Hawkesbury City Council

attachment

to

item 60

Attachment 1

The Yarramundi Reserve Draft Plan of Management

date of meeting: 27 March 2007

location: council chambers

time: 5:00 p.m.

Yarramundi Reserve

Draft Plan of Management

Prepared by LandArc Pty Limited

22 September 2006

CONTROLLED DOCUMENT
Draft Issue C: 22 September 2006

This Plan of Management for
Yarramundi Reserve, Yarramundi
was prepared by

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1.0 Introduction

1.1 Overview

This Draft Plan of Management applies to the Crown land described as Yarramundi Reserve, located at the confluence of the Grose and Nepean Rivers, being the start of the Hawkesbury River. The study area lies to the west of Agnes Banks and Yarramundi Lagoon within a predominantly rural context *(refer to Figure 1: Location Plan).* On 5 April 2002 the Minister for Land and Water Conservation established and named the Yarramundi (R1003168) Reserve Trust and appointed Hawkesbury City Council to manage the affairs of the trust (ie. care, control and management).

In March 2002 LandArc Pty Limited, landscape and heritage consultants, were engaged by Hawkesbury City Council to prepare a plan of management for the reserve. The project cost for the consultancy was $30,000.00 with an equal (50:50) funding split shared between the NSW Department of Land and Water Conservation (now NSW Department of Lands) and Hawkesbury City Council. The release of the draft for public exhibition however was delayed as a result of the Yarramundi Bridge Replacement project. The new bridge, located immediately to the north of the old bridge, was constructed by the NSW Roads and Traffic Authority (RTA). The replacement bridge opened in early 2004. This Draft Plan of Management has been amended and updated accordingly to include these and other changes to the reserve.

1.2 Location and Context

Yarramundi Reserve covers an area of 78 hectares and is comprised of a linear parcel of land and water (including the river bed). The study area is located wholly within the riparian corridor. It is a diverse landscape of natural river and flood channels, former quarried lagoons and back-waters, wetlands, steep river banks and gently sloping foreshores, sand and gravel beaches, sand dunes, ridges and swales of alluvial silts and constructed rock revetments. The reserve's geomorphic and hydrological characteristics have been significantly modified by past extensive sand and gravel extraction.

The landscape surrounding Yarramundi Reserve is defined by intensive agricultural uses (ie. market gardens, orchards, plantation timber and turf growing). Springwood Road and Yarramundi Bridge bisect the reserve and form important points for visitor access into the reserve. Navua Reserve, adjoining the north-western boundary of Yarramundi Reserve, provides a key recreational focus for the reserve. Although not part of this Plan of Management, Navua Reserve, provides visitor access to the northern section of Yarramundi Reserve *(refer to Figure 2: Study Area).*

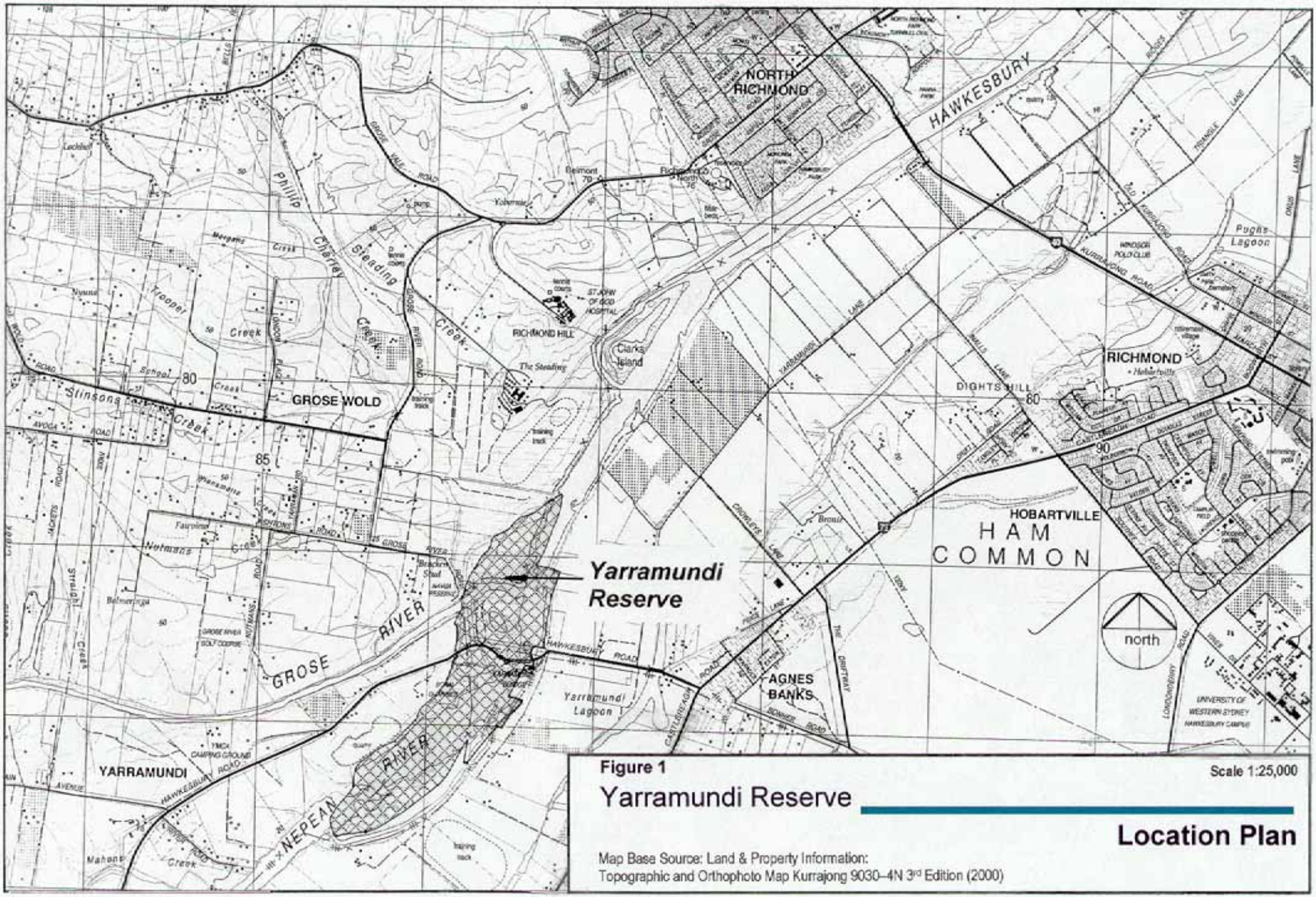

Figure 1

Yarramundi Reserve

Location Plan

Map Base Source: Land & Property Information:
Topographic and Orthophoto Map Kurrajong 9030–4N 3rd Edition (2000)

The reserve's landscape and environmental quality are products of the dynamic riverine environment and the changes brought by a range of human-induced impacts. Its natural values have been highly modified and degraded since European settlement, particularly as a result of vegetation clearing, reduced river flows, past gravel and sand extraction, agricultural and urban development within the catchment and subsequent weed invasion. The reserve's aquatic and terrestrial ecosystems and their natural processes remain under significant threat from further degradation and fragmentation. Nevertheless, the reserve represents an outstanding resource and a regional asset with significant opportunities for rehabilitation and restoration of environmental, visual, social, scientific, educational and recreational values.

Yarramundi Reserve's riparian natural setting currently offers a unique opportunity for local and regional recreation with a focus on water-based, active/ passive and nature-based activities. Fishing, canoeing, swimming, nature-based study/ bird-watching, educational activities, walking, mountain-bike riding, jogging, exercising the dog(s) and horse riding are all popular uses of the reserve. Furthermore, the reserve's scenic, environmental and biodiversity values, are similarly highly valued by the community. The reserve offers significant habitat for a range of aquatic, wetland and terrestrial plants and animals including threatened species protected under State legislation.

This combination of recreational opportunities, river/ foreshore access, water quality, diversity in natural settings, scenic quality, tranquillity and public safety are all considered key values in determining the significance of this reserve within the lower Hawkesbury-Nepean catchment. These values are discussed further in section *4.0 Basis for Management.* It is important that this Plan of Management establishes an appropriate balance in protecting, restoring and managing these values.

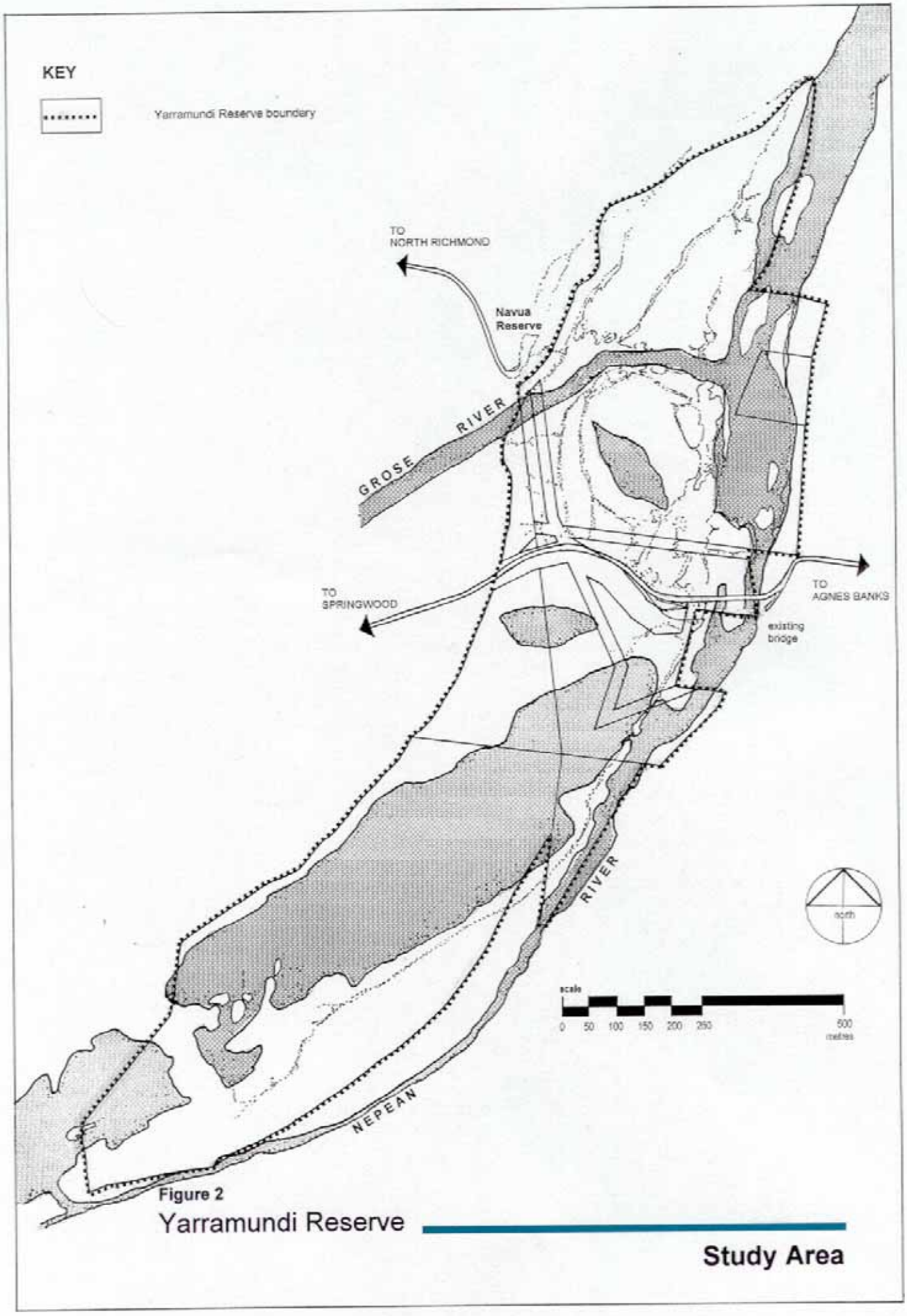

Figure 2

Yarramundi Reserve

Study Area

1.3 Aims and Objectives

This Plan of Management has been prepared in accordance with the *Crown Lands Act 1989*, case law and all other relevant policies and legislation. The Plan aims to provide a clear, concise and practical framework for the management, development and rehabilitation of Yarramundi Reserve. There are three main objectives which have guided the preparation of this Plan of Management:-

- *To determine the future management of Yarramundi Reserve and the balance between conservation and protection of the environment and the recreational needs of the wider community;*
- *To develop a staged management strategy identifying site rehabilitation, appropriate management and development for recreational opportunities whilst facilitating the continuation and enhancement of natural processes; and*
- *To identify and prioritize the costs involved in required works, taking into account available funding sources, and to identify potential funding sources for ongoing site development and rehabilitation.*

The Plan of Management aims to be performance oriented in order to contribute towards Council achieving its strategic goals, vision, mission and strategic outcomes as outlined in the *Draft Hawkesbury City Council Management Plan* and the *Draft Hawkesbury City Council Open Space and Recreation Plan*. The Plan of Management is to be reviewed on a five year basis.

As a means to achieving these aims, the Plan of Management uses a values-based approach to land planning and management. This approach facilitates strategies which will protect and enhance values, whilst identifying the issues which may pose a threat to these values. It thus ensures the longer term objectives of sustainable management.

While preparation of the Plan of Management has ensured an environment of consultation with the local community and key stakeholders, it is important to recognize that the approach has remained values-based rather than issues-driven in the management outcomes. At an organizational level, the Plan of Management has evolved through a team approach with direction provided by a Steering Committee including representatives from the NSW Department of Lands (formerly Department of Land and Water Conservation) and key members of Hawkesbury City Council staff.

The Plan of Management aims to provide the following strategic outcomes for Yarramundi Reserve:-

- identification and assessment of the reserve's values, public purpose, existing uses and condition and its role within the Hawkesbury City Council local government area (LGA) and broader regional context;
- identification and assessment of key issues affecting the reserve's values;
- establishment of guidelines for future permitted uses and development of this land including leases and/ or licences;
- development of appropriately staged management strategies, including priorities for a strategic plan (5-years), estimated capital works expenditure and ongoing resourcing implications; and
- preparation of a landscape masterplan.

1.4 List of Abbreviations used in this Plan

CLA	Crown Lands Act 1989
HCC	Hawkesbury City Council
HNCMA	Hawkesbury-Nepean Catchment Management Authority
HRCC	Hawkesbury River County Council
HRFS	Hawkesbury Rural Fire Service
LEP	Local Environmental Plan
LGA	Local Government Area (Hawkesbury City Council)
NPWS	National Parks & Wildlife Service (NSW)
NSWRFS	New South Wales Rural Fire Services
RTA	NSW Roads & Traffic Authority
ROTAP	Rare or Threatened Australian Plants database
SCRFF	Sydney Coastal River-flat Forest
TSC Act	Threatened Species Conservation Act (1995)

2.0 Land Description and Planning

2.1 Land Description

Yarramundi Reserve is located within Hawkesbury City Council local government area (LGA). The south-eastern portion of the reserve shares a common boundary with the City of Penrith LGA. As outlined in the previous section, the reserve is comprised entirely of Crown land parcels including Lot 1 DP 1040789 (formerly identified as Lot 190 DP 803295), Lot 3 DP 393015 (formerly identified as Lot 191 DP 803295), Lots 188 – 189 inclusive DP 803295, Lot 90 DP 786549, Lots 57 and 293 DP 751660, and Part Lot 28 DP 752021 within the Parishes of Ham Common, County of Cumberland, City of Hawkesbury, Parish of Castlereagh, County of Cook, City of Penrith and Parish of Nepean *(refer to Figure 3: Crown Reserve and Table 1: Land Description).*

The boundaries of the reserve are largely defined by the original survey of the middle thread of the river channel. The fluvial patterns of the Hawkesbury-Nepean and Grose Rivers have changed considerably over time, primarily as a result of major flood events and also through modification of the river bed during past gravel and sand extraction. The western boundary follows a former river channel while the eastern boundary is more closely aligned to the existing river channel of the Hawkesbury-Nepean River.

Between 1927 and 1989, Boral Resources (NSW) Pty Limited (formerly BMG Resources Limited) substantially modified the study area through gravel and sand extraction. Much of the earlier operations focussed on freehold land [Lot 1 DP 1040789, Lot 3 DP 393015 and Lots 188 – 189 DP 803295 and Lot 90 DP 786549 (ie. the land parcels north of Springwood Road and the immediate areas to the south of this road). Lot 57 DP 751660 was also occupied under Special Lease 21.5 granted 3.2.1922.

A Permissive Occupancy was granted to BMG Resources Limited in 1987 over the Crown land comprising the southern portion of the reserve [Lots 57 and 293 DP 751660]. The holder of the occupancy agreed to transfer to the Crown a significant area of freehold land (ie. Lots 188-191 and Lot 90 excluding road reserves) for the creation of a public reserve with the public purpose of Public Recreation and Environmental Protection. The Permissive Occupancy was terminated in 1994 by the Department of Conservation and Land Management (later known as the Department of Land and Water Conservation and more recently, the Department of Lands). *Refer to Appendix II: Community Issues Discussion Paper: A.2 Past Gravel and Sand Extraction*.

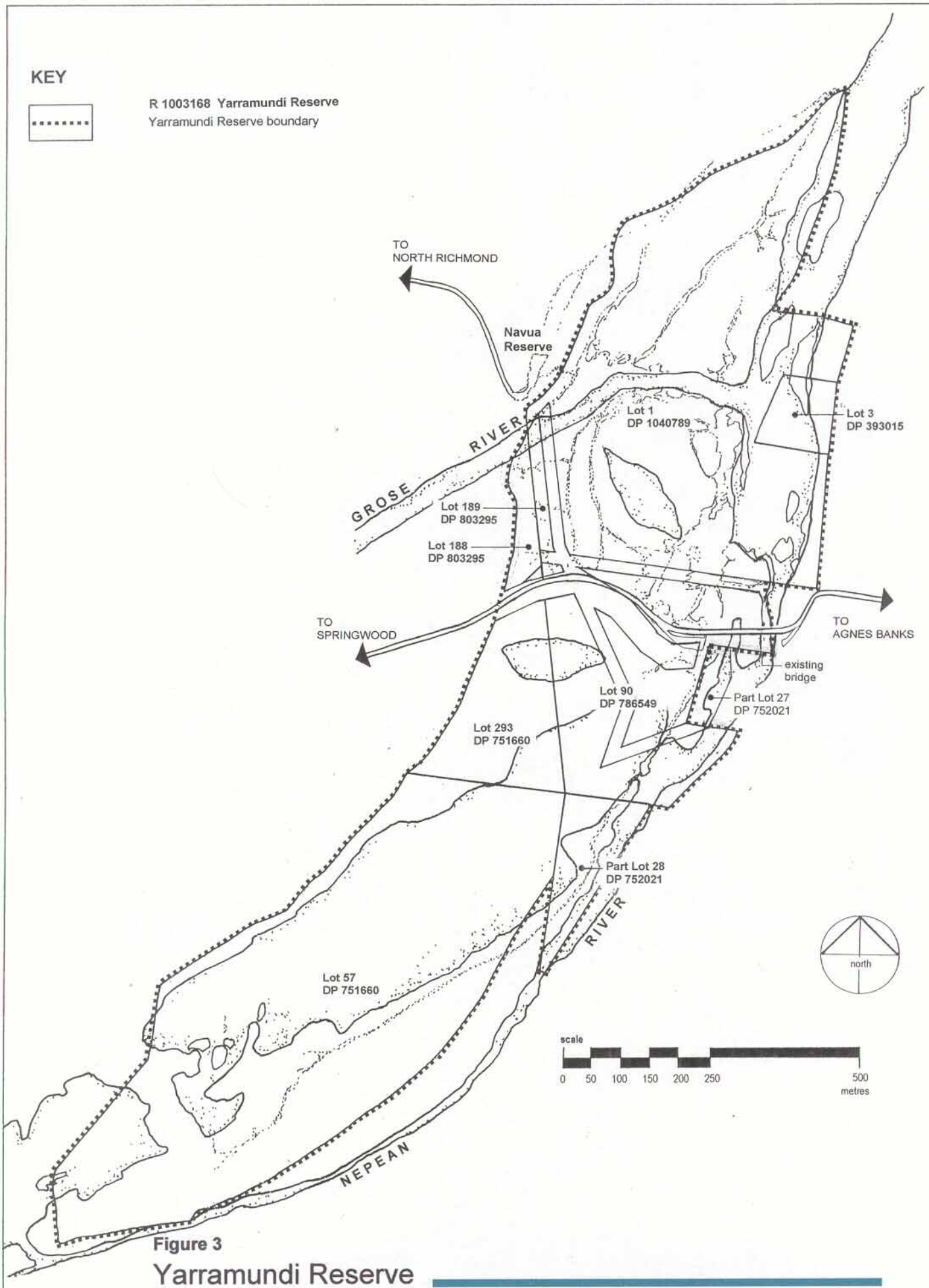

Figure 3

Yarramundi Reserve

Crown Reserve

Table 1: Land Description

Crown Land Description	Existing Facilities/ Improvements	Condition
R 1003168		
Lot 57 DP 751660	no facilities; "block wall"/ river channel diversion; unformed tracks	poor
Lot 293 DP 751660	no facilities or improvements; unformed tracks	poor
Lot 90 DP 786549	new bridge/ roadway, southern sealed carpark, rock batters, vehicular guard rails/ gates, landscaping, eastern portion of old bridge approach [road closure]	good
	unformed tracks	poor
Lot 188 DP 803295	no facilities; unformed tracks	poor
Lot 189 DP 803295	no facilities; unformed tracks	poor
Lot 1 DP 1040789	no facilities; unformed tracks	poor
Lot 3 DP 393015	no facilities; unformed tracks	poor
Part Lot 28 DP 752021	no facilities; unformed tracks	poor

The two large land parcels within the southern portion of the reserve [ie. Lots 57 and 293 DP 751660] were gazetted on 5 April 2002 as Reserve No. 1003168 for the public purpose of "Public Recreation and Environmental Protection". The total area of land for these parcels is 39.65 Ha. The Yarramundi (R1003168) Reserve Trust was established and appointed as trustee of the reserve. Hawkesbury City Council was appointed to manage the affairs of the reserve trust (refer to *2.2 Principles of Crown Reserves Management: Reserve Trust).* Additional parcels of land comprising Lot 3 DP 393015 (formerly Lot 191), Lot 90 DP 786549, Lots 188 – 189 DP 803295 and Lot 1 DP 1040789 (formerly Lot 190) were gazetted on 19 July 2002. The total area of land for these parcels is 38.69 Ha bringing the reserve's total area of Crown land to 78.34 Ha. An additional parcel of land, identified as Part Lot 28 DP 752021, and two other separate portions of land require further investigation to determine whether they should be included in the reserve (refer to following *Anomalous Items for Investigation*.

Native Title Act (Commonwealth) 1993

It is considered that Native Title is not an issue at this time with respect to Crown lands which were held under a former Permissive Occupancy for the extraction of gravel and sand [Lots 57 and 293 DP 751660]. If any significant proposal for development over these lands is considered in the future a detailed investigation of Native Title will be required.

This Plan of Management acknowledges the significance of the Yarramundi area as a traditional resource area. No future recreational development or infrastructure is proposed within these land parcels. Furthermore, the preparation of this Plan of Management has pursued an open, transparent approach to community consultation. The Plan encourages the broader involvement of Council with

traditional Aboriginal custodians in the future management of the reserve (see *5.0 Management Strategies: 5.1 Action Plan, items E2 and E3*).

Native Title is considered to be extinguished for the former freehold lands donated by Boral Ltd [Lot 90 DP 786549, Lot 1 DP 1040789 and Lot 3 DP 393015].

Anomalous Items for Investigation

As previously discussed, land title consists of mainly Old System titles and due to the movements in river boundaries from flood events, ownership and extent of some parcels of land is a complex issue. The following land parcels require further investigation of ownership with Land & Property Information (LPI) and preparation of appropriate survey plans for possible inclusion of these land parcels within the Crown reserve:-

- Existing triangular parcel of land within reserve boundary [south-eastern portion] identified as Part Lot 28 DP 752021, adjoining Lot 90 DP 786549 and Lot 57 DP 751660;
- Existing boundary anomalies occurring within the south-eastern lineal portion of land (immediately west of the Nepean River) and containing significant habitat values; and
- Existing parcel of land adjoining reserve boundary [eastern portion south of bridge] identified as Part Lot 27 DP 752021, adjoining Lot 90 DP 786549.

When no longer required for through access, the following road reservations should be closed and added to the Crown reserve:

- Portion of unmade road reserve between Lot 90 DP 786549 and Lot 1 DP 1040789;
- Portion of unmade road reserve between Lot 189 DP 803295 and Lot 1 DP 1040789).
- Portion of unmade road reserve within Lot 90 DP 786549.

The inclusion of the above land parcels would be important for the reserve's future integrated management and ecological restoration as a contiguous area of Crown land.

2.2 Principles of Crown Reserves Management

The management of Crown land is administered under the provisions of the *Crown Lands Act, 1989* for the benefit of the people of New South Wales and having regard for the principles of Crown land management. The NSW Department of Lands (formerly the Department of Land and Water Conservation) is responsible for management of the Crown reserve system throughout New South Wales. Section 11 of the *Crown Lands Act 1989* provides a set of principles for Crown land management as follows:-

- *environmental protection principles be observed in relation to the management and administration of Crown land;*
- *the natural resources of Crown land (including water, soil, flora, fauna and scenic quality) be conserved wherever possible;*
- *public use and enjoyment of appropriate Crown land be encouraged;*
- *where appropriate, multiple use of Crown land be encouraged;*
- *where appropriate, Crown land should be used and managed in such a way that both the land and its resources are sustained in perpetuity;*
- *Crown land be occupied, used, sold, leased, licensed or otherwise dealt with in the best interests of the State consistent with the above principles.*

Reserve Trust

The management of a Crown reserve is generally in the form of one of the following:-

- reserve trust;
- devolved management under s.48 of the *Local Government Act 1993*;
- Departmental (Department of Lands) direct; and
- administrative orders.

A reserve trust is an incorporated entity that can be established to manage a Crown reserve (eg. local councils, community trust boards or administrators). In its role as appointed manager of the trust, Hawkesbury City Council has the ongoing responsibility to provide care, control and management of Yarramundi Reserve and to ensure that the reserve's uses are consistent with the dedicated "public purpose" of the reservation in accordance with the *Crown Lands Act 1989*.

Public Purpose

The *Crown Lands Act, 1989* provides for the reservation and dedication of Crown land for a range of "public purposes" which must deliver a public benefit. Suitable and appropriate land use, activities, development, any leases/ licences and management practices are broadly defined by the public purpose of the reservation. The public purpose for Yarramundi Reserve is "Public Recreation and Environmental Protection".

2.3 Crown Reserves - Plans of Management

To ensure compliance with the requirements of the *Crown Lands Act 1989*, the *Crown Lands Regulation 2000*, case law and relevant policies of the NSW Department of Lands, this Plan of Management aims to address the following:-

- the plan must be prepared in accordance with the ***principles for land management*** under the *Crown Lands Act*;
- existing and proposed land uses, developments, activities, leases/ licences and management practices must be consistent with the dedicated ***public purpose*** of the reservation;

- the plan must address any matters required by the Minister responsible for the *Crown Lands Act*; and
- public exhibition of the draft plan and submissions must be referred to the Minister (responsible for the *Crown Lands Act*) prior to adoption.

When preparing a plan of management for Crown land the reserve trust manager, acting on behalf of the reserve trust, must comply with the following requirements of the *Crown Lands Act 1989*:-

- *direction of the Minister or request by Trust for plan of management preparation;*
- *drafts circulated for comment;*
- *exhibition of Draft Plan;*
- *Draft Plan exhibition notices provided.*

With the following outcomes:-

- *the Minister shall consider timely comment;*
- *Ministerial adoption of the Plan;*
- *Trust must follow the Plan; and*
- *all operations must be in accordance with the Plan.*

Case law judgements are also important in determining the policy and management practices affecting reserved or dedicated Crown land as follows:

- use of the reserve must be consistent with public purpose of the reservation;
- improvements and developments must support, or be ancillary to, the public purpose of the reservation;
- provision must be made for broad community access and equity. Reasonable entry fees and charges may be imposed but access may only be restricted where there is a legal requirement (eg. health and safety) or need for maintenance/ operational facilities or equipment storage relating to the reserve's public purpose;
- a lease or licence must be consistent with public purpose of the reservation.

