Wungong River

Champion Drive to Armadale Road

Management Plan 2010 to 2015

August 2010

CITY OF Armadale

CONTENTS

Acknowledgements

The City of Armadale would like to acknowledge the following people who have contributed significantly to development of this draft Management Plan:

- Martin Gehrmann - who prepared a draft Wungong River Management Plan for the Armadale Gosnells Landcare Group and Palomino Reserve Catchment Group in 2003 and which has laid the foundation for this plan.
- Nicola Mincham who took on development of this plan as part of work experience for the City of Armadale;

EXECUTIVE SUMMARY

This draft Wungong River Management Plan is to address the following Action/ Objective from the City of Armadale's State of the Environment Report "*Prepare and implement management plans for the Canning and Wungong Rivers that address Swan River Trust objectives, revegetation and public use and enjoyment of the foreshores*".

This management plan incorporates the Wungong River south of Champion Drive and north to Armadale Road. North of Champion Drive and south of Armadale Road the River is under the jurisdiction of the Armadale Redevelopment Authority, and is covered by the Wungong Urban Water Project Master Plan.

The City has previously requested that the Swan River Trust extend the Swan Canning Riverpark from the City's boundary to Armadale Road. It is hoped that this Management Plan will assist the Trust in making a decision on this matter.

Much of the river's flow, structure and vegetation have been modified from the initial environment. It has been suggested that before 1900 the Wungong River was likely a series of disjointed wetlands but clearing and channelisation has modified this. Currently much of the river resembles a channel or drain with little to no native vegetation although areas on both sides of the river are undergoing rehabilitation, particularly around McNeil Road. The majority of flow into the river is from stormwater drains, several of which have catchments in urban areas and one originates from the Kelmscott Light Industrial Area. Theses drains flow directly into the river with no process of purification and introduce contaminants including nutrients, chemicals, metals and hydrocarbons. Also flowing into the river is the Riverside Lane Drain which in a 2005 survey of water quality produced output with high concentrations of nitrogen and low dissolved oxygen (Aquatic Science Branch, Department of the Environment, 2005). This management plan endeavours to manage the water quality within the reserve to the benefit of the river environment and the surrounding catchments.

Rehabilitation efforts along the river are currently being carried out by the Palomino Reserve Catchment Group and Armadale Gosnells Landcare Group. Both groups are working together to improve the riparian vegetation of the reserve by spraying for weeds and planting areas with native vegetation. Their efforts have restored the upper storey but the understorey is still badly affected by weeds. Within the reserve is the Bush Forever site 260,with Flooded Gum (*Eucalyptus rudis*) woodlands and Paperbark (*Melaleuca rhaphiophylla*) Low Forest which is considered regionally significant. The site is undergoing weed control but also requires rehabilitation. This management plan seeks to assist the Palomino Reserve Catchment Group and Armadale Gosnells Landcare Group in revegetation and weed control.

The Wungong River is used by the local community for passive and active recreation. The main forms of recreation are walking and equestrian activities. Active recreation occurs in Palomino Park which is dedicated to equestrian activities and has clubrooms for local equestrian groups. The reserve has trails throughout and it is the intention of this management plan to update these trails so they can accommodate a wider range of uses, including equestrian users, emergency vehicles, pedestrians and cyclists.

The eastern side of the river has recently been zoned Urban under the Metropolitan Region Scheme and this new zoning offers an opportunity to implement plans to make the reserve accessible to a greater variety of people whist still improving the River environment.

This Management Plan has identified a number of Strategic Directions, and actions that would assist in achievement of those directions, which are reproduced below.

Strategic Direction 1: Ensure uniform governance of land along the Wungong River.				
Action	***Category***	***Resource estimate***	***Lead Agency***	***Partners***
Action 1.1: Accept vesting of lands to the north of Lake Road, owned by the Western Australian Planning Commission subject to Area Assistance Grants being available to bring the land to a suitable standard.	2	Staff resources to seek and implement Area Assistance Grants.	CoA (Environment)	
Action 1.2: For Lots 901 and 883 McNeill Road, Champion Lakes seek Area Assistance Grants to construct a boardwalk, revegetate and install interpretive signs, and then accepting vesting for the Western Australian Planning Commission/ Department for Planning and Infrastructure lands.	2	Staff resources to prepare and implement Area Assistance Grants	CoA (Environment)	PRCG
Action 1.3: Lobby for extension of the Swan River Trust Riverpark from the City's boundary to Armadale Road.	2	Staff resources	CoA (Environment)	

Strategic Direction 2: Improve riparian vegetation along river, reduce the impacts of weeds and improve in stream fauna habitat.				
Action	***Category***	***Resource estimate***	***Lead Agency***	***Partners***
Action 2.1*:* Revegetate within a 15m buffer or up to the firebreaks on either side of the river.	1	Not costed as it is considered to be a long-term project. In 2008 it was estimated that without the use of volunteers revegetation (including weed control) cost about $11 per sqm.	AGLG	CoA
Action 2.2: Batter and revegetate the western bank in two locations (Figure 9) to increase the damp zone, which will assist in nutrient stripping and also create diverse habitats for birds and fish.	5	Requires the approval from the Department of Indigenous Affairs and a Section 18 permit which take significant resources. Not costed.	AGLG	CoA
Action 2.3: Undertake a regular weed control program spraying yearly with herbicides to facilitate rehabilitation and maintain existing revegetated areas.	4	Annual cost for weed control within the Reserve currently between $20,000 - $25,000 (Estimate from AGLG).	AGLG CoA	

Strategic Direction 3: Improve the water quality of the Wungong River by supporting initiatives to reduce contamination at source, monitor associated drains and utilize on-site wetlands to maximize opportunity for water quality improvement.				
Action	***Category***	***Resource estimate***	***Lead Agency***	***Partners***
Action 3.1: Encourage local land owners to participate in the Swan-Canning Property Planning courses and seminars to manage nutrients on their properties.	3	The City may assist the Heavenly Hectares program with direct marketing to rural living properties that drain into the Wungong River.		CoA
Action 3.2 : Convert Riverside Lane drain to an open drainage channel and lay channel with woodchips to decrease the high levels of nitrogen and increase dissolved oxygen.	5	Seek external funding.	CoA	
Action 3.3: Consider implementing the Fertilise Wise program within the Wungong River catchment if the program review shows it works successfully in North Forrestdale.	3	Currently North Forrestdale costs $40 per household.	CoA	SERCUL
Action 3.4: Apply the Better Urban Water Management framework to new urban development in the Wungong River catchment so that the quality of water reaching the Wungong River is of the highest quality practicable.	2	Implement through the planning process	CoA	
Action 3.5: Replace weedy grass basins with native sedge and rush beds to strip nutrients and re-establish the relationship between the floodplains and the Wungong River.	5	This is a future project of the Palomino Reserve Catchment Group	PRCG AGLG	CoA
Action 3.6: Assess the feasibility of redirecting open stormwater drains to a wetland systems to remove nutrients to prior to discharge into the river, as shown in Figure 9.	5	Revegetation cost estimated at $11 per sqm in 2008.	PRCG AGLG	CoA
Action 3.7: Establish a program to monitor, document and evaluate the water quality within the reserve and the effectiveness of implemented projects (e.g. wetlands).	5	Refers to Actions 3.5 and 3.6.	PRCG AGLG	CoA

Strategic Direction 4: Manage fuel loads to protect life and property (including fuel loads created through revegetation efforts), and protect revegetation efforts from fire.				
Action	***Category***	***Resource estimate***	***Lead Agency***	***Partners***
Action 4.1: Utilise mechanical or other low environmental impact methods to maintain fuel load to 6 tonnes per hectare and 4 tonnes per hectare for a least 10m either side of	4	Current management requirement of the City, budget implementation not considered within this Plan.	CoA	

trails.				

Strategic Direction 5: Design and implement a circular trail system that can be used by pedestrians, cyclists, equestrian users and emergency vehicles along the river between Armadale Road and Champion Drive, as per Figure 8 that includes interpretive signage.				
Action	***Category***	***Resource estimate***	***Lead Agency***	***Partners***
Action 5.1: Upgrade current trail between Arabian Court and Ranford Road (Figure 10).	1	Upgrade estimate $20,000 to $30,000 (including installation of bollards every 100m). Annual maintenance - $6,600 based on an annual cost of $1/m².	CoA	
Action 5.2: Investigate logistics and costs of building a circular trail system which can accommodate all users, including emergency vehicles (Figure 8).	5	Initial construction and installation - $342,000 based on a 3,800 length x 3m width at $30/m². Annual maintenance - $8,550 based on an annual cost of $0.75/m². Estimated construction and installation of box culvert bridges at $10,000 each (based on 1.2 x 1.2 reinforced concrete box culverts with a hard stand surface).	CoA (Civil Works & Parks)	
Action 5.3: Seek funding sources to build long term circular trail system and the associated bridges, as per Figure 8.	5	Staff resources to apply for external funding and project management.	CoA	
Action 5.4: Design and install interpretive sign(s) and housing to provide information to the public about the natural resources of the area	5	$4 000, including installation per each A-frame.	CoA	
Action 5.5: Construct a river viewing platform with interpretive signage.	5	Initial construction and installation – $15,000 based on $150/m² for a 100m² platform. Annual maintenance - $1000 based on $10/m².	CoA	

1. INTRODUCTION AND BACKGROUND

The City of Armadale's State of the Environment Report 2005 identified the following Action/ Objective "*Prepare and implement management plans for the Canning and Wungong Rivers that address Swan River Trust objectives, revegetation and public use and enjoyment of the foreshores*". The risk of not investing in this action was identified as losing the opportunity to combine the City's investment with other funds to achieve greater outcomes. The desired start date of 2005/ 06 was delayed for a number of reasons, but it is now considered timely to prepare a draft Wungong River Management Plan.

1.1. Rationale for area covered by management plan

The area covered by the draft Management Plan extends from Champion Drive south to Armadale Road (Figure 1).

North (downstream) of Champion Drive the Wungong River is in the Champion Lakes redevelopment area which is under the jurisdiction of the Armadale Redevelopment Authority. Rehabilitation of the Wungong River is required by environmental conditions relating to the Champion Lakes redevelopment area.

South of Armadale Road (upstream) the area on both sides of the Wungong River is also under the jurisdiction of the Armadale Redevelopment Authority, and is covered by the Wungong Urban Water Project Master Plan and subsidiary plans such as the Wungong Foreshore Management Plan.

In between Champion Drive and Armadale Road (i.e. the area covered by this draft Management Plan), all the land along the Wungong River is reserved Parks and Recreation in the Metropolitan Region Scheme and apart from one property on Ranford Road and two properties just before Armadale Road are either vested in the City of Armadale or owned freehold by the Western Australian Planning Commission/ Department for Planning and Infrastructure (see Figure 2).

Land use change is also about to occur in this vicinity as a result of Metropolitan Region Scheme Amendment 1140/57 which recently rezoned the Rural zoned land on the eastern side of the Wungong River from Champion Drive to Lake Road to Urban.

1.2. Swan Canning Riverpark and the Swan River Trust

The Swan Canning Riverpark is a river reserve which is managed jointly by the Swan River Trust and various other agencies. At present the Riverpark ends at the City's northern boundary.

Previously the City has lobbied that the Riverpark be extended past Tonkin Highway to Armadale Road. The extension of the Riverpark to include this section of the Wungong River is considered beneficial, allowing for greater expertise in management and the possibility of increased funding.

It is hoped that this management plan, which addresses the Swan and Canning Riverpark objectives of restoration, conservation and long term planning for ecological and community use will assist the Trust in its decision to extend the Riverpark.

1.3. Public Participation

The process of preparing the management plan included consultations with the local community, key stakeholders and City staff.

Prior to the Draft Wungong River Champion Drive to Armadale Road Management Plan 2010 - 2015 being released for public comment the City of Armadale Manager Parks, Manger Ranger and Emergency Services, Environmental Coordinator and Environmental Officer, reviewed the proposed management plan.

The Draft Wungong River Champion Drive to Armadale Road Management Plan 2010 – 2015 was available for comment for a six-week public consultation period from 24 September 2009 to 5 November 2010 (T76/9/09). During the public review period:

- advertisements were published in the Comment News and Weekend Examiner,
- the City's Bushcare and Environmental Advisory Committee were notified of the consultation period and provided access to copies of the document,
- the document was available on the City's website for members of the public to download,
- a copy of the management plan was sent to each landholder adjacent to the Reserve, and
- copies were sent to relevant Government agencies for comment.

4 submissions were received. Appendix 7 provides a list of submitters, summary of the submissions and response to submissions highlighting changes made to the Management Plan in response to the document.

This plan was adopted by Council (T60/08/10) 9 August 2010 as follows:

> *That Council adopt the Wungong River Champion Drive to Armadale Road Management Plan 2010-2015.*

2. EXISTING ENVIRONMENT

2.1. Statutory and strategic planning framework and surrounding land use

As noted in the introduction the Wungong River is reserved Parks and Recreation in the Metropolitan Region Scheme and Parks and Recreation (Regional) in the City of Armadale's Town Planning Scheme No. 4. The Metropolitan Region Scheme reservation means that over time the remaining private land will be acquired by the Western Australian Planning Commission.

Land on either side of the Wungong River between Champion Drive and Lake Road was developed as an equestrian estate many years ago, and this is reflected in the pattern of Parks and Recreation (Local) zoning and subdivision which provides for trails for equestrian use (e.g. the strip behind Lots 70 & 71 Poad Street). Equestrian use appears to be a dominant land use in the area currently.

Land to the west of the river is zoned Rural Living 2, which means that a minimum lot size of 2ha applies, and uses are limited to rural uses compatible with small lot sizes.

The eastern side of the river has recently been zoned Urban under the Metropolitan Region Scheme but under the City's Town Planning Scheme No. 4, it has yet to be rezoned. Under the *Planning and Development Act 2005*, if a region scheme is inconsistent with a local planning scheme (such as the City's Town Planning Scheme No. 4) the local government is to initiate a local planning scheme amendment within 90 days that renders the scheme consistent with the region scheme. In the interim the Metropolitan Region Scheme prevails. At the time of writing (December 2008) the City was awaiting applications from landholders to initiate rezoning that contain detailed information such as a proposed Structure Plan that identifies amongst other things the pattern of roads and public open space in the area.

The surrounding land use affects recreational needs and drainage water quality. There will be an increasing need to cater for passive recreation (i.e. walking) whilst still maintaining equestrian uses.

2.2. Bush Forever and Conservation Category Wetlands

Bush Forever site 260 identifies about 840m of the Wungong River south of Champion Drive as regionally significant river (Figure 3). Bush Forever site 260 extends north of Champion Drive to the City of Armadale boundary.

