRAP (FDT)

Floating debris traps (FDTs), or litter booms, are made by stringing partly submerged floating booms across waterways. The booms collect floating objects as they collide with it. Newer designs use floating polyethylene boom arms with fitted skirts to deflect floating debris through a flap gate into a storage compartment. The performance of any boom is influenced by the flow conditions of the waterway – they are best suited to slow-moving waters. Because more pollutants sink than float, the traps are only useful for trapping highly buoyant materials, and thus miss most of the gross pollutant load.

Gross Pollutant Traps For Baludarri Wetlands

Two main options are suitable for applications such as the main drainage inflow at Baludarri Wetlands. These are CDS units, generally installed off line in the existing drainage network, and Pratten Traps, which can be retrofitted on line, and are generally installed at the end of pipe.

ROCLA'S CDS UNIT

CDS GPTs such as Rocla's CDS units (Figures 62 and 63) are suitable for subdivisions and roads, residential, commercial and industrial developments, carparks and shopping centres. They can provide pre-treatment for wetlands, and for reuse applications, and can be installed on pipes, channels, culverts and creeks.

Figure 60. Rocla's CDS 0708: empty, and full of gross pollutants.

Figure 61. Precast diversion units can be installed almost anywhere; the filternator sits inside the unit and screens bulk solids from stormwater.

Around the Baludarri Wetlands area the catchment is considered stable, with little major construction activity, thus the level of sediment generated is not very great. As a result, sediment removal from wetlands may only be required every 3 to 5 years. Wetlands immediately downstream of inlets may require removal of sediment build-up, and should have regular maintenance examinations. When sediment levels reach 150mm, or become sufficient that they interfere with the effective functioning of the GPT, this sediment should be removed. Wetland zones further downstream from inlets may not require management of sediment levels at all.

Figure 62. How the centrifugal diversion screen system works.

The size and type of CDS® GPT required depends on catchment area, flows, pollution loads, performance requirements, maintenance method, hydraulic limitations and site constraints. Precast diversion chambers can be manufactured to suit most typical installations, or chambers can be tailored to meet the hydraulic limitations of the site. The diversion chamber has the capacity to cater for the highest possible flow in the stormwater system. The chamber is configured on the assumption that the CDS® unit has not been maintained and there is no flow passing through the unit. A weir is located within the diversion chamber to create a driving head and direct the majority of flows into the CDS® GPT.

Advantages of the Rocla CDS GPT include:

- 95% capture of gross pollutants >1mm
- 95% sediment capture >200µm
- Captures organics and oils
- Captures adsorbed toxics and nutrients
- Can treat any pipe or multiple pipes

- Various sump sizes available
- Customised bypass requirements
- Underground - small footprint
- Easy installation
- No moving parts
- Lowest life cycle costs
- More water treated than comparable treatment designs
- Pollutants stored in the sump, not the screens

Figure 63. CDS GPTs can be cleaned using a grab arm or a suction cleaner.

END OF LINE PRATTEN TRAPS

Pratten Traps are used to capture stormwater pollutants at drainage outlets. They are a customisable gross pollutant trap that is fitted to the end of stormwater pipes and captures gross pollutants and other wastes. These end-of-pipe traps capture pollutants that enter the drainage network during heavy storms (during high flow bypass), ensuring the maximum possible collection of waterborne pollution.

Figure 64. Retrofit Pratten Traps.

Among the main advantages of the Pratten Traps is the ease with which they can be retrofitted to most outlets; minimal risk of flooding; and low product and performance risk as the trap has no complicated moving parts. Their maintenance requirements are simple, and their simplicity reduced long term maintenance as well. Regular examination is required after storm events, which involves a simple visual check to determine the volume of debris collected, and whether the trap needs to be emptied (Figure 63). The traps are detachable yet secure to allow for easy removal of pollutants and repair, if necessary, while minimising the risk of theft and vandalism (Figure 65).

Figure 65. Detachable traps are easy to maintain, but secure.

Pratten Traps are cheaper to install and easier to access than CDS units, but lack the visual amenity. Where aesthetics is an important consideration for treatment structures, Pratten Traps may be less suitable than other options.

APPENDIX H RABBIT PROBLEMS IN AUSTRALIA

Rabbits, like most other pest species, were introduced when Europeans first settled in Australia. Rabbits were introduced from two main sources; the domesticated rabbit which provided early settlers with a ready source of meat, and the wild rabbit introduced later for hunting. Thomas Austin is credited with releasing 24 wild rabbits at his Barwon Park property near Geelong in Victoria in 1859. This small population exploded to cover Victoria and New South Wales by 1886. By 1900, rabbits had reached the Northern Territory and Western Australia.