2.4 Zoning

The *Environmental Planning and Assessment Act, 1979* forms the basis of statutory planning in New South Wales, including the preparation of Local Environmental Plans (LEPs) which regulate land use and development. Hawkesbury City Council, as the consent authority under the *Local Environmental Plan 1989 (LEP, 1989)* and the *Environmental Planning and Assessment Act, 1979* controls development and the use of land on parks and reserves in the Hawkesbury City Council local government area. It is desirable that provisions in Council's LEP, particularly zoning of the reserve, are consistent with the reserve's public purpose (ie. public recreation

and environmental protection). This Plan of Management defines land uses, activities and developments that will be permitted in accordance with the reserve's public purpose, including designation of areas for public recreation and protection of environmentally sensitive areas. Refer to *5.0 Management Strategies: 5.1 Action Plan, items A7, F2 and H9-H22.*

Proposed Amendments to Existing Zoning

The southern portion of Yarramundi Reserve (including Lots 57 and 293 in DP 751660, the major portion of Lot 90 in DP 786549, Part Lot 27 and Part Lot 28 DP 752021) is zoned *7(d1) Environmental Protection (Scenic)* under the *Hawkesbury City Council Local Environmental Plan 1989 (LEP) (refer to Figure 4: Zoning).* Springwood Road (including Yarramundi Bridge) are identified in the LEP as an existing arterial and main road corridor. Unmade road reserves are also identified however the new replacement bridge and road approaches are not shown on the LEP plan. The objectives for Zone *7(d1) Environmental Protection (Scenic)*, identified in the LEP, are as follows:-

- *to preserve the river valley systems, scenic corridors, environmentally sensitive areas and other local features of scenic attraction;*
- *to protect hilltops, ridgelines, river valleys and other local features of scenic significance by controlling the choice of colour of building materials and the position of buildings, access roads and landscaping;*
- *to ensure that development does not create unreasonable or economic demands, or both, for provision or extension of public amenities or services;*
- *to prevent the establishment of traffic generating development along main and arterial roads; and*
- *to control outdoor advertising so that it does not disfigure the rural landscape".*

Most of the northern portion of the reserve (including the balance of Lot 90 DP 786549, Lots 188 – 189, and the major portion of Lot 1 DP 1040789 are not identified with any specific zoning under the *Local Environmental Plan 1989.* The eastern portion of Lot 1 DP 1040789 however is shown as Zone *7(d1) Environmental Protection (Scenic)* and *1(c) (Rural "C").* The whole of Lot 3 DP 393015 is currently zoned *1(c) (Rural "C").* Both of these areas are within the Crown reserve. The objectives for Zone *1(c) (Rural "C")*, are as follows:-

- *to primarily provide for a rural residential living style; and*
- *to prevent the establishment of traffic generating development along main and arterial roads.*

The existing zoning needs to be further investigated and amended accordingly. Proposed zoning for the entire reserve should recognize the dual objectives of public purpose (ie. Public Recreation and Environmental Protection). The *6(a) (Open Space (Existing Recreation))* zoning has the following objectives:-

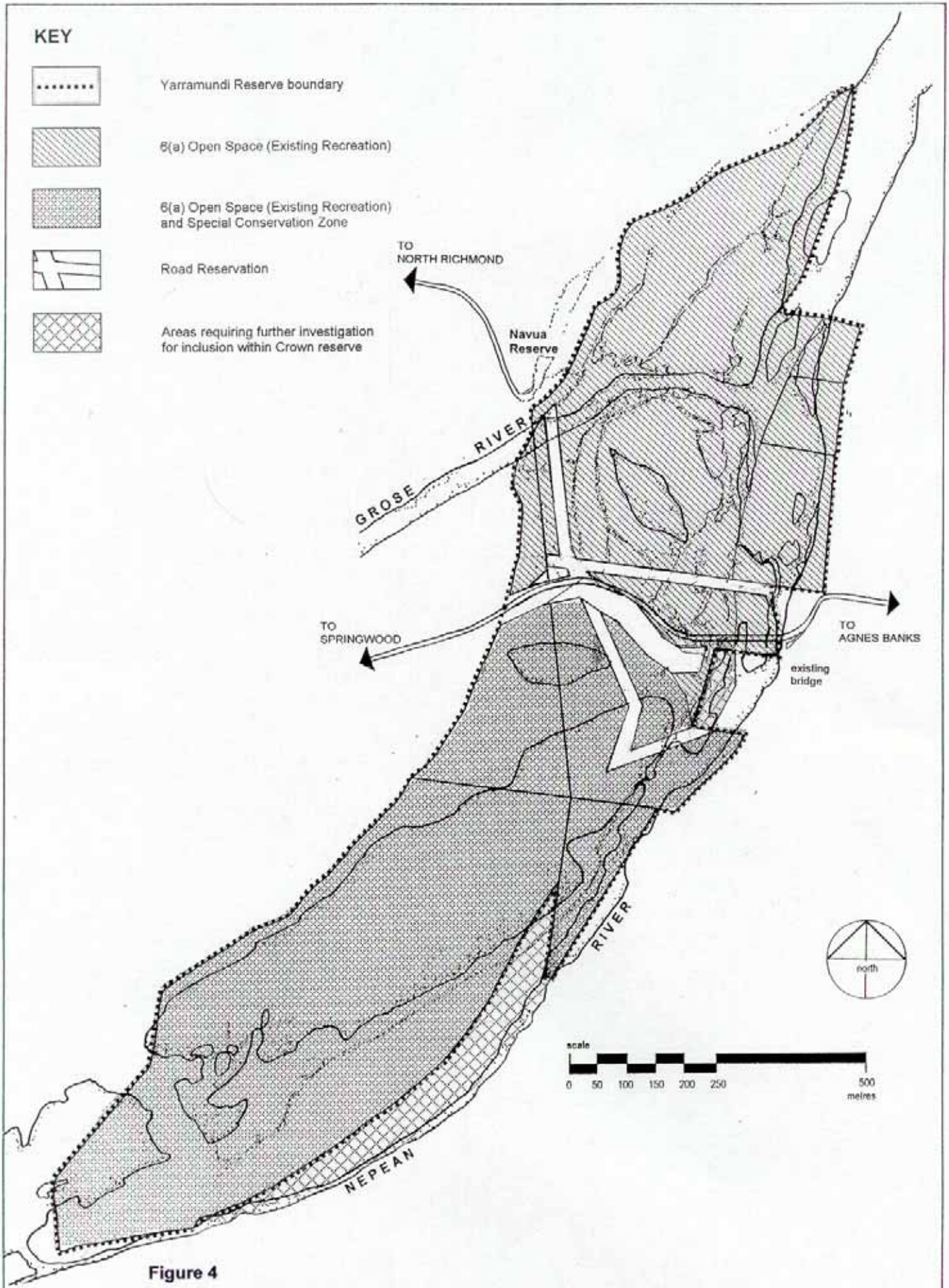

Figure 4

Yarramundi Reserve

Zoning

- *to identify existing publicly owned land that is used or is capable of being used for active or passive recreation purposes;*
- *to encourage the development of public open spaces in a manner which maximises the satisfaction of the community's diverse recreation needs;*
- *to enable development associated with, ancillary to or supportive of public recreation use; and*
- *to encourage the development of open spaces as major urban landscape elements.*

These open space and recreation objectives need to be considered in conjunction with the reserve's broader environmental significance, its dynamic riverine context, and the need for appropriate management and ecological restoration *(refer to 4.0 Basis for Management).* This Plan of Management establishes a Special Conservation Zone or "environmental protection area" within the southern portion of the reserve to protect fragile and sensitive habitat values from inappropriate recreational activities and development *(refer to Figure 4: Zoning and 5.1 Action Plan: item A7).*

Adjoining Land Uses and Zoning

Yarramundi Reserve shares boundaries with the following adjoining land uses and zonings as identified on Council's LEP map:-

- *7(d1) Environmental Protection (Scenic);*
- *7(d) Environmental Protection (Scenic);*
- *1(b) (Rural "B");*
- *1(c1) (Rural "C");*
- *1(c) (Rural "C");*

The surrounding land uses are predominantly rural. Navua Reserve, community land owned in fee simple by Hawkesbury City Council and zoned *(6(a) Open Space (Existing Recreation)),* shares a common boundary with Yarramundi Reserve on the Grose River. Navua Reserve is not shown on the LEP map.

2.5 Leases and Licences

A lease or licence may be granted, in accordance with an express authorization by this Plan of Management, providing the lease or licence is consistent with the reserve's public purpose, the *Crown Lands Act 1989 (s.102 CLA 1989)*, the *Crown Lands Regulation 2000,* case law and policy guidelines of the NSW Department of Lands, Council's Land Management Goals, adopted policies and other relevant legislation. The following is applicable:-

- *the Reserve Trust has significant interest in the estate over the reserved land;*

- *Crown land may be leased or licensed by the Reserve Trust – subject to the Minister's consent; and*
- *Any lease over five years (including options) must be publicly notified.*

Temporary licences may be issued by the Reserve Trust to authorize uses or occupation of the reserve for a period less than 12 months for prescribed activities in accordance with the *Crown Lands Act 1989 (s.108)* and the *Crown Lands Regulation 2000*. These temporary licences are not required to be referred to the Minister for consent *Crown Lands Act 1989 (s.102 (d) CLA 89).*

No existing leases or licences currently apply to Yarramundi Reserve, however this Plan of Management expressly authorizes future leases or licences (subject to compliance with this Plan's requirements as scheduled in *5.0 Management Strategies: 5.1 Action Plan item G1*).

2.6 Other Relevant Legislation and Policies

This Plan of Management must be prepared in accordance with the provisions contained within other relevant legislation and policy guidelines, including but not limited to the following:-

- Native Title Act (Commonwealth) 1993
- Environment Protection and Biodiversity Conservation Act 1999
- Rivers and Foreshores Improvement Act 1948
- Native Vegetation Conservation Act 1997
- Threatened Species Conservation Act 1995
- Fisheries Management Act 1994
- National Parks and Wildlife Act 1974
- Noxious Weeds Act 1993
- Rural Fires Act 1997
- Environmental Planning and Assessment Act 1979
- Disability Discrimination Act 1992
- NSW Heritage Act 1977
- SEPP 19: Bushland in Urban Areas
- Hawkesbury Lower Nepean Catchment Blueprint 2002
- SREP No. 20 Hawkesbury Nepean River 1996
- Hawkesbury Nepean Floodplain Management Strategy 1998
- NSW Flood Policy 1984
- NSW State Rivers and Estuaries Policy 1993
- NSW Wetlands Management Policy 1996
- NSW Floodplain Management Manual 2001
- Warragamba Dam Auxiliary Spillway Environmental Impact Study – Flood Study
- Draft Hawkesbury City Council Management Plan
- Hawkesbury City Council Local Environmental Plan 1989
- Draft Hawkesbury City Council Open Space and Recreation Strategy Plan 1999
- Section 94 Contributions Plan Review 2001

3.0 Community Issues

3.1 Community Consultation

Introduction

The NSW Department of Lands and Hawkesbury City Council encourage the community to be either directly involved in, or contribute to the planning and management of reserved and dedicated land. Accordingly, community consultation has been an important component in the preparation of this Plan of Management. LandArc has promoted an open, transparent approach to all community consultation, providing opportunities for all stakeholders and members of the community to contribute comments and submissions or to discuss specific issues (refer to *Appendix I: Community Issues Summary* and *Appendix II: Community Issues Discussion Paper).*

In October 2002, this process was temporarily interrupted by the Yarramundi Bridge Replacement project by the NSW Roads and Traffic Authority (RTA). During the period 2002-2003, further community consultation was undertaken by the RTA with respect to this work. Following completion of the Yarramundi Bridge project, this amended Draft Plan of Management can now be placed on Public Exhibition for discussion and final written submissions. This process highlights the importance of community ownership in the Final Plan of Management for Yarramundi Reserve.

Prior to the RTA bridge project, two public meetings/ workshops were held at the Richmond Neighbourhood Centre on Wednesday 10th April 2002 and Thursday 11th April 2002. These public workshops aimed to establish community values and to provide an opportunity to discuss the issues affecting these values at Yarramundi Reserve. A total of 48 people attended these workshops. A Community Issues Workshop Questionnaire was distributed at each of these workshops with a total of 18 responses received.

At each of these workshops, the issues raised by participants were summarised as well as being recorded in detail for further development in the Community Issues Paper. *Appendix I: Community Issues Summary* and *Appendix II: Community Issues Discussion Paper,* issued on 27 June 2002 to workshop participants and stakeholders, provided a detailed analysis of key issues and community values. The Community Issues Paper was amended in response to further issues raised by participants since the issue date.

Over the period since these workshops, a number of government departments, stakeholders and interest groups have been consulted or have prepared written submissions or contacted our office to discuss specific issues affecting the reserve. Apart from individual participants and adjoining/ nearby land-holders, the key stakeholder groups have included the following (in alphabetical order):-

- Australian Plant Society
- Bass Sydney Fishing Club Inc.
- Blue Mountains & Nepean District Angling Association
- Darug Custodian Aboriginal Corporation (DCAC)
- Darug Tribal Aboriginal Corporation (DTAC)
- Great River Walk Committee
- Hawkesbury Bushcare Network
- Hawkesbury City Council
- Hawkesbury Historical Society
- Hawkesbury-Nepean Aquatic Weeds Task Force
- Hawkesbury River County Council (HRCC)
- Navua Community Group
- NSW Department of Agriculture (Windsor Advisory Office)
- NSW Department of Lands
- NSW National Parks & Wildlife Service (NPWS Richmond Office)
- NSW Roads & Traffic Authority (RTA)
- On all 4's 4WD Club Inc.
- Richmond Lions Club
- Yarramundi Community Centre
- Yarramundi Progress & Development Association
- Yarramundi Rural Fire Brigade

Community Issues

A broad range of issues continue to affect the reserve's natural resource base and its recreational values. Key issues raised during the consultation process (although not ranked in any order) include the following:-

- riverine context/ riparian corridor
- flood impacts and river processes
- past gravel and sand extraction/ site rehabilitation
- water quality and pollution
- protection of Aboriginal heritage values
- protection of natural values (scenic qualities/ setting and biodiversity)
- weed management and restoration (including past quarry impacts)
- public access issues:
  - Yarramundi Bridge
  - water access (eg. canoes and fishing)
  - vehicular control and management

  - parking areas (visitor safety and security)
  - improvements to walking tracks
  - pedestrian safety and security issues
  - unleashed dogs
- recreational facilities and public amenities
- rubbish dumping, vandalism and other anti-social behaviour
- opportunities for community involvement.

The community highlighted the need to address these issues and provide an appropriate framework for the management, protection and restoration of identified values as follows:-

- *to balance existing and future recreational uses with regard to the reserve's natural setting and dynamic riverine context (eg. flood impacts, weeds, etc);*
- *to address past natural resource degradation within the reserve;*
- *to protect and manage fragile habitats and threatened species within the reserve, ensuring their long term viability;*
- *to ensure appropriate rehabilitation of the reserve's natural values and continue programs to address weed invasion (incl. terrestrial, wetlands and aquatic habitats);*
- *to encourage community involvement in the rehabilitation process and ownership of the reserve;*
- *to address rubbish dumping, pollution issues and anti-social behaviour;*
- *to provide opportunities for appropriate informal, passive and nature-based activities, including low key water-based recreation compatible with the natural setting;*
- *to review public access issues, opportunities and constraints affecting vehicular, pedestrian and water access (including options relating to bridge and roadway re-alignment on Springwood Road);*
- *to address periodic peak parking and vehicular congestion/ safety problems along Springwood Road;*
- *to ensure that any infrastructure development for recreation (eg. vehicular access, public amenities, picnic settings, litter bins) is appropriately designed and located with regard to flood impacts, sensitive habitat values and public safety; and*
- *to ensure management of the reserve is consistent with Navua Reserve.*

These community issues and objectives are examined in *Appendix II: Community Issues Discussion Paper.* The Paper is divided into the following sections:-

A.1 Environmental Context
A.2 Past Gravel and Sand Extraction
A.3 Weed Management and Habitat Restoration
A.4 Public Access
A.5 Proposed RTA Bridge Replacement.

PHOTO 1: View of the old Yarramundi Bridge [now demolished] looking east showing traffic signals/ one-lane crossing and tight curves on approach roads. Photo taken March 2002.

PHOTO 2: View looking west over the new Yarramundi Bridge with elevated approaches, bridge deck, shared pedestrian/ bikepath [centre right] and south-western carparking area [left background].
Photo taken August 2004.

4.0 Basis for Management

4.1 Objectives

This section of the Plan of Management addresses the following objectives:-

- *to define the reserve's regional context and ensure consistency with the Objects of the Crown Lands Act (s.10 CLA 1989);*
- *to identify the values attached to this Crown reserve by the community, why they are valued and the importance of each of these values;*
- *to determine the significance of this reserve within the greater Hawkesbury City and Western Sydney metropolitan open space system;*
- *to define the reserve's role in providing recreational opportunities for the broader regional community;*
- *to establish a mechanism for reviewing values in relation to specific issues/ threats and develop opportunities for appropriate management consistent with the Principles of Crown Land Management (s.11 CLA 1989); and*
- *to provide a vision for the future of this significant area.*

4.2 Regional Context

Overview

Hawkesbury City Council local government area (LGA), located in the north-western portion of the Sydney Basin, is an area of great scenic diversity from fertile alluvial floodplains along the Hawkesbury River to rugged, deeply dissected plateaus and gorges of the Blue Mountains and Wollemi National Parks. Yarramundi Reserve is located in the south-western portion of the Hawkesbury City LGA, within the urban-rural fringe of the Sydney metropolitan area.

In accordance with the *Crown Lands Act 1989*, the Department and Reserve Trust must ensure that the Crown reserve is managed for the "benefit of the people of NSW" (s.10 CLA 1989) in accordance with the reserve's public purpose and the Principles of Crown Land Management (see *2.2 Principles of Crown Reserves Management*). This plan of management addresses these principles in this section and *5.0 Management Strategies: Action Plan.*

Regional Open Space

The area offers a broad range of outdoor recreational and nature-based opportunities for the broader community. The LGA is surrounded by expansive

areas of national parks (eg. Blue Mountains NP, Wollemi NP, Scheyville NP and Cattai NP), regional parks (eg. Yellomundee RP), nature reserves (eg. Castlereagh NR) and many other smaller reserves.

Although the Hawkesbury Nepean River is a dominant element in the floodplain landscape, opportunities for public access to the river and water-based recreation are limited. Yarramundi Reserve offers significant opportunities for public access and recreation on the river within a natural setting, albeit highly modified and currently degraded. In this way, the reserve has the potential to be an important part of the regional park system within the north-western metropolitan area.

Population and Demographics

Over the past two decades, the Hawkesbury City LGA has experienced significant population growth and urban expansion which has placed existing recreational infrastructure and resources under considerable pressure. This effect has been driven by a number of factors such as rising Sydney residential market prices and people seeking a quieter rural lifestyle without losing many of the urban conveniences (*Draft Hawkesbury Recreation and Open Space Plan, 1999*).

In 1996, Hawkesbury City's population was estimated to be 57,381. Over the preceding five year period (1991-96) the population grew by 11.80% representing an annual growth rate of 2.36% (*Section 94 Contributions Plan Review, 2001, p.6*). This trend however has not been uniform across the LGA. The areas of South Windsor/ Bligh Park and outlying townships experienced high levels of growth while the larger centres of Richmond and Windsor recorded a small net decline in population during this period.

It was anticipated that the population growth rate for the LGA would slow to approximately 1.02% over the 1996-2001 period. However, the Australian Bureau of Statistics, in its latest population estimate for June 2001, provides a population figure of 63,548. This represents an annual growth rate of approximately 2.15% over the past five years (1996-01) which is similar to the preceding five year period.

Community Profile

The Hawkesbury City LGA is unlike many other LGAs in the Sydney metropolitan area and NSW in having a very high proportion of young people in the population. In 1996, 43.6% of the population were under 24 years. The Australian Bureau of Statistics identify a median age for Hawkesbury City LGA of 32.4 years for June 2001. This compares to the median age for neighbouring Blacktown City LGA of 31.1 years. Unemployment levels remain high amongst the young people of the area. A lack of public transportation in the Hawkesbury LGA means that it is difficult for young people to access open spaces and recreational facilities. These factors highlight the need to provide improved public access to reserves and to enhance the range of recreational opportunities and facilities in these reserves.

4.3 Community Values

The consultation process defined a strong sense of community ownership in this Crown reserve with the desire to ensure the protection and rehabilitation of its natural, ecological, scenic and recreational values. The most important community values attached to this reserve are natural setting, water/ rivers, heritage, public access/ recreation. The following list of broader values identified (although not ranked in any order) are essentially a sub-set of these four key values:

- river and foreshore access
- water quality
- scenic quality
- diversity in natural settings
- quiet solitude and tranquillity
- biodiversity (eg. aquatic and wetland habitats, avifauna)
- a traditional resource area for the Burruberongal people
- opportunities for water-based/ river-side recreation
- opportunities for informal, passive/ active and family-based recreation
- opportunities for nature-based recreation/ environmental studies
- opportunities for informal, active land-based activities (eg. horse riding and mountain-bike riding).

Recreational values are discussed in more detail in *4.8 Public Recreation and Environmental Protection.*

4.4 Determining Key Values

As previously discussed, this Plan of Management takes a values-based approach to planning and management of Yarramundi Reserve. This approach allows the reserve's key values, role and purpose to be identified so that these assets may be protected and enhanced. "Values" can be simply described as the things which make a place important. Community values and the issues affecting these values have been identified through the community consultation process (refer to section *3.0 Community Issues* and *Appendix II: Community Issues Discussion Paper.*

The key values have been developed through further investigation and analysis of the reserve's resource base. These key values are divided into four major categories which form the basis for further discussion in this section as follows:-

1. Riparian Corridor/ Natural Setting
2. Indigenous and Cultural Heritage
3. Environment/ Biodiversity
4. Public Recreation and Environmental Protection

Table 2: Values and Level of Significance

Values	Level of Significance		
	Local	Regional	State
Riparian Corridor/ Natural Setting			
Confluence of rivers and riparian corridor	■	■	
natural setting within cleared floodplain	■	■	
scenic values	■	■	
Indigenous & Cultural Heritage			
Aboriginal/ Indigenous	subject to further investigation		
Environmental/ Biodiversity			
Geodiversity values	■	■	
water quality/ stream condition	■	■	
riparian vegetation values	■	■	
remnant ecological community	■	■	
Scheduled endangered species	■	■	■
Educational/ scientific values	■	■	■
Public Recreation/ Environmental Protection			
water-based/ river-side recreation	■	■	
informal, passive & family-based recreation	■	■	
nature-based recreation	■	■	
informal, active land-based recreation	■	■	
public access/ circulation & linkages	■	■	

Note: Aboriginal/ Indigenous heritage values require further investigation to determine level of significance.

Table 2: Values and Level of Significance assigns a significance ranking to each of these values, based on either a local, regional (Sydney metropolitan/ Lower Blue Mountains), state or national basis. The reserve, its river context and natural setting, located within the lower Nepean Hawkesbury River catchment, is significant as a regional asset. The reserve supports biodiversity values of regional and state significance. Recreation values have the potential to attract a broader regional user catchment providing ecological values are not in any way compromised by future recreational development.

Further investigation is required to establish the significance of archaeological/ indigenous heritage values. There are currently no confirmed Aboriginal sites or relics within the reserve. It is unlikely that any intact sites or relics would remain due to the history of disturbance through gravel and sand extraction. Nevertheless, the reserve's significance as a traditional resource area needs to be recognized and opportunities explored for interpreting these values (refer to *4.6 Indigenous and Cultural Heritage Values*).

4.5 Riparian Corridor/ Natural Setting

Hawkesbury Lower Nepean Catchment

Yarramundi Reserve is centrally located within the Hawkesbury – Nepean River catchment comprising an area of almost 22,000 square kilometres and 31 sub-catchments. The river system provides potable and non-potable water for Sydney's population and provides opportunities for agriculture, irrigation, commercial fishing, recreation and habitat for aquatic, wetland and riparian biodiversity.

The *Hawkesbury Lower Nepean Catchment Blueprint (2002)* has been prepared to address the urgent need for sustainable management of the catchment downstream of Warragamba Dam and the Nepean, Avon, Cordeaux and Cataract Dams. The area has a long history of vegetation clearing, agricultural development, altered flow regimes and ecosystem disturbance and modification. The construction of dams in the upper catchment and the allocation of water for irrigation purposes have significantly reduced downstream flows and the frequency and impact of storm/ flood events. In addition, the catchment is experiencing extraordinary pressures from increasing urban development which is affecting the overall health of the river.

The *Hawkesbury Lower Nepean Catchment Blueprint* adopts an integrated approach across several local government areas. The document emphasizes the need for new opportunities with partnerships, education, advocacy and community involvement to deliver the following first order objectives:-

- *The waters are suitable for people to use and enjoy;*
- *Diverse native plants and animals live and evolve;*
- *The cultural heritage values within the catchment are acknowledged, respected, maintained and enhanced;*
- *The beauty and natural processes of the catchment are protected while providing for social and economic needs;*
- *Everyone is working together – individuals, community groups, business and government.*

The *Hawkesbury Lower Nepean Catchment Blueprint* establishes detailed catchment and management targets for the next ten years. The outcomes from this *Catchment Blueprint* will have significant consequences for the overall management of Yarramundi Reserve.

Riverine Context and Scenic Values

Yarramundi Reserve is located wholly within the riverine corridor. It consists of dynamic channel boundaries and river beds, lagoons, wetlands, islands and adjacent riparian land including embankments, sand dunes and beaches, levees and swales and associated biodiversity. The reserve is a natural, albeit highly modified setting with outstanding scenic values which are, in part, recognized and protected under the provisions of *7(d1) Environmental Protection (Scenic)* in the

Hawkesbury City Council Local Environmental Plan 1989. The riparian corridor provides a distinctive topographical change in the floodplain landscape (eg. there is an approximate change in levels of 16-18 metres between the river and the adjoining levee banks at Yarramundi Bridge). It also creates a dramatic contrast as a "natural" setting within the surrounding cleared floodplain of market gardens and orchards.

The existing riparian vegetation is a defining element in the character of this landscape. It is however a temporal landscape – one which is in transition, reflecting the changes brought by land clearing, agriculture, mining, irrigation, modification to channel flows and water quality and invasion by exotic weeds. These processes have shaped the way we see the existing riparian landscape. It also affects the way the landscape is used for recreation.

Climate

Yarramundi Reserve has a warm temperate climate (ie. with a summer and winter season) and rain may occur at any time throughout the year. Median annual rainfall for the reserve is 1000 millimetres. The catchment has recorded significant changing rainfall patterns, oscillating between periods of high and low rainfall. These patterns have defined alternating flood and drought regimes which affect the management of this reserve.

Geodiversity Values

The reserves "geodiversity" is an important component in defining the significance of place. "Geodiversity" describes the broad range of earth features (ie. geological, geomorphological, palaeontological, soil, hydrological and atmospheric features, systems and earth processes). Yarramundi Reserve is located near the junction between two geomorphic regions:-

- Cumberland Lowlands
- Hawkesbury – Shoalhaven Plateaux

The Cumberland Lowland is a region of undulating to low hilly topography on largely Triassic shales of the Wianamatta Group and Cainozoic alluvium. To the west of the reserve the land rises to undulating foothills and then the deeply dissected Triassic sandstone scarps of the Hawkesbury – Shoalhaven Plateaux (ie. Blue Mountains).

The rivers flowing within the reserve are consistent with the "Partly Confined" river category identified in the *Geomorphic Categorisation of Streams in the Hawkesbury Nepean Catchment (DLWC, 2001).* The channel geometry is variable but the extent of lateral channel migration is controlled by the bedrock of the western valley margins. The lower reach of the Grose River before the confluence with the Hawkesbury – Nepean River, immediately west of the reserve boundary, is described as "Confined" (ie. the channel pattern is controlled by the river valley bedrock).

PHOTO 3: View of the Grose River looking west from near the junction with the Hawkesbury – Nepean River [Navua Reserve is located background right].

PHOTO 4: View looking north-west over the southern lagoon near the “block wall”. This natural area has significant scenic, ecological and educational values. The southern island, lagoon and western foreshores are to be protected and managed as a Special Conservation Zone.

PHOTO 5: View of the Nepean River and Yarramundi Bridge looking west from the closed road section [former bridge approach road]. The river retains many of its 'wild' characteristics of rapids, shingle/ gravel banks, islands, back lagoons, sandy beaches and riparian vegetation.

PHOTO 6: Group of students on the Grose River [opposite Navua Reserve]. Yarramundi Reserve's broad range of geodiversity and biodiversity values provide significant opportunities for environmental education and interpretation.

The reserve lies within the present active floodplain of the Hawkesbury – Nepean River. This fluvial landscape is dominated by broad, relatively flat floodplains, meander scrolls, levees and back-water lagoons and wetlands such as Yarramundi Lagoon. The soils are typically deep layered unconsolidated sediments (ie. sands and loams) deposited as alluvium during periods of flood. These soils are deposited over the underlying bedrock or relict soils. The rivers in this location have a sinuous, meandering character flowing over and through their own deposited material of gravel, cobble, sand and soil.

The river channels play a dynamic role in defining the reserve's character and geodiversity. The riparian corridor is subject to frequent flooding and high stream bank erosion hazard as well as deposition of sedimentary materials as the flood waters recede. These events can obliterate past channel formations and create entirely new channel patterns and landscapes within the riparian corridor. Refer to *Appendix II: Community Issues Discussion Paper: Historic Changes to River Morphology.*

The reserve's soil landscapes and the condition of the catchment are key factors in determining the way the reserve is used for recreation. The southern portion of the reserve (upstream of Yarramundi Bridge) tends to have fine-grained dark-brown and red-brown alluvial loams. The altered low flow regimes and urbanisation of this portion of the catchment has increased the level of suspended fine-grained sediments in the water column affecting water quality and use of the waterway.

This is in contrast to the portion of the reserve influenced by the Grose River (ie. downstream of Yarramundi Bridge) which is largely dominated by coarse-grained alluvial sand, gravel and cobble. These materials have been deposited along the lower reach of the Grose River (adjacent to Navua Reserve), the western bars and beaches and throughout the northern flood channel. The overall water quality in this lower section of the Grose River is relatively good with generally low turbidity levels reflecting the good condition of this sub-catchment. It is the favoured location for water-based recreation, particularly swimming.

4.6 Indigenous and Cultural Heritage Values

"Over many thousands of years, Aboriginal people have left signs of their occupation of Australia. The reminders of where people lived, where they ate or collected food, how they hunted, their art and their sacred sites are all a special part of Australia's heritage ... [These places] document the lives of Australian indigenous people not only before European settlement, but also the changes wrought by colonialism".

Australian Heritage Commission (1997)

For many thousands of years, the Hawkesbury – Nepean riparian corridor provided a great source of materials for the Darug Aboriginal people. The Sydney region supported many local clans of the Darug including the Burruberongal clan from the Richmond area. Their chief was Yarramundi, the name given to this reserve. Governor Arthur Phillip encountered Yarramundi on his first overland expedition to the Hawkesbury River in 1791. This river, known to the Darug people as Deerubbin, provided water, fishing, hunting and special plants for food, fibres, tools, canoe making and medicine. The area now known as Yarramundi Reserve at the confluence of the Hawkesbury – Nepean and Grose Rivers was a traditional resource area for the local Burruberongal and a significant site for collection of raw materials for the manufacture of stone artefacts such as axe-heads.

The early years of European colonisation was a period of intense competition for resources between early settlers and the Burruberongal people. This period gave way to bitter conflict, reprisal and disintegration of Aboriginal culture. This rich traditional resource area was cleared for agriculture and later mined for gravel and sand. Although the area was significantly altered by these activities, the surrounding terraces and land to the south-west of the reserve still contain important archaeological fabric including artefact scatters and grinding stones. Other archaeological fabric such as the Aboriginal common burial sites within the farmed eastern terraces (outside the reserve) have been highly disturbed and modified.

The reserve's Aboriginal heritage needs to be further investigated and any places, relics or potential archaeological deposits (PAD) properly protected and managed. The Cultural Heritage Services Division of NSW National Parks & Wildlife Service (NPWS) maintains the Aboriginal Sites Register for the Hawkesbury City local government area. These sites include rock engravings, axe grinding grooves, water holes, open shell middens and rock shelters with occupation deposits, camp sites, burial sites and quarries. Under the *National Parks and Wildlife Act (1974)* and the *Heritage Act (1977),* all Aboriginal sites, whether recorded or not, are protected. Protection under these Acts includes limiting public access to sites, promotion of educational/ interpretive programmes in Aboriginal heritage and conducting archaeological surveys to better understand this heritage.

