COXS CREEK WETLAND AND RESERVE

PLAN OF MANAGEMENT

July 2010

STRATHFIELD COUNCIL

CMA Sydney Metropolitan CATCHMENT MANAGEMENT AUTHORITY

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COXS CREEK WETLAND AND RESERVE PLAN OF MANAGEMENT

The Sydney Metropolitan Catchment Management Authority are working with Strathfield Council to protect endangered remnants of native vegetation and wetland environments in Sydney such as Coxs Creek Reserve and the endangered species that live in them. This project was undertaken jointly by Strathfield Municipal Council and the Sydney Metropolitan Catchment Management Authority with funding from the Australian Governments Caring for our Country and Catchment Action NSW programs.

The plan outlines how Strathfield Municipal Council will manage and improve the wetland and reserve to maintain and enhance the local biodiversity and ensure the longevity of the threatened frog species, the Green and Golden Bell Frog as well as the endangered ecological community Cook River Castlereagh Ironbark Forest. This plan was compiled by M.Brainwood and A.Carey with the assistance of D.Hellot and C.Forest. The authors would like to acknowledge Bernadette Murray, Geoff Swinney and Jeanie Muspratt (Strathfield Municipal Council), Katie Oxenham (Sydney Olympic Park Authority) and the bushcare volunteers who have assisted with preparation of this report.

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This plan was adopted at the meeting of Strathfield Council on July 6 2010 following minor amendments to the draft Plan of Management and following Council's resolution 174/10.

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1. INTRODUCTION

Strathfield Municipal Council is currently reviewing its existing Plan of Management (POM) for the Coxs Creek Environmental Management Area (Urban Bushland Management Consultants 2001). This document has been designed to provide best management practices and strategies to assist Council in better managing the reserve's assets, to increase biodiversity values and assist in the management of threatened species and vegetation communities on site. The preparation and contents of this Plan of Management are in accordance with the requirements of the *Local Government Act 1993*, and the *Local Government (General) Regulation 2005* for the contents of Plans of Management.

WHAT IS A PLAN OF MANAGEMENT?

Council is required under the Local Government Act 1993 to prepare a Plan of Management for Community land. The purpose of a Plan of Management is to identity the needs of an area, propose actions and to guide Council as owner and / or manager of Community land in future management of Coxs Creek Bushland Reserve. The purpose of the Coxs Creek Reserve Plan of Management is to enable Council to manage and conserve the bushland.

LAND TO WHICH THIS PLAN OF MANAGEMENT APPLIES

This Plan of Management applies to Coxs Creek Reserve. Coxs Creek Reserve is a small area of remnant bushland located in the inner western suburb of Greenacre, approximately 14 Kilometres south-west of Sydney.

OBJECTIVES OF THIS PLAN OF MANAGEMENT

Objectives of this Plan of Management for Coxs Creek Reserve are to:

- Establish a sound and balanced approach to the management of Coxs Creek while providing a flexible framework within which Council can respond to current needs and opportunities, as well as to future directions and pressures; and

- Establish a framework to guide day-to-day and long-term decision-making regarding the
management of the reserve.

2. DESCRIPTION OF COXS CREEK RESERVE

LAND LOCATION & CONTEXT

Coxs Creek Reserve is a small area of remnant bushland located in the inner western suburb of Greenacre, approximately 14 kilometres south-west of Sydney. Coxs Creek Reserve is located in an older, mixed residential / industrial area, lying in the lower part of the broad triangle formed by Roberts Road (west), Juno Parade (south) and Wentworth Street (northeast).The site is surrounded on all but the eastern boundary by industrial development, including Finemore's Industrial Complex to the north and a Cold Storage and Distribution Facility on land formerly occupied by the Bankstown Sanitary Depot to the south. Residential development occurs to the east (Sylvanus Street, Drone Street) and west (see Figure 2).

Figure 1 Location

Coxs Creek Reserve has a range of significant natural features from the natural watercourses that flow through the site to the uniqueness of the vegetation that represents one of the last examples of the original vegetation of the area. Key features of Coxs Creek include:

- Remnant bushland
- Green and Golden Bell Frog Habitat
- Cooks River Castlereagh Ironbark Forest habitat – endangered ecological community
- Constructed wetland expanding a natural wetland area

LAND OWNERSHIP & MANAGEMENT

The reserve, which was acquired by Strathfield Council in February 1994, comprises 1.553 ha of Council-owned land, and 0.29 ha land currently owned by Trust Company of Aust LTD. In total, the reserve covers an area of 1.84 ha.

Property Description	Owner	Zoning	Area	Manager
Lot 4 DP835847	Strathfield Municipal Council	6(c) Open Space – Urban Bushland	1.533 ha	Strathfield Municipal Council
Part of Lot 3 DP835847	Trust Company of Aust. LTD	4(a) Industrial General	0.29 ha	Strathfield Municipal Council

Under the terms of the LEP 57 land in the reserve owned by Strathfield Municipal Council is zoned as 6(c) Open Space - Urban Bushland. A small area of reserve to the west of the Council land is owned by Colonial First State Investments, and is zoned as 4(a) Industrial General.

For the purposes of SEPP-19, urban bushland is defined as: land on which there is vegetation which is either a remainder of the natural vegetation of the land or, if altered, is still representative of the structure and floristics of the natural vegetation. Coxs Creek Reserve is classified as community land, and the remnant bushland therein is afforded protection under the terms of SEPP-19. Previous reports stated a concern that development at the time on the site occupied by the former Bankstown Sanitary Depot (south) had the potential to impact on the protected bushland in the reserve and water in Coxs Creek, both during construction and afterwards, depending on future land use activities (see clause 9 SEPP-19).

Figure 2 Cadastral boundaries (2009)

CHARACTERISTICS AND SETTING

TOPOGRAPHY, GEOLOGY AND SOILS

The study area is located on a level to gently undulating alluvial floodplain formed by the ancient river system draining the Wianamatta Group Shales of the Cumberland Lowlands. Local relief in the region is less than five metres, with slope gradients averaging less than three metres. The geology of the area has been mapped as Bringelly Shale from the Wianamatta Group (Herbert, 1983), and described as consisting mostly of shale, with some carbonaceous claystone, laminite and occasional fine to medium-grained lithic sandstone. This stratum overlays a thin layer of Minchinbury Sandstone, followed by Ashfield Shale. The local soil landscape is the Blacktown unit, however Coxs Creek and the adjoining reserve are both located on ‘disturbed terrain’. The soils of the Blacktown unit are described as shallow to moderately deep, with red and brown podzolics on crests, upper slopes and well-drained areas, and yellow podzolics and soloths on lower slopes and in areas of poor drainage (Chapman and Murphy 1989).A study of land contamination in the neighbouring land (former Bankstown Sanitary Depot) by Bankstown City Council (April 1993) referred to elevated levels of heavy metals, ammonia, total Nitrogen levels, total Phosphorus levels, faecal coliforms and e-coli in the ground waters (SMC 1999).

HYDROLOGY

The Cooks River occurs as 23 km of modified river channel, passing through a highly urbanised catchment before emptying into Botany Bay at Kyeemagh. Strathfield Municipality is located in the Upper Cooks River Catchment, which has four main drainage lines. One of these is the Punchbowl Road branch, of which Coxs Creek forms a part (SMC 1999).

Coxs Creek is a minor tributary of the Cooks River, discharging into the River at Water Street, Strathfield (Figure 3). The creek drains a catchment area of 8.8 square kilometres, flowing in a northeasterly direction starting at the Enfleld Marshalling Yards and meeting the Cooks River at Strathfield South (Cooks River Stormwater Management Plan, 1999).

Coxs Creek begins as a series of stormwater drains west of Roberts Road, entering the reserve as an open drain between Finemores' Industrial Complex and the former Bankstown Sanitary Depot, which has been developed as a commercial / semi-industrial complex. The watercourse, which does not follow the original creek line, runs through the reserve paralleling the north-western boundary for approximately 200 metres before entering an enclosed stormwater drain at the northeastern corner (Drone Street). The drain is referred to by local residents as Coxs Creek - the name of the original watercourse that drained the paperbarks swamps, originally located near the junction of Roberts Road and Juno Parade. A smaller drainage channel runs from the former Bankstown Sanitary Depot to the south, joining Coxs Creek immediately prior to the stormwater culvert. This channel is not a natural watercourse, but is thought to have been formed at some time in the past to drain the former Depot site. The greater part of the Cumberland Lowlands has long been cleared of native vegetation. Bushland was cleared in the early days of settlement for grazing and agriculture, and more recently (since World War II) for residential and industrial development. As a result of these intensive land uses, most local drainage lines have been converted to lined concrete and brick channels.

Coxs Creek is unusual in the region as a small portion of its length has been retained as an open creek , although highly modified. The stormwater system entering Coxs Creek drains parts of Lakemba, Wiley Park, Belfield and Enfield. Sydney Environmental and Soil Laboratory carried out water quality investigations (June, 1995) during the preparation of the 1996 POM. Results at that time indicated decreased levels of oxygen in the main creek and tributary drain. Wherever high salinity values occurred, possibly due to the low flow through the saline sodic clay subsoils, Typha was present. The water-monitoring site located in the lower reaches of Coxs Creek (as part of a separate investigation), indicated a poor to very poor compliance with specified guidelines for toxic substances (such as copper, cadmium, lead, mercury, zinc and some pesticides). The water was also found to exceed recommended levels for PCBs, and to contain high levels of oil and grease (SMC State of Environment Report 1999).These tests will monitor water quality issuing from land formerly occupied by the Bankstown Sanitary Depot. No water quality assessment has been carried out as part of the revised POM and at this time, data from PK Rust has not been made available.

Figure 3 Coxs Creek 2009

CLIMATE

Climatic data was obtained from the nearest meteorological station at Bankstown A/P AWS (records from 1968 to 2009). Meteorological records indicate a yearly average maximum temperature of 23.1^{o}C and a yearly mean minimum temperature of 11.9^{o}C. Mean annual rainfall is 874.7 mm, with the number of days having a rainfall event > 1mm being 82.8. Heavy rain is more common between January and March. Rainfall is lower in September and July, with the wettest period during January and February (Australian Bureau of Meteorology 2000).

HISTORY

The Strathfield Municipality was once inhabited by the Wangal clan of the Darug tribe. Little remains of the former Aboriginal occupation of this area. The Wangal clan's country or territory was known as Wanne and it originally extended from the suburbs of Birchgrove and Balmain in the east, to Silverwater and Auburn in the west, the northern boundary was the Parramatta River but the southern boundary is unknown.

The Wangal clan's neighbours were the Cadigal to the east, the Wategora to the west, the Wallumedegal to the north and the Bediagal to the south. All these clans of the Darug tribe spoke the coastal or Eora dialect of the Darug language. The Darug tribe's inland clans known as the 'woods tribes' spoke a different dialect.

The most famous Wangal warrior was Bennelong who became the only member of the Wangal tribe to travel overseas to England in 1792 and returned three years later to tell his people of what he saw there. Bennelong would have travelled through the Strathfield Municipality many times with the Wangal tribe (Rosen 1996).

The local rivers, including the Georges and Cooks Rivers and tributaries provided a range of resources for the local people. In the early 1900s, timber getters removed Ironbark and Woollybutt from the thick bush that grew in the area around what is now Roberts Road. Roberts Road and Roberts Road Reserve were named after William Roberts who was the supervisor of the convict gang. This convict gang built the Liverpool Road in 1814. Roberts Road marks the boundary of a 500 acre grant in Bankstown given to William Roberts in 1816. In 1837 he purchased a further 593 acres adjacent to his original grant. The parish maps of that time show no clear drainage lines or creeks existed at this time in the vicinity of the reserve. Between 1920 and 1930 the area was developed for residential properties and also used for small dairies, market gardens, orchards and poultry farms. (Pollon, 1988, Lawrence, Madden & Muir, 1999).

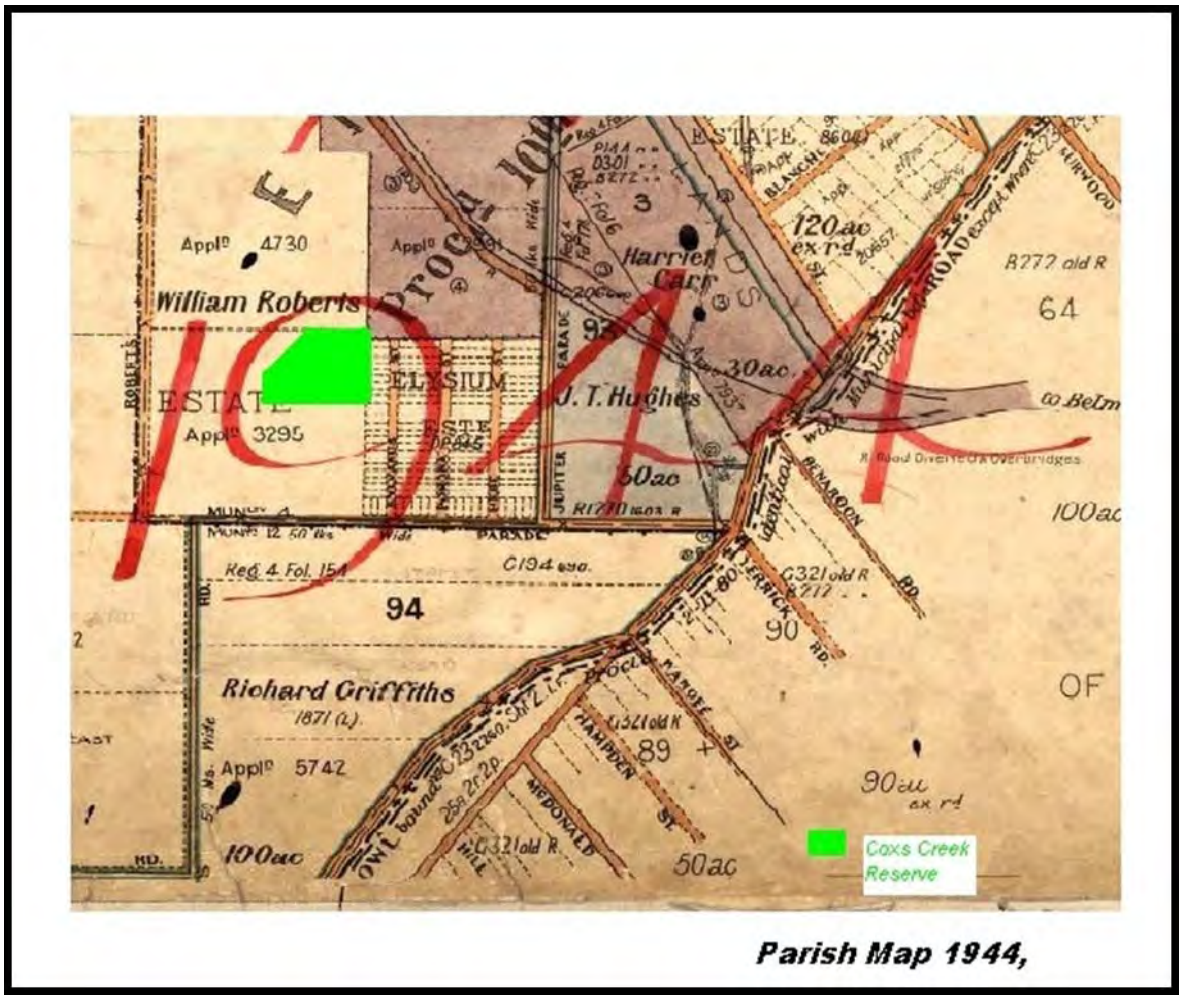


Figure 4 1944 Parish Map showing William Roberts' estate.

3. BASIS FOR MANAGEMENT

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

LAND CATEGORIES AND OBJECTIVES

Coxs Creek Reserve is catergorised as a Natural Area in accordance with section 36 (4) & (5) of the Local Government Act 1993 and further catergorised as a Watercourse, its core objectives are:

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

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

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

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

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

(f) to manage watercourses so as to protect the biodiversity and ecological values of the instream environment, particularly in relation to water quality and water flows, and

(g) to manage watercourses so as to protect the riparian environment, particularly in relation to riparian vegetation and habitats and bank stability, and

(h) to restore degraded watercourses, and

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

PERMITTED FUTURE USES OF THE LAND

Restricted public access to the reserve to protect and conserve the natural features including the flora and fauna. Access will be limited to supervised restoration work and community education programs as outlined in this Plan of Management undertaken by Council staff, contractors and community volunteers to protect and conserve the natural features of the reserve.

Planned developments and improvements to Coxs Creek Reserve must be in line with the core objectives of the reserve and are limited to protecting and conserving the natural features of the site. The scale and intensity of permitted uses should generally be consistent with the scale and intensity of current use, and as specified by Council in licence agreements. Increased use of the Reserve for recreational activities, such as community events, will only be permitted where damage to the Reserve and inconvenience to local residents is minimised.

LEASES, LICENSES AND OTHER ESTATES THAT CAN BE GRANTED.

In respect of community land in general, a lease, licence or other estate may not be granted within Coxs Creek Reserve

4. LEGISLATIVE CONTEXT

STATE GOVERNMENT LEGISLATION

THREATENED SPECIES CONSERVATION ACT 1995

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

A single flora species (*Acacia pubescens*) listed as' vulnerable' under Schedule 2 of the Threatened Species Conservation Act has been recorded in the study area. Tadgell's Bluebell (*Wahlenbergia multicaulis*) local population has been listed as an 'endangered population' in the Strathfield LGA. The reserve vegetation has been classified as Cooks River/Castlereagh Ironbark Forest which is listed as 'endangered' under Schedule 1, Part 3 of the Act. This is sometimes referred to as Cooks River Clay Plain Scrub Forest (CRCPSF).

The Green and Golden Bell Frog (*Litoria aurea*) is the only fauna species recently recorded in the reserve that has been listed under the Threatened Species Conservation Act, and is classified as 'endangered' (Schedule 1, Part 1). Several other species noted on site are classed as regionally significant, including the ground-foraging Superb Fairy-wren and the shrub insectivore Yellow Thornbill.

NOXIOUS WEEDS ACT 1993

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

Noxious plants are nominated to the Minister of Agriculture by local government authorities. On listing, weeds are categorised according to the specific action required to control them. An amended Noxious Weeds Act came into effect 1 March 2006. The above criteria still apply, but changes have been made to the list of currently declared noxious weeds (increased from 42 to 86) and to the "categories". The former W1, W2, W3 and W4 categories have been changed to "control classes" (CC) 1, 2, 3, 4 and 5.

Four noxious plants are currently reported at Coxs Creek Reserve: *Cestrum parqui* (Green Cestrum) C3; *Rubus fruticosus* agg. spp. (Blackberry) C4; *Cortaderia selloana* (Pampas Grass) C4; and *Parietaria judaica* (Pellitory) C4.

STATE ENVIRONMENTAL PLANNING POLICY NO 19 – BUSHLAND IN URBAN AREAS (SEPP 19)

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

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

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

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

RURAL FIRES ACT 1997

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

PESTICIDES ACT 1999

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

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

applying the pesticide (employee and/or employer), contractor or company directors may be liable for any damage caused by the inappropriate use of a pesticide.

The pesticides act was amended in 2005. As a requirement of the act a *Pesticides Notification Plan, 2007* was prepared. The plan has been prepared to satisfy the requirements of the Pesticides Regulation 1995, as amended 2005. All works must consider the requirements of the plan.

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

FEDERAL GOVERNMENT LEGISLATION

ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

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

The Act introduces a new assessment and approvals system for:

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

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

OTHER RELEVANT LEGISLATION FOR BUSHLAND RESERVES

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

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

5. GENERAL CONCEPTS FOR SUCCESSFUL REHABILITATION STRATEGIES

CONSERVATION MANAGEMENT ISSUES IN VEGETATION COMMUNITIES

CONSERVATION AND BIODIVERSITY

Conservation of biological diversity is a foundation of ecologically sustainable development. Biodiversity enables us to undertake selective breeding programs, for example, to create new medicines and crops. It enables plants and animals to develop natural resistance to disease and to survive environmental change. Biodiversity increases our options - to find solutions to management problems such as increased salinity, to look for new agricultural products and to fight increasing resistance to traditional medicines by infectious diseases. Biodiversity is directly reliant on maintaining the genetic resources of the whole ecosystem and the processes which sustain it, including understorey plants.

The retention of vegetation is imperative if we are to preserve our flora and fauna and attempt to slow down or even halt the processes of human-induced extinction. For a diversity of animals there must be a diversity of vegetation - different foliage types, qualities of light, a range of heights and sizes. A variety of plant forms and species must be present in order that an ecosystem can be sustained. Maintaining the genetic species diversity provides a buffer against climate change, allowing evolution and adaptation to a more rapidly changing environment. To achieve this, the rules are simple:

- Conserve what remains, and protect it
- Encourage the return from surrounding areas
- Plant or direct seed to increase the rate of return

IDENTIFYING THREATENING PROCESSES

Threatening processes for water-dependent systems include:

1. River regulation
2. Urban development pressures
3. Damming and diversion practices
4. Exotic species such as carp and invasive plant
5. Nutrient enrichment from point source pollution
6. Floodplain management and drainage
7. Groundwater level decline
8. Chemical pollution including acid sulphate releases and increasing salinity
9. Overfishing, overhunting or over-collecting

Threatening processes for terrestrial communities include:

- Clearing for crop production practices
- Clearing for forestry practices
- Clearing for livestock production practices
- Clearing for grazing practices
- Clearing for urban housing development
- Clearing for commercial/industrial development
- Change in land use, other than processes of urbanisation
- Clearing for recreation based development
- Recreation vehicle use in sensitive environments
- Poaching or commercial collecting
- Alteration of natural fire regimes
- Parasites or pathogens
- Invasion by non-native or non-endemic species

PLANNING TO MINIMISE THREATENING PROCESSES

Urban areas are chronically and acutely impacted by human activities. The effects of these activities, however, can be reduced to minimise the effects of threatening processes. Some ways to accommodate the effects of unavoidable threatening processes are:

- Retain existing clumps of remnant vegetation, paddock trees and native pastures.
- Retain, where possible, fallen and standing dead trees, fallen timber, rocks, logs and stumps as native wildlife habitat.
- Minimise the perimeter of remnants to reduce “edge effects” or disturbances, such as changes in levels of weeds, predators, noise, humidity, sunlight, wind, temperature and nutrients.
- Retain native vegetation areas near water bodies, such as creeks, dams and wetlands, to greatly enhance the area’s habitat value.
- Fence rivers and creeks for possible buffer zones, wildlife corridors and erosion control areas and increase the areas of vegetation.
- Have a range of microhabitats in streams, for example, deep pools, rocky riffles, submerged logs and snags.
- Prevent chemicals, fertilisers and gross pollutants from running off into streams or wetlands.
- Prevent nutrient enrichment from addition of untreated stormwater to streams
- Consider fencing the wetland’s catchment to manage separately to reduce input of sediment and gross pollutants.
- Create a buffer zone of vegetation around the wetland to help absorb the impacts of on-farm activities.

MANAGEMENT ACTIONS FOR CONSERVATION OUTCOMES

All management processes require some evidence for success, or failure. The best way to achieve this is to have clearly identified goals, and steps to work towards these goals. There are a number of important things to remember when developing your conservation goals, including:

- Monitor your progress – this is the most important part of the process, and needs to be established at the very beginning. Set up fixed photo points, take photos every six months initially, and then every year or couple of years for comparison; keep a diary of events eg, when you planted or fenced, success rates of species and revegetation methods; compile species lists and monitor any changes.
- Prioritise conservation of remnant patches in the area. High priority should be given to areas that are in good condition, have mature trees, as well as young trees, have existing links with other patches, have a reliable water source, are large patches, and have good structure (trees, shrubs & groundcover). Remnant patches include areas such as native grasslands and wetlands.
- Allow for natural re-establishment and expansion of a patch by making the fenced area larger than the existing patch. Natural regeneration is the most economical, least labour intensive and most successful way to improve your existing vegetation.
- Plan ahead to protect areas that will perform a dual purpose. Protect areas that are of high conservation value and will also contribute to ecological integrity, such as areas that provide natural buffers, shelterbelts and wind breaks.
- Be aware of how activities in adjacent areas may influence the area you want to conserve, especially run-off, which can lead to erosion and pollution.
- Use local species and seed stock to revegetate areas. These species are adapted to the environmental conditions in the area, and will therefore require less maintenance and will provide the natural food and habitat needs of native fauna in the area.
- Use revegetation as a way to increase the total amount of habitat in the landscape, to link individual remnants, and to increase the size of remnants to be self-sustaining.
- Use revegetation to replace missing elements in the vegetation, for example, adding canopy trees for feeding, nesting and perching, adding understorey shrub species for feeding and perching, adding groundlayer plants for feeding and refuges for small birds and reptiles.

MANAGEMENT ACTIONS IN CREEKS AND WETLANDS

Effective management for conservation outcomes in creeks and wetlands involves some different considerations. Important things to consider when establishing or rehabilitating habitat include:

- Revegetate wetlands to increase or improve habitat availability for a range of species, improve water quality, and reduce sediments and erosion.
- Standing dead trees near or within dams provide safe water bird roosts. Logs, rocks and litter within and around the dam provide shelter for fish and frogs.
- Incorporate wider patches of vegetation in the streamside corridor eg. at creek bends
- Retain logs and rocks for shelter for frogs.
- Ensure foliage from trees and shrubs overhang creek water, providing shade for fish and tortoise habitat.
- Retain dead trees for waterbird roosts.
- Use fire carefully. Do not burn during wildlife breeding seasons. Retain areas with nesting habitat

CONSERVATION MANAGEMENT ISSUES FOR FAUNA

FROGS

Dramatic declines in some Australian frog species have been reported since the 1980s, with concern increasing more recently with the disappearance of a number of species from apparently intact ecosystems. For most species, there is no clearly identifiable cause of decline, although several factors are implicated. Some declines can be associated with loss and degradation of habitat, land use practices, changes to hydrology, pollution and predation, but others are as yet inexplicable. Disease is being investigated as a possible major cause for some declines.

So far no factors of a global nature have been shown to be related to frog declines, but these are being investigated around the world. Possible factors include air pollution, climate change and the increase in ultra-violet radiation resulting from depletion of the ozone layer. This last has implications for basking species in particular.

A threatening process usually entails associated impacts: eg. seepage change: includes localised changes to water content of soils, bogs, or watertable; native forest logging includes road building, siltation, altered flow, changed ground water characteristics, possibly altered water chemistry, turbidity; associated impacts of habitat destruction, degradation, fragmentation, changed drainage patterns, pollution, trampling , noise; stock damage includes trampling, compaction, grazing, drainage and ground water changes, destruction of vegetation (eating or damage), associated burning and nutrient changes (fertilisers, excreta).

Enormous arrays of human activities affect the viability of frog populations. These include:

1. Insecticide use in agricultural and horticultural areas, particularly aerial spraying.
2. Land reclamation by drainage in wetland areas, resulting in loss of breeding sites.
3. The conversion of temporary ponds to dams for stock use resulting in the destruction of peripheral sheltering sites.
4. Introduction of the Mosquito Fish *Gambusia holbrooki* which preys on frog eggs and tadpoles.

Other factors being considered as potentially implicated in frog declines include: global changes to air and water quality, increased exposure to ultra-violet radiation caused by depletion of the ozone layer, habitat modification, impacts of introduced species, pollution, hormonally active pesticide residues, pathogens and disease, acidification and climate change, including changes in climatic extremes. While some local losses of frogs can be attributed to specific causes (such as drainage of wetlands), there are many disappearances that cannot be explained.

Direct human activities have been a significant causal factor in the decline of species, and these activities have accelerated over recent years, with the result that declines have become even more noticeable. It is possible that the declines are the consequence of long-term effects of human activities, or that there is a cumulative response to at least several

factors. The existence of frogs in urban areas has been a feature of suburban life, but many suburban declines have also been noted.

It is easy to blame chemical pollution for frog declines. Some chemicals such as herbicides are widely used and drain into waterways. At the present time, the active constituents of herbicides in common use are exposed to reasonably rigorous toxicological scrutiny during their developmental stages, and their approval for release in Australia hinges upon an assessment of their action upon non-target organisms such as frogs. However, many herbicides, such as glyphosate, are mixed with chemical dispersants which are not subject to the same scrutiny.

FROGS AND CHYTRIDIOMYCOSIS

More recently, the amphibian chytrid fungus *Batrachochytrium dendrobatidis*, has been linked with frog decline. It appears that the fungus occurs naturally and has only been identified recently because it has become more virulent or more prevalent in the environment, or because host populations have become less resistant to the disease.

Chytrid fungi typically live in water or soil, although some are parasites of plants and insects. They reproduce asexually and have spores that 'swim' through the water. Only the amphibian chytrid fungus is known to infect vertebrate species. Individual frogs are thought to contract the disease when their skin comes into contact with water that contains spores from infected animals. Much is still unknown about the fungus and the disease in the wild, including reasons for the death of hosts, how the fungus survives in the absence of amphibian populations, and how it spreads. Interactions between the fungus and environmental factors are known to be important. Environmental stress, perhaps from global warming or increased exposure to ultraviolet radiation, may be reducing resistance to infection. However, such interactions between the fungus and other factors are not well understood.

The fungus invades the surface layers of the frog's skin, causing damage to the keratin layer. Tadpoles only have keratin in their mouths, so while they may carry the fungus, they do not succumb to it. But once they metamorphose into a frog, the fungus can take hold and kill the frog. It is not yet known exactly how this happens. The fungus may release toxins that are absorbed through the skin, or it may directly affect water uptake and respiration. In some frog populations, the disease causes only some animals to die; in others, it can cause 100% mortality. Surviving individuals are thought to be carriers. Some species are highly susceptible and die quickly; others seem to be less susceptible. There is no known treatment once the fungus is contracted. Although the fungus has caused the death of a number of individual Australian frogs, it is not clear whether it is the primary cause of population declines.

Eradication of *B. dendrobatidis* from Australia is not feasible at this time because:

- *B. dendrobatidis* appears to have an existence in the environment independent of amphibian hosts
- *B. dendrobatidis* is geographically widespread
- *B. dendrobatidis* occurs in water bodies in remote locations at which eradication strategies would be expected to be difficult to implement
- there is no effective remediation process and
- the severity of pathogenicity is associated with host and climatic conditions, which are aspects that are difficult to modify.

Control rather than eradication is the only option at this time. The overall goal of control should be to prevent chytridiomycosis from causing any amphibian to become threatened or to change to a greater threatened species status. The best option in controlling chytridiomycosis is to prevent the spread of *B. dendrobatidis* into areas where it may impact on threatened amphibian species or may lead to amphibian species becoming threatened.

BIRDS

Habitat loss, fragmentation and/or degradation have affected nearly two-thirds of all bird species in Australia. Seeds and terrestrial invertebrates are in short supply as result of threatening processes, although food shortage is considered a problem of only a quarter of these species. Most threatening processes reduced the probability of survival after birds have reached maturity. Despite this, for many species, threatening processes reduce nest success, either because nest site availability has been reduced or because nests fail. Many birds are unable to cross hostile habitat that surrounds them as a result of habitat modification, and this has affected around 20% of species.

Even after clearing has stopped, its effects continue through the impacts of edge effects associated with habitat fragmentation and continued degradation. Land clearing and grazing by sheep and cattle, and predators continue to be a major problem, while an altered fire regime is also thought to be having a long-term detrimental effect on many species. Up to 90% of coastal freshwater wetlands have been cleared in NSW, and the remaining wetland areas exist in various states of modification. Most temperate woodland habitat has been cleared, including over 70% in New South Wales. Land clearance has excluded nearly all the better quality agricultural land. This is of particular consequence for terrestrial migratory birds such as the Regent Honeyeater and Swift Parrot, both of which seek out large, heavily flowering eucalypts on fertile soils. Remaining woodland habitat is fragmented and continues to be degraded by ongoing clearing and a decline in tree health.

Over-grazing, weed invasion, salinisation and other flow-on processes also gradually make fragments unsuitable. Within fragments, essential habitat features that may be lost are leaf litter and sticks, and associated invertebrates which are food for species such as the Bush Stone-curlew and Grey-crowned Babblers, hollows suitable for nesting by cockatoos, parrots, owls and treecreepers, and key food plants for many species. For treecreepers, and possibly babblers and bellbirds, females dispersing from fragments to find mates are unlikely to be replaced, so many fragments are below carrying capacity. Foxes may have

exacerbated the impacts of habitat loss and caused further declines in ground-dwelling species.

