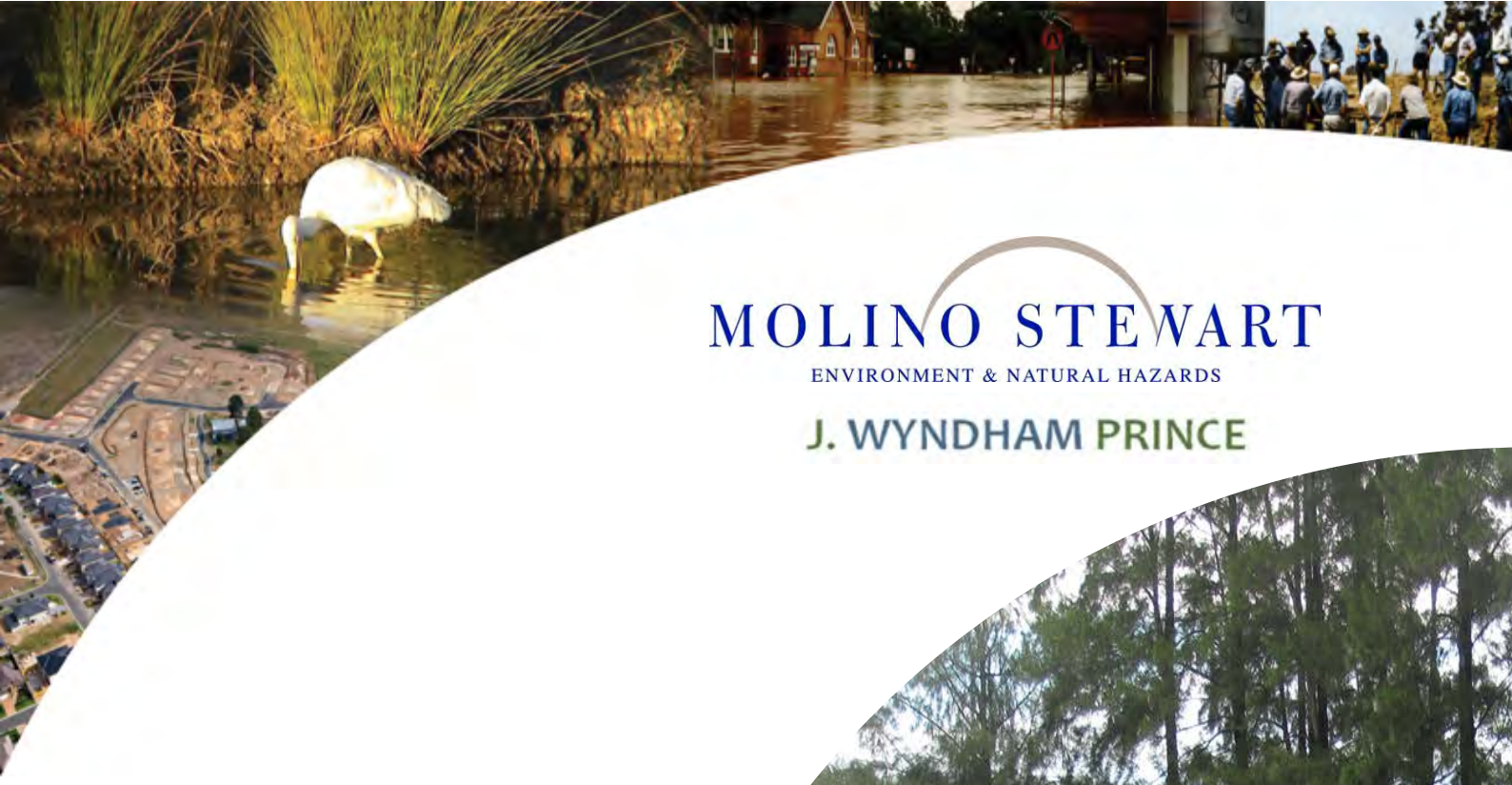

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ENVIRONMENT & NATURAL HAZARDS
J. WYNDHAM PRINCE

NSW GOVERNMENT Catchment Management Authority
Sydney Metropolitan

Holroyd City
a place for everyone

Hyland Road Park Wetlands and Riparian Corridor

Plan of Management 2013

MOLINO STEWART
ENVIRONMENT & NATURAL HAZARDS

Hyland Road Park Wetlands and Riparian Corridor

PLAN OF MANAGEMENT

for

Holroyd City Council

by

Molino Stewart Pty Ltd

ACN 067 774 332

MARCH 2013

MOLINO STEWART
ENVIRONMENT & NATURAL HAZARDS

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DOCUMENT APPROVAL

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For Client Name	Holroyd City Council
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Position	Landscape Architect

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GLOSSARY

AMSL – above mean seal level

ANSTO – Australian Nuclear Science and Technology Organisation

Anthropogenic: caused or produced by humans (www.macquarieonline.com.au)

AHD – Australian Height Datum: a common national surface level datum approximately corresponding to mean sea level.

ANZECC – Australian and New Zealand Environment Council

ARI – Average Recurrence Interval: is the average or expected value of the period between exceedances of a give discharge.

Catchment - an area of land from which all runoff water flows to a low point (river, creek harbour, etc). (www.stormwater.net.au/definitions)

Climate Change - is a long-term change in the statistical distribution of weather patterns over periods of time that range from decades to millions of years. (Wikipedia accessed 16/11/10).

CPW – Cumberland Plain Woodland

EEC - Endangered Ecological Community – a group of species that occur together in a particular area of the landscape that are listed on Schedule 1 of the NSW Threatened Species Conservation Act 1995

EPI – Environmental Planning Instrument

GPT - gross pollutant traps are used to prevent large items from polluting waterways

HCC – Holroyd City Council

Hydrology: the science dealing with the occurrence, circulation, distribution, and properties of the waters of the earth and its atmosphere. (www.dictionary.com)

Impervious surfaces that do not allow water to penetrate, such as roof, driveways, paths, paving etc. (adapted from "Stormwater Detention" www.stormwater.net.au/definitions)

LPT - Liverpool-Parramatta Transitway

NHMRC – National Health and Medical Research Council

NWQMS – National Water Quality Monitoring Strategy

OSD – On Site Detention: is the temporary on site storage of stormwater with a controlled release into the drainage system. (adapted from "Stormwater Detention" www.stormwater.net.au/definitions).

PMP – Probable Maximum Precipitation: the greatest depth of precipitation for a given duration meteorologically possible for a given size storm area at a particular location at a particular time of year. (BOM, 1994).

PMF – Probable Maximum Flood: is the flood that occurs as a result of the runoff generated by the Probable Maximum Precipitation.

RAMSAR – The international convention on wetlands, an intergovernmental treaty that embodies the commitments of its member countries to maintain the ecological character of their wetlands of international importance.

RFEF – River – flat eucalypt forest

SMCMA – Sydney Catchment Management Authority

SOF – Swamp oak floodplain forest

SLR – Sea Level Rise: as oceans warm, they expand and take up more space; therefore, any increase in global temperature will result in sea level rise, which relates specifically to the long term trend in movement of mean sea level.

TWL – Top water level

VMP - vegetation management plan.

WSUD – Water Sensitive Urban Design: the planning and design of urban environments that is 'sensitive' to the issues of water sustainability and environmental protection.

ACKNOWLEDGEMENTS

The Hyland Road Park wetlands and riparian corridor Plan of Management (PoM) has been prepared by Molino Stewart and J Wyndham Prince for Holroyd City Council (HCC). The plan was co-funded by the Sydney Metropolitan Catchment Management Authority (SMCMA).

Molino Stewart and J Wyndham Prince wish to acknowledge the contributions made to the preparation of this PoM by HCC, SMCMA and members of the Greystanes community who responded to the community newsletter and questionnaire.

EXECUTIVE SUMMARY

The Hyland Road Park wetlands and riparian corridor study area is located approximately 27 kilometres west of Sydney and just under 2 kilometres east of Prospect Reservoir. The study area extends over 1 kilometre from the southern boundary of the Lower Prospect Canal and Grey Box Reserve, located in Silverthorne Avenue, Pemulwuy to the Jack Ferguson pond; a constructed wetland in Gipps Road Sporting Complex, Greystanes. The riparian corridor and wetlands drain to Prospect Creek which is a tributary of the Georges River.

The study area is typically undulating in the north and east and otherwise consists of the relatively flat alluvial plain associated with Munro Creek, a tributary of Prospect Creek, which is regulated by: piped culverts under Hyland Road; an earthen embankment upstream of the Transitway which has created a wetland; and the creation of the Jack Ferguson pond on line in the Jack Ferguson Reserve. The Watercourse is piped underground from the Jack Ferguson pond to Prospect Creek. The Jack Ferguson pond located in Jack Ferguson Reserve is part of a water reuse scheme developed in 2009 that is used to irrigate the adjoining Australian Football League (AFL) fields in Gipps Road Sporting Complex.

The riparian corridor supports four endangered ecological communities (EECs) listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

- Cumberland Plain Woodland EEC listed as critically endangered on the EPBC Act and TSC Act;
- Swamp Oak Floodplain Forest (SOF) EEC listed on the TSC Act;
- River-flat Eucalypt Forest (RFEF) EEC listed on the TSC Act; and
- Freshwater Wetlands on Coastal Floodplains EEC listed on the TSC Act.

The Hyland Road 'Arboretum' Bushland Reserve and Hyland Road Park exhibit high levels of past disturbance and weed invasion throughout the riparian corridor. Weed density increases towards the northern end of the corridor.

The Hyland Road Park wetlands and riparian corridor forms an important wildlife corridor linking the Lower Prospect Canal Reserve, the ex-Boral site, Prospect Reservoir, Alpha Road Park and Prospect Creek Reserve. The corridor supports a high diversity of bushland dependent native birds, three endangered ecological communities and the highly mobile swamp wallaby *Wallabia bicolour* (James and Barker 2009).

The Hyland Road Park wetlands and riparian corridor are highly valued by the local community as natural areas supporting native plants and animals and for the provision of passive and active recreation. Residents observe the red-bellied black snake and brown snake during spring and summer throughout the riparian corridor. Local residents, walkers and bike riders all utilise and value the area but are concerned about the levels of weed invasion, perceived low maintenance levels and rubbish dumping. The development of a path network, increased weed control and maintenance have been identified as ways the corridor could be improved.

Ongoing resources will be necessary in order to secure grant funds and deliver bushland and weed management to protect the endangered ecological communities present in the corridor, control weeds of national significance and noxious weeds. The control of aquatic weeds will assist in maintaining water quality.

1 INTRODUCTION

1.1 HYLAND ROAD PARK

The Hyland Road Park wetlands and riparian corridor study area is located approximately 27 kilometres west of Sydney and just under 2 kilometres east of Prospect Reservoir. The study area extends over 1 kilometre from the southern boundary of the Lower Prospect Canal and Grey Box Reserve, located in Silverthorne Avenue, Pemulwuy, to the constructed wetland in Gipps Road Sporting Complex, Greystanes. The riparian corridor and wetlands drain to Prospect Creek which is a tributary of the Georges River.

Holroyd City Council has prepared a Draft PoM and Masterplan for Gipps/Hyland Road open space and the land to the west of the riparian corridor which has identified the future use of that area for active recreation. This includes the extension of the existing water harvesting and reuse from Munro Creek in the riparian corridor. This PoM specifically defines the wetland and riparian corridor within the Gipps/Hyland Road open space.

Hyland Park Road is community land as defined by the Local Government Act, 1993 and as such requires a Plan of Management (PoM).

1.2 PLAN OF MANAGEMENT

The Plan of Management (PoM) for Hyland Road Park wetlands and riparian corridor has been developed to:

"Establish a balanced approach to the management of the riparian corridor within a flexible framework, to protect and enhance this natural ecosystem."

Holroyd City Council (2011a)

1.2.1 Objectives

The PoM will guide management and address the objectives identified by Holroyd City Council (HCC) (HCC 2011a). The objectives are to:

- Establish a sound balanced approach to the management of Hyland Road Park riparian corridor while providing a flexible framework within which Council can respond to current needs and opportunities;
- Identify, manage and enhance areas of remnant native vegetation and fauna habitat;
- Establish a framework to guide day to day and long term decision making regarding the management of the wetlands;
- Provide detailed methodologies to guide "on ground works" including the re-establishment of severely degraded parts of the corridor and preservation and regeneration of the remnant natural sections of the corridor;
- Define the area of the corridor for categorisation.

The PoM also aims to reflect the community's concerns and aspirations for the wetland and surrounding area.

1.3 SCOPE OF THE PLAN

The PoM contains a description of the wetland and riparian corridor and an examination of its hydrology, environmental and social values. Relevant policies, acts and strategies are also considered. An issues analysis is presented along with management strategies to address issues and to enhance values. Management objectives and actions are prioritised and costed and potential funding sources identified. A monitoring plan for wetland management is also presented.

As indicated above the plan aims to define the riparian corridor, identify management issues and strategies to guide its day to day and long term operations. The PoM also provides detailed methodologies to guide on ground works. Management strategies and actions have been developed to improve water quality and riparian habitat. The monitoring plan provides a guide for assessing the effectiveness of management actions.

The Plan of Management should be reviewed every five years to enable the effectiveness of the recommended management actions to be considered and updated with new information

or technology and community concerns. Wetland management actions should be reviewed annually and reported within the framework of HCC's reporting commitments.

1.4 LOCAL GOVERNMENT 1993 ACT

The Local Government (LG) Act, 1993 sets out the requirements for Plans of management prepared under the Act. They include:

- Categorising the land that is the subject of the Plan of Management;
- Defining objectives and performance targets;
- Stating the means by which objectives and performance targets will be met;
- Stating the means by which performance targets will be measured;
- Observing the requirements of any threat abatement plans and recovery plans made under the *Threatened Species Conservation Act 1995* and *the Fisheries Management Act 1994*.

The minimum requirements as listed in the LG Act and where they are satisfied in this report are listed below in Table 1.

Table 1 Local Government Act 1993 Requirements

LG Act Requirement	**Addressed**
Categorise the land	Table 1
Objectives and performance targets of the plan	Section 1.2.1
Indicate the means of achieving objectives and performance targets	Chapter 8, Chapter 9, Table 9
How Council will measure and assess objectives and targets	Chapter 9
Permitted future uses of the land	Section 2.3
Leases licences and other estates that can be granted	None known

2 SITE SETTING AND CONTEXT

2.1 LOCATION AND SETTING

The study area is surrounded by the existing residential area of Pemulwuy to the north, the residential area of Greystanes in the east and the open space of Hyland Road 'Arboretum' Bushland Reserve and Hyland Road Park to the west and the existing sporting facilities of Gipps Road Sporting Complex to the south.

For consideration in this PoM, the study area has been divided into three sections that reflect the current masterplanning being undertaken for the site by HCC. The study area is shown on Figure 1. The three sections are:

- Hyland Road 'Arboretum' Bushland Reserve (north of Hyland Road to Lower Prospect Canal Reserve and Grey Box Reserve). This incorporates the eastern side of Munro Creek, which is known as Munro Street Park;
- Hyland Road Park (south of Hyland Road to the Transitway); and
- Jack Ferguson Reserve.

The study area is typically undulating in the north and east and otherwise consists of the relatively flat alluvial plain associated with Munro Creek; a tributary of Prospect Creek which is regulated by:

- 3 x 900 mm diameter piped culverts under Hyland Road;
- an earthen embankment upstream of the Transitway with culverts under the Transitway which have created a wetland; and
- the construction of the Jack Ferguson pond on line in the Jack Ferguson Reserve.

Munro Creek is piped underground from the Jack Ferguson pond to Prospect Creek.

The catchment area of the Munro Creek, wetland and Jack Ferguson pond is approximately 115 hectares. About half of the catchment is native bushland without stormwater control. The remaining area supports residential and industrial development. Areas of new and proposed development within the catchment will be required to provide water quality measures that aim to retain current levels of water quality.

The riparian corridor supports four endangered ecological communities (EECs) listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Previous survey and mapping (Total Earth Care 2007; James and Barker 2009) and current field investigations reveal the following EECs occur in the study area:

- Cumberland Plain Woodland EEC listed as critically endangered on the EPBC Act and TSC Act;
- Swamp Oak Floodplain Forest (SOF) EEC listed on the TSC Act;
- River-flat Eucalypt Forest (RFEF) EEC listed on the TSC Act; and
- Freshwater Wetlands on Coastal Floodplains EEC listed on the TSC Act.

The Hyland Road 'Arboretum' Bushland Reserve and Hyland Road Park exhibit high levels of past disturbance and weed invasion throughout the riparian corridor. Weed density increases towards the northern end of the corridor.

2.2 SITE HISTORY

As part of the Cumberland Plain, much of the broader study region would have been covered with a diversity of eucalypt (iron bark, stringy bark, box, blue and other gum species) as well as thick grasslands prior to European settlement (Benson & Howell 1990).

The region was one of earliest areas of land grants after European settlement. Whilst little is known of what modifications early settlers made to the study area, it is expected that land-clearing was almost certainly undertaken (Austral Archaeology, 2009).

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Figure 1: Study Area Location

Molino Stewart endeavours to ensure that the information provided in this map is correct at the time of publication. Molino Stewart does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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Primarily a dairy area, it is likely that the site was used for grazing and crops from these early settlement days until the residential development of Greystanes in the 1950s and 1960s (James & Barker 2009). In the 1880s the Prospect Reservoir and Upper Nepean Scheme was completed. Associated changes within the study area included the construction of a water supply canal at the northern border of the study site, and later in the 1930s and 1950s, the construction of pipes across the southern section of the study site

In 1967 the Hyland Road area was transferred to Council and zoned Open Space Existing Recreation. In late 1987 a Forestry Commission arboretum had been partly developed in the southern section of the Hyland Road 'Arboretum' Bushland Reserve. Works that were undertaken included blade ploughing and disc harrowing of the site, provision of services, kerbed and guttered roads, erection of fences and gates, and the planting of approximately 2,500 trees and shrubs (James & Barker 2009).

For many years active management at the study area was limited to mowing and slashing. Until recently, part of the area south of Hyland Road was used as a site for landfill and surplus soil and has since been capped.

In 1995 the Upper Nepean water supply canal that forms the northern boundary of the study area was decommissioned and the corridor was dedicated as public open space and a regional cycleway.

In 2003 the Liverpool-Parramatta Transitway (LPT) began operation on a 2-lane road constructed adjacent to the water supply pipes in the southern section of the study site, between Hyland Road Park and Jack Ferguson Reserve.

The Jack Ferguson pond located in Jack Ferguson Reserve is named after the Australian politician and member of the NSW General Assembly. The pond is part of a water reuse scheme developed in 2009 that is used to irrigate the adjoining Australian Football League (AFL) fields in Gipps Road Sporting Complex.

2.3 LAND TENURE, ZONING AND MANAGEMENT

The Hyland Road Park wetlands and riparian corridor as well as the Jack Ferguson pond and stormwater harvesting and reuse scheme are owned by Holroyd City Council. The legal ownership description and zoning are presented in Table 2.

The land parcels are classified as community land but are currently uncategorised. The categories under the Local Government Act 1993 proposed for the various land parcels are shown in Table 3.

The applicable community land categories for the Hyland Road Park wetlands and riparian corridor as defined by the Local Government (General) Amendment (Community Land Management) Regulation 1999 are listed in Table 3.

The core objectives for each land category are listed in the Local Government Act 1993 and presented in Table 4.

2.3.1 Current Zoning

The Hyland Road Park wetlands and riparian corridor are currently included in the Holroyd City Council Local Environmental Plan (LEP) 1991.The 1991 LEP will be superseded by the Draft Holroyd LEP 2012 which has been adopted by Council and has been forwarded to the NSW Department of Planning and Infrastructure for gazettal which is expected to occur in early 2013.

The study area is in the interim covered by zone 6(a) open space and classified as Community Land under the Local Government Act 1993. The Transgrid transmission easement located on the southern end of Hyland Road Park is within this 6(a) zoning.

The Liverpool-Parramatta transit way (LPT) (adjacent to water supply pipes) which divides Hyland Road Park and Jack Ferguson Reserve is zoned as 5(a) Special Uses 'A' under the Holroyd LEP 1991. The zones are shown in Figure 2.

The objectives of zone 6(a) Public Open Space are:

(a) to identify land which is currently used or is intended to be used for the purposes of open space or public recreation; and

(b) to allocate sufficient open space to serve the present and future recreational needs of residents and visitors; and

(c) to enable development associated with, ancillary to or supportive of public recreational use.

Works for the purposes of landscaping, gardening or bushfire hazard reduction are permitted in zone 6(a) without consent.

2.3.2 Proposed Zoning

The Hyland Road Park wetlands and riparian corridor are included in the Draft Holroyd Local Environmental Plan 2012. The study area is covered by zone RE1 Public Recreation and classified as Community Land under the Local Government Act 1993. The Transgrid transmission easement located on the southern end of Hyland Road Park is within this RE1 zoning.

The Liverpool-Parramatta transit way (LPT) (adjacent to water supply pipes) which divides Hyland Road Park and Jack Ferguson Reserve is zoned as SP2 Infrastructure under the Holroyd LEP 2012. The proposed zones are shown in Figure 3.

The objectives of zone RE1 Public Recreation are:

- *To enable land to be used for public open space or recreational purposes.*
- *To provide a range of recreational settings and activities and compatible land uses.*
- *To protect and enhance the natural environment for recreational purposes.*

Environmental protection works are permitted without consent.

The following are permitted with consent:

Building identification sign; Business identification sign, Child care centres; Community facilities; Environmental facilities; Information and education facilities; Kiosks; Recreation areas; Recreation facilities (indoor); Recreation facilities (major); Recreation facilities (outdoor); Respite day care centres; Roads; Signage; Water recreation structures.

The objectives of the SP2 Infrastructure zone are:

- *To provide infrastructure and related uses;*
- *To prevent development that is not compatible with or that may detract from the provision of infrastructure.*

Environmental protection works are permitted with consent in this zone.

2.3.3 Proposed Biodiversity Map

Part of the study area is mapped as remnant native vegetation on Council's Draft LEP 2012 Biodiversity Map.

The objectives of the biodiversity clause as detailed in the draft LEP are as follows.

(1) The objective of this clause is to conserve biodiversity through:

a) ensuring the conservation of remnant native vegetation communities, and

b) protecting native flora and fauna species and their habitats, and

c) protecting the ecological processes necessary for ecosystem health.

(2) This clause applies to land identified on the Biodiversity Map.

(3) Exempt or complying development must not be carried out on land to which this clause applies.

(4) Before determining an application for development on land to which this clause applies, the consent authority must consider whether the development would have any adverse impacts on:

(a) the condition, extent or long-term viability of any remnant of a native vegetation community,

(b) native flora or fauna, its habitat, its life cycle, or the long-term viability of a population,

(c) the integrity or functioning of any wildlife corridor, or

(d) the functioning of any ecosystem.

(5) The consent authority shall not grant consent to any development on land to which

this clause applies where it is considered that the development may result in any of the impacts identified in subsection (4)(a).

(6) Before granting consent to development on land to which this clause applies, the consent authority must be satisfied that:

(a) the development is sited, designed and managed to avoid the adverse impacts identified in subsection (4).

(b) where an impact cannot be avoided, it is minimised through the incorporation of effective mitigation measures including the restoration of any existing disturbed areas on the site to a condition that is consistent with their former natural condition.

2.3.4 Scale and Intensity of Permitted Uses

The scale and intensity of development within the study area will be guided by the objectives and permissible uses set out for the RE1 zone in the 2012 LEP. Any proposed development will also be required to consider the objectives of the biodiversity clause in the 2012 LEP and will be required to consider the potential impacts on biodiversity values and ensure impacts are mitigated. Any formal development in the study area would be outside the riparian corridor discussed in detail in Section 7.1.

Table 2 Land Ownership and Management Hyland Road wetlands and riparian corridor

Legal Description	**Owner**	**Current Zoning**	**Proposed Zoning**	**Classification**	**Proposed Categorisation**
Lot 2 DP 525167 Hyland Road Bushland Reserve	Holroyd City Council	6(a) Open Space HCC Local Environmental Plan (LEP) (1991)	RE1 Public Recreation	Community Land	Bushland and Munro Creek
Lot Pt2 DP 1129303 Hyland Road Bushland Reserve	Holroyd City Council	6(a) Open Space HCC Local Environmental Plan (LEP) (1991)	RE1 Public Recreation	Community Land	Bushland, Munro Creek and wetland
Munro Street Park	Holroyd City Council	6(a) Open Space HCC Local Environmental Plan (LEP) (1991)	RE1 Public Recreation	Community Land	Bushland, Munro Creek and park
Lot 2 1129303 Gipps Road Park	Holroyd City Council	6(a) Open Space HCC Local Environmental Plan (LEP) (1991)	RE1 Public Recreation	Community Land	Park and wetland

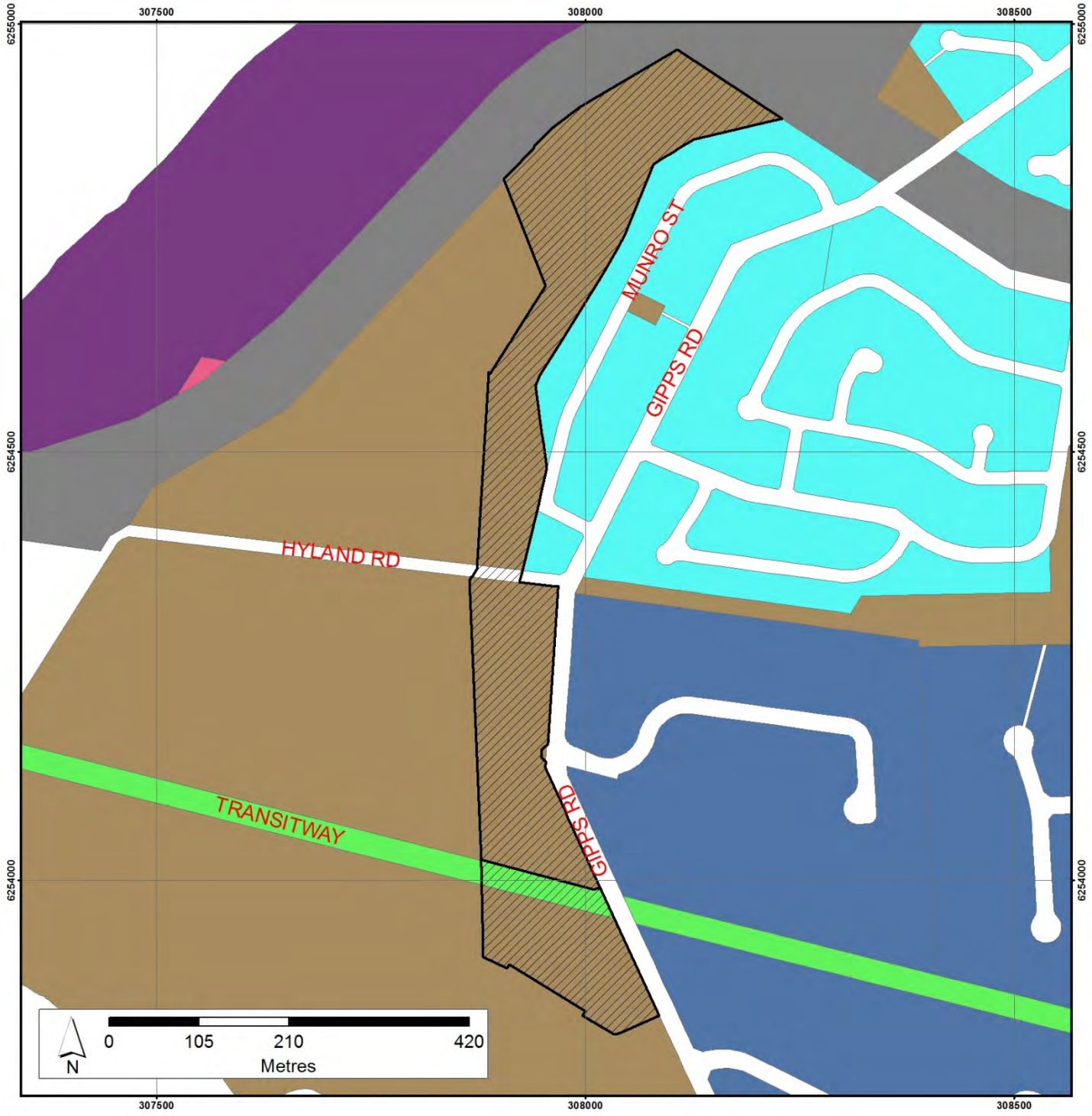
Table 3 Applicable Community land categories

Category	Guidelines for Categorisation
Natural area: Bushland	Is the natural vegetation or a remainder of the natural vegetation of the land. Or although not the natural vegetation of the land, is still representative of the structure or floristics, or structure and floristics, of the natural vegetation in the locality. This includes bushland that is mostly undisturbed, or moderately disturbed or, highly disturbed
Natural area: Watercourse	any stream of water, whether perennial or intermittent, flowing in a natural channel, or in a natural channel that has been artificially improved, or in an artificial channel that has changed the course of the stream of water, and any other stream of water into or from which the stream of water flows, and associated riparian land or vegetation, including land that is protected land for the purposes of the Rivers and Foreshores Improvement Act 1948 or State protected land identified in an order under section 7 of the Native Vegetation Conservation Act 1997.
Natural area: Wetland	The land includes marshes. mangroves, backwaters, billabongs, swamps, sedgelands, wet meadows or wet heathlands that form a waterbody that is inundated cyclically, intermittently or permanently with fresh, brackish or salt water, whether low moving or stationary.
Park	If the land is or is proposed to be improved by landscaping gardens or the provision of non-sporting equipment and facilities, for use mainly for passive or active recreational, social, educational and cultural pursuits that do not unduly intrude on the peaceful enjoyment of the land by others.

Source: Local Government (General) Amendment (Community Land Management) Regulation 1999

Table 4 Core objectives for community land management

Category	Core management objectives
Natural area: Bushland	(a) to ensure the ongoing ecological viability of the land by protecting the ecological biodiversity and habitat values of the land, the flora and fauna (including invertebrates, fungi and micro-organisms) of the land and other ecological values of the land, and (b) to protect the aesthetic, heritage, recreational, educational and scientific values of the land, and (c) to promote the management of the land in a manner that protects and enhances the values and quality of the land and facilitates public enjoyment of the land, and to implement measures directed to minimising or mitigating any disturbance caused by human intrusion, and (d) to restore degraded bushland, and (e) to protect existing landforms such as natural drainage lines, watercourses and foreshores, and (f) to retain bushland in parcels of a size and configuration that will enable the existing plant and animal communities to survive in the long term, and (g) to protect bushland as a natural stabiliser of the soil surface.
Natural area: Watercourse	a) to manage watercourses so as to protect the biodiversity and ecological values of the instream environment, particularly in relation to water quality and water flows, and (b) to manage watercourses so as to protect the riparian environment, particularly in relation to riparian vegetation and habitats and bank stability, and (c) to restore degraded watercourses, and (d) to promote community education, and community access to and use of the watercourse, without compromising the other core objectives of the category.
Natural area: Wetland	(a) to protect the biodiversity and ecological values of wetlands, with particular reference to their hydrological environment (including water quality and water flow), and to the flora, fauna and habitat values of the wetlands, and (b) to restore and regenerate degraded wetlands, and (c) to facilitate community education in relation to wetlands, and the community use of wetlands, without compromising the ecological values of wetlands.
Park	(a) to encourage, promote and facilitate recreational, cultural, social and educational pastimes and activities, and (b) to provide for passive recreational activities or pastimes and for the casual playing of games, and (c) to improve the land in such a way as to promote and facilitate its use to achieve the other core objectives for its management.