Vegetation in the Bush Forever site is indentifed as Flooded Gum *Eucalyptus rudis* woodlands with Paperbark *Melaleuca rhaphiophylla* Low Forest to Low Woodland, Wattle *Acacia saligna* and Marri *Corymbia calophylla* Woodlands on the higher ground and scattered Loose Flower Rush *Juncus pauciflorus* (Government of Western Australia, 2000).

As Bush Forever site is considered regionally significant it can be argued it should have a greater priority for investment, particularly in relation to restoration, recreation and conservation. However, investment is also driven by the willingness of community volunteers to assist in river rehabilitation works.

There are three conservation category wetlands to east of but generally adjacent to the reserve. These wetlands, situated just south of the Bush Forever site, have a good understory and represent

an area which could act as a seed source. The sites are on private property which has recently been zoned Urban and are not covered in this management plan as they are protected by existing policy.

2.3. Historical context, topography and hydrography/ flooding

It is probable that in the 1900's what is now the river was a series of discontinuous wetlands created by runoff from the Darling Range. A study of the area south of Armadale Road to the City's southern boundary along the current alignment of the river showed that in the 1900's watercourses were largely discontinuous (Figure 4), and channelisation of the watercourses to a more formal drainage system occurred over time with most works having been completed before 1970 (Armadale Redevelopment Authority, 2006). In this context, determination of historical environmental flows is problematic, and there should perhaps be more of a focus on recreating wetland habitat.

The Wungong River within the reserve is flat having a fall of only 1.7m over 3000m (i.e. 1:1765) from Ranford Road to Allen Road, based on survey of 20cm contours. This minimal level of slope adds weight to the view that the river was a series of discontinuous wetlands.

The implications associated with the reserve being so flat are that water moves slowly, large areas are inundated when water levels rise and the river can flow upstream in response to large flows from adjacent urban areas.

The reserve is on the north-eastern edge of the Jandakot Groundwater Mound. On average groundwater moves through the soil at less than 100 meters per year to discharge into wetlands, rivers and streams. The Perth Groundwater Atlas (accessed 16 February 2009 at www.water.wa.gov.au/idelve/gwa) shows that at Palomino Park the historical maximum groundwater level is 23m AHD, and that at May 2003 the groundwater level was 21m AHD, and the information tool that provides information about depth to groundwater recorded groundwater level as 21m AHD but noted that "Estimates may fluctuate between 0.5 and 3m due to seasonal variation". The land contours along the floodplain only have a height of about 22m. In periods when groundwater levels are high, areas along the river can become waterlogged as groundwater flows into the river.

Figure 5 shows the 1:100 year floodway and floodplain. The 1:100 year floodplain is 450m at its widest point between Poad Street and Lake Road. The floodway is approximately 100m wide (50m on either side of the bank), and roughly correlates to the park boundaries. The channel width also varies. At its widest, near McNeill Road the channel is approximately 15m but it can be as narrow as 5m.

The implication of the flat reserve and floodway boundaries is that any proposals for pedestrian access along the reserve need to be located on the highest possible ground to maintain year-round access and use.

Numerous stormwater drains also enter the river from the surrounding semi rural and urban areas (Figure 2). In one case the stormwater drain prevents access along the river.

2.4. Soils

Figure 6 shows the soil types present in the immediate vicinity of the Wungong River. The area dissects the eastern boundary of the Bassendean System (Bs) and the western boundary of the Pinjarra System (Pj). The major soil type in this region consist of deep well drained uniform brownish sands or loams subject to periodic flooding. Others include red and yellow duplex soils and well-drained deep bleached grey sands with an iron-organic hardpan at 1-2m depth (Agriculture WA, 2000). Small patches of Muchea Limestone are believed to be located within the reserve near the McNeill road bridge. The soil associated with this limestone is brown to black in colour and has small limestone cobbles intermixed through out the soil horizon. Surrounding areas were mined for limestone during the early 1900's for fertiliser and evidence for this is seen with numerous old quarry pits located along Twelfth road in Armadale.

The main implication of the soil types is in relation to nutrient runoff from surrounding land uses. The Pinjarra Plain soils are characterised by "drainage channels that allow nutrients fast access to watercourses", and the low permeability means that "nutrient run-off may be higher than for many bleached sands" (Agriculture Western Australia, 2000). The Bassendean soils are characterised by low nutrient retention, particularly phosphorus.

The sandy soils on the western side have a low ability to hold nutrients because of their low iron and aluminium oxide content. The primary mechanism of nutrient discharge into the Wungong Brook is via vertical leaching to the shallow groundwater table and lateral leaching in waterlogged sandy soils and rivers (Swan River Trust, 2000).

Nutrient shedding is a major problem in the Palomino Reserve Catchment. Following heavy rainfall, the export rate of phosphorus is significantly increased when runoff forms sheet flow across the low-lying soils of the western catchment (Swan River Trust, 2000). Landholders and hobby farmers must be encouraged to address land use and practices in the area in order to reduce the nutrient loading from fertiliser application and manure deposits. Left unchecked, the area will continue to shed nutrients over land into the nearest waterway.

2.5. Remnant Vegetation

The fringing vegetation of the Wungong River bears little resemblance to the natural vegetation that once occurred in the area. In 2003 most of the native species had disappeared or drastically declined in abundance, leaving only the dominant trees and a few relic shrubs and sedges (Figure 7). Whilst significant revegetation efforts along most of the river have restored the upper storey, the understorey is still badly affected by weeds.

The vegetation structure and abundance throughout the reserve are varied. For this reason, the river foreshore can be broken up into four sections. Photos of these sections are found in Appendix 1.

<u>SECTION 1: Champion Drive to McNeill Road</u>

This section contains the Bush Forever site number 260. There is scattered Flooded Gum (*Eucalyptus rudis*) with Paperbark (*Melaleuca rhaphiophylla*) in Low Forest to Low Woodland, Wattle (*Acacia saligna*) and Marri (*Corymbia calophylla*) (Government of Western Australia, 2000). Woodlands are also present on the higher ground. This section contains very little native understorey, the majority of which is composed of scattered patches of Loose Flower Rush (*Juncus*

pauciflorus) and small Robin Red Breast Bush (*Melaleuca lateritia*) (Government of Western Australia, 2000). Also contained along the banks of the river are areas which have maintained their native riparian vegetation of rushes such as Loose Flower Rush (*Juncus pauciflorus*).

This section of the reserve contained two stands of Swamp Cypress (*Actinostrobus pyramidalis*).

To the east of this section of the reserve are three conservation category wetlands, in the general area of Arabian and Bay Court.

The Armadale Gosnells Landcare Group has undertaken revegetation works on land vested with the Western Australia Planning Commission north of McNeill Road.

SECTION 2: McNeill Road to Poad Street Bridge

The reserve has been extensively cleared for grazing during the last century. The entire understorey has been removed and a large majority of the overstorey vegetation has also been removed.

The remnant vegetation in this section includes scattered Paperbarks (*Melaleuca rhaphiophylla*, *Melaleuca preissiana*) and Broom bush (*Melaleuca uncinata*), which partially line the riverbank and floodplain. There are one or two Marri (*Eucalyptus calophylla*) on the upper edge of the floodplain and a small grove of Marri near McNeill Road Bridge. Small clumps of Loose Flower Rush (*Juncus pauciflorus*), Pale Rush (*Juncus pallidus*) and Centella (*Centella cordifolia*) line the riverbanks and floodplain.

Much of the vegetation observed now along this section of river is the result of extensive revegetation by the Armadale Gosnells Landcare Group and Palomino Reserve Catchment Group. This revegetation involved the planting of native over and understorey species including Banksia, Acacias, extensive regeneration of Paperbarks (*Melaleuca rhaphiophylla*) and increasing the proportion of native rushes along the riverbanks.

SECTION 3: Poad Street Bridge to the corner of Lake and Ranford Road

This section of river has sparse Freshwater paperbark (*Melaleuca rhaphiophylla*) and Modong (*Melaleuca preissiana*) with the occasional Marri (*Eucalyptus calophylla*) on the up slopes and a few Robin red breast bushes (*Melaleuca lateritia*), acting as the understorey.

Some *Melaleuca rhaphiophylla* from a previous regeneration effort exists along the top of the banks. At one point the channel had been split creating an island which supports large *Melaleuca rhaphiophylla*. The understorey along this section is sparse with a few areas that have retained native riparian vegetation in the form of rushes lining the banks.

The Armadale Gosnells Landcare Group have weed control and revegetation works scheduled for 200/10 in this section of the reserve. At the time of writing this Plan, they were in the process of applying for approval to undertake works through the Department of Indigenous Affairs under Section 18 of the *Aboriginal Heritage Act.*

SECTION 4: Lake Road to Armadale Road

This section of the river is structurally similar to that of Section 1, Champion Drive to McNeil Road, with the exception that the vegetation is generally contained close to or within the river channel. The

width of the riparian vegetation varies from an estimated 15m on either side of the river to under 5m. The overstorey of widespread paperbarks (*Melaleuca rhaphiophylla*) and scattered Flooded Gum (*Eucalyptus rudis*) shade the river which contains a few areas of native riparian rushes. There is little native understorey within this section of the reserve.

It is also of note that whilst the majority of the Reserve is owned by the City of Armadale there is one property Lot 1 Ranford Road at the corner of Lake and Ranford Road which is still privately owned. From observations the native riparian vegetation on this privately owned land is sparse. There is an estimated 117m of waterway within the bound of this property about 50m of which has little observable riparian vegetation, native or introduced. The remaining vegetated areas have between 10-17m of overstorey vegetation lining the river. The estimation of the riparian vegetation widths are calculated from measurements of aerials photographs and thus the condition of the understorey has not been mapped. It was observed that much of the understorey is in a degraded condition or has been totally replaced by weeds.

2.6. Aquatic vegetation

The aquatic vegetation growing in the Wungong River is commonly referred to as macrophytes. Most macrophytes are attached to the river bottom by their roots in the sediment but some are free floating with their roots in the water for example *Salvinia sp.* (Water and Rivers Commission, 2001). The species that grow within the reserve include: Ribbon Weed (*Vallisneria americana*), Water Thyme (*Hydrilla verticillata*), Slender Knotweed (*Persicaria decipiens*) and *Potamogeton javanicus* (Sainty *et al,* 1994).

2.7. Fauna

There have been no systematic surveys of the fauna in the area; however members of the community and the Palomino Reserve Catchment Group have recorded fox sightings and casual bird sightings within the reserve. Some of the common birds include: Wagtails, Swallows, Magpies and Ringneck Parrots. During winter, a different selection of birds has been sighted. These include the White-faced heron, Pacific Black Duck, Purple Swamp hen and Straw -necked Ibis (personal comm. Ian Simpson (PRCG)). A bird species list compiled around 2003 is provided as Appendix 2. Nocturnal fauna includes bats, species unidentified at present.

There are numerous frog species, which inhabit the surrounding floodplain. Some of the calls identified include the Slender Tree frog (*Litoria adelaidensis*), the Banjo frog (*Limnodynastes dorsalis*), the Motorbike frog (*Litoria moorei*) and the Clicking frog (*Crinia glauerti*). Tiger snakes (*Notechis scutatus*) have also been recorded in the area (personal comm. Ian Simpson (PRCG)).

Storey (1998) conducted a fish and fish habitat survey of the Canning River and its tributaries. Out of 17 sites surveyed, McNeill Road Bridge, Wungong River (within management area) was the only site where there was an absence of native freshwater fish species. The introduced mosquito fish (*Gamboosia holbrooki*) was the only recorded fish species.

Volunteer groups sampled the Wungong River for macro-invertebrates in 2002. Macro-invertebrates can be used as an indicator of river health. From a number of samples, the Wungong River was found to have a low variety of aquatic macro-invertebrates. Some of them included

freshwater snails, ostracods, mosquito larvae, copepods, freshwater shrimps, water mites and diving beetles.

2.8. Water quality

High levels of dissolved nutrients encourage the growth of algae and algal blooms, which are common in some waterways and are a direct result of excess nutrients. These blooms result in decreases in the dissolved oxygen content of the water and can cause decreases aquatic productivity. Low dissolved oxygen is also a significant problem in watercourses, especially if the watercourse is slow flowing and results in the river being unable to support a larger proportion of aquatic biota.

Historically, the standard practice has been to channel runoff directly into surface waters, with little or no treatment, via open or closed stormwater drains. In the process, natural purification processes are bypassed and the potential for serious adverse effects on water quality arises, involving a wide variety of oxygen demanding substances, nutrients, bacteria, suspended solids and toxic compounds.

The Williams Road Main Drain has a catchment of 270ha with 70% of that being suburban housing. Drainage systems such as the Williams Road Main Drain contribute quantities of non-point source pollutants. Being unable to pinpoint the sources of pollutants concerned (e.g. fertilisers, hydrocarbons and particulates from road surfaces and motor vehicles, and accidental spillages of chemicals, construction sites and excrement of domestic pets, urban runoff), water quality is difficult to control. The Armadale Gosnells Landcare Group received funding from the City of Armadale and Water Corporation to undertake rehabilitation works in a section of the drain west of Seville Grove.

The Champion Drive drain flows into the river just south of the Champion Drive Bridge and is an open drain from the corner of Champion Drive and Lake Road in Armadale. This stormwater drain originates in the Kelmscott Light Industrial Area, which could present numerous opportunities for potentially polluting businesses to affect water quality. Industries that may contribute to point source pollution can include motor mechanics, metal fabrication, spray painters and petrol stations.

A 2005 snapshot survey of water quality flowing out of drains into the river indicated that Riverside Lane Drain produced output with high concentrations of nitrogen and low dissolved oxygen (Aquatic Science Branch, Department of the Environment, 2005). Fortunately the outflow from the Riverside Lane Drain is relatively low so the overall load of nutrients reaching the Wungong River is also low. The City sought the Swan River Trust's advice on possible methods to reduce the impact this outflow has on the Wungong River, including how best to maximise the impact of natural purification processes**.**

2.9. Land Use History

2.9.1. European Land use

The land along the Wungong River was first cleared in the 1830's and 1840's for cattle grazing and dairies. Most of the Wungong River passes through semi-rural areas, which are becoming increasingly urbanized and industrialized consistent with the Southern River/Forrestdale/Brookdale/ Wungong District Structure Plan.

Up until the early 1980's, the Public Works Department classified this section of river as a drain and regularly dredged the river channel.

In 1991, in response to pressure from some local landowners concerned about constant flooding in the Palomino Reserve area, the City of Armadale conducted large-scale earthworks along some sections of the river to remove sediment and weed growth from the channel to prevent flooding. The original channel was approximately 4m wide and 1.5m deep. This was widened to 10-12m and deepened to 2m. Channel widening is clearly evident upstream of McNeill road bridge to Poad Street bridge. The Caring for the Canning Management Plan (2001) states that "…*this part of the river has been straightened and resembles little more than a drain with virtually no ecological value*". From Ranford Road, northwards along the west side of the river, the City of Armadale filled, levelled and revegetated the area with *Eucalypts*, *Casuarina* and *Melaleuca* species indigenous to eastern Australia during 1991.