Fragmentation may also favour open-country native species like Noisy Miners (*Manorina melanocephala*), Pied Butcherbirds (*Cracticus nigrogularis*) and Pied Currawongs (*Strepera graculina*) which prey on smaller species or exclude them from their territories. Each of these species was recorded in this survey. Trapping of parrots and finches for the bird trade may also have exacerbated local declines.

The health of associated habitats such as wetlands and grasslands can be linked to woodland management practices. Many of the natural wetlands have been drained, degraded by overgrazing or have simply, are key habitats for a number of endangered species, including bitterns recorded in this survey. Grasslands provide essential foraging and roosting habitat for a range of species, and are also threatened by clearance for agriculture, fragmentation, degradation and, predation by feral animals such as foxes and cats (both recorded in this survey).

RECOMMENDED MANAGEMENT ACTIONS

- Identify key species and protect areas where they have been recorded regularly, monitoring compliance at six month intervals.
- Identify all significant habitats on public land, and place this under secure conservation management, particularly those in reserves, transport corridors and local government land.
- Undertake habitat extension by implementing ongoing revegetation programs with targeted weed removal programs, in a process of land reclamation that recreates woodland habitat with a full complement of biodiversity.
- Undertake habitat extension by implementing community education programs with land-holders that have suitable woodland habitat to promote sound management of remnants, encouraging greater connectivity between sub-populations.
- Undertake habitat extension by implementing community education programs with land-holders to maintain litter layer and fallen timber debris within wooded remnants.
- Reduce urban land management practices where appropriate in remnant woodland and native grasslands.
- Maintain a buffer around nest trees used by threatened or near threatened hollow-nesting species.
- Undertake long-term monitoring of core species.
- Determine and rectify causes of failure of regeneration where it occurs in targeted areas
- Maintain or establish feral predator control, where cats and/or foxes are a recognized problem.
- Where appropriate, maintain a fire regime that establishes a mosaic of fire ages.
- Protect, manage and rehabilitate wetlands that are important for a range of aquatic birds and other threatened wetland species.
- Coordinate conservation management of threatened species at a regional level.

CONSERVATION MANAGEMENT IN MODIFIED HABITATS

MANAGEMENT CONSIDERATIONS FOR MODIFIED HABITATS

Any bushland area that has been affected by human activities has become a modified habitat. The level and type of modification may vary, and the degree of impact on the habitat quality will reflect this. The success of any restoration or rehabilitation process will depend on a number of considerations, including:

- Modification affects different species differently.
- Modification of a particular site needs to be considered in terms of the elements of habitat removed.
- There may be reasons to consider the mix of modified habitats in the landscape in a regional conservation assessment, including inability to reach targets from unmodified habitat; and when the benefit of choosing modified habitat in a desirable site configuration outweighs the advantages of choosing a less modified, isolated site.

THE ROLE OF CORRIDORS IN A MODIFIED LANDSCAPE

The conservation of habitat corridors is a strategy for increasing landscape connectivity that can be used effectively under certain circumstances. The evaluation of their role will depend on:

- Whether they are natural or artificial
- Whether they are already necessary to meet regional comprehensiveness and representativeness targets
- Their scale
- Their landscape context
- How effective they are for targeted species

In general, natural vegetation is to be preferred (especially if its interior is intact and the edges are minimally disturbed). Linkages to areas requiring partial or major restoration are expensive, take time and may not ever be fully effective (Bennett 1999). If the corridor or habitat linkage already meets comprehensiveness and representativeness targets then it will require protection. Natural corridors or habitat linkages that maintain the integrity of ecological processes and communities at the regional scale are more significant than those at the local scale (Bennett 1999). They have benefits at bioregional and national levels as well as local scales. Examples include river and riparian systems, forested mountain chains, wetlands and forest blocks for migratory birds. They are difficult or impossible to reconstruct and so must be identified and protected early on (Bennett 1999).

Local scale linkages (for example a corridor between two woodlands) will be more important in fragmented landscapes and should be based on the requirements of the focal species approach. In more intact landscapes the aim will be to manage the landscape as a mosaic rather than as a series of connected remnants; Links that enhance habitat for assemblages are to be preferred over those that provide benefits for only one species (this would be an indicator of their wider ecological role in any case). Again, where a species approach is adopted in fragmented or relict landscapes, such as usually exist in highly urbanised areas, or where threatened species warrant special consideration, corridors should be considered if there is evidence that they will counteract the cause of decline of the species.

To consider their effectiveness, it is necessary to ask:

- Will it re-establish population continuity? Existing knowledge of the distribution of the species needs to be sufficient to determine the most effective location for linkages to other populations.
- Will the species find and enter it?
- Are their requirements for refuge and food during movement being met?
- Do the species presently occur in it?
- What are their requirements for space and how does this relate to the proposed width?
- Will the species have specialised food or habitat requirements or are they sensitive to the presence of other species?

6. OPTIONS TO PROVIDE, MAINTAIN AND IMPROVE GREEN AND GOLDEN BELL FROG HABITAT

ABOUT GREEN AND GOLDEN BELL FROGS

The frogs are usually located in and around water bodies such as wetlands, lakes and dams, and often on sites which humans have disturbed such as abandoned quarries. Their preferred habitats always contain plenty of vegetation in and around water. Their diet typically consists of beetles, ants, spiders, crickets and smaller frogs, including the young of their own species.

Males call while floating in the water to attract females. Their call is a long sound followed by a medium sound, then two short sounds (brrrrrrkbrrrrk-brrk-brrk). The frogs normally breed during spring and summer. Tadpoles take about 10–12 weeks to turn into frogs.

DOES AND DON'T'S FOR GREEN AND GOLDEN BELL FROGS: A SUMMARY

If Green and Golden Bell Frogs are to successfully recolonise the reserve at Coxs Creek there are a number of things that can be done to help the process:

DO:

- Restore, retain and extend all wetland areas on the reserve - bell frogs need large areas to disperse to after breeding. Wetland areas that are ephemeral (temporary) are also particularly valuable due to the absence of predatory fish – in particular gambusias, which are voracious predators of bell frog spawn. These wetlands don't need to be very deep but they do need to last for at least two months over the breeding season (spring and summer) so the tadpoles can grow to maturity.
- Maintain healthy amounts of riparian vegetation – while gambusia can be virtually impossible to eradicate once they get into a permanent waterbody, bell frogs can sometimes live and breed in the presence of predatory fish if they have adequate amounts of native vegetation to shelter in – particularly rushes and reeds such as *Juncus* sp, *Eleocharis* sp and *Typha* sp, or other large clumping reeds.
- Retain logs and rock piles or create them. These provide important sheltering and foraging sites. Grassy banks nearby are also important as these frogs like sun basking.
- Retaining or planting native trees provides shade. Trees and other vegetation will attract insects, providing a vital food source. Care must be taken not to create excessive shading of frog ponds and foraging areas.
- Reduce feral animal predation by means of fox ,rat and cat traps.
- Be careful when driving, bell frogs can be found on nearby roads after rainfall.

DON'T:

- Use herbicides, pesticides or chemicals anywhere near waterways,
- Clear or destroy wetlands – they are vital habitat for frogs and other animals.
- Allow activities that will result in soil erosion as this can lead to turbidity, increased nutrient input and reduced water quality.
- Allow fertilizers or effluent to runoff into wetlands, they will also reduce water quality and cause algal blooms.

TYPES OF HABITATS FOR LIFECYCLE STAGES

BREEDING HABITAT

The Green and Golden Bell Frog successfully breeds in and around a wide variety of water bodies, ranging in size from large freshwater and estuarine lakes to small temporary pools and depressions. They have been recorded in coastal swamps, marshes, dune swales, lagoons, lakes and other estuary wetlands as well as around riverine floodplain wetlands, billabongs and ponds in slow flowing or non-perennial streams.

Constructed water bodies such as stormwater detention basins, farm dams, areas bunded by earthworks and by road or rail structures, drains, ditches and other excavated areas that can capture water such as quarries and brick pits have been used as breeding habitat. Smaller or less obvious structures have also been used, including water tanks, bunded safety areas surrounding industrial chemical storage areas, wells, irrigation pits, water troughs, laundry tubs and old bath tubs.

FORAGING HABITAT

Green and Golden Bell Frogs prefer foraging areas that contain flowering plants, grasses and foliage. Plants that form tussocks provide foraging habitat and shelter. For these frogs to utilise foraging habitat this vegetation may be near breeding habitat sites or some considerable distance away.

REFUGE HABITAT

Refuge habitat contains areas in which the frog can escape from dangers such as predation or fire, and can retreat to avoid climatic extremes for short periods. Refuge habitat can include sites where individuals might spend extended periods during cooler months in an inactive state. The frog may be found hiding in human refuse including dumped building materials that substitute for natural shelter. These can include piles of sheet iron, fibro, concrete and bricks. When unfavourable conditions occur, these shelter sites can be occupied by many green and golden bell frogs.

CONNECTIVITY HABITAT

Connectivity habitat enables frogs to move between different areas of habitat at different times of the year. It also allows for interaction between frogs from different populations so populations can adapt and survive. Connectivity habitat generally includes wet areas such as river banks or wetlands, drainage lines, stormwater culverts and swales. It can also include periodically damp areas such as connecting or partially connecting areas of preferred vegetation, easements, laneways, and grassy open areas that do not restrict movement.

VEGETATION REQUIREMENTS FOR HABITAT

The main components of any green and golden bell frog habitat are appropriate vegetation and a pond. Plants should be planted around water bodies, placed in water bodies when appropriate (e.g. reeds), and dispersed over the site. When creating foraging habitat, it is a good idea to plant relatively low plants including groundcovers, grasses and sedges across the site, and plant taller aquatic plants near water or periodically wet areas. Include plants that form tussocks for shelter, such as such as *Lomandra* and *Dianella* species.

DESIGNING A GREEN AND GOLDEN BELL FROG POND

Green and golden bell frogs will use a wide variety of water bodies as habitat, habitats can be created through a number of means according to DECC (2008b) and are described in this section. Different options for ponds include in-ground ponds with a clay base, those made with pond liners, prefabricated ponds, above ground plastic swimming pools or concrete troughs, and ponds made out of old bath tubs, plastic tubs or laundry tubs. A pond previously used for fish can be converted into a frog pond if fish and spawn are removed.

A Green and Golden Bell Frog pond can be constructed anywhere, from backyards to industrial premises. Ponds should be raised above the ground, as they can exclude ground frogs which may compete with, or prey on, bell frog eggs and tadpoles. While bell frogs may use in-ground ponds, breeding may not be successful if ground frogs are present. A pond should have sides at least 35 cm above ground level and preferably a lip that turns outwards. An inward-turning lip may prevent frogs from getting out of the water and cause them to drown.

Additional requirements for the creation of effective bell frog habitat include:

- relatively shallow (no more than a metre in depth at maximum) but varying in depth to allow for different growth stages
- still or, at most, very slow flowing
- ephemeral or permanent (ideally either periodically drying out or with fluctuating water depth – a permanent water body with associated ephemeral depressions that periodically hold water is likely to be an ideal combination)
- near a range of preferred vegetation such as clumps of sedges and rushes, away from exotic trees (as many trees shed leaves which are poisonous to bell frogs) and in a sunny position without heavy shading, to allow frogs to bask in the sun

- free of exotic fish such as carp and plague minnow
- characterised by having both emergent and submerged aquatic plants which provide food and shelter for tadpoles, and encourage aquatic insects on which the frog can feed surrounded by rock piles or logs on which the frog can bask and in which the frog can hide.

LANDSCAPE REQUIREMENTS AROUND THE BELL FROG POND

Landscape features that can be implemented to create or improve Green and Golden Bell Frog refuge habitat include:

- dense tussock forming vegetation
- deep fissures and earth cracks in mud
- underground holes and burrows
- rotting logs with hollows
- logs embedded in the earth or piles of timber
- rock piles
- compost piles help to attract insects on which the frog feeds

When creating connectivity habitat, underpasses or other ways to enable frogs to cross busy roads may have to be constructed. Viaducts, culverts and openings under retaining walls, buildings or roads could be used. Frog fencing may need to be installed to direct the movement of frogs away from busy roads or towards underpasses to allow them to move safely between habitats.

A frog fence can be made of any durable material but will need to have a roof and lip or curve to prevent frogs climbing over it. The fence will need to be at least one metre high so frogs cannot jump over it. There should also not be any vegetation within a metre of the fence to prevent frogs hopping from plants over the fence. Several different styles of fencing include recycled plastic planks and posts with a metal hood, or curved metal posts embedded into the ground with the curve facing the frogs' habitat. Shade cloth is attached from the curve edge to the ground and can be dug in up to 20 cm deep to help prevent frogs burrowing under it and escaping.

Underpasses should be considered in any new residential or industrial development and when constructing new roads. These can be retrofitted in areas where creating a designated corridor is problematic, and should be considered as an alternative or supplement to ground level corridors. The frog is highly mobile, may use different habitat components from time to time and, where these are some distance apart, will need to be able to move between them.

Things that can be done to enhance existing habitat include:

- weed control
- native plant control
- pest control

- improving water quality
- fire management
- monitoring

Correct management actions for each of these habitat enhancement activities are discussed in more detail in sections outlining zone management activities. Further information can be found from the Department of Environment & Climate Changes publication “Best Practice Guidelines: Green & Golden Bellfrog Habitat” (DECC 2008b)

7. OPTIONS FOR IMPROVEMENT AND MAINTENANCE OF REMNANT COOK'S RIVER CASTLEREAGH IRONBARK FOREST

KEY THREATENING PROCESSES AND PRIORITY RECOVERY ACTIONS

COOKS RIVER CASTLEREAGH IRONBARK FOREST (CRCIF)

The Cooks River Castlereagh Ironbark Forest (CRCIF) is part of the Cumberland Plain Woodlands. In most areas Cumberland Plain Woodlands is dominated by Grey Box (*Eucalyptus moluccana*) and Forest Red Gum (*E. tereticornis*) with Narrow-leaved Ironbark (*E. crebra*) occurring less frequently on the hills and plains, and Thin-leaved Stringybark (*E. eugenioides*) and Spotted Gum (*Corymbia maculata*) present less frequently on the plains. In areas where there is a strong influence of alluvium or ironstone (i.e. in the Shale Gravel Transition Forest component) the vegetation is generally dominated by Red Ironbark (*Eucalyptus fibrosa*), with Grey Box and Forest Red Gum occurring less frequently.

CRCIF ranges from open forest to low woodland, with a canopy dominated by Broad-leaved Ironbark *Eucalyptus fibrosa* and Paperbark, *Melaleuca decora*. The canopy may also include other eucalypts such as woolybutt *E. Longifolia*. The dense shrubby understorey consists of *Melaleuca nodosa* and peach heath *Lissanthe strigosa*, with a range of 'pea' flower shrubs, such as *Dillwynia tenuifolia*, *Pultenaea villosa* and *Daviesia ulicifolia* (can be locally abundant). The sparse ground layer includes grasses and herbs, including kangaroo grass (*Themeda australis*), weeping meadow grass (*Microlaena stipoides var stipoides*) and *Entolasia stricta*. This community includes many more species (see Table 3.)

The CRCIF has a restricted natural distribution, occurring mainly on clay soils derived from the deposits of ancient river systems (alluvium), or on shale soils of the Wianamatta Shales. As a community it can intergrade into Shale-Gravel Transition Forest (where the alluvium is shallow), Castlereagh Swamp Woodland (in moist depressions) and Castlereagh Scribbly Gum Woodland (on sandier soils). These communities, however, are not currently recorded from near Coxs Creek Reserve. A key aspect of the CRCIF is that most species in the community are able to regenerate from lignotubers and buds beneath the bark as well as seeds stored in the soil. This characteristic improves the resilience of the EEC to disturbances including slashing, trampling and fire of moderate intensity and frequency.

The priority recovery and threat abatement actions required for this ecological community are:

- Promote public involvement in these restoration activities.
- Apply necessary fire regimes to maintain the community's appropriate floristic and structural diversity.

- Protect habitat by minimising further clearing of the community. This requires recognition of the values of all remnants of the community in the land use planning process, particularly development consents, rezonings and regional planning.
- Protect habitat by controlling run-off entering the site if it would change water, nutrient or sediment levels or cause erosion.
- Weed control.
- Undertake restoration including bush regeneration and revegetation

This list does not encompass all actions that may be of benefit to this ecological community, but highlights those that are considered to be of the highest priority. In all, 16 key priority actions have been identified for this community, and these have been used to inform management strategies for the Coxs Creek Reserve.

DOWNY WATTLE (ACACIA PUBESCENS)

Other considerations for Coxs Creek Reserve include conservation of *Acacia pubescens*, which occurs primarily in CRCIF. This species is clonal in its reproduction. Seed production is low while predation of seeds is high, and recruitment is mainly from vegetative reproduction rather than seedlings. The suckering mechanism of *A. pubescens* allows the species to tolerate levels of disturbance, including fire and slashing. The degree of tolerance, however, is not clear, and too frequent fire may kill suckering plants. Fire (particularly smoke) may promote the germination of seed, which are often harvested by ants and carried up to several metres from the plant before being buried. This burial serves to ensure that germination is triggered by penetrating rainfall or fire. High intensity fires may burn seeds that are not deeply buried.

TADGELL'S BLUEBELL (WAHLENBERGIA MULTICAULIS)

Tadgell's Bluebell has recently been recorded on site. A number of key threatening processes for this species have been identified, and include:

- Genetic swamping through hybridisation with *W. gracilis* and *W. littoricola*
- Weed invasion
- habitat clearing
- intrusive ballast dumping
- deposition of industrial refuse and excavated material

Priority recovery actions include:

- Prevent further loss, fragmentation and degradation of habitat.
- Removal of hybrids is not recommended at this stage as they contain genetic material of *W. multicaulis*. Sites with hybrids should be closely monitored and DEC should be consulted prior to undertaking any actions to remove hybrids.
- Prepare and implement Plans of Management or similar

IMPLEMENTATION OF HABITAT MAINTENANCE AND IMPROVEMENT ACTIONS

An extensive list of species has been recorded for CRCIF. The species listed in the following table (Table 1) are a representative list provided in the Scientific Determination (DECC 2002), and are provided as a guide to revegetation. This is not exclusive, and additional species should be included if there is evidence to indicate that they are appropriate to the EEC on this site.

Table 1. Representative list of species recorded in Cooks River/Cumberland Ironbark Forest (DECC 2002).

TREES	SHRUBS	HERBS	GRASSES
Acacia binervia	*Bursaria spinosa*	*Astroloma humifusum*	*Aristida ramosa*
Acacia falcata	*Cassinia arcuata*	*Boronia polygalifolia*	*Aristida vagans*
Angophora bakeri	*Dillwynia parviflora*	*Calotis cuneifolia*	*Austrodanthonia setacea*
Angophora floribunda	*Dillwynia sieberi*	*Cassytha glabella* form *glabella*	*Austrodanthonia tenuior*
Eucalyptus capitellata	*Hakea sericea*	*Dianella revoluta*	*Austrostipa pubescens*
Eucalyptus fibrosa	*Kunzea ambigua*	*Einadia nutans*	*Austrostipa rudis*
Eucalyptus longifolia	*Leptospermum trinervium*	*Einadia trigonos*	*Dichelachne micrantha*
Eucalyptus moluccana	*Leucopogon juniperinus*	*Gonocarpus tetragynus*	*Entolasia stricta*
Eucalyptus resinifera	*Lissanthe strigosa*	*Goodenia belledifolia*	*Eragrostis brownii*
Exocarpos cupressiformis	*Melaleuca decora*	*Goodenia hederacea* subsp. *hederacea*	*Microlaena stipoides*
Notelaea longifolia	*Melaleuca nodosa*	*Goodenia paniculata*	*Panicum simile*
Syncarpia glomulifera	*Melaleuca stypheliodes*	*Hibbertia empetrifolia*	*Paspalidium distans*
	Opercularia diphylla	*Hibbertia serpyllifolia*	*Themeda australis*

TREES	SHRUBS	HERBS	GRASSES
	Ozothamnus diosmifolius	*Laxmannia gracilis*	
	Podolobium ilicifolium	*Laxmannia gracilis*	**CLIMBERS**
	Pomax umbellata	*Lomandra longifolia*	*Billardieria scandens*
	Poranthera microphylla	*Lomandra multiflora subsp. multiflora*	*Glycine clandestina*
	Pultenaea villosa	*Orthoceras strictum*	
	Rhytidosporum procumbens	*Pratia purpurascens*	**FERNS**
	Xanthorrhoea media	*Stackhousia viminea*	*Cheilanthes sieberi* subsp*. sieberi*
		Thelymitra pauciflora	
		Vernonia cinerea var. *cinerea*	**SEDGES**
		Wahlenbergia gracilis	*Lepidosperma laterale*

The extent of species diversity provided in the above table gives an indication of the loss of species richness currently occurring on the site at Coxs Creek Reserve. No comprehensive survey of flora on site appears to have been conducted in the recent past. A flora species list was compiled by UBM Consultants as part of their Bush Regeneration Works Report, and is presented below (Table 2). This list does not include all species currently present on site. Additional native species from the CRCIF EEC list were noted on site (M.Brainwood, pers. obs.).

Table 2. Partial flora species list for Coxs Creek Reserve (UBM Consultants, 2008).

CANOPY TREES	SHRUB	GRASSES &	GROUNDCOVER
Casuarina glauca	*Acacia decurrens*[2]	*Aristida ramosa*	*Arthropodium*
Eucalyptus fibrosa	*Acacia falcata*	*Austrodanthonia*	*Cassytha pubescens*
Eucalyptus sideroxylon[1]	*Acacia longifolia* var	*Cymbopogon*	*Centella asiatica*
Melaleuca nodosa	*Acacia pubescens*	*Dichelachne*	*Cheilanthes sieberi*
Melaleuca styphelioides	*Banksia spinulosa*	*Echinopogon*	*Commelina cyanea*
Syncarpia glomulifera	*Bursaria spinosa*	*Juncus bufonus*	*Dichondra repens*
	Callistemon pinifolius	*Juncus usitatus*	*Einadia hastata*
	Dillwynia sieberi	*Microlaena stipoides*	*Glycine clandestina*
	Dodonea triquetra[2]	*Oplismenus aemulus*	*Glycine tabacina*
	Gahnia aspera[2]	*Triglochin striata*	*Hardenbergia violacea*
	Glochidion ferdinandi		*Lomandra obliqua*
	Kunzea ambigua		*Opercularia diphylla*
	Leucopogon		*Polymeria calycina*
	Lomandra longifolia		*Pratia purpurascens*
	Macrozamia spiralis		*Senecio quadridentatus*
	Omalanthus populifolius		*Tetragonia tetragonoides*[3]
	Ozothamnus		*Wahlenbergia communis*[3]
	Pimelea linifolia		*Wahlenbergia gracilis*
	Pittosporum undulatum		*Wahlenbergia stricta*
	Pomaderris lanigera		
	Pultenea retusa		
	Pultenaea villosa		

We recommend that additional planting in all areas of the reserve be utilised to compensate for the existing losses. Preference should be given to species that have been identified as integral to the CRCIF. Seeds should be sourced from nearby localities or from similar habitat areas (ie. other reserves where CRCIF is conserved). General guidelines for the sourcing of local provenance seeds are provided in section 10.

1 Debate exists on the status of *Eucalyptus sideroxylon* as either locally indigenous or a cultural planting.

2 Planted from local seed sourced outside Coxs Creek Reserve

3. Planted / escaped species not representative of local plant community.

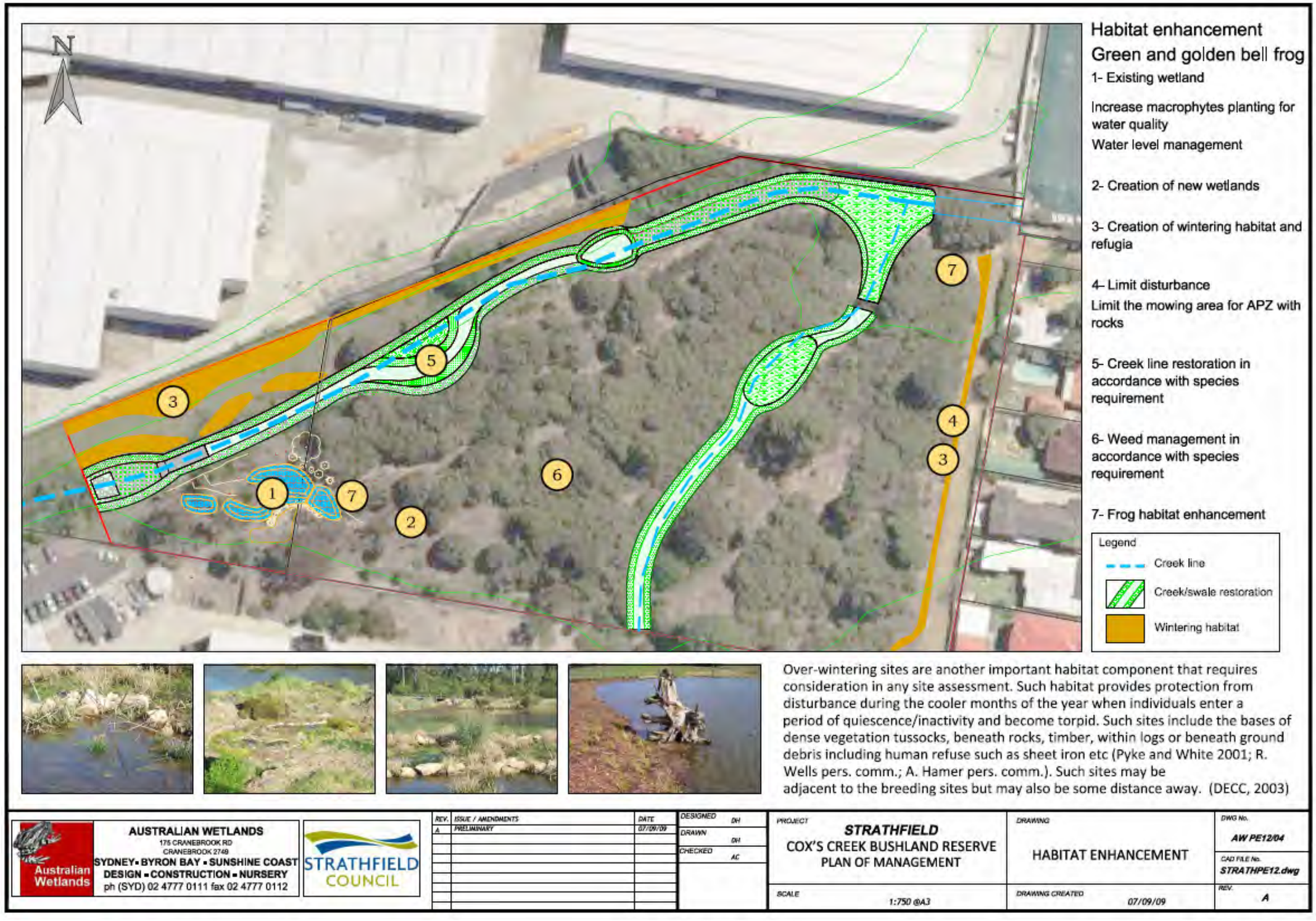
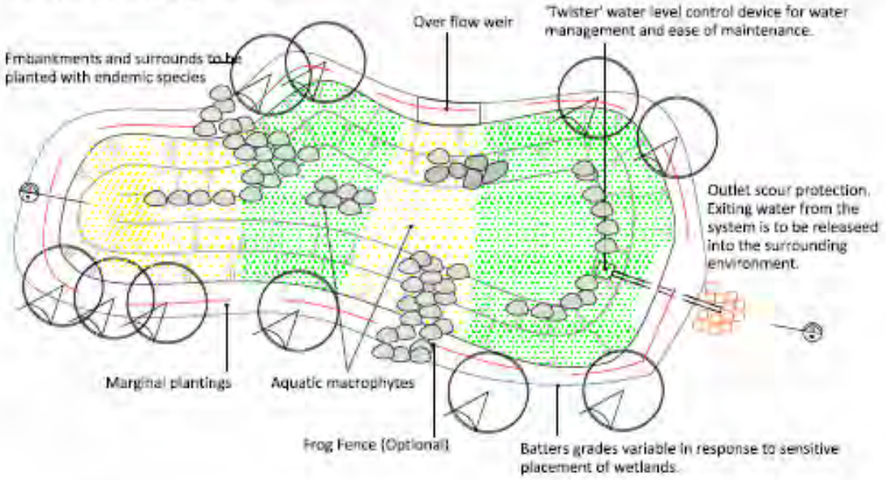


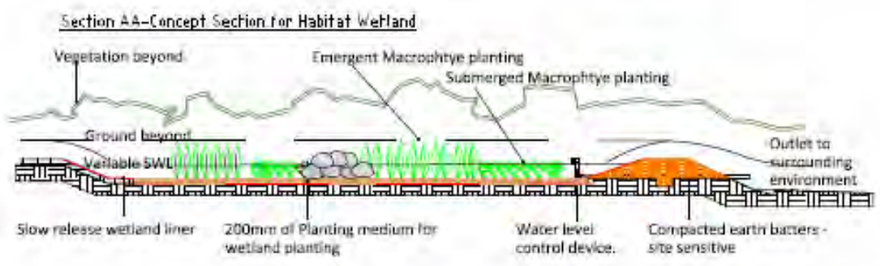
Figure 5 - Habitat Enhancement Green & Golden Bell Frog – Plan 1 (Drawing No. AW PE 12/04)

Concept Plan for Habitat Wetland

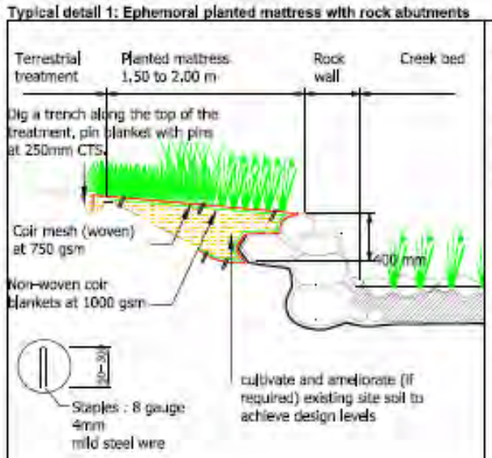
NOTES:
Plant material to be sourced from the existing site via 'slabbing' or from similar sites within 3klm with the the same hydrology and geology as the site.