Aboriginal Consultation

This Plan of Management encourages a consultative strategy to address land management issues with the traditional Aboriginal custodians including access and protection of heritage sites, cross cultural training, visitor management and interpretation of heritage values *(refer to 5.0: Management Strategies).*

4.7 Environment and Biodiversity

Stream Condition and Water Quality

Although the rivers running through the reserve retain much of their natural river qualities, the aquatic biodiversity and ecological processes have been seriously

impacted by poor water quality and restricted flow regimes. Almost 70% of the Nepean River sub-catchment is in a degraded condition. The large number of weirs on the Nepean River have reduced the river to a series of weir lakes. Together with the reservoirs located upstream, irrigation for farms and sewage treatment plant discharges the river's flow regime has been drastically altered. The section of the Nepean River flowing through the reserve displays the following characteristics:

- modified stream flows and channels as a result of upstream dams, irrigation and past gravel and sand extraction activities;
- abnormal and accelerated stream bank and river channel instability;
- river channel storing large volumes of sediment in the form of benches and islands;
- excessively high volumes of suspended solids and coarse sediments which blanket the river bed reducing habitat diversity;
- high nutrient loadings and reduced oxygen levels in the water column;
- low levels of natural vegetation stabilising the stream banks;
- extensive weed infestation (aquatic and terrestrial) with significantly reduced opportunities for natural recruitment;
- extensive spread of *Salvinia sp*. (floating noxious aquatic weed) over the past two years of drought; and
- significant exotic Willow (*Salix spp.)* growth along the narrow channel and margins obstructing river flows (recently brought under control in the Black Willow Program 2002-03).

The *Geomorphic Categorisation of Streams in the Hawkesbury Nepean Catchment* and *Draft Hawkesbury Lower Nepean Catchment Blueprint* highlight the need to establish an appropriate level of environmental flows for the Hawkesbury – Nepean River to improve the current degraded condition of the River. These broader catchment issues are beyond the scope of this Plan of Management but nevertheless are central to developing sustainable management strategies for the reserve. Notwithstanding these issues, the reserve still retains significant terrestrial, wetland and aquatic habitat values.

Riparian Vegetation Values

Natural riparian vegetation has many important values including, but not limited to, the following:

- reservoir of natural heritage and biodiversity values;
- assists in maintaining good water quality;
- assists in stream bank stability and prevention of erosion;
- reduces turbidity and enhances biological productivity for aquatic invertebrates and fish;
- provides a source of habitat for both terrestrial and aquatic species;
- provides high visual qualities; and
- improves recreational opportunities and diversity in the landscape.

PHOTO 7: View of the Nepean River looking south-west from the eastern approach to Yarramundi Bridge showing broad-scale infestation of the floating water-weed, Salvinia [*Salvinia molesta.].* This noxious weed has increased rapidly over the past two years – a period marked by drought, warmer weather, fewer frosts, low water levels and a build-up of nutrients.

PHOTO 8: Mechanical harvesting of the noxious floating water-weed, Salvinia was commenced in early 2004 at a cost of $600,00 [Hawkesbury – Nepean River] funded by the federal and state government. By August 2004,Salvinia covered approximately half of the southern lagoon at Yarramundi Reserve.
Photo taken near the south-western carpark, August 2004.

Natural Heritage Significance

Natural heritage incorporates a broad spectrum of values, ranging from existence value at one end (ie. living organisms and ecosystems may have value beyond social, economic or cultural values held by people) to socially-based values at the other end. The fundamental concept of natural heritage, which most clearly differentiates it from cultural heritage, is that of the following *(Australian Natural Heritage Charter, 1999)*:

- *dynamic ecological processes;*
- *ongoing natural evolution; and*
- *the ability of ecosystems to be self-perpetuating.*

The concept of natural heritage recognizes the role played by indigenous people in the Australian landscape for at least 50,000 years and possibly much longer (refer to *4.6 Indigenous and Cultural Heritage Values*). Prior to European settlement of the floodplain, this area would have contained a dynamic mosaic of vegetation communities and habitats. They would have shared a high degree of connectivity and opportunities for genetic exchange. Extensive vegetation clearing of the floodplain and riverbanks for agricultural uses and gravel/ sand extraction had a massive destabilizing impact on the riverine corridor and its ecology (refer to *Appendix II: Community Issues Discussion Paper: A.2 Past Gravel and Sand Extraction).*

The prolific weed growth within the reserve is overwhelming the last vestiges of remnant natural vegetation and significantly impacts on any areas natural regeneration. This weed growth maintains an impoverished and highly simplified landscape and promotes negative visual, environmental and social impacts.

Whilst some introduced and exotic weed species in the reserve, may have visual, cultural or social values relating to rural development of the floodplain (eg. Willows *(Salix spp.),* Honey Locust *(Gleditsia triacanthos),* Pecan *(Carya pecan)* or Box Elder *(Acer negundo)),* these items are not part of the area's natural heritage and its ongoing natural evolution and ecological processes. Nevertheless, some of these weed species have been found to have significant habitat values for threatened species such as the Grey-headed Flying-fox *(Pteropus poliocephalus*). This factor underlines the complexity of determining appropriate management strategies for the reserve (refer to *Appendix II: Community Issues Discussion Paper: Weed Management, Restoration and Reinstatement).*

Biodiversity Significance

Biodiversity refers to the richness and diversity of a place, its life forms including plants, animals and micro-organisms, the genes they contain, and the ecosystems they form. Although highly degraded and modified, Yarramundi Reserve is an area which is highly significant as both an existing and potential reservoir of rare and threatened biodiversity. These values can be summarised as follows:

- remnant components of the Sydney Coastal River-flat Forest (SCRFF), scheduled as an endangered ecological community under the *Threatened Species Conservation Act (1995*);
- in terms of regional context, there are now only very small fragmented remnants of this community along the Hawkesbury – Nepean corridor;
- threatened species habitat for a transitory colony of Grey-headed Flying-fox *(Pteropus poliocephalus*);
- regionally significant aquatic and wetland habitats;
- opportunities to enhance habitat values for aquatic, wetland and terrestrial species and promote genetic integrity;
- opportunities for the reserve to play a vital role in conserving regional biodiversity; and
- opportunities to develop faunal corridors, bio-linkages and “mosaics”.

Endangered Ecological Community

The Western Sydney Native Vegetation Mapping Project was commenced by the National Parks and Wildlife Service (NPWS) in 1998 to provide data on the distribution and relative condition of all remnant vegetation in Western Sydney. Special attention was given to vegetation communities scheduled under the *Threatened Species Conservation Act (1995*).

Sydney Coastal River-flat Forest was gazetted as an endangered ecological community (12.02.99) following listing in the Final Determination by the NSW Scientific Committee (refer to *Appendix III: Final Determination*. The remnant components of this community however are not identified in the *Native Vegetation Maps of the Cumberland Plain Western Sydney (NPWS, 2000)*. This is due to the highly disturbed and modified nature of the reserve’s natural vegetation and the scale of mapping (ie. >5 Ha) undertaken in the study.

In this study, River-flat Forest, as described by Benson as Map Unit 9f (1992), is divided into three separate riparian communities: Map Unit 11 (Alluvial Woodland), Map Unit 12 (Riparian Forest) and Map Unit 5 (Riparian Woodland). Map Units 11 and 12 fall within the definition of the endangered ecological community “Sydney Coastal River-flat Forest”. Map Unit 11 (Alluvial Woodland) is found on the floodplains of the Hawkesbury – Nepean River but grades into Map Unit 12 (Riparian Forest) on the levee banks immediately adjacent to the river. The reserve lies wholly within the riverine corridor. Therefore, it is likely the natural vegetation community would have been described as Map Unit 12 (Riparian Forest).

Both communities have no particular tree species occurring frequently across all sample sites. In addition, many species are shared between these two communities. A number of shallow water and semi-aquatic species, associated with this forest type, typically grow along the river’s edge, helping to stabilise the banks.

Riparian Forest can be further divided into a number of sub-groupings or associations including the following:

- Blue Gum – River Peppermint – Blue Box Forest;
- Camden White Gum – River Peppermint Forest;
- Cabbage Gum – Broad-leaved Apple Forest;
- River Oak Forest; and possibly
- Swamp Mahogany Forest.

The River Oak Forest association likely occurred in this location. River Oaks *(Casuarina cunninghamiana)* still are common in the reserve with some larger trees scattered along the water's edge and levee banks. However, many of these trees are of unknown genetic source, having been planted during rehabilitation work between 1989-1994. It is likely that there were other associations present along the mid to upper levee banks including Cabbage Gum – Broad-leaved Apple Forest (southern portion of reserve) and possibly a Mountain Blue Gum – Blue Gum component (northern portion of reserve and associated with the Grose River valley). *Riverside Plants of the Hawkesbury – Nepean (Howell, McDougall & Benson, 1995)* identifies representative tree species for this segment of the river which are consistent with these associations including:

- Broad-leaved Apple *(Angophora subvelutina);*
- Cabbage Gum *(Eucalyptus amplifolia);*
- Mountain Blue Gum *(Eucalyptus deanei);*
- Sydney Blue Gum *(Eucalyptus saligna);*
- Forest Red Gum *(Eucalyptus tereticornis);*
- Grey Gum *(Eucalyptus punctata);* and
- Blue-leaved Stringybark *(Eucalyptus agglomerata).*

Cabbage Gum *(Eucalyptus amplifolia),* Mountain Blue Gum *(Eucalyptus deanei)*, Sydney Blue Gum *(Eucalyptus saligna)* and Forest Red Gum *(Eucalyptus tereticornis)* can still be found within the reserve There is however no physical evidence at this stage to support the restoration of Blue Gum – River Peppermint – Blue Box Forest or Camden White Gum – River Peppermint Forest, associations which are found on upstream alluvial soils on the Nepean River.

Native wattles such as Coast Myall *(Acacia binervia),* Sally Wattle *(Acacia floribunda),* Sydney Green Wattle *(Acacia parramattensis),* Hickory *(Acacia implexa)* and Silver-stemmed Wattle *(Acacia parvipinnula)* are still relatively common native shrub components. These species would have been common shrubs and trees in the original Riparian Forest community. However, the original complex mix of native shrub and understorey ferns, herbs, climbers and grasses is absent. Only a few of the more common and persistent native understorey species are present. *Figure 5: Existing Vegetation* identifies the dominant highly modified/ disturbed riparian landscape and areas of natural regeneration.

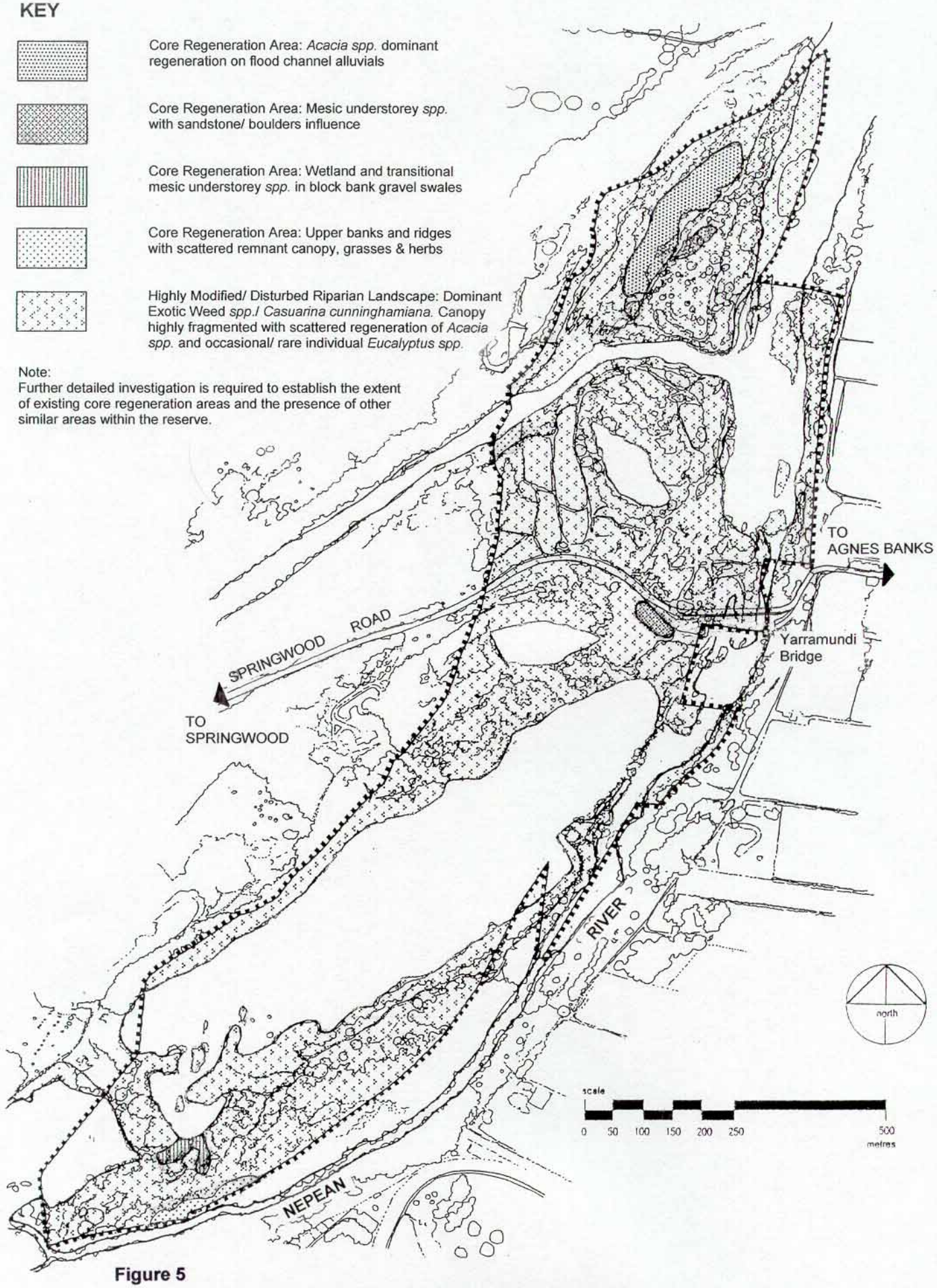

Figure 5

Yarramundi Reserve

Existing Vegetation

PHOTO 9: View of the Southern Island section of Yarramundi Reserve taken in March 2004 showing a highly fragmented native canopy and rampant exotic weed growth. Exotic vines and climbers dominated the understorey and posed a serious threat to remnant native regrowth and natural regeneration.

PHOTO 10: View of the Southern Island [upper levee bank adjacent to Nepean River] taken in August 2004 showing the impact of contract weed management and bush regeneration [ie. skirting exotic vines on trees, targeted primary weed treatments, follow-up treatments and protection of native species]. Work commenced in December 2002 and is part of a long term restoration strategy which focuses on recovery, recruitment and long term durability of the natural riparian community.

PHOTO 11: View of the Grose River and steep southern levee bank opposite Navua Reserve, showing area of natural regeneration [incl. Coast Myall *Acacia binervia*]. This core area has been targeted for treatment under the contract bush regeneration program.

PHOTO 12: Core regeneration area on the Southern Island [upper levee Bank near the location of Photo 10]. Exotic vines have been removed from native canopy trees [incl. River Oak *Casuarina cunninghamiana* and Mountain Blue Gum *Eucalyptus deanei*]. Following successive treatments, the ground layer is now dominated by native grasses [incl. I*mperata sp*., *Microlaena sp.* and *Oplismenus sp.*]

Refer to *Appendix II: Community Issues Discussion Paper: Weed Management, Restoration and Reinstatement: Remnant Biodiversity and Management Realities for Unstable Riparian Ecosystems.*

Threatened Species

A transitory colony of Grey-headed Flying-fox *(Pteropus poliocephalus)* has established in the southern portion of the reserve. The preferred habitat lies within a gallery thicket of weed species dominated by Box Elder *(Acer negundo).* The Flying-foxes are a protected species and are of particular significance. In May 2001, the NSW Scientific Committee made a Final Determination to list the Grey-headed Flying-fox as a "vulnerable species" under the *Threatened Species Conservation Act (1995).* A Draft Recovery Plan will be prepared by the NPWS in liaison with key stakeholders.

The National Parks and Wildlife Service (NPWS) is closely monitoring the status and any impacts or interference with this colony. In addition, existing boundary anomalies within this portion of the reserve are to be investigated in accordance with this Plan of Management.

Management Realities for Unstable Riparian Ecosystems

It is important to recognize the implications of managing unstable ecosystems in terms of resourcing and financial expenditure. For this valuable regional asset, there must be a program of long term commitment and funding. The co-ordinated planning and management response must be based on sound ecological principles to ensure an appropriate level of stability and durability over time. The following issues affecting the reserve's ecological processes and long term durability need to be addressed:

- resilience in remnant natural ecosystems;
- reduction in geographical range;
- relative size, location and spatial configuration of the reserve;
- poor level of natural recruitment;
- changes to dispersal and colonization;
- intervention strategies;
- isolation vs. connectivity;
- faunal corridors, bio-linkages, buffers and "mosaics".

Resilience in remnant natural ecosystems

Different natural ecosystems have different levels of resistance and resilience to environmental impacts and human-induced impacts. Resistance can be defined as an ecosystem's ability to withstand an initial impact whereas resilience is the ability of an ecosystem to recover from an impact and return to its pre-disturbance condition over time. Resilience can also be defined as the ability of an ecosystem to persist and maintain itself. These relative levels of resistance and resilience have important implications for management of Yarramundi Reserve.

The original riparian ecosystem at Yarramundi formed a lineal corridor within the broader floodplain, restricted to within the boundaries of adjoining levee banks. The vegetation community developed on deep layered, unconsolidated sediments. Erosion, sedimentation and stream channel changes due to flood impacts continue to shape the reserve and its biota.

Riparian alluvial ecosystems are typically fragile by nature, exhibiting very low resistance as well as very low resilience to environmental and human-induced impacts. Change can occur rapidly and recovery is likely to be extremely slow without further human intervention. The small populations, size and lineal spatial configuration (ie. high edge to area ratio) of these ecosystems may be easily overwhelmed by continuing internal and external pressures leading to long-term simplification and ecosystem instability.

Reduction in geographical range
The trend towards increasing urbanization will inevitably impose further pressures on this reserve's natural values. As remnant habitat outside the boundaries of major reserves continues to decline there will be added pressure to protect and restore these values in this reserve. Each step towards smaller and more isolated populations will increase the chance of local extinction through random fluctuation, introduced pathogens, predation, habitat disturbance, reproductive isolation and reduced gene flow.

Relative size, location and spatial configuration of the reserve
The reserve has a high edge to area ratio (ie. extensive boundaries compared to the relative size of the reserve). This configuration within a highly modified environment (including adjoining rural land-uses) effectively amplifies edge conditions and their negative impacts on all parts of the reserve. The continuing range of deleterious inputs (weeds, nutrients, pollutants, etc.) from upstream sources further complicates these management issues.

Poor level of natural recruitment
The highly fragmented remnants of the former Sydney Coastal River-flat Forest community cannot compete effectively with introduced weed species. Under the altered environmental conditions (ie. exotic weeds, altered stream flows, fire and nutrient regimes) natural recruitment remains very low throughout the reserve. In addition, the dominance of exotic weeds increases edge effects such as exposure to gale-force winds and storms, greater temperature gradients, wind turbulence and wind shear impacts which further destabilizes native regrowth.

Changes in dispersal and colonization
In combination, environmental and human-induced stresses can create synergies, leading to an accelerated rate of species decline in fragmented habitats. These processes have the greatest affect on the older endemic species and least on the

more widely distributed, common and more adaptable species. This point has important implications for providing long-term protection of natural values.

Clearing and loss of understorey components across Sydney has contributed to the disappearance of many smaller species of birds such as the Superb Fairy-Wren *(Malurus cyaneus)* and the dominance of more aggressive and group territorial species such as the Noisy Miner *(Manorina melanocephala)* and Pied Currawong *(Strepera graculina).* Yarramundi Reserve retains significant populations of smaller bird species which depend on the weed understorey. Gallery weed thickets also support a transitory colony of the Grey-headed Flying-fox. It is important that the restoration strategy should be carefully staged and managed to ensure no net loss of vital habitat values.

Under the altered nutrient loadings, particularly on the sandy loam soils, there is likely to be changing patterns of dispersal and colonization in native species. Native opportunist species such as Cheese Tree *(Glochidion ferdinandi)* and White Cedar *(Melia azedarach)* are clearly advantaged by increased nutrient levels and altered fire regimes.

Intervention Strategies
It is important that intervention strategies emphasize the integration of regeneration, restoration, enhancement and reinstatement processes in accordance with the following definitions *(Australian Natural Heritage Charter, 1999):*

Regeneration – the recovery of natural integrity following disturbance or degradation.

Restoration – returning existing habitats to a known past state or to an approximation of the natural condition by repairing degradation, by removing introduced species, or by *reinstatement*.

Enhancement – the introduction to a place of additional individuals of one or more organisms, species or elements of habitat or geodiversity that naturally exist there.

Reinstatement – to introduce to a place one or more species or elements of habitat or geodiversity that are known to have existed there naturally at a previous time but can no longer be found at that place.

The strategy should aim to provide a high level of species and structural diversity based on a successional or staged approach to ensure long-term stability and durability. The strategy should not simply maintain a situation of “arrested succession” based on the depauperate level of native species present on the site.

Measures for monitoring conservation processes also need to be implemented. These include soil sampling, analysis and amendment, recording of biophysical

variables, introduction of site assessment methodology (eg. use of quadrats or rapid assessment methods), assessment of any impact on threatened species and habitat values and research into fire management strategies for desired ecological outcomes. Appropriately funded long-term maintenance regimes will also need to be established and monitored.

An integrated weed management and restoration strategy has been implemented within the reserve since December 2002. This work has focussed on priority areas and actions as outlined in this Draft Plan of Management. Refer to *Figure 6: Intervention Strategies, 5.0 Management Strategies and Appendix IV: Schedule of Existing Native Plant Species, Appendix V: Schedule of Existing Weed Species and Appendix VI: Schedule of Species for Restoration and Enhancement at Yarramundi Reserve.*

Isolation vs. connectivity

Yarramundi Reserve offers significant opportunities for connectivity of riparian vegetation and habitat along the Hawkesbury – Nepean River corridor. Adjoining private rural lands, including Yarramundi Lagoon and its wetlands and Navua Reserve should be better integrated within these broader objectives of biodiversity management and conservation. There is no doubt that to allow fragments to disappear involves unknown risks to the surviving biota as well as the loss of important parts of Hawkesbury City's natural landscape heritage. All the remaining "pieces" of floodplain communities should be considered as important to the whole.

Faunal corridors and bio-linkages

The creation of faunal corridors, bio-linkages, buffers and "mosaics" aim to reduce the effects of isolation, ecosystem simplification and instability. However, corridors or bio-linkages, while potentially enhancing vital habitat and increasing the movement of mobile species, can also extend edge effects. Faunal corridors can also act as conduits facilitating movement of weed species, feral animals and diseases between isolated populations *(Hobbs, 1997 and Crome, 1997).*

Suitable bio-linkages may not be the only limiting factor for many species – it may be determined by the size and quality of suitable remaining habitat and the level of predation (eg. foxes). Existing data gaps in habitat and movement requirements of mobile species, the design, overall size and width of corridors have been the subject of ongoing debate amongst the scientific community, conservation groups and general public.

Ideally, faunal corridors need to address the following criteria:

- identify the faunal species which may benefit (incl. endangered species);
- sample a range of habitats and topographic features;
- no gaps or discontinuities within corridors;
- further research to address data gaps in species habitat requirements;
- ongoing monitoring and adjustment.

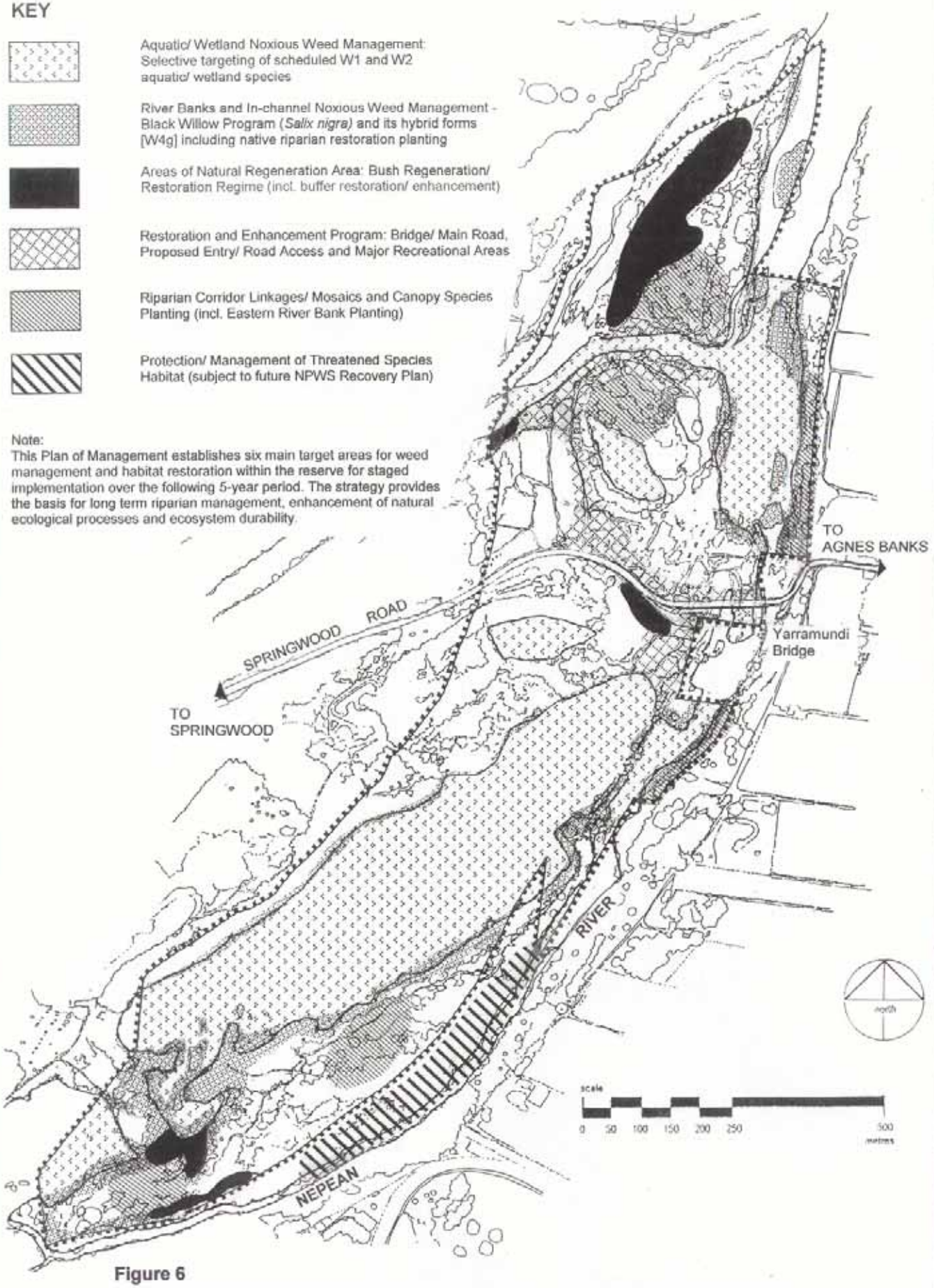

Figure 6

Yarramundi Reserve

Intervention Strategies

Riparian Buffers
The establishment of riparian buffers should be considered in the strategy to reduce edge effects as well as providing critical ecotonal habitat values. The provision of buffers, particularly along adjoining private land, would potentially enhance opportunities for maintaining ecosystem resilience. They can also provide the habitat requirements for faunal species dependent on these dynamic edge conditions for their survival and evolution *(Harrington, 1995).*

Mosaics
"Mosaics" emphasize the inter-connectivity of all the fragmented components, utilizing and expanding upon core remnant and regenerating areas in the reserve. It is vital that these "mosaics" be allowed to develop a range of age structures, understorey component species and habitat values (including nesting sites, hollow logs, river snags for fish habitat, etc). This combination of approaches stresses the importance of each of the component parts, their evolutionary processes and "resilience" of the entire ecosystem.

4.8 Public Recreation and Environmental Protection

Recreation Values
Recreational values are closely linked with the setting and the opportunities it provides. As outlined in *4.3 Community Values*, the most important community values attached to this reserve are natural setting, water/ rivers, heritage, public access/ recreation. There is a strong recreational focus in the way the reserve is valued. There is also a strong appreciation of the need to balance these activities with environmental protection. Recreational values can be divided into four main sub-groups as follows:

- water-based/ river-side recreation (eg. swimming, canoeing, and fishing);
- informal, passive and family-based recreation (eg. walking, picnics and family gatherings);
- nature-based recreation/ environmental studies; and
- informal, active land-based recreation (eg. horse riding and mountain-bike riding).

In order of preference, the reserve is used primarily for water-based recreation (eg. swimming, canoeing, and fishing) and passive recreational opportunities (eg. walking, picnics and family gatherings). There was an even split on these preferences by respondents. These activities were followed by nature-based recreation/ environmental studies and informal, active land-based activities (eg. horse riding and mountain-bike riding).