In 1999, in response to a request from the (now) Armadale Gosnells Landcare Group the City of Armadale requested adjacent landholders fence their property boundaries to provide public access to the river between Poad Street and McNeill Road for revegetation and community use.

At present, the reserve is commonly used as an exercise area for the equestrian clubs and by surrounding land and horse owners. There is one interconnected bridle trail within the management area.

2.9.2. Indigenous land use

A search of the Aboriginal Heritage Inquiry System on the Department of Indigenous Affairs website found that the Wungong River is on the Register of Aboriginal Sites as a mythological site (S02601). This site is protected under the *Aboriginal Heritage Act 1972*, providing restrictions on what can be done to the land. Development on an Aboriginal Site requires consent from the Minister for Indigenous Affairs under Section 18 of the Act.

Information contained in the Report on an Ethnographic Survey of the Williams Road Main Drain/ Lake Road culvert upgrade, Lake Road, Armadale (2000) states that the closest registered Aboriginal site, known as Southern River (S02601) is 200m away. The report states that this site (S02601) is an important spiritual dreaming place for the local aboriginal people and should be promoted as an important place of aboriginal heritage. This information was reviewed in 2008 from the Department of Indigenous Affairs website and the classification of the Southern River site remains current.

2.10. Recreation and access

The Wungong River is used by the local community for passive and active recreation. The main forms of recreation are walking and equestrian activities. Active recreation occurs in Palomino Park which is dedicated to equestrian activities and has clubrooms for local equestrian groups.

The Wungong River can be accessed through Ranford Road, Lake Road, Palomino Place, McNeill Road, Bay Court, Arabian Court and Mustang Road. Currently pedestrian and vehicular access is through a series of informal paths and the bridal trails that cross the reserve.

At present there are two bridal paths within the reserve. The first is between McNeil Road and the Palomino Reserve, and is also used by pedestrians. The second trail is on the opposite side of the river and extends from Poad Street Bridge to McNeil Road; this trail is not accessible for pedestrians because it crosses a relatively large stormwater drain. In addition there is also another trail from Palomino Reserve to Ranford Road, which appears to have been designed for pedestrians.

2.11. Existing land managers and their roles

2.11.1. City of Armadale

The City's role in respect to this section of river includes a strategic planning role to maximise the opportunity for the reserve to be used for public recreation. In this regard, the City's Strategic Trail Network Plan 2004 identifies a trail between Champion Drive and Armadale Road as an indicative long-term unfunded trail (Figure 8). This draft Management Plan represents another strategic planning step.

The City has not historically been involved in revegetation and river restoration activities except where these are done in partnership, usually with a community group. For watercourses, the City invests significantly in the Armadale Gosnells Landcare Group, who in this section of the Wungong River often works with the Palomino Reserve Catchment Group to undertake revegetation and river restoration activities. In general, the City supports revegetation and river restoration activities only where it is reasonably confident that it will have the resources to maintain the works so the investment of community groups is not lost. Ongoing maintenance is a key role of the City in this section of river. This draft management plan does not propose changing the status quo.

2.11.2. Department for Planning and Infrastructure/ Western Australian Planning Commission

Currently the Western Australian Planning Commission owns in freehold title four lots which are part of the area reserved for Parks and Recreation. Whilst not policy, the Commission aims to revest the acquired land in local government authorities. This revesting is dependent on a variety of factors including the City's willingness to manage the lands, the proportion of lands acquired and any ongoing capital works. At present none of the land vested in the Commission is in the process of being revested.

As a long term goal the Department of Planning and Infrastructure will endeavour to acquire the remaining privately owned land in the area reserved for Parks and Recreation and revest this land in the local government if approached. In the shorter term the Department/Commission has indicated it is willing to lease the lands under their control to the City for 25 years until they acquire the remaining lots.

2.11.3. Palomino Reserve Catchment Group and Armadale Gosnells Landcare Group

The Palomino Reserve Catchment Group plays an important role in the rehabilitation of the reserve and has as its vision:

"To create and maintain a pollution free watercourse and environs rich in local vegetation, fauna and aesthetic beauty, for the enjoyment of the present and the future generations"

The objectives of the Palomino Reserve Catchment Group are:

- To re-establish the relationship between the floodplain and the watercourse;
- To revegetate the reserve with local species to provide shade to the river and increase the biodiversity of the area;
- To enhance the sedge and rush beds throughout the reserve to facilitate stripping of nutrients into the waterway;
- To create an enjoyable reserve for multi-use recreational activities with emphasis on conservation and education.
- Educate the public about river restoration, management and rehabilitation.

The Palomino Reserve Catchment Group considers the reserve to be of conservation, recreation and educational significance and value it as a site for public and regional use. The management goals of the group are:

a) Rehabilitation and Conservation
Enhancement of the floodplains environmental value by restoring the local riparian vegetation and degraded areas to a stable condition.

b) Recreation
Provide the public with a recreational area on the river foreshore, in a manner compatible with rehabilitation, conservation and education, for a wide variety of users.

c) Education and Community Involvement
Encourage the use of Palomino Reserve (public open space) for educational purposes, as a focus for broader education about the importance of river systems and management issues.

As the Palomino Reserve Catchment Group is not an incorporated body, the Armadale Gosnells Landcare Group acts as a trustee for the funds received for projects within the reserve.

This partnership allows the Armadale Gosnells Landcare Group to supply funds for various projects and work in tandem with the Palomino Reserve Catchment Group to achieve the Armadale Gosnells Landcare Group's vision:

"To protect, rehabilitate and enhance areas of degraded bushland and foreshores through the promotion of conservation and community involvement.

In most cases the Armadale Gosnells Landcare Group acquires funds for various projects and whenever possible encourages and organises volunteer groups to carry out theses projects. In relation to the Wungong River existing projects of the Armadale Gosnells Landcare Group are:

- Restore the native foreshore vegetation to enhance the biodiversity and habitat
- Improve water quality by increasing nutrient stripping from the Reserve
- Implement a weed control management program
- Encourage and assist community groups in rehabilitation and protection of the Reserve

The Armadale Gosnells Landcare Group has recently received funding for rehabilitation of the Wungong River from the Swan Alcoa Landcare Program, Main Roads Western Australia, Water Corporation, Department of Environment and Conservation, and City of Armadale.

2.12. Existing and proposed projects

Both the Palomino Reserve Catchment Group and the Armadale Gosnells Landcare Group are active in the Wungong Reserve and have ongoing and future projects which merit acknowledgement within this management plan.

The Palomino Reserve Catchment Group is keen to excavate two large damp zones within Section 2, McNeill Rd and Poad St Bridge. These zones would be formed by excavating at a gentle decline to the river and would be revegetated. Damp zones act in a similar way to wetlands in that they can partly purify the water before it enters the river and will also provide an important habitat for riverine species. The two sites are displayed in Figure 9.

The Palomino Reserve Catchment Group is also keen to excavate a larger area and create an artificial wetland to incorporate four drains between Poad Street and Randford Road. This proposed site for an artificial wetland involves moving the open stormwater drains in addition to excavation.

Currently the Armadale Gosnells Landcare Group is involved in revegetation efforts from McNeil Road Bridge to 330m upstream of Poad Street. The Swan Alcoa Landcare Program (SALP) has been funding this project since 2006. The Armadale Gosnells Landcare Group anticipates that they will continue to apply for funding for rehabilitation and restoration work along the Wungong River for the foreseeable future.

The Armadale Gosnells Landcare Group is also under contract with the City of Armadale and Water Corporation to revegetate and undertake weed control along a section of Williams Road Main Drain west of Seville Drive.

In 2009/ 2010 the Armadale Gosnells Landcare Group and the Palomino Resereve Catchment Group the continued to revegetate corridor in the areas south of Poad Street and continued extensive weed control between McNeil Road and Poad Street.

In 2008 Armadale Gosnells Landcare Group recieved funding from the Water Corporation to offset the new pumping station and this funding is to be spent on revegetation efforts within the reserve.

The Armadale Gosnells Landcare Group is also rehabilitating 1.23ha of reserve to the north of McNeil Road which is vested in the Western Australian Planning Commission. The Commission and Main Roads Western Australia are funding the weed control and revegetation project being undertaken on the site. The Armadale Gosnells Landcare Group intends to continue revegetatation with SALP funding in 2010 and continue weed control in 2010/ 2011 with funding from the Western Australian Planning Commission.

The Palomino Reserve Catchment Group and the Armadale Gosnells Landcare Group both aim to revegetate and carryout weed control on areas south of Poad Street Bridge, and they are presently in the process of revegetating the reserve north to McNeill Road.

Both groups have expressed support for improved trails along the Wungong River.

3. MANAGEMENT ISSUES AND RECOMMENDATIONS

3.1. Governance and tenure

Strategic Direction 1: Ensure uniform governance of land along the Wungong River.

As can be seen in Figure 2, the City of Armadale currently manages the large majority of land in this section of the river, and as indicated in Section 2.8.3 above, the Department for Planning and Infrastructure does not intend being a long-term manager. The current situation leads to different rules and jurisdictions applying on different parts of the Wungong River, depending on land ownership or vesting.

As noted above, ultimately all the remaining private land along the river will be acquired by the Department for Planning and Infrastructure/ Western Australian Planning Commission as landholders become willing sellers. As there is no ongoing negotiation for the acquisition of this land at present it is not possible to determine when this land will be acquired.

Prior to accepting vesting for the land the City would want the Reserve to be a suitable standard and this can be achieved through Department for Planning and Infrastructure Area Assistance Grants. These grants would be used to complete capital works outlined within this management plan. The works sought for this area include a proposed boardwalk though wetland areas (Figure 8) thus minimising human impact to these ecosystems, and possibly interpretive signage along the boardwalk.

It is the intention of the City to request the remaining lands from the Department of Planning and Infrastructure.

Whilst a multitude of governance arrangements have worked successfully (e.g. the Canning River Regional Park is managed jointly by the Department of Environment and Conservation and the City of Canning), having one land owner with primary responsibility for coordinating on-ground activity and managing misuse of the reserve is considered desirable for this section of the Wungong River.

Action 1.1

Accept vesting of lands to the north of Lake Road, owned by the Western Australian Planning Commission subject to Area Assistance Grants being available to bring the land to a suitable standard.

Desired start date	***Notes***	***Resource estimate***
Ongoing	Determination of a suitable standard is site specific and will be determined by the Manager Parks and Environmental Coordinator on a case by case basis.	Staff resources to seek and implement Area Assistance Grants.

Action 1.2 For Lots 901 and 883 McNeill Road, Champion Lakes seek Area Assistance Grants to construct a boardwalk, revegetate and install interpretive signs, and then accepting vesting for the Western Australian Planning Commission/ Department for Planning and Infrastructure lands.		
Desired start date	***Notes***	***Resource estimate***
2011		Staff resources to prepare and implement Area Assistance Grants

The new *Swan and Canning Rivers Management Act 2006* includes provisions relating to the establishment and responsibility for management of the Swan Canning Riverpark. The boundaries of the Riverpark are determined by Regulation which can be amended following consultation by the Minister for the Environment with other relevant Ministers. The Act makes the control and management of vested crown land in the Riverpark the joint responsibility of the Swan River Trust and the agency in which the reserve is vested, and encourages collaborative arrangements (with the approval of the Minister for the Environment) that are directed towards the protection and enhancement of the ecological and community benefits and amenity of the Riverpark. The Act therefore enables the Swan River Trust to jointly manage or jointly develop and fund projects in the Riverpark.

The City of Armadale considers that inclusion of the portion of the Wungong River covered by this Management Plan in the Riverpark would be beneficial, potentially providing expertise and funds for joint projects consistent with the Management Plan. The City has already written to the Swan River Trust suggesting that the Riverpark should be extended from the City's boundary (where it currently finishes) upstream to Armadale Road. The City intends to continue to lobby to achieve extension of the Riverpark to Armadale Road.

Action 1.3 Lobby for extension of the Swan River Trust Riverpark from the City's boundary to Armadale Road.		
Desired start date	***Notes***	***Resource estimate***
2011		Staff Resources

3.2. Restoration of local vegetation

Strategic Direction 2: Improve riparian vegetation along the river, reduce the impacts of weeds and improve in stream fauna habitat.

Modification of the river (see Section 2.6.1 above) has led to considerable problems. Much of the channel has minimal fringing vegetation and is thus deprived of the benefits that fringing vegetation provides. The vegetation of the riparian zone plays an important role in the river ecosystem by supplying food to aquatic fauna, controlling the drainage of water, stripping of nutrients and other minerals into the river provide shade to keep water temperatures low and stabilise the banks (Swan River Trust, 2000). The fish habitat survey by Storey (1998) also showed that there is a direct correlation between overhanging vegetation and the presence of native fish species. The area north of Poad St Bridge clearly depicts the results of channel modification with the area now heavily weed infested and beginning to narrow as a result of sediment deposition.

Any restoration works need to be mindful of Water Corporation infrastructure within the area. Consideration of management works undertaken on any Water Corporation infrastructure, or which might impact on this infrastructure would need to be considered by the Water Corporation prior to any works.

Action 2.1 Revegetate within a 15m buffer or up to the firebreaks on either side of the river as recommended by the Fish and Fish Habitat Survey Report (1998).		
Desired start date	***Notes***	***Resource estimate***
Ongoing	The buffer needs to consist of overstorey, middlestorey, understorey, groundcovers, sedges and rushes. *Refer to Appendix 3 for species list.* Revegetation is also important in maintaining a low groundwater table and thus reducing the probability of the stream becoming saline, and for nutrient stripping.	Not costed as it is considered to be a long-term project. In 2008 it was estimated that without the use of volunteers revegetation (including weed control) cost about $11 per sqm.

Action 2.2: Batter and revegetate the western bank in two locations (Figure 9) to increase the damp zone, which will assist in nutrient stripping and also create diverse habitats for birds and fish.		
Desired start date	***Notes***	***Resource estimate***
Possible future action	Requires the approval from the Department of Indigenous Affairs and a Section 18 permit.	Section 18 permits take significant resources. Not costed.

3.3. Weeds

Weeds are introduced plants that grow out of control in areas where they do not naturally occur. Weeds in the Wungong River cause a variety of inter-related problems. These include:

- Loss of flora and fauna biodiversity;
- Loss of ecosystems;
- Loss of indigenous vegetation;
- Loss of available habitat for fauna;
- Prevention of natural regeneration of local species;
- Increase in fire hazard due to seasonal dead plant material; and
- Blocking of the natural water flow leading to bank erosion and sedimentation.