Section AA–Concept Section for Habitat Wetland



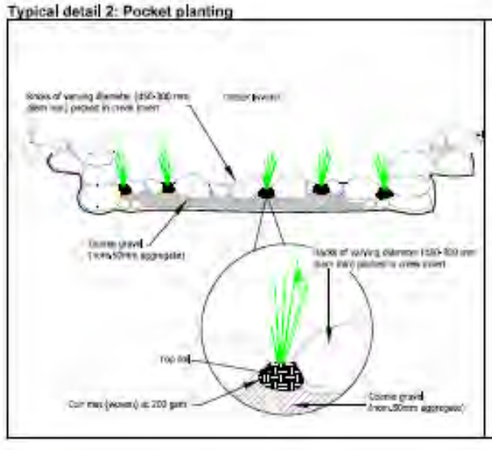
Typical detail 1: Ephemoral planted mattress with rock abutments



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

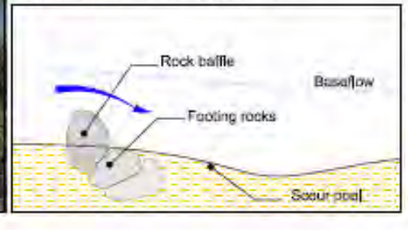
This planting strategy will provide stability for the planting substrate during high velocity "flashy flows". Coir fibre matting water holding capacity is in excess of 500% reducing the impacts of wetting and drying cycles on plant establishment. The product is entirely bio-degradable and will degrade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

Typical detail 2: Pocket planting

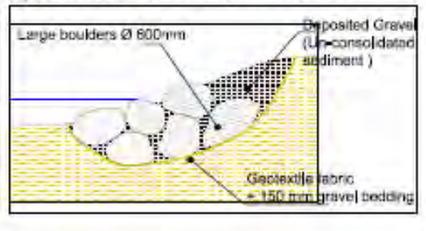


Tubestock planted into rip rap creek sections needs to have planting medium protected from both dispersal during baseflow and complete dislodgement during high velocity flows during plant establishment phase. Creating a coir mat "nest" or "pocket" to bed down the topsoil prior to planting will assist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

Typical in-stream rock baffle



Typical Rock Bank Scour Protection



AUSTRALIAN WETLANDS 175 CRANEBROOK RD CRANEBROOK 2749 SYDNEY • BYRON BAY • SUNSHINE COAST DESIGN • CONSTRUCTION • NURSERY ph (SYD) 02 4777 0111 fax 02 4777 0112	STRATHFIELD COUNCIL	REV. A — ISSUE / AMENDMENTS: PRELIMINARY — DATE: 07/09/09 DESIGNED: JH DRAWN: JH CHECKED: AC
PROJECT: STRATHFIELD COX'S CREEK BUSHLAND RESERVE PLAN OF MANAGEMENT	DRAWING: HABITAT ENHANCEMENT	DWG No: AW PE12/05 CAD FILE No: STRATHPE12.dwg
SCALE: NTS @A3	DRAWING CREATED: 07/09/09	REV: A

Figure 6 - Habitat Enhancement Green & Golden Bell Frog – Plan 2 (Drawing No. AW PE 12/05)

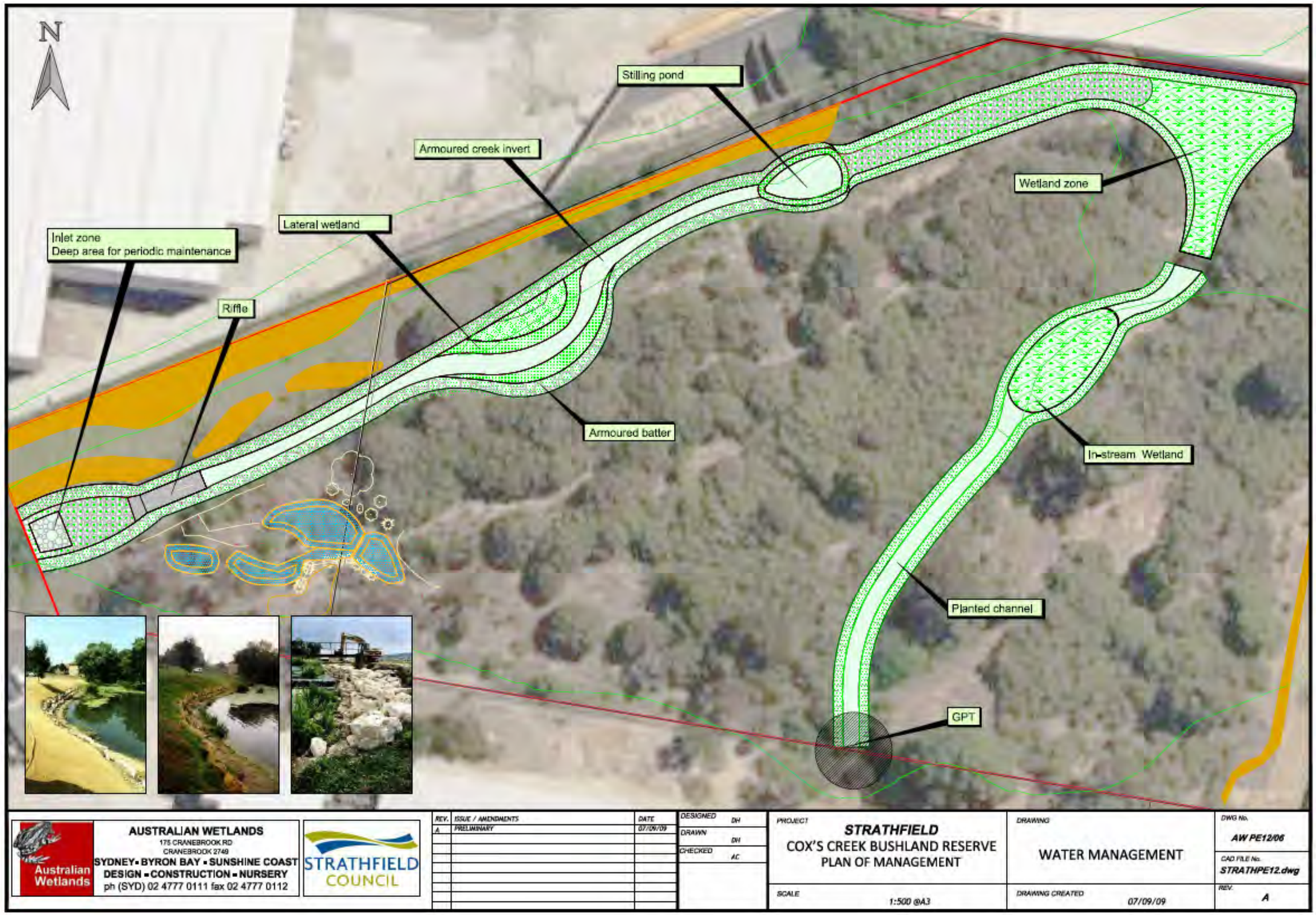
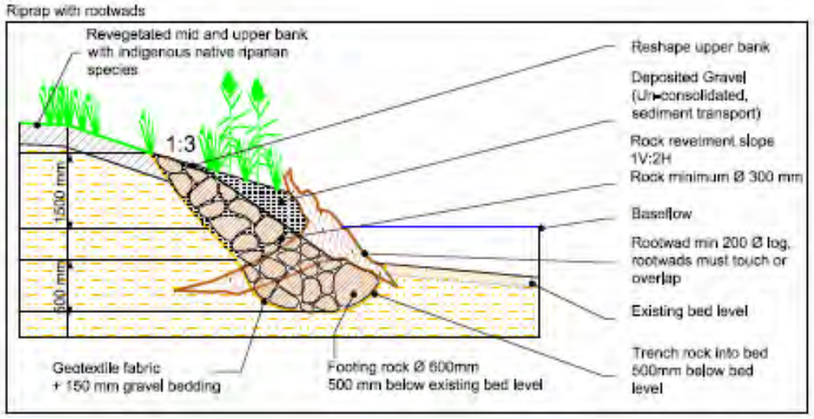
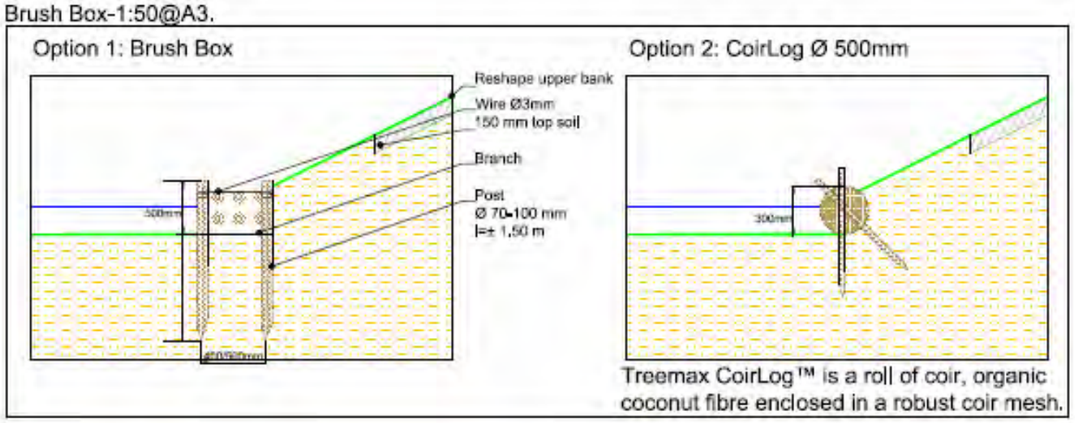


Figure 7 - Water Management - Plan 1 (Drawing No. Aw PE 12/06)

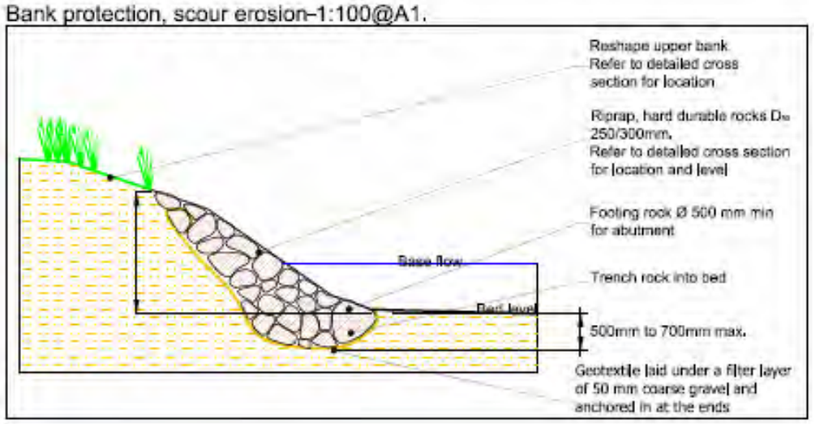
Riprap with rootwads



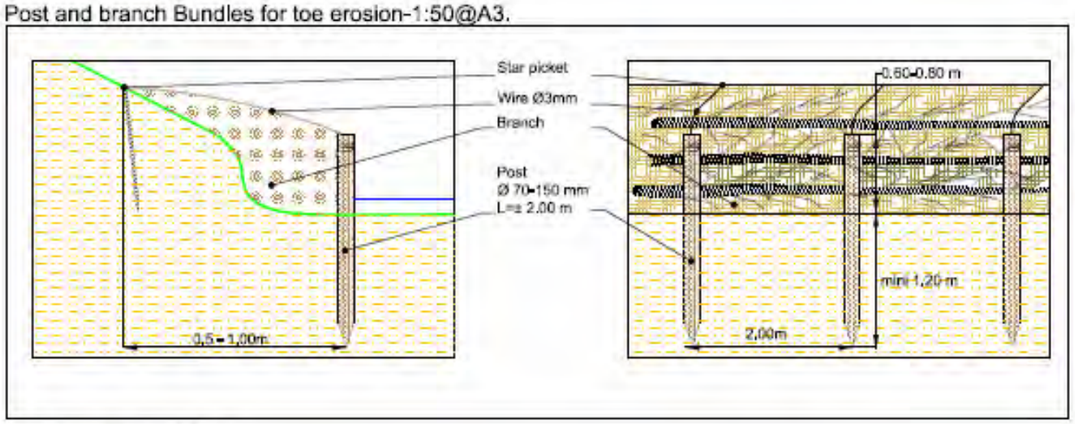
Brush Box-1:50@A3.



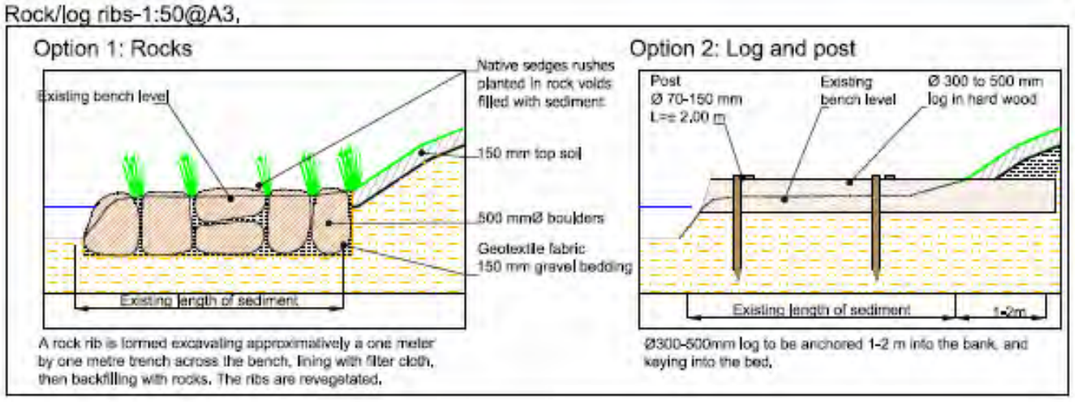
Bank protection, scour erosion-1:100@A1.



Post and branch Bundles for toe erosion-1:50@A3.



Rock/log ribs-1:50@A3,



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STRATHFIELD COUNCIL

REV.	ISSUE / AMENDMENTS	DATE
A	PRELIMINARY	07/09/09

DESIGNED DH
DRAWN DH
CHECKED AC

PROJECT: STRATHFIELD
COX'S CREEK BUSHLAND RESERVE
PLAN OF MANAGEMENT

DRAWING: WATER MANAGEMENT

DWG No. AW PE12/07
CAD FILE No. STRATHPE12.dwg
REV. A

SCALE: NTS @A3
DRAWING CREATED: 07/09/09

Figure 8 - Water Management - Plan 2 (Drawing No. AW PE 12/07)

8. MANAGEMENT ZONES

Coxs Creek Reserve have been divided into zones that require specialized management: -

Zone 1 – Western Bank of Main Channel

Zone 2 – Main Channel and Riparian Area

Zone 3 – Frog Enhancement Area

Zone 4 – Melaleuca Canopy Area

Zone 5 – Priority Bush Regeneration Areas

Zone 6 – Secondary Channel Wetland Establishment Area

Zone 7 – Low Priority Bush Regeneration Area

Zone 8 – Residential Buffer Area

The management zones are outlined in the map below.

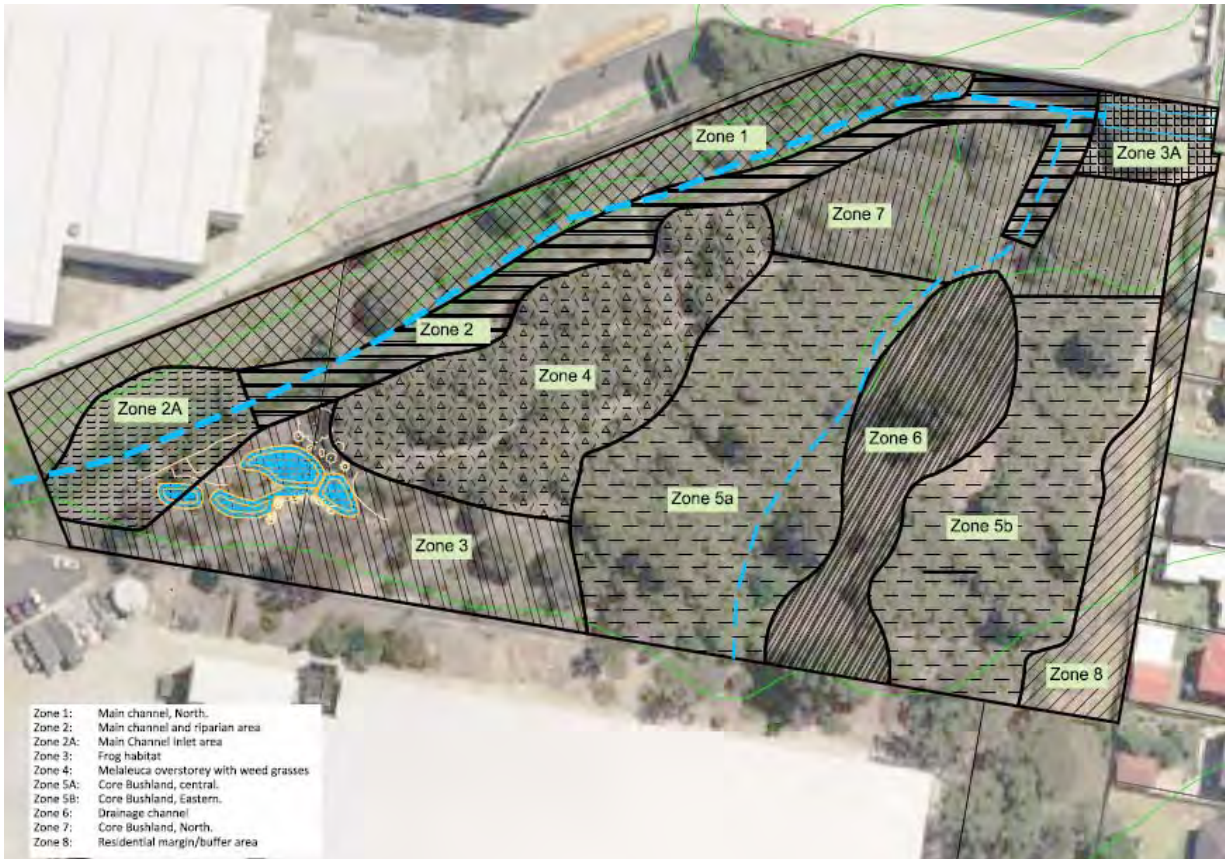

Figure 9 - Management Zones

ZONE 1 – WESTERN BANK OF MAIN CHANNEL

Description of zone

This zone includes the western bank of the main channel of Coxs Creek, and is perhaps the most degraded part of the site. Little if any native vegetation is present on the steeply sloping bank. The bank has the appearance of being constructed from landfill, sourced during the excavation of the current drainage channel alignment, with additional fill from outside areas. There is little or no topsoil, and the consolidated material forming the embankment contains chunks of concrete and other bulk material.

Assessment of vegetation and habitat value

At the southern end of the zone the vegetation consists of several weed trees and a dense understorey of weed grasses and annual or perennial herbs. Towards the northern end of the zone there has been considerable planting of native trees and shrubs, with eucalypts and acacias dominating these plantings. The plants are now around 5 to 8 years old, and have established a continuous canopy cover over much of this end of the zone. The understorey includes a mixture of native and weed grasses, and herbaceous weeds. While the tree and shrub species selected for planting provide good sources of nectar for blossom feeders, none of the planted trees are old enough or large enough to provide nesting hollows for a very long time.

The presence of extensive weed infestations is considered a key threatening process for the CRCIF EEC and for both threatened plant species present (*A. pubescens* and *W. multicaulis*). The considerable extent of the weed grasses in areas with partial or no canopy, however, provides excellent habitat for Green and Golden Bell Frogs, who like to sunbake and forage in this type of environment. Serious consideration must be given to the management of these frogs. Compensatory habitat must be provided during weed removal and should be a key consideration in selecting native species for this area. Other frog species (*Limnodynastes dumerili*) have been sighted in various parts of this zone.

Figure 10 Unnatural debris provides refuge for frogs

Threatening processes

- Modification of existing drainage channel, including filling of existing channel and excavation of new channel. Construction of concrete base in new channel alignment.
- Dense infestation of weeds associated with entry points to the reserve and merging channels above the discharge point indicates poor water quality entering and leaving the site.
- Lots of rubbish dumped from raised car park adjoining the site, including industrial debris, and general litter, lots of herbaceous weeds
- Large deep pit between the factory and the western channel bank – has the appearance of a seepage pit and associated drainage. This structure is indicative of the major changes to the local hydrology, and was constructed to maintain a lowered water table under the adjoining factory allotment.
- Below the pit is planted native canopy; groundlayer with weed grasses and some woody weeds, including noxious weeds (blackberry, broom, green cestrum)
- Evidence of past bush regeneration (weed piles), but no recent work apparent in the area. Maintenance of all restoration activities is imperative for sustained benefits of this work.
- Towards the upstream limit of site is an extensive kikuyu infestation, with some other weeds nearer the drainage line.

ZONE 2 – MAIN CHANNEL AND RIPARIAN AREA

Description of zone

This zone includes the main Coxs Creek drainage channel, from the point of inflow at the southwestern corner of the site to the point of discharge at the northeastern corner. The upstream environment is in Bankstown LGA, and comprises a highly impervious catchment with a mixture of industrial and residential land usages. Poor quality stormwater enters the site below an area of open channel, although much of the upstream channel is covered. From the point of discharge the downstream channel is covered for most of the distance to Cooks River; the remainder is a formalized concrete lined trench.

Zone 2 has been divided into two sections, with the upper extent of the drainage channel on site referred to as Zone 2A (proposed site of a sediment settling basin). The channel itself ranges from 2 to 3 metres wide, and is around 1 to 2 metres from low flow water level to top of bank. Originally, the whole area was swamp, and had no formalised channel – early maps show no defined creek through this area. The channel bed has been excavated into the existing swamp, through an overlay of building waste material. The excavated material has been piled onto the banks to create berms that increase the capacity of the channel.

Immediately upstream of the site was the location of the Bankstown Sanitary Depot (or sewage treatment works). In 1932 the Reserve site was described as a marshy grazing paddock, providing evidence of a lengthy history of disturbance. Several instances of flooding, with sewage flowing into the creek and down the streets, were reported during the lengthy operation of the Sanitary Depot. It was recognised that the locality of the depot on a drainage line was “not ideal”, and eventually the plant was decommissioned. Around this time the Strathfield/Bankstown municipal boundaries were reviewed, and the site was

transferred to Bankstown LGA in 1954. In 1998, Bankstown Council sold the depot. The site of the sanitary depot is now privately owned and occupied by Primo Smallgoods.

The base of the channel includes areas where fine sediments have been deposited, and other areas where bedrock has been exposed. A small sandstone drop of <1m forms a waterfall, with a deeper plunge pool immediately downstream. The downstream extent of the channel is concreted at the base before entering a large (1500mm diameter) pipe to exit the site. Parts of the bank near this downstream section are becoming eroded, as are parts of the western bank.

Figure 11 Southern embankment adjacent to Zone 2A

Assessment of vegetation and habitat value

The channel is largely filled with a mixture of reeds and sedges (e.g. *Typha and Juncus sp*), and is densely infested with Crofton Weed and other weeds indicative of poor water quality. Cockspur Coral Trees have been treated in the drainage line, although the success of this treatment is questionable. Despite the poor quality of the vegetation and water in the creekline, there have been reports (now 15 years ago) of gudgeons in the pools, and Green and Golden Bell Frogs have been reported from the area. Unfortunately, neither of these species has been recorded near Coxs Creek Reserve in recent years, although there is still potential for them to utilise the area.

Small bush birds are utilizing the area for foraging. Spotted pardalotes were noted here during recent field surveys, and may be nesting in exposed bank areas near the waterfall and pool. Consideration should be given to the timing of works in this area, so that nesting birds are not disturbed unnecessarily.

Figure 12 Bedrock section Coxs Creek

Threatening processes

- High levels of impact resulting from discharge of stormwater from the upstream catchment, including gross pollutants, fine sediments, flashy storm surges and poor water quality.
- Weedy riparian areas, noxious and woody weeds in creek.Sediment slugs kept in place by weeds; restoration works need to be staged to prevent a major mobilization of potentially toxic sediments. Given the location downstream from a decommissioned sewage treatment plant, testing of the sediment may be indicated before works commence.
- High volume stormflow from urban/industrial catchment channeled through the reserve into a large discharge pipe (d 1500mm). Consideration must be given to the erosive potential of storm surges in the catchment.
- Poor quality water moving through the site (there is potential to improve the water quality on site before discharging to the receiving environment – Cooks River)

ZONE 3 - FROG HABITAT ENHANCEMENT AREA

Description of zone

This zone forms part of the southern boundary of the site, and is bordered by the main drainage channel on the west and the cold storage facility to the south. The area includes a series of ponds constructed to provide habitat for Green and Golden Bell Frogs, and included a series of treatment ponds to improve water quality in the creek. Water was to be diverted to the treatment ponds and frog pond via a rising main, using a solar powered pump. This pump was stolen soon after installation, and it is questionable whether the whole structure has ever functioned as designed.

Figure 13 Constructed frog ponds

Assessment of vegetation and habitat value

Despite the loss of the pump setup, the ponds continue to provide a range of habitats suitable for various species and stages of development. As an existing structure it is ideal for Green and Golden Bell Frogs, with open water and lacking a dense canopy around at least part of the pond's perimeter. Rocks have been placed around the ponds to create refuges and areas for sunning by these frogs. Poor vegetation cover at ground level, however, reduces the overall value of the area. These frogs use this groundcover to move through the site.

A stand of ironbarks (*Eucalyptus sideroxylon*) is located in this zone, and appears to be the result of planting during a previous restoration program. Unfortunately these are not endemic to the CRCIF, but include one older tree and numerous younger trees of varying ages. Despite the poorly informed species selection, these trees provide good food and habitat for a range of birds, mammals and insects, and are growing well on poor quality, disturbed soils. Additional ironbarks (*Eucalyptus fibrosa*) and Acacias (*A. decurrens* and *A. longifolia* var *longifolia*) have been planted on the mound of spoil (from the main channel or the nearby development of the cold storage facility immediately south of the site) along the northern edge of this zone. These are all younger plantings, around 5 years old, growing well but yet to provide any real habitat in the near future.

Threatening processes

- Existing frog ponds are stagnant and fed by rainfall only, some ponds are dry, poor condition of pond liners prevents water pooling in these
- Some weedy grasses/herbs in open areas
- Inappropriate selection of species for rehabilitation planting in the past
- Poor quality soils resulting from mounding of construction spoils.

ZONE 3A – ADDITIONAL FROG HABITAT NEAR MAIN GATE

Description of zone

This zone is located immediately inside the main gate to the reserve. The northern part of this zone is overshadowed by the concrete slab forming the car park of the adjacent factory. Stormwater from this car park runs directly onto the site. There is little or no direct sunlight into the area, except around midday in high summer. A stand of Melaleucas (*M. stypheliodes* dominating) forms a dense canopy preventing much light penetration to the ground layer.

ZONE 4 – MELALEUCA CANOPY AREA

Description of zone

This zone includes a large area of degraded bushland between the two drainage channels. It is bounded immediately on the western side by the riparian zone associated with the main channel of Coxs Creek. The terrain is derived from the original swamp meadow, and has shallow troughs scattered throughout that may be remnants of braided channeling associated with the movement of stormwater through the site.

Assessment of vegetation and habitat value

The dominant canopy species is *Melaleuca nodosa*, with some *M. stypheliodes* present. Some shrubs have been planted around the edges of the zone, and most of the groundcover is weed grasses (mainly *Ehrharta* species). The dense nature of the canopy restricts light penetration to the lower layers, but provides habitat for small birds such as robins and finches. These birds can feed on the flowers and fruit, and the insects that utilise these food sources. Unfortunately the proximity of urban housing, with its associated feral animals (cats, rats, dogs), has reduced the success of many of these bush bird species.

Threatening processes

- Poor light penetration, contributing to reduced recruitment success for ironbarks and many understorey shrub species
- Mixed native and weed grasses and herb layer, dominated by Ehrharta
- Evidence of old meander channels or ephemeral overflow areas; may be areas of acid sulphate soils (typical of old swamps)
- Opportunities for predation of small birds and mammals by feral cats, rats and other domestic animals

Figure 14 Melaleuca canopy with weedy groundcover

ZONE 5A & 5B – PRIORITY BUSH REGENERATION AREAS

Description of zone

The two sections of Zone 5 are separated by the secondary drainage channel, and form the largest part of the site. This zone is bordered on the southern end by the smallgoods factory, and forms a wide strip of bushland along both sides of the second channel. Like Zone 4, there are unusual trenches that may be old meander channels through the swamp. This is the best conserved area of bushland on the whole site.

Figure 15 CRCIF at Coxs Creek Reserve. Zone 5b on left, Zone 5a on right. Zone 6 incorporates the weedy drainage easement.

Assessment of vegetation and habitat value

The vegetation in this area is archetypal CRCIF, with scattered ironbarks: *E. fibrosa* and *E. crebra*, both typical of this type of forest. Also present are *Melaleuca nodosa* and *M. styphelioides*, forming a scattered shrub canopy layer. Additional smaller shrub species typical of the CRCIF found in this zone include *Lissanthe strigosa*, *Pultenaea villosa, Cassytha glabella, Astroloma humifusum* and *Lomandra longifolia;*typical grasses present include *Microlaena stipoides* var *stipoides* and *Entolasia stricta.* There is good diversity of species and complexity of vegetation layers, both of which are indicative of the health of this part of the site. Much of this can be attributed to ongoing bush regeneration works in the area.

The ironbarks are mature and provide good nesting and roosting sites, although they are not old enough to provide many tree hollows. Several of the older trees have fallen branches

and trunks, with the apparent cause being the effects of dense termite infestations. This raises questions about the ongoing health of the local population of ironbarks, as they seem to be the primary target. Despite this there is some evidence of recruitment for the ironbarks, a factor that was not noted elsewhere in the reserve.

The combination of ironbarks and melaleucas provides a good range of flowers and fruit for foraging, and attracts insects which provide additional food resources in the area. At ground level there is a range of nectar producing shrubs and seed producing herbs and grasses, all of which contributes to a diverse array of habitats and food sources. It is surprising that there is not more evidence of use of the area by birds and mammals, which would normally be evidenced by scats, scratches on trees, feathers and fur caught on twigs. A pile of feathers on the ground is an indication of bird life and feral animals feeding on this.

Threatening processes

- Evidence of termites affecting tree health
- Evidence of predation of wildlife by feral animals
- Weed invasion, although this is currently lower here, and there is evidence of ongoing maintenance by bush regeneration
- Potential for weed encroachment from the poor quality drainage channel and nearby housing areas

ZONE 6 – SECONDARY CHANNEL WETLANDS ESTABLISHMENT AREA)

Description of zone

This zone is closely aligned with the secondary drainage channel, which enters the site from underneath the smallgoods factory to the south. The channel generally has low to no flow through the area, and is around 3 to 4 metres wide and 1 to 1.5 metres deep. The base of the channel is damp and supports sedges and rushes as well as weeds. There is a thick layer of sediment and sludge in the bottom of the channel that is evidence of anoxic conditions. Towards the downstream end of the channel there is some evidence of bank erosion, but no indication that high flows have overtopped the bank in the recent past.

Assessment of vegetation and habitat value

The vegetation in the channel bed is a mixture of weeds such as Crofton Weed and natives including *Schoenoplectus validus*, which are favoured by the poor quality stormwater that is directed through the area. The flat areas around the channel are more exposed to weed invasion, and are largely stabilised by these plants. Some ironbarks (mostly *E. fibrosa*) are scattered along the margins of the channel. There are open areas with little or no canopy cover that provide ideal habitat for Green and Golden Bell Frogs.

Threatening processes

- Some woody weeds, mainly groundlayer weeds in the channel
- Minimal erosion of banks, anoxic sludge in the base of the channel. Staging of works in this channel needs to consider the potential for mobilization of toxic sediments. Sediments may need to be tested before work commences.

ZONE 7 – LOW PRIORITY BUSH REGENERATION AREA

Description of zone

This zone is located around the secondary drainage channel and the confluence with the main channel at the northern end of the site, and includes the more degraded sections of the CRCIF. The area has the potential to respond well to a comprehensive bush regeneration program in conjunction with channel improvement works. During the colder seasons there is little direct sunlight to much of the area for most of the day. There has been some recent streambank erosion at the confluence of the two channels.

Assessment of vegetation and habitat value

The area is currently vegetated with degraded CRCIF, and has a dense *Melaleuca styphelioides* overstorey with a mixed native and exotic understorey. The habitat provided by this area lacks the diversity and complexity of the better bushland in Zone 5A and 5B, but forms a buffer between these areas of good bush and the degrading impacts associated with poor water quality and introduction of weed propagules in the drainage channels. Less bird life was noted in this area during recent field surveys.

Threatening processes

- Lots of groundlayer weeds and some woody weeds
- Reduced light penetration especially during winter months
- Some effects from poor quality stormwater and storm surges flowing through the area
- Some streambank erosion at the confluence of the two drainage channels

ZONE 8 – RESIDENTIAL MARGIN/BUFFER AREA

Description of zone

This is a narrow zone that runs along the eastern fenceline. Immediately behind the fence is the main area of residential housing that impacts the site. There are holes in the fence, and cats were sighted in several backyards. This area forms a rudimentary buffer between the influences of urban development (eg. weeds, domestic animals, domestic waste, rubbish, etc).

Assessment of vegetation and habitat value

The area between the houses and the better bushland zones is mainly covered with exotic grasses and herbs. It is currently maintained as an asset management zone, and also provides access to other parts of the reserve. It has little habitat value other than on the boundary of Zone 5B, where it includes plantings to consolidate the bush. Its primary value is as a buffer, and has the potential to extend the range of plant and animal species that prefer less canopy cover.

Threatening processes

- Mowed strip along the back of houses (one side of the triangle)
- Lots of weeds coming over the fence, weed grasses and herbs, and some woody weeds (mainly bird lolly species)
- No clear delineation of a no-mow zone around the bushland (includes better areas of bush)
- Poorly maintained fences behind some houses, providing access for domestic animals to the reserve

9. MANAGEMENT STRATEGIES

This section outlines the management strategies that Council will undertake to achieve the objectives of this plan of management including the actions required to implement the management strategies and the means of performance assessment toward these actions. The strategies and action plan are grouped by management zone and objective.