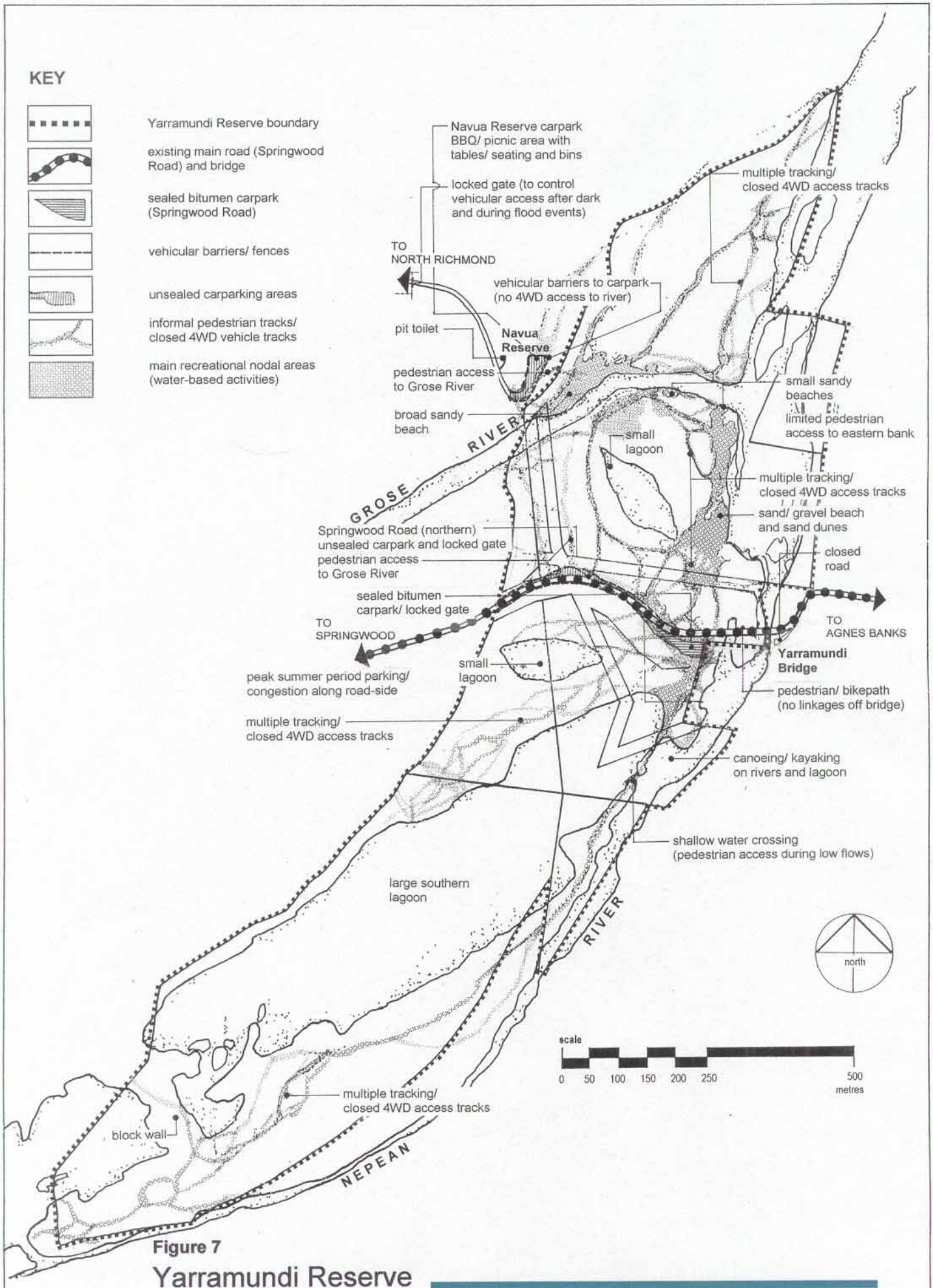

Figure 7

Yarramundi Reserve

Recreation, Access & Circulation

PHOTO 13: View of the western carpark on Springwood Road. This open, expansive carpark continues to be affected by waste dumping and vandalism of vehicular barriers, fences and gates. The area is to be re-designed as a smaller, overflow carparking area and entry point for the proposed Grose River access road and carpark.
Photo taken August 2004.

PHOTO 14: View looking east over the redeveloped south-western carpark near Yarramundi Bridge. This elevated, sealed bitumen carpark provides access to the Nepean River, southern lagoon and environs – an area proposed as a Special Conservation Zone.
Photo taken August 2004.

In order of preference for recreational locations, the Grose River/ Navua Reserve area was identified as the most popular destination for a range of water-based activities, particularly swimming. This related to water quality and public safety issues. Fishing and canoeing are also popular activities on the Grose River. Locations along the Hawkesbury – Nepean River, north and immediately south of the Yarramundi Bridge, are also highly valued by the broader community. The more remote southern "lagoon" and environs are a focus for fishing, canoeing and passive/ nature-based recreation.

Figure 7: Recreation, Access and Circulation identifies existing road access, carparking areas, the proposed Springwood Road and bridge alignment, main recreational nodal areas and informal pedestrian tracks and closed 4WD vehicle tracks. Public access and recreation issues are discussed in *Appendix II: Community Issues Discussion Paper: A.4 Public Access and A.5 Yarramundi Bridge Replacement.*

Managing Recreational Values

The number of visitors, time available to participate in leisure activities and an ever increasing range of recreational pursuits will continue to impose pressures on the reserve's fragile natural environment and significant biodiversity and geodiversity values. In addition, improved recreational facilities are likely to increase the number of visitors and attract a broader range of user groups and activities. The positive side of this would be greater visibility of people, an improved level of security, broader community "ownership" of the reserve and a potential reduction in anti-social behaviour. However, there would also be the potential for negative impacts such as perceived crowding, conflict between user groups over incompatible activities, dissatisfaction with experience and natural resource impacts. These types of conflicts can already occur during peak summer periods. Furthermore, these changes can lead to a continuing loss of experiential quality and eventual visitor/ user group displacement *(Loomis and Graefe, 1992).*

Research has shown that visitor surveys which identify the level of satisfaction are not necessarily a reliable measure for determining social carrying capacity. Reserve development and introduction of recreational facilities can easily change the type of user groups of a given area and hence alter recreation experiences and satisfaction. Creeping or incremental development of a recreational setting can easily lead to visitor displacement and recreational succession. In this context however, recreational infrastructure is severely limited by the potential for flood impacts.

Recreational activities within the reserve will inevitably lead to erosion of the alluvial soils, disturbance of vegetation communities and potential loss of wildlife habitat. These impacts exhibit relatively predictable patterns both in space and over time. Bio-physical research has consistently confirmed that the fragility of most natural environments is such that very little use causes substantial amounts of impact (ie.

most negative environmental impacts are caused during the initial phase after opening an area to visitors).

Most of the recreational activities in the reserve are concentrated near the water's edge, often on steep banks with highly erodible soils. Prior to the installation of vehicular barriers, the area provided unrestricted access for 4WD vehicles. This pattern of use left significant impacts on the quality of popular locations with long term damage to native vegetation, eroded tracks, abandoned vehicles, dumped rubbish, broken glass and health issues. The steep river banks along the Grose River and the southern island area have been particularly affected by past 4WD access and camping. Even with the restrictions on vehicle access, popular activities such as swimming, fishing and boating/ kayaking continue to have a high impact on the resource base. Within fragile areas, it is important to control the spatial extent of recreational user groups and hence impact.

It is essential that all these environmental and social impacts are managed on a sustainable basis in order to meet the future needs of the community. Objective limits need to be established on the types and amounts of change that are either desirable or acceptable for the reserve. Management strategies for recreational facilities and activities should therefore focus on the following:

- where possible, continue to maintain recreational activities within the most durable sites, having regard for flood impacts and public safety;
- maintain and promote long term sustainability of the reserve as a limited and finite resource;
- enhance opportunities for water-based access and recreation, visitor safety and circulation, providing site hardening/ shielding options;
- improve dispersal of concentrated uses/ peak summer crowds within resistant sites away from river banks and significant habitat;
- address potential changes to visitor numbers/ user groups and possible overcrowding of recreational facilities during peak summer periods;
- monitor visitor numbers and type of activities and ensure provision of appropriate facilities;
- seek to remove incompatible recreational uses and activities (environmental and social);
- restrict and regulate inappropriate activities and visitor dispersal within fragile areas;
- rationalize and maintain pedestrian track system and provide temporary site or track closures for periodic recovery;
- enhance opportunities for low impact education (eg. interpretive facilities/ signage, brochures, guides) and where appropriate, for wildlife interaction (eg. spotlighting) ensuring protection of nesting/ breeding sites;

- establish closed sites for protection, regeneration, restoration and enhancement of bushland, particularly areas identified as containing threatened species.

In establishing limits of desirable or acceptable change, this Plan of Management provides a framework for the reserve's future management.

4.9 Role and Public Purpose of Yarramundi Reserve

Public Recreation and Environmental Protection

Although there is virtually no existing recreational infrastructure, the reserve has a relatively high level of visitor usage, particularly on peak summer week-ends and holidays. It has a local and regional visitor profile within the Hawkesbury City LGA and the broader north-western metropolitan area. As Sydney continues to grow and density of development increases, accordingly there will be an ever-increasing demand for easily accessible open space, particularly in scenic bushland and river-side recreational settings. Such opportunities are rare in the western Sydney metropolitan area.

Currently, the reserve suffers from a sense of alienation and lack of appropriate public access, recreational facilities and infrastructure. As a significant regional asset on the Hawkesbury – Nepean and Grose Rivers, these opportunities should be developed, albeit in way which is sensitive to the ecology of this riparian corridor. The future role of this reserve and development of recreational infrastructure should ensure a greater level of opportunity for local and regional visitors while being low-key and non-intrusive. Proposed recreational facilities should not in any way compromise identified values or potentially limit opportunities for future generations. Recreational opportunities and facilities should also be consistent with bushfire and flood management objectives. Refer to recreational management objectives in *5.0 Management Strategies: 5.1 Action Plan, items H1-H22* and *Figure 8: Landscape Masterplan.*

4.10 Vision Statement for Yarramundi Reserve

The following statement provides a vision for Yarramundi Reserve which will form the basis of management strategies as developed in the next section of this Plan:

"To promote and enhance Yarramundi Reserve's role as a significant and unique asset within the Crown reserves system and Hawkesbury City Council's recreational open space, ensuring protection of identified values through appropriate management, in a way which best meets the environmental, recreational, educational and social needs of the present community and for future generations".

5.0 Management Strategies

5.1 Action Plan

Desired outcomes
The following Action Plan (refer to *5.1 Action Plan – Table 3: Sheets 1-14*) identifies seven key management objectives or desired outcomes as follows (item nos. A-G):-

A. To establish an appropriate land and water management framework for this Crown reserve;
B. To protect and rehabilitate the reserve's natural setting, its scenic, environmental, hydrological and geomorphic processes;
C. To restore geomorphic integrity and promote ecologically sustainable management practices;
D. To investigate the potential for Aboriginal heritage sites or relics and promote opportunities for dialogue with traditional Aboriginal custodians;
E. To establish guidelines for assessing development proposals and impacts and to ensure consistency with the relevant Acts;
F. To establish guidelines for assessing leases, licences and other estate and to ensure consistency with the relevant Acts; and
G. To maintain and enhance public access, circulation and provide for appropriate low-key recreational infrastructure.

These first order management objectives or desired outcomes have been developed through the identification of key values and an assessment of issues affecting these values as described in *4.0 Basis for Management*. Accordingly, the Action Plan is divided into four key values as previously identified (see column 1):-

1. Riparian Corridor/ Natural Setting
2. Indigenous and Cultural Heritage
3. Environment/ Biodiversity
4. Public Recreation and Environmental Protection

Each page of the Action Plan includes the following data:-

- *performance targets* or *management strategies* (column 2);
- *item* or reference number (column 3);
- *means of achievement* or *management actions* (column 4);
- *means of assessment* of the actions (column 5);
- *priority ranking* for each management action (column 6).

Performance targets (column 2)
The *desired outcomes* have guided the development of *performance targets* in the Action Plan.

Item no./ Management actions (columns 3 and 4)
The performance targets provide the direction and framework for developing the *management actions* or the *means of achievement*. Each action is assigned an item number based on the *desired outcomes*: A – G (eg. A1 to A7, B1 to B11, etc.).

Performance measures/ Means of assessment (column 5)
The Action Plan establishes a system of checks and balances to assess actions in relation to performance (ie. *means of assessment)*.

Priority (column 6)
Priorities for management actions are assigned according to relative importance – very high, high, medium and low. It is envisaged that actions will be addressed on a priority basis, by the Council Unit responsible, and in accordance with the means of assessment as follows:-

VERY HIGH	= 1 year
HIGH	= 1-2 years
MEDIUM	= 3-4 years
LOW	= up to 5 years

5.2 Capital Works Program

Priorities and cost estimates are further developed in the 5-year capital works program (refer to *Table 4: Capital Works Program* and *Table 5: Summary of Annual Budget Expenditure*). The Opinion of Probable Landscape Construction Costs is based on the Landscape Masterplan and is indicative only.

5.3 Landscape Masterplan

The Landscape Masterplan (refer to *Figure 8: Landscape Masterplan*) identifies key management actions to be implemented throughout the 5-year capital works program, subject to available funding.

5.0 Management Strategies

5.1 Action Plan

Table 3

	Performance Target (strategies)	Item	Means of Achievement (Management Actions)	Means of Assessment (of the actions)	Priority
riparian corridor/ natural setting	**Desired Outcome: To establish an appropriate land and water management framework for this Crown reserve.**				
	To ensure that identified values are given adequate protection and that the reserve's management objectives are consistent with the broader catchment objectives of the *Draft Hawkesbury Lower Nepean Catchment Blueprint* and other relevant policies.	A1	Provide overall consistency in land and water management for this Crown reserve including its waterways, river flows, water quality and groundwater, geodiversity and biodiversity, archaeological and scenic values.	Reserve's natural values protected and restored.	ongoing
		A2	Continue to address sub-catchment issues in a co-ordinated and integrated approach, including promotion of partnership opportunities, community education and involvement [see items C9-C10, C34-C35 and E2].	Reserve managed in accordance with broader catchment objectives.	ongoing
	To protect the reserve's outstanding scenic and environmental values.	A3	Protect and manage scenic vistas and provide appropriate rehabilitation of remnant natural bushland and faunal habitat [see items C1-C41].	Crown reserve's natural setting and values protected and managed in accordance with this Plan.	ongoing
	To manage recreational values and impacts on the natural setting.	A4	Ensure recreational activities and intensity of uses are consistent with the protection of reserve's identified natural values and public safety. Implement appropriate management and control measures to restrict any incompatible recreational uses and activities [see items F1-F5 and H9].	Incompatible recreational activities and uses prohibited in accordance with this Plan.	ongoing
	To address anomalies in Crown land parcels and boundaries.	A5	Investigate land parcel ownership issues and prepare appropriate survey plans for possible inclusion within the Crown reserve. When no longer required for through access, road reservations within the reserve are to be closed and added to the Crown reserve [see *Figure 3: Crown Reserve*].	Investigation and survey completed. Land parcels and closed road reserves added to Crown reserve. Broader recognition and protection of reserve's environmental values.	very high
	To address zoning issues to include all of Crown reserve	A6	Investigate existing zoning anomalies with regard to Crown reserve land and amend accordingly [see *Figure 4: Zoning*].	Anomalies addressed and amended accordingly.	very high
	To address significant environmental values and sensitive habitat of threatened species.	A7	Designate the Southern Island, Lagoon and Western Foreshores [south of Springwood Road] as a Special Conservation Zone to protect fragile and sensitive habitat values from inappropriate recreational activities.	Sensitive habitat values given appropriate conservation priority over other uses.	very high
	Desired Outcome: To protect and rehabilitate the reserve's natural setting, its scenic, environmental, hydrological and geomorphic processes.				
	River Recovery and Management: To provide better river health including implementing environmental flows. To address biophysical capabilities of the land and its use through improved management of urban and rural development.	B1	Sub-Catchment Level Initiatives: Overall river health and catchment management issues have been identified and prioritised for action in the *Hawkesbury Lower Nepean Catchment Blueprint 2002.* The following management objectives focus on actions which can be achieved within the reserve in accordance with these broader catchment management initiatives.	Implementation of the Plan in accordance with the objectives of the *Hawkesbury Lower Nepean Catchment Blueprint 2002.*	ongoing

	Performance Target (strategies)	Item	Means of Achievement (Management Actions)	Means of Assessment (of the actions)	Priority
riparian corridor/ natural setting	Desired Outcome: To protect and rehabilitate the reserve's natural setting, its scenic, environmental, hydrological and geomorphic processes.				
	River Recovery and Management [cont'd]:		Yarramundi Reserve:		
	To enhance river bank stability.	B2	Retain existing diversity of riparian landforms - river channels and banks, levees, overland flow areas, back creeks and lagoons, wetlands and islands.	Diversity of existing riparian landforms retained. Measure trends over time.	ongoing
	To ensure that post-flood instability is reduced through minimising further changes to the river's profiles and landforms.	B3	Further dredging or excavation for sand or gravel is not permitted in order to minimise further instability, erosional damage, turbidity and loss of river bank, wetland and aquatic vegetation.	Reserve protected from further inappropriate uses. Measure trends over time.	ongoing
	To provide opportunities for natural river dynamics to define the character of Yarramundi Reserve through alternating periods of flood and drought dominated regimes [FDRs and DDRs respectively]	B4	Develop a staged rehabilitation and restoration strategy ensuring minimal disturbance to river banks through human-induced impacts. Retain existing soil profiles and restrict activities which may cause erosion and interruption of natural hydrological processes.	Staged rehabilitation and restoration strategy implemented in accordance with this Plan.	very high ongoing
		B5	Retain existing constructed 'block wall' at the southern end of the large lagoon [former excavation pit] to maintain flow levels in the main right channel of the Nepean River and to ensure current water allocation to irrigators.	Retain existing weir/ flow regime subject to further investigation and implementation of broader catchment management objectives.	ongoing
		B6	Promote recreational activities which are consistent with the rehabilitation strategy, including appropriate controls on off-road vehicles, pedestrian access, river access, kayaking/ boating, dog exercise and other activities which may cause loss of vegetation and erosion [refer to items H1-H22].	Reserve protected from inappropriate recreational activities and uses. Measure trends over time.	ongoing
	Flood Planning and Management: To address public safety and risk management during periods of flooding [ie. controls over public access, provision for emergency vehicle access and evacuation]	B7	Ensure that flood planning is consistent with *NSW Flood Policy (1984), NSW Floodplain Management Manual (2001)* and the *Hawkesbury Nepean Floodplain Management Strategy (adopted 1998).*	Flood planning implemented in accordance with relevant policies, guidelines and strategies.	ongoing
		B8	Proposed public access, recreational amenities and facilities within the reserve must be located with regard to public safety in the event of flooding. New structures should not in any way obstruct, reduce or interfere with upstream or downstream flood behaviour or adversely impact occupiers of the floodplain.	Proposed development implemented in accordance with this Plan's development guidelines.	ongoing
		B9	Ensure that the reserve is closed to public access during flood events in accordance with Council's operational protocols. Maintain lockable boom-gates on all points of vehicular access and provide for emergency vehicle access [see items H7 & H15].	Adequate provisions for public safety and emergency response.	ongoing
	To develop a Flood Evacuation Plan	B10	Liaise with the State Emergency Service [SES] Sydney Western Division - Hawkesbury Unit to develop a Flood Evacuation Plan for this reserve.	Flood Evacuation Plan prepared and implemented.	very high
	To address post flood recovery works	B11	Develop a detailed Post Flood Recovery Plan.	Post flood recovery procedures addressed.	very high

	Performance Target (strategies)	Item	Means of Achievement (Management Actions)	Means of Assessment (of the actions)	Priority
environment/ biodiversity	Desired Outcome: To restore geomorphic integrity and promote ecologically sustainable management practices				
	Threatened Species & Biodiversity Management: To address conservation significance of transitory colony of Grey-headed Flying-fox within southern portion of the reserve. To identify and effectively manage threatening processes. To establish objective limits on the type and amount of acceptable change imposed on the preferred degraded habitat. To implement actions which will restrict incremental impacts. To protect and restore the reserve's riparian vegetation, its ecological communities, species and habitat values. To improve quality, extent and connectivity of native habitat and enhance opportunities for greater biodiversity within the reserve.	C1	Ensure that the transitory colony of Grey-headed Flying-fox *(Pteropus poliocephalus)* is adequately protected from any disturbance or harm in accordance with the *Threatened Species Conservation Act 1995*. Refer to item F2 for area to be designated within a Special Conservation Zone.	Conservation priorities implemented and integrity of population protected.	very high ongoing
		C2	Assist NPWS in the close monitoring of the status and any adverse impacts on this colony and the gallery habitat of the weed species Box Elder *(Acer negundo)* and other exotic weed species.	Enhanced protection of vital habitat.	ongoing
		C3	Map the extent of habitat and ensure that any weed management initiatives, including noxious weed control, are conducted within this or adjoining areas subject to NPWS permit.	Survey/ assessment completed with recommendations.	very high
		C4	Protect Flying-fox habitat from development associated with recreational access, activities or infrastructure. Ensure that management is consistent with future Recovery Plan for this scheduled 'vulnerable species'.	Enhanced protection of vital habitat. Monitor changes and trends over time.	ongoing
		C5	Review opportunities to involve tertiary institutions in faunal surveys, including trapping, focussing on any other threatened species within the reserve and specific habitat requirements.	Quantitative faunal study completed and recommendations implemented.	medium ongoing
		C6	Establish procedures for monitoring and control of feral animal populations. Investigate options for controlling predation by foxes and feral cats.	Number of rabbit and fox baiting programmes and feral cat trapping undertaken.	High ongoing
		C7	Review opportunities to involve tertiary institutions, NSW Fisheries and local fishing clubs [Angler Catch Research Program] in a biodiversity survey of aquatic habitats within the reserve. Seek to determine the status of native species. Continue investigations into the status of Freshwater Sponges under the Yarramundi Bridge.	Aquatic biodiversity study completed and recommendations implemented.	high ongoing
	Weed Management & Habitat Restoration To ensure that the biodiversity targets for this reserve are consistent with the methodology and evaluation framework of the *Hawkesbury Lower Nepean Catchment Blueprint* and the *Native Vegetation Conservation (NVC) Act.* To involve the community in partnerships and volunteer networks and to ensure a long term management commitment for sustainability.	C8	Ensure that progressive weed management/ clearing and noxious weed programs protect vital habitat values, particularly identified threatened species gallery habitat as well as wetlands/ river bank margins along the southern lagoon. Retain adequate habitat at all times for the large numbers of wading-birds and smaller bird species which frequent the dense weed thickets.	Weed management progressively staged to protect and manage vital habitat. Measure trends over time.	ongoing
		C9	Develop a consistent weed management and control program with necessary approvals under the *NVC Act*, which encompasses the work of all agencies and stakeholders involved in the environmental management of the reserve (ie. Department of Agriculture, HNCMA, HRCC, NPWS, DIPNR, NSW Fisheries, HCC and the Navua Group). The strategy should be targeted, staged and adequately funded to ensure a sustainable outcome.	Co-ordinated strategy implemented in accordance with Works Program and appropriate funding.	very high ongoing
		C10	Promote opportunities and forums for the exchange of information on current programs and initiatives by different agencies.	Forum/ meetings established as required.	ongoing

	Performance Target (strategies)	Item	Means of Achievement (Management Actions)	Means of Assessment (of the actions)	Priority
environment/ biodiversity	Desired Outcome: To restore geomorphic integrity and promote ecologically sustainable management practices				
	Weed Management & Habitat Restoration [continued]	C11	Consult with key stakeholder groups including the Navua Group.	Key stakeholder groups included in consultation.	ongoing
		C12	This Plan establishes six main target areas for weed management and habitat restoration within the reserve, focussing on the following [see items C14-C41]: 1. Aquatic/ Wetland Noxious Weed Management (targeted species); 2. River Banks and in-channel Noxious Weed Management (targeted species); 3. Areas of Natural Regeneration - bush regeneration/ restoration regimes; 4. Yarramundi bridge and road approaches landscape treatments (RTA); 5. Proposed entry/ access and major recreational use areas restoration; 6. Riparian Corridor linkages/ mosaics and canopy species planting.	Co-ordinated strategy reinforces habitat values and addresses potential issues of arrested succession and long term simplification and instability of the ecosystem. Measure trends over time.	very high ongoing
	To adequately address past deficiencies in the restoration and management of highly impacted and degraded areas following sand mining. To ensure an effective integrated management approach to weed management. To improve opportunities for simplified ecosystems to recover with enhanced durability. To involve the community in partnerships and volunteer networks and to ensure a long term management commitment for sustainability.	C13	The Restoration Program aims to re-establish a diverse mix of habitats based on historic records and current ecological data taken from similar alluvial sites within this section of the catchment. The following riparian units are proposed: (a) River Oak Forest [adjacent to the river, toe of banks and lower slopes]; (b) River-flat Forest [on well-drained upper slopes and levee banks]; (c) Freshwater Wetlands [low-lying depressions and surrounding lagoons]. These riparian units are consistent with River-flat Forest [Map Unit 9f] (Benson, 1992) and Riparian Forest [Map Unit 12] (NPWS, 2000). Refer to *Appendix VI: Schedule of Species for Restoration and Enhancement.*	Habitat values restored in a staged, integrated strategy in accordance with the relevant vegetation map units. Measure trends over time and number of species used in the strategy.	very high ongoing
	1. Aquatic/ Wetland Noxious Weed Management (targeted species); To provide consistency in targeting noxious weed species and implementing appropriate management strategies.	C14	Continue control program of targeted noxious aquatic/ wetland and terrestrial weed species including Alligator Weed *(Alternanthera philoxeroides)* [W1], Ludwigia *(Ludwigia peruviana)* [W2], Water Hyacinth *(Echhornia crassipes)* [W2] and Salvinia *(Salvinia molesta)* [W2] and other declared species under the *Noxious Weeds Act 1993* .	Program implemented in accordance with this Plan and the relevant legislation.	very high ongoing
	To ensure thorough investigation of weed infestation and status.	C15	Conduct an ongoing survey of areas within the reserve affected by aquatic and wetland noxious weed species including river channels, lagoons, banks, mid-channel islands, swales and localised depressions.	Noxious weeds identified and mapped during programs. Measure trends over time.	ongoing
	To comply with best practice methods in aquatic and wetland weed management and reduce any negative impacts on native regeneration, habitat values & bird-nesting sites.	C16	Review current management practices. Broad-scale non-selective applications of herbicides should be discontinued. Establish a program which progressively builds on natural regeneration of native aquatic and wetland plants.	Current management practices reviewed and integrated management program implemented.	very high
	To establish a quantifiable means of assessment of the program emphasizing the long term objective of sustainability.	C17	Identify and map native aquatic, wetland and adjoining terrestrial (marginal) species and populations within targeted areas for protection prior to any herbicidal treatment. Apply selective and controlled non-residual herbicidal treatments by qualified and experienced staff ensuring that no over-spray onto adjoining native vegetation and habitat occurs.	Targeted areas clearly identified prior to treatment.	very high ongoing

	Performance Target (strategies)	Item	Means of Achievement (Management Actions)	Means of Assessment (of the actions)	Priority
environment/ biodiversity	Desired Outcome: To restore geomorphic integrity and promote ecologically sustainable management practices				
	1. Aquatic/ Wetland Noxious Weed Management (targeted species); [continued]	C18	Keep records of treated target areas, dates and application rates, % of weed infestation under treatment and % of native vegetation cover, weed status and condition in accordance with NSW Agriculture Weed Recording Standards.	Monitor changes and trends over time [ie. % weed cover vs. % regenerating native cover measured over time showing positive net gains in native cover.	ongoing
	To establish a quantifiable means of assessment of the program emphasizing the long term objective of sustainability. To review impact of other non-declared species.	C19	Review opportunities to schedule Ribbon Waterweed *(Egera densa)* as a noxious species and investigate methods of controlling the spread of this species which is having a marked impact on aquatic habitats and exacerbating flood impacts.	Review conducted and recommendations implemented.	high
	2. River Banks and in-channel Noxious Weed Management (targeted species)	C20	Continue to implement Black Willow Management Program - targeting Black Willow *(Salix nigra)* and its hybrid forms [W4g] assessed as having 'extreme risk' to the Nepean River riparian zone. Apply chemical and mechanical treatments as appropriate. Ensure that replacement planting of treated Willows promotes diversity rather than simply a monoculture of River Oak *(Casuarina cunninghamiana).* Plant longstem tubestock at appropriate rates. Refer to *Appendix VI: Schedule of Species for Restoration and Enhancement.*	Program implemented in accordance with the Black Willow Management Program and this Plan of Management. Measure trends over time.	ongoing
	To provide consistency in targeting river bank weed species assessed as 'extreme risk' and implement appropriate management strategies. To enhance opportunities for stream bank stability, control soil erosion, reduce turbidity and improve river flows and conditions for aquatic invertebrates and fish.	C21	Continue to monitor regrowth/ recruitment of Black Willows within former extensive gallery thickets particularly within the southern, more isolated, parts of the reserve [eg. Nepean River right bank channel and adjoining banks]	Priorities and key threatening processes addressed. Measure trends over time.	ongoing
	To improve opportunities for establishment of a range of native plant species along the river banks and enhance associated habitat values.	C22	Co-ordinate with NPWS to ensure protection of threatened species habitat [ie. within gallery forest areas dominated by exotic weed species].	NPWS consulted and works implemented in accordance with recommendations.	ongoing
	To establish a quantifiable means of assessment of the program emphasizing the long term objective of sustainability. To continue community education programs in river bank management.	C23	Continue to monitor native replacement planting program. Remove weed growth around new plants and replace failed native plants. Over time, as bank stabilization improves, enhance species composition and structural diversity in accordance with item C13 and *Appendix VI: Restoration Schedule.*	Monitor changes and trends over time. % Willow regrowth and new seedlings controlled within reserve. % native river bank canopy established over time.	ongoing
		C24	Continue to liaise with community and stakeholders. Investigate options to address intrusive elements and structures on adjoining river banks, within private property [eg. above-ground irrigation piping and pumps].	Number of individuals/ groups contacted in program.	high ongoing
	3. Areas of Existing Natural Regeneration: bush regeneration/ restoration regimes	C25	Ensure that the Program fully addresses long term sustainability as its key objective and is consistent with current and future budget projections.	Bush regeneration program appropriately staged, implemented and reviewed quarterly and annually.	ongoing
	To protect and regenerate small pockets of natural regeneration.	C26	Program should target the following key core remnant areas containing natural regeneration as identified and mapped in *Figure 6: Intervention Strategies:* (a). Old river channel corridor - northern sector (*Acacia spp.* dom. canopy); (b). Springwood Road boulder stabilised area [south-western side of road]; (c). Protected swale directly east of block wall [large southern lagoon]; (d). Upper banks and ridges containing isolated remnant grasses and herbs. (e). Individual remnant canopy species [saplings, immature and mature].	Monitor changes and trends over time.	ongoing