There are a number of weed species within the management area. A list of the species is in Appendix 4. Weeds of immediate concern include Couch grass (*Cynadon dactylon*) Kikuyu grass (*Pennisetum clandestinum*), Bulrush (*Typha orientalis*), Arum lily (*Zantedeschia aethiopica*), Deadly Nightshade (*Solanum nigrum*), Cape Tulip (*Homeria flaccida*), Pie Melon (*Citrullus lanatus*), Echium plantagenium (Patersons Curse) and Watsonia (*Watsonia spp.)*.

The Palomino Reserve Catchment Group has piloted the technique of lining the riverbanks with thick rubber matting to smother and eradicate weeds from small sections of the river. Results to date indicate that the rubber matting is effective in removing all weed growth on the banks before revegetating areas. This method whilst effective is no longer in active use as there were concerns of possible contamination from the recycled rubber, which had been previously used in mining.

Action 2.3 Undertake a regular weed control program spraying yearly with herbicides to facilitate rehabilitation and maintain existing revegetated areas.		
Desired start date	***Notes***	***Resource estimate***
Ongoing	In the long-term need to direct efforts to establishing an understory that minimises need for weed control.	Annual cost for weed control within the Reserve be estimated at between $20,000 - $25,000 (Estimate from AGLG).

3.4. In-stream fauna habitat

The Fish and Fish Habitat Survey conducted on behalf of the Upper Canning Southern/ Wungong Catchment Team by the University of Western Australia, on Section 2 (McNeill Rd to Poad St) of the Wungong River showed that there were no native fish species in that section of the reserve. The main reason for this was the absence of riparian vegetation (Storey, 1998). It indicated that the sites with little riparian cover receive more sunlight, are hotter and have unsuitable oxygen levels for survival of aquatic fauna. The area was also void of large woody debris, bedrock, emergent plant life, boulders and cobbles, all of which provide native fish habitat.

Part of this section of river (upstream of Poad Road) has been revegetated, and lined with large woody debris. This large woody debris was added with the aim of creating a more meandering path for the flow of the river and pools of water behind the logs. The debris would modify the structure of the river and thus allowing for a more varied habitat. As such the large woody debris has not achieved its purpose within the Wungong River, although it has been successfully implemented in the Canning River. Through observation it seems that the woody debris is less effective in the Wungong because the river's flow is far slower, thus it is not producing the desired results. This may be in part because the Wungong River was probably a series of disconnected wetlands and is very flat.

Therefore the City has not recommended further re-introduction of large woody debris, but would not object if further projects were implemented in accordance with Department of Water guidelines (i.e. the Water and River's Commission's River Restoration Manual) at no cost to the City.

3.5. Water Quality

Strategic Direction 3: Improve the water quality of the Wungong River by supporting initiatives to reduce contamination at source, monitor associated drains and utilize on-site wetlands to maximize opportunity for water quality improvement.

3.5.1. Source management – surface water

Rural Living areas

In the Palomino catchment there is small-scale livestock grazing and numerous horse/hobby farms. Traditional land use practices contribute significant amounts of organic and inorganic Nitrogen (N) and Phosphorus (P) to the river each year. For example, a typical mature horse will excrete 49kg N and 1kg P in urine and 13kg N and 5kg P in manure per year, a significant proportion of which can leach/runoff into the river unless adequate property management occurs. Excess nutrients that enter the river contribute to algal blooms and the associated odour, water deoxygenation and midge problems.

Action 3.1 Encourage local land owners to participate in the Swan-Canning Property Planning courses and seminars to manage nutrients on their properties.		
Desired start date	***Notes***	***Resource estimate***
Ongoing	The City may assist the Heavenly Hectares program with direct marketing to rural living properties that drain into the Wungong River. Great Garden Workshops also run in the City also address this problem.	

Existing residential areas

Residential areas also can contribute significant amounts of pollutants to the waterways from fertilisers, cleaning agents and car waste. As noted in Section 3.8 above, Riverside Lane Drain has discharges low volumes of water with high concentrations of nitrogen, and the City has sought advice from the Swan River Trust on water treatment options

The North Forrestdale behaviour change program Fertilise Wise is aimed at reducing the amount of nitrogen and phosphorous entering our water ways by educating residents to use Fertilise Wise branded products to enhance plant growth rather than using high water soluble fertilisers. This program aims to modify the behaviour of community members by promoting the use of fertilisers which have lower water solubility, a higher capacity to develop overall soil nutrition and health, and a capacity to hold nutrients. The program commenced in late 2008 and will be evaluated on an ongoing basis, with a full review about three years into the program.

Action 3.2 Convert Riverside Lane drain to an open drainage channel and lay channel with woodchips to decrease the high levels of nitrogen and increase dissolved oxygen.		
Desired start date	***Notes***	***Resource estimate***
Possible future action	Suggested by the Swan River Trust. Potential to be achieved through the Urban Waterways Program through Federal funding commitment, inconjunction with the City, Department of Water and the Swan River Trust.	Approx. $200,000 project to be potentially achieved through Federal funding sources.

Action 3.3 Implement the Fertilise Wise program within the Wungong River catchment if the program review shows it works successfully in North Forrestdale.		
Desired start date	***Notes***	***Resource estimate***
2012	This project should be implemented depending on the success of the North Forestdale trial.	$40 per household.

Future residential areas

Land adjoining the eastern side of the reserve from Champion Drive to Lake Road has recently been rezoned Urban and as such the amounts and types of pollutants will change over the period of this Management Plan. Pre 2008 the area was zoned Rural Living 2 and thus the pollutants were similar to those already discussed under rural living. As the land is subdivided and built upon the impact of pollution from hobby farmers will be reduced but overall pollution from nutrients is expected to increase (Kitsios and Kelsey, 2008). As the area is subdivided and built upon leaching from septic tanks will be reduced as the area becomes sewered.

The Better Urban Water Management framework that integrates water management into the planning system should be applied to new urban development in the Wungong River catchment with a focus on ensuring that best practice is applied so that quality of water reaching the Wungong River is of the highest quality practicable. The Better Urban Water Management document includes water quality management and stormwater modelling criteria.

Action 3.4 Apply the Better Urban Water Management framework to new urban development in the Wungong River catchment so that the quality of water reaching the Wungong River is of the highest quality practicable.		
Desired start date	***Notes***	***Resource estimate***
Ongoing	Implement through the planning process	

Industrial areas

The catchment for the Wungong River includes the Kelmscott Light Industrial Area, the presence of which could result in a potentially greater proportion of contaminants. At present the City has a program to inspect industrial areas and is entering into discussion with the Perth NRM, which also undertakes similar inspections, with the aim of enhancing their current program. The City is also in discussion with the Laggard project which is funded by SERCUL. The Laggard project aims to develop strategies for working with the poorest environmental performing light industrial, small and micro, businesses.

3.5.2. Source management - groundwater

As indicated in Section 2.3 "Historical context, topography and hydrography/ flooding" in periods when groundwater levels are high, areas along the river can become waterlogged as groundwater flows into the river.

Sandy soils are predominant in the western side of the catchment and have virtually no capacity to retain phosphorus. In many areas of the management area, the groundwater table is less than one meter from the surface and absorption indices for phosphate are very low (1-10).

Restoration of vegetation along the Wungong River has the potential to improve the quality of groundwater before it reaches the river. Proposed actions to restore vegetation are outlined in 3.2 above. Establishment of wetlands may also help improve ground water quality before it reaches the river.

3.5.3. Potential use of wetlands to improve water quality

The use of natural or created wetlands in water purification has been standard practice for sewerage treatment for many years and has had mixed success for treatment of stormwater partly due to the nature of stormwater flow being highly variable. Several studies have indicated that the bioretention capacities of vegetation and soils of wetlands can reduce the levels of nitrogen, phosphorous and metal contaminants in drain outflows.

One constructed wetland to treat stormwater flows which has been a success is the Liege Street Wetland, the construction of which began in 2004. The objectives of this wetland's construction were to reduce the effects of autumn first flush, (which washes contaminants accumulated in summer into the river), to also reduce the effect of summer baseflow, and the flow from the ground water into drains. In both accounts the wetland was a success reducing both nitrogen and phosphorus levels throughout the year, particularly the baseflows.

It is important to note that not all constructed wetlands are as successful as the Liege Street wetland due to differences in stream flow, design, and overall aims.

There are three locations where wetlands or damp zones could potentially be situated within the reserve (Figure 9). All three would require earthworks and revegetation efforts before they could function as an active and productive wetland. The two potential damp zones have been discussed under section 4.5.3 Restoration of local vegetation.

The third proposed wetland land (Figure 9), upstream of Palomino Reserve would require earthworks, redirecting two open storm water drains and extensive revegetation activities. This wetland is smaller and is situated differently then the site proposed by the Palomino Reserve

Catchment Group but it is considered to be a more beneficial to the City and the reserve. The proposed site incorporates the largest of the drains and a natural spring, within a pre-existing depression. It is estimated that the wetland would be 2,100sqm in area once completed and require the removable of approximately 1,000m^3 of soil.

It is intended that the outcome of proposed wetland in improving the water quality of the river influence later decisions in relation to converting the remaining drains in that area into a single wetland.

Action 3.5 Replace weedy grass basins with native sedge and rush beds to strip nutrients and re-establish the relationship between the floodplains and the Wungong River.		
Desired start date	***Notes***	***Resource estimate***
	This a future project of the Palomino Reserve Catchment Group	

Action 3.6 Assess the feasibility of redirecting open stormwater drains to a wetland systems to remove nutrients to prior to discharge into the river, as shown in Figure 9.		
Desired start date	***Notes***	***Resource estimate***
2013	Idea proposed by PRCG. Will require moving the flow of two drains. Dependent upon the assessment of the feasibility of redirecting open stormwater drains.	Revegetation cost estimated at $11 per sqm in 2008.

3.5.4. Water quality monitoring

As previously discussed the water quality of the River greatly depends upon and is affected by drain flow from surrounding areas. A program to monitor the water quality of the reserve, wetlands and surrounding drains would allow a greater understanding into the health of the river, particularly the success of the wetlands in improving the quality of flow into the river.

Action 3.7 Establish a program to monitor, document and evaluate the water quality within the reserve and the effectiveness of implemented projects (e.g. wetlands).		
Desired start date	***Notes***	***Resource estimate***
Possible future action	Scientifically valid (i.e. to a level to enable statistical significance of changes to be determined) water quality and invertebrate monitoring requires specialist expertise not held by the City of Armadale. A reduced program could be undertaken using the Rivers of Blue methodology could be carried out by PRCG and assisted by AGLG.	

3.6. Fire

Strategic Direction 4: Manage fuel loads to protect life and property (including fuel loads created through revegetation efforts), and protect revegetation efforts from fire.

Responsibility for fire management rests with the City of Armadale as the landowner. The City of Armadale has responsibility for the preparation of fire management plans, risk and hazard assessment, prevention measures, fire safety equipment and inspections.

The assets vulnerable to fire include:

- Native trees and shrubs within the reserve
- Newly planted revegetation areas
- Club house and associated training area for Pony Club
- Neighbouring residential areas
- Park furniture

Generally neighbours and the PRCG consider the risk of fire ignition moderate because the area is under reasonable surveillance and fuel loads over a significant portion of the site are managed by mowing. The risk of fires entering the reserve from the outside is also assessed as moderate. It is likely that the risks of fire will increase both as the area is more readily used and as the surrounding rural properties are developed urban.

The recommended best management practice (BMP) guide is *Fire Management Planning for Urban Bushland – A Guide for Landowners, Fire Officers and Bushland Friends Groups* by the Fire and Emergency Services Authority (1999). There are two main concerns for fire management within the reserve, firstly access, which will be addressed in section 4.7 Recreation and Access and secondly fuel loading. For optimum safety the fuel load with in the reserve should be less than 6 tonnes per hectare. An additional decrease of 2 tonnes per hectare for a 10m radius on either side of trails would assist in emergency vehicle access.

Action 4.1 Utilise mechanical or other low environmental impact methods to maintain fuel load to 6 tonnes per hectare and 4 tonnes per hectare for a least 10m either side of trails.		
Desired start date	***Notes***	***Resource estimate***
2010	To be assessed annually by City's Ranger and Emergency Services section just prior to commencement of fire season. Is a consideration when revegetating.	

3.7. Recreation and Access

Strategic Direction 5: Design and implement a circular trail system that can be used by pedestrians, cyclists, equestrian users and emergency vehicles along the river between Armadale Road and Champion Drive as per Figure 8 that includes interpretive signage.

At present there is no appropriate trail to use along the entire length of the Wungong River. From Palomino Reserve to Ranford Road is a grassed trail suitable for the majority of pedestrians but between the Palomino Reserve and McNeil Road pedestrians rely on the reserve being mowed and parts of the route consists of sandy areas.

Pedestrian and vehicular access to the reserve is via Ranford Road, Lake Road, Poad Street, McNeill Road, Bay Court, and Arabian Court and a series of bridle trails, which traverse the reserve. Pedestrian and vehicle access along the length of the reserve is limited by private landholdings that abut the river and drains that cross the reserve.

The reserve is currently used as a bridle and walk trail by members of the community. It is envisaged that over time the existing trail system will eventually be upgraded to an appropriate standard to cater for walkers, cyclists and equestrian users, as well as to provide access for emergency vehicles.

The feasibility of various standards of tracks would need to be investigated during the design stage and prior to construction of any trails.

In the City's Strategic Trail plan a tentative trail has been shown along the Wungong River. This plan suggests trails along Armadale Rd, the Wungong River and Champion Drive. The long term trail system (Figure 8) would be to an appropriate standard to incorporate all users, including emergency vehicles, but the funds are not yet available to build this. In the short term a less ambitious trail (Figure 10) would be constructed to facilitate use of the reserve by pedestrians.

How to minimise conflict between equestrian and pedestrian trail users is an issue that will become more important over time as the eastern side of the river becomes Urban and will need to be considered by the City in the future.

When proposing a route for both the short-term and long term trails, Figure 10 and 8, several additional factors were considered beyond high ground. Placing sections of the trail at a slightly lower height, and thus closer to the river was decided on as a better alternative because the trail

would then make best use of the reserves natural surroundings and pre-existing trails, particularly between Palomino Reserve and Ranford Road. Additionally the proposed short-term trail does not follow the River the entire way but rather a bridal trail behind several lots so as to avoid crossing over a private bridge and driveway at Lots 70 and 71. On the opposite side of the private bridge is an area of Crown land and thus there is no difficulty continuing the walk along the river.

