

Management Plan

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# The Green and Golden Bell Frog Key Population of the Lower Cooks River



August 2008

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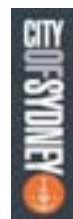
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**Cover photograph:** Aerial photo looking northwest over the lower Cooks River and Botany Bay.

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## Introduction

### The Green and Golden Bell Frog

The Green and Golden Bell Frog (GGBF) *Litoria aurea* is a large, muscular species with a robust form. Adult frogs range from approximately 45mm to 100mm, with most individuals being in the 60-80mm size class.

The colouration of the back is variable, ranging from a vivid pea green splotted with almost metallic brass brown or gold (Figure 1) to almost entirely green (Figure 2a), or having golden bronze markings that almost cover the whole back (Figure 2b).

Tadpoles of the species reach up to 35mm in length and, at that size, can be readily identified (Figure 3). Smaller tadpoles are more difficult to distinguish from the tadpoles of other species and identification may need to rely on mouth part features (for details, refer to Anstis, 2002).

The former distribution of the GGBF ranged from the NSW north coast near Brunswick Heads southwards along the NSW coast to Victoria, where it extended into East Gippsland and west to Bathurst, Tumut and the ACT. In the 1960s, the species was considered widespread, abundant and commonly encountered. Today, the species exists as a series of isolated populations within its former range (Figure 4).



**Figure 1:** *Green and Golden Bell Frog*  
Photo © Garry Daly

The GGBF is listed as 'endangered' under Schedule 1 of the NSW *Threatened Species Conservation Act 1995* (TSC Act), and 'vulnerable' under Schedule 1 Part 2 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. As a consequence of its status, a recovery plan has been prepared under the TSC Act, while under the NSW *Environmental Planning and Assessment Act 1979* (EPA Act) consideration of this species is required when assessing the impact of development and activities on populations of the species and its habitats.

The Green and Golden Bell Frog *Litoria aurea* (Lesson 1829) Recovery Plan (draft) defines key populations as conservation management units and lists 43 such populations in NSW. The actions within the Recovery Plan are also listed as actions within the NSW Department of Environment and Climate Change (DECC) Priorities Action Statement for amphibians found at:

[http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/pas\\_speciestype\\_details.aspx?type=Amphibians&kingdom=Animal](http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/pas_speciestype_details.aspx?type=Amphibians&kingdom=Animal)

a)



b)



**Figures 2a & 2b: Colour variants of the Green and Golden Bell Frog**

Photos © (a) Garry Daly (b) Dave Hunter



**Figure 3: Tadpole of the Green and Golden Bell Frog**

Photo © Mark Parsons

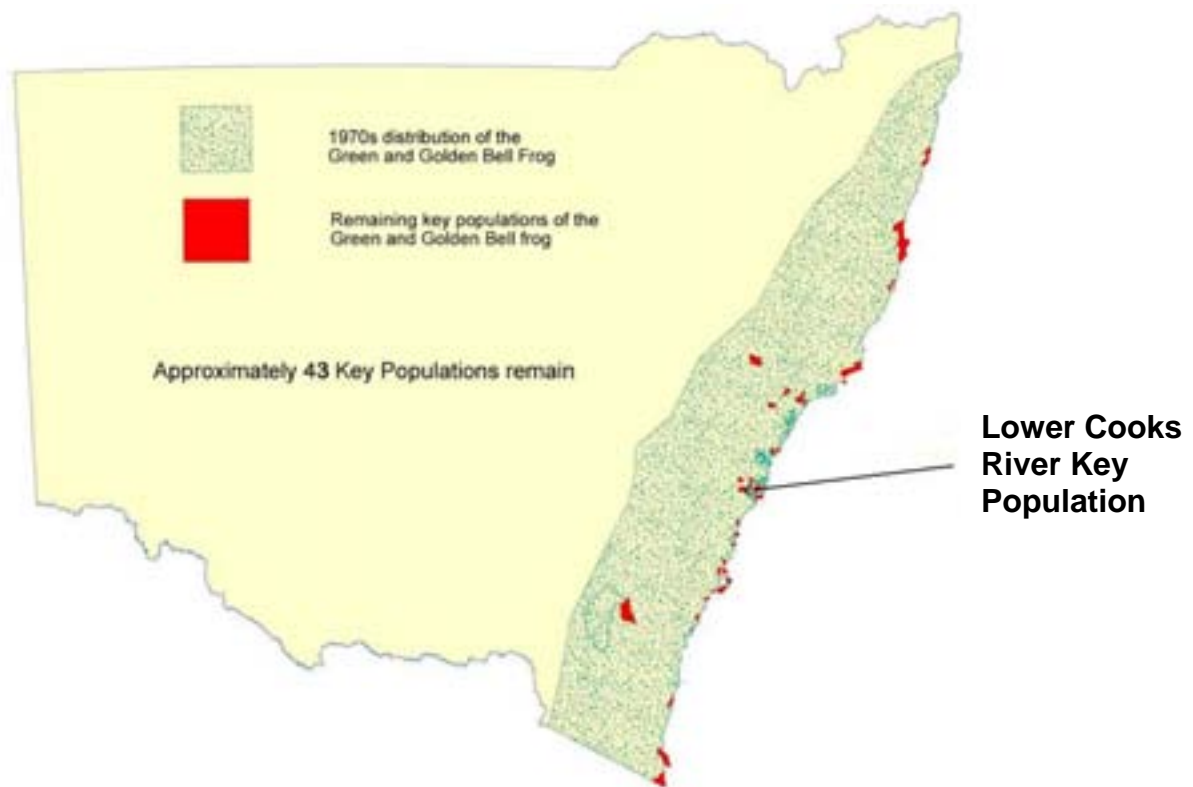
## The Lower Cooks River Management Plan

This Management Plan has been prepared to satisfy Action 11.3.4 of the Recovery Plan and Priority Action Statement (PAS) Action 21 for the GGBF. These require the DECC to prepare and implement a 'GGBF Management Plan' for each key population on DECC estate and to liaise with other public authorities (e.g. local councils, government departments) to encourage the preparation and implementation of a 'GGBF Management Plan' for key populations occurring on other public lands.

The Lower Cooks River GGBF Management Plan relates to the Arncliffe Key Population and the other population remnants (including at Rosebery) in the locality within the Sydney Green and Golden Bell Frog (GGBF) Management Region as identified in the draft NSW GGBF Recovery Plan. This Management Plan has been prepared to primarily ensure that the Arncliffe key 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. Other outlying population elements are also incorporated into the scope of this plan.

The purpose of this Management Plan is:

1. To identify and, where possible, address the threats and other issues/factors affecting or likely to affect the conservation of the species in the Lower Cooks River area.
2. To manage the species in accordance with the strategies outlined within the draft GGBF Recovery Plan.



**Figure 4:** *Previous and current distribution of the GGBF in NSW*

### **Management Objectives and Strategies**

The three objectives of the Lower Cooks River GGBF Management Plan are as follows:

1. To maintain the GGBF population and outliers;
2. Where possible enhance existing GGBF habitat and thus measures of population viability; and
3. To increase connectivity within and between sub-populations.

Given the precarious nature of the Rosebery GGBF population outlier, the strategy below is considered an urgent priority:

1. Develop an urgent conservation response strategy for the Rosebery GGBF outlier

The remaining six strategies will be used to achieve the objectives above:

2. Further development of GGBF breeding and other habitat components, where appropriate, on public and private lands;
3. Improvement of habitat within the GGBF key populations;
4. Education and communications to build awareness of the GGBFs and encourage further on-ground actions by community and other stakeholders;
5. Reduction of external threats to GGBFs;
6. Monitoring and research to better understand the extent and dynamics of the Lower Cooks River GGBF population; and
7. Coordination, communication and strategic funding opportunities sought between and by the various stakeholders, land managers and the community.

### Stakeholder Consultation

A stakeholder workshop was facilitated by consultants Molino Stewart Pty Ltd to identify the above initiatives and formulate other possible management initiatives as a basis for preparing this plan, and as an action of the draft GGBF Recovery Plan and PAS. The workshop was held on 29 June 2007 with representation from:

- Rockdale City Council (RCC)
- City of Sydney Council (CSC)
- City of Botany Bay Council (CBBC)
- Rockdale Wetlands Preservation Society (RWPS)
- Wolli Creek Preservation Society (WCPS)
- Sydney Airport Corporation (SAC)
- Sydney Water Corporation (SWC)
- The Roads and Traffic Authority (RTA)
- Biosphere Environmental Consultants Pty Ltd
- Boyd Cook Cove Pty Ltd (BCC)
- Cumberland Ecology Pty Ltd

A draft Plan was distributed to the above participants and the following additional stakeholders for comment:

Sydney Metropolitan Catchment Management Authority (SM CMA)	Commonwealth Department of Environment Water Resources, Heritage and Arts (DEWHA)
Randwick Council	Bardwell Valley Preservation Society
Canterbury City Council (CCC)	Kogarah Golf Club
Australian Wetlands Pty Limited	Taronga Zoo
Department of Transport and Regional Services (DOTAR)	Cooks River Foreshores Working Group
Meriton Apartments	East Lakes Golf Club
Australian Golf Club	Bardwell Valley Bushcare Group
Frog and Tadpole Study Group (FATS)	



## Plan Duration

The duration of this plan will be three years i.e. from September 2008 to August 2011. Following this, the outcomes will be reviewed and the Plan revised.