SUMMARY OF MANAGEMENT STRATEGIES PER ZONE

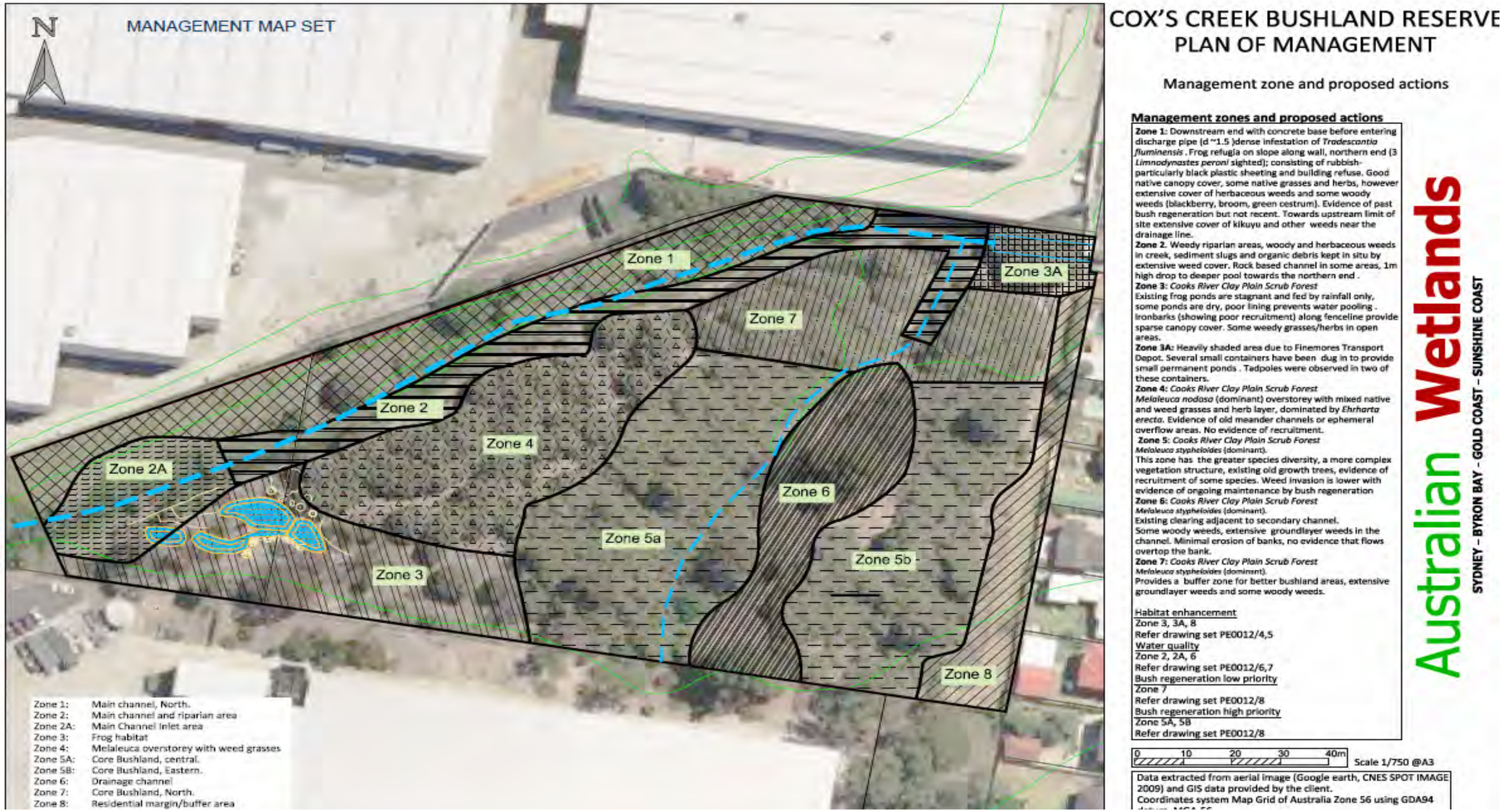

Figure 16 - Summary of Management Strategies per Zone

ZONE 1 – VEGETATION MANAGEMENT FOR GREEN AND GOLDEN BELL FROG

Figure 17 Zone 1 location

MANAGEMENT STRATEGIES FOR ZONE 1

Figure 18 . Proposed management strategies for Zone 1 include development of frog refugia and wintering habitat (shown in orange; from Drawing Sheet AW/PE090012/04).

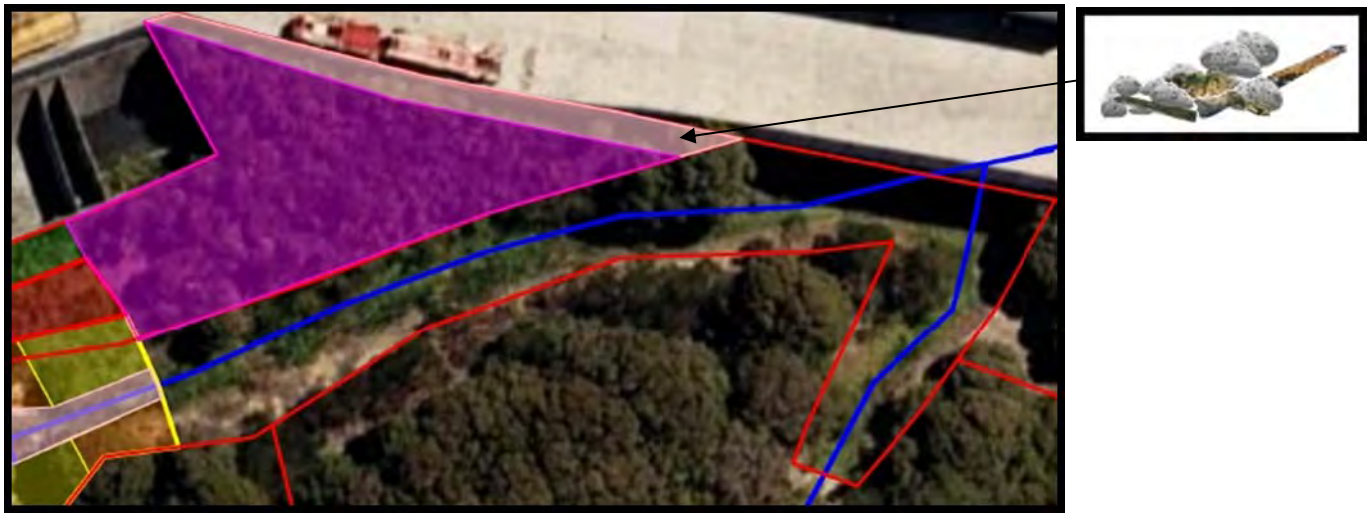

Figure 19 . Area for creation of frog refuge habitat along factory wall (pale pink) and bush regeneration weeding (bright pink) for Zone 1.

WEED CONTROL

Weed control should be done during the cooler months (April–August) when the frogs are less active. Spraying with herbicide should not be undertaken on any frog habitat. Instead, accepted bush regeneration techniques should be used including:

- hand-pulling small soft plants such as many annual weeds, for example, fleabane (*Conyza* species), milk thistle (*Silybum marianum*), Crofton weed (*Ageratina adenophora*) and grasses; and the seedlings of privet (*Ligustrum ovalifolium*), camphor laurel (*Cinnamomum camphora*) or lantana (*Lantana camara*)
- crowning: inserting a knife into the ground near the plant and cutting around the root for plants with rhizomes or long tap roots, for example, asparagus fern (*Asparagus aethiopicus*) and some grasses (best for clumping grasses)
- scraping the stem of vines and scramblers, for example, Japanese honeysuckle (*Lonicera japonica*) and morning glory (*Ipomoea cairica*), and plants with extensive root systems, for example, ochna (*Ochna serrulata*) and camphor laurel, with a knife and applying herbicide to the length of the scrape
- cutting small woody weeds as near to ground level as possible and applying herbicide within 20 seconds to the cut, for plants with stems less than 5 centimetres in diameter, for example, lantana, privet and cassia (*Senna bicapsularis* – note that some Sennas respond better to scraping that cut and paint)
- 'frilling' large woody weeds with stems greater than 5 cm in diameter, for example, privet, camphor laurel, coral tree (*Erythrina crista-galli*), by making a cut with a chisel at the base of the plant and applying herbicide into the gap immediately. Continuing in a circle round the trunk, repeat the 'cut and poison' technique at five centimetre intervals. Alternatively, a drill can be used to bore holes in the trunk and fill them with poison every five centimetres round the base.

The leaves and stems of some plant species can remain on-site in small piles to decompose. Other species such as lantana and many vines can re-sprout if left on the ground. To prevent this happening, create a raft or base of branches, palm fronds, fallen

timber or rocks and stack small piles of weeds on top. These piles can then also act as shelter for many animal species.

Any fruit or seeds should be removed from plants and placed in bags which should then be emptied into council 'green bins' for removal. Vines that sprout tubers, such as madeira vine (*Anredera cordifolia*), and those with bulbs such as asparagus fern, should also always be placed in bags and never left on piles, as they will quickly re-establish. Plants with thorns such as blackberry (*Rubus fruticosus*), golden locust (*Gleditzia japonica*) and coral tree should be removed from the site as they pose a hazard to the frogs (and workers).

NATIVE PLANT OVERGROWTH

Generally, green and golden bell frogs like ponds with around 20% of open, unshaded water to bask in. It may be necessary to remove overgrown native plants from within and around Zone 3. Hand removal or mechanical techniques should be used in or near ponds or other water bodies to remove overgrown aquatic plants. Do not spray herbicides or any other chemical. Branches of shrubs and trees overhanging a pond should be pruned and left on-site in piles.

Table 3. Management issues, actions and timeframes for Zone 1.

ACTION PLAN – ZONE 1					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
REVEGETATION					
This zone consists of mounded spoil, and has little likelihood of having any suitable seed bank. This was suggested by UBM (2000), and the absence of any regeneration confirms this. Suitable species for immediate planting include ironbarks: *Eucalyptus fibrosa* and *E. crebra*, with some *E. longifolia*. Suitable shrubs include colonisers such as *Acacia falcata, Melaleuca nodosa*, *Pultenaea villosa, Dillwynia tenuifolia,* and *Daviesia ulicifolia*. Suitable colonizing grasses and herbs include *Dichelachne micrantha, Entolasia stricta, Microlaena stipoides, Themeda australis, Dianella revolute, Lomandra longifolia,* and *Lomandra multiflora*.	Staged replacement of kikuya with native species. Spraying should be conducted during autumn and winter when the frogs are less active, and more likely to have found overwintering shelters. Only use Roundup Biactive® around possible bell frog locations, or around waterways. Early plantings should be supplemented after establishment with a different mix of species .	Spot spray areas after clearing of bell frogs (will require searching), plant after weed dieback and mulch or use a weed suppression mat (jute squares). Use of plant guards will improve establishment success	High	Reduced weed cover. Survivorship % of planting.	Ongoing

ACTION PLAN – ZONE 1					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
WEED REMOVAL					
Woody weeds There are very few trees on much of this part of the site, so removal of woody weeds should be after some replacement trees have been established. Main areas for woody weeds are shown in bright pink in Figure 2.	.	Cut and paint, pile on site to provide habitat for bell frogs. Some species will require stem injection for effective treatment. Follow up treatment of woody weeds	High	Reduced weed cover	Ongoing
Herbs and grasses Removal of exotic herbs and grasses will initially be to create areas for planting.	Alternate methods for management of weedy grasses include hand pull or crown, although these are not effective for Kikuyu. Areas where weeds are hand removed can be planted immediately. Exclusion fencing can be used as a temporary measure for control of Kikuyu in areas after weed removal. Alternately, areas can be delineated by logs and rock piles installed for frog habitat. Consolidation of planted areas can commence after several years, and this will become the primary goal from this stage.	Spot spray areas after they have been thoroughly searched for bell frogs. These areas are best delineated by some sort of exclusion fencing (frog fencing). Plant areas after weed dieback, and mulch or use weed suppression mats. Use of plant guards will improve establishment success.	High	Reduced weeds in groundlayer Survivorship % of planting and area of natural recruitment extended.	Ongoing

ACTION PLAN – ZONE 1					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
	Slashing may be useful for pretreatment of some areas before spraying, or as an interim management strategy during plant establishment.				
EROSION CONTROL					
Consideration needs to be given to management of soils on steep slopes and along creek banks.	Weed removal should be staged, and soils may need some further consolidation.	Use of logs and rock piles to create habitat for bell frogs can be extended for use as erosion control structures: placement of logs and rock piles should therefore consider potential for erosion on steeper slopes or where there is evidence of prior scouring.	High	No erosion or evidence of sediment export from channel embankments	Ongoing Establish a series of permanent monitoring points (photo-points and quadrats).
EXTENSION OF COOKS RIVER CASTLEREAGH IRONBARK FOREST EEC					
This area provides an ideal opportunity to create an extension of the CRCIF community. Sparsely planted ironbarks with some understorey shrubs creates ideal habitat for bell frogs as it leaves some open areas for basking and foraging.	Use appropriate plants from CRCIF species list for supplementary planting	Plant and mulch or use weed suppression mats. Use of plant guards will improve establishment success	High	Increase in CRCIF extents on site (m^2). % survivorship of plantings	Ongoing Establish a series of permanent monitoring points (photo-points and quadrats).
GGBF HABITAT ENHANCEMENT					

ACTION PLAN – ZONE 1					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
Overwintering habitat and refugia for the GGBF is currently limited, fragmented and of poor quality. Currently the best refugia sites are building debris and heavily infested weedy areas along the drainage easements.	Add habitat elements such as logs and rock piles to create refuge habitat and foraging areas. This is particularly appropriate for the northern factory wall where frogs are using piles of building and other rubbish as refuge sites (see Figure 2). Use staged removal of exotic grasses and herbs to ensure that good bell frog habitat is available at all times. Manage impacts of domestic and feral animals though trapping, exclusion fencing and public education campaigns.	Retain areas of open grassland (or create them through plant management) for foraging and basking. Create or retain slow flowing or ponding areas in the creekline for breeding and foraging habitat. Identify and establish avenues for habitat connectivity with nearby bell frog habitat.	High	Increased use of Reserve by GGBF. Permanent presence of GGBF on the Reserve. Evidence of breeding on site.	Ongoing GGBF surveys

ZONE 2 & 2A – WATERWAYS MANAGEMENT FOR GREEN AND GOLDEN BELL FROG HABITAT

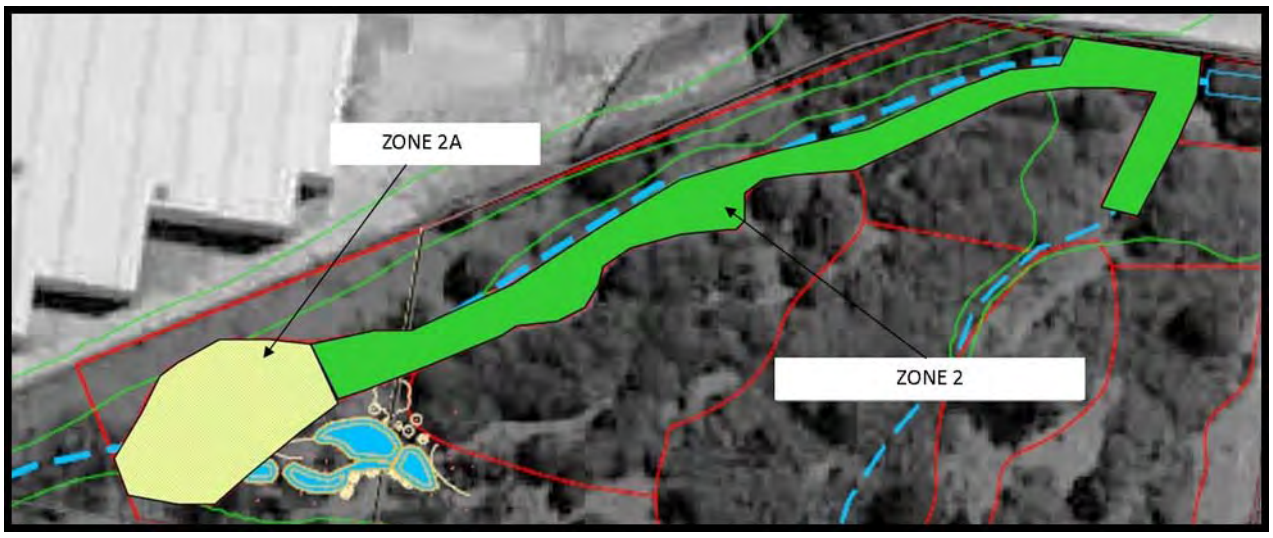

Figure 20 Zones 2 and 2A location

WATER QUALITY AND BELL FROGS

Runoff entering green and golden bell frog habitat could contain pollutants from the application of chemicals in the catchment, excess sediments and nutrients. These can all adversely influence the presence and movement of Green and Golden Bell Frogs. Efforts should be made to ensure the water quality entering the frog's habitat is as unpolluted as possible. Many Water Sensitive Urban Design (WSUD) features are quite compatible with bell frog habitat needs or could easily be adapted to them.

Green and Golden Bell Frogs require unpolluted water but can tolerate a low level of salt. If water in the creek looks oily, is very turbid or is inundated by salt water or other pollutant source, installation of a water quality treatment train is strongly indicated. Determining the appropriate treatment for any water body is a complex task and designs should be prepared by suitably qualified professionals. Each catchment is different, water quality issues within the catchment can vary, and desired outcomes from treatment can include a range of improvements.

If there is evidence of frog chytrid infection (frogs may exhibit lesions or sloughing skin and be lethargic):

- Place the frog into a container without directly touching it.
- If the frog is still alive, make sure the container is escape-proof and has a few small air holes and a small amount of water. Ring the Frogwatch Helpline on 0419 249 728 for an opinion on whether the frog is sick or whether it is likely

to survive transportation. The Helpline will advise you where and how to transport the frog.

- If the frog is dead, put the container into a plastic bag and into your freezer as soon as possible then call the DECC Environment Line on 131 555 for further advice.
- Consult the frog hygiene protocol – see www.environment.nsw.gov.au/resources/nature/hyprfrog.pdf (PDF- 1.6MB).
- Clean out the pond if possible, and leave to dry for several days.

FROG FRIENDLY POND PLANTS FOR SYDNEY

A number of species of aquatic, riparian and terrestrial plants have been identified as providing good habitat for Green and Golden Bell Frogs. Many of these species are found in the Sydney Basin region, and are suitable for use in habitat creation for bell frogs at Coxs Creek Reserve (appendix C).

Best results are achieved when areas are planted with a variety of species. This serves many purposes, including creating different layers in the vegetation, increasing the overall habitat complexity; providing a range of food sources, often over different seasons; accommodating fluctuating conditions which may favour some species at different times; and having a variety makes it easier to maintain good vegetation cover. Australian Wetlands can provide a detailed planting plan if this is required.

MANAGEMENT STRATEGIES FOR ZONE 2/2A

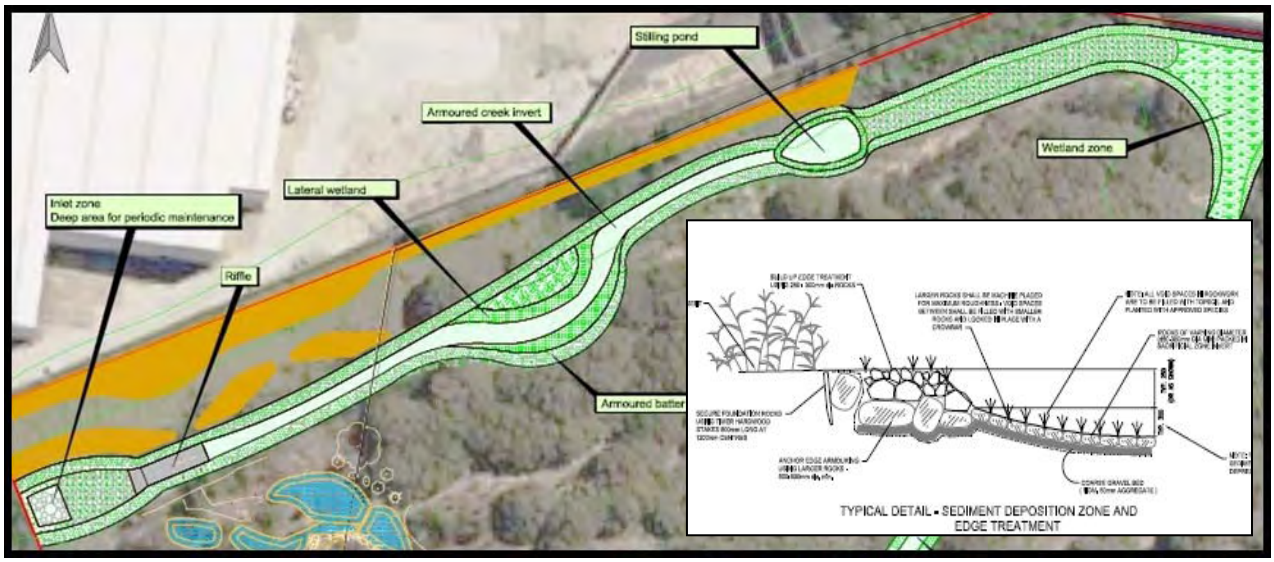

Figure 21 Examples of potential creekline treatments as part of a management strategy for Zone 2/2A (from Drawing sheet AW/PE090012/4).

Creekline restoration works result in a “blank canvas”. Weedy vegetation is removed, and more importantly the seed bank of weed seed is also removed.

Table 4. Management issues, actions and timeframes for works in Zone 2 & 2A.

ACTION PLAN – ZONE 2 & 2A					
BACKGROUND	**STRATEGIES**	**ACTION**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
STREAMBANK STABILISATION AND EROSION CONTROL					
Coxs Creek is restricted to a straight excavated drainage line and suffers from heavy weed infestations and deposition zones of coarse and fine sediments and gross pollutants, particularly in Zone 2A. There is little treatment of water in the current configuration. The dense weed cover provides some habitat value to fauna and stabilizes batters and deposition zones, however it acts as a weed source for adjacent areas. Good stream rehabilitation will take into account the nature of the upstream catchment, the volume and frequency of storm flows evolved, the type and volume of nutrients and sediments likely to be evolved, the desired water quality outcomes for the project (eg. effective treatment of stormwater to WSUD standards, improvement of water quality for better habitat), and the hydrological requirements of the receiving environment. Green and Golden Bell Frogs can utilise constructed ponds such as sediment	The concept design presented on Drawing sheet AW/PE090012/04 includes a number of key components, including a deep zone at the inlet to the reserve. This provides for periodic removal of bulk pollutants and sediments, and can be managed as a sacrificial zone to improve the water quality entering the reserve. A riffle zone provides good aeration for water, aiding in the removal of nutrients and combating the development of anoxic conditions in the channel. The riffle zone also provides habitat for a range of aquatic invertebrates, which also provides food for bell frogs. A lateral wetland then provides a treatment zone to remove excess nutrients and fine sediments through the establishment of wetland plants which provide a substrate for biofilms. High energy sections of the channel can be rock armoured to provide stability and additional habitat for bell frogs. A stilling pool can be located in the area of an existing pool and can be created through minor modification of this pool. The result will be better hydraulic management of stormflows into the	Commission detailed design work to develop a suitable design for construction of streambank stabilisation and erosion control works. Design requirements may include development of a project that can be constructed within a pre-determined budget.	High	Improved water quality. Improved habitat value. M^2 weeds removed Tonnes/cubic metres of weeds and sediments removed	Ongoing

ACTION PLAN – ZONE 2 & 2A					
BACKGROUND	**STRATEGIES**	**ACTION**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
basins, treatment wetlands and detention ponds for breeding and feeding.	downstream environment, and provision of further habitat. Deeper pools such as this are ideal for gudgeons, reported in the area around 10 years previously but not recorded in recent surveys. The need for flood attenuation can be identified from hydraulic modeling; however, verbal reports suggest that stormflows rarely exceed the capacity of the existing channel. Since the entire reserve is considered a swamp community, there is little likelihood of adverse effects from overtopping the bank during extreme storm events.				
IMPROVEMENT OF WATER QUALITY					
This project should be considered in conjunction with Bankstown Council as the stormwater is generated from Bankstown Council land. Access to this part of the site is best maintained through Bankstown Council land.	Model catchment sediment and nutrient loads and design appropriate treatment train. This will, almost certainly, include establishment of GPTs (eg. end of line devices such as Pratten Traps) at relevant locations in Bankstown LGA. Consideration needs to be given to treatment of water in both drainage channels.	Design and construct a sediment pond at the upstream end of the site (Zone 2A). This will reduce sediment loads on site and in the receiving environment, and improve habitat quality for bell frogs. Construct wetland areas for water quality treatment, for example, linear wetlands can be formed along the margins of the channel. Location of wetlands just out of the	High	Improved water quality Tonnes/cubic metres of weeds and sediments removed	Ongoing

ACTION PLAN – ZONE 2 & 2A					
BACKGROUND	**STRATEGIES**	**ACTION**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
		main flow path reduces the impacts of high velocity flows on the wetland, providing refuge habitat for bell frogs and reducing maintenance costs.			
NEED FOR ALTERNATE HABITAT FOR BELL FROGS AND NATIVE FISH; NEED TO MAINTAIN FISH PASSAGE FOR MIGRATORY FISH					
Consideration should be given to providing alternate habitat for bell frogs and native fish (gudgeons have been reported from this stream in the past). Some native fish are migratory, thus adequate fish passages need to be maintained.	A staged approach to construction works is recommended. Work should be timed for summer when frogs are most active. Provision of good refugia and alternative habitat prior to inception of streambank rehabilitation works will help ensure that bell frogs are not in the proposed construction zone.	Vegetation should be slashed to approximately 20cm and left overnight. The area should be thoroughly surveyed for frogs the following day by a suitably experienced herpetologist and any frogs removed. The vegetation can then be further slashed to ground level and works proceed with confidence that there is minimal chance of harm to frogs. Fish may need to be netted and transferred to alternate ponds upstream or downstream, depending on the requirements of the species. Gambusia (plague minnow) will need to be removed and destroyed.	High	No harm to aquatic fauna during works.	Throughout project

ACTION PLAN – ZONE 2 & 2A					
BACKGROUND	**STRATEGIES**	**ACTION**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
IMPROVE AND EXTEND GREEN AND GOLDEN BELL FROG HABITAT					
The creek line can provide additional habitat for bell frogs. Creekbank stabilisation and weed control needs to be undertaken with due consideration given to bell frogs. Key factors contributing to the success of bell frogs in this part of the site are improved water quality, better management of hydrology, and increased availability of breeding foraging and refuge habitats.	Management of riparian vegetation to improve bank stability and water quality will also provide habitat for foraging and refuges. Streambank stabilisation using rock armouring, rock groyes, logs and rootwads will create more foraging, basking and sheltering habitat for bell frogs.	Creation of wetlands for stormwater treatment will provide additional habitat for post breeding dispersal of bell frogs.	High	Gain (m^2) of GGBF habitat	Ongoing
PROTECT EXISTING BELL FROG POPULATIONS AND HABITAT					
As weedy areas currently provide refugia and foraging areas for the GGBF manage weed removal in stages, for example, starting at the top of the stream reach and working downstream.	Manage access by domestic and feral animals by trapping, installing fencing, and initiating a community education program. Monitor streams and ponds for the presence of Gambusia.	Limit use of herbicide in known frog habitat (including foraging areas); use low impact mechanical weeding methods (where applicable) and progressively rehabilitate riparian bushland. Use Roundup Biactive ® only around waterways and in areas that may be utilised by bell frogs.	High	No net loss of GGBF habitat	Ongoing

ACTION PLAN – ZONE 2 & 2A					
BACKGROUND	**STRATEGIES**	**ACTION**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
DEVELOP APPROPRIATE VEGETATION MANAGEMENT STRATEGIES					
For effective management of all issues associated with streambank rehabilitation, a full detailed design should be commissioned. This design should include details of what species to plant where, and in what density; bank stabilisation treatments including use of jute matting or mesh, and/or mulching should also be provided in the detailed design.	There are two options for weed management: it can be completed in stages, working from the top of the catchment down; however, completing all the streambank earthworks and revegetation will provide better habitat more quickly. This is a comparatively short stretch of creekline, and by completing all earthworks in on go, council can ensure that the contractor has an appropriate erosion and sediment control plan in place before commencement of works.	Plant species selection should be informed by species lists for CRCIF communities, for habitat creation or enhancement for GGBF, for water quality treatment outcomes, and for establishment of habitat for other fauna that uses or is likely to use the stream and surrounding areas.	High	Appropriate plan (cost/benefit) adopted	
COMMUNITY SUPPORT AND INVOLVEMENT					
Historically the GGBF has been located in residential gardens in Greenacre. “Frog friendly” gardens provide valuable links for dispersing frogs from other key populations in the area. In lieu of formal linkages and corridors being established community support is invaluable in maintaining the presence of the GGBF in Coxs Creek Reserve.	Carry out a community awareness program highlighting the presence of the bell frog population within an EEC.	Provide education on the role that residents can play in maintaining these environmental treasures, including management of domestic animals, garden escape plants, garden refuse, littering and fire. Incentives for establishing frog friendly gardens.	Medium	Educational material distributed (no. of households). Resident attendance at open days (no of residents). Increase in no. of bushcare volunteers.	Ongoing

ZONE 1, 2 & 2A – A LOW IMPACT, INTEGRATED APPROACH

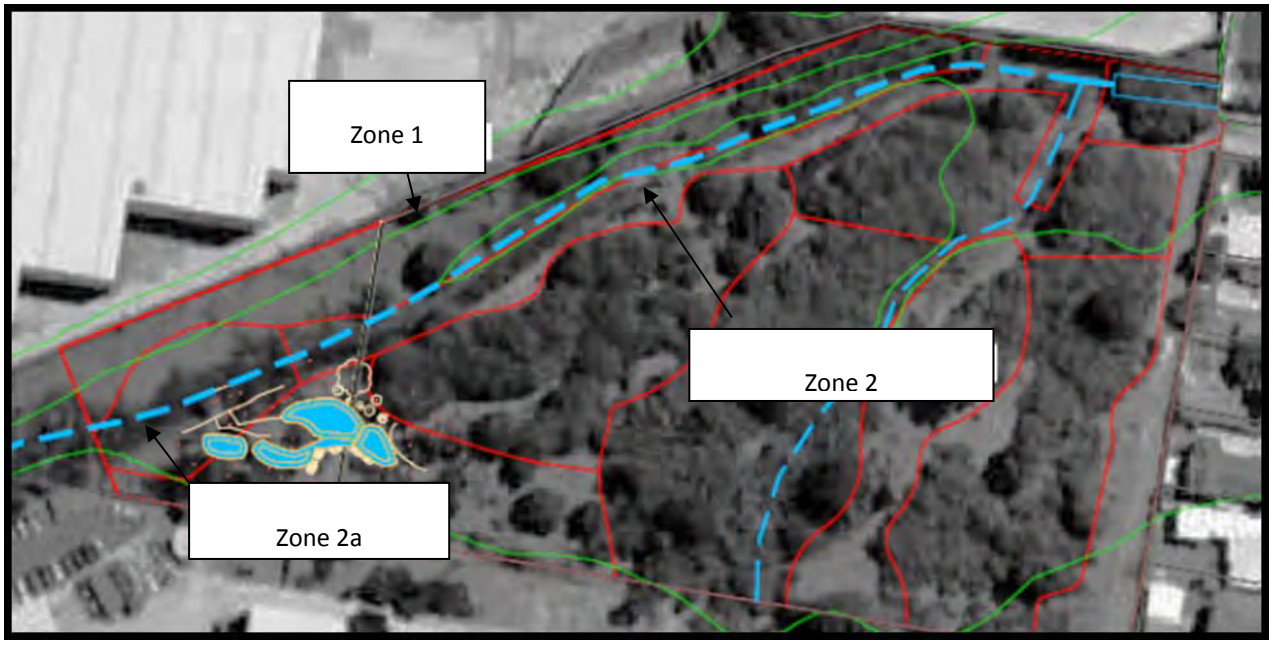

Figure 22. Riparian weed management given to maintaining GGBF habitat.

STAGE ONE: SEDIMENT FOREBAY (YEAR 1)

The alternative to clearing out the entire channel and stabilizing and planting the banks is to complete similar works one step at a time. Regardless of the timing, construction of a sediment forebay is imperative. Unless something is done to greatly limit, or prevent, the introduction of weed propagules will mean that any weed treatment works on site will be expensive and of doubtful benefit. Maintenance costs will be high as weeds will continue to invade the site, and potentially out compete natives planted in the area. The sediment forebay needs to be constructed so that it can be cleaned regularly, therefore access should be designed to be straightforward, and the basin designed and constructed in such a manner that it can be cleared of silt, rubbish and weed propagules. This type of structure is generally considered sacrificial, and should not be expected to contribute significantly to the existing or planned habitat. Access is available via the “Primo” carpark (Bankstown LGA).