Action 5.1 Upgrade current trail between Arabian Court and Ranford Road as of Figure 10.		
Desired start date	***Notes***	***Resource estimate***
2010	There is already an established pathway used mainly for equestrian purposes on the western side. Past Poad Street Bridge (private property) the trail also includes bridges over the drains and park benches	Upgrade estimate $20,000 to $30,000 (including installation of bollards every 100m). Annual maintenance - $6,600 based on an annual cost of $1/m².

Action 5.2 Investigate logistics and costs of building a circular trail system which can accommodate all users, including emergency vehicles as per Figure 8.		
Desired start date	***Notes***	***Resource estimate***
2010	Pathway is required to be at least 3m wide to accommodate small emergency vehicles	Initial construction and installation - $342,000 based on a 3,800 length x 3m width at $30/m². Annual maintenance - $8,550 based on an annual cost of $0.75/m².

Action 5.3 Seek funding sources to build long term circular trail system and the associated bridges, as per Figure 8.		
Desired start date	***Notes***	***Resource estimate***
	Potential funding sources through grants such as Department of Sport and Recreation Trails Grants Program and Lotterywest.	Staff resources to apply for funding and project management.

3.8. Signage and Interpretation

The installation of interpretive signage and signage housing can raise public awareness of ecological issues concerned with the reserve. Proposed signage could describe information about local plants and animals, a brief history of the reserve or the Palomino Reserve Catchment Group. An opportunity exists to construct a viewing platform, which would overlook the river and could also house the interpretive signage.

Some potential subjects for the signs include safe usage of the multiuse path, particularly in relation to pedestrians and horses. Other possible subjects include details of the river restoration and the problems that weeds and introduced species present. The Palomino Reserve Catchment Group suggested signage should encourage the respect for private properties adjacent to the reserve.

Action 5.4 Design and install interpretive sign(s) and housing to provide information to the public about the natural resources of the area		
Desired start date	***Notes***	***Resource estimate***
Possible future action	See design in Appendix 5: Interpretive Signage Housing River viewing platform could be incorporated into a boardwalk though a section of the wetland	$4 000, including installation per each A-frame.

Action 5.5 Construct a river viewing platform with interpretive signage.		
Desired start date	***Notes***	***Resource estimate***
Possible future action	See design in Appendix 5: River Viewing Platform. Only likely with external funding.	Initial construction and installation – $15,000 based on $150/m² for a 100m² platform. Annual maintenance - $1000 based on $10/m².

4. MONITORING AND EVALUATION – RIVER REHABILITATION

Monitoring and evaluation are important elements of river rehabilitation because they show why some efforts succeed, why some fail and what can be done to improve the chances of success in the future. Monitoring is the gathering of information. Monitoring may involve observing or measuring change and is often the raw material or data used for evaluation. Evaluation is an assessment of the effectiveness of a project against pre-defined objectives. It is usually based on some form of monitoring, but unlike monitoring, evaluation involves an assessment of the projects success or failure.

A summary of monitoring indicators, methods and the evaluation process that could be used are listed below.

Monitoring	• Partnerships formed • Level of public awareness • Number of people involved in project
Indicators	• Abundance of native species with riparian buffer strip • Weed abundance within reserve • Stream cover (% cover/shade) • Seedling growth (% established) • Macro-invertebrate diversity • Native fish abundance and diversity • In-stream habitat types
Monitoring Methods	• The 'Stream Condition Index' can be used to rate the overall condition of the riparian zone. • Photographs should be taken of the river every year during spring (Photo points). • Native fish monitoring should commence one year after the installation of large woody debris. It would also assess the habitat diversity of the river. • Water quality monitoring such as measuring salinity, dissolved oxygen, turbidity, temperature, pH and conductivity.
Evaluation Evaluation Process	• Use stream condition index to check for change • Use photographs to validate change • Is there a water quality improvement? • Was the rehabilitation successful? • Is there a need for improvement? • Is there a need for further rehabilitation?

Monitoring and evaluation provides tangible evidence of the present ecological health of the reserve and would enable results to be reported to stakeholders.

5. IMPLEMENTATION AND COSTING

5.1. Potential Funding Sources

Council allocated funding will not be enough to cover the cost of the proposed works in the reserve. Funding from external sources must be sought, however the City will be required to allocate budget for ongoing maintenance costs. The sources of funding could include:

- Lotteries Commission (Gordon Reid Foundation)
- Ministry for Sport and Recreation (TrailsWest)
- Swan Alcoa Landcare Program (SALP)
- Environmental Community Grants (Department of Environment and Conservation)
- Water Corporation
- Caring For Our Country (Federal funding)
- Lotterywest

5.2 Summary of Strategic Directions and proposed actions

The Plan provides for a number of recommendations for the effective management of the Reserve during the immediate future.

The following implementation plan provides a guide to the actions of the plan, priorities, resource estimates and responsible organisations, in order to ensure all necessary actions can be achieved.

Definitions of the type of works and timelines for the priorities are:
Category 1: On-ground works and capital works with a high priority for implementation. Action 2.1 is an on-going long-term project.
Category 2: Planning processes that require staff resources to implement however, have no budget associated with them. These can be implemented in the short term, however, the processes involved will take considerable time to be complete.
Category 3: Education and monitoring programs considered to be long-term projects to be implemented as opportunities arise.
Category 4: Ongoing maintenance works that are required to maintain the area to a standard for use by the public. It is anticipated that these maintenance costs would reduce as the area becomes established.
Category 5: Possible future actions reliant on external funding.

Successful implementation of the actions in the plan will require partnerships between the City of Armadale (CoA), Armadale Gosnells Landcare Group (AGLG), Palomino Reserve Catchment Group (PRCG) and South East Regional Centre for Urban Landcare SERCUL.

The following table is the Strategic directions and proposed actions from the draft Wungong River Management Plan.

Summary of Strategic Directions and proposed actions

Strategic Direction 1: Ensure uniform governance of land along the Wungong River.				
Action	***Category***	***Resource estimate***	***Lead Agency***	***Partners***
Action 1.1: Accept vesting of lands to the north of Lake Road, owned by the Western Australian Planning Commission subject to Area Assistance Grants being available to bring the land to a suitable standard.	2	Staff resources to seek and implement Area Assistance Grants.	CoA (Environment)	
Action 1.2: For Lots 901 and 883 McNeill Road, Champion Lakes seek Area Assistance Grants to construct a boardwalk, revegetate and install interpretive signs, and then accepting vesting for the Western Australian Planning Commission/ Department for Planning and Infrastructure lands.	2	Staff resources to prepare and implement Area Assistance Grants	CoA (Environment)	PRCG
Action 1.3: Lobby for extension of the Swan River Trust Riverpark from the City's boundary to Armadale Road.	2	Staff resources	CoA (Environment)	

Strategic Direction 2: Improve riparian vegetation along river, reduce the impacts of weeds and improve in stream fauna habitat.				
Action	***Category***	***Resource estimate***	***Lead Agency***	***Partners***
Action 2.1*:* Revegetate within a 15m buffer or up to the firebreaks on either side of the river.	1	Not costed as it is considered to be a long-term project. In 2008 it was estimated that without the use of volunteers revegetation (including weed control) cost about $11 per sqm.	AGLG	CoA
Action 2.2: Batter and revegetate the western bank in two locations (Figure 9) to increase the damp zone, which will assist in nutrient stripping and also create diverse habitats for birds and fish.	5	Requires the approval from the Department of Indigenous Affairs and a Section 18 permit which take significant resources. Not costed.	AGLG	CoA
Action 2.3: Undertake a regular weed control program spraying yearly with herbicides to facilitate rehabilitation and maintain existing revegetated areas.	4	Annual cost for weed control within the Reserve currently between $20,000 - $25,000 (Estimate from AGLG).	AGLG CoA	

Strategic Direction 3: Improve the water quality of the Wungong River by supporting initiatives to reduce contamination at source, monitor associated drains and utilize on-site wetlands to maximize opportunity for water quality improvement.				
Action	***Category***	***Resource estimate***	***Lead Agency***	***Partners***
Action 3.1: Encourage local land owners to participate in the Swan-Canning Property Planning courses and seminars to manage nutrients on their properties.	3	The City may assist the Heavenly Hectares program with direct marketing to rural living properties that drain into the Wungong River.		CoA
Action 3.2 : Convert Riverside Lane drain to an open drainage channel and lay channel with woodchips to decrease the high levels of nitrogen and increase dissolved oxygen.	5	Seek external funding.	CoA	
Action 3.3: Consider implementing the Fertilise Wise program within the Wungong River catchment if the program review shows it works successfully in North Forrestdale.	3	Currently North Forrestdale costs $40 per household.	CoA	SERCUL
Action 3.4: Apply the Better Urban Water Management framework to new urban development in the Wungong River catchment so that the quality of water reaching the Wungong River is of the highest quality practicable.	2	Implement through the planning process	CoA	
Action 3.5: Replace weedy grass basins with native sedge and rush beds to strip nutrients and re-establish the relationship between the floodplains and the Wungong River.	5	This is a future project of the Palomino Reserve Catchment Group	PRCG AGLG	CoA
Action 3.6: Assess the feasibility of redirecting open stormwater drains to a wetland systems to remove nutrients to prior to discharge into the river, as shown in Figure 9.	5	Revegetation cost estimated at $11 per sqm in 2008.	PRCG AGLG	CoA
Action 3.7: Establish a program to monitor, document and evaluate the water quality within the reserve and the effectiveness of implemented projects (e.g. wetlands).	5	Refers to Actions 3.5 and 3.6.	PRCG AGLG	CoA

Strategic Direction 4: Manage fuel loads to protect life and property (including fuel loads created through revegetation efforts), and protect revegetation efforts from fire.				
Action	***Category***	***Resource estimate***	***Lead Agency***	***Partners***

Action 4.1: Utilise mechanical or other low environmental impact methods to maintain fuel load to 6 tonnes per hectare and 4 tonnes per hectare for a least 10m either side of trails.	4	Current management requirement of the City, budget implementation not considered within this Plan.	CoA	

Strategic Direction 5: Design and implement a circular trail system that can be used by pedestrians, cyclists, equestrian users and emergency vehicles along the river between Armadale Road and Champion Drive, as per Figure 8 that includes interpretive signage.				
Action	***Category***	***Resource estimate***	***Lead Agency***	***Partners***
Action 5.1: Upgrade current trail between Arabian Court and Ranford Road (Figure 10).	1	Upgrade estimate $20,000 to $30,000 (including installation of bollards every 100m). Annual maintenance - $6,600 based on an annual cost of $1/m².	CoA	
Action 5.2: Investigate logistics and costs of building a circular trail system which can accommodate all users, including emergency vehicles (Figure 8).	5	Initial construction and installation - $342,000 based on a 3,800 length x 3m width at $30/m². Annual maintenance - $8,550 based on an annual cost of $0.75/m². Estimated construction and installation of box culvert bridges at $10,000 each (based on 1.2 x 1.2 reinforced concrete box culverts with a hard stand surface).	CoA (Civil Works & Parks)	
Action 5.3: Seek funding sources to build long term circular trail system and the associated bridges, as per Figure 8.	5	Staff resources to apply for external funding and project management.	CoA	
Action 5.4: Design and install interpretive sign(s) and housing to provide information to the public about the natural resources of the area	5	$4 000, including installation per each A-frame.	CoA	
Action 5.5: Construct a river viewing platform with interpretive signage.	5	Initial construction and installation – $15,000 based on $150/m² for a 100m² platform. Annual maintenance - $1000 based on $10/m².	CoA	

6. REFERENCES

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7. APPENDICES

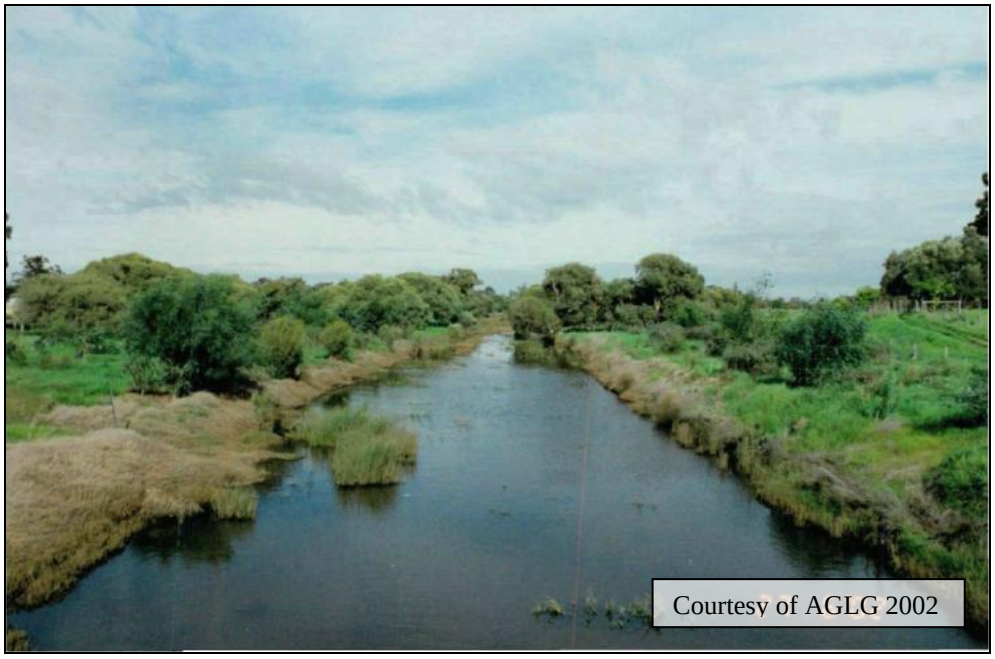
Appendix 1: Vegetation photos

SECTION 1: Champion Drive to McNeill Road

Revegetation 2009

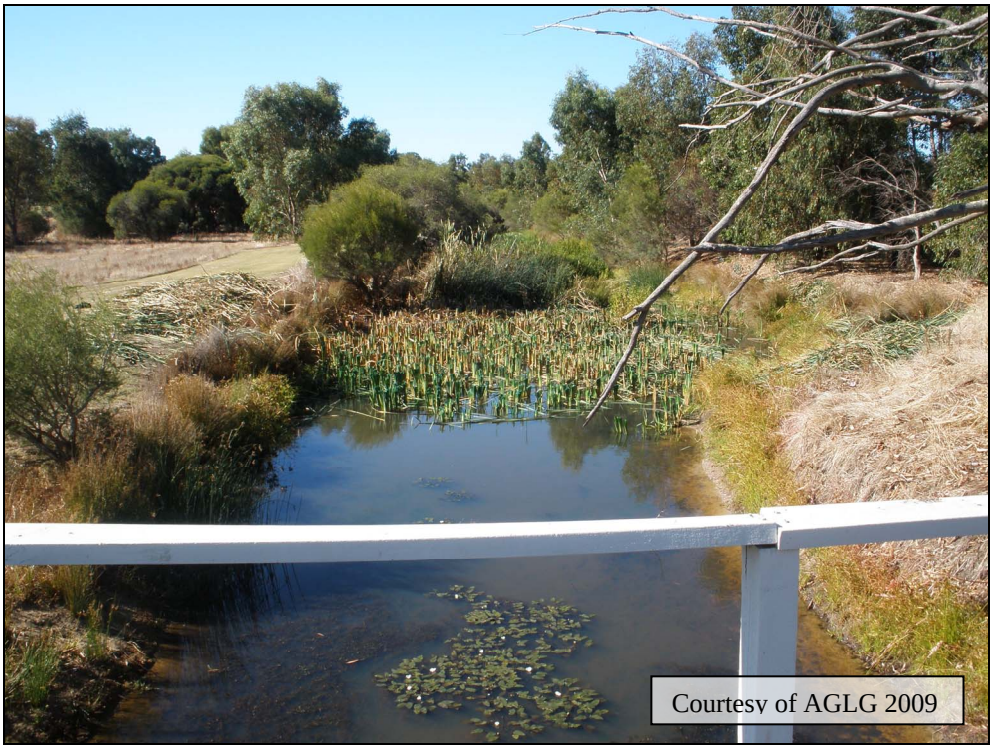
Revegetation 2009

SECTION 2: McNeill Road to Poad Street Bridge



Upstream of McNeill Road Bridge 2002

Upstream of McNeill Road Bridge 2009



Recently treated Typha – Poad Street Bridge looking downstream (north)

SECTION 3: Poad Street Bridge to the Corner of Lake and Ranford Road

Upstream (looking south) from Poad Street Bridge

Area with weed control undertaken in preparation for planting in 2010.