	Performance Target (strategies)	Item	Means of Achievement (Management Actions)	Means of Assessment (of the actions)	Priority
environment/ biodiversity	Desired Outcome: To restore geomorphic integrity and promote ecologically sustainable management practices				
	3. Areas of Existing Natural Regeneration: bush regeneration/ restoration regimes [continued]	C27	Establish an integrated restoration strategy which focuses on the recovery, recruitment, long term durability and expansion of isolated remnant species and populations beyond existing core areas. Identify key threatening species and processes and implement a minimal disturbance bush regeneration approach where positive net gains are achievable. Consolidate core habitat areas through staged removal of weed species and buffer enhancement.	Co-ordinated strategy reinforces habitat values and addresses potential issues of arrested succession and long term simplification of the ecosystem. Area under regeneration per annum. Area under restoration/ enhancement per annum.	very high ongoing
	To implement an integrated approach to bush regeneration and restoration based on site-specific constraints and opportunities consistent with the high level of site disturbance. To improve quality, extent and connectivity of native habitat and enhance biodiversity. To identify and effectively manage key threatening species and processes. To secure genetic integrity as a key component of the restoration and enhancement strategy.	C28	Ensure that program is carefully integrated with suitable restoration, enhancement and reinstatement strategies using locally-sourced indigenous species [ie. use of local genotypes of species rather than introducing genotypes from different unrelated areas]. Collect seed and cuttings for propagating under an approved NPWS program. Source material from a number of plants to conserve genetic diversity. Do not deplete or compromise the ability for natural regeneration in other source stock.	Measure trends over time. Number and % of overall species used being locally-sourced [ie. local genotypes]. Off-site sources adequately protected and managed.	ongoing
	To establish a quantifiable means of assessment of the programme emphasizing the long term objective of sustainability.	C29	Implement a quantifiable bushland management assessment process that monitors changing patterns of ecosystem durability and sustainability over time: - investigate opportunities to involve tertiary institutions in monitoring; - introduce objective monitoring of regeneration/ restoration sites using standard rapid assessment/ measurement techniques [photographic record]; - investigate options for introducing quantitative measurement and assessment methods.	Monitor changes and trends over time. Objective monitoring to provide basis for cost/ benefit analysis.	high ongoing
	To secure sources of appropriate tubestock for staging the strategy.	C30	Utilize the resources of Council's native community nursery and investigate options for contract growing to order by specialist nurseries for delivery of required quantities of tubestock according to staging of the program.	Investigation completed and recommendations implemented. Appropriate staged supply established.	very high ongoing
	To manage recreational impacts and protect regeneration/ restoration areas from trampling and erosion. To improve visitor awareness of environmental programs.	C31	Install low-key fencing as required to protect areas of regeneration/ restoration or where trampling and erosion may cause problems. Use fencing to limit multiple tracking and inappropriate uses. Fencing to be typically pine log/ galvanised pickets and tensioned wire. Install low-key interpretive signage with information on joining the bushcare network.	Fencing and signage installed in accordance with Works Program and appropriate funding.	low
	To provide enhanced opportunities for isolated regenerating native canopy species which are threatened by rampant exotic weed growth.	C32	For individual remnant canopy species, provide necessary controls and maintenance to prevent exotic vine growth from smothering canopies.	No weed growth on any regenerating canopy species. Measure trends over time.	very high
		C33	Selectively apply non-residual glyphosate herbicide to target species and areas. Drill/ cut large shrub and tree weed species and apply herbicide direct. Monitor results and ensure appropriate follow-up applications as necessary. Cut and slash dead standing weed vegetation and rake weeds into small stockpiles for burning to promote natural regeneration [subject to Rural Fire Service approval and supervision]. Mulch & plant tubestock at appropriate rates.	Number of remnant canopy species secured. Measure trends over time.	ongoing

	Performance Target (strategies)	Item	Means of Achievement (Management Actions)	Means of Assessment (of the actions)	Priority
environment/ biodiversity	Desired Outcome: To restore geomorphic integrity and promote ecologically sustainable management practices				
	3. Areas of Existing Natural Regeneration: bush regeneration/ restoration regimes [continued]	C34	Continue to support community involvement and applications for grant funding, particularly the Navua Community Group, for the ongoing riparian restoration of adjoining Navua Reserve.	Number of grants applied for annually. Measure trends over time.	ongoing
	To address declining volunteer interest and involvement in local bushcare and rivercare programs.	C35	Seek to establish a broader volunteer network for both reserves, taking an integrated approach to their management. Raise community awareness of opportunities to join the volunteer network [eg. review options for establishing *"Friends of Yarramundi Reserve"* group, involve *Combined Community Services Youth Development Program* , organize public exhibitions/ displays, media releases, brochures, rate notices, etc.].	Number of people involved in volunteer network. Measure trends over time. Community programs developed.	medium ongoing
	4. Yarramundi bridge and road approaches landscape treatments (RTA) To provide representative species diversity and structural composition with all landscape embellishment of the bridge and approaches.	C36	Continue to maintain and enhance landscaping/ restoration works to road-side shoulders, embankments and carparking areas. Replace damaged and dead stock with appropriate species [see item C39]. Provide well-composted recycled mulches with neutral pH in landscape restoration works. Do not use green recycled wood chip as mulch. Install bio-degradable, 'jute-fibre' weed-mat and peg securely with galv. stakes. Spread selected mulch to min. depth of 50mm.	Works implemented in accordance with this Plan.	very high ongoing
	5. Proposed entry/ access and major recreational use areas restoration To improve environmental compliance and restrict dumping of waste materials.	C37	Remove existing dumped and deleterious materials on reserve [incl. glass, plastics, rusting steel, dumped and burnt-out vehicles, garden waste, etc]. Continue to remove dumped materials as soon as they are evident and make appropriate investigations. This Plan authorizes temporary stockpiling of materials for any restoration works in progress.	Monitor changes and trends over time.	ongoing
	To significantly enhance environmental, ecological and scenic qualities in these areas. To provide representative species diversity and structural composition in landscaped areas. To address security issues and provide a visitor-friendly environment.	C38	Ensure that all landscape works in high use areas provide a range of amenity values for visitors and enhance overall scenic, visual and environmental qualities. Plant selection should retain important sight-lines and afford a sense of security to reduce opportunities for anti-social behaviour [ie. No dense shrub planting in these areas].	Works implemented in accordance with this Plan.	ongoing
		C39	Ensure all landscaping/ restoration works are in accordance with the overall restoration strategy, including use of locally-sourced indigenous species consistent with item C13 and *Appendix VI: Restoration Schedule* .	Works implemented in accordance with this Plan.	ongoing
	6. Riparian Corridor linkages/ mosaics canopy species planting. To improve quality, extent and connectivity of native habitat and enhance remnant biodiversity.	C40	Continue to maintain and consolidate existing bush regeneration work within core areas. Subject to funding and labour constraints, progressively restore and expand upon existing work to provide faunal corridors, bio-linkages, buffers and mosaics to reduce the effects of isolation, ecosystem simplification and instability. Design for an enhanced range of riparian habitats.	Consolidation and expansion of restoration program in accordance with appropriate funding.	ongoing
		C41	Provide linkages with Navua Reserve and natural areas within the riparian corridor. Investigate opportunities for connectivity with other natural areas beyond the riparian corridor. This work should not in any way be allowed to compromise or over-stretch resources employed in the effective recovery of core remnant areas or rehabilitation work in high use areas.	Works implemented subject to appropriate funding. Area/ extent of faunal corridor links and buffers established within 10 years.	ongoing

	Performance Target (strategies)	Item	Means of Achievement (Management Actions)	Means of Assessment (of the actions)	Priority
environment/ biodiversity	Desired Outcome: To restore geomorphic integrity and promote ecologically sustainable management practices				
	Bushfire Management: The reserve must be managed in a manner that is consistent with the Hawkesbury Bush Fire Management Plan and the appropriate zoning as mapped in the plan. To protect life, property and the environment. To address emergency access in the reserve. To protect, maintain and wherever possible enhance natural and cultural values through the management of appropriate fire regimes.	D1	Maintain a rationalized network of fire-trails and access for emergency services vehicles. Fire trails and emergency vehicular access is to be provided in the following locations [refer to Landscape Masterplan]: - access off Springwood Road [east bank of river - closed section of old bridge]; - access from south-western sealed carpark [south-western side of new bridge] and emergency access only to south island/ southern lagoon areas. - access off Springwood Road to proposed northern carpark near the Grose River [north-western side of new bridge]; - access via Navua Reserve to Grose River and north island area; - address fire issues relating to adjoining properties and emergency evacuation.	Fire trails/ emergency access maintained at all times. No increase/ widening of fire trails in vital habitat.	high ongoing
	To develop a Bush Fire Evacuation Plan.	D2	Develop a Bush Fire Evacuation Plan for the reserve.	Bush Fire Evacuation Plan prepared and implemented.	very high
		D3	Co-ordinate with NSWRFS to implement public education programs. Ensure that appropriate bush fire hazard reduction/ public safety measures are undertaken within the reserve and adjoining properties.	Public education programs and appropriate safety measures implemented.	medium
	To address post bush fire recovery works.	D4	Ensure that a thorough inspection of the reserve is made following bush fire prior to opening to the public. Assess property/ infra-structure loss, damage and public risk. Prepare an inventory to address repairs and refurbishment.	Post bush fire recovery procedures addressed.	ongoing
	To ensure a co-operative partnership with other environmental agencies and community volunteers involved in restoration works. To develop appropriate ecological fire regimes.	D5	Co-ordinate with Hawkesbury Rural Fire Service [HRFS] and Richmond NPWS to establish an appropriate fire regime for rehabilitation and restoration of ecological communities within the reserve [incl. riparian protection buffer zones and appropriate thresholds for biodiversity and threatened species management].	Co-ordinated strategy with NSW Rural Fire Service. Appropriate fire regimes implemented.	ongoing
		D6	Integrate environmental and biodiversity programs with the objectives of fire management policy. Promote co-operation in facilitating an appropriate ecological fire regime for restoration of the Riparian Forest community.	as above	ongoing
		D7	Ensure protection of threatened species habitat [refer to items C1-C4].		
		D8	Seek necessary approvals for 'ecological burn-offs' during clearing and restoration works [see item C33].		

	Performance Target (strategies)	Item	Means of Achievement (Management Actions)	Means of Assessment (of the actions)	Priority
heritage	**Desired Outcome: To investigate the potential for Aboriginal heritage sites or relics and promote opportunities for dialogue with traditional Aboriginal custodians.**				
	To ensure that any potential Aboriginal heritage sites or relics are investigated.	E1	Aboriginal heritage needs to be further investigated and any places or relics properly protected and managed in accordance with the *National Parks & Wildlife Act 1974* and *NSW Heritage Act 1977*.	Investigations undertaken and recommendations implemented.	high
	To promote improved dialogue and consultation with traditional Aboriginal custodians.	E2	Promote a consultative environment with the traditional Aboriginal custodians regarding the proposed uses, development and rehabilitation of the reserve.	Level of consultation with traditional custodians regarding uses or development within the reserve.	ongoing
	To develop opportunities for Aboriginal involvement in educational and interpretive services.	E3	Investigate opportunities for local Aboriginal involvement in a management role [incl. cross-cultural training, visitor management and interpreting the reserve as a traditional resource area and the stories associated with this heritage].	Opportunities reviewed with traditional custodians for management role, interpretive and educational services in accordance with this Plan.	medium
public recreation & environmental protection	**Desired Outcome: To establish guidelines for assessing development proposals and impacts and to ensure consistency with the relevant Acts.**				
	To ensure consistency with public purpose of the Crown reserve: "Public Recreation and Environmental Protection", other relevant legislation and Council's *Local Environmental Plan* and policies.	F1	Ensure consistency in development proposals with the *Crown Lands Act 1989*, *Rivers & Foreshores Improvement Act 1948*, *Native Vegetation Conservation Act 1997*, the Department of Lands policy guidelines, including *NSW State Rivers & Estuaries Policy and NSW Wetlands Management Policy,* case law, *Hawkesbury Lower Nepean Catchment Blueprint, SREP No.20, Council's LEP1989: 7(d1) Environmental Protection (Scenic)* and Council's Land Management Goals, adopted policies and other relevant legislation.	Number and % of changes to reserve not consistent with relevant legislation and policy.	ongoing
	To ensure consistency with relevant threatened species legislation.	F2	Development must be consistent with the objectives of the *Environmental Protection and Biodiversity Act (EPBC Act) 1999*, the *Threatened Species Conservation Act (TSC Act) 1995* and the *Fisheries Management Act 1994* as the case requires. Development proposals which may adversely impact on any scheduled threatened species and/ or endangered communities are not permissible. Recreational uses and development within the Special Conservation Zone is to be restricted to low key, nature-based and water-based activities. Motorised boats on the southern lagoon are not permitted.	Number and % of changes to reserve not consistent with relevant legislation and policy. Recreational uses and activities restricted within the Special Conservation Zone [ie. South island/ lagoon and western foreshores south of Springwood Road]	ongoing
	To ensure thorough community consultation for all development proposals.	F3	Continue to promote an open community-based consultative process for all development proposals.	Level of community consultation for new uses or development within the reserve.	ongoing
	To protect reserve's geomorphic, hydrological, biodiversity, scenic, heritage, recreational, educational and scientific values from inappropriate development and ensure appropriate restoration and rehabilitation.	F4	Development proposals and uses within the reserve must address the following: - dynamic riparian context, flood hydrology and geomorphic processes - protect geomorphic character and natural features - protect river bank stability - enhance biodiversity and habitat values - protect Aboriginal and archaeological heritage values	Number and % of proposed developments that adhere to development guidelines. Measure trends over time.	ongoing

	Performance Target (strategies)	Item	Means of Achievement (Management Actions)	Means of Assessment (of the actions)	Priority
public recreation and environmental protection	**Desired Outcome: To establish guidelines for assessing development proposals and impacts and to ensure consistency with the relevant Acts.**				
	[continued] To protect reserve's geomorphic, hydrological, biodiversity, scenic, heritage, recreational, educational and scientific values from inappropriate development and ensure appropriate restoration and rehabilitation. To address flood planning and evacuation of the reserve. To address bush fire management, emergency vehicle access and evacuation. To address public safety and security.		- enhance the natural setting and scenic values - ensure environmental sustainability and protect sensitive habitat - demonstrate a clear connection with the reserve's public purpose, its role and riparian setting - demonstrate consistency with character and scale of Navua Reserve and intensity of use [ie. low-key water-based and nature-based recreation] - flood planning and risk management issues [refer to items B7-B11] - bush fire hazard and fire management/ emergency issues [see items D1-D8] - minimise or mitigate any disturbance caused during site works - maintain pre-development/ natural ground levels and groundwater flows - promote public accessibility, equity and appropriate recreational uses - maintain and enhance public safety and security - minimize vehicular traffic impacts and potential for pedestrian conflict	Number and % of proposed developments that adhere to development guidelines. Measure trends over time.	ongoing
	To protect reserve's values from inappropriate development.	F5	Development proposals which may directly or indirectly threaten identified values are not permissible.	as above	ongoing
	Desired Outcome: To establish guidelines for assessing leases, licences and other estate and to ensure consistency with the relevant Acts.				
	To protect reserve's values from inappropriate leases, permits and commercial activities.	G1	This Plan of Management expressly authorizes the granting of leases, licences/ permits, or any other estate over the land, subject to compliance with the following:- that the permitted use is consistent with the *Crown Lands Act 1989* , *Crown Lands Regulation 2000* , the reserve's public purpose of "Public Recreation and Environmental Protection", Department of Lands policy guidelines and case law, relevant threatened species legislation [see item F2] and the following: 1. Proposed Development: in accordance with items F1-F5; 2. Consult with the Department of Lands in the drafting of any lease agreement, ensuring consistency in permitted uses. Prepare a "Memorandum of Understanding" with the lessee. 3. Access by the General Public: provide for broad community access and equity [ie. no designated recreational areas should imply an exclusive use]. 4. General Administration: lessee to ensure that day-to-day operations, including functions/ special events, have no negative impact on the use of the reserve by other visitors. Any income generating activities would also need to comply with the above requirements.	Leases implemented in accordance with this Plan. Measure trends over time.	ongoing

	Performance Target (strategies)	Item	Means of Achievement (Management Actions)	Means of Assessment (of the actions)	Priority
public recreation and environmental protection	Desired Outcome: To maintain and enhance public access, circulation and provide for appropriate low-key recreational infrastructure				
	To provide a well integrated bridge/ roadway with appropriate landscaping/ restoration. To improve opportunities for recreation and access between the new bridge and the reserve. To provide for multi-use recreational opportunities with shared pedestrian/ bikepath access. To address the poor amenity, access and visual quality of the Springwood Road interface and existing open carpark areas.	H1	Yarramundi Bridge [Springwood Road] Continue to maintain, extend and integrate native landscaping/ planting [initiated as part of the bridge replacement project by the RTA]. All landscaping to the road-side shoulders, embankments and carparking areas are to be consistent with the overall restoration strategy [see items C36 and C39].	Works implemented in accordance with this Plan and subject to Works Program and funding.	very high ongoing
		H2	Extend and upgrade planting in drainage swale [eastern side of bridge] and all other areas to comply with RTA *Yarramundi Bridge Replacement Landscape Plan* . Continue to replace plant losses in southern carpark beds.		
		H3	Pedestrian/ bikepath linkages - eastern side of bridge Construct shared pedestrian/ bikepath linkage from bridge [north-east] along top of batter [behind vehicular guard rail]. Provide formal link to road shoulder. Install shared pedestrian/ bikepath signage. See *Fig 8: Landscape Masterplan* .	Works implemented in accordance with this Plan and subject to Works Program and funding.	high
		H4	Pedestrian/ bikepath linkages - bridge to south-western carpark Construct shared pedestrian/ bikepath linkage from bridge [northern side] to to the sealed bitumen south-western carpark [15 car spaces] via bridge underpass. Multi-use pathway to be in reinforced concrete, min. 2.2 metres in width. *Refer to Figure 8: Landscape Masterplan.*	Works implemented in accordance with this Plan and subject to Works Program and funding.	high
	To address flood impacts and provide appropriate recreational infrastructure.	H5	Recreational Facilities and Infrastructure [south-western carpark] Due to flood levels in this location, recreational infrastructure should be minimal. Provide large litter bins [2] and interpretive/ directional signage [see item H22].	Works implemented in accordance with this Plan and subject to Works Program and funding.	medium
	To enhance opportunities and access for appropriate low-key, river-based recreation.	H6	Proposed Canoe/ Small Boat Ramp [south-western carpark] Install suitably designed low-key and flexible canoe/ small boat ramp access to Nepean River adjacent to carparking area. Review construction options and anchoring for the ramp to address flood impacts and high velocity flows in this location. Provide connecting pathways. See item H9 regarding motor boats.	Works implemented in accordance with this Plan and subject to Works Program and funding.	High
	To address carpark access and security issues. To ensure that access after dark is controlled and that clubs are accountable for actions of members.	H7	Carpark Security [south-western carpark] Install additional boom-gate at entrance to carpark [off Springwood Road]. Retain existing boom-gate to reserve [in carpark area]. Provide locks for security. Both gates are to be locked during periods of flooding. Subject to a trial review period, the top gate will be open at all times while the lower gate would have a key made available for recreation access [eg. fishing and canoe/ kayak clubs]. Keys are to be strictly controlled and as arranged with Council protocols. Clubs must ensure that members using the area at night are responsible for lock-up.	Appropriate vehicular access and security protocols established and implemented. Conduct trial period with use of keys. Monitor level of compliance and adjust strategy as required.	high ongoing

	Performance Target (strategies)	Item	Means of Achievement (Management Actions)	Means of Assessment (of the actions)	Priority
public recreation and environmental protection	Desired Outcome: To maintain and enhance public access, circulation and provide for appropriate low-key recreational infrastructure				
	To address emergency access issues and provide for bush fire vehicular access in the reserve.	H8	Emergency Vehicle Access [Nepean River south section] Maintain unsealed emergency vehicular access off south-western carpark with linkages to south island/ lagoon area [see item H9]. Emergency access tracks to serve dual role of providing low-key pedestrian access to river and southern lagoon areas.	Emergency vehicle access maintained and security implemented in accordance with this Plan.	ongoing
	To continue to focus recreational activities within the most durable sites [ie. Yarramundi Bridge to Grose River areas north of Springwood Road]. To address uncontrolled activities and dispersal issues within fragile areas. To improve low-impact environmental education amongst user groups.	H9	Proposed Special Conservation Zone: Southern island, lagoon and western foreshore Recreational uses are to be restricted within the Special Conservation Zone to low impact, nature-based and water-based activities. Construct a low key, pedestrian pathway circuit around the lagoon in compacted decomposed aggregate finish with access to the water's edge in selected locations. Final location of pathway will be subject to detailed site investigation. The southern lagoon is to be restricted to canoes/ kayaks and small rowing boats. No motorised boats are permitted on the southern lagoon unless authorised for maintenance or rehabilitation/ restoration purposes. Similarly, other motorised sports and model craft are not permitted in this area. Install appropriate protective fencing/ barriers across points of multiple tracking and provide signage in the southern carpark.	Restricted low impact, nature-based recreational uses permissible within the Special Conservation Zone	low
	To address unrestricted vehicular access, bank erosion, multiple-tracking through reserve, vandalism and anti-social behaviour.	H10	Proposed Vehicular Barriers [Springwood Road] Install appropriately designed tensioned-steel cable vehicular barriers [thicker and higher grade than existing barriers to reduce vandalism] and steel posts securely fixed in concrete footings along perimeter of roadway or alternatively install metal vehicular guard rails. Review options to install selected rock/ boulders as a barrier, subject to road safety considerations.	Works implemented in accordance with this Plan and subject to Works Program and funding.	high
	To reduce size, scale and negative visual impact of upper western carpark. To address need for over-flow parking in summer months.	H11	Springwood Road - Upper western carparking area Construct landscape buffer strip to edge of roadway [min. 10 metres width] and small over-flow carparking area. Provide sealed bitumen access and parking bays in compacted gravel finish [20 car spaces]. All landscaping to be in accordance with restoration strategy, using only tall trees and low groundcovers. Do not use any dense shrubs. Provide vehicular entry point to reserve and Grose River [refer to item H12]. *Refer to Figure 8: Landscape Masterplan.* Provide large litter bins [2] and interpretive/ directional signage [see item H22].	Works implemented in accordance with this Plan and subject to Works Program and funding.	medium
	To optimise the reserve's access and recreational opportunities as a regional asset. To improve visitor access off Springwood Road to the river and address peak loadings during summer period.	H12	Proposed Grose River Access and Carpark [off Springwood Road] Construct bitumen vehicular access from Springwood Road along the alignment of the upper terrace track terminating with a formed carpark on the high ground near the Grose River [max. 30-35 car spaces]. Close the lower track and rehabilitate. Provide a gentle rising grade from the proposed carpark to Springwood Road in accordance with Flood Planning strategy. Ensure that	Works implemented in accordance with this Plan and subject to Works Program and funding.	medium

Table 3 continued

	Performance Target (strategies)	Item	Means of Achievement (Management Actions)	Means of Assessment (of the actions)	Priority
public recreation and environmental protection	Desired Outcome: To maintain and enhance public access, circulation and provide for appropriate low-key recreational infrastructure				
	To implement policies which will restrict further incremental impacts on the reserve's natural values. To provide enhanced visitor access to the Grose River and environs. To ensure low impact strategies.	H12 [cont'd]	Proposed Grose River Access and Carpark [continued] access road and carpark are sensitively sited with respect to river flows/ flooding, environmental, scenic and amenity values. Construct compacted decomposed aggregate pathway with gentle grades to the Grose River. Provide a diverse mix of Riparian Forest canopy species and groundcovers [no shrub planting in carpark]. See *Figure 8: Landscape Masterplan.*	Works implemented in accordance with this Plan and subject to Works Program and funding.	medium
		H13	Proposed Pedestrian Access to Grose River Rationalize pedestrian access to selected locations along the Grose River. Maintain existing emergency vehicle access. Install protective fencing or log barriers to direct pedestrian traffic and reduce multiple tracking and erosion. Provide restoration planting to high use areas along the river banks.	Works implemented in accordance with this Plan and subject to Works Program and funding.	medium
	To enhance opportunities and access for appropriate low-key, river-based recreation.	H14	Proposed Canoe/ Kayak Access to River [Grose River carpark] Provide low-key canoe/ kayak access to Grose River with pathway linked to proposed carpark area.	Works implemented in accordance with this Plan and subject to Works Program and funding.	medium
	To address carpark, vehicular access and security issues and provide opportunities for clubs to assist in access management.	H15	Grose River Access Road and Carpark Security Install appropriately designed and constructed boom-gate at entry off Springwood Road. Gates are to be locked during the night and during periods of flooding. No keys will be made available for vehicular access to this carpark area at night [see item H9].	Appropriate vehicular access and security protocols established and implemented.	medium ongoing
	To maintain current restrictions on off-road vehicle access to the river.	H16	Emergency Vehicle Access [Grose River - Springwood Road] Maintain emergency vehicular access off proposed Grose River carpark to junction with Nepean River [east]. Maintain dual role as low key pedestrian tracks. Locked gates to be installed at entry points to emergency access tracks. Close and restore upper terrace tracks.	Emergency vehicle access maintained and security implemented in accordance with this Plan.	medium
	To address flood impacts and provide appropriate recreational infrastructure. To continue to focus recreational activities within the most durable sites [ie. Yarramundi Bridge to Grose River areas north of Springwood Road]. To provide an appropriate level of recreational facilities and amenity.	H17	Recreational Facilities and Infrastructure [Grose River carpark area] Provide a restricted range of recreational facilities and infrastructure located on higher ground [ie. adjacent to proposed carpark] away from main channel flow. Siting of facilities would be subject to further investigation. Protect any native vegetation or sensitive habitat values. Infrastructure to include environmentally sustainable, elevated self-composting pit toilets, picnic settings/ tables [5], small shelter structure [1], LPG gas BBQ [2 plates], secured large bins [3] and signage [similar to Navua Reserve infrastructure]. Camping in this area and other parts of the reserve is not permitted.	Works implemented in accordance with this Plan and subject to Works Program and funding.	low

	Performance Target (strategies)	Item	Means of Achievement (Management Actions)	Means of Assessment (of the actions)	Priority
public recreation and environmental protection	Desired Outcome: To maintain and enhance public access, circulation and provide for appropriate low-key recreational infrastructure				
	To enhance opportunities and access for appropriate low-key, river-based recreation. To continue appropriate management and restrictions on off-road vehicle access to the rivers.	H18	Navua Reserve [Access to Northern Portion of Reserve] Continue to provide vehicular access to the northern portion of the reserve [ie. north island section] via Grose River Road and Navua Reserve. Continue to provide secured parking area with vehicular access controlled by lockable boom-gate and concrete blocks to prevent off-road vehicle access to Grose or Nepean Rivers.	Works implemented in accordance with this Plan and subject to Works Program and funding.	ongoing
	To address uncontrolled activities and dispersal issues within fragile areas.	H19	Off-road Vehicular Access and Trail Bikes 4WD [off-road vehicles] and trail bike access across the Grose River and to other areas within the reserve which are beyond designated vehicular access roads/ tracks is not permitted. 4WD vehicle access would not be appropriate in terms of the size of the reserve, public safety, environmental protection and equity for a broad range of user groups.	Monitor reserve for non-compliance. Measure trends over time.	ongoing
	To ensure that visitor management is appropriate for protection of reserve's values. To monitor changing patterns of use and recreational user group behaviour.	H20	Visitor Management Regularly monitor and control unauthorised activities and anti-social behaviour, particularly in more remote locations. Investigate options for establishing ranger staff position (seasonal). Seek assistance from recreational clubs in providing community education in responsible low-impact behaviour within the natural setting. Camping is not permitted in the reserve.	Measure trends over time. Investigation completed and recommendations implemented.	high ongoing
	To address uncontrolled activities and dispersal issues within fragile areas.	H21	Companion Animals Unleashed dogs are not permitted in proposed picnic areas and adjoining popular swimming locations during peak summer period use. These areas and times will be subject to review. Install dog faeces litter bins in the proposed carpark areas. Dogs on or off-leash and pony/ horse riding activities are not permitted in the Special Conservation Zone.	Measure trends over time.	ongoing
	To address visitor orientation, facilitate public access and enhance visitor appreciation and enjoyment of the reserve's values.	H22	Reserve Signage and Branding Develop an integrated system of identification, interpretative and directional signage to improve visitor orientation and awareness of appropriate low-impact activities and range of recreational opportunities and linkages. Signs should be durable and vandal-resistant and include the use of maps and possibly sensory options.	Works implemented in accordance with this Plan and subject to Works Program and funding.	low

5.2 Capital Works Program (2005-2009)

Table 4

ITEM	ACTION	CAPITAL COST ($)	IMPLEMENTATION 2005	2006	2007	2008	2009
A1-A7	Crown Reserve - management framework						
A1-A7	no capital works component - refer to following items						
B1-B11	River recovery and flood management						
B1-B6	no capital works component - refer to following items						
B6	see items H1-H22	see below	■	■	■	■	■
B7-B10	implementation of flood planning and management	not costed	■				
C1-C41	Ecological restoration and management						
C1-C5	no capital works component - refer to following items						
C6	monitoring and control of feral animals [$3,000.00 per annum]	$15,000.00	■	■	■	■	■
C7-C13	refer to following items						
C14-C24	noxious weed management program (Dept Agriculture, HNCMA & HRCC)	not costed	■	■	■	■	■
C25-C41	establish long-term contract bush regeneration [$30,000.00 per annum]	$150,000.00	■	■	■	■	■
	maintain core areas/ selective targeting and expand buffers and bio-linkages	incl. above	■	■	■	■	■
	delineate management zones/ establish buffers [$10,000.00 per annum]	$50,000.00	■	■	■	■	■
	community/ environmental education & volunteers [current and new programs]	not costed	■	■	■	■	■
	nursery program [seed collect/ propagation & maintenance - $20,000 per annum]	$100,000.00	■	■	■	■	■
	assessment and monitoring	incl. above	■	■	■	■	■
D1-D8	Bushfire management						
D1	maintain network of fire-trails & emergency access [$10,000.00 per annum]	$50,000.00	■	■	■	■	■
D2-D8	implementation of bushfire planning and management	not costed	■	■	■	■	■
E1-E3	Heritage planning and management						
E1-E3	further investigations	$30,000.00			■	■	
F1-F5	Crown Reserve management - development						
F1-F5	no capital works component						
G1	Crown Reserve management - leases, licences & other estate						
G1	no capital works component						
H1-H22	Public recreation and environmental protection						
H1-H2	Yarramundi Bridge landscaping	incl. above	■	■			
H3-H4	Yarramundi Bridge - pedestrian/ bikepath linkages [incl. underpass connection]	$15,000.00		■			
H5-H6	south-western carpark - recreational facilities/ boat ramp, pathways & boom-gate	$20,000.00		■	■		
H8-H9	Special Conservation Zone - pathway circuit [compacted aggregate finish]						
	circuit length approx. 3,270 metres + interpretive/ directional signage	$200,000.00				■	■
H10	Springwood Road - vehicular barrier [approx. 380 metres]	$120,000.00		■			
H11	proposed upper western overflow carparking area [Springwood Road]	$30,000.00			■		
H12-H17	proposed Grose River access road, carparking area & vehicular barriers	$150,000.00			■	■	
	pedestrian access to river/ boom-gate & landscaping	$50,000.00				■	
	recreational facilities - pit toilets, picnic tables, shelter, BBQs, bins & signage	$100,000.00				■	■
H18-21	visitor management and regulatory control [incl. part-time ranger]	not costed	■	■	■	■	■
H22	refer to other items	see above					
	TOTALS	$1,080,000.00					

continued over page

Note: * Opinion of probable landscape constructions costs is based on the Landscape Masterplan and all figures shown are indicative only.