## Relationship with Other Plans

This Management Plan integrates with a number of the state-wide targets for natural resource management (NRM) set out as Priority E4 in the NSW Government's State Plan (2006), including:

- *By 2015 there is an increase in native vegetation extent and an improvement in native vegetation condition.*
- *By 2015 there is an increase in the number of sustainable populations of a range of native fauna species.*
- *By 2015 there is an increase in the recovery of threatened species, populations and ecological communities.*
- *By 2015 there is a reduction in the impact of invasive species.*

Similarly, the successful implementation of this Plan should contribute to a number of the Catchment Targets identified in the Sydney Metropolitan Catchment Management Authority (SMCMA) Catchment Action Plan (CAP) (draft as at 12/06/08). These include:

**Biodiversity:** Enhance ecological resilience and connectivity of bushland and aquatic habitats

- *CTB1 By 2016 the extent and condition of terrestrial native vegetation in all landscapes is maintained or improved.*
- *CTB3 By 2016 there is an increase in the connectivity of terrestrial native vegetation.*
- *CTB4 By 2016 aquatic and terrestrial threatened species and Endangered Ecological Communities (EECs) and populations are better conserved by implementing actions identified in the Priority Action Statements.*
- *CTB5 By 2016 the impact of terrestrial and aquatic invasive species on biodiversity is reduced by decreasing the number, distribution and impact of invasive weeds, pest animals and pathogens.*

**Water:** Enhance the positive connectivity of aquatic processes

- *CTW1 By 2016 there is a net improvement in the health of modified waterways and riparian corridors and conservation of natural waterways.*
- *CTW2 By 2016 there is an improvement in the condition and extent of wetlands.*
- *CTW3 By 2016 there is measurable progress towards achieving the Water Quality and River Flow Objectives adopted for each waterway.*

It is also appropriate that this management plan interlinks with the long term 'vision' of the Greenacre GGBF MP in the upper Cooks River. This vision, in essence, relates to support and promotion of initiatives that lead to enhanced habitat features along the length of the Cooks River corridor, and ultimately reconnection of upper and lower Cooks River GGBF populations.

There is also a requirement under the *Local Government Act 1993* for local councils to develop and implement Management Plans, where GGBFs occur on public land under their care, control and management. It is therefore envisaged that this

Management Plan will satisfy this possible requirement of Rockdale City Council (with respect to the Arncliffe key population components that may occur on public land in the Rockdale LGA as well as the less likely but possible need for similar requirements by Sydney, Botany Bay and Randwick LGAs). This Management Plan is also intended to provide guidance, direction and coordination for other stakeholders and/or land owner/managers as well as decision makers within the Arncliffe/Lower Cooks River area and its surrounds where the frog and/or its habitat is known or likely to occur.

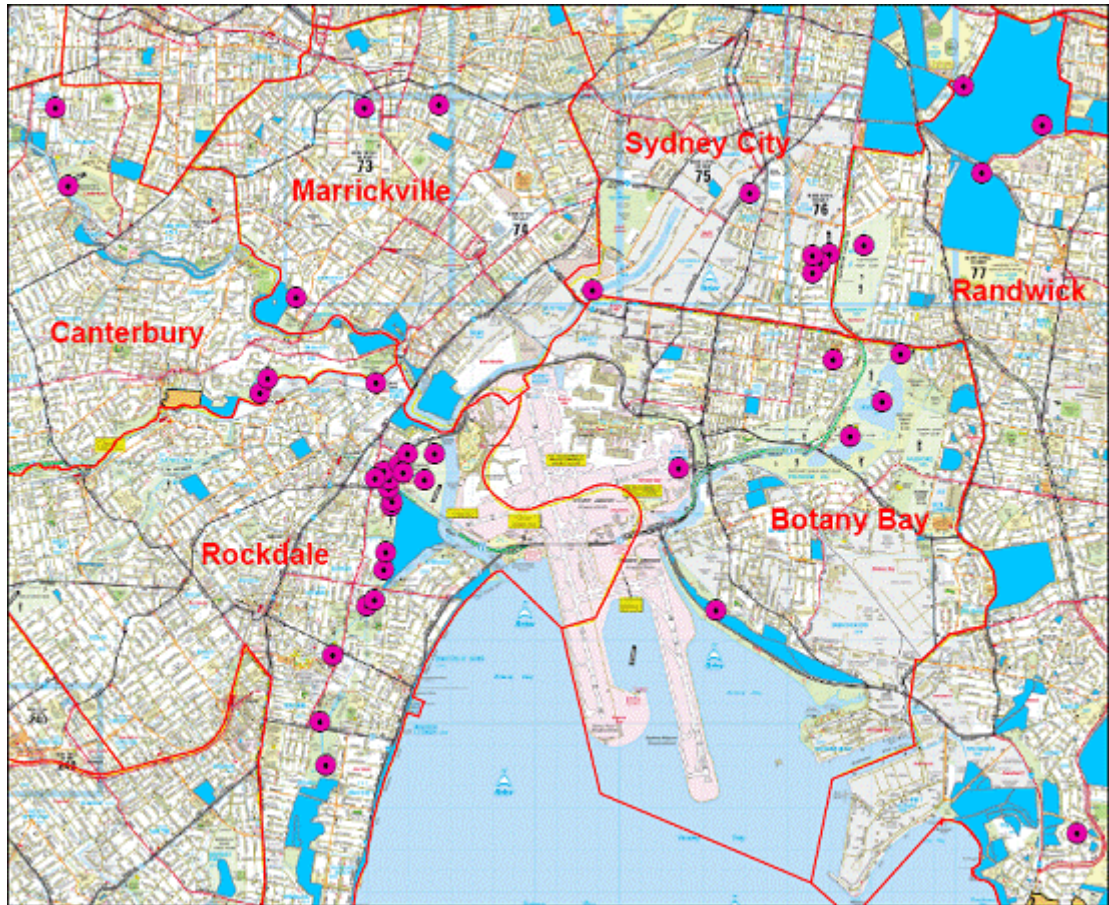
This Management Plan complements, supports, fulfils and links with aspects of the *Cooks River Foreshores Strategic Plan* (CRFSP), specifically, Objectives 3, 6, 8, 12 & 15 and Natural Conservation and Restoration Strategies 1, 2, 3, 4, 6 & 8. Similarly this Management Plan also complements the more strategic *Green Web Sydney Action Plan for Local Government* by fulfilling, complementing and supporting aspects of all of the Recommended Objectives of this initiative.

Additional special requirements also operate in relation to Commonwealth owned land. These requirements are triggered by the EPBC Act which stipulates the need for the Commonwealth to implement and be consistent with actions arising out of recovery and threat abatement plans that apply to Commonwealth owned land.

## Background

### Location

The Lower Cooks River Key Population is centred nine kilometres south southwest of the Sydney CBD (33° 56' 16 S, 151° 09' 16 E) in the Sydney Region of NSW. The key population resides in the vicinity of the lower Cooks River delta (see Figure 5) immediately to the west of Sydney's Kingsford Smith Airport. The key population consists of one main population in the vicinity of these wetlands at Arncliffe and an outlier element to the north in the vicinity of Rosebery.



**Figure 5: Map of the lower Cooks River**

This map shows the location of some of the recorded sightings of Green and Golden Bell Frogs (these records include both historic and contemporary observations from the 1970s to the present and are meant to provide an indicative distribution of the species and its habitat in the lower Cooks River) and the Local Government Areas (red) and location of Crown land (mauve shading)

This key population is identified as the 'Arncliffe' Key Population in the draft NSW GGBF Recovery Plan. The persistence of the nearby Rosebery population element and historic distribution of the species along various tributaries of the Cooks River catchment makes the 'Lower Cooks River' population a more appropriate name for this Management Plan (MP). The remaining population elements, in all likelihood, did interact at some previous time prior to total development of the area. Furthermore reintroduction sites at Marrickville and Sir Joseph Banks Reserve on the Botany Bay foreshore lends further support for the expanded scope of this MP. Thus, the key population will herein be referred to as the 'Lower Cooks River' population and includes the current and historic locations where the species occurred within the Lower Cooks River catchment.