Legend

Draft Boundary

Zoning

BUSINESS Neighbourhood

EMPOYMENT LANDS

INDUSTRIAL Extractive

INDUSTRIAL General

OPEN SPACE PUBLIC

OPEN SPACE Public

RESIDENTIAL A

Residential Land

SPECIAL USES A School, Hospitals, etc

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Figure 2: Zoning

Molino Stewart endeavours to ensure that the information provided in this map is correct at the time of publication. Molino Stewart does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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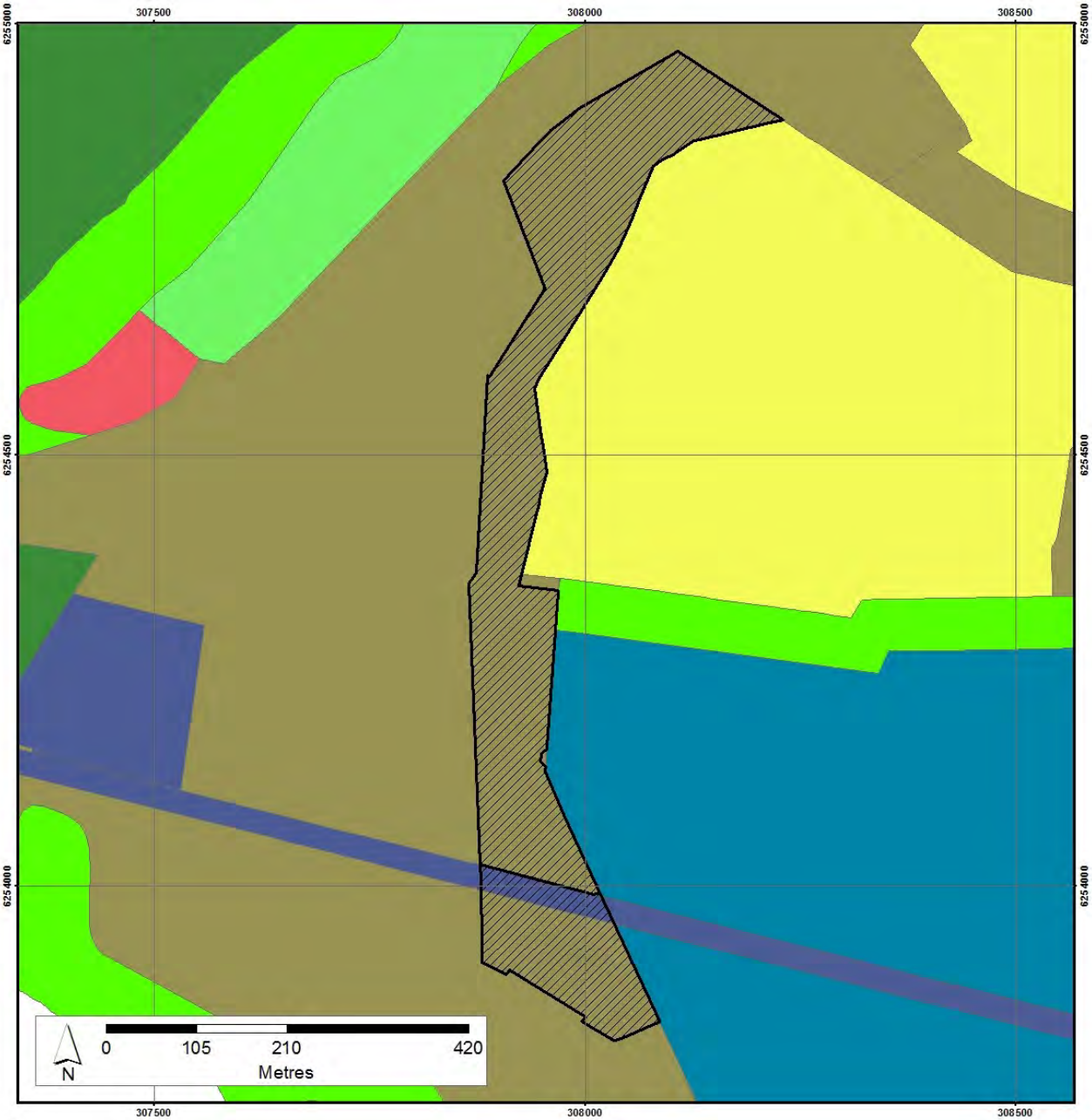

Legend

- Draft Boundary
- **2012 Draft LEP**
- Business Park
- Environmental Conservation
- General Industrial
- High Density Residential
- Infrastructure
- Light Industrial
- Low Density Residential
- Medium Density Residential
- Neighbourhood Centre
- Public Recreation

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Figure 3: Proposed Study Area Zoning

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2.4 CLIMATE

The climate of Greystanes is typical of Western Sydney, with warm to hot summers reaching an average maximum temperature of 27°C. Winter months are cool with an average maximum temperature of 17°C. The average annual rainfall is 867 mm. January and February are generally the warmest months with the majority of the rainfall between February and March (Bureau of Meteorology, 2011).

Refer to the Bureau of Meteorology graphs Figures 4, 5, 6 and 7, for the relationships between the annual and monthly averages for the Prospect Reservoir (ANSTO) Bureau of Meteorology weather recording station (# 067019) which is approximately 1.6 kms north west of the Hyland Road Park wetlands and riparian corridor. A more comprehensive set of climate and weather information is available at:

http://www.bom.gov.au/climate/averages/tables/cw_067019.shtml

2.5 PHYSICAL GEOGRAPHY

Greystanes is located on the Cumberland Plain which covers the area west from Parramatta to the Hawkesbury-Nepean River and from Windsor in the north to Thirlmere in the south. The Cumberland Plain covers a total area of around 275, 000 hectares (NSW NPWS 2002). It is an area of gently undulating countryside characterised by fertile soils (NSW NPWS 2002).

The Hyland Road Park wetlands and riparian corridor, located in Greystanes are in close proximity to Prospect Reservoir, the wall of which is approximately 1.5 km to the west. The northern boundary of the study area is characterised by the old Sydney water supply canal which has been converted to a cycleway and is now part of the Lower Prospect canal Reserve. The northern section of the study area within Hyland Road 'Arboretum' Bushland Reserve lies on an alluvial plain.

The landform within the Hyland Road Park south of Hyland Road bears little resemblance to the pre-European landform and has been extensively re-shaped and altered to accommodate a solid waste and waste transfer facility, surplus soil and more recently, playing fields.

The geology of the site is based on volcanic breccia which forms the raw material being quarried by Boral to the west of the site. The central area, Hyland Road Park, was re-graded as a flat open space area following closure of the waste transfer facility. However, the original landform was, and the surrounding landform still is, gently sloping with a slightly inclined plateau surface. Relief is less than 20% and slopes are less than 10% (Bannerman S.M. and Hazelton P.A., 1990).

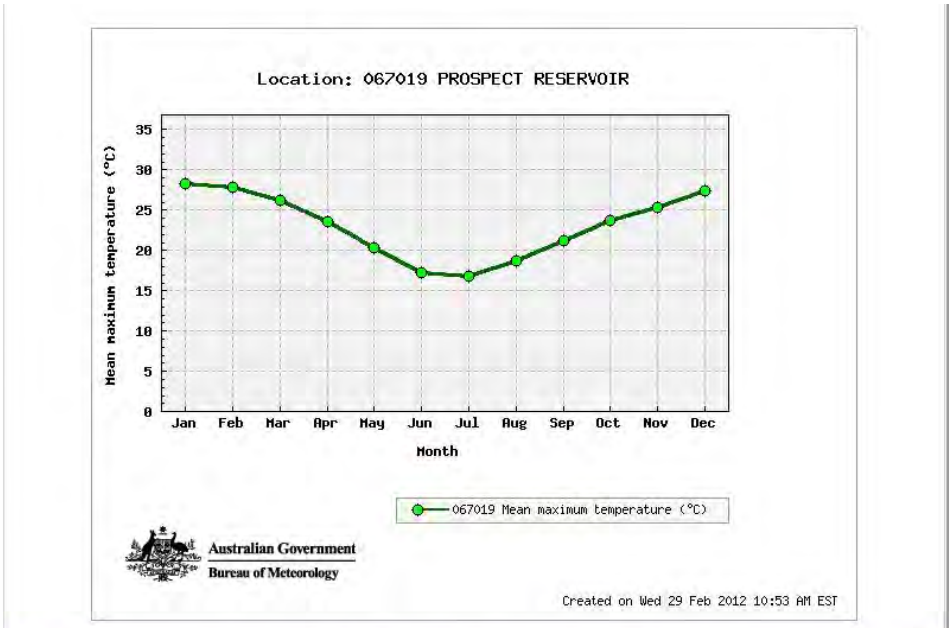
Soils of the northern section of the riparian corridor have been identified as belonging to the Blacktown soil landscape (Bannerman, & Hazleton, 1989 in James and Barker 2009) although the South Creek soil landscape may also be present along creek-lines. The soils are blackish-brown loams to hard-setting clay loams, and are likely to have been extensively modified away from the creek by agricultural and construction activities (James & Barker 2009). The mapping undertaken for the Draft Holroyd LEP 2012 indicates the study area does not contain acid sulphate soils.

2.6 ADJACENT LANDUSE

The study area has a number of different adjacent land uses. A cycleway forms the northern border of the site, beyond which lies Grey-Box Reserve - a woodland open space area which supports the critically endangered Cumberland Plain Woodland endangered ecological community (EEC). The suburb of Pemulwuy is situated to the north of the riparian area.

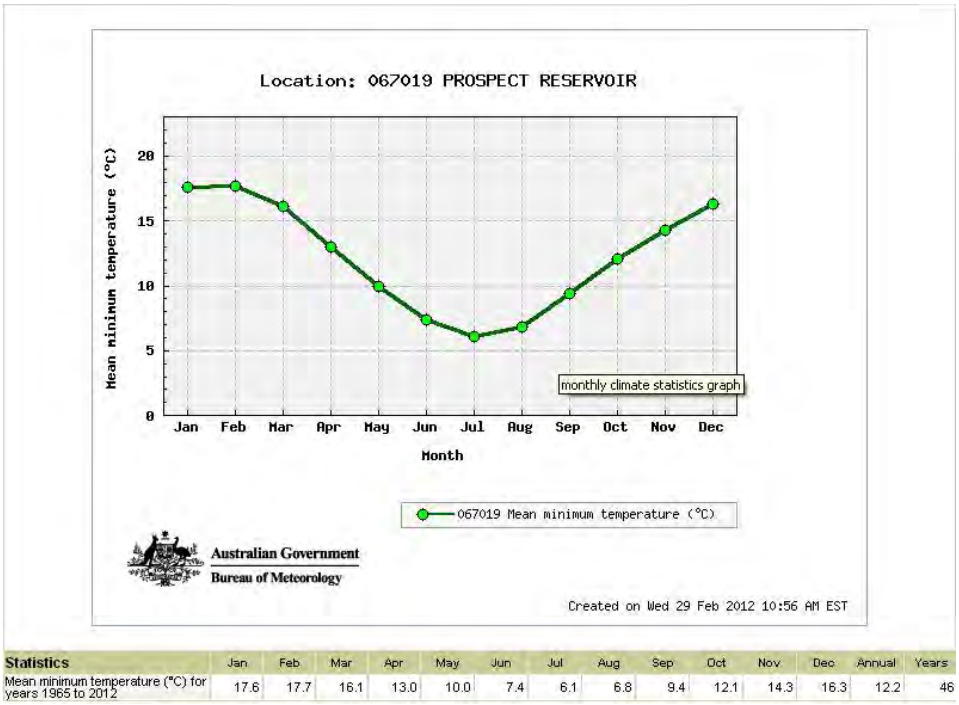
A residential area adjoins the east of the site, north of the Hyland and Gipps Road intersection. Here, residences of Hyland Rd and Munro St back on to the study site. Gipps Road forms the boundary of the study site to the southeast, with light industrial estates located east of that road.

Prospect Reservoir is approximately 1.5 kms to the west of the riparian corridors and the



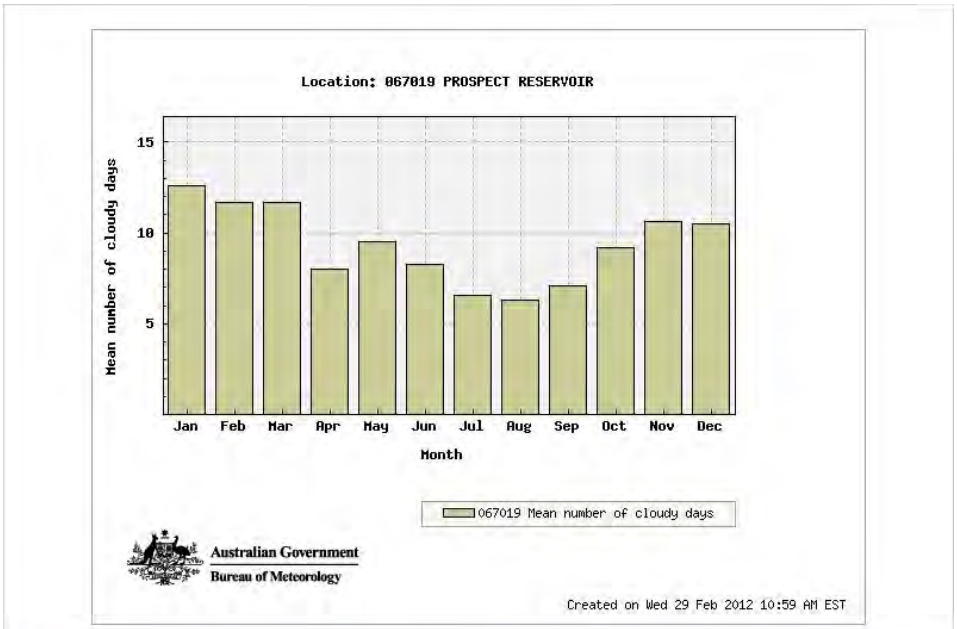
Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Mean maximum temperature (°C) for years 1965 to 2012	28.3	27.9	26.3	23.6	20.3	17.3	16.8	18.7	21.3	23.7	25.4	27.4	23.1	46

Figure 4: Mean monthly maximum temperatures



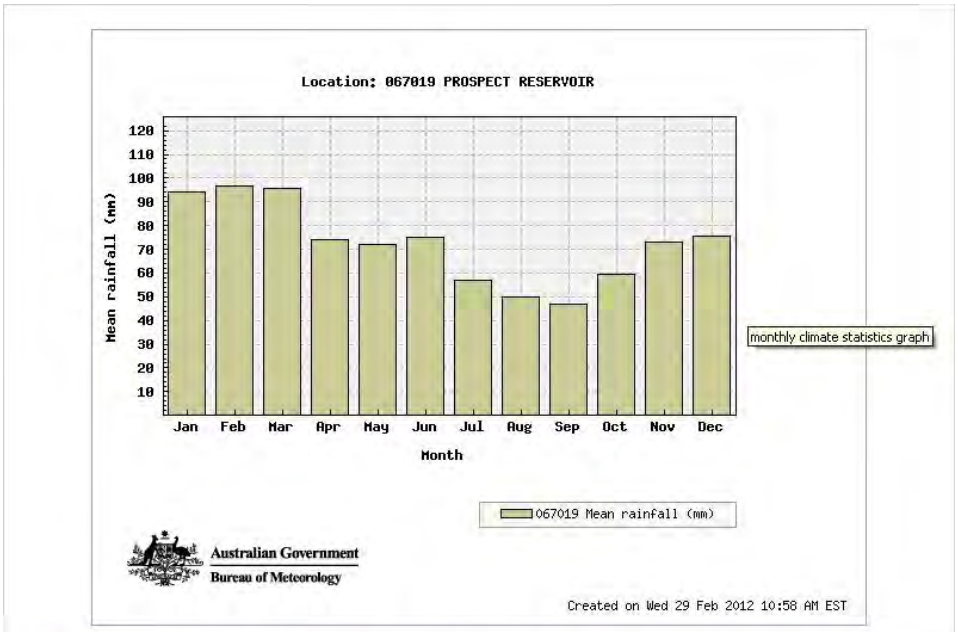
Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Mean minimum temperature (°C) for years 1965 to 2012	17.6	17.7	16.1	13.0	10.0	7.4	6.1	6.8	9.4	12.1	14.3	16.3	12.2	46

Figure 5: Mean monthly minimum temperatures



Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Mean number of cloudy days for years 1968 to 2001	12.6	11.7	11.7	8.0	9.5	8.3	6.6	6.3	7.1	9.2	10.6	10.5	112.1	33

Figure 6: Mean monthly number of cloudy days



Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Mean rainfall (mm) for years 1887 to 2012	94.1	96.7	95.6	74.1	72.0	74.9	56.9	50.1	47.1	59.3	73.0	75.5	869.6	125

Figure 7: Mean monthly rainfall.

intervening land is being used for quarrying activities with associated land rehabilitation and re-vegetation. The southern areas between the riparian corridor and Prospect Creek have been developed for active recreation (mainly Australian Rules football) with a small area around the Jack Ferguson pond set aside for passive recreation. Beyond these there is an extension of the cycleway and ultimately Prospect Creek and its associated riparian corridor. Hyland Road runs east-west through the northern half of the study site, whilst the Liverpool-Parramatta Transitway (LPT) and water pipelines transect the southern section of the study area in a similar direction.

2.7 FLOOD MANAGEMENT AND JACK FERGUSON POND WETLAND

Storm flows enter the Jack Ferguson pond through a large culvert under the Liverpool Parramatta Transitway (LPT) adjacent to and west of Gipps Road. The height of the LPT effectively restricts overland flows from entering this wetland.

Figure 8 Jack Ferguson Pond

An embankment has been constructed across Munro Creek immediately upstream of the LPT, which has created an informal shallow wetland on line with Munro Creek and upstream of the LPT. In rainfall events Munro Creek flows over the embankment, through a trash rack and into the large culvert under the LPT. These structures mitigate peak flows in Munro Creek, control sediment loads and gross pollutants before they are discharged into the Jack Ferguson pond and wetland system.

Figure 9 Culvert beneath LPT and upstream embankment across Munro Creek

The outlet from the Jack Ferguson pond is controlled by a weir and low flow pipeline, set at the static water level of the wetland, which discharges low flows directly to Prospect Creek to the north of the main Australian Rules playing field. Flows in excess of the capacity of the low flow pipeline are temporarily detained above the static water level, within a shallow extended detention volume. Inflows to the wetland, in excess of its detention capacity, discharge through the adjacent picnic areas and are directed southerly along an overland flowpath parallel to Gipps Road as far as Prospect Creek.

Figure 10 Jack Ferguson Pond Outlet Weir Control

The small storage volume, available within the Jack Ferguson pond, provides very little functionality for peak flow or flood management. Its main purpose is to protect infrastructure within Jack Ferguson Reserve from regular inundation and to harvest stormwater for reuse as an irrigation resource for the playing fields.

Figure 11 Overland Flowpath through picnic area beneath which is the underground water storage vault

Figure 12 Descriptive signage for the water harvesting and reuse scheme

2.8 WETLAND INFRASTRUCTURE

The following information relevant to Jack Ferguson pond wetland has been extrapolated from water balance calculations for the stormwater harvesting and associated reuse within the Gipps Road Sporting Complex.

- Surface area: 0.27 ha.
- Storage volume: 2.2 ML.
- Approximate average depth: 0.8 m.
- Irrigation area: 22,000 m^2
- Toilet usage: 864 L/day on weekends and 324 L/day during the week.
- Total storage volume available for irrigation purposes: 106 m^3

Figure 13 Above ground reuse storage tanks in Jack Ferguson Park

The current top water level (TWL) in the wetland is 28.2m AHD. A proposal to increase the area to be irrigated from the wetland has been suggested and investigations by HCC have proposed raising the TWL in the wetland to 29.5 AHD. This would be achieved by increasing the height of the weir in the existing wetland and flooding of a small section of the picnic area immediately to the south of the wetland.

A large underground vault, within the picnic area, is connected to the wetland and acts as a pump well and buffer storage for the reuse system. Water stored within the underground vault is pumped to 4 large concrete tanks which temporarily store the harvested water prior to it being used to irrigate the playing fields.

3 PLANNING CONTEXT

The following state and local government strategies, policies and pieces of state and national legislation are influential in the management of Hyland Road Park wetlands and riparian corridor.

3.1 LOCAL GOVERNMENT ACT 1993

Under the *Local Government Act, 1993* Holroyd City Council is required to prepare a Plan of Management (PoM) for community land. The Act incorporates legislative requirements, identifies land categories, promotes community participation and active involvement in the decision making process and maintains process transparency. The *Local Government (General) Regulation, 2005* provides the framework for the management of Council owned land.

The PoM has been prepared in accordance with the requirements for specific Plans of Management detailed in Section 36 of the *Local Government Act, 1993* and listed in Section 1.3 in Table 1.

3.2 ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979

The *Environmental Planning and Assessment Act, 1979 (EP&A Act)* establishes the statutory planning framework for environmental and land use planning in NSW. This is achieved through State Environmental Planning Policies (SEPPs), and Local Environmental Plans (LEPs) collectively known as Environmental Planning Instruments (EPIs). The EP&A Act allows EPIs to be made to guide the development process and to regulate competing land uses; it also sets out processes for approving structures and works.

3.3 THE NSW WETLANDS MANAGEMENT POLICY ACTION PLAN 2000/2003

This action plan (Department of Land and Water Conservation 2000) was developed by the State Wetlands Action Group to guide implementation of the NSW Wetlands Management Policy. It recognises that the majority of NSW's 4.5 million hectares of wetlands are located on private property and aims to resource and involve the community in wetland rehabilitation.

The action plan sets out four key strategies and associated actions for the NSW State Wetland Advisory Committee to promote the implementation of the policy. These strategies are:

- development of guidelines for preparing local wetland plans of management;
- development of guidelines for rehabilitation as well as compensatory guidelines for situations where social and economic imperatives require wetlands be destroyed;
- consideration of wetlands in the NSW Water and Vegetation reforms; and
- administration of the NSW Wetland Action Grants Program.

3.4 NSW INVASIVE SPECIES PLAN 2008-2015

The NSW Invasive Species Plan was developed through extensive consultation with a wide range of stakeholders. The NSW Invasive Species Plan aims to prevent new incursions, contain existing populations and adaptively manage widespread species. The plan aims to foster a cooperative culture where all relevant parties contribute with the aim of minimising the impacts of invasive species in NSW (Department of Primary Industries DPI 2008).

The NSW Invasive Species Plan identifies four goals:

- exclude – prevent the establishment of new invasive species;
- eradicate or contain – eliminate, or prevent the spread of new invasive species;

- effectively manage – reduce the impacts of widespread invasive species; and
- capacity building – ensure NSW has the ability and commitment to manage invasive species.

These goals aim to deliver specific measurable outcomes and actions that complement the NSW targets for natural resource management as identified in the NSW State Plan. The Plan's principles address current planning processes, efficacy and ethical issues, and is based on current commitments by the NSW Government and investment by a wide range of other stakeholders (DPI 2008).

3.5 THREATENED SPECIES PRIORITY ACTION STATEMENT

The Threatened Species Priorities Action Statement (PAS) (DECC 2007) outlines the broad strategies and detailed priority actions to be undertaken in NSW to promote the recovery of threatened species, population and ecological communities; and manage key threatening processes.

The primary objectives of the statement are to:

- move as many species as possible from threatened to non-threatened conservation status;
- abate or eliminate the impacts of key threatening processes (KTPs);
- provide a comprehensive and strategic approach to threatened species recovery, by making a list of strategies and prioritised actions;
- involve stakeholders, including managers and decision makers at all levels, in working together to implement PAS actions.

The Hyland Road Park wetlands and riparian corridor contains a number of biodiversity assets which are listed under the NSW Threatened Species Conservation Act 1995, subject to strategies and actions identified in the PAS. These include Endangered Ecological Communities and habitat suitable for threatened species outlined in Section 5. A variety of weeds present in the corridor have been identified as part of key threatening processes listed under schedule 3 of the TSC Act 1995 that would also be subject to actions identified in the PAS.

3.6 A WETLAND PRIORITISATION TECHNIQUE FOR THE SYDNEY METRO CATCHMENT MANAGEMENT AUTHORITY (SMCMA) AREA

The above report was prepared as part of the Sydney Metropolitan Catchment Management Authority (SMCMA) Wetland Management Strategy (Stage 1) (Schaeper et al 2007). The report:

- compiled existing mapping data to identify the extent of wetlands in the SMCMA region;
- remapped wetlands that are listed in the Directory of Important Wetlands in Australia (DIWA);
- developed a wetland rehabilitation prioritisation technique, and;
- assessed the condition of the eight DIWA wetlands that occur in the SMCMA region.

A desktop wetland prioritisation technique was developed to prioritise wetlands for rehabilitation. The technique considers;

- wetland values and threats;
- the representation of the range of wetland types in Sydney;
- rehabilitation project development matters; and
- consideration of the feasibility of proposed projects.

Wetlands were assessed for their values and threats to produce a ranking of high, medium or low. Although this prioritisation technique is suitable to assess wetland condition, this assessment relied on the existence of information such as exists in a plan of management (PoM). In 2009, there were approximately 30 PoM's for wetlands within the SMCMA area.

It was determined that an alternate but complementary process was required to assess many more of the wetlands in SMCMA'S area of operation using other available GIS data. Therefore a GIS database was developed and completed in 2011 and assessed 226 wetlands using the initial prioritisation method of assessing values and threats to produce a ranking of high, medium or low (Ecological 2011).

The appendices of the initial prioritisation that summarise threats, values and scoring templates, as well as the technical report for the Wetlands GIS Prioritisation, are now available on the SMCMA website.

3.7 WEED MANAGEMENT STRATEGY FOR THE SYDNEY METROPOLITAN CMA REGION 2007-2011

The Weed Management Strategy for the SMCMA aims to enhance and build on what is already being done by providing guidelines and recommending actions to improve allocation of resources, education and coordination of on ground work between 2007 and 2011. Many of the recommended actions have been identified by Council staff, state agency staff, volunteers and professional bush regenerators who were involved in the consultation and development phases of this strategy (SMCMA 2007).

The Strategy acknowledges that effective and long-term weed management by Councils, agencies and landholders does not consist only of removing weeds. The Strategy recommends:

- a review of the weed management priorities across the SMCMA region;
- directing funding and resource allocation toward the higher priorities; and
- coordinating on ground work across land management boundaries and according to the available resources and priorities.

3.8 GEORGES RIVER REGIONAL ENVIRONMENTAL PLAN

The Georges River Regional Environmental Plan (REP) (Department of Urban Affairs and Planning 1999) recognises activities undertaken on land in the catchment can adversely impact the catchment (and wetlands within it). The REP influences the land use, environmental planning and management decisions taken when land within the wider Georges River catchment is affected. The REP is to be considered in the planning and approval of development in the catchment.

The broad aims of the REP are:

- maintain and improve water quality and river flows in the Georges River and its tributaries;
- protect and enhance the environmental quality of the catchment for the benefit of all users; and
- ensure consistency in the delivery of Ecologically Sustainable Development when assessing development applications.

The REP notes the following objectives:

- preservation and protection of significant environments (including mangroves, saltmarsh and seagrass), bushland and open space corridors by identification of environmentally sensitive areas and providing for appropriate land use planning and development controls;
- preservation, enhancement and protection of estuarine ecosystems;
- to ensure development is consistent with the aims of the REP;
- to identify land uses with potentially adverse environmental impacts;
- to conserve, manage and improve the aquatic environment by providing controls to reduce pollution entering the watercourses; and
- to protect the safety and well-being of the local and regional community by improving water quality and river flows for health and recreation.

A range of planning principles are highlighted in the REP including 9(13) wetlands. The REP indicates:

- Wetlands must be protected through the application of consistent land use and management decisions that take into account the potential impact of surrounding land uses, incorporate measures to mitigate adverse effects and are in accordance with the NSW Wetlands Management Policy. Wetlands must also be protected by requiring adequate provisions where clearing, construction of a levee, draining or landscaping is to be undertaken.

3.9 THE GEORGES RIVER COMBINED COUNCILS COMMITTEE

Although not strictly part of the planning context for Hyland Road Park, the Georges River Combined Council's Committee (GRCCC) is an important body that aims to

"advocate for the protection, conservation and enhancement of the health of the Georges River, by developing programs and partnerships, and by lobbying government organisations and other stakeholders."

The GRCCC was formed in 1979 and consists of nine local council, as well as agencies and community representatives in the Georges River Catchment. The GRCCC was revamped in 2008 following a report commissioned by the Sydney Metropolitan CMA to recommend an organisational structure and operational plan to better meet current and future demands (GRCCC 2011).

The GRCCC has since 2009 aligned its works program to meet National Resource Management objectives and has collectively brought over $8 million worth of funding and in kind value to Councils within the catchment (GRCCC 2011).

The Georges River Catchment covers an area of 960 square kilometres and is one of the most highly urbanized catchments in Australia with over 1 million residents. Hyland Road Park wetlands and riparian corridor is part of the Prospect Creek catchment which is a tributary of the Georges River.

3.10 IMPROVING PROSPECT CREEK STRATEGIC MANAGEMENT PLAN

Prospect Creek is a tributary of the Georges River and is located in the mid Georges River sub catchment (Sydney Metropolitan CMA undated). The Improving Prospect Creek Project was established in 2008 in response to growing community concern regarding the poor environmental state of Prospect Creek and its associated riparian corridor.

The Plan was developed to provide a strategic framework for the management of Prospect Creek across the extent of the jurisdictional boundaries of Holroyd, Fairfield and Bankstown LGAs so that ecological and social values within the Prospect Creek riparian corridor maybe be enhanced.

Actions included in the rehabilitation plan section of the management plan include:

- stormwater quality improvement;
- streambank rehabilitation;
- revegetation;
- weed control;
- threatened species monitoring and management; and
- control and management of introduced animals.

The Prospect Creek riparian corridor adjoins the south and west of the present study site. The Hyland Road Park wetlands and riparian corridor is a tributary of Prospect Creek. Prospect Creek is a tributary of the Georges River.

3.11 LIVING HOLROYD COMMUNITY STRATEGIC PLAN

Under the *Local Government Amendment (Planning and Reporting) Act, 2009* a new integrated planning and reporting framework was developed to:

- improve integration of various statutory planning and reporting processes undertaken by councils as required by the

Local Government Act 1993 and the Department of Premier and Cabinet's guidelines and the *Environmental Planning and Assessment Act 1979;*

- strengthen councils' strategic focus;
- streamline reporting processes; and
- ensure that the *Local Government Act, 1993* and *the Integrated Planning and Reporting Guidelines* support a strategic and integrated approach to planning and reporting by local councils (Division of Local Government 2010).

The Living Holroyd Program establishes plans to outline the long term vision for the future in partnership with the community. These plans include:

- The Community Strategic Plan (HCC 2011) which covers the next 20 years identifying the Holroyd community vision for the future;
- A four year Delivery Program detailing the strategies Council will use to deliver the outcomes of the Community Strategic Plan;
- an Annual Operation Plan outlining the delivery program for the next 12 months and the resources required.

The Community Strategic plan identifies five directions linked to the NSW State Plan:

- Active Holroyd;
- Growing Holroyd;
- Balanced Holroyd;
- Connected Holroyd;
- Dynamic Holroyd.

Under the Balanced Holroyd direction a key community outcome is that:

"*My city values its natural environment*"

Relevant strategies under this outcome include:

- Preserving and enhancing natural assets;
- Providing access to open space and bushland; and
- Delivery of community education programs on environmentally sustainable initiatives.

3.12 HOLROYD CITY COUNCIL LEP 1991

The Holroyd Local Environmental Plan (LEP) 1991 is the EPI through which Council controls development throughout its Local Government Area (LGA). It divides land into different zones and, among other things, details the activities that can be carried out within each zone and those activities which are prohibited. See section 2.3 of this report for zoning details for the subject area.

3.13 HOLROYD CITY COUNCIL DRAFT LEP 2012

The Holroyd LEP 2012 was adopted by Holroyd City Council on the 10th April 2012 and is currently being considered for gazettal by the NSW Department of Planning and Infrastructure. Once gazetted the 2012 LEP will be the EPI through which Council controls development. See section 2.3 of this report for zoning details for the subject area.

3.14 HOLROYD OPEN SPACE AND RECREATION STRATGEY

The Holroyd Open Space and Recreation Strategy was prepared by Recreation Planning Associates (2006) for HCC. It updated the 1998 Open Space Strategy to reflect population and social changes in the Holroyd LGA and provides guidance for future open space and recreation planning and expenditure in Holroyd LGA. The report prepared forecasts for future demands for open space, set out the strategic framework and an action plan with strategies and actions.

3.15 HOLROYD LANDSCAPE MASTERPLAN

The Holroyd Landscape Masterplan prepared by EDAW (1995) recognised the need to bring together Council's tree preservation order, street tree planning policy and development

control policies. The objectives of the plan were to:

- Determine an appropriate landscape character for the City of Holroyd;
- Protect and preserve Holroyd's existing tree stock and natural areas;
- Maintain and enhance the tree canopy throughout the City of Holroyd;
- Foster community ownership and support for implementing the Landscape Master Plan.

The master plan process included community consultation, an inventory of trees, development of a landscape structure plan to provide a basis for determining landscape treatments throughout the city, landscape guidelines, an implementation program, plant matrices and a landscape code.

3.16 HOLROYD SECTION 94 CONTRIBUTIONS PLAN OPEN SPACE AND RECREATION

This plan adopted by HCC in 1998 enabled HCC to require a contribution from developers toward the provision, extension or augmentation of open space and recreation facilities required as a consequence of development (HCC 1998). The plan covered acquisition of land for and development and embellishment of public open space and public recreation facilities for: local open space; district open space; regional open space; and extensions to existing open spaces.

3.17 GIPPS ROAD AND HYLAND ROAD PARKS DRAFT PLAN OF MANAGEMENT AND MASTERPLAN

This draft plan of management (PoM) prepared by Environmental Partnerships NSW (2010) accompanies the draft Masterplan for the broader:

- Hyland Road 'Arboretum' Bushland Reserve (north of Hyland Road to Lower Prospect canal Reserve and Grey Box Reserve);
- Hyland Road Park (south of Hyland Road to the Transitway); and
- Gipps Road Park (sporting fields).

The plan was prepared under the Local Government Act 1993 and presents the proposed development of formal sports facilities on the western edge of the Hyland Road Park and the further development of Gipps Road Park.