5.2 Capital Works Program (2005-2009)

Summary of Annual Budget Expenditure

Table 5

YEAR	CAPITAL COST ($)
2005	$73,000.00
2006	$218,000.00
2007	$203,000.00
2008	$363,000.00
2009	$223,000.00
TOTALS	$1,080,000.00

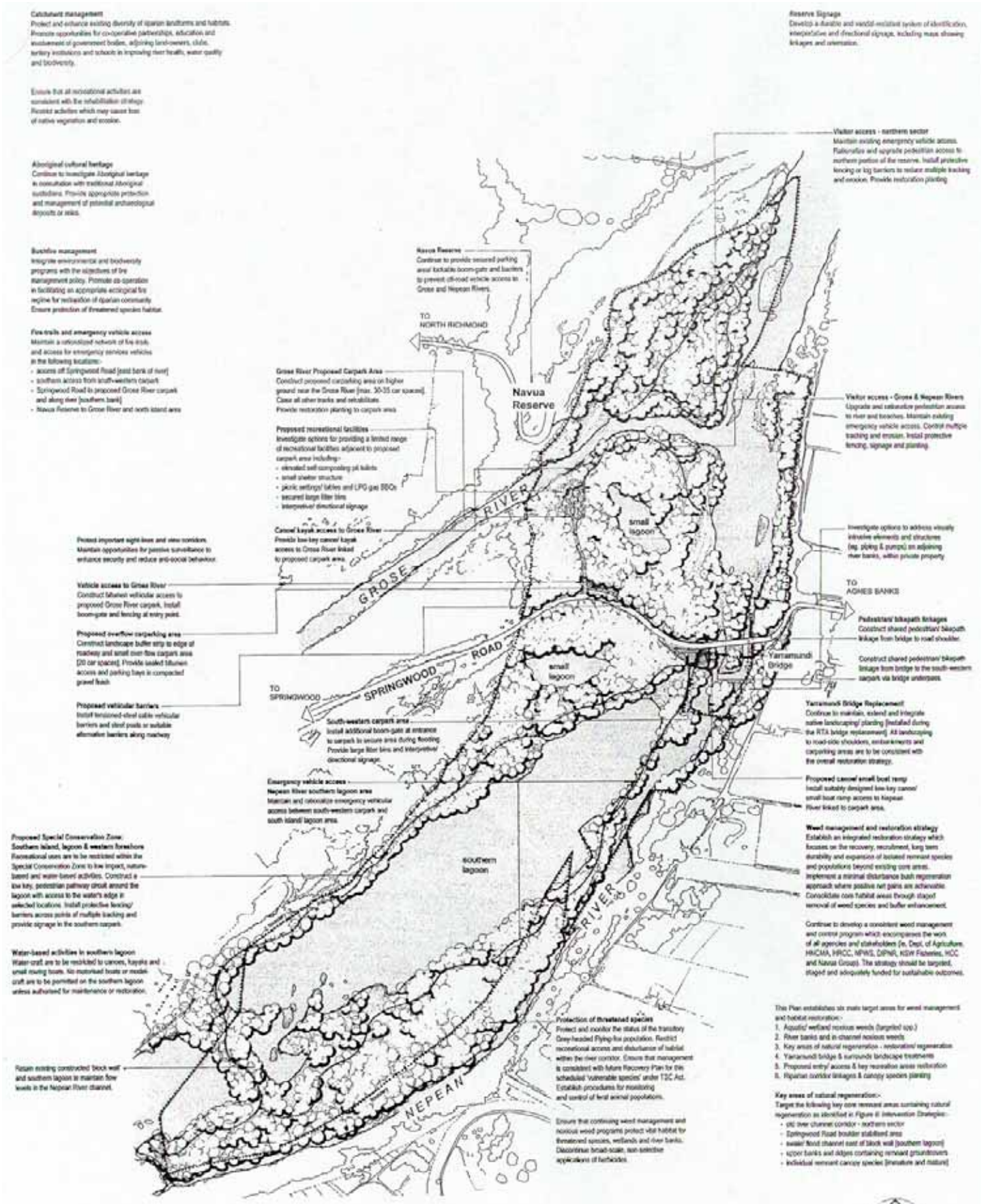

Figure 8

Yarramundi Reserve

Landscape Masterplan

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APPENDIX I

Community Issues Summary

The following document, first issued on 27 June 2002, was amended and re-issued on 22 October 2002 to address issues raised during community consultation. Completion of the Draft Plan of Management was subsequently delayed due to the Yarramundi Bridge Replacement project.

The following Community Issues Summary and Discussion Paper have not been amended since the re-issue date, except in the instance of item A.5 Yarramundi Bridge Replacement. Postscript discussion has been provided for this item. Refer to the Schedule of Addenda at the end of Appendix II.

Community Consultation

Introduction
Community consultation is a vital component in the preparation of plans of management. This process continues through to public exhibition of the Draft Plan of Management, including opportunities for public submissions. The purpose of the public meetings/ workshops is to assist Hawkesbury City Council, the Department of Land and Water Conservation (DLWC) and the community to identify the important values attached to this reserve and to provide a forum for discussion of community issues.

An understanding of the key issues will help to ensure the protection of identified values in a way which best meets the recreational, social, educational and other needs of the community. The following section provides a summary of the Community Issues. A more detailed assessment of the issues is contained in Appendix II: Community Issues Discussion Paper.

Scope of Plan of Management
This Plan of Management applies to the land described as Yarramundi Reserve, located at the confluence of the Grose and Nepean Rivers, being the start of the Hawkesbury River. This land has recently been transferred to the Crown with Hawkesbury City Council appointed as the Reserve Trust Manager (refer to Figure 2: Study Area).

The Reserve covers an area of 78 hectares and is comprised of a lineal parcel of land and water (including the river bed) and located wholly within the riparian corridor. It is a diverse landscape of river channels, former quarried lagoons and back-waters, wetlands, riverbanks and foreshores, sandy and gravel beaches, sand

dunes, hills and swales of alluvial silts, levee banks and rock revetments. The reserve's landscape and environmental quality are products of the dynamic riverine environment and past changes brought by a range of human-induced impacts. Its natural values have been highly modified and degraded since European settlement, particularly as a result of past gravel and sand extraction and subsequent weed invasion.

Public Meetings/ Workshops

The public meetings/ workshops for Yarramundi Reserve were held as follows:-

Venue:	Richmond Neighbourhood Centre
Date:	Wednesday 10th April 2002
Time:	7.00pm – 8.45pm
Attendance:	31

Venue:	Richmond Neighbourhood Centre
Date:	Thursday 11th April 2002
Time:	7.00pm – 8.45pm
Attendance:	17

Distributed Items:	Community Issues Workshop Questionnaire
Total Responses:	18

Presentation and Discussion

The community workshops/ meetings were facilitated by Noel Ruting and Suzanne Poland, the two principals of LandArc Pty Limited. A brief presentation and overview of the plan of management process was given by Noel Ruting. During this presentation, a series of overheads and slides were used to highlight the reserve's significant values, the threats and impacts affecting these values and opportunities to better manage the reserve. Both meetings were then opened for public discussion.

At each of these workshops/ meetings, the issues raised by participants were summarised as well as being recorded in detail for further development in this Paper. A Community Issues Workshop Questionnaire was distributed for any detailed comments from participants. Each of the workshops/ meetings were brought to a close after all comments from participants appeared to have been raised. It was requested that any further written comments be forwarded to the LandArc office.

A total of 48 people attended the workshops. Apart from individual participants and adjoining/ nearby land-holders, the key stakeholder groups represented at these public meetings/ workshops included the following (in alphabetical order):-

- Australian Plant Society
- Bass Sydney Fishing Club
- Blue Mountains & Nepean District Angling Association

- Great River Walk Committee
- Hawkesbury Bushcare Network
- Hawkesbury Historical Society
- Hawkesbury River County Council (HRCC)
- Richmond Lions Club
- Yarramundi Community Centre
- Yarramundi Progress & Development Association
- Yarramundi Rural Fire Brigade

There was a total of 18 written responses (37.5% of workshop participants) to the Community Issues Workshop Questionnaire.

Further Consultation and Focus Group Meetings
Following the series of public workshops, a number of other government departments, stakeholders and interest groups have been consulted or have contacted our office to discuss specific issues affecting the reserve. These include:-

- NSW National Parks & Wildlife Service (NPWS Richmond Office)
- Darug Tribal Aboriginal Corporation (DTAC)
- Darug Custodian Aboriginal Corporation (DCAC)
- NSW Roads & Traffic Authority (RTA)
- Navua Community Group
- Department of Agriculture (Windsor Advisory Office)
- Hawkesbury-Nepean Aquatic Weeds Task Force
- On all 4's 4WD Club Inc.
- Individuals/ stakeholders

Written Submissions
Written submissions were received from the following groups:-

- Darug Tribal Aboriginal Corporation (DTAC)
- Navua Community Group
- BASS SYDNEY Fishing Club Inc. (2 submissions)
- Blue Mountains and Nepean District Angling Association
- On all 4's 4WD Club Inc.
- Department of Agriculture (Windsor Advisory Office)

The relevant issues are discussed in the following sections.

Community Values and Issues

Overview of Community Values
Yarramundi Reserve's open spaces, including rivers, wetlands, lagoons and riparian natural setting offers a unique opportunity for local and regional recreation with a focus on water-based, passive and nature-based activities. The reserve's high scenic and environmental values provide an outstanding natural setting for its recreational activities. Fishing, canoeing, swimming, nature-based study/ educational activities, walking, jogging, exercising the dog(s) and horse riding are all popular uses of the reserve.

Identifying Key Values and Preferences
The combination of active/ passive and family-based recreational opportunities, river/ foreshore access, water quality, diversity in natural settings, scenic quality, quiet solitude and tranquillity and public safety are all considered key values by the community.

Respondents to the workshop questionnaire identified water access and the reserve's natural qualities as the most important values. In order of preference, the reserve is used primarily for water-based recreation (eg. swimming, canoeing, and fishing) and passive recreational opportunities (eg. walking, picnics and family gatherings). There was an even split on these preferences by respondents. These activities were followed by nature-based recreation/ environmental studies and informal, active land-based activities (eg. horse riding, mountain-bike riding).

In order of preference for recreational locations, the Grose River/ Navua Reserve area was identified as the most popular destination for a range of water-based activities, particularly swimming. This related to water quality issues. Fishing and canoeing are also popular activities on the Grose River. Locations along the Hawkesbury Nepean River, north and immediately south of the Yarramundi Bridge, are also highly valued by the broader community. The more remote southern "lagoon" and environs are a focus for fishing, canoeing and passive/ nature-based recreation.

Protecting Community Values
The meetings/ workshops defined a strong sense of community ownership in this Crown reserve with the desire to ensure the protection of its natural, ecological, scenic and recreational values. It is vital that these values are protected and managed effectively. Furthermore, it is important that public access and any possible recreational development should be sensitive to the ecology of this riparian corridor. The development of recreational infrastructure should be low-key. It should not in any way compromise identified values or potentially limit opportunities for future generations.

Identifying Key Issues

A broad range of issues continue to affect the reserve's natural resource base and its recreational values. Many issues including changing river flow and morphology, flood impacts, past quarrying, weed invasion, water quality, rubbish and car dumping, public access, safety, emergency vehicular access, vandalism, fire and arson were identified by participants at the public meetings/ workshops. Respondents to the community issues questionnaire were asked to identify key issues. These issues have been summarized and ranked according to the responses as follows:-

1. Public Access issues:
   (a) Water access (eg. canoes and fishing)
   (b) Vehicular control and management
   (c) Parking areas (visitor safety and security)
   (d) Improvements to walking tracks
2. Rubbish dumping, pollution and vandalism
3. Protection of natural values (scenic qualities/ setting and biodiversity)
4. Weed management and restoration (including past quarry impacts)
5. Flood impacts and river processes
6. Recreational facilities and public amenities
7. Opportunities for community involvement.

Since the workshops, various government departments, stakeholders and interest groups have been consulted or have contacted our office to discuss specific issues. These include the following:

- Aboriginal heritage;
- Environmental/ threatened species management;
- Yarramundi Bridge Replacement;
- Unleashed dogs in the reserve; and
- Navua Reserve management and integration with Yarramundi Reserve.

A meeting was held on 15 May 2002 with the Roads & Traffic Authority (RTA), Department of Land and Water Conservation (DLWC) and Hawkesbury City Council to discuss issues relating to the bridge proposal, vehicular and pedestrian access, parking, vehicular barriers/ fencing and the environmental/ restoration strategy in relation to Yarramundi Reserve. These issues and outcomes of the meeting are discussed further in A.5 Proposed RTA Bridge Replacement.

On 9 May 2002, meetings were held at Yarramundi Reserve with environmental officers from the National Parks & Wildlife Service (NPWS Richmond Office), Department of Land & Water Conservation, Hawkesbury City Council and the Navua Community Group. The issues discussed related to environmental and threatened species conservation and management. The issues affecting the ongoing restoration program by the Navua Community Group in Navua Reserve were also discussed.

The National Parks & Wildlife Service (NPWS Blackheath Office) highlighted issues regarding Aboriginal heritage within the reserve and local area. These issues were further discussed with the Darug Custodian Aboriginal Corporation (DCAC) and Darug Tribal Aboriginal Corporation (DTAC).

Basis for Management

The public meetings/ workshops and written responses to the questionnaire highlighted the need to address these issues and to provide a framework for management and protection of identified values as follows:-

- to balance existing and future recreational uses with regard to the reserve's natural setting and dynamic riverine context (eg. flood impacts, weed management, etc);
- to address past natural resource degradation within the reserve;
- to protect and manage fragile habitats and threatened species within the reserve, ensuring their long term viability;
- to ensure appropriate rehabilitation of the reserve's natural values and continue programs to address weed invasion (incl. terrestrial, wetlands and aquatic habitats);
- to encourage community involvement in the rehabilitation process and ownership of the reserve;
- to address rubbish dumping, pollution issues and anti-social behaviour;
- to provide opportunities for appropriate informal, passive and nature-based activities, including low key water-based recreation compatible with the natural setting;
- to review public access issues, opportunities and constraints affecting vehicular, pedestrian and water access (including options relating to proposed bridge and roadway re-alignment on Springwood Road);
- to address periodic peak parking and vehicular congestion/ safety problems along Springwood Road;
- to ensure that any infrastructure development for recreation (eg. vehicular access, public amenities, picnic settings, litter bins) is appropriately designed and located with regard to flood impacts, sensitive habitat values and public safety; and
- to ensure management of the reserve is consistent with adjoining Navua Reserve.

A detailed discussion and assessment of the reserve's values and community issues is contained in the following section – Community Issues Discussion Paper.

APPENDIX II

Community Issues Discussion Paper

A.1 Environmental Context

Hawkesbury Lower Nepean Catchment
Yarramundi Reserve is located within the Hawkesbury Lower Nepean catchment (ie. the area downstream of the Warragamba Dam and the Nepean, Avon, Cordeaux and Cataract Dams). The Hawkesbury Lower Nepean catchment covers an area of 12,000 square kilometres within the outer Sydney metropolitan area and fringe rural areas. It is now home to 700,000 residents. The catchment has a long history of vegetation clearing, ecosystem disturbance and modification through agricultural activities and urban development. The construction of dams in the upper catchment and the allocation of water for irrigation purposes have significantly altered downstream flows and reduced the frequency and impact of storm/ flood events.

The catchment is experiencing extraordinary pressures from increasing urban development. Issues affecting the health of the river include urban stormwater and rural runoff, river flow and groundwater management, water quality, aquatic and terrestrial biodiversity, land uses within the lower catchment and social and economic considerations.

A *Draft Hawkesbury Lower Nepean Catchment Blueprint* has been prepared to address the urgent need for sustainable management of the catchment. The *Draft Catchment Blueprint* focuses on tackling issues at the sub-catchment level by adopting an integrated approach across several local government areas. The document also emphasizes the need for new opportunities with partnerships, education, advocacy and community involvement to deliver the desired outcomes which include the following:-

- better management of river flows and groundwater;
- reduced degradation of water, biodiversity and land;
- improved quality and quantity of water; and
- improved quality, extent and connectivity of native habitat.

The outcomes from this *Draft Catchment Blueprint* will have significant consequences for the overall management of Yarramundi Reserve. It is envisaged that over the longer term appropriate funding and resources will be allocated for the necessary environmental restoration works within this reserve.

Riverine Context

Yarramundi Reserve is directly affected by catchment issues relating to stream flows, water quality and quantity and overall river health. In many ways the reserve demonstrates the broad range of issues affecting the entire Hawkesbury Lower Nepean Catchment. Yarramundi Reserve, covering an area of 78 hectares, is a significant parcel of Crown land located at the confluence of the Nepean and Grose Rivers (also the beginning of the Hawkesbury River). The reserve is a natural, albeit highly modified, setting with outstanding scenic values. It is located wholly within the riverine corridor. The study area consists of the river channels and beds, lagoons, wetlands, islands and adjacent riparian land including embankments, sand dunes and beaches, levees and swales and associated biodiversity.

Aboriginal Heritage and Archaeological Significance

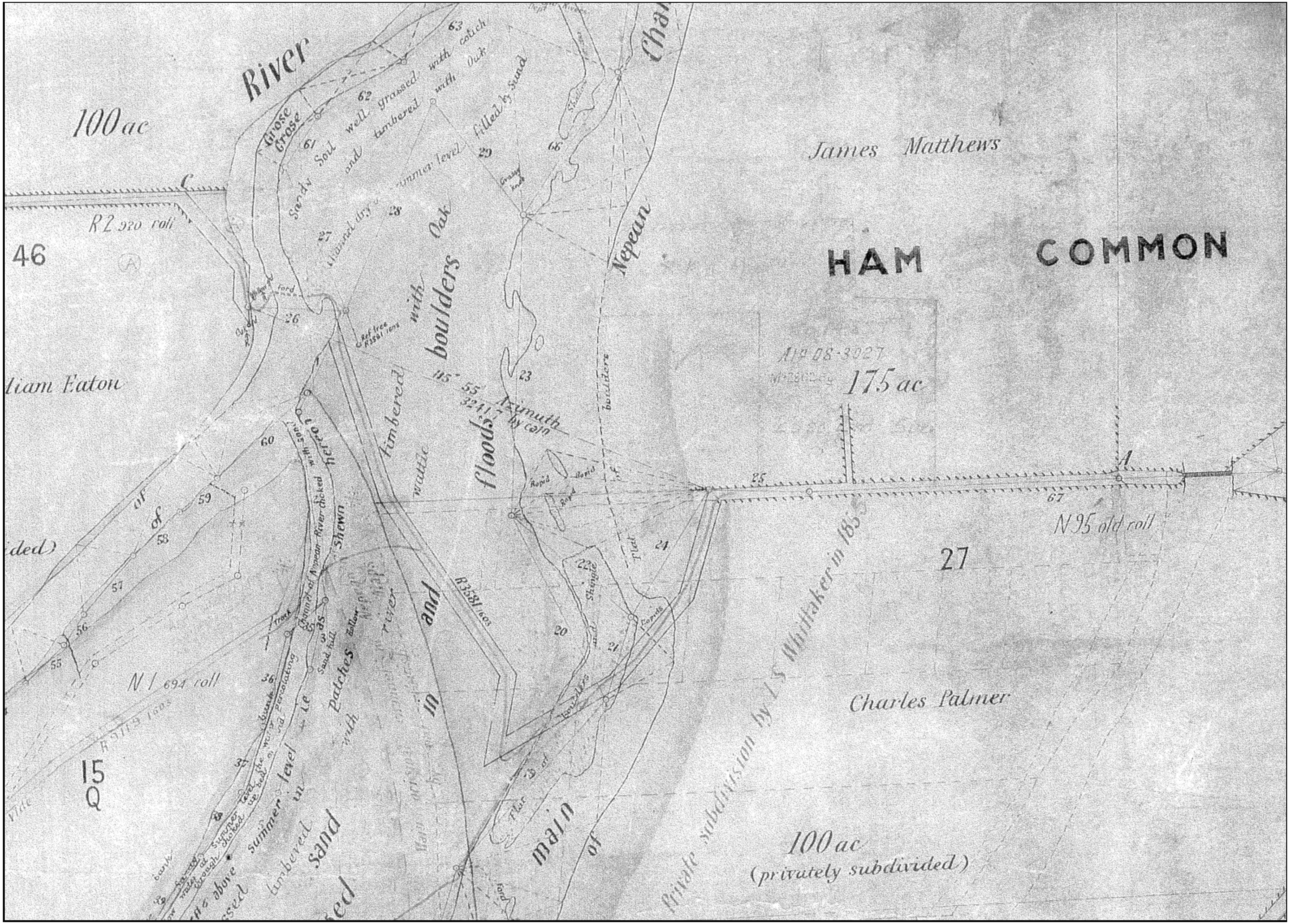
At the time of European colonisation, this resource rich area on the confluence of two rivers provided a strong focus for the local Aboriginal community. Yarramundi Reserve has been identified by the National Parks and Wildlife Service (Blackheath Office) as a "traditional resource area with a strong Aboriginal context". The area was important in terms of access to the river for water, fishing, hunting and special plants for food, fibres, tools, canoe making and medicine. It was also a significant site for collection of raw materials for the manufacture of stone artefacts such as axe-heads. The intense competition for resources between early settlers and the local Burruberongal people led to bitter conflict and the disintegration of Aboriginal culture. Although the area was significantly altered by mining activities during the twentieth century, the surrounding terraces still contain important archaeological fabric including artefact scatters and remains of Aboriginal common burial sites (eastern terraces outside the reserve). This Aboriginal heritage needs to be further investigated and any places or relics properly protected and managed.

Geomorphology and Flooding

The river channels which define Yarramundi Reserve are a dynamic, complex system. Channel morphology may change in accordance with temporal and spatial variables. River channels can change slowly over time through gradual accretion or change dramatically during periods of flooding creating entirely new channel patterns and varying landscapes within the riparian corridor and floodplain. These are alluvial rivers at this point (ie. they flow over and through their own deposited material of gravels, sand and soil).

Historic Changes to River Morphology

An extract from the Parish Map of the area dating from 1891 shows the changes to the rivers' geomorphology since the time of the first land grants in the area (refer to Figure A2-1). The map shows the main channel of the Nepean River flowing along the "right bank" (eastern side) with a second smaller channel along the "left bank" or western side linking to the Grose River. The two channels formed a single large island in the river consisting of *"sand and boulders and submerged in flood".* The island was covered in fine native pasture grasses and timbered with *"River Wattle and Oak".* The small channel was choked with sand and flowed only when the main channel *"rises 5 feet above the summer level".*



HAM COMMON
James Matthews
Charles Palmer
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46
R2 920 roll
River
Grose
Sandy Soil well grassed with cotch and timbered with Oak
timbered with boulders Oak wattle
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and in

The “original” Nepean River channel shown on earlier Parish Maps swung to the north-west and entered the Grose River at the same location as the latter choked branch. The main channel shown in the extract is far broader than it is today. The location where the existing bridge crosses the Nepean River shows a *“flat of boulders and shingles”* with adjacent *“rapids”* in the main channel. Directly to the north of this location, three further rapids span the river bed opposite small shingle islands. These rapids are likely to be the location of the “Yarramundi Falls”. This portion of the river, including the rapids, were located within the latter freehold land [Lot 190] which came under gravel and sand extraction during the greater part of the twentieth century (refer to *A.2 Past Gravel and Sand Extraction).*

A number of participants at the public meetings/ workshops believe the former “Yarramundi Falls” were removed during the early period of gravel and sand extraction. The “falls” were believed to be a series of cascades and rapids dropping [some 9 feet in height] through a boulder-strewn bed. They had historic significance and may have been the point at which Governor Phillip, in 1789, decided to turn back on the first European navigation of the lower reaches of the Hawkesbury River.

Flood Impacts

The reserve continues to be shaped by river processes. This is a dynamic environment which is ever-changing with the course of these rivers. Long periods of relative stability and deposition are followed by periodic flood events of short duration but with long lasting impacts on river channel alignment, sedimentation and erosional patterns. The river channels, embankments, creeks, lagoons, wetlands and islands are all affected by these gradual and at times dramatic changes. The affects of these natural processes can also be magnified and exacerbated by human-induced impacts.

Participants at the community meetings/ workshops discussed flood impacts and the implications for planning and design within the reserve. There was some discussion over the regularity of flood events and the heights which could be expected over the reserve.

Historic Flooding

The *Warragamba Dam Auxillary Spillway Environmental Impact Study – Flood Study* prepared by Webb, McKeown & Associates Pty Ltd (1996) for Sydney Water examined the flood records for the Hawkesbury Valley. Flood records at Windsor have been kept since 1790. In 1817, Governor Lachlan Macquarie recorded the catastrophic impact of floods in the valley. Successive floods during these early years devastated the early settlements. However the following period between 1817-1864 was dry with no significant floods recorded. In 1864 the dry spell came to a dramatic end with the largest flood recorded up to that date. Only three years passed before yet another great flood occurred. This was the greatest flood ever recorded. Although many floods have been experienced since this time none have approached the levels set in 1867.

Diversion weirs were first constructed in the early 1880's and four dams were completed on the upper Nepean River between 1907 and 1935. Warragamba Dam was completed in 1960. The November 1961flood was the largest recorded in the twentieth century. This event was followed by smaller floods in 1978, 1987, 1988, 1989 and 1990. The flood of August 1990 was the largest event since March 1978. It is evident that flooding can occur at any time of the year. Although linked to periods of higher rainfall, flood events follow no regular pattern.

Flood Planning and Design Issues

The installation of any infrastructure such as public access, services, amenities and facilities within the reserve must consider the implications of flood events. New structures should not in any way obstruct, reduce or interfere with upstream or downstream flood behaviour or adversely impact occupiers of the floodplain. The potential magnitude of flood impacts, including the rate of rise and duration need to be considered in the design. Flood planning needs to be in accordance with the *NSW Flood Policy (1984), NSW Floodplain Management Manual (2001) and the Hawkesbury Nepean Floodplain Management Strategy (adopted 1998).* Flood planning would need to address public safety issues, including closure of the reserve in times of flooding or times when the reserve may be under the threat of flooding. Flood evacuation planning should consider emergency vehicle access and safe exit from the reserve, such as a rising grade from the lowest point.

A.2 Past Gravel and Sand Extraction

Historic Use of the Site for Gravel and Sand Extraction

Yarramundi Reserve has been substantially modified by past gravel and sand extraction. Boral Resources (NSW) Pty Limited (formerly BMG Resources Limited) commenced extraction in 1927 and continued through to 1989. A crushing plant was first established in Yarramundi Lane and later moved to the site. A railway line connected the site to Richmond but was later abandoned in favour of haulage by trucks. Early work focussed on the freehold land (ie. the portion of the reserve north of Springwood Road and the immediate areas to the south of this road).

Permissive Occupancy over Crown land

A Permissive Occupancy was granted to BMG Resources Limited in 1987 over the Crown land comprising the southern portion of the reserve [Portions 57 and 293]. The granting of the occupancy allowed the removal of material and storage on the basis of final restoration of these parcels of Crown land. In addition, the holder of the occupancy agreed to transfer to the Crown a significant area of freehold land [ie. Lot 90 excluding roads and Lots 188-191] for the creation of a public reserve with the public purpose of Public Recreation and Environmental Protection. The Permissive Occupancy was terminated in 1994 by the Department of Conservation and Land Management (now Department of Land and Water Conservation) following satisfactory completion of the rehabilitation works by Boral Resources (NSW) Pty Limited.

Recent Extraction adjoining the southern portion of the reserve
Tilmunda Pastoral Company Pty Ltd has continued extractive activities for sand, soil and gravel on the left bank of the Nepean River, adjoining the southern portion of the reserve since the 1980's. These activities were the subject of a long dispute between Tilmunda Pastoral Company Pty Ltd and the Department of Land and Water Conservation (DLWC). The issue related to a Part 3A permit under the Rivers and Foreshores Improvement Act (1948) for extractive activities within the flood channel and "lake" (southern lagoon). In 1998, the application was refused on the basis of the proposal being contrary to the environmental objectives contained in SREP 20 Hawkesbury-Nepean River, the NSW State Rivers and Estuaries Policy and the NSW Sand and Gravel Extraction Policy for Non-tidal Rivers.

Former "Yarramundi Park" Proposal
Tilmunda Pastoral Company Pty Ltd first submitted a proposal in the early 1990's for the establishment of a public park (ie. Yarramundi Reserve) including provision for public access to the Nepean River and "the Broadwater" directly to the south of the reserve. The proposal was based on Tilmunda Pastoral Company Pty Ltd gaining permission to extract sand, soil and gravel from the "lake and its environs" within the Crown reserve [Portions 57 and 293].

It was proposed that the removal of material would serve to fund the establishment of the park and included site re-grading and rehabilitation planting. Although the proposal received support in principle from Hawkesbury City Council, the Department of Land and Water Conservation (DLWC) gave no support to the proposal on the basis of previously stated environmental objectives.

The subject parcels of Crown land [Portions 57 and 293] were gazetted on the 5 April 2002 as Reserve No. 1003168 for the public purpose of Public Recreation and Environmental Protection and Hawkesbury City Council appointed trustee of the reserve.

Environmental Impacts of Past Gravel and Sand Extraction
Southern Lagoon and Environs
The gravel and sand extraction on this site, which continued over a period of more than 67 years, has significantly altered natural river profiles and the configuration of existing channel flow. The large, open "lagoon" or "lake" at the southern end of the reserve is a flooded former excavation pit. It covers an area of approximately 30 hectares and originally had a depth up to 3.6 metres. Much of the lagoon is now considerably shallower due to sedimentation. This process is likely to continue, subject to flood events and their impact on the "block wall" near the southern limit of the reserve.