The Lower Cooks River key population incorporates the lower Cooks River delta and associated wetlands along with the wetlands further to the east associated with the East Lakes and Botany Swamp area. Today the population is primarily situated in the Rockdale Local Government Area (LGA), though Canterbury, Botany Bay, Marrickville and Randwick LGAs either currently or in the past contained GGBF population elements. The GGBF population is currently spread across predominantly publicly-owned land (Council Reserves, RTA, Sydney Water and Sydney Airport Corporation), albeit a considerable portion of habitat and connecting space also

occurs on private land. No part of this key population's distribution falls within the bounds of secure protected land like a conservation reserve.

The various private and public entities that own, manage or have responsibility for land that either contains GGBF population elements or its current or former habitat and, therefore covered by this MP include:

- Rockdale City Council
- City of Botany Bay Council
- Sydney City Council
- Randwick Council
- Marrickville Council
- Canterbury Council
- Sydney Water Corporation
- NSW Roads and Traffic Authority (RTA)
- Kogarah Golf Club
- Kensington, Eastlakes and the Australian Golf Clubs
- Department of Lands (Crown Reserve)
- The Commonwealth of Australia
- Sydney Airport Corporation (SAC)
- NSW Department of Planning
- Centennial Park and Moore Park Trust
- Private residents
- Industry

## Habitat

The area in which current GGBF habitat occurs is largely land that has been modified or reclaimed. The original low lying land and swamps described by early explorers and settlers have been replaced with the current urbanised lower Cooks River. Prior to European settlement, freshwater and brackish swamps along with areas of mangroves and saltmarsh were predominating in the lower Cooks River. Almost undoubtedly the current GGBF distribution is a relict of the former pattern of wetland distribution.

Existing GGBF habitat is comprised largely of created or at least modified waterbodies that require ongoing active management. GGBFs inhabit the wetlands, waterbodies and ponds that are interspersed amongst green space (golf courses and playing fields), residential development and along major transport and infrastructure routes. There remains significant potential habitat associated with wetland areas throughout the lower Cooks River valley and Botany Wetlands. Some of these areas may no longer be suitable, probably due to their degraded or much-altered nature. These areas would require rehabilitation before recolonisation or reintroduction would be possible. The GGBF population utilises a mosaic of the remnants of past wetlands, waterbodies and drainage features that provide the various habitat components necessary for them to persist.

The remaining Lower Cooks River GGBF habitat description is expanded on below.

GGBFs have survived in the Lower Cooks River area by using various components of habitat available and specifically such local features as:

- Breeding habitat. In permanent to semi-permanent water bodies such as the RTA GGBF breeding ponds (these have been made semi ephemeral in nature because it is considered to be beneficial to the GGBF), water hazards on the Kogarah Golf Course and backyard pools/ponds at Rosebery, some of

which have been specifically revamped as GGBF habitat. These remaining known breeding habitat features are of human construction/modification.

The M5 East ponds were a specified requirement of the RTA development approval as compensation for lost/altered habitat in the Marsh Street and Eve Street wetland areas where GGBF had bred previously in stormwater detention structures.

At Rosebery the remnant GGBF population was found breeding in a pond on old industrial lands. This site was subsequently re-developed and the remnant population salvaged to Taronga Zoo and the habitat destroyed. However GGBF have persisted in nearby residential properties including in a disused swimming pool. These residents have been encouraged by the Frog and Tadpole Study group (FATS) to maintain the breeding habitat of the last of the wild Rosebery population.

Other ephemeral breeding habitat exists throughout the area when it fills temporarily after heavy rain. This might include golf course water hazards, ponds, drainage depressions, stormwater detention basins and culverts along with banded areas adjacent to road, rail and other infrastructure. No recent evidence is available to suggest these areas currently function as breeding habitat, though their habitat value remains. Such ephemeral swale habitat is at times indicated by sedge plant species such as *Juncus* spp., *Schoenoplectus* spp., *Isolepis* spp. and *Baumea* spp etc.

- **Foraging habitat.** Includes areas of native or introduced grasses, tussock vegetation and emergent sedges and reeds bordering water features. Examples of suitable foraging habitat are evident to the north of the South Western and Southern Ocean Outfall Sewer (SWSOOS), on the existing Kogarah Golf Course, and to the south in the remains of the Marsh St Wetlands. The drainage channel and reed beds that border the southern extremity of the golf course may also provide foraging habitat.

At Rosebery, some created foraging habitat exists around the GGBF breeding ponds and may also exist in surrounding allotments and other residential gardens. These areas are vital for the GGBF to feed in relative safety from predators and/or to bask in the sun by day. Golf courses in the vicinity of the Rosebery population element are also likely to possess foraging habitat.

- **Shelter habitat.** Includes similar vegetation to that used for foraging and also, most particularly, rock piles, ground timber, tussock forming vegetation and other features (that are difficult to categorise but include crevices in the ground, around root systems of plants and amongst other ground debris). Significant areas of shelter habitat in the form of rock piles can be found at the RTA GGBF breeding ponds, but may also be present elsewhere in the backyards of certain residences in Rosebery and Arncliffe.
- **Movement habitat.** Generally typified by wet areas such as creek lines, drains, stormwater canals, periodically damp areas, connecting or partially connecting vegetation, easements, laneways and even open areas that do not restrict movement.

Movement habitat was factored into the RTA's motorway construction in the form of a passage underneath the M5 to facilitate north south movement. However, this passage does not seem to be regularly utilized, with frogs purportedly using a cycleway further east to negotiate the M5 'migration barrier'. Fairways of the Kogarah Golf Course provide movement habitat between breeding grounds in the RTA GGBF ponds and foraging grounds and other habitat components within the golf course. No simple movement

habitat is likely to currently exist between Arncliffe and Rosebery, nor do any favourable corridors exist, other than open ground, linking Arncliffe with the habitat/population to the east of Kingsford-Smith Airport.

Drainage structures are likely to serve as important movement corridors between remnant populations and other remaining habitat components particularly to the south in Riverine Park, the 'Landing Light' wetland, Barton Park, Muddy Creek/canal and Scarborough Ponds. To the west Wolli Creek, Bardwell Creek and the Cooks River foreshore provide linkages and opportunities for habitat creation and enhancement. Areas of former wetland habitat and where habitat remnants still occur at Turrella Reserve may provide opportunities for enhancement works and possibly reintroductions. To the north connection is much more problematic with the intensity of existing development. However, opportunities could exist along Alexandra Canal (Shea's Creek), as its foreshore area undergoes stages of rehabilitation. Thus a tenuous connective thread to Rosebery along canals, drains, residences and industrial sites could be created or enhanced. Golf courses and reserves along with private land owners could also provide for further threads of connecting habitat in this northern part of its local extent including to the north at Centennial Park. Eastlakes and Botany Swamp are similarly isolated to the east by the airport but these areas are also undergoing rehabilitation so connectivity to these areas would also be a desirable target.

- Over wintering habitat. Some of this habitat is probably in common with shelter habitat such as rock and rubble piles, ground timbers and logs and in dense tussock vegetation. However, the sexes quite often differ in their selection of over wintering habitat and may seek to shelter in different areas and in less obvious locations such as amongst overgrown or dense and moist vegetation. In some residences at Rosebery this may even include gardens that are sympathetic to the frogs' requirements. Over wintering habitat such as rock piles and crevices are possibly sufficient at the RTA GGBF breeding ponds. The placement of further examples of this habitat component at strategic locations would be beneficial.

## Species Status

The Lower Cooks River (Arncliffe) Key Population is one of two key populations that fringe the shores of Botany Bay, and one of four that inhabit the south-eastern Sydney region.

The species was once very widespread and abundant in the Sydney Region inhabiting the various coastal wetlands of the Botany Bay catchment including the Cooks River, Georges River as well as those associated with the Parramatta and Hawkesbury Nepean drainages. This former distribution of GGBFs has contracted to only eight known locations identified in the draft GGBF Recovery Plan as key populations in the Sydney Region. These populations are located at:

- Homebush Bay/Sydney Olympic Park;
- Kurnell;
- Greenacre (Upper Cooks River);
- Clyde/Rosehill (Parramatta River);
- Merrylands (Parramatta River);
- Arncliffe/Lower Cooks River (the focus of this plan);
- St Marys/Mt Druitt/Riverstone; and
- Hammondville (Georges River).

The GGBF is considered to have been a common feature of the numerous swamps and wetlands associated with the Cooks River. However, the first official records of

the population exist only as recently as the 1940s. Ironically, the GGBFs past abundance is likely to have resulted in many GGBF sightings and interactions that were not recorded prior to the 1940s. In fact even though many observations were recorded in the 1960s and 1970s many more were still not documented due to the species commonness. Nevertheless the species was observed inhabiting the remnant wetlands, canals, ponds and water-holding structures associated with, the then, numerous market gardens around Rockdale and Arncliffe.