Of relevance are the recommendations in the report relating to landscape improvements these include:

- Regeneration of remnant vegetation along creeks heavily impacted by weeds;
- Native tree planting works around the site to improve climatic conditions;
- Construction of a formal pathway allowing access to all sporting recreation and natural areas in the three parks;
- Mulching under tree plantings to reduce mowing;
- Planting of local indigenous grasses beneath trees;
- Compensatory tree planting for trees removed for sports field development;
- Use of locally indigenous species from Cumberland Plain Woodland for planting;
- Upgrade of existing rubbish bins and inclusion of recycling bins; and
- Extension of the Jack Ferguson pond retention basin.

At the time of preparation of this Plan of Management, the Gipps Road and Hyland Parks Draft Plan of Management and Masterplan had not been adopted by Council.

4 SITE HYDROLOGY AND HYDRAULICS

4.1 CATCHMENT DESCRIPTION

The Prospect Hill, at 120m AHD, represents the northwestern watershed for Munro Creek. Local relief throughout the remainder of the catchment ranges between RL 40 and RL 60 (approximately).

The total catchment area draining to the Jack Ferguson pond is 115.5 ha with an impervious fraction of 0.4. Interrogation of the aerial photography has determined that the western and southern portions of the catchment is essentially pervious (playing fields, grassland and bushland), whilst the northern and eastern portions of the catchment have been developed (residential, commercial and industrial). The catchment has been mapped along with stormwater infrastructure and is presented in Figure 14.

4.2 WETLAND HYDROLOGY

A coarse hydrological model was constructed for the catchment upstream of the Jack Ferguson pond. Sub-catchment areas were estimated from a HCC base catchment plan and estimations of sub-catchment slopes and impervious to pervious area relationships were extrapolated from aerial photography. No allowances were made for existing formal drainage systems nor for any attenuation afforded by the road crossings. Consequently the following results can only be described as providing an indicative relationship between rainfall and runoff and should be used for planning purposes only and not as a basis for making engineering decisions.

4.3 FLOW REGIME

Munro Creek is centrally located within the catchment and its location and form appears to have been highly modified as a consequence of the water supply pipeline, quarrying, landfilling activities and the construction of the Gipps Road Sporting Complex and its associated infrastructure. The channel is deeply incised and constrained by culvert crossings at Hyland Road and the LPT.

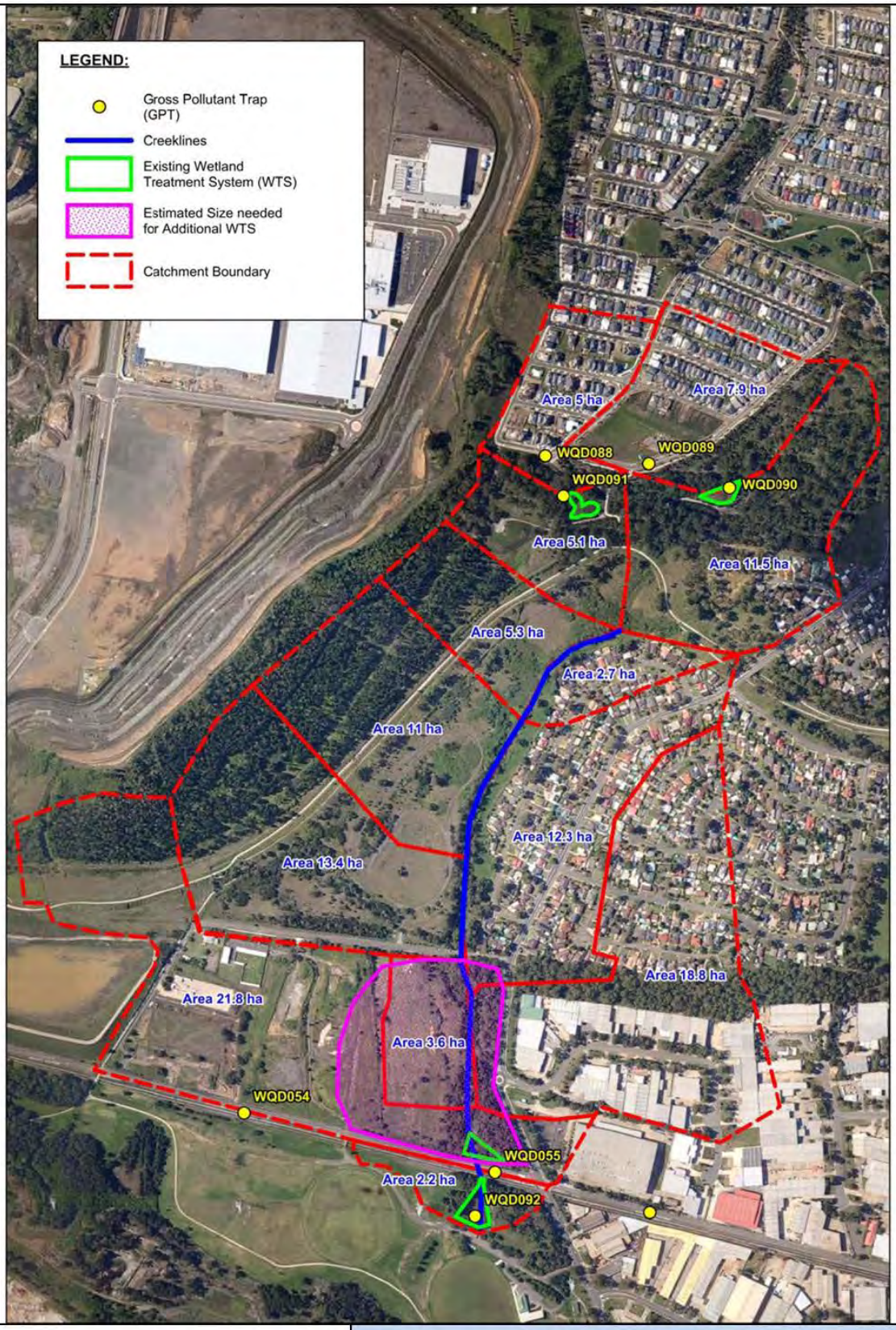
A sediment plume has developed, within the channel profile upstream of the Hyland Road culvert (3 x 900 mm diameter pipes) and a small informal wetland has been created by the formation of an earth embankment upstream of the LPT. Due to the limited information available on: the informal wetland/On Site Detention (OSD) systems upstream of the culverts; the two wetland/OSD systems in Silverthorne Drive, Pemulwuy (WQD090 and WQD091); and the flood attenuation capacity of Jack Ferguson Pond (WQD092), their combined flood mitigation impact has not been included in the estimation of the following peak flows along Munro Creek.

Table 5 Estimated Flow Rates for Critical Locations along Munro Creek for Various Recurrence Intervals

Location	**1-yr (m^3/s)**	**5-yr (m^3/s)**	**20-yr (m^3/s)**	**100-yr (m^3/s)**
Hyland Road	6	11	15	19
Transitway	11	20	26	33
Jack Ferguson Pond	11	20	27	34

To better understand the nature of the flow regime along Munro Creek it is recommended that a comprehensive flood modelling exercise be undertaken.

The Jack Ferguson Pond and wetland system is constructed on line with Munro Creek and is connected directly to Prospect Creek via an underground pipes drainage line. The entry of to this drainage system is controlled by a low



MOLINO STEWART
ENVIRONMENT & NATURAL HAZARDS

Figure 14 Catchment Map (created by J Wyndham Prince). For further information on Infrastructure Devices see Chapter 4.6.3

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weir and riffle zone immediately upstream of the inlet headwall.

Stormwater entering the wetland, in excess of its available storage capacity, is diverted to the south into a depressed overland flowpath through the adjacent recreation area, which runs parallel to Gipps Road as far as Prospect Creek. The still conditions of the pond have provided an ideal habitat for submersed plants, which provide some water quality benefit whilst floating plants such as Duckweed, *Azolla* spp. and filamentous algae, dominate the surface of the pond.

4.4 CLIMATE CHANGE

4.4.1 General

Research conducted by the United Nations Intergovernmental Panel on Climate Change (IPCC) (Solomon *et al*., 2007), has shown that there has been an observable change in global climatic conditions over the last 100 years. Observed changes include an increase in global surface temperature of 0.74^{o}C between 1906 and 2005, and a global sea level rise of 1.8 mm/year on average (a total of 0.08m) between 1961 and 2003. Solomon *et al.* (2007) also found long term changes in precipitation for a number of continents.

The effects of climate change are also predicted to result in a change in average and seasonal rainfall patterns, including flood producing rainfall events. These changes have the potential to increase the frequency and severity of flooding. However, there is still much uncertainty about the specific nature of such changes on a local basis. The NSW Office of Environment and Heritage is working towards refining the climate models to increase the confidence in climate change projections for NSW and the Sydney metropolitan region (Department of Environment, Climate Change and Water DECCW, 2010/171).

4.4.2 Hyland Road Park Wetland

The Sydney Metropolitan Catchment Management Authority, in its recent literature review of *"Impacts of Climate Change on Urban Infrastructure in Metropolitan Sydney"* (SMCMA, 2012) has projected that rainfall intensities are likely to increase in the Sydney region by approximately 15% and run off depth in summer and autumn are projected to increase by approximately 25% by 2030 (DECCW 2010/171).

Based on these projections the parkland surrounding the Jack Ferguson pond can be expected to be inundated more often with overflows through the park to Prospect Creek becoming more frequent, especially in summer. Further evaporation is expected to increase; winter rainfall is expected to decrease while the peaks and troughs in seasonal rainfall patterns are expected to become more pronounced.

The projected changes to rainfall patterns, rainfall intensities and runoff volumes are expected to greatly reduce the sustainability of stormwater harvesting and reuse schemes. These projected changes will be especially noticeable where the existing harvesting and reuse schemes have not factored into their calculations redundant storage volume and/or projected increases to evapotranspiration rates of up to 20% during spring and summer (DECCW 2010/171).

4.5 WATER QUALITY

An assessment of the existing water quality with respect to Gross Pollutants, Suspended Solids, Total Phosphorus and Total Nitrogen has been undertaken using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC). Estimations of pathogen concentrations have been based on the generic information contained in:

- the CRCCH Technical Report 04/8 "Stormwater Flow and Quality;
- the Effectiveness of Non-Proprietary Treatment Measures- A Review and Gap Analysis" (Department of Environment and Conservation DEC. 2004);
- DEC 2006/137 "Managing Urban Stormwater: Harvesting and Reuse" (April 2006);
- NWQMS 23 "Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 2)

Stormwater Harvesting and Reuse" (July 2009); and

- NHMRC "Guidelines for Managing Risks in Recreational Water" (Feb. 2008).

4.5.1 Diffuse Pollution

Diffuse pollution refers to those pollutants that are generated throughout a catchment and do not have one specific point of origin or discharge. These are the pollutants commonly found in stormwater.

Pathogens in stormwater, especially if it is to be reused to irrigate active recreational areas, are of particular concern with regard to public health and safety. The following paraphrased stormwater quality criteria have been determined by DEC 2006/137 for the management of public risks associated with the reuse of harvested stormwater.

- Level 1 – non-potable residential uses:
  Escherichia coli < 1 cfu/100ml;
  Turbidity ≤ 2 NTU;
  pH 6.5-8.5
  1 mg/L Cl_2
- Level 2 – spray or drip irrigation with no access controls:
  Escherichia coli < 10 cfu/100ml;
  Turbidity ≤ 2 NTU;
  pH 6.5-8.5
  1 mg/L Cl_2
- Level 3 – spray or drip irrigation with controlled access:
  Escherichia coli < 1000 cfu/100ml;
  pH 6.5-8.5

NWQMS 23 "Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 2) Stormwater Harvesting and Reuse" (July 2009) has identified that the mean concentration of *Escherichia coli* in "untreated sewered urban catchments within Sydney" is 35,961 cfu/100mL. Consequently any harvested stormwater must be subjected to disinfection before it is reused. The ability of constructed wetland treatment systems to remove *Escherichia coli* based on the length of time that the harvested stormwater is stored before it is reused, and is estimated to be less than 60%. Turbidity levels influence the effectiveness of treatment technologies, especially Ultra Violet radiation (UV), and DEC 2006/137 recommends the following pre-disinfection turbidity levels for the successful implementation of various disinfection technologies:

- < 10 NTU for chlorination and microfiltration;
- < 5 NTU for ozone and UV;
- < 2 NTU for any method where the reuse application demands a significant reduction in pathogens (e.g. *E. coli* less than 10 cfu/100mL).

The basic MUSIC model constructed for the Munro Creek catchment has determined the following pollutant concentrations at the Jack Ferguson Pond:

- Gross Pollutants –0.0mg/L
- Total Suspended Solids -15.0mg/L;
- Total Phosphorus - 0.06mg/L;
- Total Nitrogen - 1.0mg/L.

The dense vegetation and constrictions along the length of Munro Creek will cause the coarse fraction of the suspended solids to drop out and form point bars and/or sediment plumes at various locations within the incised channel.

Figure 15: Visual relationship between 5 NTU (LHS), 50 NTU (centre) and 500 NTU (RHS).

High nutrient levels can lead to the formation of biofilms and algal blooms which may adversely impact on mechanically operated irrigation systems. To limit the occurrence of biofilms and algae DEC 2006/137 recommends that nutrient levels in harvested stormwater be maintained below the following trigger level concentrations:

- Total Phosphorus - 0.05mg/L;

- Total Nitrogen - 5.0mg/L

DECC (2007) has recommended the following values to be used as the default environmental targets for urban stormwater:

- 90% reduction in the average annual gross pollutant (size> 5 mm) load;
- 85% reduction in the average annual total suspended solids load;
- 65% reduction in the average annual total phosphorus load;
- 45% reduction in the average annual total nitrogen load; and
- The post-development duration of flows greater that the 'stream-forming flow' being no greater that 3-5 times the natural duration of this flow.

The following approximate pollutant load reductions provide an indicative estimate of the performance of the existing STMs:

- 100% reduction in the average annual gross pollutant (size> 5 mm) load;
- 15% reduction in the average annual total suspended solids load;
- 15% reduction in the average annual total phosphorus load;
- 5% reduction in the average annual total nitrogen load; and
- No assessment of the post-development duration of flows greater that the 'stream-forming flow' has been undertaken.

An assessment of the catchment, with its current level of development, was undertaken as a preliminary estimate of the additional level of treatment required to achieve the DECC (2007) Environmental Targets. The results of this assessment estimated that an additional constructed wetland of approximately 8 ha in surface area would be required upstream of the LPT. Additional information on storage volumes within the catchment and reuse opportunities is required to adequately assess compliance with the 'stream-forming flow' target.

4.5.2 Point Source Pollution

Point Source pollution is generally associated with the release of pollutants from a single source resulting in a discharge into the creek from a single point. These types of discharges are generally illegal and/or accidental and may be related to a spill incident, illegal connection to the stormwater system or a sewer overflow into the stormwater system.

The opportunity for a point source discharge to occur in Munro Creek catchment is unlikely but is possible due to the industrial nature of much of the catchment. In the event of a point source discharge occurring it is recommended that the water harvesting operation in Jack Ferguson pond be suspended until the incident has been contained, Munro Creek cleaned and all contamination of harvested water has been removed.

4.6 CONCLUSIONS

For additional details regarding each of the following recommendations refer to Chapter 8.

4.6.1 Monitoring

DEC 2006/137 recommends the following guide for monitoring the quality of stormwater which has been harvested for the purposes of reuse in public areas:

- Level 1
  E. coli – 5 days in every week
  Turbidity – continuous
  pH – weekly
  Cl_2 – daily (chlorine disinfection)
- Level 2
  E. coli – weekly
  Turbidity – continuous
  pH – weekly
  Cl_2 – daily (chlorine disinfection)
- Level 3
  E. coli – weekly
  pH – monthly
  Cl_2 – daily (chlorine disinfection)

Monitoring is recommended to be undertaken over the following periods:

- Suspended solids – quarterly;
- Total phosphorus – biannually;
- Total nitrogen – biannually;
- Conductivity – quarterly.

4.6.2 Flood Management and Climate Change

Based on the information provided by HCC and the hydrologic calculations undertaken using a basic RAFTS model for Munro Creek catchment it would appear that the Jack Ferguson pond has limited redundant storage volume to be considered as a flood mitigation structure. Future development should take into consideration the sizing of the culverts, pipelines and drainage structures in light of projected climate change impacts.

A detailed hydrological and hydraulic assessment of the catchment and the existing infrastructure will identify the capacity of the system to accommodate floods and consider climate change impacts.

4.6.3 Stormwater Treatment Measures

HCC has identified the location and description of each of the formal stormwater treatment measures (STMs) within the catchment. The following list is provided as a summary of this information:

- WQD095 – Gipps Rd Sporting Complex reuse system: 4 concrete aboveground storage tanks, 1 underground storage tank and pump well. Responsibility of HCC. (refer to Figure 13)
- WQD092 – Jack Ferguson pond, Gipps Road Sporting Complex: Catchment Area 115 ha, Surface Area 0.27 ha, Storage Volume 2.2 ML. Responsibility of HCC. (refer to Figure 8)
- WQD090 – Silverthorne Drive Constructed Wetland and OSD system No.1, Silverthorne Drive Pemulwuy: Catchment Area 7.8 ha. Responsibility of private organisation.
- Constructed Wetland and OSD system No.2, cnr Driftway & Silverthorne Drive Pemulwuy: Catchment Area 5.1 ha. Responsibility of private organisation.
- WQD091 – Silverthorne Drive
- WQD089 – CleanAll™ (originally designated as a Humegard HG35) GPT No.11, Naying Drive opp. Daruga Ave Pemulwuy: Catchment Area 6.8 ha. Responsibility of private organisation.

Figure 16: WQD090 Constructed Wetland and OSD System

Figure 17: WQD091 Constructed Wetland and OSD System

Figure 18: WQD088 CleansAll™ Gross Pollutant Trap

- WQD088 – CleanAll ™ (originally designated as a Humegard HG27 GPT No.10, opp 124 Driftway Dve Pemulwuy: Catchment Area 4 ha. Responsibility of HCC.

Figure 19: WQD089 CleansAll™ Gross Pollutant Trap

- WAD056 – Transitway CDS GPT No.3 between Gipps & Tarlington Greystanes:

Catchment Area 6.2 ha. Responsibility of RMS.

- WQD055 – Transitway Trash Rack No.2 near Gipps Rd Greystanes: Catchment Area 93.4 ha. Responsibility of RMS.

Figure 20: WQD055 Transitway Trash Rack

- WQD054 – Transitway CDS GPT No.1 near Hyland Rd Greystanes: Catchment Area 31.5 ha. Responsibility of RMS.

A basic MUSIC water quality assessment of the Munro Creek catchment has determined that the current stormwater pollution controls do not achieve the Draft Managing Urban Stormwater - Environmental Targets recommended by the NSW DECC (October 2007). Further to meet these targets the basic MUSIC models, estimates that an additional 8 ha of constructed wetland treatment systems are required upstream of the Liverpool-Parramatta Transitway.

4.6.4 Sediment Removal

At this stage, the majority of these devices have not been handed over to Council. However, experience has shown that they should be cleaned out at least quarterly, and preferably monthly, and that the Munro Creek catchment should generate between 60 and 100 tonnes of sediment per year as well as approximately 15 m^3 per month of gross pollutant and debris.

Each of the STMs should be the subject of a detailed investigation into its capacity to retain the pollutants generated by its contributing catchment and records of the amount of solid and liquid waste removed during each clean must be maintained.

Visual observations along Munro Creek have identified areas where sediment has accumulated and has the potential to reduce the conveyance capacity of the existing creek. These deposition areas should be cleaned out and be subjected detailed hydraulic investigations to prevent any future deposition and/or scouring.

4.6.5 Water Quality

To date water quality monitoring has not been undertaken. However, a basic MUSIC water quality model of the catchment has determined that it is burdened by poor water quality. It is recommended that a comprehensive water quality monitoring strategy be implemented in accordance with the NWQMS “Australian Guidelines for Water Quality Monitoring and Reporting 7“ (2000).

The results from the monitoring should be used to confirm the existing water quality within Munro Creek and form the basis for recommendations to remedy any issues which are preventing the water quality objectives from being achieved.

5 ENVIRONMENTAL VALUES

5.1 EXISTING VEGETATION

In order to document the vegetation communities and fauna habitats present in the Hyland Road Park wetlands and riparian corridor a desktop study and field assessment were undertaken. The desktop study included consideration of existing literature and mapping and interrogation of threatened species databases. The results of the desktop study are presented below.

a) Existing Mapping

The Hyland Road Park wetlands and riparian corridor has been subject to previous mapping in the following reports:

- Cumberland Plain mapping project (NSW NPWS 2002);
- Citywide Bushland Management Plan (Total Earth Care 2007).
- Flora and Fauna Survey Hyland Road Park (North) (James and Barker 2009);
- Bird Habitat Monitoring in Holroyd LGA (Merops Services 2010);
- Bird Habitat Monitoring in Holroyd LGA (Merops Services 2011);
- Draft Native Vegetation of the Sydney Metropolitan Catchment Management Authority (SMCMA 2009).

b) Literature Review

A review of the three key reports that consider environmental values of the Hyland Road Park wetlands and riparian corridor are summarised below.

i) Citywide Bushland Management Plan (Total Earth Care 2007).

This report considered Hyland Road 'Arboretum' Bushland Reserve and Hyland Road Park (south of Hyland Road to the Transitway) as part of a broader city wide bushland management plan prepared for Holroyd City Council. The report mapped the vegetation communities in the two reserves and recognised the presence of the river flat Eucalypt forest on coastal floodplains endangered ecological community (EEC) along the creek line from the Transitway to around 300 metres north of Hyland Road. The report mapped resilience of the vegetation communities and considered the EEC as having high resilience while the wetlands and adjoining disturbed grassland had low to low to moderate resilience.

The report recognised the role of the reserves as part of a locally significant wildlife corridor for western Sydney. The riparian vegetation was recognised as the core of a corridor that currently partially linked to other areas of remnant vegetation including Alpha Road Park to the east and the Boral Quarry site to the north and the Lower Prospect canal cycleway.

Threats to the reserves were identified and included:

- Future development adjoining the reserve and within the creek catchment;
- Stormwater runoff;
- Garden refuse dumping;
- Ongoing weed invasion;
- No vegetation management of the EEC.

Management actions identified included:

- The need for bushland regeneration and restoration project planning including sourcing and managing ongoing funding;
- Noxious weed control;
- Bush regeneration;
- Revegetation;
- Fire as a management tool;
- Stormwater management; and
- Provision of recreational opportunities.

Targets and performance indicators were identified for the management actions.

ii) Flora and Fauna Survey Hyland Road Park (North) (James and Barker 2009)

The report was prepared to document the natural values of Hyland Road 'Arboretum' Bushland Reserve that were subject to environmental restoration works as part of an

Environmental Trust grant. The report also aimed to monitor restoration works and assist with future management of the reserve.

The history of the site was documented along with methodologies used for flora and fauna surveys. The results indicated the presence of two EECs within the alluvial woodland along the creek:

- Swamp oak floodplain forest (SOF EEC); and
- River flat Eucalypt forest EEC.

The report recognised some native plant regeneration occurring post restoration works on the eastern side of the riparian corridor. The extensive infestation of the area by introduced native species related to plantings for the arboretum and infestation by weeds of national significance (WONS) and noxious weeds was also noted along with the occasional persistence of Cumberland Plain Woodland EEC Species.

The swamp wallaby *Wallabia bicolour* was recorded during the fauna survey and was considered testament to the areas value as a wildlife corridor. One regionally significant species *Lespedeza juncea* subsp. *Sericea* was recorded along the riparian corridor in 2009.

The report recognised the Hyland Road 'Arboretum' Bushland Reserve and Hyland Road Park were an important area of connectivity to the surrounding bushland including Prospect Creek, Prospect Reservoir and the Lower Prospect canal cycleway.

Management measures recommended included:

- Protection and regeneration of the EECs in the alluvial woodland (conservation zone) by a managed buffer zone;
- Maintenance of open space connectivity beyond the conservation zone of alluvial woodland with existing corridor links including Hyland Road Park, the Alpha Road Park corridor, Lower Prospect canal, on ex Boral land and Prospect Reservoir;
- Ongoing control of WONS and noxious weeds and establishment of canopy trees and under storey planting and use of strategies to promote seeding of native species in the buffer connectivity zone.

Management recommendations and guidelines were provided under these management measures.

iii) Bird Habitat Monitoring in Holroyd LGA (Merops Services 2010)

This study aimed to document bird patterns in relation to habitat areas within Hyland Road 'Arboretum' Bushland Reserve. The study found the reserve supported a high diversity of bird species and forms an important core habitat area but the distribution of birds in the reserve is spatially highly variable.

The shrub layer of the riparian corridor along the creek was observed to be dominated by a mixture of woody weed species and it was noted that this provides important habitat for birds in the reserve. The riparian corridor was found to have the highest bird species diversity of all areas surveyed across the reserve. The report recommended only very small areas be cleared of weeds at any one time and no new areas be treated until the shrub layer in previously cleared areas has regenerated.

The study concluded that for core habitat areas like the Hyland Road 'Arboretum' Bushland Reserve to provide habitat for viable populations of bush dependent bird species then core areas need to be:

- of sufficient size;
- of high structural complexity;
- linked with corridors of sufficient width not to be significantly edge effected and with good structural complexity.

c) Environment Protection and Biodiversity Conservation Act 1999

An online search on matters of National Environmental Significance (NES) or other matters protected by the commonwealth EPBC Act was undertaken for a five kilometre radius of the site. The online search revealed 28 species listed on the EPBC Act, including:

- 6 birds;
- 2 fish;
- 3 frogs;
- 1 snake;

- 6 mammals (including 2 bats);
- 10 flora species; and
- 12 migratory bird species.

The species are presented in Table 10 and Table 11 in Appendix B (Threatened Flora) and Table 13 Table 14 and Table 15 in Appendix D (Threatened Fauna).

d) Threatened Species Conservation Act 1995

A spatial analysis was undertaken utilising the Office of Environment and Heritage (OEH) NSW Wildlife Atlas of threatened species records in a ten kilometre radius of the site (the locality).

The search revealed a total of 26 fauna species and 21 flora species listed on the TSC Act 1995. The species recorded during the database search and potentially occurring in the Hyland Road Park wetlands and riparian corridor are shown in Appendix B and D.

The study area is also known to support four endangered ecological communities:

- **Cumberland Plain Woodland EEC** listed at the state and national level is present in Jack Ferguson Park in the south eastern corner of the study area;
- **Swamp Oak Floodplain Forest (SOF) EEC** is found along the western creek bank in the southern end of Hyland Road 'Arboretum' Bushland Reserve;
- **River-flat Eucalypt Forest (RFEF) EEC** intergrades with SOF away from the creek in the southern end of Hyland Road 'Arboretum' Bushland Reserve; and
- **Freshwater Wetlands on coastal floodplains EEC** occupies the freshwater wetland upstream of the Liverpool Parramatta Transitway.

Schedule 3 of the TSC Act lists Key threatening processes (KTPs). A threatening process is something that threatens, or could potentially threaten, the survival or evolutionary development of a species, population or ecological community. A threat can be listed under the TSC Act as a 'Key Threatening Process' if it adversely affects threatened species, populations or ecological communities or if it could cause species, populations or ecological communities that are not threatened to become threatened.

Given the presence of EECs and the potential presence of a variety of threatened species listed on the TSC Act a number of KTPs are currently impacting on the Hyland Road wetlands and riparian corridor. These include:

- Invasion of native plant communities by African Olive *Olea europaea* L. subsp. *Cuspidate*;
- Invasion, establishment and spread of *Lantana camara*;
- Invasion of native plant communities by exotic perennial grasses.

5.1.2 Field Assessment

The field assessment included three visits to the study area. The wetland was visited by an ecologist on the 29th July 2011, the weather was cool and sunny reaching 18 degrees Celsius. The study area was visited again on the 10th November 2011 the weather was warm temperature increased from 25 degrees Celsius to around 30 degrees. A shower of rain occurred just prior to our visit at 10am and the conditions were cloudy with high humidity (over 60%). The site was visited again by two ecologists on the 4th April 2012. The weather was fine and sunny reaching 27 degrees Celsius.

The field assessment involved a traverse of the riparian corridor including the wetland and adjacent bushland and parkland adjacent to Munro Street and at Jack Ferguson Reserve.

Vegetation communities were identified on the basis of structure and dominant plant species and their distribution based on previous mapping confirmed. The dominant plant species present were identified, recorded and assessed as indicators for endangered ecological communities (EECs) and for possible threatened plant species occurrence. The density of weeds in various vegetation communities and areas of the riparian corridor and wetland were also noted.

Fauna habitats in the wetland were identified on the basis of vegetation structure and available habitat attributes. Threatened fauna species indicated as potentially present in the

study area on the basis of wildlife database analysis were considered when searching the study area. A diurnal search of the riparian corridor and wetland was undertaken on the above occasions.

Field investigations reveal six vegetation communities and fauna habitats at Hyland Road Park wetlands and riparian corridor. The distribution of the communities is shown on Figure 21 and includes:

- disturbed woodland/ grassland;
- mowed grassland;
- alluvial woodland (includes SOF and RFEF EECs;
- freshwater wetland (includes species consistent with Freshwater wetlands on coastal floodplains EEC);
- Cumberland Plain Woodland; and
- artificial wetland.

a) Disturbed woodland/ grassland

This community occupies the northern end of the Hyland Road 'Arboretum' Bushland Reserve and the western edge of the riparian corridor. This area supports clumps of planted non-local trees and shrubs planted as part of the arboretum project in the late 1980s. Cumberland Plain Woodland tree species occur sparsely and include grey box *Eucalyptus molucanna* and broad-leaved ironbark *Eucalyptus fibrosa.* The understorey includes limited regeneration of local native species including green wattle *Acacia parramattensis* and hickory wattle *Acacia implexa.* A small range of native grasses and herbs persist in the ground cover and the native sedge *Carex longebrachiata* is common.

Patches of woody weeds occur including African olive *Olea europaea* subspecies *cuspidate,* Privet *Ligustrum lucidum, L. sinense*, blackberry *Rubus fruticosus* and lantana *Lantana camara.* Introduced grasses dominate the ground cover and include Chilean needle grass *Nassella neesiana,* Paspalum *paspalum sp.,* kikuyu *Pennisetum clandestinum.*

Erosion and slumping has occurred along the upper sections of Munro Creek particularly in areas where canopy cover is absent and is considered likely to continue without remediation works (Total Earth Care 2007).

b) Mowed grassland/disturbed forest

This community occupies the eastern edge of Munro Street Park. Scattered Eucalypts occur over introduced grassland that is maintained as lawn and mowed regularly. Patches of woody weeds including African olive *Olea europaea* subspecies *cuspidate,* Privet *Ligustrum lucidum, L. sinense*, blackberry *Rubus fruticosus* and lantana *Lantana camara* occur along Munro Creek along with the occasional emergent eucalypt and swamp oak *Casuarina glauca.* Mowed grassland also occupies large areas of the formal recreation areas in Hyland Road Park and the Gipps Road Sporting Complex.

c) Alluvial woodland

This community extends from the southern section of Hyland Road 'Arboretum' Bushland Reserve through to the freshwater wetland at the southern end of Hyland Road Park. It adjoins Munro Creek running through the reserve and includes two EECs.

Swamp oak floodplain forest (SOF) EEC is found along the western creek bank. It occurs in wetter sites and is dominated by swamp oak *Casuarina glauca* the shrub layer is sparse at the northern end of this community, increasing in density further south toward the Transitway (LPT). Common species have been recorded by James and Barker (2009) and include *Melaleuca styphelioides*, *Carex longebrachiata, Centella asiatica, Lomandra longifolia, Commelina cynea* and *juncus usitatus.* Lantana and African olive occur along with a range of introduced ground covers.

The River-flat Eucalypt forest (RFEF) EEC intergrades with SOF away from the creek in the southern end of Hyland Road 'Arboretum' Bushland Reserve. The canopy is dominated by forest red gum *Eucalyptus tereticornis* with smooth bark apples occurring occasionally. The understorey consists of a variety of shrubs, some small trees and a grassy ground cover.

James and Barker (2009) indicate that approximately 44 "characteristic" species of RFEF EEC and 13 characteristic species of SOF EEC are listed in the respective final determinations from Hyland Road 'Arboretum' Bushland Reserve.

The alluvial woodland north of Hyland Road has been subject to bush regeneration and environmental restoration works since 2006 which were partly funded by an Environmental Trust grant.

d) Freshwater wetland

This community extends upstream from the Transitway (LPT) where an earthen embankment armoured with sandstone rocks has greatly reduced the flow through this reach of the creek. It has created a wetland upstream in the creek line which has become colonised by native bullrush *Typha orientalis,* native reed *Phragmites spp, australis,* river clubrush *Schoenoplectus validus* slender knotweed *Persicaria decipiens, Carex longebrachiata.* These species are consistent with the Freshwater Wetlands on coastal floodplains endangered ecological community (EEC) listed on the NSW Threatened Species Conservation Act 1995.