Appendix 2: Recorded Bird Species of Palomino Reserve

Common Name	Scientific Name
Australian Magpie	*Gymnorhina tibicen*
Australian Raven	*Corvus coronoides*
Australian Ring Neck Parrot	*Barnadius zonarius*
Black Faced Cuckoo Shrike	*Coracina melanops*
Black fronted Dotterel	*Elseyornis melanops*
Brown Honeyeater	*Lichmera indistincta*
Butcherbird	*Cracticus spp.*
Common Bronzewing	*Phaps chalcoptera*
Crested Pigeon	*Ocyphaps lophotes*
Galah	*Eolophus roseicapillis*
Laughing Kookaburra	*Dacelo novaeguineae*
Laughing Turtle Dove	*Streptopelia senegalensis*
Little Pied Cormorant	*Phalacrocorax melanoleucos*
Magpie Lark	*Grallina cyanoleuca*
Pacific Black Duck	*Anas superciliosa*
Pardalote	*Pardalotus spp*
Purple Swamphen	*Porphyrio porhyrio*
Red Wattlebird	*Anthochaera carunculata*
Singing Honeyeater	*Lichenostomus virescens*
Straw-necked Ibis	*Threskiornis spinicollis*
Tree Martin	*Hirundo neglecta*
Wagtails	*Rhipidura leucophrys*
Wedge Tail Eagle	*Aqulia audax*
Welcome Swallow	*Hirundo carteri*
White faced Heron	*Egretta novaehollandiae*

Appendix 3: Revegetation Species List

HABIT	SPECIES	COMMON NAME	HEIGHT (m)
Tree	*Banksia littoralis*	Swamp Banksia	10
	Casuarina obesa	Salt Sheoak	10
	Eucalyptus calophylla	Marri	35
	Eucalyptus rudis	Flooded Gum	25
	Melaleuca preissiana	Modong	10
	Melaleuca rhaphiophylla	Swamp Paperbark	10
	Paraserianthes lophantha	Albizzia	10
Large Shrubs	*Acacia saligna*	Coojong	6
	Agonis linearifolia	Swamp Peppermint	5
	Callistomen phoeniceus	Common Bottlebrush	4
	Callistachys lanceolata	Wonnich	6
	Calothamnus quadrifidus	One-sided Bottlebrush	2
	Hakea prostrata	Harsh Hakea	3
	Hakea varia	Variable leaf Hakea	3
	Jacksonia sternbergiana	Stinkwood	3
	Kunzea ericifolia	Spearwood	4
	Melaleuca hamulosa		3
	Melaleuca lateritia	Robin Redbreast bush	2
	Melaleuca incana		3
	Melaleuca uncinata	Broom Honey Myrtle	3
	Melaleuca viminea	Mohan	5
	Oxylobium linearis		3
	Viminaria juncea	Swishbush	4
Low Shrubs	*Acacia pulchella*	Prickly Moses	1.5
	Astartea fascicularis	Common Astartea	2
	Hakea lissocarpha	Honey Bush	1.5
	Pericalymma ellipticum	Swamp Tea Tree	1
Ground Covers	*Centella asiatica*		
	Hardenbergia comptoniana	Native Wisteria	Climber
Rushes	*Baumea articulata*	Jointed Twig Rush	2
	Baumea preissii	Broad Twig Rush	1
	Bolboschoenus caldwellii	Marsh Club Rush	.5
	Juncus pauciflorus	Loose Flower Rush	1
	Schoenoplectus validus	Lake Club Rush	2

Appendix 4: Weed Species List

COMMON NAME	SPECIES
Dock	*Rumex crispus*
Arum Lily	*Zantedschia aethiopica*
Couch	*Cynadon dactylon*
Kikuyu	*Pennisetum clandestinum*
Patersons Curse	*Echium plantagenium*
One Leaf Cape Tulip	*Homeria flaccida*
Flat Weed	*Hypocharis glabra*
Cape Weed	*Arctotheca calendula*
Cyprus (Nut grass)	*Cyprus rotundus*
Fleabane	*Conyza bonariensis*
Hares Tail Grass	*Lagurus ovatus*
Watsonia	*Watsonia spp.*
Bullrush	*Typha orientalis*
Prickly Lettuce	*Lactuca serriola*
Rye grass	
Paspalum grass	

Appendix 5: Interpretive Signage Housing

Appendix 6: River Viewing Platform

Appendix 7: Summary of submissions

Section of Plan	Comment	Officer Response	Changes to plan
3.1 Governance and tenure	It would be advisable to have a structure plan in place for the land re-zoned to urban in the Rural Living 2 Zoned area and should be put in place in conjunction with any plans to be made for the Wungong River. This would enable the paths and trails to be incorporated along the river to have minimal environmental impact.	Re-zoning of the surrounding land is not within the scope of the document. The Plan makes reference to the statutory and a strategic planning framework and surrounding land use context. The Plan already details the proposed trails to be incorporated in the area which have been considered within environmental constraints.	Nil.
3.6 Fire	The fire risk is underestimated in the report.	Strategic Direction 4 relates to fire management in the area and notes that the City's Ranger and Emergency services should annually inspect the reserve and to consider fire management during revegetation projects.	Nil.
3.7 Recreation and access	In general we support the report to improve the river surrounds and to make it more accessible.	Nil.	Nil.
	The report needs to be more detailed about the standard of the trail desired. Suggest that it should be unsealed road base, with some areas built up in low lying areas. Having a sufficient width for vehicle access (3m) will also resolve potential conflict of users.	Agreed. The Plan already states the trails will be of a minimum 3m width to accommodate emergency service vehicles.	Text added to Section 3.7 "The feasibility of various standards of tracks needs to be investigated prior to construction." Nil.
	It would be helpful to stage the implementation of a circular trail around the river. Regular mowing during winter/spring and installation of pipe bridges could be done at moderate cost immediately.	Strategic Direction 5 relates to the implementation of a circular trail in stages and Strategic Direction 4 discusses the need for ongoing maintenance of the fire hazard by slashing and mowing the grass.	Nil.
3.2 Restoration of local vegetation	Action 2.1 add that revegetation is also important in nutrient stripping.	Agreed.	Text added to include this information.
	Williams Road Main Drain discharges down steam of Poad St and the Second Road Main Drain discharges upstream of Champion Drive to the northern boundary of the area (not shown on figure 2).	Agreed.	Figure 2 amended and text added to Section 3.2 of the Plan.

	Consideration of the works on Williams Road Main Drain would be required. Water Corporation comment should be obtained prior to any works that may impact on these drains.		
	Water Corporation water and waste water infrastructure cross the river at Lake Road, any proposals for management should consider this infrastructure.	Agreed.	Text added to Section 3.2 of the Plan.
3.3 Weeds	Action 2.3 needs to be recosted. Estimated cost of weed control annually is $20,000 - $25,000.	Agreed.	Estimates updated.
3.5 Water quality	Action 3.1 add to notes use of Great Garden Workshops to achieve this.	Agreed.	Change made to notes of Action 3.1 to include reference to these workshops.
	Action 3.2 has been costed through the Federal Urban Waterway Project.	Agreed.	Changes made to discuss project.
	Action 3.5 should read "Replace weedy grass basins with sedge and rush beds …".	Agreed.	Action reworded.
2.5 Remnant vegetation	Photos of sites should be included in plan (page 4).	Agreed.	Photos of sites added to document.
	Information should reflect AGLG 2010 revegetation program.	Agreed.	Changes made through out document updating AGLG revegetation works in the area.
Figure 5	Figure 5 – is the 1:100 year floodway in the legend correct?	The figure is correct.	Nil.