In some other areas, feral domesticated rabbits also established populations. Typically, these rabbits have different colourings compared to the wild rabbits released by Thomas Austin.

Environmental Vandals

The rapid spread of the rabbit led to the destruction of large tracts of vegetation, leading to the extinction of many plant species. Loss of vegetation leads to soil erosion as the exposed soil is washed or blown away, removing valuable soil nutrients required for new plants to develop. This soil is typically deposited in waterways, causing siltation and destroying aquatic ecosystems. This wanton destruction of habitat has contributed to the demise of many native marsupial species, such as bilby and bandicoot, as their feed sources were outstripped by marauding rabbits.

Competitors

Rabbits actively compete with domestic livestock and can alter pasture composition by selectively grazing on more palatable and nutritious plants. Seven to ten rabbits eat the equivalent of one adult sheep, and, during drought periods, rabbits can totally strip a landscape bare leaving no food for sheep, cattle or native animals.

Biological Control Agents

In the past, rabbit populations have been reduced enormously with the introduction of biological control vectors. In 1950, the myxomatosis virus initially wiped out between 95 and 100% of rabbits in some areas. However, rabbits recovered with the development of resistance in many populations. The introduction of Rabbit Haemorrhagic Disease or Rabbit Calicivirus (RHDV or RCD) also helped control populations, especially in arid areas, but again, rapid resistance to RCD has left rabbits as one of Australia's most formidable pests.

The Pest Animal Control Cooperative Research Centre recently estimated the direct cost of rabbits to the Australian economy at $113.11 million; however other estimations have suggested that the costs could be much higher at closer to $600 million.

Rabbit Biology

Rabbits are territorial animals with a well defined hierarchy or 'pecking order'. Rabbit territories and areas where they feed are commonly defined by piles of scats or faeces or by a scented exudate from glands under the chin.

Rabbits will rarely feed outside these designated areas unless seasonal feed shortages force them to forage further afield. This is one of the key determinants in the success of a baiting program, as it is crucial to lay the trail where the rabbits are feeding. This area may not be where the warrens are located.

Breeding

A dominant male, or 'buck', mates with most does within the group's territory. Dominant females can prevent lesser females in the group from breeding. The gestation period of a rabbit is 28-30 days, with the average litter size between three and four kittens, depending on the age of the doe. Young does may have as few as two kittens, yet mature does may have eight or more. Five to six litters are possible in a good season.

Given excellent seasonal conditions, a mature doe is capable of mating again within hours of giving birth, while young does can start to breed at four months of age. In areas with less reliable rainfall and vegetation with poor nutritional value, breeding can be limited.

Dispersal

Juvenile rabbits will migrate from their parental territory to establish new territories of their own depending on seasonal conditions. The presence of unused warrens and harbour makes it easier for these rabbits to re-establish in an area.

Integrated Rabbit Control

For a rabbit control program to be successful, an integrated approach is vital. Shooting, baiting or fumigating without follow-up warren or harbour destruction will leave ready-made homes for young migrating rabbits from surrounding areas.

Landholders should seek advice from their local government agency, licensed contractor or Landcare coordinator. These skilled staff can provide information about supplementary action for rabbit control including:

- fumigation of warrens
- fencing
- destruction of warren systems
- removal of rabbit harbour
- shooting

The aim of any rabbit control program should be to achieve local eradication and to prevent re-infiltration. One of the best approaches to achieve this is to work with your neighbours or local Landcare group. Group programs achieve the best results and lowest long-term costs as rabbits are removed from a wider area. The wider the area of the group program, the better the chances of limiting rabbit re-infestation.

Ripping warrens and destroying harbour assist in long term rabbit control by making it difficult for rabbits to find readymade shelter.

Importance Of Achieving High Levels Of Rabbit Control

The success of any rabbit control program in the long term depends on the level of control achieved at each step. Leaving just 10% of a rabbit population will result in the need to repeat the operation next season as the 10% of the initial population of rabbits will breed back to the pre-control population within 12 months if conditions are favourable.

As with most large-scale pest problems, best results will be achieved by coordinated approaches on neighbouring properties. Aim for 100% control and remove safe havens to prevent re-establishment.