This community is subject to significacnt weed invasion by lantana, coral trees *Erythrina crista-galli* and the giant reed *Arundo donax.* The giant reed increases in dominance and density to the southern downstream end of the wetland where it broadens towards the transit way.

e) Cumberland Plain Woodland

This community occurs in the Jack Ferguson Reserve at the southern end of the riparian corridor. It consists of mature Cumberland Plain Woodland (CPW) canopy species including grey box *Eucalyptus molucanna* with a mown grass understory around a formal picnic area and children's playground.

f) Artificial Wetland

The artificial wetland is formed by the existing wet basin (Jack Ferguson pond). The basin is approximately 1.5 metres deep and supports some emergent, floating and submerged vegetation. Initial inspection indicated a number of native species including ludwigia *Ludwigia peploides* ssp*. montevidens*, *potamogeton* sp and *azolla* sp.

The edges of the west basin support emergent macrophytes including native bullrush *Typha orientalis.* Clumps of lomandra *Lomandra longifolia* also occur on the southern edge along with patches of lantana and privet.

The wet basin is bounded by a pool type fence on the western side in response to concerns by HCC that direct access to the water could present a public health and safety hazard.

g) Fauna Habitat Values

The Hyland Road Park wetlands and riparian corridor supports native and introduced vegetation that provides a diverse range of habitat for native and introduced fauna species. Habitats range from wetland communities along the creek, to woodland communities also associated with the creek to drier woodland and grassland in the northern and western part of the corridor. Extensive weed invasion has reduced habitat values for some native species but created habitat values for other species, in particular small birds which are closely associated with a dense shrub layer often provided by weed species (Merops Service 2008).

A variety of native species have been observed by Council Officers and residents to utilise the area including:

- eastern grey kangaroo *Macropus giganteus;*
- goannas *varanus sp.;*
- eastern water dragon *Physignathus lesueurii lesueurii;*
- yellow tailed black cockatoos *Calyptorhynchus funereu;*
- red-bellied Black Snake *Pseudechis porphyriacus;*
- eastern brown snake *Pseudonaja textilis.*

Recent fauna survey undertaken in the Hyland Road 'Arboretum' Bushland Reserve (James and Barker 2009) revealed the presence of a variety of native and introduced fauna species listed below.

i) Mammals

- swamp wallaby *Wallabia bicolour*;
- rabbit* *Oryctolagus cunniculua*;
- dog* *Canis lupus domesticus*;
- common brushtail possum *Trichosurus vulpecula;*
- house mouse *Mus musculus*;
- rat *Rattus* sp.;
- fox* *Vulpes vulpes;*
- cats* *Felis cattus;*

Reptiles

- blue-tongue skink *Tiliqua scincoides;*
- striped skink *Ctenotus robustus;*
- garden skink *Lampropholis delicate;*
- eastern water skinks *Eulamprus quoyii;*
- weasel skinks *Saproscincus mustelina*;

ii) Frogs

- common eastern froglet *Crinia signifera;*

iii) Invertebrates

- garden snail* *Helix aspersa;*

iv) Birds

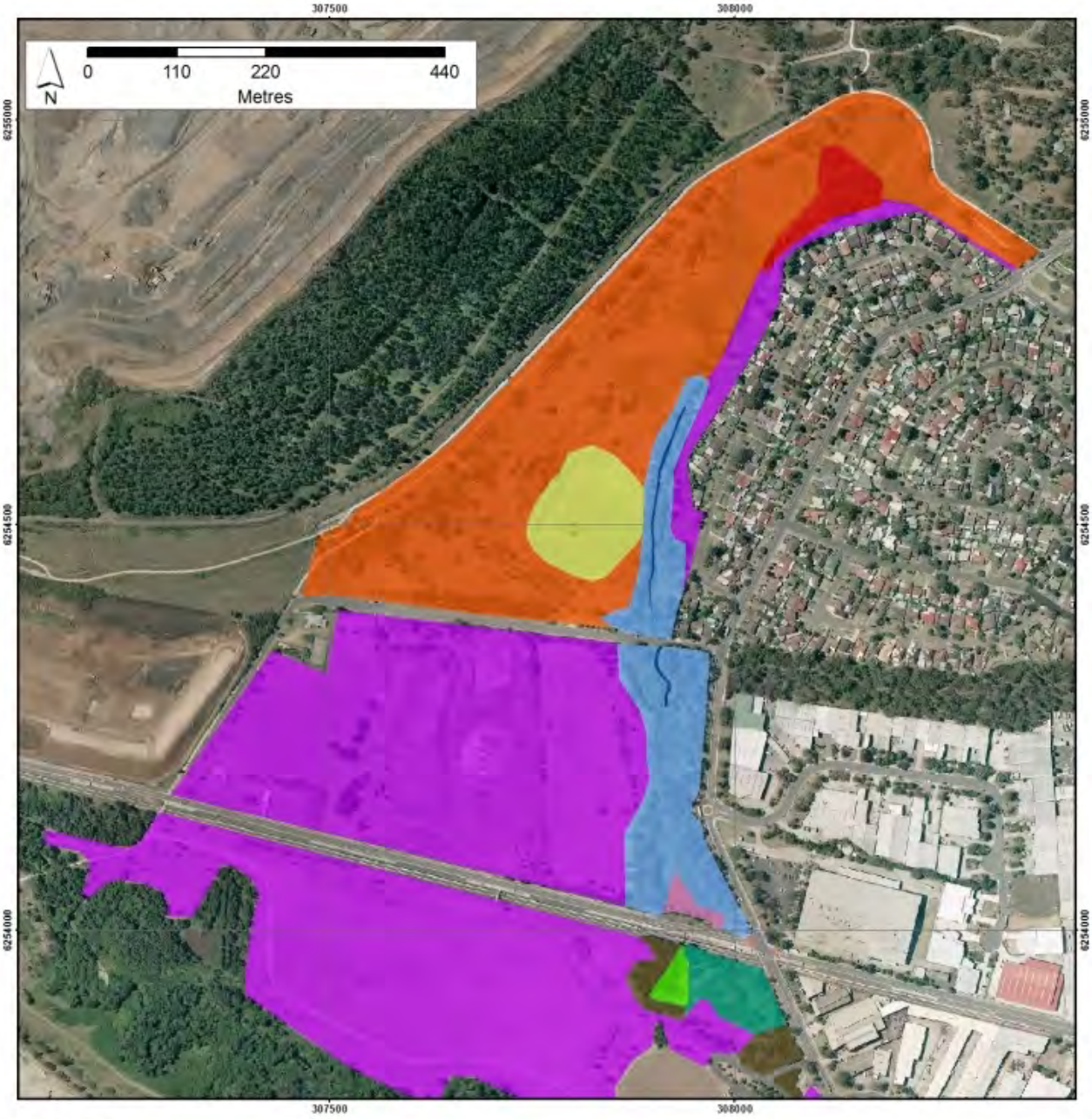
A recent bird survey identified 46 native and 6 introduced bird species within Hyland Road 'Arboretum' Bushland Reserve (Merops Services 2008). These species are listed in Appendix C.

The Hyland Road Park wetlands and riparian corridor are recognised as providing an important local wildlife corridor; this is discussed in Section 5.2.

h) Introduced Species and Noxious Weeds

Recent survey in the Hyland Road 'Arboretum' Bushland Reserve (James and Barker 2009) indicates 105 exotic species have been recorded from this area of the riparian corridor. Over 40 non-local native species have been introduced to the reserve (plantings and naturalized) which include a diverse range of *Acacia* and *Eucalypt* species (James and Barker 2009).

A number of weeds identified as Weeds of National Significance (WONS) and listed as noxious weeds by Holroyd City Council have been recorded from the reserve. These weeds are listed below in Table 6.



Legend

Community

- Alluvial Woodland (Including SOF)
- Artificial Wetland
- Cumberland Plain Woodland
- Disturbed Woodland/Grassland
- Freshwater Wetland
- Landscape Planting
- Mowed Grassland
- Native Grassland
- River Flat Eucalypt Forest
- Woody Weeds

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Figure 21 : Vegetation Communities

Molino Stewart endeavours to ensure that the information provided in this map is correct at the time of publication. Molino Stewart does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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Table 6 Weeds of National Significance and Noxious Weeds

Species	Common Name	Status
Olea europaea L. subsp. *Cuspidate*	African Olive	Class 4 noxious weed HCC
Asparagus asparagoides	Asparagus fern/Bridal creeper	WON
Nassella neesiana	Chilean needle Grass	WON Class 4 noxious weed HCC
Rubus fruticosus.	Blackberry	WON Class 4 noxious weed HCC
Lantana camara	Lantana	WON Class 4 noxious weed HCC
Cestrum parqui	Green Cestrum	Class 3 noxious weed HCC
Hypericum perforatum	St John's wort	Class 4 noxious weed HCC

Legally noxious weeds must be controlled or removed under the *Noxious Weeds Act 1993.* Weeds are declared noxious if they pose a significant problem to human health, the environment, livestock or the agricultural industry. In NSW, local Councils are responsible for controlling weeds in urban and rural areas under their responsibility.

Relevant controls for noxious weeds listed in Table 6 are:

- Class 3 - the plant must be fully and continuously suppressed and destroyed;
- Class 4 - the growth of the plant must be managed in a manner that reduces its numbers spread and incidence and continuously inhibits its reproduction and the plant must not be sold propagated or knowingly distributed.

A number of weeds occur in the Hyland Road Park wetlands and riparian corridor that are not listed as WONS or noxious weeds but their invasion of bushland is identified as a key threatening process (KTPs) under Schedule 3 of the TSC Act 1995. These include:

- Invasion of native plant communities by African Olive *Olea europaea* L. subsp. *Cuspidate*;
- Invasion of native plant communities by exotic perennial grasses (including giant Parramatta grass *Spoprobolus fertillis* present in the riparian corridor).

The Threatened Species Priorities Action Statement (PAS) (DECC 2007) outlines the broad strategies and detailed priority actions to be undertaken in NSW to:

- promote the recovery of threatened species, population and ecological communities; and
- manage key threatening processes.

The PAS is based around 34 recovery and threat abatement strategies. A number are relevant to the Hyland Road Park wetlands and riparian corridor including:

- habitat protection;
- habitat management: feral animal control;
- habitat management: weed control;
- habitat rehabilitation: restoration and rehabilitation; and
- community and landholder liaison, awareness and education.

Table 7 Summary of Vegetation Communities and Fauna Habitat Values

Vegetation Community	**Endangered Ecological Community**	**Biometric Vegetation Type (DEC 2005)**	**Dominant Species**	**Condition**	**Habitat Values**
Freshwater wetland	Yes	Coastal freshwater lagoons of the Sydney Basin and South East Corner	bullrush *Typha orientalis,* native reed *Phragmites australis,* slender knotweed *Persicaria decipiens, Carex longebrachiata* weeds: *Lantana camara* coral trees *Erythrina crista-galli* and giant reed *Arundo donax*	Poor to moderate	Moderate – foraging, shelter and breeding habitat for water fowl and foraging and shelter resources for migratory birds and reptiles and amphibians
Cumberland Plain Woodland	Yes	Grey Box – Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin	grey box *Eucalyptus molucanna*	Moderate	Some foraging habitat for birds and arboreal mammals
Artificial Wetland	No	n/a	Aquatic plants including: *Ludwigia peploides* ssp. *montevidens*, *potamogeton* sp and *azolla* sp. native bullrush *Typha orientalis.* Lomandra *Lomandra longifolia*	Moderate	Moderate – foraging, shelter and breeding habitat for water fowl and foraging and shelter resources for migratory birds and reptiles and amphibians
Open Water	No	n/a	Aquatic plants including: *Ludwigia peploides* ssp. *montevidens*, *potamogeton* sp and *azolla* sp.	Moderate	Moderate water quality variable – water source for a variety of native and introduced species, foraging resources for migratory birds and some bats, breeding habitat for amphibians, habitat for aquatic

Vegetation Community	Endangered Ecological Community	Biometric Vegetation Type (DEC 2005)	Dominant Species	Condition	Habitat Values
					species and invertebrates
Disturbed woodland/grassland	No (occasional species consistent with CPW)	n/a	African olive *Olea europaea* subspecies cuspidate, privet *Ligustrum lucidum, L. sinense*, blackberry *Rubus fruticosus*, lantana *Lantana camara*, Chilean needle grass *Nassella neesiana*, Paspalum *paspalum sp.*, Kikuyu *Pennisetum clandestinum*	Low dominated by weeds	Low to moderate some foraging habitat for birds, buffer value to higher quality habitat closer to creek, corridor values for fauna movement
Introduced shrubland	n/a	n/a	paspalum *paspalum sp.,* Kikuyu *Pennisetum clandestinum*	Low dominated by introduced grasses	Low maintained as mowed grassland
Alluvial Woodland	River-flat Eucalypt Forest (RFEF) EEC	Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin	forest red gum *Eucalyptus tereticornis*	moderate	High foraging and shelter habitat for birds and arboreal mammals, shelter resources for migratory birds and reptiles and amphibians and invertebrates
Alluvial Woodland	Yes Swamp Oak Floodplain Forest (SOF)	Swamp Oak - Prickly Tea-tree - Swamp Paperbark swamp forest on coastal	swamp oak *Casuarina glauca Melaleuca styphelioides, Carex longebrachiata, Centella asiatica, Lomandra longifolia,*	moderate	High foraging and shelter habitat for birds and arboreal mammals, shelter resources for migratory birds and reptiles and amphibians and invertebrates

Vegetation Community	Endangered Ecological Community	Biometric Vegetation Type (DEC 2005)	Dominant Species	Condition	Habitat Values
	EEC	floodplains, Sydney Basin and South East Corner	*Commelina cynea* and *juncus usitatus*. lantana and African olive		

5.2 BUFFER ZONE AND CONNECTIVITY

5.2.1 Connectivity

The Hyland Road Park wetlands and riparian corridor have been recognised as a locally significant wildlife corridor for Western Sydney (Total Earth Care 2007) and as a natural link to other patches of remnant vegetation in the local landscape (James and Barker 2009). The corridor has also been recognised as core habitat for bushland dependent birds that forms part of a series of reserves extending from Prospect Creek Reserve, Jack Ferguson Reserve, Hyland Road Park through Hyland Road 'Arboretum' Bushland Reserve and to Grey Box Reserve in the north (Merops Service 2010).

The rare presence of swamp wallabies in this part of western Sydney is considered clear testimony to the significance of the connectivity between the riparian corridor and surrounding bushland associated with Prospect Creek Reserve, the Lower Prospect Canal Reserve and Prospect Reservoir (James and Barker 2009).

DECC (2008) identified Prospect Reservoir lands as amongst the highest ranking areas of remnant bushland for biodiversity values across the SMCMA area. Biodiversity values of Prospect Reservoir included high fauna diversity, the presence of wetlands, bushland and waterfowl, its role as a drought refuge and the presence of Cumberland Plain species (DECC 2008). The UBBS (NPWS, 1997) suggested establishment of vegetated links between existing vegetated corridors of the HCC LGA such as Prospect Creek Reserve and Lower Prospect Canal Reserve. Hyland Road Park wetlands and riparian corridor is considered to comprise an area of connectivity between Prospect Reservoir (James and Barker 2009) and the Prospect Creek and Lower Prospect Canal Reserves.

5.2.2 Buffer Zone

Buffers of natural vegetation and grassy filter strips can contribute to water quality in wetlands and creeks. Natural vegetation and grassy filter strips can trap around 90 per cent of sediment moving from upslope (DEC 2005a), and buffer strips can also control levels of bacteria in run off (DEC 2005a).

Currently the Hyland Road Park wetlands and riparian corridor supports remnant native vegetation along Munro Creek that is considered a core riparian corridor linking other key local corridors as shown in Figure 22. Wide grassy buffer areas to the core corridor are present to the west ranging from 100 metres in the north to over 300 metres at Hyland Park Road and up to 500 metres in the southern end of the corridor. To the east, the buffer area is much smaller ranging from around 20 metres between the riparian zone and the rear of houses on Munro Street, around 40 metres in the central corridor to Gipps Road (forested buffer) and over 100 metres in the area around Jack Ferguson Reserve.

The condition of the buffer zone is highly variable. In the north of the corridor in Hyland Road 'Arboretum' Bushland Reserve the buffer contains extensive and dense patches of weed infestation which include weeds of national significance (WONS) and noxious weeds. The buffer does contain some patches of native grasses but is also heavily infested with Chilean needle grass (WONS) and with introduced native species.

On the eastern side of the corridor in Munro Street Park the buffer zone consists of mown grassland with occasional canopy trees. The riparian zone is heavily infested with weeds including lantana, privet and blackberry. Further south along the corridor the buffer zone supports alluvial woodland that extends to Gipps Road and in Jack Ferguson Reserve the buffer consists of a formal park area supporting Cumberland Plain Woodland canopy species and mown grassland.

The draft masterplan which covers Hyland Road Park and Gipps Road Sporting Complex indicates that the western edge of Hyland Road Park will be developed into formal sports fields. The proposed developments will

significantly reduce the western buffer areas the wetland and riparian corridor.

5.3 FISH PASSAGE ASSESSMENT

A study undertaken by the NSW Department of Primary Industries (Fisheries) indicated that fish passage in the Holroyd local government area was extremely limited and was restricted to intermittent and perennial streams (e.g. Prospect Creek) (Nichols & McGirr 2005). Munro Creek is ephemeral by nature and fish passage is constrained through the use of a pipe connection in the final reach to Prospect Creek, at the culverts under the Transitway, at the embankment on the informal wetland, at the culverts under Hyland Road and at the cycleway at the top of the catchment. Anecdotal information suggests that eels (species unknown) exist within Munro Creek.

Legend

Wildlife_Corridors

Draft Boundary

N

0 250 500 1,000

Metres

MGA56

MOLINO STEWART

ENVIRONMENT & NATURAL HAZARDS

Figure 22: Connectivity

Molino Stewart endeavours to ensure that the information provided in this map is correct at the time of publication. Molino Stewart does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

Date: 02/04/2012 Checked By: C.H Job No: 0487

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6 SOCIAL VALUES

The Hyland Road Park wetlands and riparian corridor study area is located between the suburbs of Greystanes and Pemulwuy in the Holroyd LGA of western Sydney. The Greystanes area was developed as a residential area in the 1950s and 1960s, and includes residential areas to the east of Munro Creek. Pemulwuy has been developed in recent years with the eastern portion of the suburb being largely residential and the western area including warehouses and distribution facilities.

The population of the Greystanes-Pemulwuy area was 21,899 at the 2006 census. Of this number, 151 people identified as Indigenous Australians; 14,314 identified as Australian-born; and 6,424 identified as overseas-born. There were 7,692 total dwellings in this area, the majority of which are detached dwellings.

Hyland Road Park is also adjacent to factories and industrial areas at its eastern edge. At the western side, the Prospect Quarry has been identified as 'Southern Employment Lands', This area was identified in 1999 under State Environmental Planning Policy 59 Central Western Sydney Economic and Employment Area (SEPP 59) which rezoned the Greystanes Estate for urban development including employment generating and residential landuses.

Several sport and recreation facilities are located within or adjacent to Munro Creek. These include the Gipps Road Sporting Complex, Small Bore Rifle Range and Pigeon Club. The Lower Prospect Canal Reserve cycleway forms the northern boundary of the study area. It extends around 7.7 kilometres from Prospect Reservoir to Guildford.

A draft plan of management prepared for the Gipps Road and Hyland Road Parks (Environmental partnerships 2010) included three community meetings that focused on the proposed masterplan of the site and development of formal recreational facilities. The community values identified during the development of the draft plan of management included:

- A multifunction parklands addressing a variety of community needs;
- A flexible parklands catering for both local and district usage with minimal conflict;
- A landscape setting of renewal and ongoing evolution;
- A landscape setting that enhances the quality of active and passive recreational use and optimises the parks role as an urban open space providing 'green relief'.

Issues identified during preparation of the draft PoM included: site facilities; landscape improvements; and maintenance.

6.1 EXISTING AND POTENTIAL USER GROUPS

Hyland Road Park wetlands and riparian corridor is used primarily by local residents, who take advantage of the outdoor space, and the cycleway to the north of the study area and include joggers, cyclists and dog walkers (James and barker 2009).

Response to the newsletter and questionnaire issued during the preparation of this PoM indicates Munro Street Park is used by residents for passive recreation including dog walking. Trail bikes are also known to use the area illegally.

The Jack Ferguson Reserve area supports a playground and barbeques. These attract visitors to the area and a fence between the park and the wet basin provides separation between the wet and dry areas of the park.

The area is also known to experience anti social behaviours, dumping of stolen goods and rubbish dumping (James and Barker 2009). Police searches and helicopter surveillance are considered common (James and Barker 2009).

Existing and potential user groups identified:

- Local residents and the broader community

In the Jack Ferguson Reserve:

- Holroyd-Parramatta Junior Australian Rules Football Club

Community bushland groups from the surrounding area include:

- Grey Box Reserve Bushcare Group:,

- Pendle Hill Creek Bushcare Group
- Alpha Park Bushcare Group

Bushcare group representatives identified the riparian corridor as being an important bushland area for the community. They recalled previous community tree planting events in the area and have memories of the area as an important habitat for wildlife and a safe place for interaction with nature.

Identified ways to improve the riparian corridor included community involvement (the formation of a Bushcare group and the involvement of local schools), maintenance and plantings using Cumberland Plain Woodland species, and improved transport and access.

6.2 VALUE OF HYLAND ROAD PARK TO THE COMMUNITY

The value of the Hyland Road Park wetlands and riparian corridor to the community has been gauged by the responses to a community survey distributed in March 2012.

In summary the park is highly valued by the community as:

- an area with a tranquil bush setting;
- a buffer between suburbia and provision of a country style atmosphere of living;
- a natural bushland area;
- bird habitat;
- a “natural” environment and relatively quiet area;
- a recreation area for children and adults;
- an area promoting the return of natural wildlife and the regeneration of native vegetation;
- an improved outlook and amenity for residents;
- an area for bike riding, walking and exploring.

6.3 COMMUNITY CONSULTATION

6.3.1 Approach

A community consultation program was undertaken as part of this Plan of Management. The objectives of the program were to:

- identify values of Hyland Road wetland and riparian corridor to the community;
- gain an understanding of community attitudes towards the riparian corridor and; their likes and dislikes; and
- provide an opportunity for community members to offer suggestions on how the riparian corridor could be improved.

Involving the community in the preparation of the Plan of Management ensures the plan reflects the needs and concerns of those who have an interest in the future of Hyland Road Park wetlands and riparian corridor.

A number of techniques were used to facilitate communication between the community and the study team during the preparation of the Plan of Management. These included:

- phone interviews with known user groups;
- distribution of a newsletter and questionnaire to the residents of the surrounding residential area of Greystanes;
- day to day contact through the provision of a contact name and email address; and
- a public hearing while the draft plan of management is on exhibition.

The public hearing was held after the preparation of the draft Plan of Management to provide the community with an opportunity to comment on the draft document.

6.3.2 Results

A total of 109 newsletters with surveys were distributed to properties and non-resident landowners around the study area.

A total of 6 responses were received. Residents note the presence of the red-bellied black snake and brown snake throughout the corridor during spring and summer. The

community members were asked to address the following questions in the community:

- what they liked most about the riparian corridor;
- how they thought the riparian corridor could be improved.

Participants were asked to list these things and provide any other comments.

Specific features people liked about the Hyland Road wetland and riparian corridor are listed in Section 6.2.

The residents had clear ideas on how to improve the riparian corridor:

- suggestions for Munro Street Park included the installation of benches or picnic tables or a walking track along the corridor;
- removal of the wire fence at one end of the corridor so residents can walk the entire length;
- control of trail bikes in the park;
- Improved access;
- culling of Myna birds which are perceived to have decreased the variety and numbers of native bird species using the area;
- removing lantana, blackberry, privet and other noxious weeds choking native plants;
- maintenance of the whole area by undertaking weed control and regular mowing, particularly behind the Munro Street properties.

A public hearing was held on the 7th March 2013 at Holroyd Council during the exhibition period of the draft plan of management.

A short presentation on the management plan process and the results of the studies undertaken during the preparation of the plan was provided by Molino Stewart and J Wyndham Prince. A facilitated discussion was then held and the following issues were discussed:

- the number of endangered ecological communities and threatened flora and fauna species present in the study area and the subsequent opportunities for grant funding to undertake management works;
- the high value of the area as a wildlife corridor and the opportunity to classify the park, riparian corridor and wetlands as a wildlife corridor under the NSW Local Government Act and the further opportunities for grant funding this potentially provides;
- the need for an officer within council to be actively applying for grant money and then managing that grant money with examples of other Councils having dedicated grants officers payed from the grant money;
- the need to control weeds for environmental and flood mitigation purposes;
- the high value the community place on the area and the need to manage it in the context of the broader recreational development of the adjacent site and the higher visitor numbers that will bring; and
- the need for disinfection of the water being used to irrigate the Gipps Road sporting fields and the need for ongoing maintenance of stormwater infrastructure.

6.4 INDIGENOUS HERITAGE

The extent and history of agricultural development and landfilling activities in the study area indicate that indigenous cultural heritage values are unlikely to occur. Prospect Hill, located in the suburb of Pemulway in close proximity to Prospect Reservoir is a site of cultural, historical and spiritual significance to Indigenous people. Prospect Hill is listed as an item of State Significance under the NSW Heritage Act 1977.

7 ISSUE ANALYSIS

A list of preliminary management issues are presented below:

- Riparian corridor definition;
- Funding and management;
- Open space maintenance;
- Weed management and bird habitat;
- Wildlife corridor declaration;
- Establishing access, links and boundaries;
- Catchment development and water reuse;
- Community engagement, education and capacity building.

7.1 RIPARIAN CORRIDOR DEFINITION

The purpose of this Plan of Management is to assist Council to precisely define the area of the corridor so that this area is viable and appropriately categorised.

7.1.1 Current Policy

A riparian corridor has been defined by the NSW Office of Water (2010).

"A riparian corridor forms a transition zone between the land, also known as the terrestrial environment, and the river or watercourse or aquatic environment."

The Office of Water (2010) recognises the range of environmental functions riparian corridors perform including:

- Provision of bed and bank stability and reducing channel erosion;
- Protection of water quality by trapping sediment, nutrients and other contaminants;
- Provision of habitat diversity for terrestrial, riparian and aquatic plants and animals;
- Connecting wildlife habitats;
- Conveying floodwaters and controlling the direction of flood flows;
- Providing a buffer between developments and waterways.

Three riparian zones are recommended by the NSW Office of Water (2010) for consideration in determining an appropriate width for a riparian corridor:

- Core riparian zone (CRZ) land contained within and adjacent to the channel, this should include any adjoining remnant native vegetation DIPNR (2004);
- Vegetated buffer (VB) protects the environmental integrity of the CRZ;
- Asset protection zone (APZ) required by the NSW Rural Fire Service to protect assets (buildings houses etc) from potential bushfire damage.

The Office of Water generally defines land within 40 metres of a "river", as defined by the *Water Management Act 2000*, as being "waterfront land" and any works proposed "waterfront" land is subject to a Controlled Activity Approval.

NSW Department of Primary industries (DPI) Fisheries (1999) policy and guidelines on aquatic habitat management indicate as a precautionary approach, foreshore buffer zones of at least 50 metres wide should be established and maintained, with their natural features and vegetation preserved.

7.1.2 Riparian Corridor Values

Riparian corridors have high edge to area ratios resulting in edge effects. Edge effects have been summarised by Rowley et al (1999) and DECCW (2010) and include:

- micro climatic changes including increased drying of soils and consequent changes to vegetation;
- variation in inhabitants and species at edges including decline in fauna species that are sensitive to changes in vegetation along newly created edges;
- increased pest animals;
- weed invasion;
- impacts from adjacent land use;
- noise and movement; and

- increased predation in the vicinity of the land boundary associated with aggressive species in open situations (such as nest predation by ravens and Currawongs).

Maximising the width of corridors has been suggested as a practical way to reduce edge effects (MacDonald 2003). Other measures to reduce edge effects include fencing, management to reduce the 'severity' of the boundary between corridors and surrounding landscapes and the provision of shelter belts on adjacent land (MacDonald 2003).

A previous ecological assessment of the northern area of the riparian corridor identified the establishment of a riparian corridor and buffer area conservation area (James and Barker 2009). This is consistent with current policy, with the NSW Office of Water recommending the identification and protection of a core riparian zone, vegetated buffer and asset protection zone (where applicable) to maintain or improve the shape, stability (or geomorphic form) and ecological functions of a watercourse (NSW Office of Water 2010).

The benefits of forested riparian corridors rather than grassed buffers have been explored in some detail by Shaver (2011). General sizing of forested riparian corridors have been detailed by Shaver (2011) depending on corridor function.

Table 8 General sizing of forested riparian corridors

Function	Distance in metres from top of channel					
	15	30	45	60	75	90
Bank stabilisation						
Aquatic habitat						
Water quality						
Flood mitigation						
Wildlife habitat						

The conservation of a core riparian zone consisting of existing remnant bushland requiring sustained weed removal and bush regeneration is proposed along with a vegetated buffer that will require ongoing revegetation and rehabilitation and consist of clumps of native canopy trees with native or mown grass understorey. The basis of the recommended riparian corridor is discussed below.

7.1.3 The Existing Riparian Corridor

The existing forested area adjoining Munro Creek is variable. On the western edge of the creek in the Hyland Road Arboretum Bushland Reserve the vegetated riparian zone is around 20 metres wide. The western riparian zone is widest at the southern end and tapers off to the north.

On the eastern side of the creek, fronting the rear fences of the residential development along Munro Street, the forested riparian vegetation is narrow and sporadic averaging around 10 metres in width.

The forested riparian zone in Hyland Road Park varies from over 35 metres down to around 20 metres in the central section and widens to 40 metres in the southern section. On the western side the forested riparian zone extends from over 65 metres in the north down to 30 metres in the central area and out to 70 metres in the south.

The southern portion of the corridor in Hyland Road Park will be impacted by the installation of a proposed 330 kW transmission line with a 60 metre wide easement. This area is to be excluded from this PoM. The forested riparian zone is bounded to the east by Gipps Road and human access to this area is restricted by a chain wire fence fronting the road.

At the southern end of the corridor the forested riparian zone is minimal and occurs as canopy trees in Jack Ferguson Reserve and as a single tree layer or clumps of trees adjoining the western edge of Jack Ferguson pond.

7.1.4 Recommendations

The role of the riparian corridor along Munro Creek will include all the functions listed in Table 8. The study area is recognised as a

key wildlife corridor linking Prospect Reservoir, Prospect Creek Reserve and the Lower Prospect Canal Reserve. It will be variable in width reflecting the existing remnant vegetation present along the creek that forms a core conservation zone and an adjoining buffer zone area. Both areas will require ongoing management to address weed infestation while ensuring habitat protection particularly for small woodland birds.

The corridor will be constrained in Munro Street Park where a minimum 6 metre emergency access trail is proposed behind properties. This access trail may be a suitable location for a formal pathway. The core riparian zone will require significant bush regeneration works in this area to reduce levels of weed infestation by WONS and noxious weeds and reduce the operation of KTPs. The buffer zone in Munro Street Park is proposed to support sporadic clumps of canopy plantings with native grass below trees and a mowed grass under storey between tree plantings.

The corridor will benefit from tree planting in some areas to ensure minimum widths are reached and from more formal edge definition in the form of walking trails or paths that will present a boundary and a management edge.

The corridor values will also be increased by establishing a vegetated link with Prospect Creek. This could be achieved by strategic tree planting around car park edges within the Gipps Road Sporting Complex.

The proposed corridor is shown on Figure 23.

7.2 FUNDING AND MANAGEMENT

The Hyland Road Park wetlands and riparian corridor require significant ongoing works to ensure the core objectives detailed in the LG Act 1993 for the management of the various land categories it currently supports can be met. These include:

- Bushland;
- Wetlands;
- Water courses; and
- Parks.

The land categories may also include significant natural feature: wildlife corridor (see Section 7.5). Holroyd City Council provides for maintenance of the study area in its annual budget. The budget allocation is aimed at achieving satisfactory levels for maintenance and facility provision in community land areas.

The current funding allocation for bush regeneration and environmental restoration works is inadequate to meet the core objectives for the management of the proposed land categories in the riparian corridor. The annual budget allocation will require supplementary funding from grants to meet core objectives for management.

Additional and ongoing funding and maintenance resources for weed control, bush regeneration and environmental restoration works are required to protect the ecological values of the EECs present in the riparian corridor; reduce the operation of KTPs; to meet Council's obligation for control of WONS and noxious weeds; and to protect fauna habitats and wildlife corridor functions.

The development of a natural assets register that details the current condition of environmental assets in the LGA and the costs associated with their management and restoration may assist in predicting the required levels of ongoing financial support.

Ongoing examination of potential funding sources including rate levies, state and federal grants, developer contributions and volunteer resources along with specific funding sources identified in this plan of management will be required to ensure adequate and ongoing funds are available for management of this important riparian corridor.