Wetlands associated with Shea's Creek (Alexandra Canal), Centennial Park and Scarborough Ponds were also previously GGBF habitat. GGBFs were known to inhabit the extensive Botany Swamps (Eastlakes) in large numbers in the 1960s. But by the mid-1970s, the GGBF had declined in abundance at Eastlakes, and also disappeared from the upper Lachlan Swamps at Centennial Park. Importantly, some of these areas of former habitat may still retain this suitability given some GGBF specific remediation and threat control.

Prior to the large scale urban development and the concreting of the original Cooks River delta, and subsequent diversion of its course, the GGBF population elements along the lower Cooks River, lower parts of Wolli Creek, Scarborough Ponds, Eastlakes, airport wetlands and Rosebery all likely interacted to some extent to form a large relatively contiguous population. This likely interaction is assumed based on both recent GGBF distribution in the area and the previous drainage patterns that would have facilitated GGBF movement. Scientific studies, such as detailed DNA analyses of remnant elements which might validate this assumed interaction, are currently unavailable.

The Rosebery component first brought the lower Cooks River population into prominence following its listing as threatened under interim Endangered Fauna (EFIP Act) legislation in 1991. A proposed development at Dalmeny Street by Meriton Apartments resulted in the then National Parks and Wildlife Service (NPWS) licensing a number of actions. These included the salvaging of the remaining individuals and establishing the first captive breeding colony of the species at Taronga Zoo and subsequently the destruction of the habitat and re-development of the Dalmeny Avenue site. At the time, the NPWS, with input from other experts, concluded that the Rosebery population was unlikely to be viable long term and should be salvaged. However, occasional individuals continued to be reported from various residential properties in the area for some time.

Then in about 1997 a small population of approximately 20 to 30 adults was detected south of Rosebery inhabiting a Marsh Street stormwater detention basin. This observation was made during assessments commissioned by the RTA for the M5 East motorway construction. Two new GGBF breeding ponds created as compensatory habitat for removal of GGBF habitat by the motorway's construction saw rapid colonization by the GGBFs. Supplementation from an Arncliffe provenance, captive bred stock, at Taronga Zoo assisted in the colonization of this new habitat. Regular GGBF monitoring of the ponds, the Marsh Street Wetlands and Kogarah Golf Course has revealed a generally larger resident GGBF population than before the motorways construction. In 2006, an estimated 80 individuals comprised the Arncliffe GGBF population, or at least that part which was monitored. The ongoing active management and monitoring of the GGBF at this site offers some hope for the population's ongoing viability at this critical location.

Most recently, further Rosebery sightings have led to the detection of a persisting element of this population inhabiting a degraded above ground pool in the backyard of a residence in close proximity to the original 'wild' Rosebery population (Meriton Apartments site). With some rehabilitation efforts conducted by Frog and Tadpole Study Group (FATS) members the residential property now has a series of GGBF

ponds and boggy foraging/shelter habitat. FATS have estimated the adult GGBF population to be under 20 individuals. Upon full establishment of this habitat in the breeding season of 2005-06, the pond housed large numbers of tadpoles and metamorphlings some of which may have recruited. Current estimates of the resident population's size are unknown but the viability is likely to be tenuous. Several other residences have also reported GGBFs in their backyard and this seems to suggest that the surrounding allotments are fulfilling other habitat components such as foraging and sheltering requirements. A full resident survey in this area of Rosebery is warranted.

The GGBF is also known to have historically and subsequently on occasion, inhabited several wetlands further south of the Marsh Street wetlands. The saline influenced Eve Street Wetlands are known to infrequently function as GGBF habitat, and presumably do so to this day, though recent surveys conducted by consultants have recorded no GGBF presence at this wetland. The Spring Street and 'Landing Light' wetlands further south, and Scarborough Ponds south to the vicinity of Ida Street, Sans Souci were known to have resident GGBFs in the early 1990s. Scarborough Ponds are a low lying 'sink' area with little change in relief. Ramsgate Road today forms the 'watershed' for the system with 'drainage' north and south from here respectively. This 'technical' boundary does not negate the likely historic interconnection and former distributional extent of this population. Records from around the Sandringham and Dolls Point Creeks (drains) near Ida Street indicate that the area has habitat value even though today, the GGBFs appear to have ceased occupying this poorly drained area. The species is currently assumed to be locally extinct at this southern extent of its former local distribution.

The GGBF also appeared at Orica's Southland site at Matraville in 1992 (unconfirmed) and again in 1997. The confirmed sighting in 1997 identified five juvenile GGBFs found in an ephemeral puddle on the site. Further surveys have been unable to locate the source population or any other individuals. This observation and that of a 2007 GGBF record at Sir Joseph Banks Reserve suggest either some vestiges of the former GGBF population in Botany/Lachlan Swamps may still survive to this day or that reintroduction efforts at Sir Joseph Banks Reserve may have resulted in some recruitment and dispersal.

Historical records of the GGBF also exist in the Wolli Creek valley near Turrella Reserve and were most likely associated with the previous wetlands there. No recent sightings have been recorded and so it is assumed that the GGBF has also disappeared from the Wolli Creek and Bardwell Creek valleys. While there may be no recent records along Wolli Creek, the history of the Rosebery and Sir Joseph Banks Reserve populations suggest that continued presence along Wolli Creek and its tributaries cannot be ruled out in the absence of ongoing targeted surveys. Future natural recolonisation, although unlikely, may be possible and assisted recolonisation through translocation to the Wolli Creek valley may be a consideration arising out of this management plan in consultation with the DECC.

## **Captive Breeding and Reintroduction**

Taronga Zoo has housed Green and Golden Bell Frogs from several provenances in support of reintroduction/supplementation trials. These have included the initial Dalmeny Avenue, Rosebery stock in the early 1990s and were followed by the Marsh Street, Arncliffe stock in the late 1990s. The Rosebery source stock were utilised to found the first captive breeding program to supply translocation/reintroduction trials at three sites (Sir Joseph Banks Reserve, Botany, Long Reef Golf Course, Collaroy and Marrickville Community Nursery, Addison Road). The Arncliffe founded captive stock was then used to supplement the existing population breeding efforts at the then newly created RTA GGBF ponds.



The attempts to establish wild GGBF populations at sites where there was no surviving residual population have all appeared to fail in the sense that a self sustaining population has not become re-established. However, sporadic observations from the eastern side of Kingsford Smith Airport could indicate a few individuals still persist from the Sir Joseph Banks Reserve reintroduction. Currently, only three individuals from the Rosebery source population remain at Taronga Zoo. A further 25 Arncliffe provenance GGBFs (some of which are original wild stock) comprise another of the three provenances of captive GGBF held at Taronga. Future captive breeding efforts from the Arncliffe stock may be a required outcome of a supplementation offset for potential impacts from future development proposals for the Arncliffe area.

A thorough genetic reappraisal of Rosebery and Arncliffe stock is required to resolve the captive management issue of outcrossing across provenances.

## Threat Assessment

The major factors that threaten the Lower Cooks River (Arncliffe) GGBF Key Population are loss of habitat, disease, predation by introduced pests, habitat degradation, and poor water quality.

1. Loss of habitat. The removal of foraging habitat, and some of the breeding habitat on Kogarah Golf Course poses a potential threat to this Key Population. *Sydney Regional Environment Plan (SREP) 33* was a negotiated outcome between Sydney Harbour Foreshore Authority and the then Planning NSW and NSW NPWS. A comprehensive GGBF Plan of Management has been formulated for the Cooks Cove Development as a requirement of the SREP 33. This PoM does provide a considerable number of initiatives intended to assist the local GGBF key population. It includes the creation of several more compensatory GGBF breeding and foraging areas across the new golf course. There can be significant difficulties in creating habitat that successfully lures individuals to it and then maintains its various habitat functions permanently.

The proposed F6 Freeway construction has the potential to impact on the conservation efforts for the GGBF at Arncliffe. This includes the extensive efforts undertaken by the RTA at the M5 East ponds site as well as any others initiated as part of the Cooks Cove and Kogarah Golf Course relocation proposals.

The Rosebery outlier population component has very tenuous security over remaining habitat. Supportive local residents and other private landowners will be essential for this population element to survive long term and could be greatly assisted via participation in initiatives by nearby golf course organizations.

2. Introduced Predators. These may prey on GGBF eggs, tadpoles or adults and include:
  - The Plague Minnow (*Gambusia holbrooki*) listed as a Key Threatening Process (KTP) and is present in most permanent water bodies inhabited by the GGBF on the lower Cooks River.
  - Carp (*Cyprinus carpio*) present in various waterbodies especially the Botany Wetlands.
  - The Red Fox (*Vulpes vulpes*) listed as a Key Threatening Process for a number of threatened species and is known to the area covered in this plan.
  - Feral and Domestic Cats (*Felis catus*)

All matters relating to pest animal control should be actioned and coordinated through the Southern Sydney Region Feral Animal Management Committee (SSRFAMC) and its ongoing initiatives.