APPENDIX I CONSTRUCTED HABITAT ELEMENTS FOR RESERVES

Natural Nest Hollows

A high proportion of Australian birds and mammals are dependent on hollows in trees for nesting and shelter. Over 20% of our native fauna are obligate hollow users. Gibbons and Lindenmayer (2002) have found that more than 300 native species utilise tree hollows in Australia, underlining the importance of this diminishing natural resource. Fauna including mammals, reptiles, amphibians and birds all use tree hollows, even native bees.

The number of suitable nesting hollows in trees is declining throughout New South Wales, and particularly in Sydney. Trees are dying and falling over and very few trees are becoming the age at which hollows form. It can take over 120 years for suitable hollows to develop in a eucalypt tree. There is also a huge trade in the older trees for fire wood which is recognized as a major reason for the decline in some woodland species. Nesting boxes provide an important supplement to naturally occurring hollows in urban areas. A number of native birds and mammals frequently come into urban areas to feed from native trees planted in suburban gardens. However they are unable to breed due to the lack of sufficient nesting hollows.

Native Species That Use Nest Boxes

Bats

A number of species of insectivorous bats occur in the Sydney area. They all require daytime roosts, normally tree hollows. Bats are excellent at controlling insect pests around the home. These special boxes are designed for bats only and will not attract unwanted pest species such as bees or feral birds. The area below the box should also be free from obstructions to allow easy access. Boxes should be placed as high as possible and facing to the west or east to get the morning sun.

Figure 66. Bats are becoming regular users of roost boxes.

Parrots

Parrots are amongst the most colourful of the Australian birds. Many of those in the Sydney suburban area feed on nectar from eucalypts. They require hollow branches in which to breed. Some parrot species (eg Lorikeets) tend to do better when nesting close together as this helps them compete with the more aggressive Starlings and Indian Mynahs. Two types of parrot boxes are available, vertical and horizontal.

Figure 67. Parrots are colourful users of nestboxes.

Ducks

Several duck species are known to use hollows in trees. Wood Duck and Black Ducks use tree hollows and will use nest boxes. Other duck species, such as Chestnut and Grey Teal will use nesting boxes if they are placed over water. This box has a special entrance that prevents predators from getting eggs, and can be placed on a tree or post.

Figure 68. A possum in a "natural" nesting box.

Possums: large and small

The two common species of Possums in the Sydney area are the Brushtail and Ringtail Possums. The larger Brushtail is well known for entering suburban homes. By giving them a house of its own will keep them out of yours. The smaller Ringtail possum can make its own nest in dense undergrowth, but will use nesting boxes.

Sugar gliders

Another possum species in many parts of Australia is the Sugar Glider. These beautiful animals can live in groups of five or more. They have a diet of insects, nectar and tree sap. It has been found that eucalypts that have Sugar Gliders living on them are healthier than those without. This is because of the large numbers of insect pests that they consume. Like the Squirrel Glider, Sugar Gliders prefer small entrances to their nests. In highly urbanised environments, many of the other gliders will favour nesting boxes with small entrances.

Other bird species

Many other Australian birds use nest hollows, including Tree-Creepers, Owlet Nightjars, Owls, Pardalotes and Kookaburras. There are nest boxes available that have been designed for these species, and these will be discussed in more detail in the next section.

Looking After Your Nest Box

Ideally boxes should be placed away from night time lights and at least three metres from the ground and located in a sheltered location. Choosing a location will depend on the target species, and surrounding vegetation. Aspect is usually very important – don't face them west: gliders in particular hate this! You should put a small amount of wood shavings or shredded bark in the bottom of your nesting box. This provides some insulation as well as nesting material.

Feral species

A number of introduced animals compete with Australian animals for nesting hollows. Of these the Starlings, Indian Mynahs and Honey Bees are the most destructive. They compete with native species for nesting hollows and some will even build nests over the tops of nests of native animals. Introduced species and their nests should be removed from nesting hollows and boxes. Nests built by Indian Mynahs and Starlings usually are very untidy and often contain plastic and other bits of rubbish. In the case of bees a pest strip placed in a box for a few days will kill them. All dead bees and honey comb should be removed (the honey should not be consumed).

Caution: Bees can be very aggressive. We recommend you contact a professional pest controller for advice.

Nest boxes need to be installed and maintained by suitably qualified professionals (Figure 69). Boxes should be constructed by a suitably skilled person, and made from marine plywood and painted inside and out. Maintenance regimes for nestboxes for different species will vary. The need (and opportunity) for cleaning should be determined separately for each type of nestbox.

Figure 69. Nest boxes need to be maintained by suitably qualified personnel.