Block Wall Construction
The "block wall" was constructed and maintained by Boral Resources (NSW) Pty Limited as part of their Permissive Occupancy of the Crown reserve. The wall was installed to specific design requirements to maintain the flow levels in the main right bank channel of the Nepean River and to ensure water allocation to adjoining

irrigators. Furthermore, the integrity of the block wall was an issue of concern raised by the Department of Land and Water Conservation in its response to the extractive proposal by Tilmunda Pastoral Company Pty Ltd.

Changes to the River Channel
The community meetings/ workshops raised concerns over past gravel and sand extraction within the study area and the impact that these changes have made on the river channel, historic features in the river channel (eg. "Yarramundi Falls") and mean flow levels. These activities imposed a very high level of disturbance and modification to the landscape allowing terrestrial and aquatic weed species to establish and proliferate within the riverine corridor.

Site Rehabilitation
Participants also expressed their concerns over the lack of effective measures to rehabilitate and restore native vegetation communities within the reserve prior to termination of Boral Resources (NSW) Pty Limited's Permissive Occupancy. Between the period 1989-1994, the area was re-graded, hydro-seeded with a grass cover and River Oaks *(Casuarina cunninghamiana)* planted. There appears to have been no provision made for ongoing weed management.

A.3 Weed Management and Habitat Restoration

Overview
Although containing some important vestiges of the original Sydney Coastal River-flat Forest (SCRFF) and associated riverine and wetland communities, the reserve is overwhelmingly dominated by exotic weed species. These weeds, including noxious and environmental species, are found throughout the reserve's terrestrial and aquatic environments. The community meetings/ workshops confirmed broad support and interest in the application of appropriate weed management, bush regeneration (where possible) and restoration of the reserve's degraded natural vegetation. It is believed that resources should be committed to repairing past damage to the reserve's natural values. The prolific weed infestation and degraded appearance of the reserve was identified as having a particularly negative visual and environmental impact. This was further encouraging inappropriate uses and anti-social behaviour. It was suggested by some participants that the removal of dense weed growth would improve the passive surveillance of the reserve, reduce unwanted behaviour and enhance visitor security.

Ecological Impacts
Prior to European settlement of the floodplain, this area would have contained a mosaic of vegetation communities and habitats. They would have shared a high degree of connectivity and opportunities for genetic exchange. Extensive vegetation clearing of the floodplain and riverbanks for agricultural uses had a massive destabilizing impact on the riverine corridor and its ecology. Furthermore, gravel and sand extraction over the entire site have significantly altered any remaining riparian vegetation. With each phase of extractive development, fragmented

populations of natural biodiversity have been further reduced and natural ecological processes interrupted.

As a result of long-term disturbance, modification and neglect of the river bed and its banks, the reserve's landscape is now highly degraded and impoverished. The river bed and aquatic habitats similarly have been seriously compromised providing opportunities for highly competitive exotic weed species to flourish. Any remnant components of the natural ecosystem can be easily overwhelmed by continuing environmental and human-induced impacts thus maintaining a position of long-term simplification and ecosystem instability.

This situation is clearly illustrated in photographs taken of the reserve in 1993–1994 during the latter phase of rehabilitation. The photos show a relatively open and barren landscape with scattered semi-mature and juvenile River Oaks within open grassed areas (Photos A2-1 and A2-2). In less than a decade, the reserve has been completely enveloped by exotic weed species. The rehabilitation works following completion of gravel and sand extraction failed to address an inherently unstable ecosystem and the inevitable outcome. In such an environment, change can occur rapidly and recovery is likely to be extremely slow without further human intervention.

Exotic Weed Species

The landscape is currently temporal in nature responding to natural river dynamics and past impacts with the layering of fast-growing colonizing weed species. There is no continuous canopy. Exotic trees and shrubs include Box Elder *(Acer negundo),* Hackberry *(Celtis occidentalis),* Honey Locust *(Gleditsia triacanthos),* the Pecan *(Carya pecan),* Willows *(Salix spp.),* Cottonwood Poplar *(Populus deltoides),*Tree of Heaven *(Ailanthus altissima),* Castor Oil Plant *(Ricinus communis),* Small-leaved Privet *(Ligustrum sinense),* Wild Olive *(Olea africana)*, Lantana *(Lantana camara),* Ink Weed *(Phytolacca octandra),* Fennel *(Foeniculum vulgare)* and Giant Reed Grass *(Arundo donax),* Noogoora Burr *(Xanthium occidentale).*

Emergent weed species and native regrowth species are shrouded in a dense "blanket" of exotic climbers, particularly Balloon Vine *(Cardiospermum grandiflorum)* and Madeira Vine *(Anredera cordifolia).* Open grass areas are dominated by exotics such as African Love Grass *(Eragrostis spp.),* Rhodes Grass *(Chloris gayana),* Prairie Grass *(Bromus catharticus),* Kikuyu Grass *(Pennisetum clandestinum),* Paspalum (*Paspalum dilatatum* and *P. urvillei), (Pavonia hastata)* and Paddy's Lucerne *(Sida rhombifolia).* Refer to *Appendix V: Schedule of Existing Weed Species*.

Photo A2- 1
View looking south across small lake to large southern lagoon
from near Springwood Road [Portion 293] November 1993

Photo A2- 2
View looking north over extraction area towards Springwood Road
[Portion 293] following rehabilitation February 1994

Endangered Ecological Community

There has been no comprehensive survey of native biodiversity in the reserve to date. However, it is clear from site investigations that the original biodiversity of the Sydney Coastal River-flat Forest (SCRFF) and associated riverine and wetland communities has almost completely vanished. In a regional context, there are now only very small fragmented remnants of this community along the Hawkesbury Nepean corridor. The SCRFF has been scheduled as an endangered ecological community under the *Threatened Species Conservation Act (1995).*

Remnant Biodiversity

The River Oak *(Casuarina cunninghamiana)* remains the dominant local indigenous tree species within the reserve. It is a conspicuous monocultural element within a primarily weed dominated landscape. This species would have been a component of the SCRFF community, however many of the trees on site were planted during rehabilitation work between 1989-1994.

Other remnant regrowth trees are very rare and tend to occur only as individual specimens. These tree species include Cabbage Gum *(Eucalyptus amplifolia),* Mountain Blue Gum *(Eucalyptus deanei)* and Forest Red Gum *(Eucalyptus tereticornis).* Regenerating native wattles such as Coast Myall *(Acacia binervia),* Sally Wattle *(Acacia floribunda),* Sydney Green Wattle *(Acacia parramattensis),* Hickory *(Acacia implexa)* and Silver-stemmed Wattle *(Acacia parvipinnula)* are relatively common native shrub components of this former community. Other native shrub species such as Willow Bottlebrush *(Callistemon salignus),* Yellow Tea-tree *(Leptospermum polygalifolium),* Common Hop Bush *(Dodonea triquetra),* Native Raspberry *(Rubus parvifolius)* and Native Peach *(Trema aspera)* are represented by only single specimens or a few individuals.

The original complex mix of native shrub and understorey ferns, herbs, climbers and grasses is absent. Remnant grasses, ferns, perennials and herbs are predominantly colonizing species including Soft-leaved Creeping Grass *(Oplismenus aemulus),* Weeping Grass *(Microlaena stipoides),* Harsh Ground-fern *(Hypolepis muelleri),* Berry Saltbush *(Einadia hastata),* Scurvy Weed *(Commelina cyanea)* and Polymeria *(Polymeria calycina).*

There are however some very small pockets of significant regeneration in the reserve. A substantial lineal stand of wattles dominated by Coast Myall *(Acacia binervia)* and to a lesser degree Sydney Green Wattle *(Acacia parramattensis),* occurs on the alluvial sands in the portion of the reserve north of the Grose River. This community has established since the flood in August 1990. The understorey is dominated by the weed species Wandering Jew *(Tradescantia albiflora)* and African Love Grass *(Eragrostis spp.)*. The small native terrestrial fern, Poison Rock Fern *(Cheilanthes sieberi subsp. sieberi)* is relatively common. Notably, there are no *Eucalyptus spp.* present in this part of the reserve except for a single maturing Mountain Blue Gum *(Eucalyptus deanei)* located on an alluvial rise. Within this stand of wattles, there are some discrete areas containing a greater level of species diversity including some species with rainforest/ mesic affinities such as Native

Rosella *(Hibiscus heterophyllus),* Elderberry Panax *(Polyscias sambucifolia),* Cedar Wattle *(Acacia elata),* Rusty Pomaderris *(Pomaderris ferruginea),* Native Peach *(Trema aspera)*, Common Hop Bush *(Dodonea triquetra)* and Native Raspberry *(Rubus parvifolius)*. This area also contains some unusual Blue Mountains sandstone species (upper Grose River) including Boomerang Wattle *(Acacia amoena)* and Native Daphne *(Eriostemon myoporoides).*

Another significant location containing remnant native species occurs within the large boulders on the southern side of Springwood Road immediately west of the bridge. This small area contains a number of native regenerating species, including some with rainforest/ mesic affinities such as Coachwood *(Ceratopetalum apetalum)* and Grey Myrtle *(Backhousia myrtifolia).* Refer to *Appendix IV: Schedule of Existing Native Plant Species*.

Modified Habitat

Exotic weed vegetation provides habitat opportunities for some native fauna particularly smaller invertebrates, reptiles and species with mobility (eg. birds and bats). The community workshops/ meetings and site investigations confirmed the presence of the Red-bellied Black Snake *(Pseudechis porphyriacus),* Eastern Brown Snake *(Pseudonaja textilis),* Lace Monitor *(Varanus varius),* Eastern Water Skink *(Sphenomorphus quoyii),* Eastern Water Dragon *(Physignathus lesuerii).* This list is by no means comprehensive. Feral animal populations such as the Cat, Rabbit and European Fox are likely to occur in the reserve. It is likely that the native fauna population remains impoverished. Many arboreal species (eg. gliders) will not colonize the area even over a long period of time unless there are dramatic changes made to core habitat values, buffers and bio-linkages.

It is important to note that a transitory colony of Grey-headed Flying-fox *(Pteropus poliocephalus)* has established within a gallery habitat of the weed species Box Elder *(Acer negundo)* in the southern portion of the reserve. The Flying-foxes are a protected species and are of particular significance. They are scheduled as a "vulnerable species" under the *Threatened Species Conservation Act (1995).* The National Parks and Wildlife Service (NPWS) is closely monitoring the status and any impacts on this colony and will be developing a Draft Recovery Plan in liaison with key stakeholders.

Wetland Biodiversity

The water's edge, levee banks and wetland areas are also dominated by weed species. Native wetland species include Common Reed *(Phragmites australis),* Common Rush *(Juncus usitatus),* Jointed Twig-rush (Baumea rubiginosa), Marsh Club-rush (Bolboschoenus fluviatilis), Tall-flat Sedge *(Cyperus exaltatus),* Slender Knotweed *(Persicaria decipiens)* and Water Pepper *(Persicaria hydropiper).*

The community workshops/ meetings highlighted the significance of the reserve's river and wetland habitat for a large number of water-birds including the Dusky Moorhen *(Gallinula tenebrosa),* Swamphen *(Porphyrio porphyrio),* Great Egret *(Egretta alba),* Australian Pelican *(Pelecanus conspicillatus)* and Black Swan

(Cygnus atratus). Other smaller bird species such as the Azure Kingfisher *(Ceyx azurea),* Superb Fairy-wren *(Malurus cyaneus)* and Silvereye *(Zosterops lateralis)* are also present. The understorey and dense thickets of weeds along the levee banks provide protection from predators and vital habitat for these smaller species. The reserve's waterways also offer habitat for a pair of White-bellied Sea Eagles *(Haliaeetus leucogaster).* These birds have been nesting recently in a remnant Mountain Blue Gum *(Eucalyptus deanei)* on adjoining private land. In addition, the Common Sandpiper, a scheduled RAMSAR wetland species, is known to be an uncommon seasonal visitor to the reserve.

Aquatic Biodiversity and Introduced Species

There has been no aquatic survey of biodiversity, however fisherman at the community workshops discussed the presence of relatively good populations of native fish including Australian Freshwater Bass, Catfish and Mullet. The introduced European Carp is also common, particularly in the lagoon. The presence of Freshwater Sponges under the Yarramundi Bridge has been the subject of recent scientific investigation. However, the aquatic ecosytem contains a host of introduced species, particularly within the lagoon and Hawkesbury-Nepean River sections. Common weed species include Ludwigia *(Ludwigia peruviana),* Salvinia *(Salvinia molesta)*, Water Hyacinth *(Echhornia crassipes)*, Alligator Weed *(Alternanthera philoxeroides)* and Ribbon Waterweed *(Egera densa)*.

Weed Management, Restoration and Reinstatement

The high level of disturbance and modification over the entire site has implications for the weed management strategy. The soil would contain a vast weed seed bank which would be ready to germinate following any further disturbance and clearing. In addition, the reserve's riverine context, its dynamic nature and inherent instability, poses additional challenges for weed management. The site will inevitably be affected by continuing dispersal of weed propagules from upstream sources, nutrient loadings, erosion, sedimentation and channel re-alignments. The proposed strategy would therefore need to be carefully targeted, staged and adequately funded to ensure a sustainable outcome.

Due to the high costs involved in initial weeding and ongoing maintenance, there will need to be a focus on achievable objectives within available funding. The program should therefore focus on managing specific areas and threatening processes whilst ensuring the protection of threatened species and vital habitat values. The program should include the following initiatives:

- continued selective targeting and control of noxious weeds (eg. river banks and aquatic environments);
- selective targeting and control of environmental weeds (eg. affecting pockets of natural regeneration);
- staged bush regeneration (where practical), restoration, enhancement and reinstatement strategies according to the level of disturbance and integrity of naturally regenerating areas;
- implementation of an appropriate maintenance and monitoring regime.

Selective Targeting and Control of Weed Species

The NSW Department of Land and Water Conservation and Hawkesbury River County Council (representing four local councils) are focussing on selective control and management of noxious weed species along the Nepean River. The Black Willow *(Salix nigra)* and its hybrid forms with other willow species have been assessed as having "extreme risk" to the Nepean River riparian zone. The Black Willow has the capacity to produce large volumes of viable seed which are readily dispersed along the river banks, hybridizes with a number of other Willow species and establishes large galleries of trees along the river banks. These trees effectively exclude any native regeneration. They can also create significant blockages in the river channel affecting stream flow, water quality and navigation of the river.

A specific target area for the Black Willow Management Program should include the right bank channel near the southern end of the reserve. Participants at the community meeting/ workshop highlighted the issue of willows in this portion of the river channel. The extensive gallery thicket of Black Willows has established in only a few years and is making navigation of the channel impossible for even canoes and small boats. The Willows will be treated with a non-residual systemic herbicide and the banks planted with native River Oak *(Casuarina cunninghamiana).* The overall program for the reserve should consider broader species diversity in the restoration planting phases.

There area a number of introduced noxious aquatic weeds which have been targeted in broad and sometimes non-selective herbicidal programs. These species include the free-floating aquatic weeds Salvinia *(Salvinia molesta)* and Water Hyacinth *(Echhornia crassipes)* and Ludwigia *(Ludwigia peruviana)* which can form floating islands. Alligator Weed *(Alternanthera philoxeroides*) is a particularly aggressive and adaptive species which can infest both aquatic and terrestrial habitats (ie. the river bed, riverbanks and islands). These target species have proved to be highly invasive to the exclusion of native aquatic plant species. Furthermore, these species have a rapid capability for expansion creating stream blockages, covering lagoons, modifying and reducing native aquatic habitat and affecting water quality. Concerns were raised at the workshops with regard to the non-selective use of herbicides. It was believed that the lagoon area has shown evidence of past over-spray on native species with significant impacts on regenerating native aquatic and wetland plant species and bird-nesting habitat.

The river bed is also affected by other introduced weed species. The Ribbon Waterweed *(Egera densa)*, although not yet declared noxious, has increased its range considerably in recent years. This species forms dense submerged masses in the river and during peak flood periods vast amounts of this weed are tangled in the branches of riparian trees. This creates increased loads on the tree's branches and roots which often leads to the loss of the tree as the root system fails. Participants at the workshops confirmed that the poisonous Fortesque Fish was evident in large numbers within the lagoon area and Nepean River section of the reserve. This species favoured dense water weeds such as the Ribbon Waterweed

and poses a significant threat to unwary swimmers.

The targeted weed management program should also address opportunities to enhance the environmental quality of destination and high use public areas. It is envisaged that a substantial part of the restoration program would focus on key locations such as the proposed Springwood Road/ bridge interface, carparking/ picnic areas and the popular Grose River area opposite Navua Reserve (refer to section *A.4 Public Access).*

Habitat Restoration, Enhancement and Reinstatement

The reserve contains some significant core areas, including remnant pockets and individual components of the original Sydney Coastal River-flat Forest (SCRFF) and associated riverine and wetland communities. The reserve also contains vital habitat for scheduled threatened species as discussed. These fragile areas need to be clearly identified as core remnants and an appropriate management regime established for their protection and restoration. The areas should be well-defined, fenced and sign-posted (if necessary) and placed under an appropriately funded and coordinated management regime. The weed management strategy will need to control public access and recreational impacts in these environmentally sensitive areas while ensuring access to popular recreational locations.

Some of these areas may respond to bush regeneration techniques. Other more disturbed areas will require restoration, enhancement and reinstatement strategies using locally-sourced indigenous species (ie. use of local genotypes of species rather than introducing genotypes from different unrelated areas).

Many native riparian species have very small seeds and require high light levels at ground level for seedling establishment. The dense shade created by Privets, Willows, Kikuyu Grass, Alligator Weed, African Lovegrass and many other shrub and climbing weed species will effectively prevent germination and establishment of native species. The proposed strategy in these highly disturbed areas would include selective application of glyphosate herbicide, clearing and removal of weed propagules from the site and implementation of controlled, localised burning of stockpiled weeds. Timing of herbicidal applications and burning should be related to seed production/ dispersal mechanisms and optimum growth conditions for establishing native seedlings. Ecological burns should be carefully co-ordinated under the supervision of the NSW Rural Fire Service.

The Navua Community Group, operating within Navua Reserve for over nine years, has been a particularly successful community-based initiative receiving grant funding under the Rivercare and other programs. There is currently no bushcare group working within Yarramundi Reserve. It is however important that the local community is integrally involved in the future management of Yarramundi Reserve and Navua Reserve. Council should continue to support the ongoing efforts of Navua Community Group and seek to establish a broader volunteer network for both reserves.

Faunal Corridors, Bio-linkages, Buffers and "Mosaics"
The creation of faunal corridors, bio-linkages, buffers and "mosaics" aim to reduce the effects of isolation, ecosystem simplification and instability. Expanded core areas, buffers and bio-linkages should be established in the longer term. Core areas will need to be consolidated and better integrated with adjoining remnant bushland, including the restoration initiatives of Navua Reserve. All buffer enhancement and restoration works should be staged and managed progressively in accordance with funding constraints. These issues will be thoroughly addressed in the Plan of Management.

A.4 Public Access

Northern Portion of Reserve – Navua Reserve
The northern portion of the reserve can be accessed via North Richmond on the Grose Vale and Grose River Roads at Navua Reserve, located on the northern side of the Grose River. This popular reserve has a large carpark, BBQs, picnic areas and tables and toilets. The reserve is secured at night with a locked gate. The usual level of the river in summer allows swimmers to easily wade between Navua Reserve and Yarramundi Reserve.

In 1994, responding to continuing vehicular access, environmental and safety issues, Hawkesbury City Council with the assistance and support of the Navua Community Group created a vehicular barrier to prevent 4WD access across the Grose River. The reserve was being used as a thoroughfare and short-cut between Navua Reserve and Springwood Road. Discarded concrete blocks (possibly part of an earlier rail-bridge for gravel and sand extraction) were taken from the river and used to construct a vehicular barrier along the top of the riverbank adjacent to the carpark. This action was met with considerable opposition from some members of the public. For some years, barriers and other infrastructure were vandalised and removed from Navua Reserve.

Springwood Road and Yarramundi Bridge Access
Yarramundi Reserve is divided into two parts by Springwood Road and Yarramundi Bridge over the Nepean River. The road and bridge provide an important link between the Richmond area and the lower Blue Mountains, providing access for tourist coaches, some freight haulage and local traffic. Springwood Road is the main point of access to the reserve with two informal, gravel hardstand areas for carparking on the northern (upper terrace area) and southern sides (lower river-side) of the road. The existing bridge and its approaches are the subject of a current RTA proposal (refer to section *A.5 Proposed RTA Bridge Replacement*).

Springwood Road Carparks and Access Points
Participants at the community meetings/ workshops commented on the poor visual quality and lack of amenity in the two carparking areas. The larger area is a flat, poorly delineated and desolate expanse of gravel bounded by a low steel post and

single cable barrier. Concrete blocks and a steel gate mark the upper entry track. A number of other unformed tracks radiate towards the Nepean and Grose River. Dumped rubbish and litter line the road-side and carpark. In December 2001, the adjoining area was burnt out following the lighting of deliberate fires.

The lower southern carpark is also bounded by the same type of vehicular barrier as in the northern carpark. Car access is quite tight off the roadway with large potholes adjacent to the entry due to flooding and local subsidence. The carpark offers direct pedestrian access to the Nepean River and the northern part of the lagoon. A shallow ford of shingles allows access onto the long southern island. Rampant weed growth is quickly covering over the many vehicular tracks on this island.

Vehicular Barriers on Springwood Road

The Springwood Road vehicular barriers were installed by Hawkesbury City Council in early 2001 to prevent vehicular access into the northern and southern parts of the reserve. The construction of these vehicular barriers was the most contentious of the issues raised at the community meetings/ workshops. While addressing long term issues relating to environmental degradation, vandalism and burning of stolen vehicles, this action has tended to alienate sections of the community who wish to use the reserve for passive and water-based recreation. People with disabilities or impaired mobility are also significantly disadvantaged. The long distance to preferred locations within the reserve, carrying of recreational equipment and issues of carpark security were also raised at the workshops.

There were also comments regarding the quality and strength of the steel cable used in the vehicular barrier. It was suggested that it was too easy for people to cut the existing cable and that a more expensive, thicker and higher grade cable should have been used. The current proposal for the replacement of the Yarramundi Bridge and realignment of the roadway on Springwood Road may offer significant opportunities to enhance public access whilst controlling inappropriate uses (refer to *A.5 Proposed RTA Bridge Replacement*).

Past Unrestricted Vehicular Access

For many years vehicular and 4WD access had been largely unrestricted throughout this reserve and adjoining Navua Reserve (refer to *A.4 Public Access Northern Portion of Reserve – Navua Reserve*). This allowed easy access for the launching of canoes, access to preferred fishing spots, as well as opportunities to bring a range of equipment and accessories for swimming, picnicking and week-end camping to destinations away from the main road. This uncontrolled access during peak summer periods left significant impacts on the quality of popular areas with damage to native vegetation, eroded tracks, dumped rubbish, broken glass and health issues.

The most popular destination for swimming in the reserve is on the Grose River, adjacent and upstream of Navua Reserve. The river flows down through sandstone gorges and valleys from the Blue Mountains National Park and provides good water

quality and clarity free of the sediments, turbidity and aquatic weeds found in the Nepean and Hawkesbury Rivers. This location on the Grose River is accessed from the northern carpark on Springwood Road via an upper terrace track, lower lagoon track or a longer circuit track along the Nepean River. Pedestrian access to the Grose River via the terrace track takes about 10-15 minutes from the carpark. This track was formed over an area which had been illegally used for land fill in 1998.

Trail-bike riders have also used the reserve for many years. Since the cessation of gravel and sand extraction, the unrestricted use of the reserve by cars, 4WD vehicles and trail bikes had created a multitude of tracks, erosion and damage to regenerating native vegetation. Regardless of erected barriers and signage, trail-bikes are still common in the reserve. Trail bike riders are still regularly using the reserve, ignoring signage prohibiting these activities. Furthermore, the barriers are regularly damaged imposing continuing costs to the community for repair.

Social Issues

The use of tracks into isolated areas of the reserve had provided opportunities for anti-social behaviour to develop including drinking alcohol, drug abuse and the discarding of syringes, dumping rubbish and breaking glass bottles. Abandoned and stolen vehicles were frequently set on fire. On numerous occasions, emergency vehicles and the Rural Fire Service have needed access to the reserve to deal with these issues. The anti-social and criminal behaviour was also affecting the quality of the reserve for family groups and people wanting to relax in a tranquil, natural setting.

Many people raised concerns over the amount of broken glass and syringes to be found in the sand. In effect, the broader community were being displaced by these activities. Participants at the workshops confirmed that the situation had become intolerable. While the vehicular barriers have prevented much of this behaviour, particularly dumping and burning of vehicles, the workshops confirmed that there was considerable community frustration over the loss of easy access to the rivers.

Illegal Dumping

The illegal dumping of rubbish and garden refuse/ green waste within the reserve's boundaries, particularly along Springwood Road, is an ongoing environmental issue. It is visually obtrusive, costly to remove and contributes to further weed encroachment. Past dumping has left areas such as the terrace access track (north of Springwood Road) in a poor condition. Camp fires near favoured fishing spots also typically contain an assortment of rusting cans and broken glass. These areas should be inspected and monitored regularly to ensure that any dumped materials which may cause a hazard to the public are safely removed. An education campaign in conjunction with monitoring by the rangers should be considered as many people may not be aware of the long term and cumulative impacts of their behaviour. Larger scale illegal dumping should be investigated to determine the parties responsible. All such dumping should be removed promptly from the reserve to discourage this kind of behaviour.

Pedestrian safety and Security Issues

It is important to ensure that recreational values are not diminished for the broader community, particularly as a response to inappropriate use of the reserve by other groups. Pedestrian safety and security issues were also raised over the existing carparking arrangements. It was confirmed at the community workshops that during peak summer periods, both carparks can be at full capacity with cars overflowing along both sides of Springwood Road. On most weekdays however the carparks are relatively empty. The carparks are a considerable distance from popular local fishing spots and swimming/ picnicking areas on the Grose River. Their location also raises concerns over security and any valuables left in vehicles.

Opportunities for Controlled Vehicular Access

There appeared to be considerable support at the workshops for vehicular access to be provided along the terrace track from the Springwood Road northern carpark to the Grose River, terminating with a formed carpark on the higher sloping ground. The road would need to be designed to allow an evacuation strategy in the event of flooding. The access road should be unsealed in a compacted gravel finish (for further details relating to vehicular access and parking options refer to *A.5 Proposed RTA Bridge Replacement*).

Locked Access and Security

Vehicular access would need to be controlled with appropriate fencing/ barriers and secured with a locked gate at the entry off Springwood Road (similar to the arrangement at Navua Reserve). This would provide reserve security between dusk to dawn. It was suggested at the meetings/ workshops that fishing and canoeing clubs could be issued keys to their own locks to ensure a system of responsible use of the reserve after sunset. This would also ensure greater community use and ownership over the reserve beyond daylight hours. Improved patrolling by Council's rangers to monitor security and regulate anti-social behaviour, were also suggested by participants at the meetings/ workshops.

Rationalization of Pedestrian Tracks

The existing circuit tracks north of Springwood Road should be retained only for pedestrian access. Multiple tracking would need to be rationalized and appropriate restoration planting and temporary protective fencing installed. Pedestrian access to the large southern lagoon and Nepean River sections also need to be rationalized. Sensitive environmental areas would need to be protected and managed accordingly (refer to *Weed Management and Habitat Restoration*).

Canoe and Small Boat Access

A small ramp access for canoes onto the Nepean River near the existing bridge was also suggested to enhance recreational opportunities from point to point along the river. The southern portion of the reserve, including the large lagoon, is used for fishing and canoeing but water quality issues and the amount of aquatic weed make it less popular as a place for swimming.

The constricted main channel and extent of Black Willow growth in the southern portion of the reserve has made it almost impossible for canoes to navigate (refer to *Weed Management and Habitat Restoration)*. While boats up to 4 HP were used in this part of the Nepean River and the large lagoon, they're movement is significantly affected by aquatic weeds and shallow depth. The workshops raised concerns over motor boats in the lagoon and their impact on water-birds and nesting sites. They were also criticised for the level of noise disturbance and their impact on the area's tranquillity.

Access to the Southern Lagoon – Western Foreshore

Concerns were raised over access to the remote western shoreline. Neighbouring residents had experienced vandalism, theft of property including boats and other anti-social behaviour. It was believed that access to the western shoreline should not be encouraged for these reasons. However, a low-key pedestrian circuit track around the lagoon area was suggested by some participants at the meetings/ workshops. The large southern lagoon and wetlands offer significant opportunities for bird-watching, nature-study and environmental education. The environmental sensitivity of this southern portion of the reserve, including habitat for threatened species, would need to be adequately protected and managed.

Recreational Facilities

Limited recreational facilities and infrastructure should be provided to enhance recreational opportunities within the portion of the reserve north of Springwood Road. Facilities should be located adjacent to the proposed carpark near the Grose River, away from the main channel flow and within an area which can be appropriately restored. These facilities and amenities should include pit toilets, picnic settings/ tables, secured large bins and signage (similar to Navua Reserve). The design and location of facilities need to consider flood impacts (refer to *Geomorphology and Flooding*). Camping would be considered an inappropriate activity anywhere within the reserve due to the risk of flooding and emergency evacuation.

Unleashed Dogs

Yarramundi Reserve offers opportunities for informal exercising of unleashed dogs as part of the recreational activities. Many people bring their dogs to the reserve for this kind of recreation. Nevertheless, issues have been raised regarding the control and management of unleashed dogs particularly within the more popular river-side locations and Navua Reserve. These issues include uncontrolled and anti-social dog behaviour within the Navua Reserve picnic area, children's safety, disturbance of habitat and bird nesting sites and dog faeces left in the reserve.

Dogs must be on leash at all times in Navua Reserve. However, there may be opportunities to permit owners to take their dogs off leash within specified areas of Yarramundi Reserve. For example, the area north of Springwood Road and south of the Grose River may offer these opportunities. The northern area beyond Navua Reserve could also possibly be unrestricted (ie. unleashed dogs permitted)

providing they were on a leash within Navua Reserve. Signs with maps showing designated off leash dog areas could be installed in the carparks.