Figure 23: Riparian Corridor

7.3 OPEN SPACE MAINTENANCE

The Hyland Road Park wetlands and riparian corridor supports areas of open space requiring different levels of maintenance. Currently the riparian corridor gives the appearance of vacant land due to lower than optimal maintenance levels and weed infestation. This may exacerbate the area being used for rubbish and garden waste dumping.

The grassed areas in Munro Street Park require mowing between trees and the establishment of no mow areas planted with native grass under existing trees and proposed native tree plantings. The requirements for mowing can vary with season and weather conditions for example the recent wet summer has led to increased growth and the need for additional maintenance. More frequent mowing of this are may be required under certain climatic conditions,

The grass area adjoining the corridor in Hyland Road 'Arboretum' Bushland Reserve supports some native grasses in the Arboretum circle and a variety of weeds that form important habitat for small native birds. Maintenance in this area needs to be undertaken in view of the broader mosaic weed control strategy recommended for this area in Section 7.4 and the no mow zone of native grasses maintained until development occurs.

Hyland Road Park exhibits a defined edge to the forested riparian corridor due to the past filling of the area. Establishment of the edge of the riparian corridor including the core riparian zone and vegetated buffer in this area would restrict maintenance activities including mowing to outside the riparian corridor.

The play equipment in Jack Ferguson Reserve has been proposed for removal and this area changed to nature based recreation supporting a nature trail in the north east of the reserve (Environmental partnerships 2010). No canopy recruitment of the Cumberland Plain Woodland EEC canopy species is occurring in this area. The establishment of native grasses under trees and the establishment of no mow zones immediately below clumps of trees along with some supplementary planting of local provenance plant species would benefit this pocket of critically endangered ecological community listed at the state and national level.

7.4 WEED AND BIRD HABITAT MANAGEMENT

7.4.1 A Mosaic Approach

Bird surveys in Hyland Road 'Arboretum' Bushland Reserve have found over 50 bird species (Merops Services 2010 and 2011). The high overall diversity of bird species indicated the area was an important core habitat area for birds. The highest diversity of species in Hyland Road 'Arboretum' Bushland Reserve was recorded in the forested riparian zone adjoining Munro Creek (Merops Services 2010).

The importance of the weed dominated shrub layer in the riparian corridor to bushland dependent birds was recognised by Merops Service (2010). It was recommended that only small areas of weeds be cleared at a time and a native shrub layer be re-established prior to additional clearing (Merops 2010).

The mosaic method of weed removal and native shrub layer establishment has been successful on the southern edge of Hyland Road 'Arboretum' Bushland Reserve but will require sustained and ongoing bush regeneration and restoration to ensure a high diversity of small native birds persist in the reserve.

7.4.2 Weed and Bushland Management

Weed infestation is severe throughout the Hyland Road Park wetlands and riparian corridor. A detailed bushland regeneration and restoration strategy has been recommended for the study area by Total Earth Care (2007). This strategy includes:

- noxious weed control;
- primary weeding;

- secondary weeding;
- maintenance weeding;
- revegetation;
- hazard reduction burning in the alluvial woodland.

Bush regeneration activities at this stage have focused on the eastern edge of the southern end of Hyland Road 'Arboretum' Bushland Reserve. These have required significant resources over a period of three years to achieve positive results and will need ongoing maintenance.

Bush regeneration and weed control need to be extended across the entire wetlands and riparian corridor study area. This will ensure the conservation values of the endangered ecological communities present in the corridor are maintained and that key threatening processes are controlled. Suggested species for use in revegetation within study area are presented in Appendix G. Ongoing management will also ensure the fauna habitat values can be maintained through the mosaic management approach.

While efforts have concentrated on an area of recognised high ecological resilience the program requires additional funding and resourcing to cover the broader area and include the establishment of native canopy cover on the terrestrial edge of the riparian corridor particularly the western edge and some focus on weeds of national significance (WONS) are present in the reserve.

James and Barker (2009) recommended focusing management though the dedication of a core conservation zone (currently forested riparian zone) with high levels of weed management bush regeneration and restoration and a broader buffer zone with lower levels of management including weed control and canopy establishment. This approach is sound and could support the application of the mosaic approach to weed control and shrub layer establishment.

Hyland Road Park requires bush regeneration and weed control as a priority to address the continued operation of KTPs and protect the EECs present in the riparian corridor.

Aquatic weeds also require the development of a management strategy to ensure that action is taken as a priority when highly invasive aquatic weeds occur to protect Jack Ferguson pond.

7.5 WILDLIFE CORRIDOR

The wildlife corridor values of the Hyland Road Park wetlands and riparian corridor are well recognised (James and Barker 2009, Merops Service 2010, Total Earth Care 2007, UBBS 1997). The area forms a significant corridor linking the Lower Prospect canal, the ex-Boral site, Prospect Reservoir, Alpha Road Park and Prospect Creek Reserve. The presence of a high diversity of bushland dependent native birds, four endangered ecological communities and the highly mobile swamp wallaby *Wallabia bicolour* in the corridor support the identification of the study area as a wildlife corridor.

The study area can be recognised by a declaration of Holroyd City Council under Section 36C(1)(b) as community land containing significant natural features: wildlife corridor. Such a declaration would then require amendment of this PoM to include the following core objectives for management:

(a) to conserve biodiversity and maintain ecosystem function in respect of the land, or the feature or habitat in respect of which the land is categorised as a natural area, and

(b) to maintain the land, or that feature or habitat, in its natural state and setting, and

(c) to provide for the restoration and regeneration of the land, and

(d) to provide for community use of and access to the land in such a manner as will minimise and mitigate any disturbance caused by human intrusion, and

(e) to assist in and facilitate the implementation of any provisions restricting the use and management of the land that are set out in a recovery plan or threat abatement plan prepared under the Threatened Species Conservation Act 1995 or the Fisheries Management Act 1994.

The special resolution would also mean that this plan would state the land is a wildlife corridor and why (see Section 5.2.1).

The revised plan of management would also identify objectives, performance targets and other matters that:

(i) are designed to protect the area, and

(ii) take account of the existence of the features of the site identified by the council's resolution, and

(iii) incorporate the core objectives prescribed under section 36 in respect of community land categorised as a natural area.

As the study area already supports natural areas of bushland, water course and wetland these objectives and targets are already included in this plan.

Such a declaration would also mean that until the plan of management has been amended:

(i) the use of the land must not be varied, except to the extent necessary to protect the features of the site identified in the council's resolution or in order to give effect to the core objectives prescribed under section 36 in respect of community land categorised as a natural area, or to terminate the use, and

(ii) no lease, licence or other estate may be granted in respect of the land.

The recognition of the Hyland Road Park wetlands and riparian corridor as a wildlife corridor is an acknowledgement of the significance of the natural values of this area and their function as an important wildlife corridor.

7.6 ESTABLISHING ACCESS, LINKS AND BOUNDARIES

As indicated previously the study area functions as a wildlife corridor linking Prospect Creek Reserve, Prospect Reservoir and the Lower Prospect Canal Reserve and Alpha Road Park. There is potential for the corridor to be linked to other reserves via more formal tracks or pathways to ensure access for passive and active recreation users. These paths would also function as a boundary to the riparian corridor presenting a management edge for maintenance activities and control of human access to environmentally sensitive areas. Currently the pedestrian access in the study area is considered limited (Environmental partnerships 2010).

The northern end of Hyland Road 'Arboretum' Bushland Reserve borders the Lower Prospect Canal Reserve and Munro Street Park. Currently a track is present from the Lower Prospect Canal cycleway to Munro Street Park but it is blocked almost completely by informal fencing and weed thickets. The establishment of a pathway along Munro Street Park that also forms an emergency access trail would formalise the terrestrial edge of the riparian corridor and enable a link to the cycleway and the western side of Munro Creek. Community feedback for this PoM has also indicated the desire for a formalized walking trail in Munro Street Park linking to the cycleway.

An informal dirt track is present on the western side of Munro Creek in the Hyland Road 'Arboretum' Bushland Reserve. It extends around one third of the length of the reserve. The extension of this track to the west to meet the cycleway would extend pedestrian access and create an edge to the riparian corridor.

No pedestrian access is currently present in Hyland Road Park, although the mowed grassland to the west of Munro Creek allows for ease of access along the corridor to the Transitway.

Currently there is no link between Hyland Road Park and Jack Ferguson Reserve or the Gipps Road Sporting Complex. A pedestrian bridge would be required over the Sydney Water pipeline and the bus Transitway to facilitate pedestrian movement between these areas.

A formal path network was recommended by Environmental partnerships (2010) in the Gipps Road and Hyland Road parks draft PoM. A formal path network would allow access to all sporting, recreation and natural areas across the parks and reserves and improve access. It is recommended that this path network also be used as a terrestrial boundary to the riparian corridor and include some environmental education signage on the local native species and the endangered ecological communities.

7.7 CATCHMENT DEVELOPMENT AND WATER REUSE

Future development of the catchment of the Hyland Road Park wetlands and riparian corridor will result in changes to catchment character and a potential decrease in water quality and increase in run off volumes and peak flows.

The draft masterplan for the broader Hyland Road Park and Gipps Road Sporting Fields development indicate there is potential for development adjacent to the riparian corridor further exacerbating potential water quality impacts and introducing increased human use within the corridor.

Increased development in the catchment and adjacent to the riparian corridor has the potential to reduce water quality and reduce the suitability of harvested stormwater within the Jack Ferguson pond as an irrigation supply for the Gipps Road Sporting Complex.

Three options to address this issue were considered:

- Increasing the wetland size upstream of the wetland;
- Retrofitting water quality controls throughout the urbanised catchment;
- Introduction of disinfection and flocculation.

Preliminary assessment estimates that an additional 6 to 8 hectares of constructed wetlands is required upstream of the Transitway to control water quality within acceptable levels. This would require the removal of the existing fill material and the construction of a comprehensive stormwater wetland treatment system. This option is considered unlikely to be implemented as the costs involved in construction would be significant and the costs associated with the disposal of the surplus spoil from the old solid waste site would be prohibitive.

Similarly the retrofitting of water quality controls and or biofiltration throughout the highly urbanised catchment is also considered to be cost prohibitive and difficult to implement.

In order to reduce pathogens in the stormwater harvested from Munro Creek and make it suitable for reuse on the Gipps Road Sporting Complex, turbidity must be reduced for disinfection to be effective. This will require additional water quality controls throughout the catchment and or flocculation within the Jack Ferguson pond

Broader strategic consideration of catchment development will be incorporated into the proposed new LEP for Holroyd City. The ongoing maintenance of water quality and natural values in the area will require a coordinated approach that includes management activities for bush regeneration and restoration, weed control, increased understanding of the stormwater management infrastructure and its required upgrades and maintenance regime along with community environmental education and capacity building. These processes will require commitment by Council to fund ongoing management of the area and ensure Council Officers are supported in their endeavours to secure additional grant funding for management works.

7.8 COMMUNITY ENGAGEMENT, EDUCATION AND CAPACITY BUILDING

The local community place high levels of value on the wetland for its natural amenity. This was made clear in the community responses to the newsletter and questionnaire distributed during preparation of this plan of management.

Local Bushcare groups are active in reserves in the Greystanes area. Support from Council in the establishment of a Bushcare group that could assist in the ongoing care and management of parts of the riparian corridor will require effort and funding to be successful.

It is recommended that existing Bushcare efforts are supported along with a number of supplementary measures. Bushcare groups based at Grey Box Reserve and Alpha Road Park could be funded to provide community days at Hyland Road Park wetlands and riparian corridor. These could be combined

with existing environmental initiatives including World Wetlands day and Clean up Australia Day.

The high diversity of bird species present in the riparian corridor could be the focus of a community interest bird newsletter with associated poster showing local birds. Funding of signage for bird watching walks along the corridor would assist in developing stewardship of the reserve by local interested residents.

Engagement of local schools on key national or international environmental days with information about the values of the riparian corridor may assist in engaging the youth of the community.

The longer term goals of this program of community engagement and capacity building would be to develop a Bushcare group dedicated to the care of Hyland Road Park wetlands and riparian corridor.

8 MANAGEMENT STRATEGIES

8.1 OBJECTIVES MANAGEMENT STRATEGIES

A variety of management strategies and actions have been developed to take into account the issues analysis and to provide clear and specific management objectives. Strategies include:

- Definition of the riparian corridor;
- Funding and management approaches;
- Open space maintenance;
- Weed management;
- Bushland management;
- Stormwater management;
- Jack Ferguson pond development;
- Access links and boundaries;
- Community engagement, education and capacity building.

The management actions and priorities have been summarised and are presented in Table 9.

8.2 RIPARIAN ZONE DEFINITION

8.2.1 Objectives

To define and acknowledge the riparian corridor extent.

To have the Hyland Road Park wetlands and riparian corridor formally recognised as a wildlife corridor.

8.2.2 Actions

- Map the proposed boundary of the riparian corridor;
- Define and acknowledge the extent and location of the core conservation zone and vegetated buffer zone;
- Define the land in compliance with Section 36C (Community land containing significant natural features) of the NSW Local Government Act 1993;
- Adopt this Plan of management as per Section 36C (Community land containing significant natural features) of the NSW Local Government Act 1993.

8.2.3 Performance Targets

- Recognition in appropriate strategic planning documents of the environmental and stormwater management values of the Hyland Road Park wetlands and riparian corridor.

8.2.4 Funding Sources

- Holroyd City Council annual budget.

8.3 FUNDING AND MANAGEMENT APPROACHES

8.3.1 Objectives

To ensure ongoing adequate and sustained funding is available to undertake management in the riparian corridor and Council Officers are supported.

8.3.2 Actions

- Explore the development of a natural assets register for Holroyd LGA that would build on existing information contained in strategic planning documents and digital maps;
- Explore opportunities for Holroyd City Council Officers to be involved in regional environmental and catchment initiatives;

8.3.3 Performance Targets

- Allocation by Holroyd City Council of adequate and ongoing resources to undertake management measures.

8.3.4 Funding Sources

- Holroyd City Council annual operations budget;
- NSW DPI Fisheries Habitat Action Grants 2011-2012 large grant maximum $40,000. http://www.dpi.nsw.gov.au/fisheries/habitat/rehabilitating/ahr-grants-program
- Various state and federal government grants that become available over the life of this plan.

8.4 OPEN SPACE MAINTENANCE

8.4.1 Objectives

To undertake a satisfactory level of maintenance of open space areas in a manner that is sympathetic to the riparian corridor natural values.

8.4.2 Actions

- Establishment no mow areas planted with native grass under existing trees and proposed native tree plantings in Munro Street Park;
- Establish boundaries to mowed areas in Hyland Road 'Arboretum' Bushland Reserve that protect any canopy plantings;
- Establish the boundary to the corridor on the ground in Hyland Road Park to exclude mowing from the riparian corridor;
- Increase in frequency of mowing in Munro Street Park and elsewhere when seasonal conditions lead to increased growth.

8.4.3 Performance Targets

- Regular mowing of mow areas;
- Establishment of no mow areas and under planting of clumps of canopy trees with native grasses;
- Number of locally endemic native canopy tree plantings;
- Extent of natural regeneration of canopy species.

8.4.4 Funding Sources

- Holroyd City Council annual operations budget;
- Ensure adequate staff resources are available for ongoing examination of potential funding sources including rate levies, state and federal grants, developer contributions and volunteer resources.

8.5 WEED MANAGEMENT

8.5.1 Objectives

To reduce the level of weed invasion in the riparian corridor.

8.5.2 Actions

- Secure required funding to undertake weed eradication works;
- Undertake mosaic weed eradication with a focus on weeds of national significance and noxious weeds initially in the core conservation zone and then the vegetated buffer of the riparian corridor;
- Prepare an aquatic weed management plan for the corridor.

8.5.3 Performance Targets

- The distribution and percentage cover of WONS and noxious weeds is reduced across the riparian corridor;
- Completion and implementation of the aquatic weed management plan.

8.5.4 Funding Sources

- Holroyd City Council annual budget;
- NSW DPI Fisheries Habitat Action Grants 2011-2012 large grant maximum $40,000. http://www.dpi.nsw.gov.au/fisheries/habitat/rehabilitating/ahr-grants-program

8.6 BUSHLAND MANAGEMENT

8.6.1 Objectives

To conserve and enhance the native vegetation communities including endangered ecological communities in the riparian corridor.

8.6.2 Actions

- Implement the detailed bushland management strategy detailed in Total Earth Care (2007) (contained in Appendix E) along the entire riparian corridor;
- Undertake bushland management in a manner that actively conserves habitat for small native woodland birds;
- establish native canopy cover on the terrestrial edge of the riparian corridor;
- undertake planting of casuarinas along the terrestrial edge of the core riparian zone corridor in Munro Street Park;
- undertake native canopy planting (in clumps) with native grass understory in riparian corridor buffer zone;
- undertake fire hazard reduction burns in native plant communities as per the *Rural Fires Act 1997* and RFS guidelines and standards.

8.6.3 Performance Targets

- Increased area of native plant communities under bush regeneration contracts;
- Increased native plant species richness in areas under bush regeneration contract as determined by ongoing flora surveys;
- Increased native plant species cover and species richness in stands of native plant communities in the corridor;
- Increased native plant species cover and species richness between stands of native plant communities in the corridor;
- Increased native plant species cover and species richness between stands of native plant communities between other reserves within the Holroyd City LGA;
- Approvals gained from consent authorities for broad or pile burns in the corridor.

8.6.4 Funding Sources

- NSW DPI Fisheries Habitat Action Grants 2011-2012 large grant maximum $40,000. http://www.dpi.nsw.gov.au/fisheries/habitat/rehabilitating/ahr-grants-program
- Holroyd City Council annual budget
- Commonwealth Government - Community Action Grants a small grants component of the Australian Government's Caring for our Country initiative that aims to help local community groups take action to conserve and protect their natural environment. http://www.nrm.gov.au/funding/cag/index.html (suitable for future Bushcare groups)

8.7 STORMWATER MANAGEMENT

8.7.1 Objectives

To provide clean water from Jack Ferguson pond for irrigation of Gipps Road Sporting Complex that will not be an issue for public health.

8.7.2 Actions

- Implement water quality monitoring in Jack Ferguson pond;
- **Recommended Option:** Retrofit water quality controls within the catchment; **and/or**
- **Recommended Option:** Increase the size of the wetland upstream of the Transitway; **and/or**
- **Must Undertake:** Pre disinfect the harvested stormwater before it is used to irrigate Gipps Road Sporting Complex.

8.7.3 Performance Targets

Water quality targets as listed below.

Total targets for water quality in Jack Ferguson pond:

- Suspended solids less than 50 mg/litre
- Total phosphorus .05 mg/litre
- Total nitrogen 5mg/litre

The water quality targets for various types of irrigation based on use are listed below.

- Level 1 – non-potable residential uses:
  Escherichia coli < 1 cfu/100ml;
  Turbidity ≤ 2 NTU;
  pH 6.5-8.5
  1 mg/L Cl_2
- Level 2 – spray or drip irrigation with no access controls:
  Escherichia coli < 10 cfu/100ml;
  Turbidity ≤ 2 NTU;
  pH 6.5-8.5
  1 mg/L Cl_2
- Level 3 – spray or drip irrigation with controlled access:
  Escherichia coli < 1000 cfu/100ml;
  pH 6.5-8.5

8.7.4 Funding Sources

- Holroyd City Council annual budget.

8.8 ACCESS LINKS AND BOUNDARIES

8.8.1 Objectives

Define a boundary for the riparian corridor and create public access along the edges.

8.8.2 Actions

- Establish a pathway along Munro Street Park to formalise the terrestrial edge of the riparian corridor and create a link to the cycle way and western side of the creek;
- Extend the informal track in the Hyland Road Arboretum Bushland Reserve to the cycleway to extend pedestrian access and create a formal edge to the riparian corridor;
- Investigate feasibility of pedestrian bridge to link access between Hyland Road Park and Jack Ferguson Reserve / Gipps Road Sporting Complex;
- Construct a more formal path network connecting the reserves in this PoM with each other and the cycleway.

8.8.3 Performance Targets

- Construction and use of access tracks by the public.

8.8.4 Funding Sources

- Holroyd City Council annual budget;
- Metropolitan Greenspace Program (MGP) (NSW Department of Planning grants program).

8.9 COMMUNITY ENGAGEMENT, EDUCATION AND CAPACITY BUILDING

8.9.1 Objectives

To engage the local community and users of the riparian corridor to undertake measures that will contribute to the long term management of the wetland.

8.9.2 Actions

- Identify and engage with local community user groups;
- Provide information to local groups, residents and the community in how they can become involved in management and monitoring in the riparian corridor, for example birds in backyards surveys, clean up Australia day, world wetlands day;
- Provide signage that reflects the environmental values and for the identification of birds and wildlife using the riparian corridor;
- Develop incentives for the local community to utilise the riparian corridor for educational and recreational purposes.

8.9.3 Performance Targets

- Increased community use of the riparian corridor for passive recreation;
- Engagement of local and broader community groups in programs that contribute to management and monitoring in the riparian corridor;

- Establishment of a Hyland Road Park wetlands and riparian corridor Bushcare group.

8.9.4 Funding Sources

- Office of Environment and Heritage Environmental Trust grant programs, Environmental Education – Community http://www.environment.nsw.gov.au/grants/education.htm

9 MONITORING

9.1 INTRODUCTION

Monitoring of Jack Ferguson pond will enable wetland managers to:

- Collect long term information on the success of management actions introduced as part of this Plan of management;
- Collect information on the quality of surface water in the wetland and trends in water quality;

Monitoring of the riparian corridor will enable managers to:

- Collect information on the occurrence of threatened species and health of endangered ecological communities within the riparian corridor;
- Collect information on the success of weed management actions in the riparian corridor;
- Provide an evaluation of management actions;
- Provide recommendations for future management actions.

9.2 WATER QUALITY MONITORING

9.2.1 Question

- How does water quality in Jack Ferguson pond change over time with management and climate change?
- What is the response to potential issues associated with contamination of the wetland which could pose a risk to public health (eg blue green algae, faecal contamination)?

9.2.2 Objectives

- Identify the current water quality conditions;
- Monitor diffuse and point source pollution;
- Identify trends in surface water quality;
- Provide clean water from Jack Ferguson pond for irrigation of Gipps Road Sports field that will not be an issue for public health.

9.2.3 Monitoring

- Long term water quality sampling should be instated at Jack Ferguson pond;
- Sampling should be undertaken every six months, preferably late summer and late winter;
- Monitoring should continue for the life of the stormwater reuse project.

9.3 MONITOR RIPARIAN VEGETATION

9.3.1 Question

- How do riparian corridor vegetation communities respond over time with management and climate change?

9.3.2 Objectives

- Monitor the health and status of the Swamp oak floodplain forest EEC; and River flat Eucalypt forest EEC.

9.3.3 Monitoring

- Undertake monitoring of the riparian corridor vegetation using the monitoring template developed by Jansen et al (2007) contained as Appendix F to this document.
- Longitudinal continuity of vegetation;
- Width of riparian vegetation;
- Proximity;
- Vegetation cover;
- Debris;
- Features.

It is suggested this monitoring is undertaken as part of the bushland management activities. The riparian corridor should be divided into a series of zones. A transect, perpendicular to the channel would be undertaken in each zone and the information below recorded.

Suggested zones are east and west of the Munro Creek channel in the northern and southern end of Hyland Road 'Arboretum' Bushland Reserve, and in the centre and at the southern end of Hyland Road Park.

Utilise the scoring sheet to calculate scores for each criteria and categorise to assist in the examination of results:

- Less than 25 very poor;
- 25-30 poor;
- 30-35 average;
- 35-40 good;
- More than 40 excellent.

The establishment of a control site in a natural freshwater wetland with adjoining vegetation and a more natural catchment would provide a comparison for the riparian corridor monitoring program.

This information should be recorded and distributed with appropriate supporting information through Council's state of the environment reporting.

9.3.4 Objectives

- Utilise photo points to monitor long term changes in vegetation in the corridor and adjacent to Jack Ferguson pond.

9.3.5 Monitoring

- Establish a series of photographs to cover large areas of the corridor and wetlands in each zone of the corridor as identified above;
- Establish permanent photo points within the areas covered by the photograph;
- Photos should be taken at higher than ground level utilising a step ladder or topographic changes to enable greater coverage of the wetland and riparian;
- Photo points should be established where variation in vegetation communities extent, distribution and condition is likely to occur (in the Hyland Road Park wetland and riparian corridor where bushland management activities are undertaken;
- Suggested photo points for Hyland Road Park wetlands and riparian corridor would be at the northern end of Hyland Road 'Arboretum' Bushland Reserve, at the Hyland Road crossing, at the northern end of the wetland in Hyland Road Park, at the Transitway and at Jack Ferguson pond.
- The date, time and weather conditions at the time of the photograph should be recorded;
- Photographs should be taken during spring.

9.3.6 Monitoring

- Monitor the extent and density of WONS and noxious weeds in riparian corridor vegetation.
- Implement ongoing weed management over the entire riparian corridor.

9.4 MONITOR NATIVE FAUNA

9.4.1 Questions

- What fauna species and what level of use of fauna habitats are occurring in the riparian corridor and do they change with management?

9.4.2 Objectives

- Monitor the diversity of fauna species and the level of use of fauna habitats within the riparian corridor before and after bushland management.

9.4.3 Monitoring

- Continue bird monitoring being undertaken by Merops Services and extend this into the Hyland Road 'Arboretum' Bushland Reserve;
- Establish a transect running along the western edge of the corridor that could be used for small mammal trapping;
- Consideration should be given to supporting the local community to include the riparian corridor in the Birds in Backyards Program coordinated by Birds Australia http://www.birdsinbackyards.net/
- Establish sites to be used for frog call and owl call playback;

- Establish areas that are suitable for anabat recording.

9.5 ENVIRONMENTAL EDUCATION

9.5.1 Question

- Does environmental education contribute to improved riparian management and condition?

9.5.2 Objectives

- Provide information through signage to the community and visitors about the values and/or species which may utilise the riparian corridor;
- Provide the local community with resources and opportunities to become involved in the care and management of the riparian corridor;
- Resource Council's Bushcare Officer and the Grey Box Reserve Bushcare Group and the Alpha Park Bushcare group to run BBQs on "environmental days" in the Munro Street Park and/or Hyland Road Park and/or Jack Ferguson Reserve to provide local residents with knowledge about actions they can take and projects they can join to contribute to wetland health.

9.5.3 Monitoring

- Number of riparian corridor environmental days;
- Number of participants at riparian corridor environmental days;
- Requests for further information from residents/neighbours about the riparian corridor management activities.

Table 9 Actions and Priorities

Priorities have been allocated as follows:

* High priority- short term
* Moderate priority- medium term
* Low priority- long term

Management Strategy	**Action**	**Responsibility**	**Priority**
Riparian Zone Definition	Council to consider the benefit of recognizing the study area by a declaration under Section 36C(1) (b) of the NSW Local Government Act 1993as community land containing significant natural features wildlife corridor	HCC	Low
Weed Management	Secure required funding to undertake weed eradication works;	HCC	High
	Undertake mosaic weed eradication with a focus on weeds of national significance and noxious weeds initially in the core conservation zone and then the vegetated buffer of the riparian corridor.	HCC	High
Bushland Management	Implement the detailed bushland management strategy detailed in Total Earth Care (2007) (contained in Appendix C) along the entire riparian corridor	HCC	High
	Undertake bushland management in a manner that actively conserves habitat for small native woodland birds	HCC	Moderate
Management Strategy	**Action**	**Responsibility**	**Priority**
	Establish native canopy cover on the terrestrial edge of the riparian corridor	HCC	Moderate
	Undertake planting of casuarinas along the terrestrial edge of corridor in Munro Street Park	HCC	Moderate

	Develop a fire management strategy that addresses the requirements of both the safety of park users and adjacent residential areas and the ecological requirements of the riparian corridor	HCC	Moderate
Stormwater Management	Implement water quality monitoring	HCC	Very High
	Retrofit water quality controls within the catchment;	HCC	Moderate
	Investigate sanitisation measures to ensure adequate water quality for water harvesting re-use	HCC	High
Access Links And Boundaries	Establish a pathway along Munro Street Park to formalise the terrestrial edge of the riparian corridor and enable a link to the cycle way and western side of the creek	HCC	Moderate
Management Strategy	**Action**	**Responsibility**	**Priority**
	Extend the informal track in the Hyland Road Arboretum Bushland Reserve to the cycleway to extend pedestrian access and create a formal edge to the riparian corridor	HCC	Moderate
	Investigate feasibility of pedestrian bridge to link access between Hyland Road Park and Jack Ferguson Reserve / Gipps Road Sporting Complex	HCC	Moderate
Community Engagement, Education and Capacity Building	Provide signage that reflects the environmental values and for the identification of birds and wildlife using the riparian corridor;	HCC	High

	Identify opportunities for the local community to utilise the riparian corridor for educational and recreational purposes	HCC	Low

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APPENDIX A- FLORA SPECIES

Derived from James and Barker (2009) and Total Earth Care (2007)