The sediment forebay will need to be designed to accommodate the estimated pollutant loading from the upper part of the catchment. Construction of this basin should be completed before commencing with additional works downstream. Location of this basin is shown in Figure 17 overleaf.

If this option is selected, then some changes to the boundaries of zones will effectively occur. Management of this part of the site will involve a number of stages. Stage 1 is the completion of the sediment basin.

STAGE TWO (0- 18 MONTHS)

Stage 2 is the first stage of the lower riparian area on both banks. Figure 4 shows alternating hatched areas which indicate frog exclusion zones. Yellow zones should be worked first. Frog proof fences are to be constructed around each area. It is important that there is habitat continuity between areas outside the frog free zones that are being created; for this reason, exclusion zones are alternating across the creekline. A narrow corridor (around 2-3 metres either side of the creek, defined by the 2-5 year peak flow level, is to be establishe d for later works.

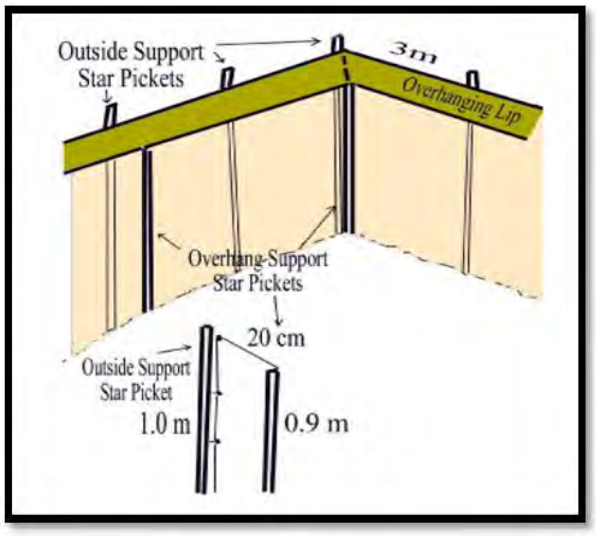

Figure 24 Frog exclusion fencing suitable for use with Green and Golden Bell Frogs (White 2008).

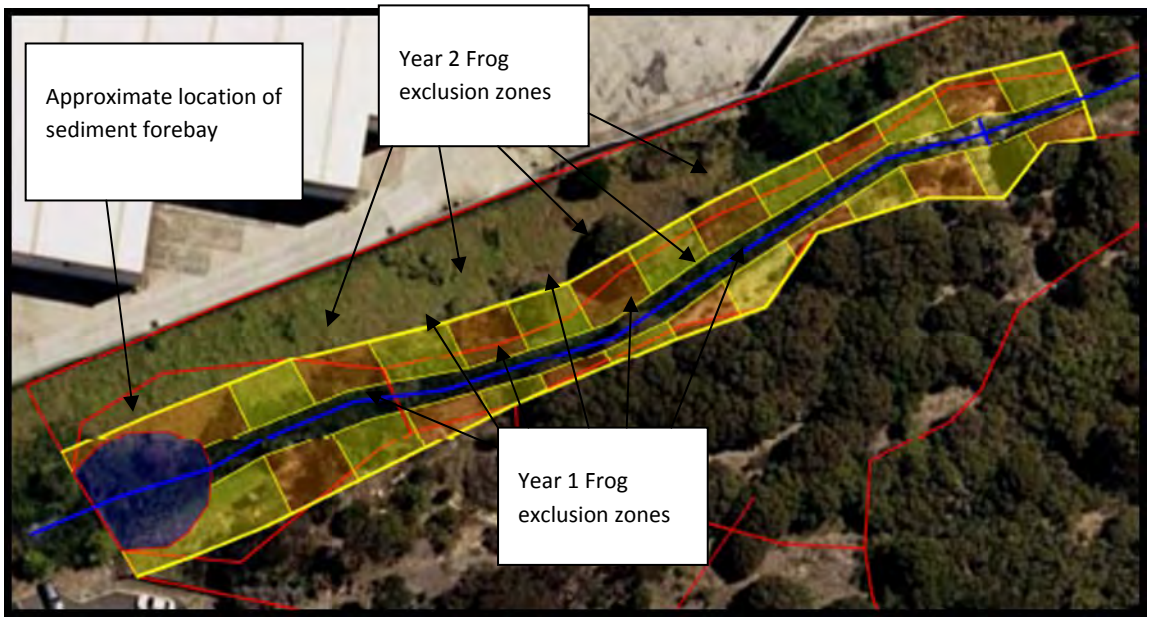

Figure 23. Frog management zones created for weed control.

Each frog exclusion zone is to be fully fenced using an appropriate frog-proof fencing (Figure 17). Once an area has been fenced, it should be thoroughly searched for frogs by an experienced herpetologist. Any frogs located should be noted, and then placed outside the exclusion zone. Once the area has been cleared of frogs it needs to be assessed for appropriate weed management.

All woody weeds are to be removed using cut and paint or stem injection techniques. Only Roundup Biactive is to be used on site (this product is licensed for use on waterways, and is considered the most frog-friendly of the herbicides currently available). Groundlayer vegetation is to be assessed for presence of native species. For exclusion zone areas with less than 15% native species, the area should be sprayed with Roundup Biactive (1:100 with a surfactant such as Pulse). When the native cover is greater than 15%, it should be hand

weeded in preparation for spraying. Weeds are removed from the area immediately around th e natives, leaving a small buffer area for spray drift or overspray. Only qualified sprayers with experience in spot spraying in sensitive areas should complete this type of work. After spraying each area should be left for around one month to allow for full control of weeds. Where necessary, some respraying should be considered, although hand weeding is preferred for followup after spraying.

Sprayed areas need to be planted with native grasses and some canopy species. Groundcover habitat for GGBF should be provided in the form of rocks and logs. Followup weeding should be conducted around 6 and 12 months after planting.

STAGE THREE (18 – 36 MONTHS)

Stage 3 is the second stage of the lower riparian area on both banks. Frog exclusion fencing should be removed from the areas worked in Stage 2, and erected on the areas indicated by orange hatching in Figure 4. These areas should be treated in the same way as the yellow areas were treated in Stage 2.

The process of searching and removing frogs from designated quadrants in Stages 2 and 3 provides an ideal opportunity to involve interested local volunteers. The work needs to be overseen by trained frog experts, but volunteers can be invited to work with them under supervision. A number of community members are passionate about the ongoing health of the local GGBF population, and this can provide a venue for them to continue to maintain their connection with and involvement in the project. The need for adequate supervision in this process, however, is vital.

STAGE FOUR (36 – 42 MONTHS)

Timing of these works needs to be informed by the seasonal requirements (during the frogs' inactive period in autumn/winter) and population status of the GGBF; the earlier stages of work should provide a good indication of the current condition of the local population. GGBF are apparently not using this site as an overwintering site so this would be a suitable time for commencing this stage. Suitable locations should be spot sprayed for planting of canopy species along the upper edge of the slope (Figure 6). These are to be spaced to provide for the density specified in the vegetation plan, which will also identify suitable species for planting.

Stages 2 and 3 commence with fencing and searching areas for GGBF and other frogs. If no GGBF are located, then the timing of this stage can be changed, and it can commence after the Stage 3 quadrants have been searched and cleared of frogs.

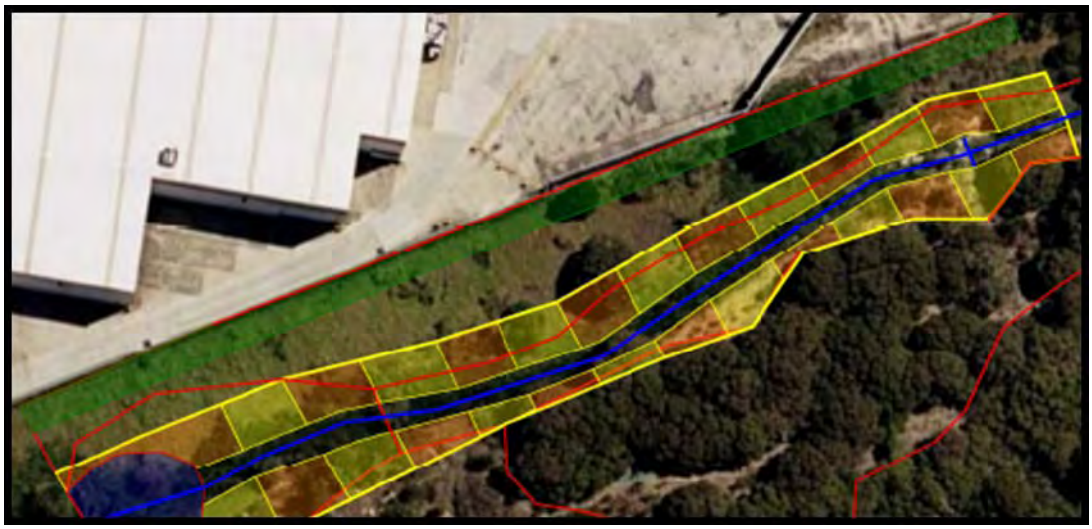

Figure 25. Area for spot spraying (in green) along the upper section of the northwestern bank.

The timing of subsequent stages of works for this drainage line can also be informed by the earlier searches of quadrants on the lower slope.

STAGE FIVE (36 – 54 MONTHS)

The next two sections of work can be run concurrently and should commence around the beginning of the third year, unless no GGBF have been found on site.

Work along the creekline itself consisting of weed removal and streambank stabilisation (see detailed designs) would normally start at the top of the reach and extend downstream. On a site such as this one, works could start in two locations, at the upstream limit of the reach and at a mid point, and progress downstream from each of these points.

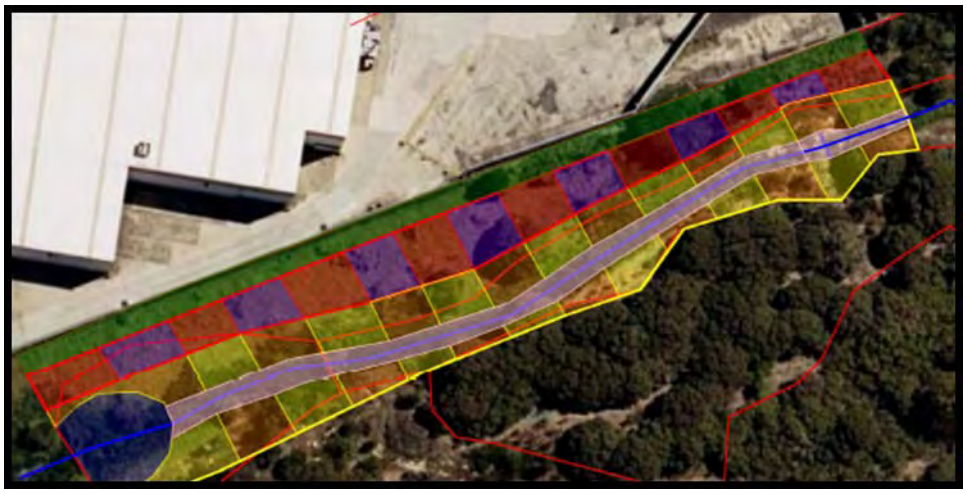

Figure 26. Example of mosaic weeding and delineation of streambank works for completion of works along the northwestern embankment.

ZONE 3 & 3A – GENERAL HABITAT MANAGEMENT FOR GREEN AND GOLDEN BELL FROGS

Figure 27 Zones 3 and 3A location

PEST CONTROL

Introduced predators may prey on eggs, tadpoles or adults, including:

- Plague minnow (*Gambusia holbrooki*)– for further details see www.angfa-nsw.org or www.environment.nsw.gov.au/pestsweeds/PlagueMinnows.htm. If plague minnow get into any waterways the fish need to be removed.
- Carp: these fish also need to be removed immediately.
- Red fox (*Vulpes vulpes*) – for more information see www.environment.nsw.gov.au/pestsweeds/Foxes.htm
- Feral and domestic cats and dogs: keep dogs and cats away from frog habitat areas. Try and keep other predators, such as carnivorous birds and introduced rats, out of areas occupied by the frogs.

MONITORING TADPOLES, FROGS AND HABITAT

DECC encourages systematic monitoring of key green and golden bell frog sites, and low key monitoring at other sites, in collaboration with local interest groups, private landholders and public authorities. This more opportunistic monitoring is required to ascertain the presence or absence of the species at historic locations, and on other sites where occasional or sporadic sightings have been reported. This is an ideal role for local community members to adopt for Coxs Creek Reserve.

FIRE MANAGEMENT

Fire and fire management can adversely affect frogs by destroying vegetation used for refuge, foraging or shelter. In conducting fire management practices, burning in low lying areas and wetlands dominated by sedge and emergent growth should be restricted, or avoided altogether. These areas form important shelter and foraging habitat for the frog and generally pose a limited fire risk. The use of chemical fire suppressants will have negative impacts on the frog, and their use should be avoided on and near known or potential breeding sites.

Table 5. Management issues, actions and timeframe for restoration activities in Zone 3 and 3A.

ACTION PLAN – ZONE 3 & 3A					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
PROTECT EXISTING BELL FROG POPULATIONS AND HABITAT					
As weedy areas currently provide refugia and foraging areas for the GGBF weed removal must be managed. Predation by pest animals, particularly Gambusia, limits the breeding success of the GGBF.	Manage weed removal in stages, for example, starting at the top of the stream reach and working downstream. Manage access by domestic and feral animals by trapping, installing fencing, and initiating a community education program.	Limit use of herbicide in known frog habitat (including foraging areas); use low impact mechanical weeding methods (where applicable) and progressively rehabilitate riparian bushland. Use Roundup Biactive ® only around waterways and in areas that may be utilised by bell frogs. Monitor ponds for the presence of Gambusia.	High	No harm to GGBF No net loss of GGBF habitat (m2) No Gambusia present in ponds on Reserve	Ongoing
IMPROVE AND EXTEND GREEN AND GOLDEN BELL FROG HABITAT					
Key factors contributing to the success of bell frogs in this part of the site are improved water quality, better management of hydrology, and increased availability of breeding foraging and refuge habitats.	Creation of wetlands for stormwater treatment will provide additional habitat for post breeding dispersal of bell frogs. Management of riparian vegetation to improve water quality will also provide habitat for foraging and refuges. Use of rock piles, logs and rootwads will create more foraging, basking and sheltering habitat for bell frogs. Better management of hydrology may	ZONE 3: Additional frog ponds should be created in this area as it provides ideal habitat: adequate light penetration for basking near ponds and refuge areas, with grassed areas for foraging also in close proximity. The design of these needs to consider establishing and maintaining an appropriate hydrological regime, as well as an accompanying vegetation plan. Australian Wetlands can provide this	Medium	Gain in suitable GGBF habitat (m2). Increased presence of GGBF in the reserve Evidence of successful breeding events	Ongoing GGBF surveys

ACTION PLAN – ZONE 3 & 3A					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
	be facilitated through finding alternate sources of water for the main frog ponds. Options for this are stormwater harvesting from roof areas of adjoining factory sites. Rather than channeling this directly to the secondary drainage line, for example, maintenance of a rainwater tank that feeds the ponds as required should be considered. for breeding and foraging habitat. Use staged removal of exotic grasses and herbs to ensure that good bell frog habitat is available at all times. Identify and establish avenues for habitat connectivity with nearby bell frog habitat	design, or it should be completed by another suitably qualified professional. ZONE 3A: Add habitat elements such as logs and rock piles to create refuge habitat and foraging areas, or create areas of open grassland for foraging and basking. Create pond areas linked to the creekline			
DEVELOP APPROPRIATE FROG HABITAT AND VEGETATION MANAGEMENT PLAN					
Supplementary frog habitat is currently provided in these zones. This supplementary habitat is utilized by frog species on site (tadpoles observed in both zones). There is scope to improve this supplementary habitat.	A full detailed design should be commissioned for extensions to the frog pond. Plant species selection should be informed by species lists for CRCIF communities, for habitat creation or enhancement for GGBF, for water quality treatment outcomes, and for establishment of habitat for other	This design should include details of what species to plant where, and in what density; bank stabilisation treatments including use of jute matting or mesh, and/or mulching should also be provided in the detailed design. Weed management should be conducted using standard bush	Medium	Appropriate plan (cost/benefit) adopted	Ongoing

ACTION PLAN – ZONE 3 & 3A					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
	fauna that uses or is likely to use the stream and surrounding areas. Year 1: identify budget constraints for project Commission detailed design for streambank rehabilitation works Year 2: (may require grant funding) commission construction of rehabilitation works	regeneration techniques, with the emphasis on non-chemical methods.			
WEED REMOVAL					
Woody weeds There are very few woody weeds on this part of the site, so work can be completed quickly.	Year 1: commence woody weed removal Year 2: follow up treatment of woody weeds	Cut and paint, pile on site to provide habitat for bell frogs. Some species will require stem injection for effective treatment.	High	Metres ^{3} woody weeds removed Area (m2) cleared of woody weeds	Ongoing
Herbs and grasses	Works should focus initially around areas of better bush, and then be extended to more degraded parts of the zone. Year 1: commence removal of exotic grasses and annuals in areas of better bushland	Hand pull or crown weed grasses and annuals, taking care that exposed areas are not susceptible to erosion. Areas disturbed by weeding should be planted and mulched immediately to stabilise soils and create additional frog habitat.	High	Area (m2) cleared of groundlayer weeds	Ongoing

ACTION PLAN – ZONE 3 & 3A					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
	Year 2: followup areas worked in year 1, and weed additional areas for this year Year 3: followup areas worked previously, and weed remaining parts of the zone Years 4&5: follow up weeding				
REVEGETATION					
At some point in the past management of the reserve a considerable number of *Eucalyptus sideroxylon* have been planted. Regardless of the establishment mechanism, there is now a healthy stand of these ironbarks in Zone 3. These trees provide good habitat in keeping with the nature of the community, but are not a local species, and are not endemic to the CRCIF. Suitable species for immediate planting include ironbarks: *Eucalyptus fibrosa* and *E. crebra*, with some *E. longifolia*. Suitable shrubs include *Acacia pubescens, Melaleuca nodosa*, *Pultenaea villosa, Dillwynia tenuifolia, Lissanthe strigosa* and Daviesia ulicifolia. Suitable grasses and herbs include *Dichelachne micrantha,*	Control of *E. sideroxylon* is strongly recommended. A few scattered adult specimens are located in other parts of the reserve and these should be targeted for removal and replacement as part of this management plan. Treatment of weeds should use mechanical methods or low impact use of chemicals, eg. cut and paint, stem injection. Spraying and scraping should be avoided unless there is no other way of successfully treating that weed species. If spraying is used, it should be conducted during autumn and winter when the frogs are less active, and more likely to have found overwintering shelters. Only use Roundup Biactive® around possible bell frog locations, or around	*Eucalyptus sideroxylon* seedlings should be removed and replaced with ironbarks more in keeping with the CRCIF indicative species. Staged removal of adult trees is not recommended at this stage as these trees contribute important habitat values to the area, despite their non-endemic status. Spot spray areas after clearing of bell frogs (will require searching), plant after weed dieback and mulch or use a weed suppression mat (jute squares). Use of plant guards will improve establishment success. Early plantings should be supplemented after establishment	High	Nil recruitment of *E. sideroxylon* No. of *E.sideroxylon* removed No. of suitable species planted % survivorship of plantings	Ongoing

ACTION PLAN – ZONE 3 & 3A					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
Entolasia stricta, Microlaena stipoides, Themeda australis, Dianella revoluta, Oplismenus aemulus, Pratia purpurescens, Lomandra longifolia, and *Lomandra multiflora*.	waterways.	with a different mix of species.			
PROTECT EXISTING BELL FROG POPULATIONS AND HABITAT					
As weedy areas currently provide refugia and foraging areas for the GGBF manage weed removal in stages.	Manage access by domestic and feral animals by trapping, installing fencing, and initiating a community education program. Monitor ponds for the presence of Gambusia.	Limit use of herbicide in known frog habitat (including foraging areas); use low impact mechanical weeding methods (where applicable) and progressively rehabilitate riparian bushland. Use Roundup Biactive ® only around waterways and in areas that may be utilised by bell frogs.	High	No net loss of GGBF habitat	Ongoing
COMMUNITY EDUCATION					
Historically the GGBF has been located in residential gardens in Greenacre. "Frog friendly" gardens provide valuable links for dispersing frogs from other key populations in the area. In lieu of formal linkages and corridors being established community support is invaluable in maintaining the presence of the GGBF in Coxs Creek Reserve.	Carry out a community awareness program highlighting the presence of the bell frog population within an EEC.	Provide education on the role that residents can play in maintaining these environmental treasures, including management of domestic animals, garden escape plants, garden refuse, littering and fire.Incentives for establishing frog friendly gardens.	Medium	Educational material distributed (no. of households). Resident attendance at open days (no of residents). Icrease in no. of bushcare volunteers.	Ongoing

ACTION PLAN – ZONE 3 & 3A					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
EXTENSION OF COOKS RIVER CASTLEREAGH IRONBARK FOREST EEC					
This area provides an ideal opportunity to create an extension of the CRCIF community. Sparsely planted ironbarks with some understorey shrubs creates ideal habitat for bell frogs as it leaves some open areas for basking and foraging.	Use appropriate plants from CRCIF species list for supplementary planting	Plant and mulch or use weed suppression mats. Use of plant guards will improve establishment success	High	Increase in CRCIF extents on site (m^2). % survivorship of plantings	Ongoing Establish a series of permanent monitoring points (photo-points and quadrats).

ZONE 4 – BUSH REGENERATION PLANTING STRATEGIES

Figure 28 Zone 4 location

Zone 4 includes an area of degraded bushland along the eastern bank of the main creekline. Much of this area consists of a dense canopy of *Melaleuca nodosa* with an understorey of weed grasses and annuals. Other sections retain more of their original CRCIF character, with a mixed canopy, understorey shrub species and some native grasses and herbs.

Figure 29. A dense canopy of Melaleucas provides heavy shading to the mainly weedy understorey.

STRATEGIES FOR PROTECTING AND RESTORING HABITAT

There are a number of basic bush regeneration strategies that can be applied broadly across a range of projects. An understanding of these strategies is fundamental to the development and implementation of successful restoration activities. The following are some strategies for protecting and restoring habitat:

- Locate (and map) important existing and potential habitat areas. Consider the habitat potential of weeds, unwanted trees and shrubs, old building materials and car bodies, etc. Potentially important habitat areas can be assessed by the existence of remnant vegetation, mature trees (particularly Angophoras and Eucalypts), dense understorey (particularly indigenous species), native fauna, exposed rock, logs and leaf litter and clean water. Look out for bird nests and Ringtail Possum dreys (nests) in dense understorey (including Lantana), listen for calls of nestling birds and feeding parent birds to indicate nest sites (eg. spotted pardelotes in steep open banks along the main Coxs Creek drainage line). Wet and waterlogged areas are also important.
- Identify potential wildlife sanctuary areas which are currently unused by humans and which could be restored to enhance the likelihood of them remaining undisturbed by humans and predatory animals in the future. An example of this type of area at Coxs Creek Reserve is at the northern end of Zone 1, where rubbish has been dumped off the raised car park adjoining the site. It has fallen onto piles of old spoil and building materials, and is currently utilised by a number of frog species.
- Assess the habitat provided by weeds before attempting removal. For example, vines in trees provide shelter for roosting and nesting birds, and Ringtail Possum dreys. At Coxs Creek, small leaved privet and blackberry provide food and shelter for small birds and reptiles.
- Avoid carrying out weed removal in areas providing important habitat for existing wildlife until nearby substitute habitat is provided. If necessary, in important habitat areas, carry out target weeding of problem species such as exotic vines in native trees and then leave the site undisturbed until adjacent sites are providing shelter and food resources. This is a particular consideration for management of waterways that may be habitat for Green and Golden Bell Frogs.
- Try to plan weed removal so that it can be carried out in a mosaic pattern leaving patches of undisturbed habitat adjacent to worked areas to maintain shelter and food resources and reduce predation and erosion. This is an important suggestion for management of grassed areas in Zone 1, and may be a useful strategy for Zone 2.
- Try to carry out major weed removal outside the main local bird (and other wildlife) breeding seasons. This will often be spring and early summer. Cutting down a woody weed to find a small nest with chicks is distressing for workers and the parent birds, and fatal for the chicks.

- Try to link habitat areas with a vegetated corridor using locally collected indigenous plant material. Plant around existing mature trees to create a dense, shrubby understorey or a group of same or similar species trees indigenous to the area. These plantings will be more attractive to the fauna which use them than individual trees. Also small migratory birds such as Yellow-faced Honeyeaters and Silvereyes will head for groups of trees which provide rest sites or from which they can locate safe feeding areas. This principle has been fundamental for many of the bushland management recommendations in this plan.
- Try to repeat the density and species mix in revegetation sites that occur naturally in remnants with similar conditions (such as soil and aspect). Ensure that a diversity of habitats are retained or included in all habitat recreation projects (eg. open unmown grassy areas near dense shrubs and trees; areas retaining fallen timber, dead trees and shrubs; exposed rocky outcrops; open areas with exposed rock, sand and timber along watercourses to provide basking sites). Maintenance and improvement of the CRCIF EEC is a fundamental aspect of this management plan. This particularly applies to Zones 7 and 8.
- Where Pied Currawongs are a problem, restrict the number of indigenous fruit-bearing plant species in revegetation work. Although these plants may provide food for small birds and other animals such as butterflies and flying-foxes, they may help increase the Pied Currawong population, a major predator of eggs, nestlings and occasionally adult birds.
- Where Noisy Miners are a problem, use insect, rather than bird, pollinated plants to avoid attracting these territorial honeyeaters. These plants include wattles, peas and tea-trees and will increase shelter, nesting and foraging sites for the small, insectivorous birds.
- The base of large outcropping boulders in regeneration/ revegetation areas provides shelter for lizards and other fauna. This kind of habitat can be mimicked by the walls of buildings and embankments, such as those found in Zone 1. The same habitat type can be created at the base of concrete walls using small piles of rocks, and planting grasses and herbs to provide good cover nearby.

SELECTING PLANTS FOR REVEGETATION AND LANDSCAPING PROJECTS.

It is important to use plants indigenous to the local area. They will be better adapted to the soils and climate and can help to reintroduce some local character into the neighbourhood. Use of plants from outside the area can create habitat problems such as:

- Invasion of nearby natural areas by planted species from wind or water or ant dispersed seed or dumped garden refuse (eg. Golden Wreath or Orange Wattle, Acacia saligna , from WA and Cootamundra Wattle, Acacia baileyana, both of which have naturalized in urban areas around Sydney)
- Invasion of distant natural areas by berry-bearing planted species from seed dispersed by fruit-eating birds (eg. Cotoneaster, African Olive, Camphor Laurel)

- Declining numbers of native animals with highly specialised diets. Examples of this are the Glossy Black Cockatoos, which only eat the seeds of species of Casuarina and need large, old Eucalypts with deep hollows for nesting. Their populations are declining everywhere as land clearing removes their required habitat. A number of small possums (Sugar and Squirrel Gliders) have been shown to depend on Acacia sap as an important source of carbohydrate during winter. The quality and quantity of gum produced by different wattles are highly variable and it is the abundance of suitable wattles (and the availability of nest hollows) which determines the number of these possums.
- Declining numbers of insectivorous and seed-eating animals. Only a small range of insects and spiders found on native vegetation are found on exotic plants (eg. Privet is eaten only by the larvae of one native hawk moth) and most exotic plants do not produce seeds that can be used by seed-eating birds.
- Increased numbers of some native bird species which are able to make use of a wide variety of plants and altered habitat. These birds include Pied Currawongs, Noisy Miners, Crested Pigeons, Rainbow Lorikeets, Red Wattlebirds, Australian Magpies, Welcome Swallows, Magpie-larks and Willie Wagtails. While some increases in populations seem harmless, others appear to apply great pressure to the smaller birds whose populations are already under threat from clearing of habitat, and reduction in food and shelter plants.

FIRE

Fire has long been acknowledged as an important management tool. Fire triggers a regeneration response and will enable Strathfield Municipal Council to gauge the depth and diversity of the Coxs Creek Reserve soil seed bank. Removal of weeds, particularly in the riparian zones and thinning of melaleucas will generate large quantities of dead biomass that could potentially be used for controlled burns (subject to obtaining relevant permits). If pile burning is implemented the procedure must abide by the regulations set by the Rural Fire Service for Pile burning. Long narrow piles limited to no more than one metre in height are recommended as this ensures that the heat generated by the fire does not sterilize the soil seed bank and the burn is always manageable. Seed from hard seeded species such as Acacias can be collected and spread on cooling embers to assist in regeneration (DECC Recovering Bushland on the Cumberland Plain,2005).

Construction of Piles

These guidelines are set to provide a procedure for the construction of piles of leaves, sticks and other vegetation in order to allow safe and efficient burning.

- Material that is to be burnt must only be vegetation from the locality, not household or building material such as plastics, wooden pallets or cardboard boxes (it is illegal to burn treated timbers or tyres anywhere in NSW);
- All vegetation to be burnt should be at least 4.5 metres clear of any log, stump or other flammable material;

- Construct long and wide piles rather than excessively high piles. Piles that are too big produce too much heat. A good size for piles is 0.5 metres high and 2 metres wide or long, maximum height should not exceed 1 metres;
- Logs over 150mm in diameter should not be added to piles – instead these should be laid on the ground to prevent erosion and provide habitat;
- Locate piles in the open and away from overhanging branches that may ignite;
- Locate piles away from overhanging power lines or telephone cables;
- If practical, place vegetation in an area where it will receive direct sunlight to allow the pile to dry out;
- All material to be burnt must be clean and dry;
- Accelerants (such as petrol) must never be used in the pile; and
- Disturb piles immediately prior to lighting to scare away lizards, snakes etc which may be taking refuge beneath the pile.

Notification

Notification must be given at least 24 hours prior to the works to all residents who adjoin the site of the pile burn and other residents that might be inconvenienced by the pile burn.

You must also notify your local RFS fire control centre or your nearest NSW Fire Brigades station at least 24 hours before the fire is lit.

Burn Safety Measures

- Before lighting the pile ensure that you have suitable tools and equipment to conduct the burn in order to control any possible spot fires, such as a rake and shovel.
- Ensure that there is sufficient water supply to extinguish the burn and you have a hose that can reach the pile.
- Supervise the burn constantly after lighting to ensure there are no flare ups in surrounding vegetation.
- Completely extinguish the pile immediately after the burn is completed.
- If multiple piles are to be burnt, burn only one pile at a time unless adequate resources and operators are present at each pile being burnt. Consideration must also be given to the smoke being produced, if multiple piles are being lit at the same time.

Do not burn on a day declared as a Total Fire Ban by the Rural Fire Service or No Burn day by the NSW EPA, unless approval has been provided by the local Rural Fire Service fire control centre or your nearest NSW Fire Brigade station officer. For further information on pile burns, contact the local Rural Fire Service control centre.

Table 6. Management issues, actions and timeframes for restoration activities in Zone 4.