Areas containing sensitive habitat values or threatened species would need to be protected with dogs restricted at all times in these areas. The dog issues affecting the reserve would need to be regulated by Council with spot fines for infringements. In addition, the program would need to be monitored for compliance and adjusted accordingly. Moreover, the success of the program would depend on the responsible behaviour of dog owners.

A.5 Yarramundi Bridge Replacement

The community issues raised in the previous section highlighted the need to address the Springwood Road interface and associated carparks. This area forms the main entry to the reserve. The existing dilapidated bridge, open gravel carparks, vehicular barriers, accumulated rubbish and weeds combine to provide a poor visual image for the reserve. The bridge has suffered from heavy vehicle traffic and the impact of past floods leading to the current interim arrangement of one lane of traffic flow and traffic lights. These lights are frequently vandalised adding to further delays and congestion on the bridge approaches.

The Roads and Traffic Authority (RTA) proposes to replace the bridge and its approaches at a cost of $2.6 million. The new bridge would be constructed immediately downstream of the existing bridge providing straighter approaches from both sides and eliminating the existing tight curves. The existing bridge would be removed. A shared bikepath/ footpath is proposed for the southern side of the bridge. The RTA has advised that no remnant native vegetation would be affected by the proposal.

The existing bridge is set at approximately RL 5.3. The new bridge is likely to be constructed at a higher level than the existing bridge (possibly between 1.5-5.5 metres higher subject to further investigation, design and budget constraints). The height of the new bridge has been a contentious community issue in addressing flood levels. Essentially, Yarramundi Lagoon at RL 13.1 on the eastern approach to the bridge is the controlling flood level for the design.

It is believed that the proposal offers opportunities to address a number of public access and environmental issues affecting the reserve's value as a regional asset. A meeting was held on 15 May 2002 with the Roads & Traffic Authority (RTA), Department of Land and Water Conservation (DLWC) and Hawkesbury City Council to discuss these issues and develop appropriate outcomes. Following the meeting a Preliminary Landscape Concept Plan – Proposed Yarramundi Bridge was prepared by LandArc Pty Limited to review the opportunities and develop options for proposed treatments including the following:-

- northern and southern carparks and vehicular barriers will need to be replaced/ relocated (ie. options for improved vehicular barrier/ controls);
- approaches to the new bridge will need to address opportunities for safe public access into the southern and northern portions of the reserve, including access to the Nepean River;
- current ad hoc parking arrangements and peak period congestion will need to be addressed (including appropriately designed carparking areas and landscaping);
- proposed shared bikepath/ footpath over the bridge will need to be connected and integrated with the reserve's entry points (including an option for safe pedestrian access via an underpass); and
- landscaping/ restoration of road-side interface and carpark areas (using local indigenous species) should be a vital component of these works.

The proposed treatments shown in Figure 5 have the potential to significantly enhance visual and environmental qualities as well as providing improved public access, controlled parking and vehicular access to selected locations (including water access and canoe ramp). It also identifies opportunities to retain the existing eastern approach road to the bridge for enhanced pedestrian access to this side of the Nepean River.

The southern carpark would be redeveloped and extended (to the north of the existing bridge) to accommodate up to 100 cars during peak summer periods. It would be linked to an off-ramp on the western side of the new bridge making use of the existing road section. Pedestrian access to the northern portion of the reserve would be provided along the river (under the new bridge).

Two options are provided for the northern carpark:

- develop vehicular access along the terrace to two small carparks near the Grose River (up to 50 cars total maximum capacity); or
- a small carpark to be located near the new bridge approach road.

All vehicular access into the reserve would need to be effectively controlled with appropriate barriers/ fencing and entry boom-gates. For discussion on vehicular access and carparking issues, refer to previous section A.4 Public Access.

The RTA has been advised of the importance placed on implementation of an appropriate landscape restoration strategy. The DLWC, NPWS and Hawkesbury City Council have emphasized the need to establish a suitable riparian vegetation community including structural and species diversity in accordance with the management strategies of this Plan of Management.

In terms of aquatic biodiversity management, the presence of Freshwater Sponges under the existing Yarramundi Bridge, should be the subject of further investigation. Furthermore, it is important to consider any potential adverse impacts posed by road re-alignment and construction in relation to Aboriginal heritage within the

Springwood Road corridor. Accordingly, the RTA have consulted with the Darug Custodian Aboriginal Corporation and the Deerubbin Local Aboriginal Council. Due to the extent of past gravel and sand extraction and extensive disturbance of the site, it was considered that the proposed RTA works were unlikely to affect any Aboriginal places or relics in this location.

YARRAMUNDI BRIDGE POSTSCRIPT (29 October 2004)

The Yarramundi Bridge Replacement Project, constructed by the NSW Roads and Traffic Authority (RTA), was opened in early 2004. The bridge replacement is located immediately to the north of the old bridge rather than the originally proposed alignment with Springwood Road (further to the north).

The bridge has a shared pedestrian/ bikepath located on the northern side however there has been no linkages provided for the eastern and western approaches. A sealed, elevated bitumen carpark (capacity of 15 car spaces) was constructed on the south-western side of the bridge. This carpark replaces a poorly delineated, unsealed gravel parking area. Proposed vehicular barriers along Springwood Road were not installed during bridge construction works. Landscaping has been undertaken but quantities and extent of planting are significantly less than that shown in the RTA Landscape Plan. Most of the scheduled tubestock plants were proposed within rock embankments providing little opportunity for planting. Nevertheless, further planting is proposed by Hawkesbury City Council to extend this initial work and replace losses incurred during the recent drought.

Noel Ruting
Director, LandArc Pty Limited

Schedule of Addenda

PAGE	PARAGRAPH	DESCRIPTION
Appendix I: Community Issues Summary		
A1-1	1/2	Introductory Notes – re: amendments (29.10.04)
A1-1	5	Figure 1 deleted – refer to *Figure 2: Study Area*.
A1-1	6	Area of reserve amended to 78 hectares.
A1-3	2	Additional stakeholders and consultation.
A1-3	3	Written Submissions.
A1-5	4	Identifying Key Issues – Further Consultation.
A1-5	4	ref: Yarramundi Bridge Replacement
Appendix II: Community Issues Discussion Paper		
A2-2	1	Area of reserve amended.
A2-2	4	Figure A2-1 [amended Figure 2].
A2-8/ 9	3	Photos A2- 1 and A2- 2 [amended references].
A2-8	5	Reference to *Appendix V.*
A2-10	5	Additional data – remnant core areas
A2-11	1/2	Additional data & reference to *Appendix IV*.
A2-12	1	Additional data – Common Sandpiper.
A2-14	5	Additional data – Restoration and Enhancement.
A2-20	6	Figure A2-2 [amended Figure 5].
A2-20	3	ref: Yarramundi Bridge Replacement
A2-20	6	Figure A2-2 – ref. deleted.
A2-21		Figure A2-2 – page deleted.
A2-22	2/3	Postscript – Yarramundi Bridge Replacement .

Sydney coastal river-flat forest - endangered ecological community listing

NSW Scientific Committee - final determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list the Sydney Coastal River-Flat Forest as an ENDANGERED ECOLOGICAL COMMUNITY on Part 3 of Schedule 1 of the Threatened Species Conservation Act. Listing is provided for by Part 2 of the Act.

The Scientific Committee has found that:

1. The Sydney Coastal River-Flat Forest (SCRFF) is the name given to the plant community that is characterised by the following assemblage of species :

- Acacia binervia
- Acacia filicifolia
- Acacia floribunda
- Acacia parramattensis
- Acmena smithii
- Adiantum aethiopicum
- Alphitonia excelsa
- Angophora floribunda
- Angophora subvelutina
- Backhousia myrtifolia
- Breynia oblongifolia
- Bursaria spinosa
- Callistemon salignus
- Casuarina cunninghamiana
- Casuarina glauca
- Cayratia clematidea
- Centella asiatica
- Clematis aristata
- Clematis glycinoides
- Commelina cyanea
- Dichondra repens
- Doodia aspera
- Duboisia myoporoides
- Einadia hastata
- Eucalyptus amplifolia
- Eucalyptus baueriana
- Eucalyptus benthamii
- Eucalyptus botryoides/saligna
- Eucalyptus deanei

- Eucalyptus elata
- Eucalyptus tereticornis
- Eucalyptus viminalis
- Eustrephus latifolius
- Geitonoplesium cymosum
- Geranium homeanum
- Glochidion ferdinandi
- Hydrocotyle peduncularis.
- Hymenanthera dentata
- Hypolepis muelleri
- Imperata cylindrica
- Leptospermum polygalifolium
- Lomandra longifolia
- Melaleuca linariifolia
- Melaleuca styphelioides
- Melia azedarach
- Microlaena stipoides
- Oplismenus aemulus
- Pandorea pandorana
- Parsonsia straminea
- Persicaria decipiens
- Phyllanthus gasstroemii
- Pratia purpurascens
- Pteridium esculentum
- Rubus parvifolius
- Stellaria flaccida
- Stephania japonica
- Stipa ramosissima
- Stipa verticillata
- Themeda australis
- Trema aspera
- Tristaniopsis laurina
- Viola hederacea
- Wahlenbergia gracilis

2. The total species list of the community is considerably larger than that given in 1 (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 1 may be present. At any one time, 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 and by its recent disturbance history. The number of species and the above-ground composition of species will change with time since fire, and may also change in response to changes in fire frequency.

3. The structure of the community was originally forest, but as a result of partial clearance may now exist as woodland or as groups of remnant trees.

4. Characteristic tree species in the SCRFF are Acacia parramattensis, Angophora floribunda, Angophora subvelutina, Eucalyptus amplifolia, Eucalyptus baueriana, Eucalyptus deanei, Eucalyptus elata, Eucalyptus tereticornis. Tree species composition varies between sites depending on geographical location and local conditions (e.g. topography, rainfall, exposure).

5. SCRFF has been recorded from the local government areas Bankstown, Baulkham Hills, Blacktown, Blue Mountains, Camden, Campbelltown, Fairfield, Gosford, Hawkesbury, Holroyd, Hornsby, Liverpool, Parramatta, Penrith and Sutherland.

6. SCRFF typically is associated with rivers and creeks and occurs

on the riparian zone and on associated floodplains, terraces and flats on alluvial soils, that is, sand silt and clay of fluvial origin. Its main areas of occurrence are associated with the Hawkesbury-Nepean, Georges and Woronora Rivers and their tributaries.

7. SCRFF includes the riverflat forests of the Hawkesbury-Nepean River as referred to in Benson & Howell (1990), Benson, Howell & McDougall (1996) and the Swamp Oak Forest, Red Gum-Cabbage Gum Forest, Blue Gum Forest, Swamp Mahogany Forest, River Peppermint Forest, River Oak Forest, Cabbage Gum-Broad-leaved Apple Forest, Camden White Gum Forest, Blue Gum/Bangalay-Peppermint-Blue Box Forest and River Peppermint Forest of UBBS (1997). It includes but is not restricted to vegetation described as map units 6d and 9f of Benson (1992).

8. SCRFF provides habitat for a number of plant species recognised as being of regional conservation significance in UBBS (1997). These include

- Adiantum formosum
- Asterolasia correifolia
- Blechnum indicum
- Cyclosorus interruptus
- Echinochloa colona
- Eucalyptus baueriana
- Eucalyptus benthamii
- Eucalyptus elata
- Glyceria australis
- Panicum obseptum
- Pellaea falcata var nana
- Persicaria prostrata
- Pratia concolor
- Pultenaea viscosa.
- Scutellaria humilis
- Senna odorata
- Seringia arborescens
- Synoum glandulosum
- Syzygium oleosum
- Tylophora paniculata

9. SCRFF has an understorey that may be either grassy and herbaceous or of a shrubby sclerophyll to mesophyll or viney nature. SCRFF can have a dense understorey in areas that have not been burnt for an extended period of time.

10. Adjacent communities on sandstone soils are generally part of the Sydney Sandstone Complex, on shale soils are Cumberland Plain Woodlands and on Tertiary alluvium are Castlereagh Woodlands. In estuarine areas on saline soils Communities dominated by Casuarina glauca (Benson & Howell 1990) occur, however these Communities have a different understorey and are not part of the SCRFF.

11. Because of the fertile nature of river flat soils, most of the SCRFF has been cleared for agriculture and intensive development, and SCRFF now exists as remnants generally in cleared agricultural country.

12. Only small areas of SCRFF are presently included in conservation reserves including Cattai National Park, Dharug National Park, Georges River National Park, Scheyville National Park, Gulguer Nature Reserve, Mulgoa Nature Reserve and Marramarra National Park.

13. Large areas of SCRFF have been cleared for agriculture, mining and other development. Remnants are small and

scattered. Identified threats include weed invasion, grazing and mowing, clearing, physical damage from recreational activities, rubbish dumping.

14. In view of the small size of existing remnants, the threat of further clearing and other threatening processes, the Scientific Committee is of the opinion that the Sydney Coastal River-Flat Forest is 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 is eligible for listing as an endangered ecological community.

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About the NSW Scientific Committee

APPENDIX IV:

Schedule of Existing Native Plant Species

KEY:

Species are scheduled in alphabetical order.

Habitat:
- A = aquatic/ shallow water and wetlands
- F = flood channel and sandy alluvial soils
- L = levee banks/ loam alluvial soils
- M = moist swales and depressions
- R = river edges
- S = sandstone/ boulder influence

Botanic Name	Common Name	Habitat
Acacia amoena	Boomerang Wattle	F
Acacia binervia	Coast Myall	FL
Acacia elata	Cedar Wattle	F
Acacia floribunda	White Sally	FLS
Acacia implexa	Hickory Wattle	FLS
Acacia longifolia var. *longifloia*	Sydney Golden Wattle	S
Acacia parramattensis	Sydney Green Wattle	FL
Acacia parvipinnula	Silver-stemmed Wattle	FL
Azolla pinnata	Ferny Azolla	A
Backhousia myrtifolia	Grey Myrtle	S
Baumea articulata	Bare Twig-rush	AR
Bolboschoenus fluviatilis	Marsh Club-rush	AR
Casuarina cunninghamiana	River Oak	FLMR
Carex appresa	Tall Sedge	MR
Centella asiatica	Swamp Pennywort	FM
Ceratopetalum apetalum	Coachwood	S
Callistemon salignus	Willow Bottlebrush	S
Cheilanthes sieberi	Poison Rock Fern	FLS
Commelina cyanea	Scurvy Weed	FLMR
Cynodon dactylon	Common Couch Grass	FLMR
Cyperus difformis	Variable Flat-sedge	AR
Cyperus exaltatus	Tall-flat Sedge	AR
Dodonea triquetra	Common Hop Bush	FS
Echinopogon caespitosus	Tufted Hedgehog Grass	FL
Einadia hastata	Berry Saltbush	L
Eleocharis sphacelata	Tall Spike-rush	AR
Entolasia stricta	Wiry Panic	FLS

Native Plant Species [continued]

Eragrostis elongata	Clustered Love Grass	FL
Eriostemon myoporoides	Native Daphne	F
Eucalyptus amplifolia	Cabbage Gum	M
Eucalyptus crebra	Narrow-leaved Ironbark	L
Eucalyptus deanei	Mountain Blue Gum	FL
Eucalyptus saligna	Sydney Blue Gum	L
Eucalyptus tereticornis	Forest Red Gum	L
Juncus planifolius	Broad Rush	AR
Juncus usitatus	Common Rush	AFMR
Hibiscus heterophyllus	Native Rosella	F
Hypolepis muelleri	Harsh Ground-fern	M
Imperata cylindrica	Blady Grass	FLS
Leptospermum polygalifolium	Yellow Tea-tree	L
Lomandra longifolia	Spiny-headed Mat-rush	FLM
Lomandra multiflora	Many-flowered Mat-rush	F
Lycopus australis		FL
Melia azedarach	White Cedar	FL
Microlaena stipoides	Weeping Grass	FLM
Opercularia aspera	Common Stinkweed	FL
Oplismenus aemulus	Soft-leaved Creeping Grass	FLM
Oxalis chnoodes		M
Paspalum distichum	Water Couch	AR
Persicaria decipiens	Slender Knotweed	AR
Persicaria hydropiper	Water Pepper	AR
Phragmites australis	Common Reed	AR
Plantago debilis	Slender Plantain	L
Plectranthus parviflorus	Cockspur Flower	F
Pratia purpurascens	White Root	LM
Polyscias sambucifolia	Elderberry Panax	F
Polymeria calycina	Polymeria	LM
Pomaderris ferruginea	Rusty Pomaderris	F
Rubus parvifolius	Native Raspberry	F
Rumex brownii	Swamp Dock	ARL
Schoenoplectus mucronatus	Club-rush	AR
Schoenoplectus validus	River Club-rush	AR
Spirodela sp.	Small Duckweed	A
Typha orientalis	Broad-leaved Cumbungi	AR
Trema aspera	Native Peach	FS
Vallisneria gigantea	Eel-weed	A
Wahlenbergia communis	Tufted Bluebell	F
Wahlenbergia gracilis	Australian Bluebell	L

APPENDIX V:

Schedule of Existing Weed Species

KEY:

The following exotic weed species were identified during site investigations. The species are scheduled in alphabetical order. Species declared noxious within the Hawkesbury River County Council area, under the *Noxious Weeds Act 1993,* are shown with a Weed Category as applicable.

W1	The presence of the weed on land must be notified to the local control authority and the weed must be fully and continuously suppressed and destroyed.
W2	The weed must be fully and continuously suppressed and destroyed.
W3	The weed must be prevented from spreading and its numbers and distribution reduced.
W4b	The weed must not be sold, propagated or knowingly distributed and any part of the weed must be prevented from growing within 3 metres of the boundary of a property.
W4f	The weed must not be sold, propagated or knowingly distributed. Any biological control or other control program directed by the local control authority must be implemented.
W4g	The weed must not be sold, propagated or knowingly distributed.

Botanic Name	Common Name	Category
Acer negundo	Box Elder	-
Ageratina adenophora	Crofton Weed	W2
Ailanthus altissima	Tree of Heaven	-
Alternanthera philoxeroides	Alligator Weed	W1
Anredera cordifolia	Madeira Vine	-
Araujia hortorum	Moth Vine	-
Arundo donax	Giant Reed Grass	-
Bidens pilosa	Cobbler's Peg	-
Bidens tripartita		-
Brassica sp.		-
Bromus catharticus	Prairie Grass	-
Cardiospermum grandiflorum	Balloon Vine	-
Carya pecan	Pecan	-
Celtis occidentalis	Hackberry	-
Cerastium glomeratum	Chick Weed	-
Cestrum parqui	Green Cestrum	W2
Chloris gayana	Rhodes Grass	-

Weed Species [continued]

Conyza bonariensis	Fleabane	-
Cortaderia selloana	Pampas Grass	W2
Cyperus eragrostis	Umbrella Sedge	-
Egera densa	Ribbon Waterweed	-
Ehrharta sp.	Veldt Grass	-
Eichhornia crassipes	Water Hyacinth	W2
Eragrostis spp.	African Love Grass	-
Foeniculum vulgare	Fennel	-
Gleditsia triacanthos	Honey Locust	-
Hypochoeris radicata	Catsear	-
Lantana camara	Lantana	-
Ligustrum lucidum	Large-leaved Privet	W4b
Ligustrum sinense	Small-leaved Privet	W4b
Ludwigia peruviana	Ludwigia	W2
Morus alba	Mulberry	-
Nothoscordum gracilis	Onion Weed	-
Olea africana	Wild Olive	-
Opuntia stricta	Prickly Pear	W4f
Paspalum dilatatum	Paspalum	-
Paspalum urvillei	Tall Paspalum	-
Pavonia hastata		-
Pennisetum clandestinum	Kikuyu Grass	-
Populus deltoides	Cottonwood Poplar	-
Rhynchelytrum repens	Natal Red Grass	-
Ricinus communis	Castor Oil Plant	-
Rumex sagittatus	Dock	-
Phytolacca octandra	Ink Weed	-
Salix babylonica	Weeping Willow	-
Salix cinerea	Basket Willow	W4g
Salix fragilis	Crack Willow	W4g
Salix matsudana X alba	New Zealand Hybrid Willow	W4g
Salix nigra	Black Willow	W4g
Salvinia molesta	Salvinia	W2
Sapium sebiferum	Chinese Tallow-tree	-
Senecio mikanioides	Cape Ivy	-
Setaria sp.	Pigeon Grass	-
Sida rhombifolia	Paddy's Lucerne	-
Solanum mauritianum	Wild Tobacco Tree	-
Solanum nigrum	Blackberry Nightshade	-
Sonchus oleraceus	Common Sowthistle	-
Tagetes minuta	Stinking Roger	-
Taraxacum officinale	Dandelion	-
Tradescantia albiflora	Wandering Jew	-
Trifolium repens	White Clover	-
Verbena bonariensis	Purple Top	-
Xanthium occidentale	Noogoora Burr	W3

APPENDIX VI:

Schedule of Species for Restoration and Enhancement at Yarramundi Reserve

Sydney Coastal River-flat Forest (Riparian Forest)

The degree of past clearing, disturbance, modification, fragmentation and weed invasion has removed almost all of the original Sydney Coastal River-flat Forest (ie. Riparian Forest) and its representative assemblage of plant species. The following schedule of species to be used in the proposed Intervention Strategy are based on site investigations and reference sources.

The maintenance of genetic integrity is a key principle of the restoration, enhancement and reinstatement components of the program (ie. use of local genotypes of species rather than introducing genotypes from different unrelated areas). However, the approach should not simply limit species selection to existing current site species and assemblages. Diversity in species composition and overall structural characteristics are to be promoted with the aim of developing long term durability and resilience. Species scheduled from sources are representative of this section of the Hawkesbury – Nepean and lower Grose Rivers. Species with a known restricted distribution outside this river segment should not be used in the proposed strategy.

Primary Sources:

1) Species identified on site during investigations*
2) Species listed in *Riverside Plants of the Hawkesbury-Nepean (Howell, McDougall & Benson, 1995)* [with likely distribution in this section of the river].
3) Species listed in Final Determination for SCRFF [not including species with a restricted distribution to other segments of the river].
4) Local Species of Regional Conservation Significance [this section of the river].
5) Additional diagnostic species scheduled in *NPWS Native Vegetation Maps of the Cumberland Plain* [as applicable to this section of the river].

*** Note:**

Species identified during site investigations are a sampling only and should not in any way be considered exhaustive. It is recommended that further investigations be conducted within the reserve and in immediate upstream and downstream areas along the riparian corridor to further enhance the species list.

Botanic Name	Common Name	Sources
Trees:		
Acacia amoena	Boomerang Wattle	1
Acacia binervia	Coast Myall	1 2 3
Acacia elata	Cedar Wattle	1
Acacia floribunda	White Sally	1 2 3
Acacia implexa	Hickory Wattle	1 2
Acacia parramattensis	Sydney Green Wattle	1 2 3
Acacia parvipinnula	Silver-stemmed Wattle	1
Acmena smithii	Lilly Pilly	3
Allocasuarina torulosa	Forest Oak	1
Alphitonia excelsa	Red Ash	3
Angophora floribunda	Rough-barked Apple	3 5
Angophora subvelutina	Broad-leaved Apple	1 2 3 5
Backhousia myrtifolia	Grey Myrtle	1 3
Callistemon salignus	Willow Bottlebrush	1 3
Casuarina cunninghamiana	River Oak	1 2 3
Commersonia fraseri	Brush Kurrajong	2
Eucalyptus agglomerata	Blue-leaved Stringybark	2
Eucalyptus amplifolia subsp. *amplifolia*	Cabbage Gum	1 2 3
Eucalyptus crebra	Narrow-leaved Ironbark	1
Eucalyptus deanei	Mountain Blue Gum	1 2 3
Eucalyptus saligna	Sydney Blue Gum	1 2
Eucalyptus punctata	Grey Gum	2
Eucalyptus tereticornis	Forest Red Gum	1 2 3 5
Ficus coronata	Creek Sandpaper Fig	
Glochidion ferdinandi var. *ferdinandi*	Cheese Tree	1 3
Leptospermum polygalifolium subsp. *polygalifolium*	Yellow Tea-tree	1 3
Melia azedarach	White Cedar	1 2 3
Toona ciliata	Red Cedar	[2]
Tristaniopsis laurina	Water Gum	3
Understorey Shrubs < 5 metres high:		
Breynia oblongifolia	Common Breynia	2 3
Bursaria spinosa	Native Blackthorn	2 3 5
Clerodendrum tomentosum	Hairy Clerodendrum	2
Croton verreauxii	Native Cascarilla	5
Dodonea triquetra	Common Hop Bush	1
Duboisia myoporoides	Corkwood	3
Eriostemon myoporoides	Native Daphne	1
Hibiscus heterophyllus var. *heterophyllus*	Native Rosella	1 2
Hymenanthera dentata	Tree Violet	3 5
Gonocarpus longifolius		5

Understorey Shrubs [continued]

Phyllanthus gasstroemii	Blunt Spurge	2 3
Phyllanthus gunnii	Spurge	2
Pittosporum revolutum	Yellow Pittosporum	2
Polyscias sambucifolia	Elderberry Panax	1
Pomaderris ferruginea	Rusty Pomaderris	1
Pultenaea viscosa		5
Rubus parvifolius	Native Raspberry	1 2 3
Senna odorata		4
Trema aspera	Native Poison Peach	1 2 3

Shallow Water and Wetland Species:

Alisma plantago-aquatica	Water Plantain	2
Azolla pinnata	Ferny Azolla	1 2
Baumea articulata	Bare Twig-rush	1
Bolboschoenus fluviatilis	Marsh Club-rush	1 2 3
Centipeda minima		2
Cyperus difformis	Variable Flat-sedge	1 2
Cyperus exaltatus	Tall-flat Sedge	1 2
Cyperus laevis	Flat Sedge	2
Eleocharis sphacelata	Tall Spike-rush	1 2
Fimbristylis velata	Fringe-rush	2
Juncus planifolius	Broad Rush	1
Ludwigia peploides subsp. *montevidensis*	Water Primrose	1 2
Paspalum distichum	Water Couch	1 2
Phragmites australis	Common Reed	1 2
Potamogeton tricarinatus	Floating Pondweed	2
Schoenoplectus mucronatus	Club-rush	1
Schoenoplectus validus	River Club-rush	1 2
Spirodela sp.	Small Duckweed	1 2
Typha orientalis	Broad-leaved Cumbungi	1 2

Submerged Freshwater Perennials:

Najas tenuifolia	Water Nymph	2
Vallisneria gigantea	Eel-weed	1 2

Grasses, Herbs and Ferns:

Adiantum aethiopicum	Maidenhair Fern	2 3
Adiantum formosum	Giant Maidenhair Fern	4
Agrostis avenacea	Blown Grass	2
Alternanthera denticulata	Lesser Joyweed	2
Asterolasia correifolia	Star-bush	4
Carex appresa	Tall Sedge	1 2
Centella asiatica	Swamp Pennywort	1 3
Cheilanthes sieberi subsp. *sieberi*	Poison Rock Fern	1 2 5
Commelina cyanea	Scurvy Weed	1 2 3
Cyclosorus interruptus		4

Grasses, Herbs and Ferns [continued]

Dichondra repens	Kidney Weed	3 5
Doodia aspera	Prickly Rasp Fern	3
Echinopogon ovatus	Tufted Hedgehog Grass	5
Echinopogon caespitosus	Tufted Hedgehog Grass	1 2
Einadia hastata	Berry Saltbush	1 2 3
Elymus scaber var. *scaber*		2
Entolasia stricta	Wiry Panic	1 2 5
Eragrostis elongata	Clustered Love Grass	1
Geranium homeanum		1 3
Glyceria australis		4
Helichrysum scorpioides	Button Everlasting	2
Hydrocotyle geraniifolia	Pennywort	2
Hydrocotyle peduncularis	Pennywort	2 3
Hypolepis muelleri	Harsh Ground Fern	1 3
Imperata cylindrica	Blady Grass	1 2 3
Juncus usitatus	Common Rush	1 2 3
Lomandra longifolia	Spiny-headed Mat-rush	1 2 3 5
Lomandra fluviatilis		5
Lomandra multiflora subsp. *multiflora*	Many-flowered Mat-rush	1 5
Ludwigia peploides subsp. *montevidensis*	Water Primrose	1 2
Lycopus australis		1 2
Microlaena stipoides var. *stipoides*	Weeping Grass	1 2 3 5
Nicotiana suaveolens		2
Opercularia aspera	Common Stinkweed	1 2
Oplismenus aemulus	Soft-leaved Creeping Grass	1 2 3 5
Oxalis chnoodes		1 2
Paspalidium distans		2
Persicaria decipiens	Slender Knotweed	1 2 3
Persicaria hydropiper	Water Pepper	1 2 3
Persicaria lapathifolia		2
Persicaria orientalis	Princes Feather	2 3
Plantago debilis	Slender Plantain	1
Plectranthus parviflorus	Cockspur Flower	1
Poa labillardieri	Tussock Grass	2
Poranthera microphylla	Small Poranthera	5
Pratia concolor		4
Pratia purpurascens	White Root	1 2 5
Pseudognaphalium luteoalbum	Jersey Cudweed	2
Pteridium esculentum	Common Bracken	2 3 5
Pteris tremula	Tender Brake	2
Rumex brownii	Swamp Dock	1 2 3
Scutellaria humilis		4
Sigesbeckia orientalis	Indian-weed	2
Stellaria flaccida	Forest Starwort	2 3
Stipa ramosissima	Stout Bamboo Grass	2 3 5

Grasses, Herbs and Ferns [continued]

Stipa verticillata	Stout Bamboo Grass		2	3		
Themeda australis	Kangaroo Grass			3		5
Viola hederacea	Ivy-leaved Violet		2	3		
Wahlenbergia communis	Tufted Bluebell	1	2			
Wahlenbergia gracilis	Australian Bluebell	1		3		5

Climbers and Twiners:

Cayratia clematidea	Slender Grape		2	3		
Cissus antarctica	Native Grape		2			
Convolvulus erubescens	Bindweed		2			
Eustrephus latifolius	Wombat Berry		2	3		
Geitonoplesium cymosum	Scrambling Lily		2	3		
Glycine tabacina			2			
Muehlenbeckia gracillima			2			
Pandorea pandorana	Wonga Vine			3		
Parsonsia straminea	Common Silkpod			3		
Polymeria calycina	Polymeria	1	2			
Sarcopetalum harveyanum	Pearl Vine		2			
Smilax australis	Austral Sarsaparilla		2			
Stephania japonica var. discolor	Snake Vine		2	3		
Tylophora paniculata					4	