* Exotic

Non-local native

DICOTYLEDONS

ACANTHACEAE

Brunoniella australis Blue Trumpet

Brunoniella pumilio

Pseuderanthemum variabile Pastel flower

**Ruellia sp.*

**Thunbergia alata* Black-eyed susan

ALISMATACEAE

**Alisma sp.* Water Plaintain

AMARANTHACEAE

Alternanthera denticulata

ANACARDIACEAE

**Schinus areira* Pepper tree

APIACEAE

Centella asiatica Pennywort

**Ciclospermum leptophyllum*

**Foeniculum vulgare* Fennel

APOCYNACEAE

**Araujia sericifera* Moth Vine

**Nerium oleander* Oleander

**Vinca major* Blue perriwinkle

ASCLEPIADACEAE

**Araujia sericifolia* Moth Vine

**Gomphocarpus fruticosus* Milkweed

ASTERACEAE

**Ageratina adenophora* Crofton weed

**Aster subulatus*

**Bidens pilosa* Cobblers Pegs

Chrysocephalum apiculatum

**Cirsium vulgare* Spear Thistle

**Conyza albida* Fleabane

Cotula australis

Euchiton sphaericus

**Gamochaeta americanum* Cudweed

Glossogyne tannensis

**Hypochaeris radicata* Flatweed

**Leontodon taraxcoides subsp. taraxcoides* Lesser Hawkbit

Ozothamnus diosmifolius Dogwood

Senecio hispidulus

**Senecio madagascariensis* Fireweed

Senecio quadridentatus

**Sonchus oleraceus* Common Sowthistle

**Taraxacum officinale* Dandelion

Vittadinia sp. Fuzzweed

BASELLACEAE

**Anredera cordifolia* Madeira Vine

BERBERIDACEAE

**Nandina domestica* Sacred bamboo

BIGNONIACEAE

**Jacaranda mimosifolia* Jacaranda

BRASSICACEAE

**Cardamine hirsuta*

**Rorippa nasturtiumaquaticum* Water cress

CACTACEAE

**Opuntia stricta* Prickly Pear

CAMPANULACEAE

Wahlenbergia gracilis Australian Bluebell

CAPRIFOLIACEAE

**Lonicera japonica* Honeysuckle

CASUARINACEAE

Casuarina glauca She Oak

CHENOPODIACEAE

Atriplex australasica

Atriplex semibaccata

Einadia hastata Berry Saltbush

Einadia nutans subsp. linifolia

Einadia trigonos

CONVOLVULACEAE

Convovulus erubescens

Dichondra repens Kidney weed

Polymeria calycina

CRASSULACEAE

**Sedum praeltum*

EPACRIDACEAE

Leucopogon juniperinus Bearded heath

ESCALLONIACEAE

**Escallonia sp.*

EUPHORBIACEAE

Chamaesyce dallachyana

Phyllanthus virgatus

Homalanthus populifolius Bleeding Heart

FABACEAE

Caesalpinoideae

#Ceratonia siliqua Carob

**Senna pendula var. glabrata* Senna

#Senna (pinnate leaves) Senna

Faboideae

Desmodium rhytidophyllum

Desmodium varians Slender Tick-trefoil

Dillwynia sieberi

**Erythrina x crista-gallii* Coral Tree

Glycine clandestina

Glycine microphylla

Glycine tabacina

Hardenbergia violacea False Sarsaparilla

Indigofera australis Native Indigo

Lespedza juncea subsp. sericea

Pultenaea microphylla

Pultenaea villosa

**Trifolium dubium* Medic

**Vicia sativa subsp. nigra* Narrow-leaved Vetch

**Vicia sativa subsp.sativa*

**Vicia tetrasperma* Slender Vetch

Mimosoideae

#Acacia adunca Wallangarra Wattle

#Acacia baileyana Cootamundra Wattle

 # Acacia binervia Coast Myall

#Acacia concurrens Black Wattle

#Acacia cultriformis Knife-leaf Wattle

#Acacia irrorata Green Wattle

Acacia decurrens Black Wattle

#Acacia dealbata Silver wattle

Acacia falcata Sickle Wattle

#Acacia fimbriata Fringed Wattle

Acacia floribunda White Sally

Acacia implexa Hickory Wattle

#Acacia leiocalyx

Acacia longifolia Sydney Golden Wattle

#Acacia muelleriana

Acacia parramattensis Sydney Green Wattle

#*Acacia saligna* Golden Wreath Wattle

**Paraserianthes lophantha* Cape Wattle

GOODENIACEAE

Goodenia hederacea Ivy Goodenia

HALORAGACEAE

**Myriophyllum aquaticum* Brazilian Water Milfoil

HYPERICACEAE

Hypericum gramineum Small St. John Wort

**Hypericum perforatum* St. Johns Wort

LAMIACEAE

Ajuga australis Austral Bugle

**Mentha X piperita citrata* Eu-de-Cologne mint

Mentha satureoides Creeping Mint

Plectranthus parviflorus

#*Westringia fruticosa* Coast Rosemary

LINACEAE

Linum marginale Native Flax

**Linum usitatissimum* Flax, Linseed

LORANTHACEAE

Amyema pendulum

Dendropthoe vitellina

MALVACEAE

**Modiola caroliniana* Mallow

**Pavonia hastata*

**Sida rhombifolia* Paddys Lucerne

MELIACEAE

Melia azedarach White Cedar

MYOPORACEAE

Eremophila debilis Winter Apple

MYRTACEAE

Angophora floribunda Rough-barked Apple

Angophora subvelutina Broad-leaved Apple

#Babingtonia densifolia

#Callistemon citrinus Crirmson Bottlebrush

#Callistemon pinifolius

#Callistemon rigidus

#Callistemon salignus Sweet Willow Bottlebrush

#Callistemon? Shiressii

#Callistemon viminalis Bottlebrush

#Corymbia citriodora Lemon-scented Gum

#*Corymbia maculata* Spotted Gum

Eucalyptus amplifolia

#*Eucalyptus cf. bicostata* Eurabbie

#Eucalyptus botryoides Bangalay

**Eucalyptus cladocalyx* sugar gum

Eucalyptus crebra Narrow-leaved Ironbark

Eucalyptus fibrosa

#Eucalyptus macrorhyncha Red Stringybark

#Eucalyptus microcorys Tallow Wood

Euclayptus moluccana Grey Box

#Eucalyptus punctata Grey Gum

#Eucalyptus saligna Sydney Blue Gum

#Eucalyptus saligna-botryoides

Eucalyptus sideroxylon Mugga Ironbark

Eucalyptus tereticornis Forest Red Gum

#Eucalyptus torrelliana Cadagi

#Eucalyptus propinqua

#Melaleuca armillaris

#Melaleuca bracteata

Melaleuca decora

#Melaleuca ericifolia

#Melaleuca hypericifolia

#Melaleuca quinquenervia Broad-leaved Paperbark

Melaleuca styphelioides Prickly-leaved Paperbark

#Melaleuca thymifolia

OLEACEAE

**Jasminum polyanthum* White jasmine

**Ligustrum lucidum* Large-leaved Privet

**Ligustrum sinense* Small-leaved Privet

**Olea europaea ssp.cuspidata* African Olive

ONAGRACEAE

Epilobium billardierianum ssp.cinereum Willowherb

OXALIDACEAE

Oxalis perrenans Native Oxalis

**Oxalis thompsoniae*

PHYTOLACCACEAE

**Phytolacca octandra* Inkweed

PITTOSPORACEAE

Bursaria spinosa Blackthorn

#*Hymenosporum flavum* Native Frangipani

PLANTAGINACEAE

Plantago gaudichaudii Narrow-leaf Plaintain

**Plantago lanceolata* Plaintain

POLYGONACEAE

Persicaria decipiens Knotweed

**Rumex conglomeratus* Clustered Dock

**Rumex obtusifolius* Broad-leaf Dock

PORTULACACEAE

Portulaca oleracea Portulaca

**Portulacaria sp*. Jade plant

PRIMULACEAE

**Anagallis arvensis* Pimpernell

PROTEACEAE

#Banksia integrifolia

#Grevillea robusta Silky Oak

#Hakea salicifolia

Hakea sericea

RANUNCULACEAE

Ranunculus lappaceus Common Buttercup

ROSACEAE

**Rosa rubiginosa* Briar rose

**Rubus fruticosus sens. lat*. Blackberry

RUBIACEAE

Asperula conferta Common Woodruff

Opercularia diphylla

**Paronychia brasilensis* Brazilian whitlow

**Richardia stellaris*

SALICACEAE

**Populus alba* White Poplar

**Salix babylonica* Weeping Willow

SANTALACEAE

Exocarpos cupressiformis

SAPINDACEAE

#Alectryon cf. subcinereus

#Cupaniopsis anacardioides Tuckeroo

#Diploglottis australis native tamarind

Dodonaea triquetra Hop-bush

Dodonaea viscosa ssp. cuneata Hop-bush

SOLANACEAE

**Cestrum parqui* Cestrum

**Lycium ferocisissimum* African Box Thorn

**Solanum chenopodioides*

**Solanum mauritianum* Wild Tobacco Plant

**Solanum nigrum* Black-berry Nightshade

Solanum prinophyllum Forest Nightshade

**Solanum pseudocapsicum* Madeira Cherry

**Solanum seaforthianum* Climbing Nightshade

STACKHOUSIACEAE

Stackhousia viminea

STERCULIACEAE

#Brachychiton acerifolius Brachychiton

ULMACEAE

**Celtis occidentalis* Hackberry

VERBENACEAE

**Lantana camara* Lantana

**Verbena bonariensis* Purpletop

**Verbena incompta* Purple-top

**Verbena officinalis* Purple-top

**Verbena rigida* Purple-top

VITACEAE

Cayratia clematidea

ZINGIBERACEAE

**Hedychium gardnerianum* Ginger lily

MONOCOTYLEDONS

ANTHERICACEAE

Tricoryne elatior Yellow Rush-lily

ARACEAE

**Monstera deliciosa* Fruit-salad plant

ASPARAGACEAE

**Asparagus aethiopicus* Asparagus Fern

**Asparagus asparagoides* Bridal Creeper

**Asparagus plumosus* Asparagus Fern

**Asparagus virgatus* Asparagus Fern

ASPHODELEACEAE

**Aloe* sp.

COMMELINACEAE

Commelina cyanea

**Tradescantia fluminensis* Wandering Jew

**Tradescantia pallida*

**Tradescantia zebrina*

CYPERACEAE

Carex inversa

Carex fascicularis

Carex longebrachiata

Cyperus gracilis

*Cyperus eragrostis**

Cyperus sanguinolentus

Fimbristylis dichotoma Damp grassland

**Isolepis prolifera*

Schoenoplectus validus River club-rush

IRIDACEAE

**Dietes sp.*

JUNCACEAE

Juncus continuus

Juncus usitatus Common rush

LOMANDRACEAE

Lomandra confertifolia

Lomandra filiformis ssp. filiformis wattle mat-rush

Lomandra longifolia

Lomandra multiflora Many-flowered Matrush

PHORMIACEAE

Dianella longifolia var.longifolia Blue Flax Lily

POACEAE

Aristida ramosa Three-awn Grass

**Arundo donax* Giant Reed

Austrodanthonia bipartita Wallaby Grass

Austrodanthonia linkii Wallaby Grass

Austrodanthonia racemosa Wallaby Grass

**Axonopus affinis* Carpet Grass

Bothriochloa decipiens Red-leg Grass

Bothriochloa macra Red-leg Grass

**Briza subaristata*

Capillipedium spicigerum Scented-top Grass

**Chloris gayana* Rhodes Grass

Chloris truncate Windmill Grass

Chloris ventricose Tall Chloris

**Cortadeira selloana* Pampas Grass

Cymbopogon refractus Barbed Wire Grass

Cynodon dactylon Couch

Dichanthium sericeum Queensland Bluegrass

**Ehrharta erecta* Panic Veldt

Elymus scaber var.scaber

Entolasia stricta Wiry Panic

Entolasia marginata

Eragrostis brownii Brown's Lovegrass

**Eragrostis curvula* African Lovegrass

Eragrostis leptostachya Paddock Lovegrass

Eriochloa psuedoacrotricha Early Spring Grass

Imperata cylindrica Blady Grass

Lachnagrostis filiformis Blowngrass

**Melinis repens* Red Natal Grass

Microlaena stipoides Weeping Grass

Oplismenus aemulus

Oplismenus imbecillus

**Nasella neesiana* Chilean Needle Grass

**Poa annua* Winter Grass

**Paspalum dilatatum* Paspalum

Paspalum distichum Water Couch

**Pennisetum clandestinum* Kikuyu

**Phalaris aquatica*

Phragmites australis

**Setaria gracilis* Slender Pigeongrass

Sporobolus creber Slender Rat's Tail Grass

**Sporobolus indicus var. capensis* Parramatta Grass

Sporobolus elongates Slender Rat's Tail Grass

**Sporobolus fertilis* Giant Parramatta Grass

Themeda australis Kangaroo Grass

TYPHACEAE

Typha orientalis Broadleaf Cumbungi

FERNS

ADIANTACEAE

Cheilanthes sieberi

APPENDIX B - THREATENED FLORA SPECIES

Table 10: Summary of flora species listed under the NSW Threatened Species Conservation Act 1995 recorded within the locality.

Scientific Name	Common Name	NSW Status
Acacia bynoeana	Bynoe's Wattle	E1,P
Acacia pubescens	Downy Wattle	V,P
Callistemon linearifolius	Netted Bottle Brush	V,P
Cynanchum elegans	White-flowered Wax Plant	E1,P
Dillwynia tenuifolia		V,P
Diuris aequalis	Buttercup Doubletail	E1,P
Eucalyptus nicholii	Narrow-leaved Black Peppermint	V,P
Eucalyptus scoparia	Wallangarra White Gum	E1,P
Grammitis stenophylla	Narrow-leaf Finger Fern	E1,P
Grevillea juniperina subsp. juniperina	Juniper-leaved Grevillea	V,P
Hibbertia superans		E1,P
Persoonia nutans	Nodding Geebung	E1,P
Pilularia novae-hollandiae	Austral Pillwort	E1,P
Pimelea curviflora var. curviflora		V,P
Pimelea spicata	Spiked Rice-flower	E1,P
Pterostylis saxicola	Sydney Plains Greenhood	E1,P
Pultenaea parviflora		E1,P
Pultenaea pedunculata	Matted Bush-pea	E1,P
Syzygium paniculatum	Magenta Lilly Pilly	E1,P
Tetratheca glandulosa		V,P
Triplarina imbricata	Creek Triplarina	E1,P

Data source: NSW Office of Environment and Heritage Data Atlas. P= Protected; V= Vulnerable; E1 – Endangered; E4A – Critically Endangered

Table 11: Summary of flora species listed under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 recorded within the locality.

Scientific Name	Common Name	Commonwealth Status
Acacia pubescens	Downy Wattle	V
Asterolasia elegans		E
Cynanchum elegans	White-flowered Wax Plant	E
Grevillea parviflora subsp. parviflora	Small-flower Grevillea	V
Persoonia nutans		E
Pimelea curviflora var. curviflora		V
Pimelea spicata		E
Pomaderris brunnea	Rufous Pomaderris	V
Pterostylis gibbosa	Illawarra Greenhood	E
Pterostylis saxicola	Sydney Plains Greenhood	E

Data source: Australian Government Protected Matters Search Tool. V = Vulnerable; E = Endangered; C = Critically Endangered

Table 12: List of flora species present in the study area listed as noxious weeds within the Holroyd Local Government Area.

Scientific Name	Common Name	Noxious Weed Class
Asparagus asparagoides	Bridal Creeper	4
Cestrum parqui	Cestrum	3
Hypericum perforatum	St. Johns Wort	4
Lantana camara	Lantana	4
Ligustrum lucidum	Broad leaf privet	4
Ligustrum sinense	Narrow leaf privet	4
Nassella neesiana	Chilean needle grass	4
Olea europaea subspecies cuspidata	African olive	4
Opuntia stricta	Prickly Pear	4
Rubus fruticosus aggregate species	Blackberry	4

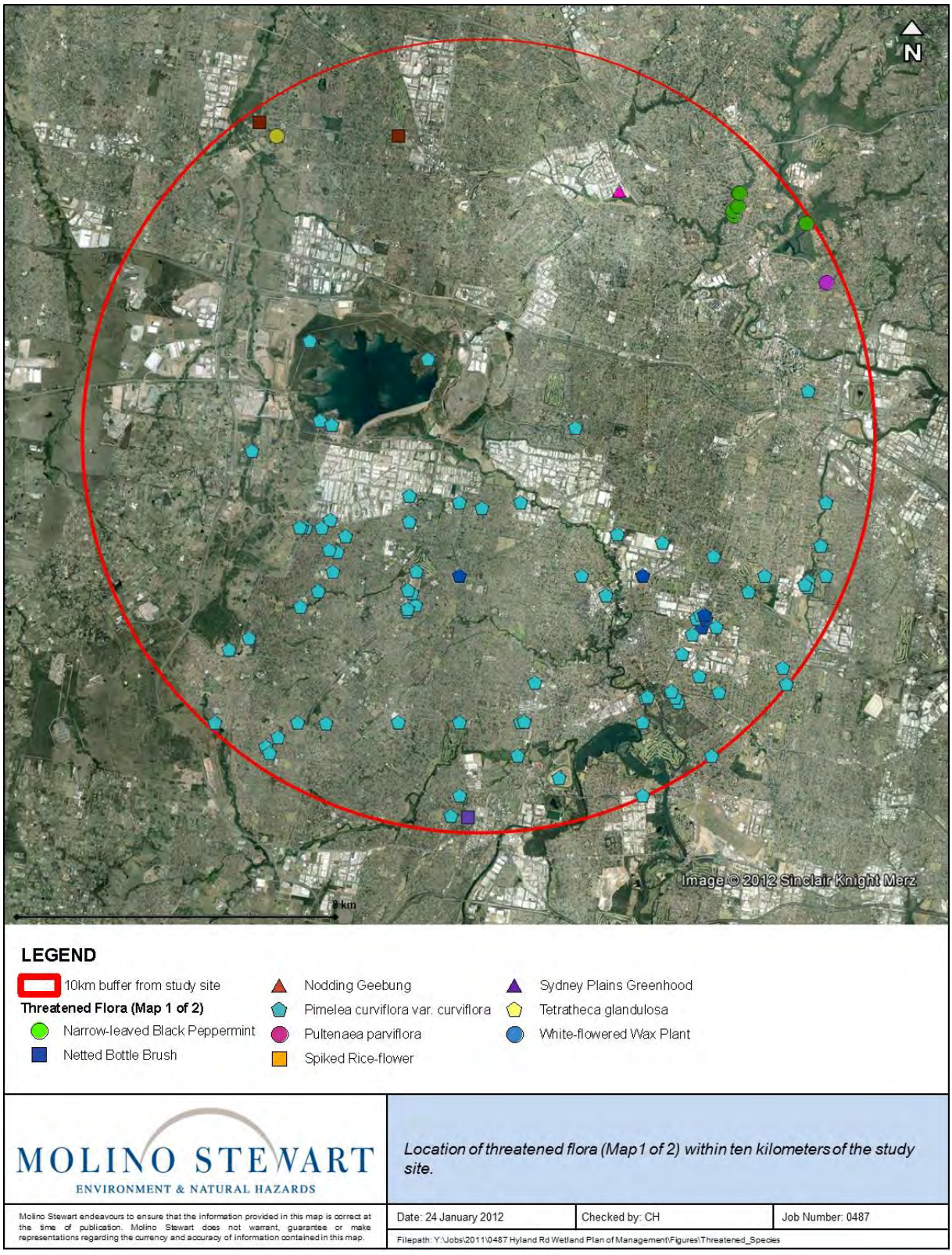

Figure 24: Location of threatened flora (Map 1 of 2) within ten kilometres of the study site

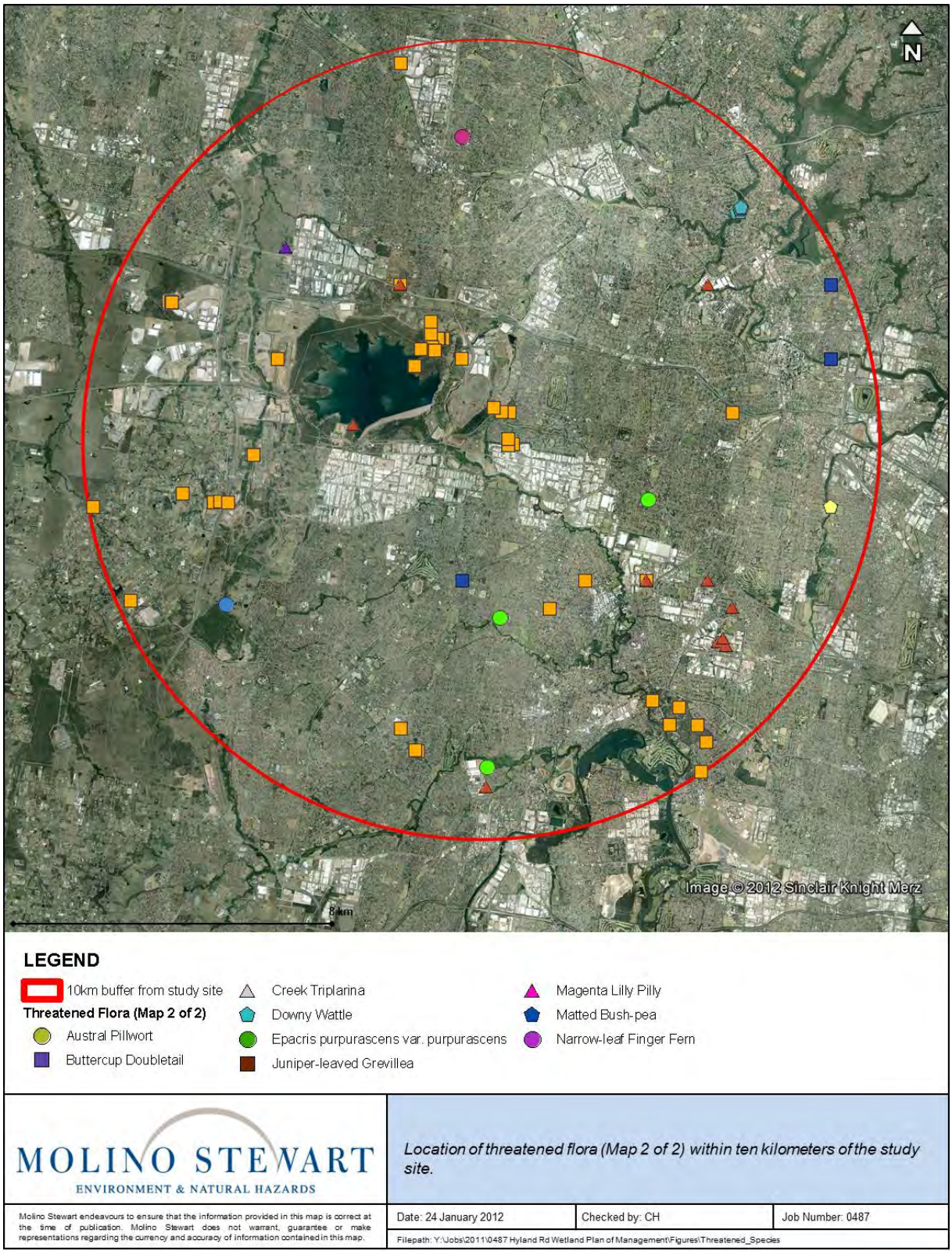

Figure 25: Location of threatened flora (Map 2 of 2) within ten kilometres of the study site

APPENDIX C - FAUNA SPECIES

Class Aves derived from Merop Services (2011). All other fauna derived from James and Barker (2009).

*exotic species

Class AVES

Australian magpie

Australian raven

Australian reed-warbler

bar-shouldered dove

black-faced cuckoo-shrike

brown goshawk

collared sparrowhawk

common blackbird*

common myna*

common starling*

crimson rosella

double-barred finch

eastern koel

eastern spinebill

eastern yellow robin

eastern yellow robin

European goldfinch*

fan-tailed cuckoo

galah

golden whistler

golden-headed cisticola

grey butcherbird

grey fantail

grey shrike-thrush

Horsfield's bronze-cuckoo

house sparrow

laughing kookaburra

little wattlebird

magpie-lark

mistletoebird

musk lorikeet

New Holland honeyeater

noisy miner

mutmeg mannikin*

pied currawong

rainbow lorikeet

red wattlebird

red-browed finch

red-whiskered bulbul*

rufous whistler

sacred kingfisher

shining bronze-cuckoo

silvereye

spotted dove*

spotted pardalote

superb fairy-wren

tawny frogmouth

white-browed scrubwren

white-plumed honeyeater

willie wagtail

yellow thornbill

yellow-faced honeyeater

Class MAMMALIA

Subclass Marsupialia

Order Diprotodontia

PHALANGERIDAE

Trichosurus vulpecular common brushtail possum

MACROPODIDAE

Wallabia bicolor black (swamp) wallaby

Order RODENTIA

MURIDAE

Mus musculus house mouse

Rattus sp. – rat

Order CARNIVORA

CANIDAE

Canis lupus domesticus dog

Vulpes vulpes fox

FELIDAE

Felis catus cat

Order LAGOMORPHA

LEPORIDAE

Oryctolagus cuniculus European rabbit

Class REPTILIA

Order SQUAMATA

SCINCIDAE

Ctenotus robustus striped skink

Eulamprus quoyii eastern water skink

Lampropholis delicate garden skink

Pseudechis porphyriacus red-bellied Black Snake

Pseudonaja textilis eastern brown snake

Saproscincus musteline weasel skink

Tiliqua scincoides eastern blue-tongue

Class AMPHIBIA

Order ANURA

MYOBATRACHIDAE

Crinia signifera common eastern froglet

APPENDIX D - THREATENED FAUNA SPECIES

Table 13: Summary of fauna species listed under the NSW Threatened Species Conservation Act 1995 recorded within the locality.

Scientific Name	Common Name	NSW Status
Birds		
Anthochaera phrygia	Regent Honeyeater	E4A,P
Callocephalon fimbriatum	Gang-gang Cockatoo	V,P
Glossopsitta pusilla	Little Lorikeet	V,P
Hieraaetus morphnoides	Little Eagle	V,P
Lathamus discolor	Swift Parrot	E1,P
Lophoictinia isura	Square-tailed Kite	V,P
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V,P
Ninox connivens	Barking Owl	V,P
Ninox strenua	Powerful Owl	V,P
Petroica boodang	Scarlet Robin	V,P
Petroica phoenicea	Flame Robin	V,P
Polytelis swainsonii	Superb Parrot	V,P
Tyto novaehollandiae	Masked Owl	V,P
Frogs		
Litoria aurea	Green and Golden Bell Frog	E1,P
Pseudophryne australis	Red-crowned Toadlet	V,P
Mammals		
Cercartetus nanus	Eastern Pygmy-possum	V,P
Chalinolobus dwyeri	Large-eared Pied Bat	V,P
Dasyurus maculatus	Spotted-tailed Quoll	V,P
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V,P
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V,P
Mormopterus norfolkensis	Eastern Freetail-bat	V,P
Myotis macropus	Southern Myotis	V,P
Phascolarctos cinereus	Koala	V,P
Pteropus poliocephalus	Grey-headed Flying-fox	V,P
Scoteanax rueppellii	Greater Broad-nosed Bat	V,P
Invertebrates		
Meridolum corneovirens	Cumberland Plain Land Snail	E1

Data source: NSW Office of Environment and Heritage Data Atlas P= Protected; V= Vulnerable; E1 – Endangered; E4A – Critically Endangered

Table 14: Summary of fauna species listed under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 recorded within the locality.

Scientific Name	Common Name	Commonwealth Status
Birds		
Anthochaera phrygia	Regent Honeyeater	E
Botaurus poiciloptilus	Australasian Bittern	E
Dasyornis brachypterus	Eastern Bristlebird	E
Lathamus discolour	Swift Parrot	E
Rostratula australis	Australian Painted Snipe	V
Sternula nereis nereis	Fairy Tern	V
Fish		
Macquaria australasica	Macquarie Perch	E
Prototroctes maraena	Australian Grayling	V
Frogs		
Heleioporus australiacus	Giant Burrowing Frog	V
Litoria aurea	Green and Golden Bell Frog	V
Litoria raniformis	Growling Grass Frog	V
Reptiles		
Hoplocephalus bungaroides	Broad-headed Snake	V
Mammals		
Chalinolobus dwyeri	Large-eared Pied Bat	V
Dasyurus maculatus maculatus	Spotted-tail Quoll	E
Petrogale penicillata	Brush-tailed Rock-wallaby	V
Potorous tridactylus tridactylus	Long-nosed Potoroo	V
Pseudomys novaehollandiae	New Holland Mouse	V
Pteropus poliocephalus	Grey-headed Flying-fox	V

Data source: Australian Government Protected Matters Search Tool. V = Vulnerable; E = Endangered; C = Critically Endangered

Table 15 Summary of migratory species listed under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 recorded within the locality.

Scientific Name	Common Name	Commonwealth Status
Apus pacificus	Fork-tailed Swift	Migratory Marine Bird
Ardea alba	Great Egret	Migratory Marine Bird; Migratory Wetlands Species
Ardea ibis	Cattle Egret	Migratory Marine Bird; Migratory Wetlands Species
Haliaeetus leucogaster	White-bellied Sea-Eagle	Migratory Terrestrial Species
Hirundapus caudacutus	White-throated Needletail	Migratory Terrestrial Species
Merops ornatus	Rainbow Bee-eater	Migratory Terrestrial Species
Monarcha melanopsis	Black-faced Monarch	Migratory Terrestrial Species
Myiagra cyanoleuca	Satin Flycatcher	Migratory Terrestrial Species
Rhipidura rufifrons	Rufous Fantail	Migratory Terrestrial Species
Xanthomyza phrygia	Regent Honeyeater	E; Migratory Terrestrial Species
Gallinago hardwickii	Latham's Snipe	Migratory Wetlands Species
Rostratula benghalensis s. lat.	Painted Snipe	V; Migratory Wetlands Species

Data source: Australian Government Protected Matters Search Tool. V = Vulnerable; E = Endangered;

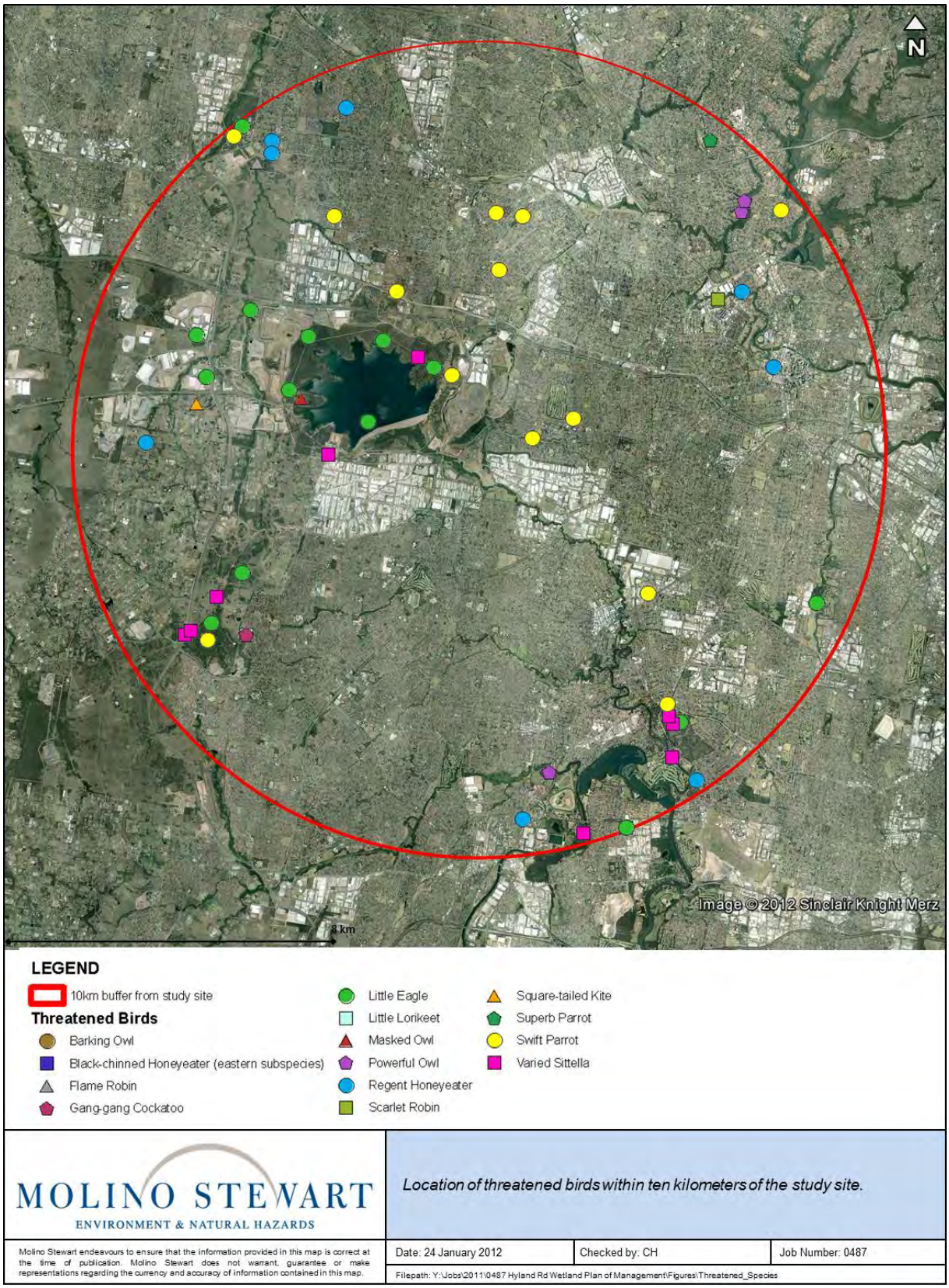

Figure 26: Location of threatened birds within ten kilometres of the study site

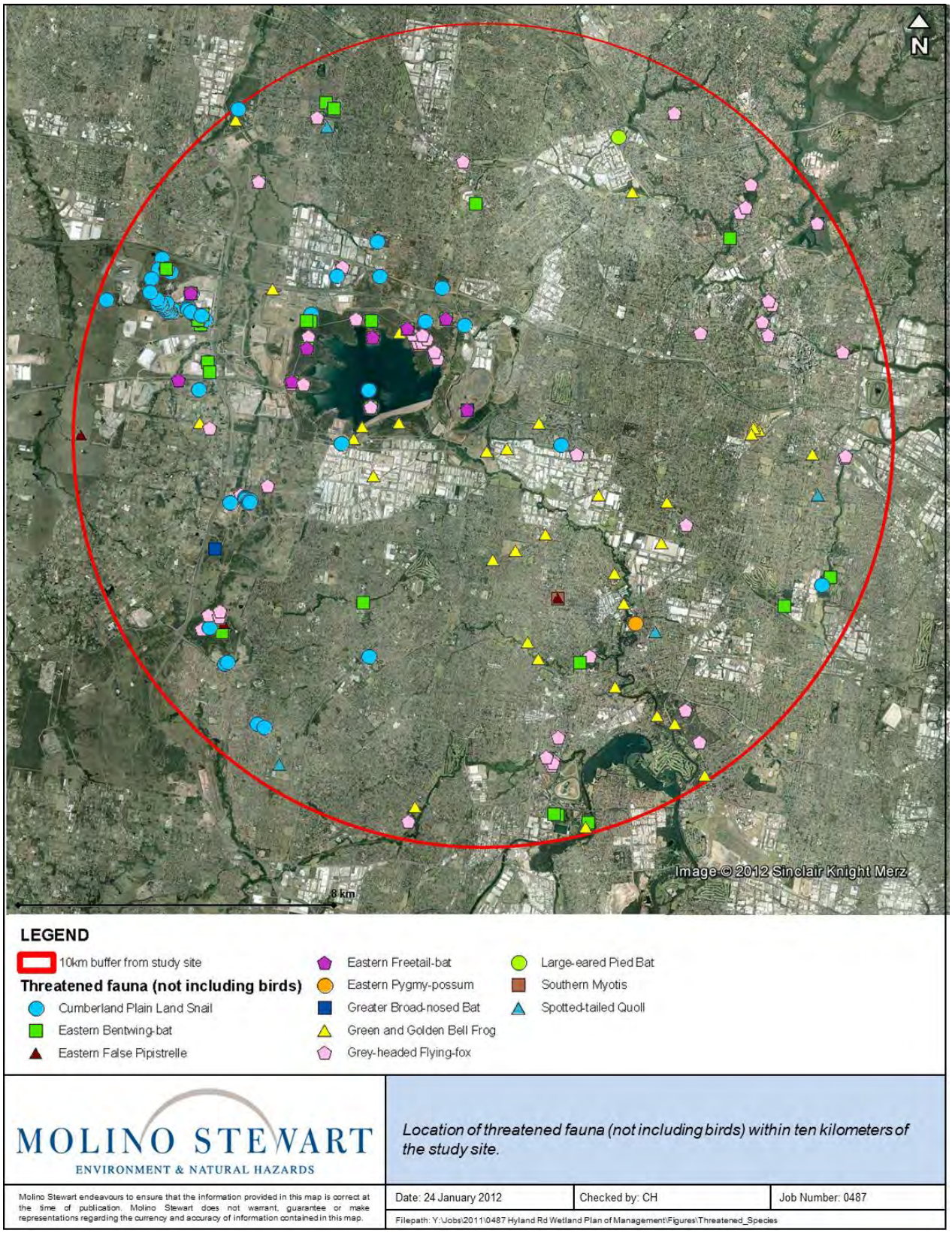

Figure 27: Location of threatened fauna (not including birds) within ten kilometres of the study site

APPENDIX E - BUSHLAND MANAGEMENT ACTIONS

Extract from the Citywide BMP for Hyland Road Park (Total Earth Care 2007)

5.6 Vegetation Management Measures

5.6.1 Bushland Management Strategy

The aim of vegetation management for the northern and southern sections of Hyland Road Park will be to maintain open space that incorporates urban bushland, threatened species and habitat conservation and recreational opportunities. The specific objective for native vegetation will be to enhance the condition of the River Flat Eucalypt Forest on Coastal Floodplains (RFEFCF) communities. This objective will be met by implementing a program of vegetation management measures that;

- ensures a nil or minimal amount of further disturbance occurs to the remnant and regrowth endangered ecological communities of the sites that will compromise their current resilience or long term survival;
- restores or replicates native plant communities that are similar in structure and floristics to RFEFCF;
- improves the habitat value for existing fauna of the sites and habitat potential for threatened or other fauna recorded from the locality;
- secures natural heritage for the local community in the long term.