8. FIGURES

FIGURE 1 - (2008) AERIAL PHOTOGRAPH
WUNGONG RIVER

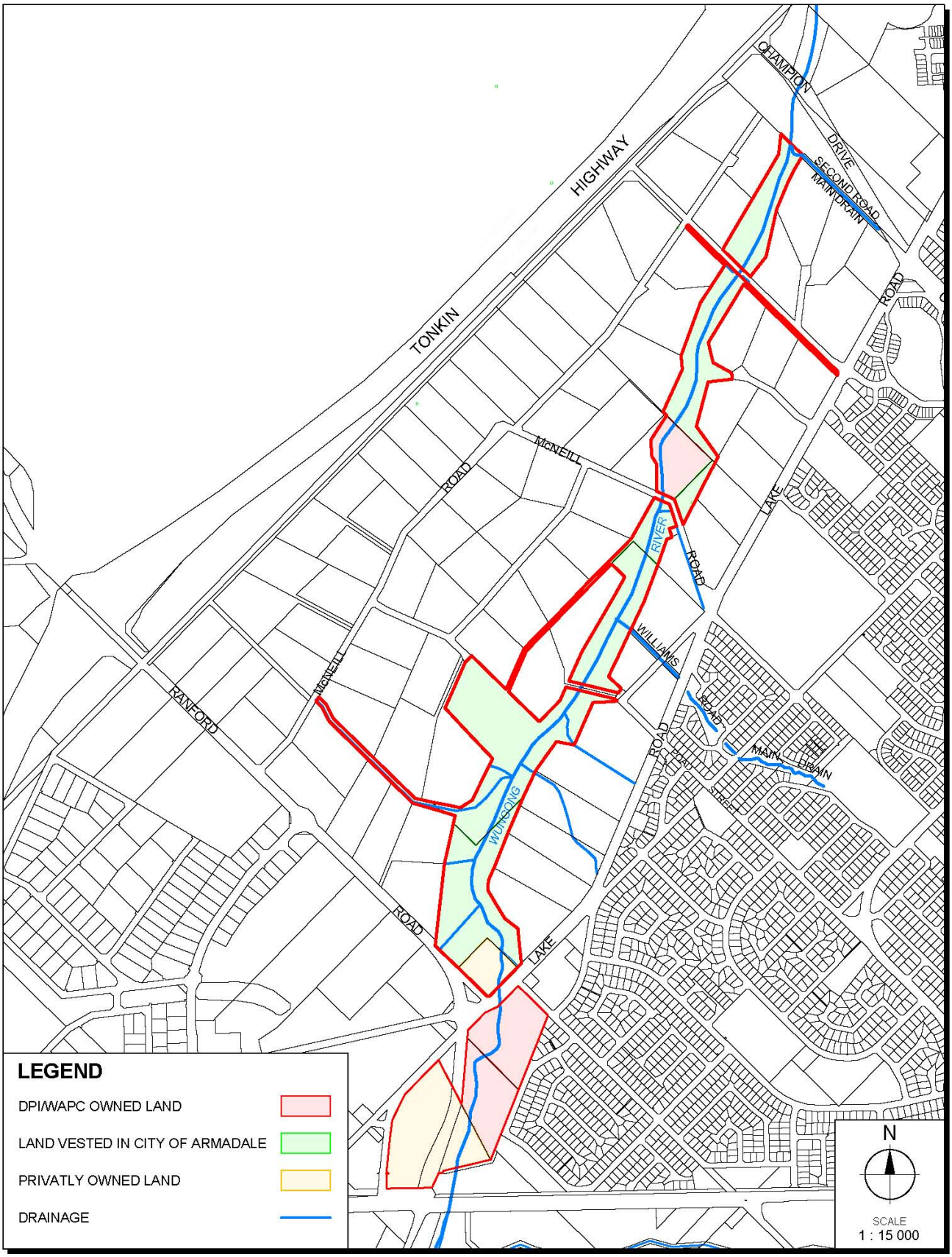


FIGURE 2 - WUNGONG RIVER TENURE AND DRAINAGE IN TO WUNGONG RIVER

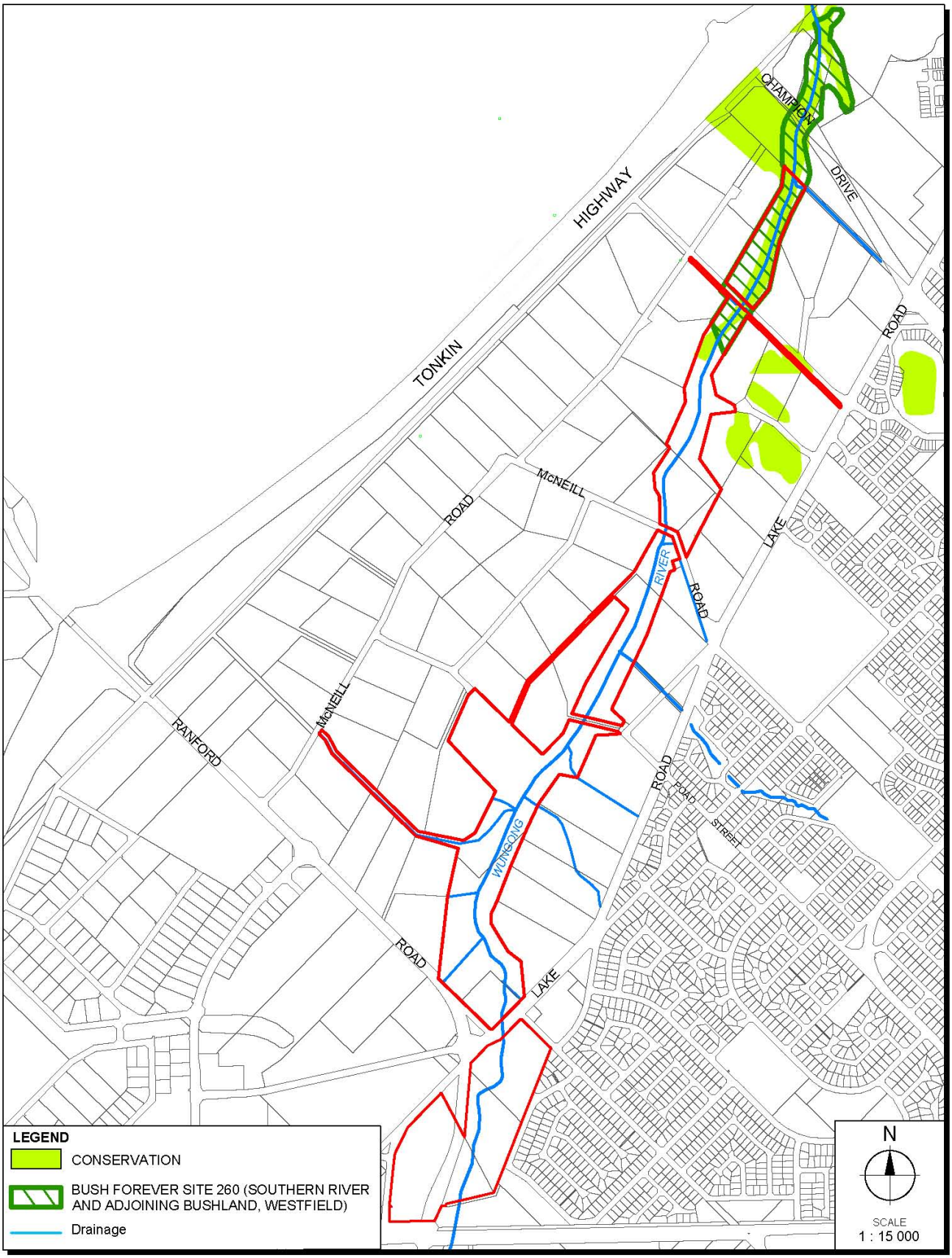


FIGURE 3 - BUSH FOREVER SITE 260 AND CONSERVATION CATEGORY WETLANDS

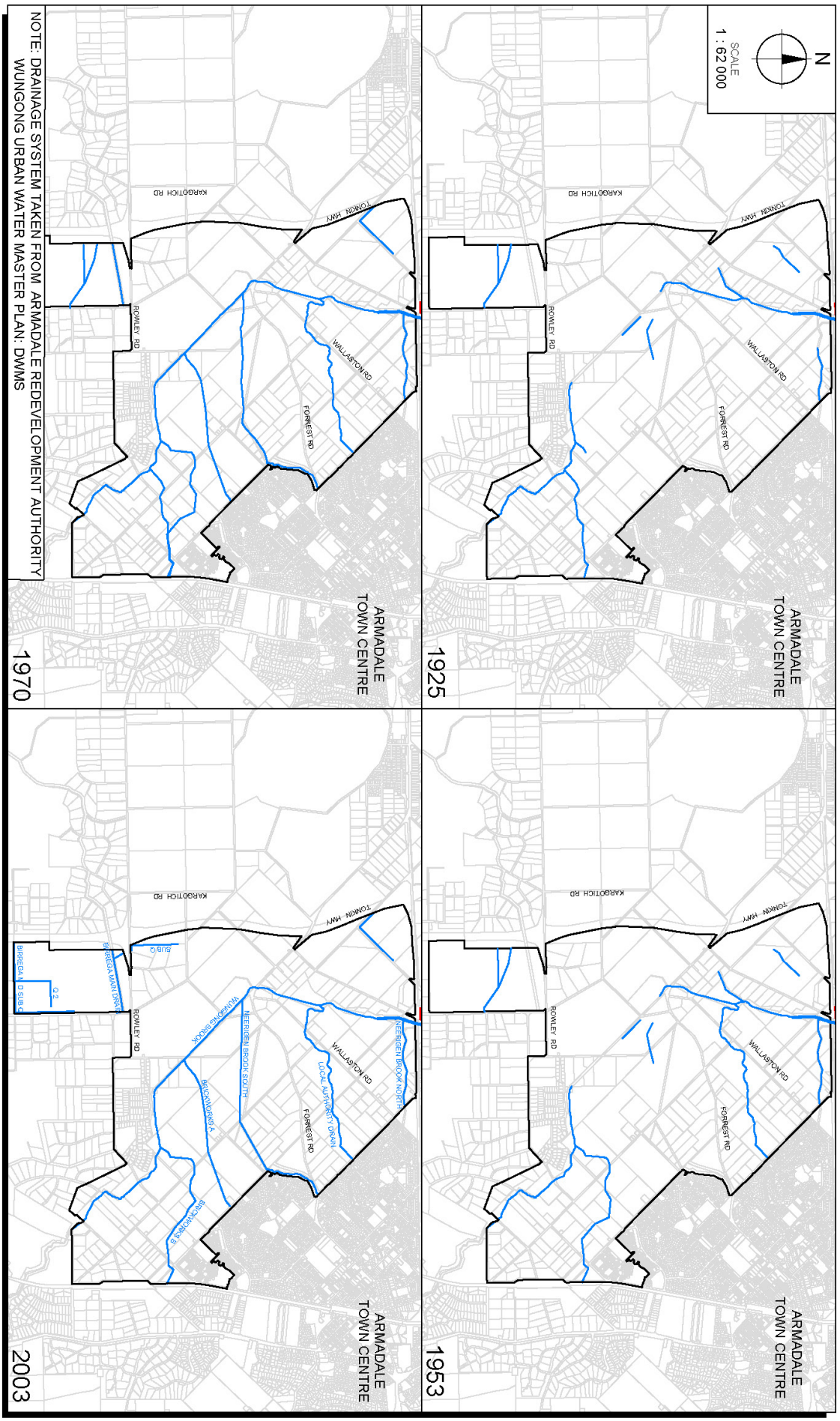


FIGURE 4 - DRAINAGE SYSTEM OF ARMADALE OVER TIME

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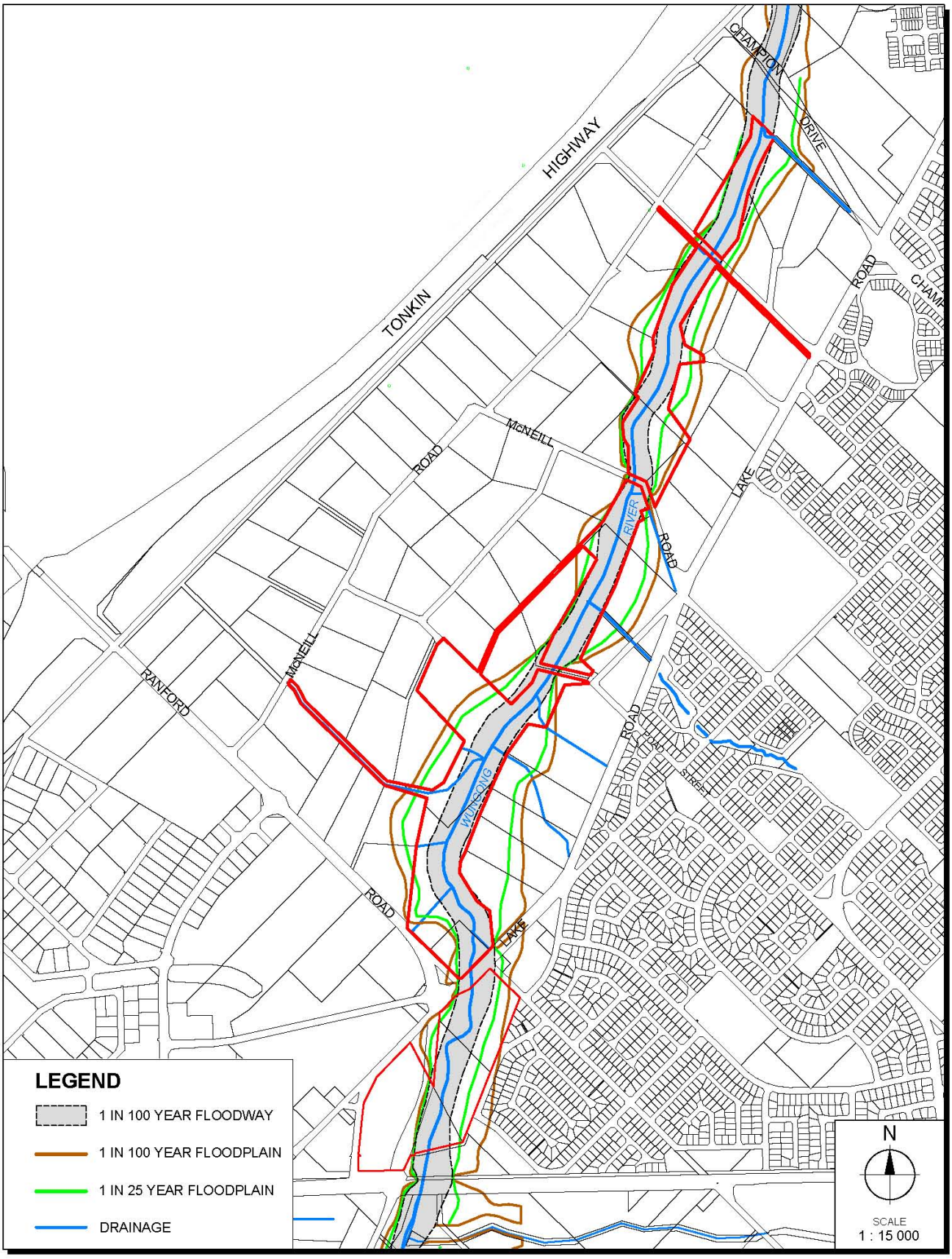