3. Frog Chytrid Disease (*Batrachochytrium dendrobatidis*). This frog fungal disease is listed as a Key Threatening Process at state and national levels and is rapidly emerging as possibly the single biggest threat to the species (as well as for many other frog species). Frog chytrid fungus is possibly responsible for the failure of the Botany, Marrickville and a number of other GGBF reintroduction trials. Further investigation of frog chytrid to frog interactions in contaminated or saline influenced 'fields' should be encouraged/supported. The fact that the GGBF population continues to persist at Kogarah Golf Course in the vicinity of contaminated deposits lends further support for the need for these investigations into pathogen attenuation as an influence on frog survival. See Appendix 1: Frog Hygiene Protocol for advice on preventing the spread of this disease.
4. Habitat degradation. This includes weed invasion or general vegetation overgrowth in foraging and breeding areas. Vegetation overgrowth in artificial habitat ponds can reduce the habitat value of the ponds by reducing open water areas. Lack of water as a result of drought or imperfect artificial habitat construction (e.g. leakage through pond liners) can also result in habitat degradation or failure. Alternative water sources (bore/tank) are an ideal contingency component consideration for any created habitat initiative.

The RTA is currently required to manage the RTA GGBF breeding ponds, but is interested in transferring ownership and management obligations for these ponds to other stakeholders. Any such change may result in the loss of existing stringent monitoring and management requirements and would need to be a consideration in approval of such ownership/responsibility transfer.

5. Water quality. Marsh Street Wetland receives urban runoff which potentially contains pollutants, excess sediment and high nutrient loads. This situation did persist in the 1990s and before this, when the area acted as a refuge for GGBFs, prior to the construction of the RTA breeding ponds. The use of chemicals (herbicide, insecticide and fertiliser) on public reserves and golf courses may also influence the presence and movement of the GGBF, threatening foraging and breeding habitat. The use of chemicals on the proposed/relocated and adjacent Kogarah Golf Course (KGC) must adhere to environmentally responsible management practices, including but not limited to those as outlined in the KGC (Preliminary) Golf Course Maintenance Manual.
6. Native predators. These are particularly a threat where GGBF populations have declined to small size and are no longer robust. Native predators may include Eels (*Anguilla* spp.), Red-bellied Black Snake (*Pseudechis porphyriacus*), and the Australian White Ibis (*Threskiornis molucca*), and potentially the Silver Gull (*Larus novaehollandiae*), along with other wader bird and snake species that may occur within the region.
7. Anthropogenic climate change (listed as a Key Threatening Process) may result in changes to rainfall patterns and ultimately sea level changes that could affect the breeding habitat of the GGBF, in particular the presence of ephemeral ponds and the extent of wetland areas. The impact on reduced recruitment may lead to population decline or collapse at some sites, especially where populations are represented only by mature adults due to previous repeated breeding failures. Senescent populations may be unable

to recover even if or when conditions do become suitable. Additionally, attempts to manage the impacts associated with sea level rise so that they have a minimised impact on humans could have an adverse affect on GGBF within areas of the Marsh Street wetlands that might, as a consequence, experience increasing saline inundation.

8. Fire and fire management has the potential to adversely impact frogs through the destruction of vegetation used for refuge, foraging or as shelter habitat. In conducting fire management practices, efforts should be made to restrict burning in low lying areas and wetlands predominated by sedge and emergent macrophyte growth. These areas form important shelter and foraging habitat for the GGBF and generally pose a limited fire risk anyway. The use of chemical fire suppressants may also have negative impacts on the GGBF, and their use should be avoided in the vicinity of known or potential breeding sites.

## Past and Current Management

This Management Plan builds upon a range of past and current actions to manage the species in the lower Cooks River area. Past efforts at managing the species on private land has largely been development driven and lacking coordination and integration with other similar actions. This plan aims to overcome this situation.

Past management actions along with other measures undertaken for GGBF include:

- An assessment for the development of a site in Dalmeny Street Rosebery around 1992-3 by Meriton Apartments was subject to the *Endangered Fauna (Interim Protection) Act 1991*, which preceded the *TSC Act*. Approvals were given and licences were issued for the salvage and captive breeding of the Rosebery population. Funding commitments were not forthcoming and the reintroductions were largely conducted via voluntary efforts by Dr. Arthur White and Dr. Graham Pyke and later by Taronga Zoo education staff. The frequency of the monitoring of the frog ponds waned as funding came to an end and failure to detect recruited GGBF occurred over the ensuing period. Unconfirmed occasional occurrences may indicate the species persists in very low numbers but the Sir Joseph Banks Reserve site is currently not considered viably extant.
- In 1996, an Environmental Impact Statement (EIS) was prepared for the M5 East Motorway where it traversed the Marsh Street wetland. The EIS included a Species Impact Statement for the GGBF. This document indicated that there would be significant impacts on the GGBF at the existing Marsh Street Wetlands, and that the implementation of ameliorative measures would be required to protect the species in the area. Long term management of the Marsh Street wetlands however is problematic and a guarantee of future management must be given a high priority.
- The RTA funded the preparation of a GGBF management plan by Dr Arthur White. This plan was finalised in 1998 to guide GGBF management during activities that might have affected the population both during and after construction of the motorway. The plan also detailed the need for establishment of a captive-breeding colony (as an insurance policy) and the maintenance/monitoring of the habitat by a management committee.
- The RTA created two GGBF breeding ponds on the north side of the motorway and SWSOOS in 1999. Ponds were constructed with associated foraging and shelter habitat planted, along with rock piles to provide over wintering habitat. The habitat has been actively managed by the RTA under

direction of Dr Arthur White, who has also overseen several working bees that undertook weed and macrophyte control. The earlier (Rosebery provenance) captive breeding program at Taronga Zoo was extended to accommodate the Arncliffe provenance specimens. As described above, the Rosebery captive bred stock were previously utilised in various reintroduction experiments and Arncliffe provenance captive bred stock have been used in supplementation initiatives at the M5 East RTA ponds.

- Most recently the City of Sydney Council has funded habitat rehabilitation works to be undertaken by the FATS group in the backyard of a Rosebery resident where the Rosebery population has been re-detected. The created habitat consists of a series of three small ponds of varying depths, with some auxiliary foraging and shelter habitat provided by floating plants and boggy garden features.
- As part of the development consent for the development of Kogarah Golf Course and surrounding lands, Boyd Cook Cove and Cooks Cove Development Corporation engaged environmental consultants *Cumberland Ecology* to formulate a Green and Golden Bell Frog Plan of Management (PoM) as part of the Regional Environment Plan for defining development potential for the site. The PoM guides the management required for GGBF and their habitat prior to, during and following the construction process of the Cooks Cove development. The Cooks Cove PoM must effectively interlink with rather than compromise this management plan.
- From 1998 to 2003, Taronga Zoo developed and implemented a program that aimed to educate the community on the importance of frog conservation and biodiversity generally. This program also aimed to collect species data and improve habitat for frogs generally. Following the earlier GGBF reintroductions and habitat creation/enhancement activities at Sir Joseph Banks Reserve, The City of Botany Bay Council, local schools and a community group participated in the GGBF reintroduction program at Botany as part of 'Frog Focus Botany' activities. The second phase of this project was sponsored by the Australian Stock Exchange (ASX Frog Focus) and involved the national delivery of frog conservation education on the internet and via educational CD-ROM circulation.
- The Sydney Airport Corporation (SAC) leases and has management responsibility for the Commonwealth land comprising Kingsford Smith Airport and several other strategically located surrounding land parcels. This land includes the Engine and Mill Ponds (historical GGBF habitat) at the western extremity of the Botany/Lachlan Wetlands, which is managed together with the Botany Bay Steering Committee. Current management of wetlands has resulted in riparian vegetation augmentation and aquatic habitat restoration of 5000 square metres of wetlands. In addition, a weed eradication program for the Engine Ponds and periodic feral animal control is also conducted. Other land managed by SAC includes land to the west of the airport including parts of the existing Kogarah Public Golf Course and adjacent wetlands implicated in the Cooks Cove development proposal. SAC also maintains a large mosaic tile 'sculpture' of the GGBF in the departure area at Sydney airport. This 'statue' provides a good community education opportunity regarding the local plight of the frog and could perhaps be better utilised as part of other educative initiatives.
- Sydney Water Corporation, as the owner and manager of the majority of Botany Wetlands, has formulated and is currently implementing its Botany Wetlands Plan of Management (BW PoM). The management actions are

planned and implemented under the coordination of the multi-stakeholder Botany Wetlands Environmental Management Steering Committee and have been designed with a vision for future GGBF colonisation. Litter and sediment control, algae and nutrient management, weed and pest management, and vegetation rehabilitation, as guided by this BW PoM, has seen improvement in the water quality of Botany Swamps and the habitats available for amphibians. These areas provide significant opportunities for specific GGBF initiatives and possibly reintroduction. The Eve Street Wetland is also managed by Sydney Water under a separate PoM (due for review by mid 2008). Similarly to Botany Wetlands, management actions are planned and implemented in a way that is sympathetic to GGBF recolonisation. Additionally, frog surveys are conducted annually throughout the section of Botany Wetlands owned by Sydney Water and, after review of the Eve Street wetland PoM, may be expanded to also include this wetland area.