ACTION PLAN – ZONE 4					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
REVEGETATION					
The western edges of this zone are along the bank of the main creekline, and consist of mounded spoil with little likelihood of having any native seed bank.Suitable species for immediate planting include ironbarks: *Eucalyptus fibrosa* and *E. crebra*, with some *E. longifolia*. Suitable shrubs include colonisers such as *Acacia falcata, Melaleuca nodosa*, *Pultenaea villosa, Dillwynia tenuifolia,* and *Daviesia ulicifolia*. Suitable colonizing grasses and herbs include *Dichelachne micrantha, Entolasia stricta, Microlaena stipoides, Themeda australis, Dianella revolute, Lomandra longifolia,* and *Lomandra multiflora*.	Thinning of the Melaleuca overstorey is strongly recommended to improve the germination success of soil seeds in better parts of the site. Melaleucas typically resprout after fire, and will produce shoots from basal epicormic buds. This will aid in the maintenance of soil stability during an interim period, and the decision can be made later whether to remove some trees altogether, or let the new ecosystem reach its own equilibrium state. Early plantings should be supplemented after establishment with a different mix of species.	Year 1: Cut selected Melaleucas, and plant trees and shrubs. Maintain plantings. Year 2: Maintain plantings, replant where necessary, spot spray and plant grasses and herbs. Year 3: Maintain plantings, replant where necessary, spot spray and plant supplementary groundlayer species Year 4: Maintain plantings, replant where necessary, spot spray and plant supplementary species Year 5: Maintain plantings and followup weeding	Medium	No. of supplementary planting %survivorship of planting % projective cover Melaleuca tinned.	Ongoing

ACTION PLAN – ZONE 4					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
WEED REMOVAL					
Woody weeds There are very few woody weeds in this part of the site, so these should be treated early in the program.	Cut and paint, pile on site to provide habitat for bell frogs. Some species will require stem injection for effective treatment.	Year 1: commence woody weed removal Year 2: follow up treatment of woody weeds	High	Metres ^{3} woody weeds removed Area (m2) cleared of woody weeds	Ongoing
Herbs and grasses Removal of exotic herbs and grasses will initially be to create areas for planting. Alternate methods for management of weedy grasses include hand pull or crown, although these are not effective for Kikuyu. Areas where weeds are hand removed can be planted immediately. Exclusion fencing can be used as a temporary measure for control of Kikuyu in areas after weed removal. Alternately, areas can be delineated by logs and rock piles installed for frog habitat. Consolidation of planted areas can commence after several years, and this will become the primary goal from this stage.	Spraying should be conducted during autumn and winter when the frogs are less active, and more likely to have found overwintering shelters. Only use Roundup Biactive® around possible bell frog locations, or around waterways. Prepare for spraying by identifying areas with reasonable native grass cover. Hand weed around these areas, leaving a cleared buffer of 100-150mm between native plants and the area to be sprayed. Spraying in these types of conditions needs to be undertaken by an experienced operator, care must be taken that overspray does not affect the health of native species. For areas where there are few native grasses, or they are sparsely distributed amongst weeds, the area should be sprayed and planted. Spot spray areas after clearing of bell frogs (will require searching), plant after weed dieback	Year 1: Spot spray and plant Year 2: Spot spray and plant Year 3: Look for areas that can be consolidated: these include areas with native trees and shrubs. Spray around natives and plant understorey species (grasses and herbs) between the existing natives. Year 4: Look for areas that can be consolidated: these include areas with native trees and shrubs. Spray around natives and plant understorey species (grasses and herbs) between the existing natives. Year 5: Final stages of consolidation: maintenance weeding	High	Area (m2) cleared of ground layer weeds	Ongoing

ACTION PLAN – ZONE 4					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
	and mulch or use a weed suppression mat (jute squares). Use of plant guards will improve establishment success. Slashing may be useful for pretreatment of some areas before spraying, or as an interim management strategy during plant establishment.				
EROSION CONTROL					
Consideration needs to be given to management of soils on steep slopes and along creek banks.	Weed removal should be staged, and soils may need some further consolidation.	Use of logs and rock piles to create habitat for bell frogs can be extended for use as erosion control structures: placement of logs and rock piles should therefore consider potential for erosion on steeper slopes or where there is evidence of prior scouring.	High	No erosion or evidence of sediment export from channel embankments	Ongoing Establish a series of permanent monitoring points (photo-points and quadrats).
EXTENSION OF COOKS RIVER CASTLEREAGH IRONBARK FOREST EEC					
This area provides an ideal opportunity to create an extension of the CRCIF community. Sparsely planted ironbarks with mixed Melaleucas and other shrub species in the understorey creates ideal habitat for bell frogs, particularly if it leaves some open areas for basking and foraging.	Use appropriate plants from CRCIF species list for supplementary planting	Plant and mulch or use weed suppression mats. Use of plant guards will improve establishment success	High	Increase in CRCIF extents on site (m^2). % survivorship of plantings	Ongoing Establish a series of permanent monitoring points (photo-points and quadrats).

ACTION PLAN – ZONE 4					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
ECOLOGICAL BURNS					
Fire has essentially been excluded from the reserve. Pile burns will enable managers to ascertain the extent of the seedbank.	Prepare site for ecological burn by thinning native vegetation and clearing woody weeds.	Annual-Cooler months. Compliance with regulations/permits. Weather dependant.	Low-medium	No. plants/species recruited	Compile species list from proposed pile site to monitor recruitment post burn.
GGBF HABITAT ENHANCEMENT					
A limiting factor on a permanent presence of GGBF in the Reserve is fragmented refugia and suitable foraging habitat	Use staged removal of exotic grasses and herbs to ensure that good bell frog habitat is available at all times. Manage impacts of domestic and feral animals though trapping, exclusion fencing and public education campaigns. Identify and establish avenues for habitat connectivity with nearby bell frog habitat.	Add habitat elements such as logs and rock piles to create refuge habitat and foraging areas. Retain areas of open grassland (or create them through plant management) for foraging and basking.	Medium	Gain in suitable GGBF habitat (m2). Increased presence of GGBF in the reserve Evidence of successful breeding events	Ongoing GGBF surveys

Species selected for revegetation should be sourced from CRCIF species lists, and preference should be given to species that are already recorded on site as these will tolerate local conditions. Later stages of a planting strategy may include introduction of species from nearby reserves with introducing greater genetic diversity, as long as these are considered integral to CRCIF.

ZONE 5A & 5B – STRATEGIES FOR MANAGING HABITAT DURING BUSH REGENERATION

Figure 30 Zones 5A and 5B location

Zones 5A and 5B include the better bushland on site. These areas can be worked according to the bush regeneration principles discussed in the previous section. As this zone provides the best habitat on site, this is the area where native fauna are most likely to be encountered. Some additional considerations for the management of habitat are as follows:

- With Tawny Frogmouths, Ringtail Possums and other more obvious wildlife, try to only approach or work in areas if resident animals are away from the site. Talk in low, calm voices and avoid making any sudden, loud noises or calling out.
- Replace logs, rocks and leaf litter wherever possible to provide shelter, and foraging and breeding sites for lizards and invertebrates. Use smaller branches for stabilizing steep slopes or in pile burns to stimulate regeneration.
- Remove weed trees gradually to maintain the resources they are providing while allowing more sun to reach the ground and stimulate regeneration of understorey and native trees such as Angophoras and Eucalypts. Consider poisoning in autumn to mimic natural cycles of some exotic trees. If these dead trees can be left in situ they provide hollows, perches and other habitat. Artificial components such as nest boxes for birds, possums and microbats can also be considered but seek expert advice on construction, installation and monitoring.

Figure 31. The interface between the weedy understorey in Zone 4 (at front) and the good native understorey (at rear) of Zone 5 is obvious in this picture.

Table 7 Management issues, actions and timeframes for restoration activities in Zone 5

ACTION PLAN – ZONE 5					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
WEED REMOVAL					
Woody weeds Most of the woody weeds in this area have been treated during previous contracts. Treatment of woody weeds is mainly follow up, thus seedlings can be hand pulled, while larger plants may need to be cut stump and painted	Some woody weeds do not respond well to the cut and paint technique, including Ochnas and some Sennas, and these will need to be scraped and painted.	Year 1: treat woody weeds Year 2: followup Year 3: maintenance	Medium-high	m^2 treated for weeds No. of supplementary plantings %survivorship of plantings	Ongoing
Herbs and grasses Much of this area has been worked to remove exotic grasses and annuals. Spraying in these types of conditions needs to be undertaken by an experienced operator, care must be taken that overspray does not affect the health of native species. For areas where there are few native grasses, or they are sparsely distributed amongst weeds, the area	Spraying should only be considered for areas that are too large to hand weed effectively using mechanical removal techniques. Spraying should be conducted during autumn and winter when the frogs are less active, and more likely to have found overwintering shelters. Only use Roundup Biactive® around possible bell frog locations, or around waterways. Prepare for spraying by identifying areas with reasonable native grass cover. Hand weed around these areas,	Year 1: hand remove exotic grasses and herbs in better areas Year 2: Spot spray and plant Year 3: Look for areas that can be consolidated: these include areas with native trees and shrubs. Hand weed or spray around natives and plant understorey species (grasses and herbs) between the existing	Medium-high	m^2 treated for weeds No. of supplementary plantings %survivorship of plantings	Ongoing

ACTION PLAN – ZONE 5					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
should be sprayed and planted.	leaving a cleared buffer of 100-150mm between native plants and the area to be sprayed. Plant after weed dieback and mulch or use a weed suppression mat (jute squares). Use of plant guards will improve establishment success. Areas where weeds are hand removed can be planted immediately.	natives. Year 4 & 5: Final stages of consolidation: maintenance weeding			
REVEGETATION					
The eastern edges of this zone 5B are along the back of the residential area, with an asset protection zone in between. Much of the area is already good bush, and a reasonable soil seed bank is likely to exist. Most parts of the site should not require planting. Planting should only be used to extend the edges of this zone. Suitable species for immediate planting include ironbarks: *Eucalyptus fibrosa* and *E. crebra*, with some *E. longifolia*. Suitable shrubs include colonisers such as *Acacia falcata, Melaleuca nodosa*, *Pultenaea villosa, Dillwynia*	Options for revegetation include use of brush matting with seed in areas where soils exposed after weeding are susceptible to erosion. Thinning of the Melaleuca overstorey should be considered in some areas to improve the germination success of soil seeds in better parts of the site. Melaleucas typically resprout after fire, and will produce shoots from basal epicormic buds. This will aid in the maintenance of soil stability during an interim period, and the decision can be made later whether to	Year 1: Hand weed, cut selected Melaleucas, and apply seeding brush matting. Year 2: Hand weed or spot spray and plant grasses and herbs, maintain plantings. Year 3: Maintain plantings, replant where necessary, spot spray and plant supplementary groundlayer species Year 4: Maintain plantings, replant where necessary, hand weed or spot spray and plant	Medium-Low	No. of supplementary plantings %survivorship of plantings	Ongoing

ACTION PLAN – ZONE 5					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
tenuifolia, and *Daviesia ulicifolia*. Suitable colonizing grasses and herbs include *Dichelachne micrantha, Entolasia stricta, Microlaena stipoides, Themeda australis, Dianella revolute, Lomandra longifolia,* and *Lomandra multiflora*.	remove some trees altogether, or let the new ecosystem reach its own equilibrium state. Early plantings should be supplemented after establishment with a different mix of species.	supplementary species Year 5: Maintain plantings and followup weeding			
EXTENSION OF COOKS RIVER CASTLEREAGH IRONBARK FOREST EEC					
This area contains intact CRCIF community. Sparsely planted ironbarks with mixed Melaleucas and other shrub species in the understorey creates ideal habitat for bell frogs, particularly if it leaves some open areas for basking and foraging.	Planting should only be used to extend the edges of this zone.	Early plantings should be supplemented after establishment with a different mix of species.	Medium	No. of supplementary plantings %survivorship of plantings	Ongoing
ECOLOGICAL BURNS					
Fire has essentially been excluded from the reserve. Pile burns will enable managers to ascertain the extent of the seedbank.	Prepare site for ecological burn by thinning native vegetation and clearing woody weeds.	Annual-Cooler months. Compliance with regulations/permits. Weather dependant.	Low-medium	No. plants/species recruited	Compile species list from proposed pile site to monitor recruitment post burn.

ACTION PLAN – ZONE 5					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
GGBF HABITAT ENHANCEMENT					
A limiting factor on a permanent presence of GGBF in the Reserve is fragmented refugia and suitable foraging habitat	Use staged removal of exotic grasses and herbs to ensure that good bell frog habitat is available at all times. Manage impacts of domestic and feral animals though trapping, exclusion fencing and public education campaigns. Identify and establish avenues for habitat connectivity with nearby bell frog habitat.	Add habitat elements such as logs and rock piles to create refuge habitat and foraging areas. Retain areas of open grassland (or create them through plant management) for foraging and basking.	High	Gain in suitable GGBF habitat (m2). Increased presence of GGBF in the reserve	Throughout project
COMMUNITY SUPPORT AND INVOLVEMENT					
Historically the GGBF has been located in residential gardens in Greenacre. “Frog friendly” gardens provide valuable links for dispersing frogs from other key populations in the area. In lieu of formal linkages and corridors being established community support is invaluable in maintaining the presence of the GGBF in Coxs Creek Reserve.	Carry out a community awareness program highlighting the presence of the bell frog population within an EEC.	Provide education on the role that residents can play in maintaining these environmental treasures, including management of domestic animals, garden escape plants, garden refuse, littering and fire. Incentives for establishing frog friendly gardens.	Medium	Educational material distributed (no. of households). Resident attendance at open days (no of residents). Increase in no. of bushcare volunteers.	Ongoing

ZONE 6 – CONSTRUCTED WETLANDS FOR WATER QUALITY AND HABITAT

Figure 32 Zone 6 location

WHY ARE WETLANDS IMPORTANT?

Urban stormwater pollution has been recognised as a significant source of pollutants that enter waterways. Stormwater run-off typically contains pollutants such as phosphorous, nitrogen, litter, oil/grease and suspended solids. Constructed wetlands are universally recognised as an ecologically sustainable and cost effective stormwater management tool given their ability to:

- Significantly reduce stormwater pollutants;
- Provide a buffer for natural aquatic ecosystems;
- Create habitat for flora and fauna; and
- Provide an attractive public amenity.

HOW DO WETLANDS WORK?

Wetlands are complex systems where biological, chemical and physical processes combine to reduce pollutant loads found within stormwater.

Biological processes include direct uptake of nutrients by wetland plants, in addition to nutrient removal processes assisted by microorganisms found around the root-zones of plants and in soil.

Some chemicals such as hydrocarbons, metals and organic compounds are broken down or converted into non-harmful forms through chemical processes such as precipitation, volatisation and oxidation/reduction.

Physical processes include slowing down the speed of water entering the wetland. This is achieved by passing stormwater either through a densely vegetated area or a deep sedimentation zone that allows sufficient time for the suspended solids to filter or settle out of the water column.

WETLAND COMPONENTS: PLANTS

One of the most important components of wetlands is the presence of vegetation. A number of studies have demonstrated that water treatment is greater within densely planted systems than systems with little or no vegetation (Morris 1999). Plants provide the following functions within a wetland system:

- Uptake of nutrients such as nitrate, ammonia and phosphorus from stormwater and conversion into biomass;
- Plants provide organic litter, which provides soil with organic carbon that is the limiting factor in the process of de-nitrification. De-nitrification is responsible for removing nitrogen permanently from wetlands and;
- Plants have the ability to transport oxygen to the rhizome, or root system. Oxygen is essential for establishing and maintaining a population of beneficial bacterial, such as nitrifying bacteria that assist in converting ammonia to nitrate.

WETLAND COMPONENTS: SOIL

Soil is the base component of most natural system. Soil provides a substrate for plants and populations of bacteria that are necessary for biological and physical processes within wetlands.

Phosphorus and other nutrients are known to adsorb (attach) onto soil particles, when suspended soil particles are settled out of the water column, these pollutants are effectively immobilised at bottom of the wetland.

Shallow, densely planted wetlands are generally better oxygenated than deep, sparsely planted systems. This is because atmospheric oxygen exchange is limited to surface waters and water circulation in deeper water is generally poor. As well, there are often few or no plants to oxygenate the soil.

Oxygen is essential to prevent sediments from becoming anaerobic (oxygen depleted). Anaerobic conditions will trigger a release in nutrients, especially phosphorus, heavy metals and other chemicals bound to sediments. Phosphorus release can promote eutrophic conditions, where a water body becomes nutrient enriched that leads to algal blooms and other water quality problems.

LANDSCAPING A WETLAND

Planning a wetland requires a clear understanding of the intended purpose. Commonly described purposes include:

- Creation of habitat
- Appearance
- Water treatment

One general recommendation can be made for most types of created wetlands: Make them as large as you can within the space you have available and the limitations of your budget.

The most basic type of treatment wetland is filled by surface flows, where water runs through a shallow basin that is heavily planted. Various combinations of baffles and channels can be used to keep a uniform flow through as much of the wetland as possible. No wetland will cure serious water quality problems, however, incorporating a pretreatment (such as a pratten trap or other gross pollutant trap) to filter or settle out bulk pollutants will help considerably.

An important note is that effective water treatment wetlands offer a fairly restricted type of habitat. They are shallow, often with little variation in flow rates, and are densely packed with an often limited range of plant species. As a result, many birds and insects will thrive in these wetlands, but species diversity is rarely as high in more varied wetland systems. A stormwater treatment wetland will, ideally, include plant species that:

- Establish rapidly
- Have a year round nutrient uptake
- Are tolerant to fluctuations in water levels and considerable shading
- Become part of a plant-based mosaic that creates more effective habitat

Plant species selected for this project are based on these requirements.

Table 8. Management issues, actions and timeframe for restoration activities in Zone 6.

ACTION PLAN – ZONE 6					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
STREAMBANK STABILISATION AND EROSION CONTROL					
Zone 6 consists of a drainage (artificial) line with inflow from the cold storage facility to the south. The drainage line is heavily infested with weeds and embankments consist of mounded spoil excavated when constructing the drainage line. The need for flood attenuation can be identified from hydraulic modeling. Since the entire reserve is considered a swamp community, there is little likelihood of adverse effects from overtopping the bank during extreme storm events. Green and Golden Bell Frogs can utilise constructed ponds such as sediment basins, treatment wetlands and detention ponds for breeding and feeding.	Design requirements may include development of a project that can be constructed within a pre-determined budget. Good stream rehabilitation will take into account the nature of the upstream catchment, the volume and frequency of storm flows evolved, the type and volume of nutrients and sediments likely to be evolved, the desired water quality outcomes for the project (eg. effective treatment of stormwater to WSUD standards, improvement of water quality for better habitat), and the hydrological requirements of the receiving environment.	Commission detailed design work to develop a suitable design for construction of a project that combines streambank stabilisation and erosion control works with water quality treatment and habitat creation. Year 1: identify budget constraints for project Commission detailed design for streambank rehabilitation works Year 2: (may require grant funding) commission construction of rehabilitation works	Medium	Improved water quality. Improved habitat value. M^2 weeds removed Tonnes/cubic metres of weeds and sediments removed	Ongoing

ACTION PLAN – ZONE 6					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
IMPROVEMENT OF WATER QUALITY					
This project should be considered in conjunction with Bankstown Council as the stormwater is generated from Bankstown Council land. Access to this part of the site is best maintained through Bankstown Council land. Model catchment sediment and nutrient loads and design appropriate treatment train. This will, almost certainly, include establishment of GPTs (eg. end of line devices such as Pratten Traps) at relevant on site in Bankstown LGA.	Design and construct a sediment pond at the upstream end of the site. This will reduce sediment loads on site and in the receiving environment, and improve habitat quality for bell frogs. Construct wetland areas for water quality treatment, for example, linear wetlands can be formed along the margins of the channel. Location of wetlands just out of the main flow path reduces the impacts of high velocity flows on the wetland, providing refuge habitat for bell frogs and reducing maintenance costs. (Consideration needs to be given to treatment of water in both drainage channels.)	Year 1: identify budget constraints for project Commission detailed design for streambank rehabilitation works Year 2: (may require grant funding) commission construction of rehabilitation works	medium	Improved water quality. Improved habitat value. M^2 weeds removed Tonnes/cubic metres of weeds and sediments removed	Ongoing

ACTION PLAN – ZONE 6					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
NEED FOR ALTERNATE HABITAT FOR BELL FROGS AND NATIVE FISH; NEED TO MAINTAIN FISH PASSAGE FOR MIGRATORY FISH					
Consideration should be given to providing alternate habitat for bell frogs and native fish (gudgeons have been reported from this stream in the past). Some native fish are migratory, thus adequate fish passages need to be maintained.	A staged approach to construction works is recommended. Work should be timed for summer when frogs are most active. Provision of good refugia and alternative habitat prior to inception of streambank rehabilitation works will help ensure that bell frogs are not in the proposed construction zone.	Vegetation should be slashed to approximately 20cm and left overnight. The area should be thoroughly surveyed for frogs the following day by a suitably experienced herpetologist and any frogs removed. The vegetation can then be further slashed to ground level and works proceed with confidence that there is minimal chance of harm to frogs. Fish may need to be netted and transferred to alternate ponds upstream or downstream, depending on the requirements of the species. Gambusia (plague minnow) will need to be removed and destroyed.	High	No harm to aquatic fauna during works.	Throughout project

ACTION PLAN – ZONE 6					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
IMPROVE AND EXTEND GREEN AND GOLDEN BELL FROG HABITAT					
Key factors contributing to the success of bell frogs in this part of the site are improved water quality, better management of hydrology, and increased availability of breeding foraging and refuge habitats.	The creek line can provide additional habitat for bell frogs. Creekbank stabilisation and weed control needs to be undertaken with due consideration given to bell frogs.	Streambank stabilisation using rock armouring, rock groynes, logs and rootwads will create more foraging, basking and sheltering habitat for bell frogs. Creation of wetlands for stormwater treatment will provide additional habitat for post breeding dispersal of bell frogs. Management of riparian vegetation to improve bank stability and water quality will also provide habitat for foraging and refuges.	High	Gain (m^2) of GGBF habitat	Ongoing
PROTECT EXISTING BELL FROG POPULATIONS AND HABITAT					
Manage access by domestic and feral animals by trapping, installing fencing, and initiating a community education program. Monitor streams and ponds for the presence of Gambusia.	Limit use of herbicide in known frog habitat (including foraging areas); use low impact mechanical weeding methods (where applicable) and progressively rehabilitate riparian bushland. Use Roundup Biactive ® only around waterways and in areas that may be utilised by bell frogs.	High	No net loss of GGBF habitat	Ongoing	

ACTION PLAN – ZONE 6					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
DEVELOP APPROPRIATE VEGETATION MANAGEMENT STRATEGIES					
There are two options for weed management: it can be completed in stages, working from the top of the catchment down; however, completing all the streambank earthworks and revegetation will provide better habitat more quickly. This is a comparatively short stretch of creekline, and by completing all earthworks in on go, council can ensure that the contractor has an appropriate erosion and sediment control plan in place before commencement of works.	For effective management of all issues associated with streambank rehabilitation, a full detailed design should be commissioned. This design should include details of what species to plant where, and in what density; bank stabilisation treatments including use of jute matting or mesh, and/or mulching should also be provided in the detailed design. Plant species selection should be informed by species lists for CRCIF communities, for habitat creation or enhancement for GGBF, for water quality treatment outcomes, and for establishment of habitat for other fauna that uses or is likely to use the stream and surrounding areas.	Year 1: identify budget constraints for project Commission detailed design for streambank rehabilitation works Year 2: (may require grant funding) commission construction of rehabilitation works	High	Appropriate plan (cost/benefit) adopted	

ACTION PLAN – ZONE 6					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
COMMUNITY SUPPORT AND INVOLVEMENT					
Historically the GGBF has been located in residential gardens in Greenacre. “Frog friendly” gardens provide valuable links for dispersing frogs from other key populations in the area. In lieu of formal linkages and corridors being established community support is invaluable in maintaining the presence of the GGBF in Coxs Creek Reserve.	Carry out a community awareness program highlighting the presence of the bell frog population within an EEC.	Provide education on the role that residents can play in maintaining these environmental treasures, including management of domestic animals, garden escape plants, garden refuse, littering and fire. Incentives for establishing frog friendly gardens.	Medium	Educational material distributed (no. of households). Resident attendance at open days (no of residents). Increase in no. of bushcare volunteers.	Ongoing

ZONE 7 – PLANT SELECTION FOR FAUNA HABITAT

Figure 33 – Zone 7 location

To attract the greatest variety of wildlife to the reserve, good habitat should be provided with a range of different sizes of plants as well as different species. This will include areas where small birds can hide from danger and build nests such as dense shrubs. Groundcovers like grasses and 'clumping' plants provide cover for ground dwellers such as skinks. Climbing plants add variety and a mulch of twigs and leaves make a home for lizards and insects. Permanent water will encourage birds to visit.

Below is a list of some of the native plants that can be used to turn the reserve into a haven for wildlife. The plants on the list are suitable for the parts of western Sydney on soils from clay.

GRASSES

- Kangaroo Grass, *Themeda australis*, is a tussock grass with beautiful bronze highlights, providing seed for birds and protection for small reptiles and amphibians.
- Wallaby Grass, *Danthonia spp*., attracts butterflies and provides seed for birds. Some moth larvae feed on the roots.
- Plume Grass, *Dichelachne* sp., attracts butterflies.
- Weeping Grass, *Microlaena stipoides* are food for caterpillars and seed for birds.

GROUNDCOVERS

- Scurvy Weed, *Commelina cyanea*, is shelter for ground dwelling frogs and lizards.
- Centella, *Centella asiatica*, shelters lizards
- Fan flowers, *Scaevola* spp. Butterflies love the nectar from the long lasting flowers.
- Guinea Flowers, *Hibbertia* spp., offer food for moths, butterflies, bees and birds.

- Native Cranberry, *Lissanthe strigosa* have tubular flowers rich in nectar for birds and butterflies, and produce juicy white fruit that attract birds and small marsupials.
- *Goodenia* spp. The bright yellow flowers attract insects which are food for small birds.

FERNS

- Water Ferns, *Blechnum* spp., Rasp Ferns, *Doodia* spp, and Fragrant Fern *Microsorum scandens*, can grow densely and shelter many small birds and frogs.
- Bracken, *Pteridium esculentum*, shelter and nest sites for Fairy Wrens, Silvereyes and other small birds.
- Coral Ferns, *Gleichenia* spp. Form dense thickets in moist areas and are refuge for birds.
- Tree Ferns provide nest holes for native bees in broken trunks and stems.

CLUMPING PLANTS

- Flax lilies, *Dianella* spp., have blue flowers and berries that are food for birds and attract butterflies and other insects.
- Mat Rushes, *Lomandra* spp, offer refuge for lizards and attract butterflies and seed & fruit eating birds.
- Swamp or River Lily, *Crinum pedunculatum*. Frogs like to live amongst the fleshy leaves.
- Rushes, *Juncus* spp, are habitat for small lizards and attract birds and butterflies
- Saw Sedges, *Gahnia* spp are great habitat and can grow to be quite large. Sword-grass Brown Butterfly larvae feed on the leaves.

CLIMBERS

- Apple Berry, *Billardieria scandens*, attract birds and butterflies and the fruit is edible once it turns purple.
- Old Man's Beard, *Clematis aristata*, provides a great nest site for birds and the masses of white flowers attract butterflies and other insects.
- False Sarsparilla, *Hardenbergia violacea*, is refuge, nest sites & food for birds and the bees, moths and butterflies love the flowers.
- Native Sarsparilla, *Smilax glyciphylla*, birds & possums like the bunches of black berries and the wiry stems are great nest material.
- Love Creeper, *Glycine clandestina* attract nectar, seed & fruit eating birds, butterflies, moths, small insects such as bees.

SHRUBS

- Wattles, *Acacia* spp. Any local wattle species provides seed for birds and ants and nectar for butterflies and bees. Those with dense foliage give shelter for small birds
- Blackthorn, *Bursaria spinosa*, The prickly foliage shelters small birds such as finches. The scented flowers attract butterflies and it is the host for many species such as the Eltham Copper Butterfly.
- *Dillwynia* spp. Many butterflies and other small insects visit these plants, along with seed eating birds.
- Bush Peas, *Pultenea* spp., attract native bees, moths, butterflies and seed eating birds.
- Melaleucas provide nectar and seeds for birds and insects.

TREES

- Native Apples, *Angophora floribunda* and *A. bakeri*, are among the best plants for attracting a wide range of insects to their abundant summer flowers.
- She-Oaks, *Allocasuarina* spp. Attract seed and fruit eating birds.
- Melaleucas are important for wildlife being as a source of food for birds and insects as well as providing nest sites.
- *Exocarpus cupressiformis* attract birds, butterflies and other insects.
- Turpentines, *Syncarpia glomulifera*, provide flowers and fruit, and nesting and roosting sites for a range of birds, marsupials and insects.
- Gum trees, *Eucalyptus* spp.all provide a wide range of food and living places for many animals.

Table 9. Management issues, actions and timeframes for restoration activities in Zone 7.

ACTION PLAN – ZONE 7					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
REVEGETATION					
The western edges of this zone are along the bank of the main creekline, and consist of mounded spoil with little likelihood of having any native seed bank. Suitable species for immediate planting include ironbarks: *Eucalyptus fibrosa* and *E. crebra*, with some *E. longifolia*. Suitable shrubs include colonisers such as *Acacia falcata, Melaleuca nodosa*, *Pultenaea villosa, Dillwynia tenuifolia, and Daviesia ulicifolia*. Suitable colonizing grasses and herbs include *Dichelachne micrantha, Entolasia stricta, Microlaena stipoides, Themeda australis, Dianella revolute, Lomandra longifolia,* and *Lomandra multiflora*.	Thinning of the Melaleuca overstorey is strongly recommended to improve the germination success of soil seeds in better parts of the site. Melaleucas typically resprout after fire, and will produce shoots from basal epicormic buds. This will aid in the maintenance of soil stability during an interim period, and the decision can be made later whether to remove some trees altogether, or let the new ecosystem reach its own equilibrium state. Early plantings should be supplemented after establishment with a different mix of species.	Year 1: Cut selected Melaleucas, and plant trees and shrubs. Maintain plantings. Year 2: Maintain plantings, replant where necessary, spot spray and plant grasses and herbs. Year 3: Maintain plantings, replant where necessary, spot spray and plant supplementary groundlayer species Year 4: Maintain plantings, replant	Medium	No. of supplementary planting %survivorship of planting % projective cover Melaleuca tinned.	Ongoing

ACTION PLAN – ZONE 7					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
		where necessary, spot spray and plant supplementary species Year 5: Maintain plantings and follow up weeding			
WEED REMOVAL					
Woody weeds There are very few woody weeds in this part of the site, so these should be treated early in the program.	Cut and paint, pile on site to provide habitat for bell frogs. Some species will require stem injection for effective treatment. Hand pull seedlings or scrape and paint if this is the recommended action for the weed species.	Year 1: commence woody weed removal Year 2: followup treatment of woody weeds	High	Metres ^{3} woody weeds removed Area (m2) cleared of woody weeds	Ongoing
Herbs and grasses Removal of exotic herbs and grasses will initially be to create areas for planting. Spraying in these types of conditions	Spraying should be conducted during autumn and winter when the frogs are less active, and more likely to have found overwintering shelters. Only use Roundup Biactive® around possible bell frog	Year 1: Spot spray and plant Year 2: Spot spray and plant Year 3: Look for	Medium	Area (m2) cleared of groundlayer weeds	Ongoing

ACTION PLAN – ZONE 7					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
needs to be undertaken by an experienced operator, care must be taken that overspray does not affect the health of native species. For areas where there are few native grasses, or they are sparsely distributed amongst weeds, the area should be sprayed and planted. Consolidation of planted areas can commence after several years, and this will become the primary goal from this stage.	locations, or around waterways. Prepare for spraying by identifying areas with reasonable native grass cover. Hand weed around these areas, leaving a cleared buffer of 100-150mm between native plants and the area to be sprayed. Spot spray areas after clearing of bell frogs (will require searching), plant after weed dieback and mulch or use a weed suppression mat (jute squares). Use of plant guards will improve establishment success. Alternate methods for management of weedy grasses include hand pull or crown, although these are not effective for Kikuyu. Areas where weeds are hand removed can be planted immediately. Exclusion fencing can be used as a temporary measure for control of Kikuyu in areas after weed removal. Alternately, areas can be delineated by logs and rock piles installed for frog habitat. Slashing may be useful for	areas that can be consolidated: these include areas with native trees and shrubs. Spray around natives and plant understorey species (grasses and herbs) between the existing natives. Year 4: Look for areas that can be consolidated: these include areas with native trees and shrubs. Spray around natives and plant understorey species (grasses and herbs) between the existing natives. Year 5: Final stages of consolidation: maintenance			

ACTION PLAN – ZONE 7					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
	pretreatment of some areas before spraying, or as an interim management strategy during plant establishment.	weeding			
EROSION CONTROL					
Consideration needs to be given to management of soils on steep slopes and along creek banks.	Weed removal should be staged, and soils may need some further consolidation.	Use of logs and rock piles to create habitat for bell frogs can be extended for use as erosion control structures: placement of logs and rock piles should therefore consider potential for erosion on steeper slopes or where there is evidence of prior scouring.	High	No erosion or evidence of sediment export from channel embankments	Ongoing Establish a series of permanent monitoring points (photo-points and quadrats).