FIGURE 5 - WUNGONG RIVER 1 IN 25 AND 1 IN 100 YEAR FLOODWAY AND FLOODPLAIN

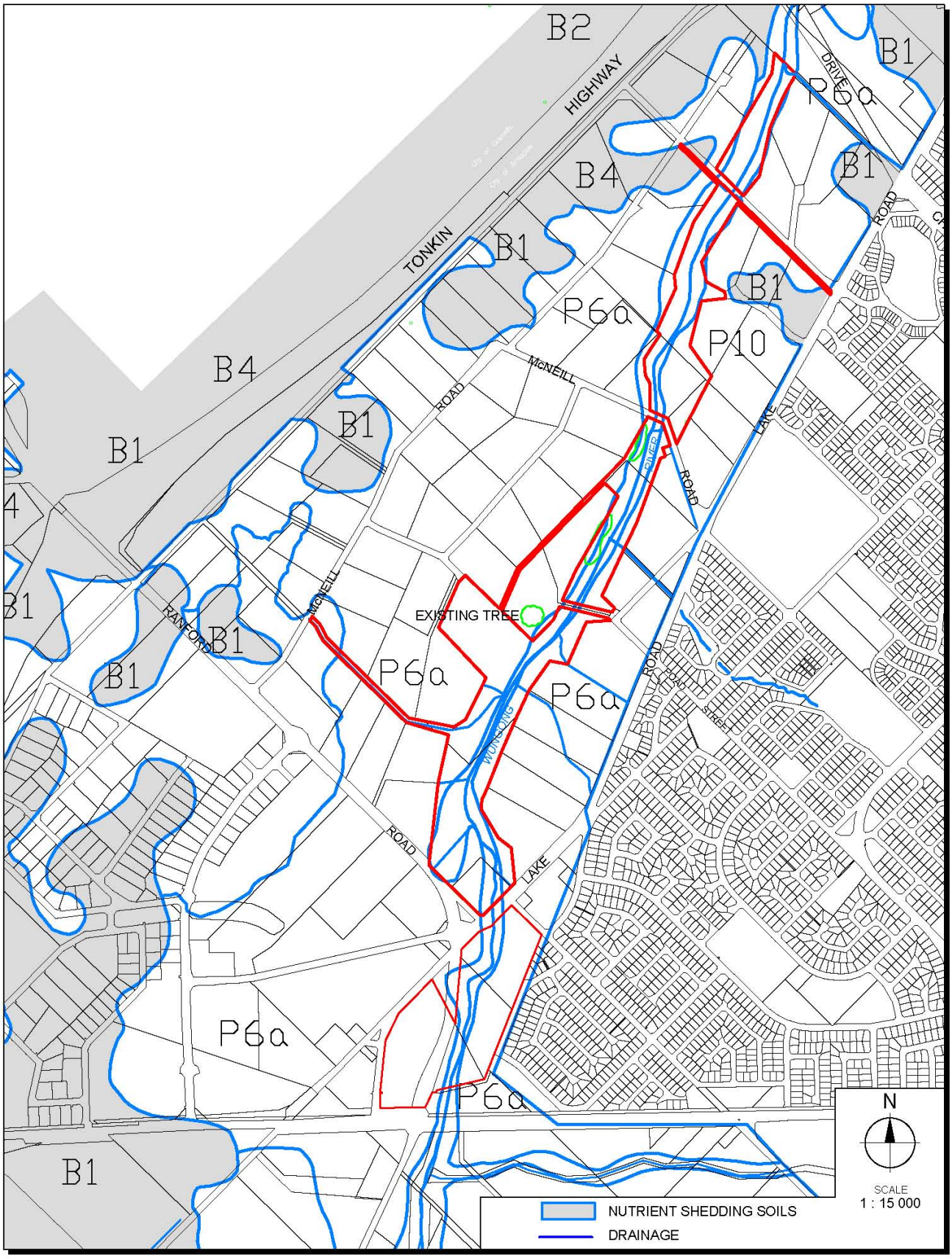

FIGURE 6 - WUNGONG RIVER RESERVE - SOILS

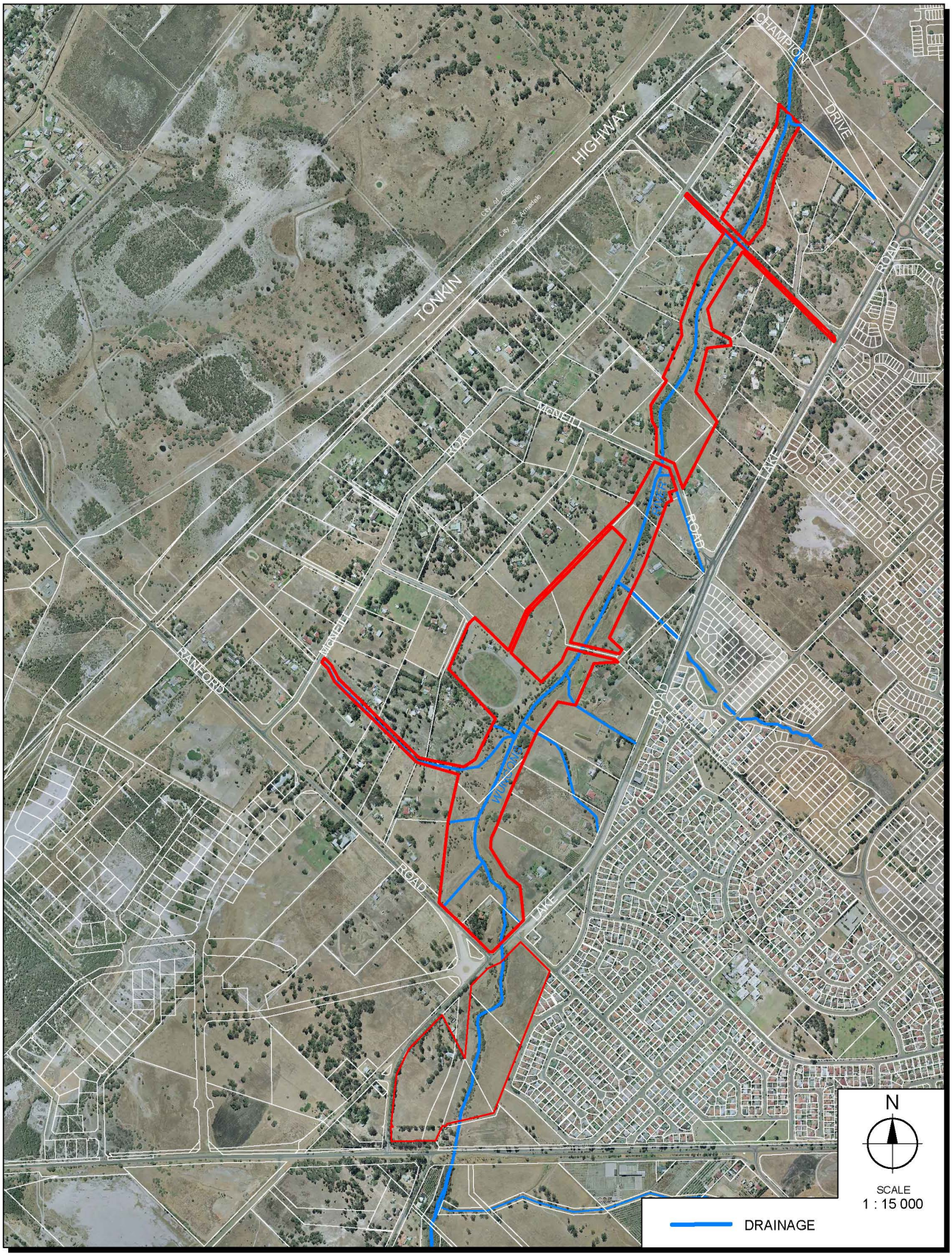

FIGURE 7 - (2003) AERIAL PHOTOGRAPH
WUNGONG RIVER

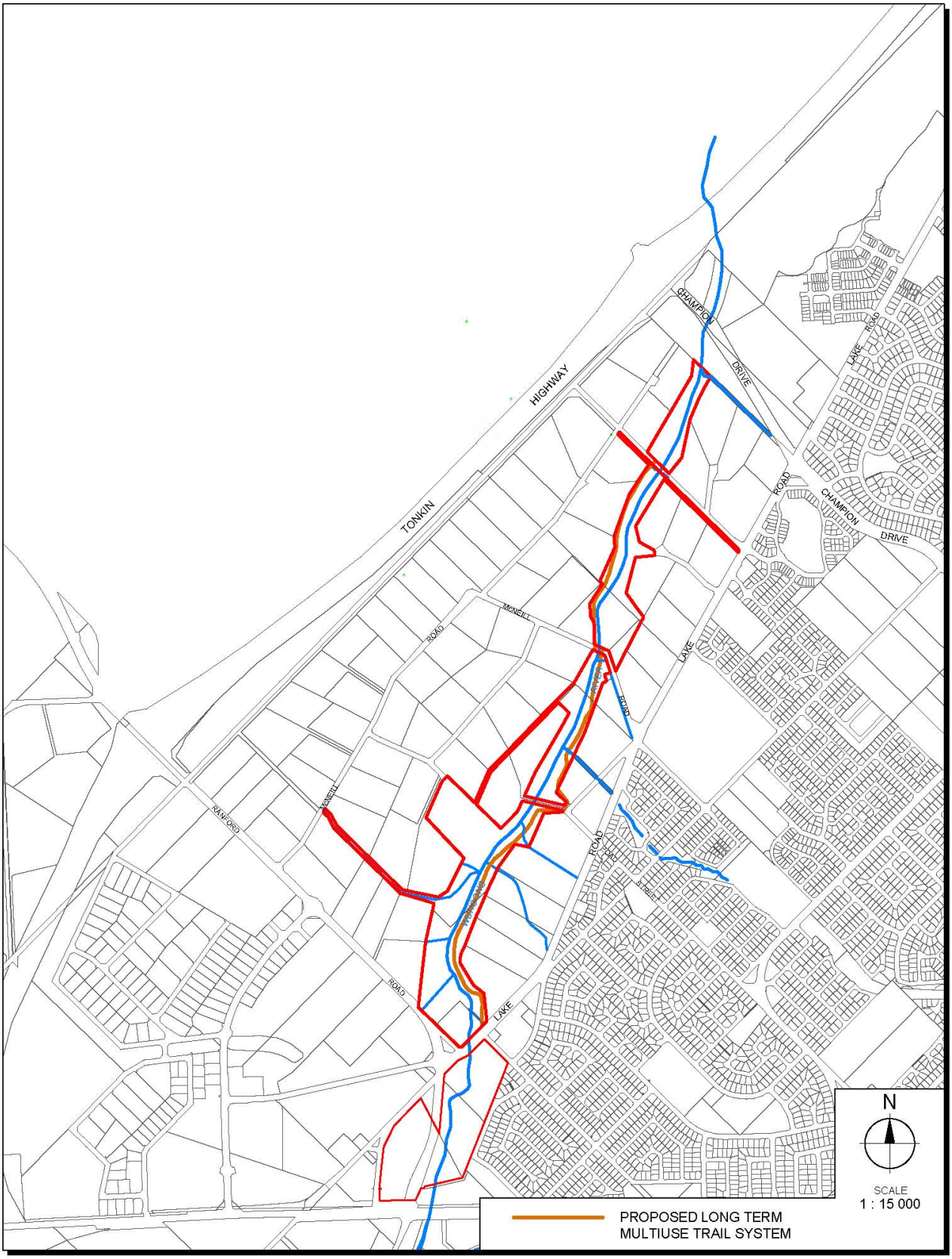

Figure 8 - WUNGONG RIVER RESERVE
PROPOSED LONG TERM MULTIUSE TRAIL SYSTEM

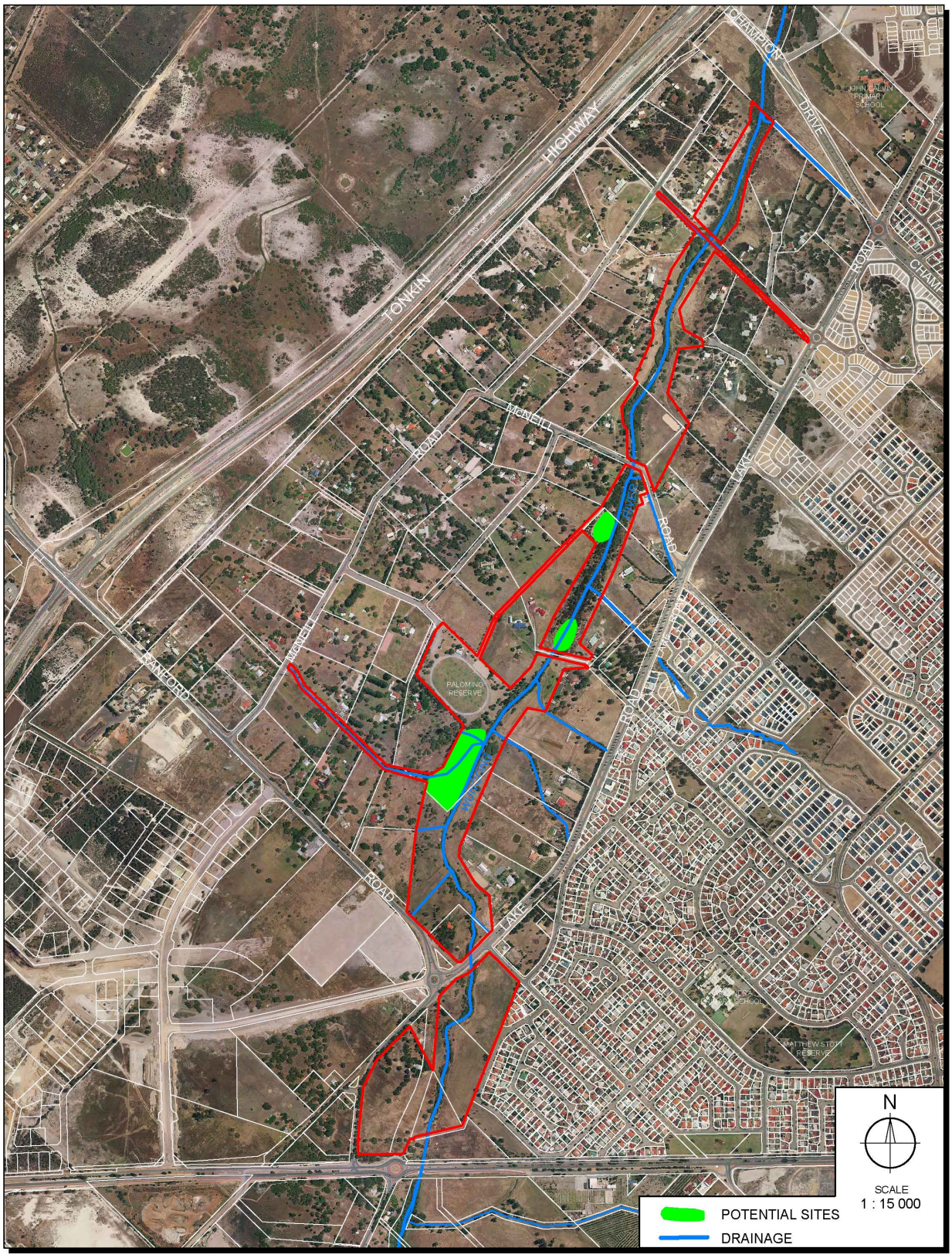

FIGURE 9 POTENTIAL SITES FOR WETLANDS TO IMPROVE WATER QUALITY

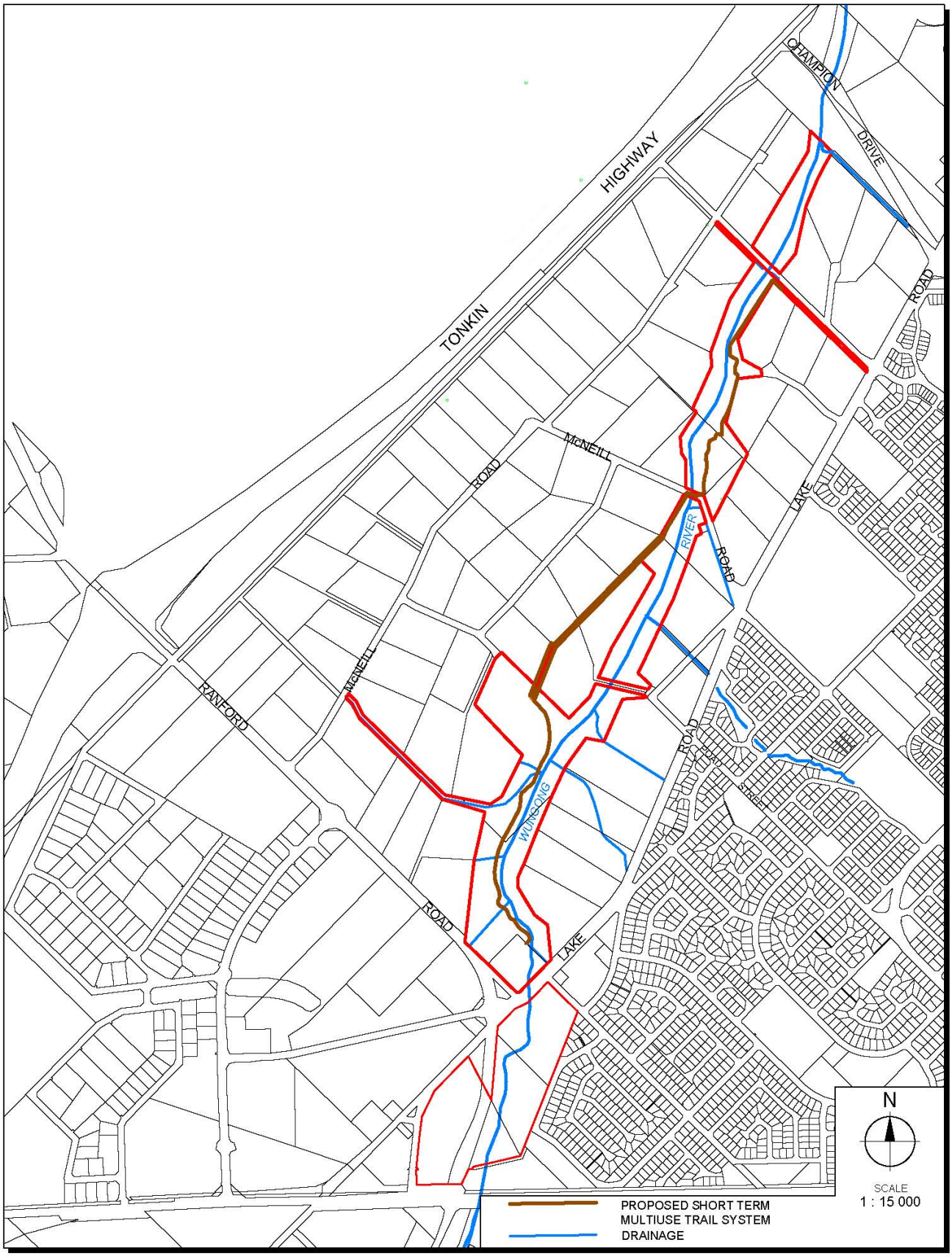

Figure 10 - WUNGONG RIVER RESERVE
PROPOSED SHORT TERM MULTIUSE TRAIL SYSTEM