## **Arncliffe**

The Lower Cooks River GGBF population component at Arncliffe is likely to be isolated from other known GGBF Key Populations in the Sydney Region. Historically, the Arncliffe population was most likely connected to populations fringing Botany Bay and along the Cooks and Georges Rivers and further east and north-east to include the Lachlan/Botany Swamp areas. Today, the interconnection of the Arncliffe population and the Rosebery outlier is restricted by the intervening area of dense urbanisation and the loss of most of the connecting wetland habitat along Shea's Creek (Alexandra Canal) and the Cooks River delta.

The Cooks Cove development covers an area extending from Kogarah Golf Course in the north to Bestic Street and Muddy Creek in the south, excluding the M5 East, SWSOOS and Marsh and Eve Street Wetlands. This area includes large sections of existing and previous habitat area. The Plan of Management for this development states that the functionality of the proposed GGBF ponds and habitat will be monitored through tadpole searches over successive breeding seasons. The compensatory habitat proposed will be the key to the long-term survival of this population and such monitoring will thus be of high importance. However, the monitoring is proposed for the period after project completion and is based on the assumption that constructed habitat will have functionality. The current PoM does not outline any measures should the new habitats prove to be unsuccessful in the long term and/or not be adaptively and actively managed into the future. This should be addressed before existing habitat will be destroyed.

The Cooks Cove PoM relies heavily on the release of captive bred tadpoles or spawn into the newly developed ponds. At other locations, such a release has so far only been successful where natural colonisation has also occurred in tandem. It will thus be important to allow free movement of the existing frogs in the area. Care must thus be taken where wetlands are to be fenced to prevent frogs from entering the development sites as this will also stop the frogs from leaving these areas (e.g along the boundary between the Eve and Marsh Street wetlands).

The long-term survival of this key population is also dependent on the continued active and adaptive management of the whole area as a habitat mosaic into the future. This management will need to include the proposed offset habitat and be coordinated with the already created RTA breeding pond habitat, along with maintained connectivity between all habitat elements. The management of indirect impacts and other threats such as runoff, weed dispersal and chemical use will also need to be addressed. Some of these issues have been addressed within a Kogarah Golf Club, Golf Course Maintenance Manual which deals with chemical use and application in the vicinity of GGBF conservation habitat. This manual also outlines

the need for staff training to ensure correct implementation of the maintenance manual.

A commitment to long term monitoring and adaptive management should also be a component of the ongoing active management of any created habitat that may eventually be required perhaps in perpetuity. Monitoring and reporting of monitoring outcomes should also be publicly reported. Consequently the Cooks Cove SREP PoM should be refined/revised to align it with this plan and the final outcome of the Cooks Cove Development. Additionally, it will be important that management actions and monitoring are carried out with an adaptive response framework in accordance with this plan.

## **Rosebery**

The precarious Rosebery population element was licensed in the early 1990s by the then National Parks and Wildlife Service (NPWS) for 'salvage' as part of development consent. Due to the poor quality of existing habitat and its isolated nature, there was little hope for the long term viability of this local population element. The salvaged individuals were relocated to Taronga Zoo for captive breeding and reintroduction of the species to suitable habitat areas elsewhere around Sydney where the frogs had once occurred. A proposed re-establishment programme associated with the development on the Meriton site did not occur so Dr. Arthur White and Dr. Graham Pyke later initiated reintroduction trials at Sir Joseph Banks Reserve, Long Reef and to a 'contained' situation at the Marrickville Council nursery.

Whilst sporadic reports of a few individuals at Rosebery have occurred since this period, the rediscovery of another component population over 10 years later is testimony to the species resilience. The site is in a residential backyard and the owners are generally sympathetic however some neighbours are opposed to the GGBFs presence for a variety of reasons including odours, mosquitoes and perceived loss of property value and/or development potential. The known population consists of approximately 15-20 adults which is an even more tenuous position than it was in the early 1990s. The population however could also extend across other private residences in the area. A community survey approach in this area is warranted.

## **Future Management**

The main focus of future management for the Lower Cooks River GGBF key populations is discussed below and further detailed as management actions in the Implementation Plan section of this document.

### **1. Actions for immediate consideration regarding Rosebery GGBFs**

An urgent response strategy that includes a community survey and that simultaneously seeks to raise awareness and allay unfounded concerns among land owner/residents is warranted. Council and DECC should lead such an initiative, and frog interest groups such as FATS should also be encouraged to assist. An analysis of the genetic provenance and an assessment of possibilities for further captive breeding should be undertaken. Funding will be required to implement these actions.

Opportunities for maintaining the population in situ should be explored, at least for a period long enough for strategies and analysis to occur. If the removal/salvage option is deemed most appropriate then this should be in concert with sponsored captive breeding and reintroduction/supplementation trials at strategic locations. Such an approach should be informed or improved by reference to prior reintroduction efforts and give considerations to frog chytrid research findings and hygiene protocols.

The securing of key habitat areas within this population should perhaps be followed by strategies aimed at extending habitat and population nodes into other suitable habitat areas (e.g. Golf Courses, Council parklands and perhaps Centennial/Moore Park Trust lands), as well as possibly attempt to re-connect the upper and lower Cooks River GGBF populations.

**2. Further development of GGBF breeding and other habitat components, where appropriate, on public and private lands.**

A significant portion of the lower Cooks River GGBF habitat area at Arncliffe is the subject of a large scale Cooks Cove development proposal. This development will to some extent surround the GGBF RTA breeding ponds and will remove a large area of foraging, breeding and other possible habitat elements from land that is currently Kogarah Public Golf Course. Some of this habitat was proposed for replacement via offsetting to the south in the vicinity of Barton Park where a new golf course is to be built. To ensure there is no net loss of habitat, and to be in accord with the GGBF recovery plan, the proposed habitat offsets should be appropriately staged and linked, as well as monitored to ensure that created habitat is functionally sustainable.

**3. Improvement of habitat within the GGBF key populations.**

Existing GGBF habitat will require on-going management to ensure that the quality of the habitat is maintained or improved. This includes the management of all types of habitat used by the GGBF, breeding, foraging, refuge and connectivity. For details of specific habitat requirements of the GGBF refer to the Best Practice Guidelines GGBF Habitat booklet available from the DECC.

Systematic surveying of former or potential habitat areas where GGBF records are either known or presumed is desirable. These areas include the entire area potentially utilised in reintroduction efforts at Sir Joseph Banks Reserve (including adjacent properties), the vicinity of the Orica site at Botany, Eastlakes Golf Course and environs, lower Wolli Creek, Scarborough Ponds, Eve and Spring Street wetlands, the 'Landing Light' Wetlands and at La Perouse. Such systematic and coordinated surveys may result in further GGBF rediscovery and perhaps identify additional elements or areas being utilised as habitat. Some of these areas should be considered for reintroduction once threatening processes have been eliminated or are able to be managed. In particular, Wolli Creek valley has areas (Turrella Reserve) that provide good opportunity for either future natural or assisted colonisation from nearby populations of the GGBF at Arncliffe or as an ideal habitat area for translocation trials to be undertaken.

**4. Education and communications to develop awareness of the GGBFs and encourage further on-ground actions.**

Education of on-ground staff and environmental volunteers in identification of the GGBF is also recommended to further assist in the reporting of frogs and to develop a more comprehensive understanding of its distribution in the area. In the event that the GGBF occurs on an industrial site it may be beneficial to train selected staff in identification and reporting along with a protocol on what to do if the frogs are found on a particular site.

There is potential for the Sydney Olympic Park Authority (SOPA) to act as a 'lighthouse' to educate Councils, developers, industry landholders and residents about managing the GGBFs. The SOPA site provides an excellent example of ongoing monitoring, implementation of responsible management practices and successful creation and ongoing maintenance of GGBF habitat components. The site is therefore also useful as a demonstration site to educate and assist other land

managers to do the same. The provision of tours and workshops could be used to further disseminate this information.

#### **5. Reduction of external threats to GGBFs.**

As identified previously, the biggest threat to the GGBF is habitat loss and degradation. The Rockdale, Botany and City of Sydney Councils can assist in the protection of this species through the preservation of any existing wetlands in this area and in the rehabilitation or construction of wetlands through development application conditions.

Visitors to any site where GGBF are found should adhere to the Hygiene Protocol for the Control of Disease in Frogs to reduce the spread of Chytrid fungus. Regular surveys of currently used sites (e.g. Botany Wetlands, RTA ponds) for Gambusia (Plague Minnow) and Carp should be conducted and if detected, measures to remove these species should be undertaken immediately. Areas of potential habitat should also be surveyed for Plague Minnow and Carp and abatement measures implemented as necessary.