ACTION PLAN – ZONE 7					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
EXTENSION OF COOKS RIVER CASTLEREAGH IRONBARK FOREST EEC					
This area provides an ideal opportunity to create an extension of the CRCIF community. Sparsely planted ironbarks with mixed Melaleucas and other shrub species in the understory creates ideal habitat for bell frogs, particularly if it leaves some open areas for basking and foraging.	Use appropriate plants from CRCIF species list for supplementary planting	Plant and mulch or use weed suppression mats. Use of plant guards will improve establishment success	High	Increase in CRCIF extents on site (m^2). % survivorship of plantings	Ongoing Establish a series of permanent monitoring points (photo-points and quadrats).
GGBF HABITAT ENHANCEMENT					
A limiting factor on a permanent presence of GGBF in the Reserve is fragmented refugia and suitable foraging habitat	Use staged removal of exotic grasses and herbs to ensure that good bell frog habitat is available at all times. Manage impacts of domestic and feral animals though trapping, exclusion fencing and public education campaigns. Identify and establish avenues for habitat connectivity with nearby bell frog habitat.	Add habitat elements such as logs and rock piles to create refuge habitat and foraging areas. Retain areas of open grassland (or create them through plant management) for foraging and basking.	Medium	Gain in suitable GGBF habitat (m2). Increased presence of GGBF in the reserve Evidence of successful breeding events	Ongoing GGBF surveys

ZONE 8 – THE IMPORTANCE OF BUFFER ZONES

Figure 34 Zone 8 location

THE ASSET PROTECTION ZONE (APZ)

Development on bush fire prone land will normally require the implementation of a set back distance which is referred to as an asset protection zone. An asset protection zone (APZ) is also known as a fire protection zone and aims to protect human life, property and highly valued assets. It is a buffer zone between a bush fire hazard and buildings, which is managed progressively to minimise fuel loads and reduce the potential radiant heat levels, flame contact, ember and smoke attack on life and property.

When creating and maintaining a reserve area that is part of an APZ it must be ensured that:

- vegetation does not provide a continuous path to the house
- all noxious and environmental weeds are removed
- plant or clear vegetation into clumps rather than continuous rows
- prune low branches two metres from the ground to prevent a ground fire from spreading into trees
- locate vegetation far enough away from the asset so that plants will not ignite the asset by direct flame contact or radiant heat emission
- plant and maintain short green grass in the APZ as this will slow the fire and reduce fire intensity. Alternatively, provide non-flammable pathways directly around the dwelling
- ensure that shrubs and other plants do not directly adjoin the asset
- avoid erecting brush type fencing and planting flammable trees near assets

Plants that are less flammable have the following features:

- high moisture content
- high levels of salt
- low volatile oil content of leaves
- smooth barks without “ribbons” hanging from branches or trunks
- dense crown and elevated branches

While the removal of fuel is necessary to reduce a bush fire hazard, soil stability should also be considered, particularly on sloping areas. A small amount of ground cover can greatly improve soil stability and does not constitute a significant bush fire hazard. Ground cover includes any material which directly covers the soil surface such as vegetation, twigs, leaf litter, clippings or rocks. A permanent ground cover should be established (for example, short grass). This will provide an area that is easy to maintain and prevent soil erosion.

THE ECOLOGICAL BUFFER ZONE

Functional isolation of reserves such as Coxs Creek Reserve can be reduced by maintaining or increasing connectivity with other reserves in the area, and by establishing buffer zones that can increase the functional area of the reserve and reduce the effects of external disturbances. In reality, buffer zones around reserves can have different functions, depending on how they are planned and used. The outermost buffer generally permits a range of activities that are compatible with the major purposes of the reserve, for example, the APZ at Coxs Creek Reserve.

Table 10 Management issues, actions and timeframes for restoration activities in Zone 8

ACTION PLAN – ZONE 8					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
REVEGETATION					
This zone forms the buffer between the residential area east of the site and the CRCIF EEC. It has a number of important uses, including asset protection from bushfires, and protecting the core area of the CRCIF from the effects of these properties. Suitable species for scattered planting include ironbarks: *Eucalyptus fibrosa* and *E. crebra*. Suitable shrubs include colonisers such as *Acacia falcata, Pultenaea villosa, Dillwynia tenuifolia,* and Daviesia ulicifolia. Suitable colonizing grasses and herbs include *Dichelachne micrantha, Entolasia stricta, Microlaena stipoides, Themeda australis, Dianella revoluta, Lomandra longifolia,* and *Lomandra multiflora*. Climbers such as *Billardiera scandens* and *Glycine clandestina* are useful in buffer areas.	Care must be taken that any revegetation in this zone is in accordance with the directives of the NSW RFS Planning for Bushfire Protection. Early plantings should be supplemented after establishment with a different mix of species.	Year 1: Plant trees and shrubs. Maintain plantings. Year 2: Maintain plantings, replant where necessary, hand weed and plant grasses and herbs. Year 3: Maintain plantings, replant where necessary, hand weed and plant supplementary groundlayer species Year 4: Maintain plantings, replant where necessary, hand weed and plant supplementary species Year 5: Maintain plantings & follow up weeding	Medium	No. of supplementary planting %survivorship of planting	Ongoing

ACTION PLAN – ZONE 8					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
WEED REMOVAL					
Woody weeds There are very few woody weeds in this part of the site, so these should be treated early in the program.	Cut and paint, pile on site to provide habitat for bell frogs. Some species will require stem injection for effective treatment. Hand pull seedlings or scrape and paint if this is the recommended action for the weed species.	Year 1: commence woody weed removal Year 2: followup treatment of woody weeds	Medium	Metres ^{3} woody weeds removed Area (m2) cleared of woody weeds	Ongoing
Weed removal: herbs and grasses Removal of exotic herbs and grasses should initially be to create areas for planting. A number of threatened species are known to occur in this area, including Tadgells Bluebell (*Wahlenbergia multicaulis*) and Downy Wattle (*Acacia pubescens*). This area may also serve as foraging habitat for Green and Golden Bell Frogs.	The preferred methods for removal of exotic grasses and herbs are mechanical: hand pull or crown. Prepare for spraying by identifying areas with reasonable native grass cover. Hand weed around these areas, leaving a cleared buffer of 100-150mm between native plants and the area to be sprayed. Spraying in these types of conditions needs to be undertaken by an experienced operator, care must be taken that overspray does not affect the health of native species. Hand weeding is more labour intensive, and can often	Year 1: Spot spray and plant Year 2: Spot spray and plant Year 3: Look for areas that can be consolidated: these include areas with native trees and shrubs. Spray around natives and plant understorey species (grasses and herbs) between the existing natives.	Medium	Area (m2) cleared of groundlayer weeds	Ongoing

ACTION PLAN – ZONE 8					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
	require a considerable degree of skill, and may be supplemented with spot spraying. For areas where there are few native grasses, or they are sparsely distributed amongst weeds, the area may be sprayed and planted. Do not spray near threatened species. Spraying should be conducted during autumn and winter when the frogs are less active, and more likely to have found overwintering shelters. Only use Roundup Biactive® around possible bell frog locations, or around waterways. Spot spray areas after clearing of bell frogs (will require searching), plant after weed dieback and mulch or use a weed suppression mat (jute squares). Use of plant guards will improve establishment success. Consolidation of planted areas should be achieved after several years, and this will become the	Year 4: Look for areas that can be consolidated: these include areas with native trees and shrubs. Spray around natives and plant understorey species (grasses and herbs) between the existing natives. Year 5: Final stages of consolidation: maintenance weeding			

ACTION PLAN – ZONE 8					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
	primary goal from this stage. Slashing may be useful for management of the asset protection zone.				
MANAGE THE ASSET PROTECTION ZONE (APZ) IN ACCORDANCE WITH RURAL FIRE SERVICE REQUIREMENTS					
The APZ can provide important benefits to the core area of the CRCIF, as well as for asset protection. Consideration needs to be given to the requirements for non-continuous layers of vegetation in the zone. The preparation of a zone specific Vegetation Plan that accommodates the requirements of the APZ and the RFS should be prepared. Australian Wetlands can provide this, or a similarly qualified and experienced company. Plant species selection should be informed by species lists for CRCIF communities, for habitat creation or enhancement for GGBF, for water quality treatment outcomes, and for establishment of habitat for other fauna that uses or is likely to use the	Vegetation in the APZ needs to be maintained. For the APZ, this may be removal of all plants other than low-flammability groundcovers such as native grasses and herbs. These grasses and herbs may need to be slashed periodically to meet requirements. For the APZ consideration must be given the continuity of layers. Vegetation should not be allowed to develop into continuous layers, eg. canopy, shrub understorey. This will help to reduce the potential length of flames by slowing the rate of spread, filtering embers and suppressing crown fire. Consideration should be given to thinning some of the shrubs in this part of the site. If this is done while plants are seeding this will provide	Year 1: weed removal and planting Year 2: thinning of shrubs, follow-up weed removal and planting	Medium	Appropriate species established No. and % cover	Ongoing

ACTION PLAN – ZONE 8					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
stream and surrounding areas.	good seeded brush matting for other parts of the site (eg. Zone 1). Care should be taken that the IPZ is kept clear of weed debris and other rubbish; access for fire fighting vehicles must be maintained at all times.				
MANAGE THE ASSET PROTECTION ZONE (APZ) AS A BUFFER FOR CORE CRCIF EEC					
	The shrub layer may need to be thinned. Cleared areas can be planted with low-flammability species in arrangements that will not develop into continuous vegetation layers.	Year 1: commission vegetation plan for the OPZ Year 2: commence or continue implementation of the vegetation plan.	Medium	No. of supplementary planting %survivorship of planting % projective cover Melaleuca thinned.	Ongoing

ACTION PLAN – ZONE 8					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
EXTENSION OF COOKS RIVER CASTLEREAGH IRONBARK FOREST EEC					
This area contains intact CRCIF community. Sparsely planted ironbarks with mixed Melaleucas and other shrub species in the understorey creates ideal habitat for bell frogs, particularly if it leaves some open areas for basking and foraging.	Planting should only be used to extend the edges of this zone.	Early plantings should be supplemented after establishment with a different mix of species.	medium	No. of supplementary plantings %survivorship of plantings	Ongoing
GGBF HABITAT ENHANCEMENT					
A limiting factor on a permanent presence of GGBF in the Reserve is fragmented refugia and suitable foraging habitat. Refugia can be utilized to delineate management zones and protect Tadgells Bluebell (*Wahlenbergia multicaulis*) from incremntal increases in the “mow zone”.	Add habitat elements such as logs and rock piles to create refuge habitat and foraging areas. Manage impacts of domestic and feral animals though trapping, exclusion fencing and public education campaigns. Identify and establish avenues for habitat connectivity with nearby bell frog habitat.	Logs and rocks can be positioned to create a clear edge between the IPZ and the OPZ. Management actions in these zones are different, and the zone boundaries need to be clearly identified for the best ecological outcomes. Retain areas of open grassland (or create	Medium	Gain in suitable GGBF habitat (m2). Increased presence of GGBF in the reserve Evidence of successful breeding events	Ongoing GGBF surveys

ACTION PLAN – ZONE 8					
BACKGROUND	**STRATEGIES**	**ACTIONS**	**PRIORITY**	**PERFORMANCE MEASURES**	**MONITORING**
		them through plant management) for foraging and basking. Use staged removal of exotic grasses and herbs to ensure that good bell frog habitat is available at all times.			
COMMUNITY SUPPORT AND INVOLVEMENT					
Historically the GGBF has been located in residential gardens in Greenacre. “Frog friendly” gardens provide valuable links for dispersing frogs from other key populations in the area. In lieu of formal linkages and corridors being established community support is invaluable in maintaining the presence of the GGBF in Coxs Creek Reserve.	Carry out a community awareness program highlighting the presence of the bell frog population within an EEC.	Provide education on the role that residents can play in maintaining these environmental treasures, including management of domestic animals, garden escape plants, garden refuse, littering and fire. Incentives for establishing frog friendly gardens.	Medium	Educational material distributed (no. of households). Resident attendance at open days (no of residents). Increase in no. of bushcare volunteers.	Ongoing

AN AFTERWORD: ANIMAL SURVIVAL IN URBAN BUSHLAND RESERVES (ARTHUR WHITE)

Bushland reserves have been established in built-up areas as a means of conserving remnant flora and fauna. Recent fauna survey work allows for an assessment of the effectiveness of these reserves as conservation areas for native animals. Many bushland reserves are surrounded by houses and are subject to various forms of degradation, weed infestation and abuse. None are free of outside impacts. Therefore, it is likely that the composition of the fauna in the reserves will change in response to the pressures. If so, what animal groups will be most affected?

Fauna surveys have recently been carried out in three large bushland reserve areas. Large reserves are likely to be less severely impacted and may provide a useful picture of the changes in animal communities. For these three large reserve areas, the average survival of species was as follows; Mammals 45%; Birds 70 %; Reptiles 40%; Frogs 47 %.

Birds

Bird species lost was less severe than for other types of fauna. The greatest loss of birds occurred amongst the ground-nesting species. The least affected were the tree-nesting species with generalised diets. Certain species were favoured by urbanisation such a currawongs, wattlebirds, magpies and noisy miners. These birds are aggressive, territorial users of open woodland.

Impacts which have lead to the loss of birds are:

- Loss of low ground cover (through clearing or too frequent burning). For ground-nesting birds this has resulted in an almost complete loss of nesting and shelter habitat.
- Loss of nesting hollows (through removal of old trees and dead branches; feral species also compete for the use of remaining hollows)
- Loss of mid-canopy layer (through removal of shrubs). This opens up woodland areas for aggressive birds to displace other species.
- Change in composition of flora (through dumping of garden plants, loss of native plants). Food plants may be lost (e.g. native grasses for finches).

Mammals

The most severe impact recorded on any animal group has been on the ground dwelling mammals (such as Antechinus, bandicoots, wallabies and native rodents). In many reserve areas these animal have been completely eradicated. Grassland and wetland habitats appear to be the habitats that have been reduced the most. There was less impact on arboreal and flying mammals. Note: possum boxes provide hollows, but there is a need to monitor these to ensure they are not used by feral fauna.

Impacts which have lead to the loss of mammals are:

- Loss of ground cover (through clearing or too frequent burning)
- Increased predation by exotic and native predators (due to increased tracks through reserves and "edge-effects" in long, thin reserves)
- Displacement by exotics (such as foxes and black rats) in disturbed habitats.

Reptiles

Some groups of reptiles have fared badly in bushland reserves. Marked losses have occurred amongst the vertebrate predators (such as goannas and snakes), large species (such as goannas, snakes and large skinks) and diurnal species (such as skinks and dragons).

Small reptiles and nocturnal reptiles have suffered much smaller losses. Species which have benefited include the cavity dweller such as wall skinks, and the gastropod feeders (these include blue-tongue lizards - however, these may now be being lost due to hunting by dogs).

Impacts which have lead to the loss of reptiles are:

- Loss of ground cover and shelter. Protective shelter sites are lost through the removal of fallen timber or the burning off of dead branches and sticks. The broad-headed snake has been lost from many areas due to the collection of bush rock and from snake bashing.
- Increased predation by exotic and native predators (foxes, black rats and the high density of currawongs and kookaburras)
- Loss of breeding sites especially those which breed in loose sand (generally the first areas to be made into car parks)

Frogs

Species adversely affected by urbanisation include riparian species (river and creek frogs) and ecospecialists (with highly specialised diets). Similarly, species that require thick, dense ground-cover have been adversely affected. Those species which have been positively affected include those that breed in still water, and species with some tolerance of water pollution.

Impacts which have lead to the loss of frogs are:

- Loss of water quality (through contamination of storm water by household chemicals, pesticides, fertilisers, petro-chemicals and detergents)
- Loss of breeding sites, especially ephemeral sites where water collects after rain. Low-lying ground is often filled in and levelled or drained.
- Increased predation by exotic and native predators (especially foxes and black rats)

10. STRATEGIES FOR MANAGING HABITAT CONNECTIVITY

GREEN AND GOLDEN BELL FROGS

HABITAT IMPROVEMENT

The objectives of the Greenacre GGBF Management Plan need to be included in the POM for Coxs Creek Reserve. These objectives involve maintaining the three existing GGBF sub-populations, enhancing the existing GGBF habitat, and increasing connectivity between sub-populations. A number of strategies were proposed to direction actions to meet these objectives:

- Further development of GGBF breeding and other habitat components on public and private lands
- Improvement of habitat within the GGBF key populations
- Education and communications to build awareness of the GGBFs and encourage further on-ground actions
- Reduction of external threats to GGBFs
- Monitoring and research to better understand the extent and dynamics of the Greenacre GGBF population
- Coordination and communication between the various stakeholders, land managers and the community

The occasional presence of GGBFs in the residential sector between Coxs Creek Reserve and the Juno Parade brick pit site has been noted, and suggests this area may be utilised as foraging, shelter and possible overwintering habitat. There is a good opportunity to raise awareness of the frogs in these and surrounding residential areas through the provision of information and incentives to create ‘frog friendly’ gardens and raise community awareness about GGBF issues.

HABITAT CONNECTIVITY

The absence of GGBFs from potential habitat at Coxs Creek Reserve over the last few years is of concern. While it is likely the population is fluctuating spatially and temporally, and dispersing amongst other habitat, a more regular monitoring program at past and present habitats would help define the population’s status. This should be combined with habitat creation and enhancement initiatives within the reserve and adjoining properties. A major portion of the Greenacre GGBF Key Population is on land owned by companies or organisations and has little conservation security, a factor which is of concern.

This emphasis on habitat creation in and around Coxs Creek Reserve has played a fundamental role in deciding management recommendations for the future. Creation of habitat is a key outcome in four of the eight management zones defined. Management

actions include recommendations for ‘frog friendly’ construction and ongoing management techniques. The primary aim here is to create good GGBF habitat in the reserve, regardless of the current status of the population in the area. By improving habitat, frogs will return, or can be re-introduced to the reserve.

Other key outcomes for the GGBF population in the area are the improvement of connectivity between areas of good habitat. Poor quality corridors become population sinks, rather than linkages, leading to isolation of core habitat areas. Seasonal use of areas becomes limited or untenable, and local populations begin to decline. The suggestion to close Drone St to facilitate the provision of a good quality frog corridor has been made several times in the past, and is supported by Australian Wetlands. A design for the closure of the street that includes access to facilities and provision for turnarounds at the end of each adjoining street is relatively straightforward. The design can provided in conjunction with appropriate civil engineering, and include details of ‘frog friendly’ habitat elements to be created in the corridor. Alternatives for frog corridors include acquisition of a strip of land (currently outside the fence) along the edge of the factories on the northern side of the street, and using this for a corridor. Some sections of the corridor may need to be located underground and designs may need provision for frog habitat located below street level.

COOKS RIVER CASTLEREAGH IRONBARK FOREST (CRCIF) EEC

FREQUENCY OF FIRE

There are four aspects of fires that need to be examined for best practice management: frequency, intensity, duration and seasonality. These aspects are important for germinating seeds, maximising biodiversity values and vegetative recruitment (Auld 1986). The most recent approach to ensuring adequate biodiversity conservation with respect to fire involves a strategy based on vegetative fire responses (Bradstock 2006).

The interval of time between fires affecting a site is critical. Flora must be given the opportunity to mature and replenish a viable seedbank and hence maintain the species after future fires. For example, a high fire frequency will lead to the local decline of turpentine as it takes many years for a tree to start producing viable seeds. Alternatively, if a remnant Cooks River Castlereagh Ironbark Forests (CRCIF),remains unburnt for long periods of time, plants that require fire for seed germination will senesce and the soil seedbank can decay. Also, low-frequency fires will compromise the structure (for example, increase weed growth) and flammability of the stands.

The fire interval thresholds are based on a consideration of the broad vegetation type and the species composition of communities. The minimum interval is based on the primary juvenile periods of species sensitive to extinction under frequent fire regimes and does not include the time to replenish seed bank reserves. The maximum interval indicates the time since a fire at which species may be lost from the community due to senescence.

For CRCIF the minimum fire frequency is seven years and the maximum fire frequency is 30 years, with only a small area of the remnant burnt at a time. Ideally, prescribed burns should be conducted between 15 and 30 years (DECC, 2008). Fire history records and maps need to be kept accurate and up to date for the reserve, and should include all planned and unplanned burns. This will help with determining the ecological impacts of fire on plant species which have poorly known fire responses. Late summer/early autumn burns are more likely to result in successful regeneration of vulnerable species. Use of wetting agents and chemical retardants is not recommended, and weed treatment before and after burning is essential.

HABITAT CONNECTIVITY

CRCIF is considered to be one of the most threatened ecological communities in Australia. It has been reduced to around 1000 hectares, which is around 7% of its original distribution. A further 6% of highly degraded CRCIF consists of scattered trees; around 1% is effectively conserved in national parks and nature reserves. Most of the larger remnants are located in the Castlereagh and Holsworthy areas, with others in western Sydney LGAs. Residential development, mining, fragmentation, weed invasion, poor water quality in stormwater runoff, rubbish dumping, inappropriate fire regimes and mowing continue to reduce the extent and quality of the remaining CRCIF EEC.

The extreme fragmentation alone is enough to complete the decline of many of the smaller sections of conserved CRCIF, including Coxs Creek Reserve. Inbreeding depression will occur in species with an inadequate gene pool in the reserve, or in the area. The best option is to expand the size of the reserve, which may be possible through liaison with Bankstown Council and joint management of Coxs Creek Reserve and Roberts Road Reserve. This reserve has a high perimeter to area ratio, however, and while it has the capacity to provide a further buffer zone is unlikely to provide a high quality addition to the core area of the CRCIF.

An alternative to extending the reserve as an option for increasing the available gene pool is to bring additional genetic stock in from other reserves. Care must be taken to select seed from healthy plants in reserves with similar environmental conditions, and grow them in disease free soil media. Local genetic pools for threatened species, in particular, can be supplemented through planting. Planting can be used to change the balance of species in the community where other management techniques have failed. For example, burning at too short intervals can reduce the availability of soil seed stock for obligate seeders (eg. *Persoonia nutans*), while too long an interval between fires can result in deterioration of seed that requires heat and/or smoke to initiate germination (eg. ironbarks).

Additional buffering for the reserve can be achieved through involvement of local residents. Local native trees in backyards provide good seed sources at the very least. Where a group of adjacent yards retain native vegetation there is an opportunity for these residents to collectively provide additional conservation resources. For residents that have yards that adjoin reserves such as Coxs Creek Reserve, these remnant trees, shrubs and understorey have additional value as an extension to the reserve's capacity for conservation by providing additional buffering, allowing the core area of the reserve to be increased in size. If this kind of resource does not already exist, education programs such as the Cooks River Castlereagh Ironbark Forest Guardian program encourage residents living next to reserves to help in the creation or maintenance of bushland corridors.

A important consideration for this type of program, and for any bushland regeneration plan is careful selection of species to plant and seed as a source. At some point in the past management of the reserve a considerable number of *Eucalyptus sideroxylon* have been planted. These trees are quite distinctive, with pink flowers, dark deeply furrowed bark, and lighter grey-green leaves. From the size of the trees, one or two large trees were planted along the southern boundary of the site, perhaps 50 to 70 years ago. These trees may have provided the seed for further restoration planting, perhaps in conjunction with the establishment of the frog ponds in the southwestern corner of the site. Regardless of the establishment mechanism, there is now a healthy stand of these ironbarks in this area (Figure 11). These trees provide good habitat in keeping with the nature of the community, but are not a local species, and are not endemic to the CRCIF.

Figure 35. Distribution of ironbark (and related) species in Coxs Creek Reserve.

Control of *E. sideroxylon* is strongly recommended. *Eucalyptus sideroxylon* seedlings should be removed and replaced with ironbarks more in keeping with the CRCIF indicative species. Staged removal of adult trees is not recommended at this stage as these trees contribute important habitat values to the area, despite their non-endemic status. A few scattered adult specimens are located in other parts of the reserve and these should be targeted for removal and replacement as part of this management plan.

MANAGEMENT OF DISEASES: *PHYTOPTHORA CINNAMOMI*

Phytophthora cinnamomi is not visible to the naked eye. Under a microscope, its main body, the mycelium, looks like white hair-like threads. Sporangia (spore sacs) are produced on the mycelium in moist and aerobic conditions and at temperatures of 22-28ºC. In each sporangium 30-40 zoospores are formed and released. Zoospores are motile by way of two flagella, which enables Phytopthora to infect new and healthy root tips. Zoospores survive up to four days.

When conditions for growth become less favourable, generally when the soil dries out, mycelium may form another type of spore, known as a chlamydospore. This resting spore has a thick cell wall and is able to survive in the soil or host tissue for many years, waiting for growth conditions to become suitable again. The mycelium can also survive on plant debris on or in the soil.

The most critical interaction in disease development is the simultaneous presence of Phytopthora zoospores and susceptible host plants. A range of factors determines the severity of the disease and its rate of spread. These include temperature, rainfall, soil type and characteristics, and microbial soil populations. *Phytopthora* is generally found in areas where:

- average annual rainfall is greater than 500 mm (20 inches)
- soils are acid to neutral with low amounts of nutrients and organic matter
    - have few micro-organisms
    - have poor drainage

Hot bushfires may destroy *Phytopthora* to a depth of 15 cm below the soil surface. However, the fire also lowers surface soil organic matter and microbial populations, making it more favourable for its growth.

Symptoms of disease

The roots and stems of plants affected by *Phytophthora* decay with root-rot and then disintegrate, destroying their ability to extract water and nutrients. An infected plant is then subject to water stress which is also known as ‘internal drought’. The first visual symptoms of infection are generally shown as yellowing of the foliage (chlorosis) followed by dieback of the entire plant. Depending on local site and environmental conditions, this can occur in a matter of weeks for small shrubs or even several years for large shrubs or trees. Symptoms vary between different plant species. *Xanthorrhoea* species for example, die rapidly and may collapse. *Acacia* species may die quickly but symptoms can be masked by other dieback causes such as general drought conditions. Leaves of *Banksia* species and *Eucalyptus*

species show slower signs of dieback on their branch tips but may temporarily re-shoot. The Fabaceae, Acacia, Leptospermum and some Epacridaceae become yellow and die back in warm moist periods during spring and autumn. They may recover and form new growth during dry periods in summer or cold periods in midwinter. The cycle continues with dieback occurring again in spring and autumn.

Dieback may also be caused by factors other than *Phytophthora*. These may include chemicals, old age, fire, mechanical damage, insects, and environmental factors including drought, waterlogging, salt, frost and hail.

How the disease is spread

The single most important cause in the spread of *Phytophthora* appears to be through the transport of infested gravel, soil and plant material, which adheres to vehicles and heavy machinery. Such machinery is usually used in logging, firefighting, road construction and maintenance of roads and powerlines. A vehicle not cleaned after working in an infested area could easily spread the disease to another site many kilometres away. *Phytopthora* can also be spread in the following ways:

- through transport of soil and plant material adhering tobicycles, footwear, tools and camping equipment
- through water (as drain off, irrigation or moving ground water). *Phytopthora* will spread quickly downhill in surface and sub-surface water flows. If found along a watercourse, then surface water will most likely carry *Phytopthora* downstream into the catchment
- by transfer of infested gravel, soil, water or any other raw material
- from plant to plant through natural sub-surface root contact. The spread uphill and on flat ground is slower (approximately 1 metre per year) as it is confined to root contact from plant to plant
- by transferring infested plants to other sites
- by animals, particularly those with cloven hooves

Prevention of spread: Maintenance of vehicles and machinery

To prevent the spread of *Phytopthora* vehicles and machinery should be kept hygienically clean of soils which may be infected. A visual inspection should confirm that vehicles and machinery are free of clods of soil, slurry (water and soil mixture) and plant material. The cleaning procedure consists of two steps:

1. Dry brushing

    - Remove all soil and plant material with a hard brush or tool. Pay particular attention to wheels, mudflaps and undercarriage.

2. Disinfection

    - Disinfect vehicles (wheels, mudflaps and undercarriage in particular) and machinery with water containing a disinfectant until any remaining soil and mud is saturated.
    - Allow disinfectant to penetrate for 10 minutes.
    - Avoid recontaminating vehicles and machinery! The following disinfectants can be used:

A fungicide, such as **Phytoclean**®. Dilute 1 part in 50 parts water. **Sodium hypochlorite** (pool chlorine). Dilute 1 part in 1500 parts water.

Points to remember:

- Clean down on a hard, well-drained surface (such as an unsealed road) in high risk areas.
- Do not wash down with water only, as this will create a more suitable environment for infestation. Always use a disinfectant!
- Phytoclean® is preferred above sodium hypochlorite as it is a more effective disinfectant, as well as being biodegradable and noncorrosive.
- The use of a pressurised spray unit is preferred, as this will minimise the amount of water used.
- Do not drive through wash-down effluent.
- Do not allow mud and wash-down effluent to drain into bushland and surface waters such as rivers, creeks, reservoirs and dams.

Cleaning Footwear and Hand Tools

The fundamental hygiene principle to minimise the spread of *Phytopthora* is to keep footwear and hand tools hygienically clean and therefore free of *Phytopthora*. A hygiene kit should contain:

- hard brush
- bottle of disinfectant, such as methylated spirit (undiluted) or household bleach (dilute 1 part in 4 parts water)
- spray bottle

The cleaning procedure consists of two steps:

1. Dry brushing

Remove all soil and plant material from footwear and tools with the hard brush.

2. Disinfection

- Disinfect the entire sole of your footwear and tools using the spray bottle containing the disinfectant
- Allow the sole of the boot to dry for at least one minute
- Step forward to avoid recontamination of footwear
- Disinfect the hard brush!

Points to remember:

- Clean down on a hard, well-drained surface (such as an unsealed road) in high risk areas.
- Do not wash down with water only, as this will create a more suitable environment for infestation. Always use a disinfectant!
- Hand tools can also be disinfected by soaking for a few minutes in the bleach solution, then rinsing with distilled water and wiping dry with a clean paper towel. Clean down on a hard, well-drained surface.

Safety, Health and Welfare

Wear Personal Protective Equipment when handling or using disinfectants, wear, including gloves and safety goggles. All disinfectants are toxic to water organisms and extreme care must be taken in the use and disposal of undiluted, diluted and exhausted solutions. Remember to:

- re-use containers where possible. Undiluted disinfectants and used containers must be disposed of in an approved refuse disposal site. Triple rinse and crush used containers before disposal.

- dilute exhausted and diluted solutions an extra five times and spread over the ground a minimum of 50 metres away from surface waters. They may also be inactivated in a pit by addition of organic matter, such as sawdust, absorbing clay or paper.

11. GUIDELINES FOR PLANT PROPAGATION FOR REVEGETATION WORKS

This project is considered a rehabilitation effort to improve habitat quality within the Cooks River Cumberland Ironbark Forest. All disturbed soil is to be revegetated with appropriate species, i.e. trees, shrubs, groundcovers, sedges etc (appropriate species are provided in planting plans for each management zone). All revegetation works are to be conducted in accordance with current best practices. These include:

1) Collection of seed

a) Must be by appropriately qualified and licenced personnel

b) Must be local provenance seed stock (refer Florabank Guideline No.10)

c) Must be collected in a manner that maximises genetic quality of seeds (refer Florabank Guideline No.5)

d) No more than 20% of the fruit or 10% of plant material should be removed from one plant

2) Determining local provenance

a) Environmental conditions at the collection site should match the existing or desired environmental conditions at the proposed planting site

b) Consider the method is pollination and seed dispersal for the species concerned before deciding on local provenance boundaries (Figure 24).

c) While it is best to collect seed as locally as possible, care must be taken to maximise the genetic diversity of available seed stock to avoid problems associated with inbreeding

Collection Range					
Factors	Narrow		Intermediate		Regional
Pollination	self-pollinated	wind-pollinated	insect-pollinated	bird-pollinated	bat-pollinated
Seed dispersal	gravity			wind or water	bats and birds
Longevity	short-lived				long-lived
Extent	small number and small area				large number and large area
Density	low		medium		high
Fragmentation	low		medium		high

Figure 36. Collection ranges for determining local provenance areas (adapted from Florabank Guideline No.10).

3) Storage of seed

a) Seed must be stored appropriately (refer Florabank Guideline No.1)

b) Seed should be tested for viability before storage (refer Florabank Guideline No.8)

4) Propagation of plants

a) Plants should be propagated so that seedlings will be large enough to transplant onto site

b) Care should be taken that unexpected delays in construction do not cause seedlings to become root-bound

c) Propagation should be conducted in accordance with current best practices

5) References for plant propagation information:

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12. COMMUNITY CONSULTATION

Community consultation is an integral part of successful management of community land and reserves. Coxs Creek is located in a mixed residential commercial/industrial precinct with residents abutting the reserve on the eastern boundary. The reserve also has a rich history of volunteer bushcare. A list of approximately 100 stakeholders was provided by Strathfield Council and initial contact was made through email (Appendix A) asking for feedback and community aspirations for the reserve. An open invitation to a guided "walk and talk" through the reserve and to discuss the POM was held on Saturday the 22nd of August. Invitations (Appendix B) to this open day were sent via email and post. In addition, 75 adjoining properties were letterboxed. Nine community members attended the open day and shared their knowledge and anecdotes regarding the reserve.