The program will focus on retaining and using the existing native vegetation and natural resilience of the site to meet the guiding objective and this will require:

- weed removal and control;
- bush regeneration techniques;
- erosion control; and
- revegetation.

5.6.2 Bushland Regeneration and Restoration Project Planning

Sourcing of adequate and ongoing funding for the implementation of bush regeneration and restoration project is critical for success of any bush regeneration and revegetation works. Council must first decide on the level of financial commitment it is prepared to make over a medium to long term period and funding sources such as rate levies, state and federal grants, developer contributions and the likelihood of volunteer resources before commencing bush regeneration or restoration projects.

Planning of the implementation of bush regeneration and restoration project must also consider that departures from the works recommended in the Bushland Management Plan may be required in response to changing site conditions due to natural processes or future land uses of the locality.

5.6.3 Bushland Regeneration and Restoration Works Hyland Road North

Noxious Weed Control

Weeds that are listed as 'noxious' for Holroyd LGA must be removed from the site or controlled, depending on the control class of weed and according to the provisions of Weed Control Order No. 20 from the NSW Noxious Weeds Act 1993. Noxious weed control must also be consistent with specific regional weed control strategies that are currently under review or in development.

Primary Weeding

Primary weeding is to commence in the RFEFCF and should not progress into other plant communities of Hyland Road North (other than as noxious weed control) until the RFEFCF is stabilised and maintenance weeding is providing a level of certainty to the long term survival and enhancement of resilience for this community. Primary weeding should progress in stages throughout the remainder of Hyland Road North from areas of highest resilience to areas of lower resilience.

Primary weeding of the RFEFCF at Hyland Road North will take several weeks to complete and the bulk of weed biomass should be transported off site. Noxious weeds that have potential for vegetative reproduction must be removed from site and disposed of appropriately. Woody debris from noxious weeds that have little potential for vegetative reproduction (eg Broadleaf Privet) can remain on site for composting and provision of habitat. Compost piles are to be placed well away from the watercourse channel so they are not washed into stream flow during storm events.

Retention of habitat should be considered during the primary weeding of woody weed thickets. During the current field survey small bird species (Superb Blue Wren and Red Browed Firetail) were observed using Blackberry and Privet infestations for foraging and cover. Some woody weed thickets (such as Blackberry) should be initially treated and left in situ with follow up treatment until regeneration or revegetation works are providing suitable replacement habitat.

Primary weeding has previously been carried out in the Regenerating Closed Grassland at Hyland Road North.

Secondary Weeding

Secondary weeding will occur three to six months after the completion of primary weeding, depending on the amount of regrowth of herbaceous annuals (and other weeds that have an abundant seed source present in the soil) that typically occurs after primary weeding. The appropriate timing of secondary weeding will vary according to the timing of the primary weeding, insofar as regrowth will be stronger if primary weeding occurs during spring and summer, and slower during autumn and winter. The need for secondary weeding will also depend on climatic

conditions in the intervening period (eg periods of sustained rainfall will promote germination of weed seeds and require secondary weeding to occur sooner than it would under dry conditions).
Secondary weeding is to focus on the RFEFCF and Regenerating Closed Grassland. Secondary weeding will require targeted removal of noxious weed regrowth and hand removal and spot spraying of exotic grasses, herbaceous weeds and seedlings of woody weeds throughout both areas.
Maintenance Weeding
Maintenance weeding will be required in the RFEFCF and Regenerating Closed Grassland to ensure that weed growth following secondary weeding is controlled in the long-term. Maintenance will be on going and as mentioned previously, the undertaking of a bush regeneration and restoration project is likely to only be successful and an efficient allocation resource if there is a long-term commitment. Weeding activities will include continued noxious weed control (throughout Hyland Road North) and bush regeneration techniques such as hand weeding, spot spraying, assisted seedling recruitment, soil scarification, brush matting and other appropriate techniques as determined by site response.
Revegetation
The UBBS (NPWS, 1997) suggests the establishment of vegetated links between existing vegetated corridors of the LGA such as Prospect Creek and Lower Prospect Canal Reserve. The existing native plant communities of the Hyland Road Parks, including Hyland Road North, provide the core for a corridor to link the two larger reserves for such a strategic approach. Generally revegetation works will aim to: supplement and consolidate the RFEFCF and extend and create canopy cover to nearby areas of highest resilience or remnant bushland; reduce the potential for erosion in the watercourse; and be consistent with the floristics of RFEFCF or other native plant communities that occur nearby or are likely to have been present on the site, for example Cumberland Plain Woodland (CPW). Additionally plantings will need to be staged over several years to replicate or supplement age class recruitment and be of local provenance stock.
Revegetation of the core RFEFCF is likely to require planting of native groundcover, shrub and small to medium sized tree species. Ultimately the species and life form required in the revegetation works will be determined by regeneration in response to weeding and other bush regeneration works.

The short term revegetation strategy should also aim to provide a vegetated link from the RFEFCF to the Regenerating Closed Grassland and to create a structured native plant community in the Regenerating Closed Grassland. Installation of canopy species should form the first stage and once established these should be supplemented by shrub species. Native groundcover species are well represented in the Regenerating Closed Grassland but this does not exclude the potential for supplementary ground cover plantings in this area. Due to previous disturbances and high percentage cover of exotic grasses in the area between the RFEFCF and the Regenerating Closed Grassland the installation of groundcover species should only occur if adequate resources can be allocated in maintenance.
Longer term vegetation planning for Hyland Road North should aim to link the northern limit of the RFEFCF along the upper section of the watercourse and on to areas of CPW of Lower Prospect Canal Reserve. Revegetation of this area will need to be staged commencing with canopy species providing the initial corridor linkage. The addition of understorey and groundcover stratums by planting works should only be carried once canopy is becoming established and sufficient resources can be committed in the long term to create and maintain a fully structured plant community.
Planting works should attempt, where possible, to utilise existing site features that will improve survival rates including landscape features such as dips or depressions, natural water sheds and shade.
Stormwater Management
The watercourse forms part of the local stormwater system which is impacting on the RFEFCF of Hyland Road North. Impacts include stream bank erosion and slumping, scouring, sedimentation, elevated and altered plant nutrient fluxes, weed plumes and weed seed and litter dispersal. Stormwater management in this section of the watercourse could include piping of low flows, sub surface infiltration devices, GPT's, sediment traps and rock armouring, and drainage line reconstruction works that may include some of the above management devices.
Management of stormwater in this section of the watercourse also needs to take a strategic approach and should involve design that primarily considers flood and erosion prevention. Design should also incorporate ecological function (aquatic and terrestrial) and long term maintenance including routine works (eg removal of litter and silt) and potential for expansion or alteration of stormwater management in response to changing conditions in the catchment locality.
Open Space Maintenance
The Cleared and Disturbed plant community can be broadly described as open space. In the short term it is unlikely that Council will have sufficient resources to carry out bushland regeneration or restoration works in this plant community and as such it can be managed as open space. Current vegetation management of this plant community the site involves little or no intervention to control weeds or other practices. Despite the diversity and cover of weed species in the Cleared and Disturbed plant community the current minimal management strategy is resulting in the provision of a large area of habitat for small bird species (foraging, sheltering and nesting resources) and potential habitat for reptile and small mammal species.
Recreation
Hyland Road North is proposed as an optional site for the development of a new sporting complex and which is currently the subject of a review and assessment process. Any assessment in relation to this proposal must incorporate

the potential impacts (eg stormwater runoff or trampling in regeneration areas) on the mapped RFEFCF during construction and operation. The resulting opportunity and constraints analysis must address how the need for provision of built community resources can be best integrated with community natural resources that have statutory protection.
Hyland Road North is currently used for passive recreation (ie community accessible open space) but could support other passive and active recreation opportunities that should be limited to the Cleared and Disturbed plant community.

5.6.4 Bushland Regeneration and Restoration Works Hyland Road South

Noxious Weed Control

Weeds that are listed as 'noxious' for Holroyd LGA must be removed from the site or controlled, depending on the control class of weed and according to the provisions of Weed Control Order No. 20 from the NSW Noxious Weeds Act 1993. Noxious weed control must also be consistent with specific regional weed control strategies that are currently under review or in development.

Primary Weeding

Hyland Road South has previously been proposed for bushfire hazard reduction works through a broad area burn (HCC, 2004). Although it is not the main intent for this action, a hazard reduction burn would provide a substantial amount of primary weed removal and other ecological benefits including the stimulation of the soil stored native seed bank.
As an alternative to a broad area burn primary weeding should be carried out throughout the RFEFCF (except the channel and wet areas) targeting woody weeds. Burn piles should be created with the woody weed debris and a program of pile burning carried out.
Where hazard reduction burns are not carried out for the site primary weeding is to commence in the eastern section of RFEFCF between the watercourse and Gipps Road. This section of the RFEFCF has the highest resilience for the site and continued primary works should not progress into the drainage line or other plant communities to the west of the watercourse (other than as noxious weed control) until the RFEFCF is stabilised and maintenance weeding is providing a level of certainty to the long term survival and enhancement of resilience for this community. Primary weeding should progress in a second stage to the RFEFCF and Regenerating Closed Grassland on the western side of the watercourse.
Primary weeding of the eastern RFEFCF at Hyland Road South will take several weeks to complete and the bulk of weed biomass should be transported off site if not used for creating pile burns. There is potential for the regeneration of a greater diversity of native shrub and groundcover species in this section through the selective culling of Native Blackthorn. If the current dense stand of Native Blackthorn is thinned it should be trialled in a small area first, and if there is a positive regeneration response then the culling should then be expanded. Culling should also take place to be timed with seed fall with the resultant plant material used as brush matting elsewhere at Hyland Rd South or North.
Noxious weeds that have potential for vegetative reproduction must be removed from site and disposed of appropriately. Woody debris from noxious weeds that have little potential for vegetative reproduction (eg Broadleaf Privet) can remain on site for composting and provision of habitat. Compost piles are to be placed well away from the watercourse channel so they are not washed into stream flow during storm events.
Retention of habitat should be considered during the primary weeding of woody weed thickets in the RFEFCF and Regenerating Closed Grassland on the western bank of Munro Creek. During the current field survey small bird species (Superb Blue Wren) were observed using Blackberry infestations for foraging and cover. Some woody weed thickets (such as Blackberry) should be initially treated and left in situ with follow up treatment until regeneration or revegetation works are providing suitable replacement habitat.

Secondary Weeding

Secondary weeding will occur three to six months after the completion of primary weeding, depending on the amount of regrowth of herbaceous annuals (and other weeds that have an abundant seed source present in the soil) that typically occurs after primary weeding. The appropriate timing of secondary weeding will vary according to the timing of the primary weeding, insofar as regrowth will be stronger if primary weeding occurs during spring and summer, and slower during autumn and winter. The need for secondary weeding will also depend on climatic conditions in the intervening period (eg periods of sustained rainfall will promote germination of weed seeds and require secondary weeding to occur sooner than it would under dry conditions).
Secondary weeding is to be carried out in the RFEFCF and Regenerating Closed Grassland on both sides of the creek and following this a staged approach should be taken with the western side weeding following works on the eastern side of Munro Creek. Secondary weeding will require targeted removal of noxious weed regrowth and hand removal and spot spraying of exotic grasses, herbaceous weeds and seedlings of woody weeds throughout both areas.

Maintenance Weeding

Maintenance weeding will be required in the RFEFCF and Regenerating Closed Grassland to ensure that weed growth following secondary weeding is controlled in the long-term. Maintenance will be on going and as mentioned previously, the undertaking of a bush regeneration and restoration project is likely to only be successful if there is a

long-term commitment and an efficient allocation of resources. Weeding activities will include continued noxious weed control (throughout Hyland Road South) and bush regeneration techniques such as hand weeding, spot spraying, assisted seedling recruitment, soil scarification, brush matting and other appropriate techniques as determined by site response.

Revegetation

Revegetation of Hyland Road South will follow a similar strategic approach and general aims as described above for Hyland Road North.

Revegetation of the core (eastern section) RFEFCF will only be required if the regeneration response to either hazard reduction burns or weeding works is not as predicted. Revegetation in the eastern RFEFCF will generally only require small tree, shrub and groundcover species as there is currently a good cover of canopy.

Revegetation of the western RFEFCF will aim to create or supplement canopy where it is absent, such as the Regenerating Closed Grassland and where there is currently little recruitment. The addition of groundcover and shrub species in the planting works for this area should be carried out in areas that have an existing or emerging resilience in response to weeding works and only of there are sufficient resources to consolidate and maintain a fully structured plant community. Where there are insufficient resources to achieve this then less resilient sections of the western RFEFCF should be managed for canopy and prevention of weed dispersal back into resilient regeneration areas.

Planting works should attempt, where possible, to utilise existing site features that will improve survival rates including landscape features such as dips or depressions, natural water sheds and shade.

Fire

HCC has previously carried out a Review of Environmental Factors (REF) to assess a proposed bushfire hazard reduction burn in the bushland at Hyland Road South (HCC, 2004a). The REF suggests and absence of fire in the RFEFCF of the reserve for at least 20 years and recognises the potential ecological benefits to the native plant community as well as the reduced fire hazard. Key issues are addresses such as potential impacts on threatened communities and species and the recommendations reference the approvals processes and outline a planning strategy (HCC, 2004a).

Consistent with the previous assessments by HCC (2004a) this survey and report recommends the carrying out of hazard reduction burns in areas of the RFEFCF at Hyland Road South Reserve. The native plant community is likely to respond well to either broad burning or pile burning carried out as part of a bushfire hazard reduction. As previously noted by HCC (2004a) follow up control of weeds post burn will be a critical element in protecting the resilience of the RFEFCF that will have been triggered in using fire for assisted regeneration.

Stormwater Management

As previously mentioned Munro Creek forms part of the local stormwater system which is also impacting on the RFEFCF of Hyland Road South. Impacts include stream bank erosion and slumping, scouring, sedimentation, elevated and altered plant nutrient fluxes, weed plumes and weed seed and litter dispersal. Stormwater management in this section of the watercourse could include piping of low flows, sub surface infiltration devices, GPT's, sediment traps and drainage line reconstruction works that may incorporate some or all the above management devices.

Design and construction of any stormwater management works in this section of the watercourse must be incorporated into a strategic approach taken for the northern section in Hyland Road North.

Open Space Maintenance

The Cleared and Disturbed plant community at Hyland Road South incorporates open space and Council managed materials storage and depot. Parts of the site have been used as a waste facility in the past and in the short term it is unlikely that Council will have sufficient resources to carry out bushland regeneration or restoration works in this area. Current vegetation management of this plant community on the site involves slashing of the grassed area adjacent to the western portion of RFEFCF and this should continue. Despite the diversity and cover of weed species in the Cleared and Disturbed community the area provides some potential habitat for small bird species (foraging, sheltering and nesting resources) and potential habitat for reptile and small mammal species.

Recreation

Hyland Road South is proposed as an optional site for the development of a new sporting complex and which is currently the subject of a review and assessment process. Any assessment in relation to this proposal must incorporate the potential impacts (eg stormwater runoff or trampling in regeneration areas) on the mapped RFEFCF during construction and operation. The resulting opportunity and constraints analysis must address how the need for provision of built community resources can be best integrated with community natural resources which also have statutory protection.

Hyland Road South is currently used for passive recreation (ie community accessible open space) but could support other passive and active recreation opportunities that should be limited to the Cleared and Disturbed plant community.

5.7 Summary of Actions, Targets and Performance Indicators

Table 5-2 following summarises the vegetation management measures (actions) and recommends targets and performance indicators for the implementation of the Citywide BMP at Hyland Road Reserve. As described in earlier sections of the Citywide BMP targets should specify achievable outcomes to meet objectives, whilst performance indictors should provide a means of measuring progress of the action relative to the objective.

Table 5-2 Actions, targets and performance indicators for the implementation of the Citywide BMP for Hyland Road Park.

Action	Target	Performance Indicators
Noxious weed control	Noxious weeds are managed according to the control category specified in the Noxious Weeds Act 1993 and species specific regional management plans.	The distribution and percentage cover of noxious weeds is reduced in the reserve. Occurrences of previously unrecorded noxious species for the reserve are prevented from establishing.
Bush regeneration	Management and conservation of the endangered ecological communities and other native plant communities of the reserve.	Increased area of native plant communities under bush regeneration contract. Increased native plant species richness in areas under bush regeneration contract as determined by ongoing flora survey and monitoring.
Revegetation	Expansion of native plant communities to form a regional vegetation corridor.	Increased native plant species cover and species richness in stands of native plant communities within the reserve. Increased native plant species cover and species richness between stands of native plant communities within the reserve. Increased native plant species cover and species richness between other reserves within the LGA.
Fire	Fire hazard reduction and ecological burns are carried out in native plant communities according to the Rural Fires Act 1997 and RFS guidelines and standards.	Approvals gained from consent authorities. Broad burns or pile burns carried out.
Stormwater Management	Management and conservation of the endangered ecological communities and other native plant communities of the reserve without compromising flood mitigation.	Installation of stormwater management devices and flood mitigation works that integrate engineering and ecological restoration works.
Recreation	Provision of recreational opportunities that does not compromise the management and conservation of the endangered ecological communities and other native plant communities of the reserve.	No loss of native plant cover from the construction of recreational facilities or infrastructure.

APPENDIX F - RAPID APPRAISAL OF RIPARIAN CONDITION

Rapid Appraisal of Riparian Condition

Site: _____ te Number: _____ GPS Start: _____
Date: _____ Observer: _____ GPS End: _____

Longitudinal continuity of riparian canopy vegetation (> 5 m wide)

Map	Score

0 = < 50%, 1 = 50-64%, 2 = 65-79%, 3 = 80-94%, 4 = > 95% vegetation bank, with 1/2 point

Width of riparian canopy vegetation

Transect	Channel Width (CW)	Vegetation Width (VW)	Score
1			
2			
3			
4			
Average			

Proximity

Score

Nearest path of native vegetation > 10 ha:
0 = > 1 km, 1 = 200 m - 1 km,
2 = contiguous, 3 =

Channel < 10m wide: 0 = VW < 5 m, 1 = VW 5-9 m, 2 = VW 10-19 m, 3 = VW 20-39m, 4 = VW >
Channel > 10m wide: 0 = VW/CW < 0.5, 1 = VW/CW 0.5-0.9, 2 = VW/CW 1-1.9, 3 = VW/CW 2-3.

Vegetation cover: Canopy > 5m, Understorey 1-5 m, Ground cover < 1 m

Transect	Canopy	Native Canopy	Understorey	Native Understorey	Ground Cover	Native Ground Cover	Number of Layers
1							
2							
3							
4							
Average							

Canopy and ground cover: 0 = none, 1 - 1-30%, 2 = 31-60%, 3 = > 60%
Understorey cover: 0 = none, 1 = 1-5%, 2 = 6-30%, 3 = > 30%

Debris

Transect	Leaf Litter	Native Leaf Litter	Standing Dead Trees	Hollow-bearing Trees	Fallen Logs
1					
2					
3					
4					
Average					

Leaf litter and native leaf litter cover: 0 = none, 1 = 1-30%, 2 = 31-60%, 3 = > 60%
Standing dead trees (>20 cm dbh) and hollow-bearing trees: 0 = absent, 1 = present
Fallen logs (>10cm diameter): 0 = none, 1 = small quantities, 2 = abundant

Features

Transect	Native Canopy Species Regeneration	Native Understorey Regeneration	Large Native Tussock Grasses	Reeds
1				
2				
3				
4				
Average				

Regeneration < 1 m tall: 0 = none, 1 = scattered, and 2 = abundant with 1/2 point subtracted fo
Reeds and large tussock grasses: 0 = none, 1 = scattered, and 2 = abundant

Calculation of Scores

Site Number: _____

Longitudinal continuity of riparian canopy vegetation

Score	A

Width of riparian canopy vegetation

Average	B

Proximity

Score	C

Vegetation Cover

Average	Canopy		Native Canopy		Understorey		Native Understorey		Ground Cover	
	D		H		E		I		F	

Native Ground Cover		Number of Layers	
J		G	

Debris

Average	Leaf Litter		Native	Standing		Hollow-		Fallen Logs
	K		L	M		N		O

Features

Average	Native Canopy		Native	Large Native		Reeds	
	K		L	M		N	

Totals

Site Number	Habitat		Cover		Natives		Debris		Features	
(out of)	11		12		9		10		8	
	A+B+C		D+E+F+G		H+I+J	K+L+M+N+O			P+Q+R+S	

Total
50

Source: Jansen et al (2007) Rapid Appraisal of Riparian Condition Technical Guideline for the southern tablelands of New South Wales Land Water and Wool Canberra ACT http://www.act.waterwatch.org.au/Files/Library/RARC.pdf

APPENDIX G – PLANTING SCHEDULES

VEGETATION COMMUNITIES	PLANTING SCHEDULE
Disturbed Woodland Grassland	As per species listed in the Cumberland Plain Woodland (CPW) EEC final determination attached
Mowed grassland	*Casuarina glauca* adjoining the main channel (additional species from CPW, SOF and RFEF EEC determinations
Alluvial Woodland (includes SOF and RFEF EECs)	As per species listed in the Swamp oak floodplain forest (SOF) and River-flat Eucalypt forest (RFEF) EEC determinations attached
Freshwater Wetland	As per species listed in the Sydney Freshwater Wetlands in the Sydney Bioregion determination attached
Cumberland Plain Woodland	As per species listed in the Cumberland Plain Woodland EEC determination attached
Artificial Wetland	As per species listed in the Sydney Freshwater Wetlands in the Sydney Bioregion determination attached

- **Cumberland Plain woodland - 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 Cumberland Plain Woodland as an ENDANGERED ECOLOGICAL COMMUNITY on Part 3 of Schedule 1 of the Act. Listing of Endangered Ecological Communities is provided for by Section 12 of the Act.

Any submissions received following advertisement of the Preliminary Determination have been considered by the Scientific Committee.

The Scientific Committee has found that:

1. The Cumberland Plain Woodland is the accepted name for the plant community that occurs on soils derived from shale on the Cumberland Plain.

2. The Cumberland Plain Woodland is characterised by the following assemblage of plant species:

- *Acacia decurrens*
- *Acacia falcata*
- *Acacia implexa*
- *Acacia parramattensis*
- *Aristida ramosa*
- *Aristida vagans*
- *Arthropodium milleflorum*
- *Asperula conferta*
- *Brunoniella australis*
- *Bursaria spinosa*
- *Cheilanthes sieberi*
- *Chloris truncata*
- *Chloris ventricosa*
- *Commelina cyanea*
- *Cyperus gracilis*
- *Daviesia ulicifolia*
- *Dianella longifolia*
- *Dianella revoluta*
- *Dichelachne micrantha*
- *Dichondra repens*
- *Dillwynia sieberi*
- *Echinopogon caespitosus*
- *Echinopogon ovatus*
- *Entolasia marginata*
- *Eragrostis leptostachya*
- *Eremophila debilis*
- *Eucalyptus crebra*
- *Eucalyptus eugenioides*
- *Eucalyptus fibrosa*
- *Eucalyptus maculata*
- *Eucalyptus moluccana*
- *Eucalyptus tereticornis*
- *Exocarpos cupressiformis*
- *Glycine clandestina*
- *Glycine tabacina*
- *Goodenia hederacea*

- *Hardenbergia violacea*
- *Hibbertia diffusa*
- *Hypericum gramineum*
- *Hypoxis hygrometrica*
- *Indigofera australis*
- *Lepidosperma laterale*
- *Lissanthe strigosa*
- *Lomandra filiformis*
- *Lomandra multiflora*
- *Melaleuca decora*
- *Microlaena stipoides*
- *Oplismenus aemulus*
- *Oxalis exilis*
- *Panicum simile*
- *Phyllanthus filicaulis*
- *Pratia purpurascens*
- *Solanum pungetium*
- *Themeda australis*
- *Tricoryne elatior*
- *Vernonia cinerea*
- *Wahlenbergia gracilis*

The total list of plant species which occur in the community is much larger, with many species occurring in one or a few sites, or in very low abundance. Not all species listed above occur in every single stand of the Community.

3. The Cumberland Plain Woodland sites are characteristically of woodland structure, but may include both more open and more dense areas, and the canopy is dominated by species including one or more of the following: *Eucalyptus moluccana, Eucalyptus tereticornis, Eucalyptus crebra, Eucalyptus eugenioides* and *Eucalyptus maculata.*

4. The understorey is generally grassy to herbaceous with patches of shrubs, or if disturbed, contains components of indigenous native species sufficient to re-establish the characteristic native understorey.

5. The Cumberland Plain Woodland includes regrowth which is likely to achieve a near natural structure or a is seral stage towards that structure.

6. The Community has been reported as occurring in the local government areas of Auburn, Bankstown, Baulkham Hills, Blacktown, Camden, Campbelltown, Fairfield, Hawkesbury, Holroyd, Liverpool, Parramatta, Penrith and Wollondilly.

The Scientific Committee noted that a more detailed description of the community is provided in:

- Benson (1992) The natural vegetation of the Penrith 1:100,000 map sheet. See particularly p. 556-7, p. 558, p. 566-575.

In additon, general information on the Cumberland Plain Woodland is also provided in:

- Benson, D. & Howell, J. 1990. 'Taken for Granted - The Bushland of Sydney and its Suburbs'. Kangaroo Press, Kenthurst
- Benson, D., Howell, J., and McDougall, L., 1996, Mountain Devil to Mangrove: a guide to the natural vegetation in the Hawkesbury-Nepean Catchment. Royal Botanic Gardens, Sydney

The Scientific Committee has found that:

7. The Community, as defined by the proposal, satisfies the definition of an Ecological Community under the Act, i.e. an assemblage of species occupying a particular area.

8. Only 6% of the original extent of the community remained in 1988 (Benson, D. & Howell, J. 1990 Proc. Ecol. Soc. Aust. 16, 115-127) in the form of small and fragmented stands. Although some areas occur within conservation reserves, this in itself is not sufficient to ensure the long term conservation of the Community unless the factors threatening the integrity and survival of the Community are ameliorated.

9. Threats to the survival of the community include clearance for agriculture, grazing, hobby and poultry farms, housing and other developments, invasion by exotic plants, and increased nutrient loads due to fertiliser run off from gardens and farmland, dumped refuse or sewer discharge.

10. In view of the substantial reduction in the area occupied by the Community, its fragmentation and the numerous threats to the integrity of the Community, the Scientific Committee is of the opinion that the Cumberland Plain Woodland is likely to become extinct in nature in New South Wales unless the factors threatening its survival cease to operate.

Dr Chris Dickman

Chairperson

Scientific Committee

Gazetted: 13/6/97

About the NSW Scientific Committee

Page last updated: 27 February 2011

Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions - 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 Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions, as an ENDANGERED ECOLOGICAL COMMUNITY in Part 3 of Schedule 1 of the Act. Listing of endangered ecological communities is provided for by Part 2 of the Act.

The Scientific Committee has found that:

1. Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions is the name given to the ecological community associated with grey-black clay-loams and sandy loams, where the groundwater is saline or sub-saline, on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains. Floodplains are level landform patterns on which there may be active erosion and aggradation by channelled and overbank stream flow with an average recurrence interval of 100 years or less (adapted from Speight 1990). Swamp Oak Floodplain Forest generally occurs below 20 m (rarely above 10 m) elevation in the NSW North Coast, Sydney Basin and South East Corner bioregions. The structure of the community may vary from open forests to low woodlands, scrubs or reedlands with scattered trees. Typically these forests, woodlands, scrubs and reedlands form mosaics with other floodplain forest communities and treeless wetlands, and often they fringe treeless floodplain lagoons or wetlands with semi-permanent standing water (e.g. Pressey 1989a).

The composition of Swamp Oak Floodplain Forest is primarily determined by the frequency and duration of waterlogging and the level of salinity in the groundwater. Composition also varies with latitude. The community is characterised by the following assemblage of species:

Acmena smithii
Alphitonia excelsa
Alternanthera denticulata
Baumea juncea
Blechnum indicum
Callistemon salignus
Carex appressa
Casuarina glauca
Centella asiatica
Commelina cyanea
Crinum pedunculatum
Cupaniopsis anacardioides
Cynodon dactylon
Dianella caerulea
Entolasia marginata
Enydra fluctuans
Flagellaria indica
Gahnia clarkei
Geitonoplesium cymosum
Glochidion ferdinandi
Glochidion sumatranum
Hypolepis muelleri
Imperata cylindrica var. *major*
Isolepis inundata
Juncus kraussii subsp. *australiensis*
Juncus planifolius
Juncus usitatus
Lobelia alata
Lomandra longifolia
Lophostemon suaveolens
Maundia triglochinoides
Melaleuca alternifolia
Melaleuca ericifolia
Melaleuca quinquenervia
Melaleuca styphelioides
Myoporum acuminatum
Oplismenus imbecillis
Parsonsia straminea
Persicaria decipiens
Persicaria strigosa
Phragmites australis
Selliera radicans
Smilax australis
Stephania japonica var. *discolor*
Viola banksii

2. The total species list of the community is considerably larger than that given above, with many species present at only one or two sites or in low abundance. The species composition of a site will be influenced by the size of the site, recent rainfall or drought conditions and by its disturbance (including fire, grazing, flooding and land clearing) history. The number and relative abundance of species will change with time since fire, flooding or significant rainfall, and may also change in response to changes in grazing regimes. At any one time, above-

ground individuals of some species may be absent, but the species may be represented below ground in the soil seed banks or as dormant structures such as bulbs, corms, rhizomes, rootstocks or lignotubers. The list of species given above is of vascular plant species, the community also includes micro-organisms, fungi, cryptogamic plants and a diverse fauna, both vertebrate and invertebrate. These components of the community are poorly documented.

3. Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions is known from parts of the Local Government Areas of Tweed, Byron, Lismore, Ballina, Richmond Valley, Clarence Valley, Coffs Harbour, Bellingen, Nambucca, Kempsey, Hastings, Greater Taree, Great Lakes, Port Stephens, Maitland, Newcastle, Cessnock, Lake Macquarie, Wyong, Gosford, Pittwater, Warringah, Hawkesbury, Baulkham Hills, Hornsby, Lane Cove, Blacktown, Auburn, Parramatta, Canada Bay, Rockdale, Kogarah, Sutherland, Penrith, Fairfield, Liverpool, Bankstown, Wollondilly, Camden, Campbelltown, Wollongong, Shellharbour, Kiama, Shoalhaven, Eurobodalla and Bega Valley but may occur elsewhere in these bioregions. Bioregions are defined in Thackway and Creswell (1995). Major examples once occurred on the floodplains of the Clarence, Macleay, Hastings, Manning, Hunter, Hawkesbury, Shoalhaven and Moruya Rivers.

4. Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions has a dense to sparse tree layer in which *Casuarina glauca* (swamp oak) is the dominant species northwards from Bermagui. Other trees including *Acmena smithii* (lilly pilly), *Glochidion* spp. (cheese trees) and *Melaleuca* spp. (paperbarks) may be present as subordinate species, and are found most frequently in stands of the community northwards from Gosford. Tree diversity decreases with latitude, and *Melaleuca ericifolia* is the only abundant tree in this community south of Bermagui (Keith and Bedward 1999). The understorey is characterised by frequent occurrences of vines, *Parsonsia straminea* (common silkpod), *Geitonoplesium cymosum* (scrambling lily) and *Stephania japonica* var. *discolor* (snake vine), a sparse cover of shrubs, and a continuous groundcover of forbs, sedges, grasses and leaf litter. The composition of the ground stratum varies depending on levels of salinity in the groundwater. Under less saline conditions prominent ground layer plants include forbs such *Centella asiatica* (pennywort), *Commelina cyanea*, *Persicaria decipiens* (slender knotweed) and *Viola banksii*; graminoids such as *Carex appressa* (tussock sedge), *Gahnia clarkei* (a saw-sedge), *Lomandra longifolia* (spiny-headed mat-rush), *Oplismenus imbecillis*; and the fern *Hypolepis muelleri* (batswing fern). On the fringes of coastal estuaries, where soils are more saline, the ground layer may include the threatened grass species, *Alexfloydia repens*, as well as *Baumea juncea*, *Juncus kraussii* subsp. *australiensis* (sea rush), *Phragmites australis* (common reed), *Selliera radicans* and other saltmarsh species. The composition and structure of the understorey is also influenced by grazing history, changes to hydrology and soil salinity and other disturbance, and may have a substantial component of exotic grasses, vines and forbs.