#### **6. Monitoring and research to better understand the extent and dynamics of the Lower Cooks River GGBF population.**

Monitoring of GGBF populations, habitats and threats is important to enable land managers to continue to provide good quality breeding, foraging, refuge and movement habitat that is free of threats such as Gambusia (Plague Minnow) and Chytrid fungus. It is also necessary to monitor the frogs to determine the size and extent of the population.

Further research into the GGBF, its habitat components and threats etc. is required to enable good, adaptive management programs to be implemented.

The evolutionary interrelatedness and historic interconnection of the Arncliffe and Rosebery GGBFs has implications for any future connection between these currently divided GGBF entities. Given the previous distribution and spatial extent of wetlands in the area, these two vestiges of a formerly extensive population almost certainly interacted to some extent as a contiguous meta-population. A genetic differentiation analysis should be undertaken to inform captive breeding, reintroduction and possible supplementation activities in the future.

#### **7. Coordination and communication between the various stakeholders, land managers and the community.**

The long term management of the M5 East 'RTA' GGBF breeding ponds has become problematic. The RTA has indicated that it would prefer to transfer ownership and management of the ponds to another party such as Rockdale City Council (RCC). However the M5 East consent conditions do not stipulate a time limit for duration of management and ownership responsibilities of these critically important ponds and associated habitat area by the RTA. A provision exists for the transfer of this responsibility to an alternate body provided that this change is justified, an operating budget is provided, and all parties (including the DECC) agree to this handover. At this point it is understood that RCC would prefer the current situation prevails. It remains vital for this key population's continued viability that the original consent conditions imposed by the then NPWS, (or updated conditions to that effect), are preserved in any responsibility transfer. That is, that the protection of the habitat remains secure, the habitat remains fenced and actively managed under direction of a GGBF expert, and regular monitoring and reporting continues. It is uncertain whether active management by the RTA is currently occurring to schedule as was originally required and specified.



In addition, clarification of the status of the long term proposed F6 Freeway is crucial. This freeway development, if it proceeds, has the potential to compromise all previous and planned conservation efforts including the mitigation and offsetting measures required as part of the Cooks Cove and Kogarah Golf Course relocation developments. The proposed F6 Freeway would impact on the golf course and also on other sites throughout the Rockdale 'corridor'. It is important therefore that consideration be given to the effects of this possible future development and that contingencies be put in place in relation to ensuring the ongoing viability of the Lower Cooks River Key Population of the GGBF.

## Review

A review of the plan is required after 2.5 years (in early 2011) as a basis for its next iteration after three years. This should include a meeting of stakeholders to discuss recent results and recommendations for future management actions.

Informal review of the plan is also encouraged both within organisations and through networks and partnerships. All recommendations to improve the plan should be directed to the DECC contact on the inside front cover of this Plan.

## Implementation

The Implementation Plan in the following table provides a framework of actions for the management focus outlined above. The Implementation Plan should be read and actioned with reference to the draft GGBF Recovery Plan and PAS.

For each management action, the Implementation Plan describes:

- the linkages to the draft Recovery Plan and PAS
- the stakeholders responsible for the management action (lead organisation/group in bold)
- the estimated cost associated with the management action, and possible sources of funding
- the time frame for undertaking the various tasks is also provided.

Some management actions apply to more than one strategy (see 'Objectives and Strategies' section) in the plan.

Actions attributed to certain parties will be subject to available funding and resourcing, unless they are conditions of existing approvals or proposals, or are a result of a statutory requirement.

In the tables below, the acronyms under "Responsibility" and "Funding Sources" stand for the following organisations/groups:

- COC = Caring for Our Country program by the Federal Government (which replaced the the Natural Heritage Trust on 1 July 2008).
- BVBG = Bardwell Valley Bushcare Group
- CMA = Catchment Management Authority
- CRFWG = Cooks River Foreshores Working Group
- DECC = NSW Department of Environment and Climate Change
- DEWHA = Department of the Environment, Water, Heritage and the Arts
- DoP = Department of Planning
- DPI = Department of Primary Industries (Fisheries)

- Env Trust = Environmental Trust
- FATS = Frog and Tadpole Study Group
- Fox TAP = Fox Threat Abatement Plan for NSW
- RWPS = Rockdale Wetlands Preservation Society
- SM CMA = Sydney Metropolitan Catchment Management Authority
- SSRFAMC = Sydney Region Feral Animal Management Committee
- TSN = Threatened Species Network
- WCPS = Wollli Creek Preservation Society

## Implementation Plan

### Strategy 1: *Actions for immediate consideration regarding Rosebery GGBFs*

<b>ACTION</b>	<b>RECOVERY PLAN LINKS / PAS LINKS</b>	<b>RESPONSIBILITY<sup>†</sup></b>	<b>COST*</b>	<b>FUNDING SOURCES</b>	<b>TIMEFRAME</b>
1.1 DECC to discuss with City of Sydney Council measures to improve the situation of the Rosebery outlier. This might include providing assistance to GGBF friendly residents, dispelling concerns regarding constraints that GGBFs might impose on private land owners etc.	Action 10.3.1 / PAS 8, 11	DECC, City of Sydney Council, FATS	Negligible	Recurrent	2008-2009
1.2 DECC to liaise with residents in the immediate vicinity of current Rosebery GGBF ponds to allay concerns relating to the presence of GGBF on private properties.	Action 10.3.1 / PAS 18	DECC, City of Sydney Council, FATS	Negligible	Recurrent	2008-2009
1.3 Undertake a community survey and advertising campaign seeking other Rosebery residents with residual GGBFs or those with an interest in GGBF initiatives. Could also include information to allay fears of the loss of use or value of private property with identified GGBF.	Actions 12.3.1, 14.3.2 / PAS 31	DECC, FATS, City of Sydney Council	< \$500	DECC, City of Sydney Council	2008 - 2009
1.4 DECC to investigate options regarding the future of the Rosebery GGBF remnant. Options may include: Translocating the population to captivity as a salvage option, translocate population remnant to another site, or maintain the remnant in its current location. This will also require genetic reappraisal of provenance issues between Arncliffe and Rosebery specimens and the identification of potential reintroduction sites/owners.	Action 12.3.2	DECC, Taronga Zoo, Local Residents, City of Sydney Council, FATS, land owners and Lower Cooks River GGBF 'Friends' Group.	~\$8000	DECC	2008 - 2010
1.5 DECC to initiate talks with Meriton Apartments seeking support (sponsorship) in relation to GGBF initiatives that are the product of investigations in Action 1.4. With emphasis on Meriton's past involvement with GGBFs at Rosebery	Action 10.3.1	DECC, Meriton Apartments	Negligible	Recurrent	2008 - 2009

\*Note: Costs are indicative only and subject to available funding; <sup>†</sup> lead organisation or group responsibility in bold

**Strategy 2: Further development of GGBF breeding and other habitat components, where appropriate, on public and private lands**

<b>ACTION</b>	<b>RECOVERY PLAN LINKS / PAS LINKS</b>	<b>RESPONSIBILITY<sup>†</sup></b>	<b>COST*</b>	<b>FUNDING SOURCES</b>	<b>TIMEFRAME</b>
2.1 Consent authorities will ensure that losses of habitat resulting from proposed and future developments are accompanied by appropriate offsetting. Habitat creation initiatives linked to development approvals will exhibit/demonstrate functionality prior to destruction of any original habitat as set out in the DECC GGBF EIA guidelines.	Actions 10.3.1, 11.3.1, 11.3.3, 14.3.1 / PAS 1, 5, 30	DECC, City of Botany Bay, City of Sydney & Rockdale City Councils, DoP, DEWHA, Boyd Cook Cove Pty Ltd	In-kind	Recurrent funding of agency staff	2008 - 2011
2.2 Investigate possibilities of creating GGBF habitat on the southern Wolli Ck floodplain between RailCorp land and Wolli Creek (link to Action 6.7) and in the vicinity of Turrella Reserve.	Action 11.3.3 / PAS 9	DECC, Wolli Creek Preservation Society, RailCorp, Canterbury City & Rockdale City Councils	In-kind	Recurrent	2008 - 2011
2.3 Investigate possibilities of creating GGBF habitat or modifying existing habitat at Sydney Park wetlands (CSC LGA) and at Centennial Park (Randwick LGA).	Action 11.3.3 / PAS 9	DECC, City of Sydney & Randwick Councils, FATS, Centennial Parklands Trust	In-kind	Recurrent	2008 - 2010
2.4 Rehabilitation works conducted by Sydney Water and Sydney Airport Corporation to include GGBF habitat elements and appropriate plantings with a vision for GGBF re-colonisation incorporated.	Action 11.3.3 / PAS 9	DECC, Sydney Water Corporation, Sydney Airport Corporation, FATS	Undetermined	Sydney Airport Corporation, Sydney Water Corporation	2008 - 2011
2.5 Existing strategic frameworks such as the Cooks River Foreshore Strategic Plan and the Green Web management plan will be used to coordinate initiatives and explore options for funding and implementing habitat restoration and creation projects of mutual benefit.	Action 10.3.1 / PAS 1, 11.3.1 / PAS 5,	CRFWG, Rockdale and Canterbury City Councils, WCPS, SM CMA, DECC, BVBG, RWPS, GGBF Friends Group.	Undetermined	SM CMA, DECC, Env. Trust, COC	2008-2011