Figure 37 Community day August 22nd 2009

13. FURTHER KEY RECOMMENDATIONS

- Improved linkages between the reserve and other GGBF populations in the Greenacre area be established. It is acknowledged that the constraints regarding improved linkages are many, however a feasibility study regarding the closure of Drone Street is recommended as a first stage in a linkages program.
- Partnership with Bankstown Council to improve biodiversity values on Roberts Road Reserve. This reserve could be managed to supplement the diversity of the EEC on Coxs Creek Reserve.
- Investigation of the use of roof water from adjacent commercial premises to provide a relatively clean source of water for supplementary frog ponds.

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15. LITERATURE REVIEW

REGIONAL PLANNING INSTRUMENTS

COOKS RIVER FORESHORES STRATEGIC PLAN (1997)

The Cooks River Foreshores Strategic Plan (1997) aimed to ensure that the river foreshores are managed in a coordinated manner. Foreshores are defined as the extent of land zoned open space either side of the river, although adjacent land use zoning and the wider influences of the total catchment on the foreshores integrity were considered essential components in the Plan.

Coxs Creek is a minor tributary of the Cooks River, thus the 'Strategic Plan' was relevant to the management of the reserve and its watercourse. Strathfield Municipal Council adopted the Foreshores Strategic Plan in August 1997. Some specific actions mentioned Coxs Creek but these tended to focus on the confluence with Cooks River and associated lands.

COOKS RIVER CATCHMENT MANAGEMENT STRATEGY (1999)

The aims of the 'Strategic Plan' (1999) were to enhance, conserve and protect the natural resources of the Cooks River Catchment (CRC) while considering the social and economic requirements of the community. The 'Strategic Plan' provided a single instrument for all members of CRC, as well as government bodies and other organisations which have control over aspects of the CRC. The Strategic Plan described goals for water, land and vegetation, biodiversity, cultural heritage and community education, and identified specific actions required to achieve sustainable management, and details on how to implement these actions.

The Cooks River Catchment Management Committee (CRCMC) now known as the Cooks River Foreshore Working Group (CRFWG) included representatives from environment and community groups and state and local government authorities. Their strategy sought to complement the existing comprehensive planning framework for the catchment, including the Cooks River Foreshores Strategic Plan 1997 and the Cooks River Stormwater Management Plan 1999. Catchment strategies provided a framework for fostering cooperation and coordination between landholders and other resource users, community groups, local government and state agencies. Some of the actions were achieved voluntarily, while other requirements needed to be actioned by the government bodies represented in the Committee.

COOKS RIVER STORMWATER MANAGEMENT PLAN (1999)

This Plan was a joint proposal from the 13 local councils of the CRC, working together with State authorities and the community. The Plan aimed to improve water quality and the health of the Cooks River by identifying practical and long-term solutions to stormwater problems. The restoration of the Cooks River required strategies that addressed the range of factors contributing to poor water quality and consequent poor river health. The Stormwater

Management Plan aimed to address issues specifically relating to stormwater, whilst working within the existing Catchment Management Framework.

STRATHFIELD ENVIRONMENTAL ACTION PLAN 1998-2001

The Environmental Action Plan is documented as an appendix to the 1998/1999 Strathfield State of the Environment Report. The Plan was adopted by Council on 9 February 1999, and is designed to give effect to the issues, goals and actions identified in Strathfield's State of the Environment Report. Key Issues applicable to Coxs Creek Reserve were:

- To develop comprehensive water monitoring program and effective data collection.
- To understand effective management of stormwater passing through the Reserve.
- To create an open space system that consists of a comprehensive network of natural areas and designed landscapes that will improve the health of ecosystems and human settlements.

GREEN WEB SYDNEY ACTION PLAN (GREEN WEB SYDNEY, 1996/2008)

Green Web Sydney aims to encourage the establishment of habitat corridors to link fragmented patches of bushland and facilitate the migration of wildlife and natural dispersal of native plants. Of equal importance, Green Web Sydney aims to highlight local government's role in biodiversity management and suggests actions and strategies that Sydney's local councils can adopt to protect and enhance these habitat corridors. The six long-term objectives of Green Web Sydney are to:

- Identify, protect and enhance biodiversity, environmental health, natural heritage and landscape amenity.
- Re-establish habitat by means of enhancing and creating sustainable ecological systems where the long-term survival of local species is guaranteed.
- Create bush corridors between core habitats for the movement of native animals and plant species.
- Protect habitat from degradation caused by inappropriate use, encroachment of invasive plants and predators. Encourage natural regeneration on public and private land with a particular focus on riverine environments, coastal foreshores and endangered species and ecological communities.
- Restore natural ecosystems to repair environmental degradation and to prevent increasing costs to the community by preventing further loss of natural systems, ecological processes and natural resources.

Preparation of a Plan of Management for Coxs Creek Reserve is the first step in the process of restoration for the site. Ideal outcomes from the project would be the development and implementation of strategies that bio-link the reserve with the wider landscape.

COOKS RIVER INTERPRETATION STRATEGY, 2008

The Cooks River Integrated Interpretation Strategy aims to provide direction for effective and engaging on and off-site interpretation of the values of the Cooks River. It includes the relevant resources available for interpreting the river and identifies relevant themes, audiences and gaps in the resources. It also provides interpretive objectives, key messages, techniques and recommendations to apply the interpretive strategies.

This Strategy is designed to be followed by site-specific interpretation planning involving the collaboration of community members and others with management responsibilities—particularly council's cultural and amenity planners, architects and landscape architects. Site-specific interpretation planning and content development will continue into the future. Suggestions and examples of strategic actions given in this plan would be ideally suited for use at the Coxs Creek Reserve, which falls into the Cooks River Catchment.

The Strategy addresses the diverse cultural mix of people that live in the areas adjacent to the Cooks River. It provides some broad direction for engaging the interest and support of subgroups within the wider population. Social research undertaken by the Department of Environment and Conservation suggests that people relate well to information provided by environmental groups, scientists and technical experts.

Like the immediate community at Coxs Creek Reserve, there is a high proportion of Culturally and Linguistically Diverse (CALD). They are best served, as are most people, by plain English media. NESB community members are likely to respond to interpretation provided in their own community languages, which might be made available through community newspapers and schools, or through specialist tours such as those occasionally delivered by expert guides

Another group of people who are likely visitors to the Reserve are classed as cultural tourists. These are people who enjoy visiting places with heritage values; they often enjoy a combination of natural and cultural heritage. They usually consist of small or large groups, and may include schools, clubs, or social groups. Their visits are planned and they arrive with an expectation to engage in an interpretive experience. They will respond well to engaging experiences with cohesive themes and creative interpretive media. They are likely to promote 'good' interpretation by word of mouth.

STATE OF THE ENVIRONMENT SUPPLEMENTARY REPORT, 2007-2008 (STRATHFIELD COUNCIL)

The Strathfield SOE Supplementary Report outlines the key threats and responses to some important reserves in the LGA. The local biodiversity of Strathfield is described as playing a vital role in contributing to local and regional ecosystems and human settlements. Natural areas such as Coxs Creek Reserve act as reminders of their natural heritage and support localised populations of plants and animals, including several endangered species that are threatened by the impacts of human settlement. Weeds and feral animals threaten natural areas by competing with local species for space, light and food. Various invasive species such as foxes, feral cats and weeds are recognized under the Threatened Species

Conservation Act 1995 as key threatening processes, and are direct threats to vulnerable, threatened and endangered species.

Coxs Creek Reserve is home to a number of vulnerable, threatened or endangered species of flora and fauna. A need was identified for site-specific threat abatement measures for *Wahlenbergia multicaulis* to be incorporated into the upcoming review of the Plan of Management for Coxs Creek Bushland Reserve. One of the main threats to the species is genetic swamping through hybridisation with other *Wahlenbergia* species. Other threats include habitat loss and habitat degradation.

Similarly, the Greenacre population of Green and Golden Bell Frogs (*Litoria aurea*) are listed as an endangered population under the Threatened Species Conservation Act 1995. The draft recovery plan for this species has been published and is to be implemented through the development of site specific management plans. The Draft Management Plan for the Green and Golden Bell Frog Key Population at Greenacre (DECC, 2007) details actions for stakeholders in the Greenacre area for the conservation of the Green and Golden Bell Frog. As part of the Green and Golden Bell Frog Community Awareness Project, frog tours are being conducted in Coxs Creek Bushland Reserve.

Requirements for both these species will be incorporated into the Plan of Management for the Coxs Creek Reserve.

MANAGEMENT OF COXS CREEK RESERVE

COXS CREEK ENVIRONMENTAL AREA PLAN OF MANAGEMENT (UBM, 1996)

The first Plan of Management for the site was prepared by Urban Bushland Management Consultants in 1996. Field investigations provided baseline information on native flora, and fauna, weed populations, condition of bushland and habitat, and water quality. With the help of the local community (Friends of Coxs Creek), a series of goals and objectives was developed, problems or constraints to effective management were identified and habitat requirements for a threatened species (*Litoria aurea* – Green and Golden Bell Frog) were determined. The POM (1996) recommended management strategies for habitat conservation and bushland rehabilitation, and included a five (5)-year program of works.

COXS CREEK ENVIRONMENTAL MANAGEMENT AREA PLAN OF MANAGEMENT (UBM CONSULTANTS, 2001)

The 1996 POM was superceded at the end of its five year life span by a second POM from Urban Bushland Management Consultants. This more comprehensive plan of management for the reserve also had a stated five year life span, and incorporated the following aims and objectives:

- To document the structure and floristics of the vegetation communities in Coxs Creek Reserve, and to report on the condition of the remnant bushland
- To identify major threats to the sustainability of the bushland
- To recommend appropriate strategies and actions to reduce threats to the sustainable management of the bushland
- To protect and enhance fauna habitat, in particular habitat for *Litoria aurea* (Green and Golden Bell Frog), an endangered species listed by the Threatened Species Act
- To provide a staged works-plan, with appropriate costing for the rehabilitation of high priority areas
- To identify ways to enhance community appreciation of, and participation in, bushland management activities

The resulting bushland management plan began by defining urban bushland. It developed site assessment guidelines, outlined bush regeneration methods, and detailed weed control methods. The relative merits of passive regeneration of bushland versus revegetation as restoration strategies were reviewed. The resultant Action Plan developed provided site-specific strategies and actions, including the identification of management zones and management issues. The recommendations of the NSW NPWS draft Recovery Plan for the endangered Cool River Clay Plain Scrub Forest (CRCPSF) provided the basis for management recommendations for the remnant at Coxs Creek Reserve. These recommendations included in situ conservation of known populations, amelioration of

threatening processes, ecological restoration and translocation where appropriate, underpinned by research and investigation. These recommendations were considered during the choice of appropriate rehabilitation strategies, including weed control, planting and landscaping, and monitoring and assessment strategies.

COXS CREEK CONSTRUCTED WETLANDS OPERATION AND MAINTENANCE MANUAL (AUSTRALIAN WETLANDS, 1999)

In 1999 Australian Wetlands designed a series of ponds to create habitat for the Green and Golden Bell Frog. These ponds are located in the southwest corner of the reserve adjacent to Coxs Creek. The wetland system consists of four basins. A concrete pit with a submersible pump and timer was fitted into Coxs Creek. Unfortunately this pump and timer were stolen shortly after installation, and not replaced. The original design aimed to pump base flows from the creek for treatment in the wetland system. Pumped water was to enter the system via a rising main fitted with a diversion pit to allocated water between the Frog Pond and Treatment Pond 1. The Frog Pond is approximately 1m deep, with deeper and shallower zones, surrounded by logs for habitat and stablised with geotextile at the outlet. No treatment of water quality occurs in the Frog Pond.

Pond 1 is a flat shallow wetland that was densely planted with emergent macrophyte species. Water is directed from this pond along a shallow rock lined channel to the Deep Pond. This Deep Pond is around 0.5m deep, with a flat base and steep sides. Edge planting with aquatic macrophytes has left an area of open water. The next pond is the second shallow pond (Pond 2), which was a natural wetland. Modifications to this pond included creation of an inflow channel from the Deep Pond, and a rock lined outlet channel to Coxs Creek. Pond 2 was weeded and replanted with emergent wetland species.

The original intention of this design has been negated by early vandalism in its lifespan. However, the ponds are holding water from storm events, and this is resulting in a series of temporary ponds of different depths and duration of wetting. The result has been a frog friendly habitat for Green and Golden Bell Frogs, who prefer temporary ponds and ponds with open water areas, surrounded by groundcover for protection during movement between ponds. Ponds contained many tadpoles during fieldwork conducted in July 2009.

BUSHLAND PLAN OF MANAGEMENT: RESERVES AT GREENACRE (BROMLEY RESERVE & ROBERTS ROAD RESERVE), 2005

Roberts Road Reserve forms an extension to the Coxs Creek Reserve, but lies in the neighbouring Bankstown LGA. It comprises a narrow strip of degraded bushland that surrounds two sides of the small goods storage warehouse next to Coxs Creek Reserve. There are no records of bushland restoration activities within the Roberts Road Reserve. Bankstown Council is planning campaigns for social change so that residents can value, care for and understand the bushland in their local area. To date, these campaigns have focused on improving stormwater quality but the new emphasis will be for residents to take ownership of their local public land. This will be in the context of the Biodiversity Strategy for Bankstown and the new Bushland Plan of Reserves at Greenacre. Roberts Road Reserve is currently regarded as a low priority area for works, however, an integrated program of works

in partnership with Strathfield Council would enable Banksrown Coucil to prioritise works in the adjacent Roberts Road Reserve (pers comm.Cameron Lownds, Bushland Officer Bankstown City Council).

THREATENED SPECIES AND ENDANGERED COMMUNITIES – SCIENTIFIC DETERMINATIONS

TADGELL'S BLUEBELL (*WAHLENBERGIA MULTICAULIS*) POPULATION IN THE AUBURN, BANKSTOWN, BAULKHAM HILLS, CANTERBURY, HORNSBY, PARRAMATTA AND STRATHFIELD LGAS (DECC, 2003; DEC, 2008)

The Scientific Committee made a Final Determination in December, 2003, to list the population of Tadgell's Bluebell *Wahlenbergia multicaulis* Benth., in the local government areas of Auburn, Bankstown, Baulkham Hills, Canterbury, Hornsby, Parramatta and Strathfield as an Endangered Population in Part 2 of Schedule 1 of the Threatened Species Conservation Act.

Habitat and ecology

- In Western Sydney most sites are closely aligned with the Villawood Soil Series, which is a poorly drained, yellow podsolic extensively permeated with fine, concretionary ironstone (laterite). However, the sites in Hornsby LGA are on the 'Hawkesbury' soil landscape.
- Found in disturbed sites and grows in a variety of habitats including forest, woodland, scrub, grassland and the edges of watercourses and wetlands. Typically occurs in damp, disturbed sites (with natural or human disturbance of various forms), typically amongst other herbs rather than in the open.
- In Hornsby LGA it occurs in or adjacent to sandstone gully forest. In Western Sydney it is found in remnants of Cooks River/ Castlereagh Ironbark Forest.
- Usually flowers throughout the year, although a late spring/early summer peak has been observed at some locations Creek.
- Usually a perennial, particularly in protected situations which provide greater protection during the summer months. However, in more exposed situations, the species may be more annual in its life cycle due to exposure and/or lack of soil moisture.
- Responds favourably to disturbance of soil in some situations with high exposure to sunlight. However, too much disturbance can eventually exhaust the seedbank and lead to local extinctions.

What needs to be done to recover this species?

- Prevent further loss, fragmentation and degradation of habitat.

- Removal of hybrids is not recommended at this stage as they contain genetic material of *W. multicaulis*. Sites with hybrids should be closely monitored and DECC should be consulted prior to undertaking any actions to remove hybrids.
- Prepare and implement Plans of Management or similar.

DOWNY WATTLE (ACACIA PUBESCENS), DEC 2005

Distribution

- Concentrated around the Bankstown-Fairfield-Rookwood area and the Pitt Town area, with outliers occurring at Barden Ridge, Oakdale and Mountain Lagoon.

Habitat and ecology

- Occurs on alluviums, shales and at the intergrades between shales and sandstones. The soils are characteristically gravely soils, often with ironstone.
- Occurs in open woodland and forest, in a variety of plant communities, including Cooks River/ Castlereagh Ironbark Forest, Shale/ Gravel Transition Forest and Cumberland Plain Woodland.
- Longevity is unknown, but clonal species have been known to survive for many decades.
- Flowers from August to October. Pollination of Acacia flowers is usually by insects and birds. The pods mature in October to December.
- Recruitment is more commonly from vegetative reproduction than from seedlings. The percentage of pod production and seed fall for this species appears to be low.
- Acacia species generally have high seed dormancy and long-lived persistent soil seedbanks. It is thought that the species needs a minimum fire free period of 5 - 7 years to allow an adequate seedbank to develop.

What needs to be done to recover this species

- Remove hybrids and protect known populations
- Investigate causes of disease
- Undertake studies into genetic variability
- Enhance existing habitat
- Encourage community involvement in the recovery of species, particularly in the implementation of threat and habitat management programs

- Provide advice and assistance to private landholders, to identify actual and potential threats and to negotiate the implementation of on ground works to reduce threats
- Identify sites that are a high priority to protect through land use planning mechanisms or conservation agreements.
- Monitor the reproductive status of populations
- Research other aspects of species including population dynamics, fire ecology, distribution

GREEN AND GOLDEN BELL FROG (LITORIA AUREA) THREATENED SPECIES DETERMINATION (DEC, 2000)

Habitat and ecology

- Inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typha* spp.) or spikerushes (*Eleocharis* spp.).
- Optimum habitat includes water-bodies that are unshaded, free of predatory fish such as Plague Minnow (*Gambusia holbrooki*), have a grassy area nearby and diurnal sheltering sites available.
- Some sites, particularly in the Greater Sydney region occur in highly disturbed areas.
- The species is active by day and usually breeds in summer when conditions are warm and wet.
- Males call while floating in water and females produce a raft of eggs that initially float before settling to the bottom, often amongst vegetation.
- Tadpoles feed on algae and other plant-matter; adults eat mainly insects, but also other frogs.
- Preyed upon by various wading birds and snakes.

What needs to be done to recover this species?

- Maintain captive bred populations for future possible re-introduction programs.
- Initiate community awareness programs that highlight the presence of populations and catchment management approaches to improving stormwater quality, habitat retention and management.
- Develop measures to control or eradicate the introduced Plague Minnow.
- Establish protocols for handling of frogs and educational strategies to minimise the inadvertent spread of fungal pathogens from site to site.
- Develop strategies to provide for the development or enhancement of frog habitat to improve reproductive success and recruitment at known sites.

- Develop site specific plans of management to improve conservation outcomes for targeted populations.
- Develop strategies to provide disease-free and fish-free breeding habitat.

COOKS RIVER/CASTLEREAGH IRONBARK FOREST IN THE SYDNEY BASIN BIOREGION - ENDANGERED ECOLOGICAL COMMUNITY LISTING (NSW SCIENTIFIC COMMITTEE DETERMINATION; DECC, 2002)

Cooks River/Castlereagh Ironbark Forest is predominantly of open-forest to low woodland structure usually with trees of *Eucalyptus fibrosa* and *Melaleuca decora*, sometimes with *Eucalyptus longifolia*. A relatively dense shrub stratum is typical, commonly with *Melaleuca nodosa* and *Lissanthe strigosa*, and to a lesser extent *Melaleuca decora*. A variety of shrub species may occur, including *Acacia pubescens*, *Dillwynia tenuifolia, Daviesia ulicifolia, Pultenaea villosa* and *Grevillea juniperina*. Commonly occurring species in the ground stratum include *Entolasia stricta, Lepidosperma laterale, Opercularia diphylla*, *Dianella revoluta, Themeda australis, Microlaena stipoides* and *Pratia purpurascens*.

Cooks River/Castlereagh Ironbark Forest usually occurs on clay soils on Tertiary alluvium, or on shale soils on Wianamatta Shale including the Birrong Soil Landscape and associated shale lowlands. Disturbed Cooks River/Castlereagh Ironbark Forest remnants are considered to form part of the community including remnants where the vegetation would respond to assisted natural regeneration such as where the natural soil and associated seedbank is still at least partially intact.

This vegetation community has been extensively cleared for urban and rural developments. About 7% of the original distribution is estimated to remain (DECC, 2002). There has been very extensive clearing and major fragmentation and isolation of remnants in the Canterbury-Auburn-Strathfield-Bankstown-Parramatta-Holroyd area. Much of the remaining area of Cooks River/Castlereagh Ironbark Forest elsewhere has been disturbed by clearing, tracks, weed invasion and soil disturbance. Continuing threats to the community include invasion by exotic species, illegal dumping, water pollution, unauthorised access, fragmentation and clearing for urban, rural-residential, recreational and industrial development. The eastern occurrences of this community, in the Canterbury-Auburn-Strathfield- Bankstown-Parramatta-Holroyd area, are currently listed as the Cooks River Clay Plain Scrub Forest Endangered Ecological Community.

THREATENED SPECIES AND OTHER FAUNA AT COXS CREEK

DRAFT MANAGEMENT PLAN FOR THE GREEN AND GOLDEN BELL FROG KEY POPULATION AT GREENACRE. (DEPARTMENT OF ENVIRONMENT AND CLIMATE CHANGE, 2007)

The Greenacre Management Plan relates to the Greenacre Key Population located in the Sydney Green and Golden Bell Frog (GGBF) Management Region as identified in the draft NSW GGBF Recovery Plan. The draft Recovery Plan calls for the preparation and implemention of a GGBF Management Plan for each key population on its own land, and to liaise with other landowners to prepare and implement site specific Management Plans across the extent of the species distribution in NSW. This plan should inform the Coxs Creek Reserve POM where it addresses GGBF issues. The Recovery Plan is intended to provide guidance, direction and coordination for other stakeholders, land owner/managers at Greenacre where the frog and/or its habitat occur.

The Greenacre GGBF Management Plan has been prepared to ensure that the Greenacre population is successfully managed and monitored such that the species continues to persist at the location and measures of the population's viability are maintained or improved over time.

There are two aims of the Management Plan.

1. To identify and, where possible, address the threats and other issues/factors affecting or likely to affect the conservation of the species at Greenacre.

2. To manage the species in accordance with the strategies outlined within the draft GGBF Recovery Plan.

The Greenacre GGBF Key Population is located eight kilometres west of the Sydney central business district in the upper parts of the Cooks River catchment. It consists of three population satellites, or sub-populations, at or around the following sites:

1. Juno Parade former brick pit site

2. Old Enfield Marshalling Yards

3. Coxs Creek Reserve

The Key Population incorporates the Cooks River and its tributaries and is included within Bankstown City and Strathfield Council Local Government Areas (LGA). The population is known to occur across residential areas where the species has been detected in frog friendly gardens between Coxs Creek Reserve and the former brick pit site at Greenacre. The site of the former sewage treatment plant (STP), now in part Coxs Creek Reserve, also provides GGBF habitat. The frogs also occur across the site of the former NSW Railways Enfield Marshalling Yards that are now divided up amongst a number of state government departments and private or semi-private enterprises.

The upper Cooks River catchment is a generally highly developed area with dense areas of residential and industrial land along with disused land now proposed for re-development. There are small areas with fragments of original vegetation intermingled with residential development and associated green areas. Only a few areas preserving the original vegetation remain, including the Coxs Creek Reserve. The bushland at the reserve is a mix of closed paperbark scrubland (*Melaleuca decora, Melaleuca stypheloides* and *Meleleuca nodosa*), rushland/sedgeland and (introduced) grassland. The GGBF population utilises these remnants and has survived in the area by using other local features such as:

• Breeding habitat e.g. in permanent water bodies such as the 'Frog Habitat Area' ponds on the former brick pit site and former 'FreightCorp' pond. More ephemeral breeding habitat that fills after heavy rain consists of ponds, drainage depressions, stormwater detention basins and culverts. Most of these habitat areas are human constructions made for purposes other than frog habitat. Such features are located within Coxs Creek Reserve and at a few locations along Cosgrove Road.

• Foraging habitat, including areas of native or introduced grasses, tussock vegetation and emergent sedges and reeds such as *Schoenoplectus validus*, *Gahnia spp*. and sparse *Typha orientalis* bordering water features. A Kikuyu grass (*Pennisetum clandestinum*) bank on the northern side of Coxs Creek has been identified as important foraging habitat and, in the absence of other extensive areas of foraging habitat, is likely to continue being an important foraging area for the local population. These areas are vital for the GGBF to feed in relative safety from predators and for basking in the sun by day.

• Shelter habitat, includes similar vegetation to that used for foraging and, most particularly, rock/brick piles, ground timber, tussock forming vegetation and other features that are difficult to categorise (e.g. crevices in the ground, around root systems of plants and under on-ground debris). Shelter habitat has been provided as part of the created habitat on the former brickpit site (Hannas development), although substantial areas of shelter habitat were removed by the infilling of the brickpit. Additional shelter habitat is also provided bordering the area.

• Movement habitat, generally typified by wet areas such as creeklines, canals, drains, periodically damp areas, connecting or partially connecting vegetation, gardens, easements, and even by open areas that do not restrict movement. Movement habitat is believed to be limited between sub-populations at Greenacre. Where the frogs do move between sub-populations, they generally do so along any open areas without traffic, such as stormwater drains, swales, easements, laneways, depressions and vegetated areas including parts of residential areas.

• Over wintering habitat. Some of this habitat is most likely similar to shelter habitat, such as rock and rubble piles, ground timbers and logs and dense tussock vegetation. Most shelter habitat is provided by embankment structures of the former 'FreightCorp' ponds and the boulder habitat areas created on the old brickpit site. There is evidence that males and females often differ in their selection of over wintering habitat and may seek to shelter in different areas, such as amongst boulders, inside logs or even amongst overgrown or dense and moist vegetation in residential gardens.

Conclusions from the studies in the area to date are that the Greenacre population is critically endangered. The Juno Parade brickpit site is vital to the ongoing survival of the species at Greenacre, and coordinated actions are required to maintain all the existing sites, establish additional habitat components and enhance existing habitat areas. Linkages between the various sites containing elements of the population must be established, maintained and strengthened.

The Greenacre GGBF population seems to be currently isolated from all other known Key Populations in the Sydney Region. Small remnant population size in association with its isolation makes the Greenacre population highly vulnerable to stochastic or catastrophic events. This makes insurance strategy considerations a high priority, including possible reintroduction and supplementation initiatives at a number of created and/or existing sites in the area, e.g. Chullora Wetlands, Coxs Creek Reserve and Rookwood Cemetery. Interconnections between Coxs creek Reserve and the Juno Parade site are more problematic.

Vacant land adjoining the Juno Parade site, on the Wentworth Street side of the property, would strategically link with Coxs Creek Reserve via Drone Street. Drone Street is a narrow low traffic road bordering the northern section of the intervening residential properties. This road has previously been considered for closure as a vehicular road and conversion to a passive 'greenspace' and landscaped walkway that would be conducive to frog movements between these two GGBF habitat nodes.

VERTEBRATE FAUNA STUDY, STRATHFIELD LOCAL GOVERNMENT AREA (AMBROSE ECOLOGICAL SERVICES), 2009

This recent report aimed to document the results of a vertebrate survey of public parks within the Strathfield LGA and to provide recommendations on future management of these parks as habitat for native fauna. This included Coxs Creek Reserve, where diurnal and nocturnal birds surveys were conducted, hair tubes set for small mammals, reptile funnels set, and dip nets used to sample pools in the main creek channel. Frog and tadpole surveys were conducted at the same time.

Twenty-seven (27) fauna species (six mammals, 16 birds, two reptiles and three frogs) were recorded in Coxs Creek Bushland Reserve. Of significance is the detection of three Green and Golden Bell Frog individuals in the Reserve during nocturnal surveys on 3 December 2008. No Green and Golden Bell Frogs were recorded on the site on 4 and 5 December 2008, suggesting that the individuals detected on 3 December were dispersing along Coxs Creek. The Coxs Creek Reserve population was previously believed to be locally extinct because they had not been detected there for at least three years, despite targeted surveys for them. While gudgeons were recorded on site in 1995, they were not recorded in this more recent survey.

Exotic mammal species (House Mouse, Black Rat, Dog and Cat) are the only ground-dwelling mammals recorded in the Reserve. One arboreal mammal (Common Brushtail Possum) and two insectivorous bats (Gould's Wattled Bat and Lesser Long-eared Bat) were recorded in the Reserve in December 2008. Birds detected were a mix of insectivorous species that favour a dense understorey (e.g. Superb Fairy-wren, White-browed Scrubwren

and Silvereye) and canopy forest and woodland species (e.g. Black-faced Cuckoo-shrike and Red Wattlebird). Bird species that forage in open habitats (e.g. Magpie-larks) occurred in the cleared perimeter areas of the Reserve.

General recommendations from the report included conserving biodiversity through protecting habitats, improving habitat values of existing reserves, and enhancing connectivity of bushland areas. To achieve this a number of more specific recommendations were made, included bush regeneration in reserves, controlled replanting, buffer planting of edge zones, targeted habitat creation (eg. wetlands, grasslands, tall heaths), control of domestic and feral animals , reduction in street and backyard lighting that impacts on reserves, use of compost heaps, fallen timber and rocks as habitat, accommodating frog habitat into stormwater management structures, and a community education campaign targeting care of bushland reserves. Further recommendations included the provision of artificial shelter sites (eg. possum and bird nesting boxes), regular surveys and establishment of a fauna database for the LGA's reserves.

BIRD COMMUNITIES AND HABITATS IN STRATHFIELD LOCAL GOVERNMENT AREA, 2007-2008 (INSIGHT ECOLOGY, 2008)

This study describes the bird community and habitats present in a range of greenspace types in Strathfield LGA. It discusses the contribution of greenspace types to bird habitat use, community structure and conservation in Strathfield. This is the first stage of a project that examines the role, function and performance of urban greenspace as key habitat for birds and for facilitating their movement across the local and regional landscape. Birds were selected because of their value as indicators of ecosystem health and function. Birds may also be the only connection with nature that many people have in highly urbanised environments.

Bush remnants, such as Coxs Creek Reserve, were generally small (0.5-1.65 ha), isolated remnants with ground cover, shrub layer and canopy layer habitats for insectivorous, nectarivorous and granivorous birds. Other habitats in bush remnants included grass swards and rushes growing in Coxs Creek and weedy areas at Weerona Road. Many occupied webs of the Golden Orb Weaving Spider *Nephila plumipes* were found in Coxs Creek Bushland Reserve, providing food for some bird species. There were very few tree hollows or standing dead trees (stags) in any of the remnants in the LGA. Coxs Creek Reserve contained stands of Paperbark *Melaleuca quinquenervia and M. decora* which provide key resources - invertebrate prey, nectar, bark, foliage and fallen debris – for insectivorous and nectarivorous birds.

This study concluded that the principles and practices of landscape ecology and biological conservation in highly fragmented urban environments need to be applied to improve the ecological function, structural complexity and floristic diversity of urban greenspace for birds in the study area. This includes the creation and maintenance of habitat connectivity across property, LGA, catchment and regional (landscape) scales, protection and restoration of habitat condition, improvement of structural and floristic diversity, mitigation of threats (including invasive and predatory species), and community education including promotion of small bird-friendly private garden management practices.

DEVELOPING A STRATEGY FOR PRIORITIZATION OF WETLAND REHABILITATION WORKS

A WETLAND PRIORITISATION TECHNIQUE FOR THE SMCMA AREA: SMCMA WETLAND MANAGEMENT STRATEGY (STAGE 1) (SCHAEPER ET AL, 2007)

This manual developed an assessment technique for prioritization of wetlands for rehabilitation as part of the Sydney Metropolitan CMA's Catchment Action Plan. The process began with mapping, or remapping, of the extent of wetlands in the SMCMA. A review of the methodologies from a range of sources that have been used to measure the wetland's existing condition was then completed. The assessment framework that was developed included the following steps:

1. Wetlands are ranked based on a set of values criteria.
2. Wetlands are ranked based on a set of threats criteria.
3. High condition wetlands were identified based on high values and low threats – this helped to prioritise the wetland for rehabilitation works.
4. Consideration was given to the representativeness of the wetland – poorly represented wetland types were given higher priority for rehabilitation works.
5. Projects were sought for priority wetlands, with preference given to works that protect, maintain and improve the condition of these wetlands.
6. Project feasibility was assessed based on biodiversity outcomes, value for money, longevity of benefits, and consistency with other projects in the catchment.
7. A project prioritization list was created based on feasibility and wetland priority, and used as a decision making tool for allocation of funding for rehabilitation works.

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

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