5. Unlike most other coastal floodplain communities, Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions are not a significant habitat for waterbirds (Goodrick 1970). However, they do sometimes provide food resources for the Glossy Black Cockatoo (*Calyptorhynchus lathami lathami*), and Yellow-tailed Black Cockatoo (*Calyptorhynchus funereus*) (Marchant and Higgins 1990). The fauna of Swamp Oak Floodplain Forest also includes the Squirrel Glider (*Petaurus norfolcensis*) and several species of frogs in the families Myobatrachidae (southern frogs) and Hylidae (tree frogs).

6. Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions forms part of a complex of forested wetland and treeless wetland communities found throughout the coastal floodplains of NSW. A recent analysis of available quadrat data from these habitats identified a distinct grouping of vegetation samples attributable to this community (Keith and Scott 2005). The combination of features that distinguish Swamp Oak Floodplain Forest from other endangered ecological communities on the coastal floodplains include: its dominance by a tree canopy of either *Casuarina glauca* or, more rarely, *Melaleuca ericifolia* with or without subordinate tree species; the relatively low abundance of *Eucalyptus* species; and the prominent groundcover of forbs and graminoids. It generally occupies low-lying parts of floodplains, alluvial flats, drainage lines, lake margins and fringes of estuaries; habitats where flooding is periodic and soils show some influence of saline ground water. This latter habitat feature sets it apart from other floodplain communities.

7. Swamp Oak Floodplain Forest may adjoin or intergrade with several other endangered ecological communities, which collectively cover all remaining native vegetation on the coastal floodplains of New South Wales. These include Lowland Rainforest on Floodplain in the NSW North Coast bioregion, Subtropical Floodplain Forest of the NSW North Coast bioregion, River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (including the formerly listed Sydney Coastal River-Flat Forest in the Sydney Basin bioregion), Swamp Sclerophyll Forest on Coastal Floodplains of

the NSW North Coast, Sydney Basin and South East Corner bioregions (including the formerly listed Sydney Coastal Estuary Swamp Forest in the Sydney Basin bioregion) and Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions. For example, in less saline habitats, Swamp Oak Floodplain Forest may adjoin or intergrade with several other endangered ecological communities including River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions and Subtropical Floodplain Forest of the NSW North Coast bioregion. The most saline forms of Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions may adjoin or intergrade with Coastal Saltmarsh of the NSW North Coast, Sydney Basin and South East Corner bioregions. The boundaries between these communities are dynamic and may shift in response to changes in hydrological regimes, fire regimes or land management practices (e.g. Johnston *et al.* 2003). The Determinations for these communities collectively encompass the full range of intermediate assemblages in transitional habitats.

8. A number of vegetation surveys and mapping studies have been conducted across the range of Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions. This community includes 'Sheoak Swamps' in the general coastal wetlands classification of Goodrick (1970). In the Tweed valley lowlands, this community includes '*Casuarina glauca* tall to very tall open to closed forest' (F10) of Pressey and Griffith (1992) and parts of the 'Floodplain Wetland Complex' (FL) that include *Casuarina glauca* with *Melaleuca* spp. (Pressey and Griffith 1992). In the Comprehensive Regional Assessment of the north-eastern NSW (NPWS 1999), areas mapped as 'Forest Ecosystem 143, Swamp Oak', fall within this community. In the lower Hunter valley, 'Swamp Oak - Rushland Forest' (map unit 40) and 'Swamp Oak Sedge Forest' (map unit 41) of NPWS (2000) fall within this community. On the Cumberland Plain, 'Riparian Woodland' (map unit 5) of Tozer (2003) and parts of 'Alluvial Woodland' (map unit 11) dominated by *Casuarina glauca* (Tozer 2003) are included within this community, while those parts of Benson's (1992) 'River Flat Forest' (map unit 9f) dominated by *C. glauca* also fall within this community, as do parts of the 'River-flat forests' of Benson and Howell (1990) and Benson et al. (1996) that are dominated by *C. glauca*. On the Illawarra Plain, 'Coastal Swamp Oak Forest' (map unit 36) of NPWS (2002) occurs within this community. In the Comprehensive Regional Assessment of southern New South Wales (Thomas *et al*. 2000), this community includes 'Coastal Wet Heath Swamp Forest' (forest ecosystem 24), 'South Coast Swamp Forest' complex (forest ecosystem 25) and those parts of 'Ecotonal Coastal Swamp Forest' (forest ecosystem 27) dominated by *Casuarina glauca.* In the Sydney - South Coast region, this community includes parts of 'Floodplain Swamp Forest' (map unit 105) dominated by *Casuarina glauca*, 'Estuarine Fringe Forest' (map unit 106) and 'Estuarine Creek Flat Scrub' (map unit 107) of Tindall *et al*. (2004). In the Eden region, this community includes 'Estuarine Wetland Scrub' (map unit 63) of Keith and Bedward (1999) and parts of 'Floodplain Wetlands' (map unit 60) that include *Casuarina glauca* or *Melaleuca ericifolia* (Keith and Bedward 1999). Swamp Oak Floodplain Forest South East Corner is included within the 'Coastal Floodplain Wetlands' vegetation class of Keith (2002, 2004). There may be additional or unmapped occurrences of Swamp Oak Floodplain Forest within and beyond these surveyed areas.

9. The extent of the Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions prior to European settlement has not been mapped across its entire range. However, one estimate based on a compilation of regional vegetation maps suggests that Coastal Floodplain Wetlands, which include Swamp Oak Floodplain Forest, currently cover 800-1400 km2, representing less than 30% of the original extent of this broadly defined vegetation class (Keith 2004). Compared to this combined estimate, the remaining area of Swamp Oak Floodplain Forest is likely to be considerably smaller and is likely to represent much less than 30% of its original range. Major occurrences include: less than 350 ha on the Tweed lowlands in 1985 (Pressey and Griffith 1992); less than 650 ha on the lower Clarence floodplain in 1982 (Pressey 1989a); less than 400 ha on the lower Macleay floodplain in 1983 (Pressey 1989b); less than 3200 ha in the lower Hunter - central Hunter region in the 1990s (NPWS 2000); less than 5200 ha in the Sydney - South Coast region in the mid 1990s (Tindall *et al*. 2004), including up to 4700 ha on the Cumberland Plain in 1998 (Tozer 2003) and less than 250 ha on the Illawarra Plain in 2001 (NPWS 2002); and less than 1000 ha in the Eden region in 1990 (Keith and Bedward 1999).

10. Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions has been extensively cleared and modified. Large areas that formerly supported this community are occupied by exotic pastures grazed by cattle, market gardens, other cropping enterprises (e.g. sorghum, corn, poplars, etc.) and, on the far north coast, canefields. On the Tweed lowlands, Pressey and Griffith (1992) estimated that less than 3% of the original Floodplain Wetlands and Floodplain Forest remained in 1985. Similar estimates are likely to apply to Swamp Oak Floodplain Forests in other parts of the NSW North Coast bioregion (Pressey 1989a, 1989b, NPWS 1999). In the lower Hunter - central coast region, less than 30-40% was estimated to have remained during the 1990s (NPWS 2000), while approximately 13% remained on the Cumberland Plain in 1998

(Tozer 2003). In the Sydney - South Coast region, less than 20% was estimated to remain in the mid 1990s (Tindall *et al*. 2004), in the Eden region about 30% was estimated to remain during the 1990s (Keith and Bedward 1999).

11. Land clearing continues to threaten Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions. A small minority of the remaining area occurs on public land (e.g. Pressey 1989a, b; Pressey and Griffith 1992), with most occurring on productive agricultural land or in close proximity to rural centres. The remaining stands are severely fragmented by past clearing and further threatened by continuing fragmentation and degradation, flood mitigation and drainage works, landfilling and earthworks associated with urban and industrial development, pollution from urban and agricultural runoff, weed invasion, overgrazing, trampling and other soil disturbance by domestic livestock and feral animals including pigs, activation of 'acid sulfate soils' and rubbish dumping (e.g. Pressey 1989a, b; Pressey and Griffith 1992, Boulton and Brock 1999, Johnson *et al*. 2003). Anthropogenic climate change may also threaten Swamp Oak Floodplain Forest if sea levels rise as predicted or if future flooding regimes are affected (IPCC 2001, Hughes 2003). Localised areas, particularly those within urbanised regions, may also be exposed to frequent burning which reduces the diversity of woody plant species. Clearing of native vegetation; Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands; Invasion of native plant communities by exotic perennial grasses; Predation, habitat destruction, competition and disease transmission by feral pigs; Anthropogenic climate change and High frequency fire are listed as Key Threatening Processes under the Threatened Species Conservation Act (1995).

12. Large areas of habitat formerly occupied by Swamp Oak Floodplain Forest have been directly drained by construction of artificial channels (e.g. Pressey 1989a, Boulton and Brock 1999). By the early 1900s, drainage unions or trusts were formed on the major floodplains to enable adjacent landholders to arrange for co-ordinated drainage systems, which were designed and constructed by the NSW Department of Public Works. Additional areas that have not been directly drained may have been altered hydrologically by changed patterns of flooding and drainage following flood mitigation works, particularly the construction of drains, levees and floodgates (Pressey and Griffith 1992). On the north coast of NSW, expansion of *Melaleuca quinquenervia* and *Casuarina glauca* into open floodplain swamps has been attributed to artificial drainage and shortening of the hydroperiod (Johnston *et al*. 2003, Stevenson 2003). There have also been anecdotal reports of recruitment by *Casuarina glauca* in pastures during extended dry periods, though not necessarily by other components of the community. These changes appear to be closely associated with enhanced acidity, altered ionic ratios, increased dissolved organic carbon and sulfide oxidation in the soil profile (Johnston *et al*. 2003). Alteration of tidal flows may have lead to decreased soil salinity and localised expansion of *Casuarina glauca* into areas that previously supported Coastal Saltmarsh or mangroves (Stevenson 2003).

13. Very few examples of Swamp Oak Floodplain Forest remain unaffected by weeds. The causes of weed invasion include physical disturbance to the vegetation structure of the community, dumping of landfill rubbish and garden refuse, polluted runoff from urban and agricultural areas, construction of roads and other utilities, and grazing by domestic livestock. The principal weed species affecting Swamp Oak Floodplain Forest include *Araujia sericiflora* (moth plant), *Asparagus asparagoides* (bridal creeper), *Baccharis halimifolia* (groundsel bush), *Cyperus eragrostis* (umbrella sedge), *Cinnamomum camphora* (camphor laurel), *Conyza* spp. (fleabanes), *Hydrocotyle bonariensis* (American pennywort), *Ipomoea cairica*, *I. purpurea* and *I. indica* (morning glories), *Lantana camara, Paspalum dilatatum* (paspalum), *Pennisetum clandestinum* (kikuyu) *Rubus fruticosis* agg. (blackberries), *Solanum pseudocapsicum* (Madeira winter cherry), *S. nigrum* (black-berry nightshade), *Tradescantia fluminensis* (wandering jew) and *Verbena bonariensis* (purpletop), (Tozer 2003, Keith and Scott 2005). In general, remaining examples of Swamp Oak Floodplain Forest from the most saline environments are in better condition, while those from less saline habitats are generally more degraded.

14. Small areas of Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions are contained within existing conservation reserves, including Stotts Island, Ukerebagh, Tuckean, Pambalong, Wamberal, Towra Point and Cullendulla Creek Nature Reserves and Bongil Bongil, Myall Lakes and Conjola National Parks. These occurrences are unevenly distributed throughout the range and unlikely to represent the full diversity of the community. In addition, wetlands within protected areas are exposed to hydrological changes that were, and continue to be initiated outside their boundaries. Some areas of Swamp Oak Floodplain Forest are protected by State Environmental Planning Policy 14, although this has not always precluded impacts on wetlands from the development of major infrastructure.

15. Given the dynamic hydrological relationship between Swamp Oak Floodplain Forest, Coastal Saltmarsh and other endangered ecological communities on coastal floodplains, future management of water and tidal flows may result in the expansion of some communities at the expense of others. Proposals for the restoration of natural hydrological regimes and for the rehabilitation of acid sulfate soils may also result in changes to the distribution and composition of floodplain communities. Co-ordinated planning and management approaches across whole catchments will be required to address and resolve priorities between different management objectives.

16. In view of the above the Scientific Committee is of the opinion that Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival or evolutionary development cease to operate.

Associate Professor Paul Adam

Chairperson

Scientific Committee

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About the NSW Scientific Committee

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River-flat eucalypt forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions - 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 River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions, as an ENDANGERED ECOLOGICAL COMMUNITY in Part 3 of Schedule 1 of the Act, and as a consequence to omit reference to Sydney Coastal River-Flat Forest from Part 3 of Schedule 1 of the Act. Listing of endangered ecological communities is provided for by Part 2 of the Act.

The Scientific Committee has found that:

1. River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions is the name given to the ecological community associated with silts, clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. Floodplains are level landform patterns on which there may be active erosion and aggradation by channelled and overbank stream flow with an average recurrence interval of 100 years or less (adapted from Speight 1990). River-Flat Eucalypt Forest on Coastal Floodplains generally occurs below 50 m elevation, but may occur on localised river flats up to 250 m above sea level in the NSW North Coast, Sydney Basin and South East Corner bioregions. The structure of the community may vary from tall open forests to woodlands, although partial clearing may have reduced the canopy to scattered trees. Typically these forests and woodlands form mosaics with other floodplain forest communities and treeless wetlands, and often they fringe treeless floodplain lagoons or wetlands with semi-permanent standing water (e.g. Goodrick 1970).

The composition of River-Flat Eucalypt Forest on Coastal Floodplains is primarily determined by the frequency and duration of waterlogging and the texture, nutrient and moisture content of the soil. Composition also varies with latitude. The community is characterised by the following assemblage of species:

Acacia floribunda
Acacia parramattensis
Acmena smithii
Adiantum aethiopicum
Angophora floribunda
Angophora subvelutina
Austrostipa ramosissima
Backhousia myrtifolia
Breynia oblongifolia
Bursaria spinosa
Casuarina cunninghamiana subsp. *cunninghamiana*
Casuarina glauca
Cayratia clematidea
Centella asiatica
Cheilanthes sieberi subsp. *sieberi*
Clematis aristata
Clematis glycinoides
Commelina cyanea
Cymbopogon refractus
Desmodium varians
Dichelachne micrantha
Dichondra repens
Digitaria parviflora
Doodia aspera
Echinopogon caespitosus var. *caespitosus*
Echinopogon ovatus
Einadia hastata
Einadia trigonos
Entolasia marginata
Entolasia stricta
Eragrostis leptostachya
Eucalyptus amplifolia
Eucalyptus baueriana
Eucalyptus benthamii
Eucalyptus botryoides
Eucalyptus elata
Eucalyptus grandis
Eucalyptus longifolia
Eucalyptus moluccana
Eucalyptus ovata
Eucalyptus saligna
Eucalyptus tereticornis
Eucalyptus viminalis
Euchiton sphaericus
Eustrephus latifolius
Galium propinquum
Geitonoplesium cymosum
Geranium solanderi
Glycine clandestina
Glycine microphylla
Glycine tabacina
Hardenbergia violacea
Hydrocotyle peduncularis
Hymenanthera dentata
Hypolepis muelleri
Imperata cylindrica var. *major*
Livistona australis
Lomandra filiformis
Lomandra longifolia
Lomandra multiflora subsp. *multiflora*

Melaleuca decora
Melaleuca styphelioides
Microlaena stipoides var. *stipoides*
Oplismenus aemulus
Ozothamnus diosmifolius
Paspalidium distans
Phyllanthus gunnii
Poranthera microphylla
Pteridium esculentum
Sigesbeckia orientalis subsp. *orientalis*
Stephania japonica var. *discolor*
Trema aspera
Vernonia cinerea
Viola hederacea
Melaleuca linariifolia
Melia azedarach
Opercularia diphylla
Oxalis perennans
Pandorea pandorana
Persicaria decipiens
Plectranthus parviflorus
Pratia purpurascens
Rubus parvifolius
Solanum prinophyllum
Themeda australis
Tristaniopsis laurina
Veronica plebeia
Wahlenbergia gracilis

2. The total species list of the community is considerably larger than that given above, with many species present at only one or two sites or in low abundance. The species composition of a site will be influenced by the size of the site, recent rainfall or drought conditions and by its disturbance (including fire, grazing, flooding and land clearing) history. The number and relative abundance of species will change with time since fire, flooding or significant rainfall, and may also change in response to changes in grazing regimes. At any one time, above-ground individuals of some species may be absent, but the species may be represented below ground in the soil seed banks or as dormant structures such as bulbs, corms, rhizomes, rootstocks or lignotubers. The list of species given above is of vascular plant species, the community also includes micro-organisms, fungi, cryptogamic plants and a diverse fauna, both vertebrate and invertebrate. These components of the community are poorly documented.

3. River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions is known from parts of the Local Government Areas of Port Stephens, Maitland, Singleton, Cessnock, Lake Macquarie, Wyong, Gosford, Hawkesbury, Baulkham Hills, Blacktown, Parramatta, Penrith, Blue Mountains, Fairfield, Holroyd, Liverpool, Bankstown, Wollondilly, Camden, Campbelltown, Sutherland, Wollongong, Shellharbour, Kiama, Shoalhaven, Eastern Capital City Regional, Eurobodalla and Bega Valley but may occur elsewhere in these bioregions. Bioregions are defined in Thackway and Creswell (1995). Major examples once occurred on the floodplains of the Hunter, Hawkesbury, Moruya, Bega and Towamba Rivers, although many smaller floodplains and river flats also contain examples of the community.

4. River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions has a tall open tree layer of eucalypts, which may exceed 40 m in height, but can be considerably shorter in regrowth stands or under conditions of lower site quality. While the composition of the tree stratum varies considerably, the most widespread and abundant dominant trees include *Eucalyptus tereticornis* (forest red gum), *E. amplifolia* (cabbage gum), *Angophora floribunda* (rough-barked apple) and *A. subvelutina* (broad-leaved apple). *Eucalyptus baueriana* (blue box), *E. botryoides* (bangalay) and *E. elata* (river perppermint) may be common south from Sydney, *E. ovat*a (swamp gum) occurs on the far south coast, *E. saligna* (Sydney blue gum) and *E. grandis* (flooded gum) may occur north of Sydney, while *E. benthamii* is restricted to the Hawkesbury floodplain. Other eucalypts including *Eucalyptus longifolia* (woollybutt), *E. moluccana* (grey box) and *E. viminalis* (ribbon gum) may be present in low abundance or dominant in limited areas of the distribution. A layer of small trees may be present, including *Melaleuca decora, M. styphelioides* (prickly-leaved teatree), *Backhousia myrtifolia* (grey myrtle), *Melia azaderach* (white cedar), *Casuarina cunninghamiana* subsp. *cunninghamiana* (river oak) and *C. glauca* (swamp oak). Scattered shrubs include *Bursaria spinosa* subsp. *spinosa* (blackthorn), *Solanum prinophyllum* (forest nightshade), *Rubus parvifolius* (native raspberry), *Breynia oblongifolia* (coffee bush), *Ozothamnus diosmifolius, Hymenanthera dentata* (tree violet), *Acacia floribunda* (white sally) and *Phyllanthus gunnii*. The groundcover is composed of abundant forbs, scramblers and grasses including *Microlaena stipoides* (weeping grass), *Dichondra repens* (kidney weed), *Glycine clandestina, Oplismenus aemulus, Desmodium gunnii, Pratia purpurascens* (whiteroot), *Entolasia marginata* (bordered panic), *Oxalis perennans* and *Veronica plebeia* (trailing speedwell). The composition and structure of the understorey is influenced by grazing and fire history, changes to hydrology and soil salinity and other disturbance, and may have a substantial component of exotic shrubs, grasses, vines and forbs.

5. River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions provides habitat for a broad range of animals, including many that are dependent on trees for food, nesting or roosting (Law *et al*. 2000a, b). These include cormorants (*Phalacrocorax* spp.) and egrets

(*Ardea* spp. and *Egrettia* spp.), the Osprey (*Pandion haliaetus*), Whistling Kite (*Haliastur sphenurus*), White-bellied Sea-eagle (*Haliaeetus leucogaster*), as well as the Brush-tailed Phascogale (*Phascogale tapoatafa*), Yellow-bellied Glider (*Petaurus australis*), Squirrel Glider (*Petaurus norfolcensis*) (Law *et al*. 2000a), Sugar Glider (*Petaurus breviceps*) and Grey-headed Flying Fox (*Pteropus poliocephalus*). The fauna of River-Flat Eucalypt Forest also includes a number of species of frogs in the families Myobatrachidae and Hylidae, particularly *Litoria* spp., and many species of forest birds including honeyeaters, kingfishers, cuckoos, owls, doves, whistlers and fantails.

6. River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions forms part of a complex of forested wetland and treeless wetland communities found throughout the coastal floodplains of NSW. A recent analysis of available quadrat data from these habitats identified a distinct grouping of vegetation samples attributable to this community (Keith and Scott 2005). The combination of features that distinguish River-Flat Eucalypt Forest on Coastal Floodplains from other endangered communities on the coastal floodplains include: its dominance by either a mixed eucalypt canopy or by a single species of eucalypt belonging to either the genus *Angophora* or the sections *Exsertaria* or *Transversaria* of the genus *Eucalyptus* (Hill 2002); the relatively low abundance or sub-dominance of *Casuarina* and *Melaleuca* species; the relatively low abundance of *Eucalyptus robusta*; and the prominent groundcover of soft-leaved forbs and grasses. It generally occupies central parts of floodplains and raised levees; habitats where flooding is periodic and soils are rich in silt, without deep humic horizons and show little or no influence of saline ground water.

7. River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions includes and replaces Sydney Coastal River-Flat Forest Endangered Ecological Community. River-Flat Eucalypt Forest on Coastal Floodplains may adjoin or intergrade with several other endangered ecological communities, which collectively cover all remaining native vegetation on the coastal floodplains of New South Wales. These include Lowland Rainforest on Floodplain in the NSW North Coast bioregion, Subtropical Floodplain Forest of the NSW North Coast bioregion, Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (including the formerly listed Sydney Coastal Estuary Swamp Forest in the Sydney Basin bioregion), Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions and Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions. For example, northwards from the Hunter valley, River-Flat Eucalypt Forest on Coastal Floodplains may intergrade with, or be replaced by, Subtropical Floodplain Forest of the NSW North Coast bioregion. As soil salinity increases, River-Flat Eucalypt Forest may adjoin or intergrade with Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions. The boundaries between all of these communities are dynamic and may shift in response to changes in hydrological regimes, fire regimes or land management practices. The Determinations for these communities collectively encompass the full range of intermediate assemblages in transitional habitats.

8. A number of vegetation surveys and mapping studies have been conducted across the range of River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions. In the Comprehensive Regional Assessment of the north-eastern NSW (NPWS 1999), areas that were mapped on coastal floodplains of the Manning River as 'Forest Ecosystem 47, Escarpment Red Gums' are included within this community. In the lower Hunter valley, 'Central Hunter Riparian Forest' (map unit 13), 'Wollombi Redgum-River Oak Woodland' (map unit 14) and 'Redgum Roughbarked Apple Swamp Forest' (map unit 38) of NPWS (2000) fall within this community. On the Cumberland Plain, 'Riparian Forest' (map unit 12) of Tozer (2003) and parts of 'Alluvial Woodland' (map unit 11) that are dominated by eucalypts (Tozer 2003) are included within this community. Benson's (1992) 'Camden White Gum Forest' (map unit 6d) and those parts of 'River Flat Forest' (map unit 9f) dominated by eucalypts also fall within this community, as do parts of the 'River-flat forests' of Benson and Howell (1990) and Benson *et al.* (1996) that are dominated by eucalypts. In the Warragamba catchment, small areas of 'Burragorang River Flat Forest' (map unit 88b) and 'Oakdale Alluvial Rough-barked Apple Forest' (map unit 88c) of NPWS (2002) are included within this community. On the south coast of NSW, this community includes those parts of 'Ecotonal Coastal Swamp Forest' (forest ecosystem 27) of Thomas *et al.* (2000) dominated by eucalypts, those parts of 'Coastal Lowlands Riparian Herb/Grass Forest' (forest ecosystem 48) and 'Southern Hinterland Shrub/Herb/Grass Riparian Forest' (forest ecosystem 49) of Thomas *et al*. (2000) mapped on alluvial soils, and those parts of 'Cumberland River Flat Forest' (map unit 33) and 'Floodplain Swamp Forest' (map unit 105) of Tindall et al. (2004) that are dominated by eucalypts. In the Eden region, this community includes forested parts of 'Floodplain Wetlands' (map unit 60) that are dominated by eucalypts and parts of 'Bega Wet Shrub Forest' (map unit 19) that are mapped on floodplains (Keith and Bedward 1999). River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and

South East Corner bioregions is included within the 'Coastal Floodplain Wetlands' vegetation class of Keith (2002, 2004). There may be additional or unmapped occurrences of River-Flat Eucalypt Forest on Coastal Floodplains within and beyond these surveyed areas.

9. The extent of the River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions prior to European settlement has not been mapped across its entire range. However, one estimate based on a compilation of regional vegetation maps suggests that Coastal Floodplain Wetlands, which include Temperate Eucalypt Forest on Coastal Floodplains, currently cover 800-1400 km2, representing less than 30% of the original extent of this broadly defined vegetation class (Keith 2004). Compared to this combined estimate, the remaining area of River-Flat Eucalypt Forest on Coastal Floodplains is likely to be considerably smaller and is likely to represent much less than 30% of its original range. Major occurrences include: about 2000 ha in the lower Hunter region in 1990s (NPWS 2000); less than 10 000 ha on the NSW south coast from Sydney to Moruya in the mid 1990s (Tindall et al. 2004), of which up to about three-quarters occurred on the Cumberland Plain in 1998 (Tozer 2003); and less than 1000 ha in the Eden region in 1990 (Keith and Bedward 1999).

10. River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions has been extensively cleared and modified. Large areas that formerly supported this community are occupied by exotic pastures grazed by cattle, market gardens and other cropping enterprises (e.g. turf). In the lower Hunter region, about one-quarter of the original extent was estimated to have remained during the 1990s (NPWS 2000), while less than one-quarter remained on the Cumberland Plain in 1998 (Tozer 2003). In the Sydney - South Coast region, less than one-fifth was estimated to remain in the late 1990s (Tindall et al. 2004), in the Eden region about 30% was estimated to remain during the 1990s (Keith and Bedward 1999).

11. Land clearing continues to threaten River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions. A small minority of the remaining area occurs on public land (e.g. Benson and Howell 1990), with most occurring on productive agricultural land or in close proximity to rural centres. The remaining stands are severely fragmented by past clearing and are further threatened by continuing fragmentation and degradation, flood mitigation and drainage works, landfilling and earthworks associated with urban and industrial development, pollution from urban and agricultural runoff, weed invasion, overgrazing, trampling and other soil disturbance by domestic livestock and feral animals including pigs, activation of 'acid sulfate soils', removal of dead wood and rubbish dumping (e.g. Benson and Howell 1990, Boulton and Brock 1999, Johnston *et al*. 2003). Anthropogenic climate change may also threaten River-Flat Eucalypt Forest on Coastal Floodplains if this affects future flooding regimes (IPCC 2001, Hughes 2003). Localised areas, particularly those within urbanised regions, may also be exposed to frequent burning which reduces the diversity of woody plant species. Clearing of native vegetation; Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands; Invasion of native plant communities by exotic perennial grasses; Predation, habitat destruction, competition and disease transmission by feral pigs; Anthropogenic climate change; High frequency fire; and Removal of dead wood and dead trees are listed as Key Threatening Processes under the Threatened Species Conservation Act (1995).

12. Very few examples of River-Flat Eucalypt Forest on Coastal Floodplains remain unaffected by weeds. The causes of weed invasion include physical disturbance to the vegetation structure of the community, dumping of landfill rubbish and garden refuse, polluted runoff from urban and agricultural areas, construction of roads and other utilities, and grazing by domestic livestock. The principal weed species affecting River-Flat Eucalypt Forest on Coastal Floodplains include *Anredera cordifolia* (madeira vine), *Araujia sericiflora* (moth plant), *Asparagus asparagoides* (bridal creeper), *Axonopus fissifolius* (narrow-leaved carpet grass), *Bidens pilosa* (cobbler's peg), *Cardiospermum grandiflorum* (balloon vine), *Cirsium vulgare* (spear thistle), *Conyza bonariensis* (flaxleaf fleabane), *C. sumatrensis* (tall fleabane), *Gleditsea triacanthos* (honey locust), *Hypochaeris radicata* (catsear), *Ipomoea* spp. (morning glories), *Lantana camara* (lantana), *Ligustrum lucidum* (large-leaved privet), *L. sinense* (small-leaved privet), *Lonicera japonica* (Japanese honeysuckle), *Macfaydyena unguis-cati* (cat's claw creeper), *Olea europea* subsp. *cuspidata* (African olive), *Plantago lanceolata* (plantain), *Rubus* fruticosis agg. (blackberries), *Senecio madagascariensis* (fireweed), *Senna pendula* var. *glabrata*, *Setaria parviflora* (slender pigeon grass), *Sida rhombifolia* (paddy's lucerne), *Sonchus oleraceus* (common sowthistle), *Tradescantia fluminensis* (wandering jew), *Verbena bonariensis* (purpletop), *Paspalum dilatatum* (paspalum), *P. urvillei* and *Pennisetum clandestinum* (kikuyu) (Tozer 2003, Keith and Scott 2005, J. R. Hosking, pers. comm.).

13. Small areas of River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions are contained within existing conservation reserves, including Blue

Mountains, Cattai, Dharug, Georges River, Marramarra, Morton, Deua and Wadbilliga National Parks, and Gulguer and Mulgoa Nature Reserves, and these are unevenly distributed throughout the range and unlikely to represent the full diversity of the community. The reserved examples are on localised, sheltered river flats between hills, rather than the large open floodplains that comprised the majority of the original habitat (Keith 2004).

14. In view of the above the Scientific Committee is of the opinion that River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival or evolutionary development cease to operate.

Associate Professor Paul Adam

Chairperson

Scientific Committee

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About the NSW Scientific Committee

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•Sydney Freshwater Wetlands in the Sydney Basin Bioregion - 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 Freshwater Wetlands in the Sydney Basin Bioregion as an ENDANGERED ECOLOGICAL COMMUNITY on Part 3 of Schedule 1 of the Act. The listing of Endangered Ecological Communities is provided for by Part 2 of the Act.

The Scientific Committee has found that:

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

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

- *Banksia robur*
- *Baumea articulata*
- *Baumea juncea*
- *Baumea rubiginosa*
- *Callistemon citrinus*
- *Casuarina glauca*
- *Cladium procerum*
- *Eleocharis sphacelata*
- *Empodisma minus*
- *Gahnia clarkei*
- *Gahnia sieberiana*
- *Gleichenia dicarpa*
- *Goodenia paniculata*
- *Hakea teretifolia*
- *Hypolepis muelleri*
- *Lepironia articulata*
- *Leptocarpus tenax*
- *Leptospermum juniperinum*
- *Lomandra longifolia*
- *Ludwigia peploides subsp. montevidensis*
- *Melaleuca linariifolia*
- *Melaleuca nodosa*
- *Melaleuca quinquenervia*
- *Melaleuca styphelioides*
- *Persicaria decipiens*
- *Persicaria strigosa*
- *Philydrum lanuginosum*
- *Phragmites australis*
- *Pteridium esculentum*
- *Restio tetraphyllus*
- *Schoenus brevifolius*
- *Triglochin procerum sensu lato*
- *Typha orientalis*
- *Villarsia exaltata*
- *Viminaria juncea*
- *Xanthorrhoea resinifera*

3. The total species flora and fauna list for the community is considerably larger than that given in 2 (above), with many species present in only one or two sites or in very small quantity. In any particular site not all of the assemblage listed in 2 may be present. Invertebrate species may be restricted to sediments for example. At any

one time, propagules and seeds of some species may only be present in the soil seed bank with no above-ground individuals present. The species composition of the site will be influenced by the size of the site, recent rainfall or drought conditions and by its recent disturbance history. The community includes vertebrates and invertebrates, many of which are poorly known.

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

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

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

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

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

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

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

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

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

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

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About the NSW Scientific Committee

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