\*Note: Costs are indicative only and subject to available funding; <sup>†</sup> lead organisation or group responsibility in bold

**Strategy 3: Improvement of habitat within the GGBF key populations**

<b>ACTION</b>	<b>RECOVERY PLAN LINKS / PAS LINKS</b>	<b>RESPONSIBILITY<sup>†</sup></b>	<b>COST*</b>	<b>FUNDING SOURCES</b>	<b>TIMEFRAME</b>
3.1 Ongoing active management and monitoring of key RTA GGBF breeding ponds and associated habitat on Kogarah Golf Course and at the Marsh Street wetlands.	Action 11.3.3 / PAS 21	RTA or RTA/DECC nominated body upon an agreed transfer of this responsibility	Undetermined	Development compliance cost	2008 - 2011
3.2 Investigate strategies for sourcing water to supply RTA GGBF breeding ponds and foraging habitat in times of drought, e.g. installation of water tanks or supply of treated water.	Action 10.3.1 / PAS 9	Sydney Water Corporation, Boyd Cook Cove Pty Ltd,	<\$10,000	Sydney Water	2008 - 2011
3.3 Kogarah Golf Club to adopt environmental management guidelines including, but not limited to, those outlined in the Kogarah Golf Course Preliminary Maintenance Manual (link to Action 4.4).	Action 11.3.3 / PAS 9	DECC, <b>Kogarah Golf Club</b> (current entity or future 're-incarnation')	Undetermined	Kogarah Golf Club, Boyd Cook Cove Pty Ltd,	uncertain

\*Note: Costs are indicative only and subject to available funding; <sup>†</sup> lead organisation or group responsibility in bold

**Strategy 4: Education and communications to build awareness of the GGBFs and encourage further on-ground actions**

<b>ACTION</b>	<b>RECOVERY PLAN LINKS / PAS LINKS</b>	<b>RESPONSIBILITY<sup>†</sup></b>	<b>COST*</b>	<b>FUNDING SOURCES</b>	<b>TIMEFRAME</b>
4.1 Conduct GGBF education programs targeting schools and residents in the Botany Bay, Sydney City and especially the Rockdale LGA that could incorporate access and use of GGBF habitat areas as education aids. Where possible link with existing programs. Site visitations to be in accordance with the NPWS Frog Hygiene Protocol (link to Action 5.1).	Action 14.3.2 / PAS 32	Rockdale City, City of Botany Bay & City of Sydney Councils	\$20,000	COC, Env Trust, TSN	2008-2011
4.2 Education program for staff and golfers to focus on the various Golf Clubs in the area with the aim to raise the profile of GGBFs and the possible use of golf courses as important habitat areas. For example, best management practices for Golf Courses around potential habitat ponds (link to Action 3.3).	Action 14.3.1 / PAS 32	Kogarah, East Lakes, Lakes, Bonnie Doon, Australian and Kensington Golf Clubs, DECC, FATS & Sydney Water Corporation	\$5,000	COC, Env Trust, TSN	2008-2011
4.3 Education of council field staff and contractors, with the aid of the NPWS Frog Hygiene Protocol, concerning contamination and impact on GGBF habitat (link to Action 5.1).	Actions 11.3.5, 14.3.2 / PAS 32	Rockdale City, City of Botany Bay & City of Sydney Councils	In-kind	Recurrent	2008-2011
4.4 DECC to distribute to land managers and residents guidelines for GGBF habitat creation, enhancement and maintenance strategies.	Action 11.3.3 / PAS 9	DECC, land managers and owners	\$1,000	Recurrent	2008
4.5 Liaise with local media (newspapers, newsletters, radio, TV) to encourage GGBF reporting (e.g. implementation of the management plan) and to raise awareness generally.	Action 14.3.1 / PAS 33	DECC, GGBF 'Friends' Group when established, FATS	Minimal	In-kind	2008 - 2011
4.6 A community survey will be undertaken at strategic locations seeking observations, reporting and an indication of interest in providing support, involvement or being provided further information.	Action 14.3.2 / PAS 32	DECC, Councils, FATS, Community/ Environment Groups	\$2,000	COC, CMA	2008 – 2009 repeat as necessary prior to activity period each year.

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**Strategy 5: Reduction of external threats to GGBFs**

<b>ACTION</b>	<b>RECOVERY PLAN LINKS / PAS LINKS</b>	<b>RESPONSIBILITY<sup>†</sup></b>	<b>COST*</b>	<b>FUNDING SOURCES</b>	<b>TIMEFRAME</b>
5.1 Implementation of the NPWS Frog Hygiene Protocol during any interaction with GGBF or its habitat to prevent the spread of chytrid fungus.	Action 11.3.5 / PAS 15	All Stakeholders	Nil	In-kind	2008 - 2011
5.2 Survey of GGBF habitat for presence of <i>Gambusia holbrooki</i> and, with reference to the <i>Gambusia</i> Threat Abatement Plan (TAP), and where possible remove <i>Gambusia</i> from sites as well as reduce further spread to unoccupied GGBF habitat.	Action 11.3.2 / PAS 6	DECC, Councils, DPI Fisheries	<\$5,000	DECC, Natural Heritage Trust, CMA	2008-2011
5.3 Sydney Water to continue Carp - <i>Cyprinus carpio</i> control in the Botany/Lachlan Wetlands and to liaise with other stakeholders to encourage collaborative efforts to this end.	Action 11.3.3 / PAS 3	Sydney Water, Centennial Parklands Trust and Sydney Airport Corporation	Unknown	Existing budgets	2008-2011
5.4 Survey of potential GGBF habitat that <i>Cyprinus carpio</i> occupy and examine opportunities to eradicate and prevent further spread to unoccupied habitat (link to Action 5.3).	Action 11.3.2 / PAS 14	DECC, Rockdale City, City of Botany Bay & City of Sydney Councils, Landowners, DPI Fisheries, SSRFAMC	<\$5,000	COC, SM CMA, sponsorship	2009-2011
5.5 DECC to contact relevant landholders, using existing council networks, in relation to synchronisation of fox baiting programs that are currently in place	Action 10.3.1 / PAS 3	DECC, Rockdale City, City of Botany Bay & City of Sydney Councils	Undetermined	Existing funding, recurrent funding and Fox TAP	2008 - 2011
5.6 Investigate numbers of the White Ibis at GGBF sites and their likely impacts on the GGBF. Where required, seek DECC support for implementation of control measures as necessary (to run jointly with investigations conducted for other GGBF key populations).	Action 11.3.2 / PAS 3, 14, 26	DECC, Rockdale City and City of Botany Bay Councils, CBBC, Wollongong University	Dependent on findings	COC, DECC, SMCMA, Research Grants	2008-2010

\*Note: Costs are indicative only and subject to available funding; <sup>†</sup> lead organisation or group responsibility in bold

**Strategy 6: Monitoring and research to better understand the extent and dynamics of the LCR/Arncliffe GGBF population**

<b>ACTION</b>	<b>RECOVERY PLAN LINKS / PAS LINKS</b>	<b>RESPONSIBILITY†</b>	<b>COST*</b>	<b>FUNDING SOURCES</b>	<b>TIMEFRAME</b>
6.1 Targeted surveys of areas that have furnished recent and historic GGBF records at Botany, Eastlakes, Wolli Creek, Scarborough Ponds, Eve and Spring St Wetlands and the Landing Lights Wetlands. With view to identify other population remnants or potential reintroduction sites.	Action 12.3.1 / PAS 31	DECC, Post Graduate University Students, Consultants	<\$15,000	COC, CMA	2008-2010
6.2 Establish community monitoring programs centred on recent and historic GGBF habitat that, during targeted surveys, show evidence of possible GGBF presence (link to Action 6.1).	Action 14.3.2 / PAS 31	DECC, Post Graduate University Students, Consultants, FATS, Community and Environment Groups	> \$15,000	COC, CMA	2008 -2011
6.3 Recruitment of wild Arncliffe and Rosebery GGBF tadpoles to the captive breeding program at Taronga Zoo. In the interest of continuing the program as 'insurance' populations in the event of extinction of the wild population.	Action 13.3.1 / PAS 10, 13	DECC, Taronga Zoo, sponsors, Boyds Cook Cove,, Meriton	>\$30,000	Sponsors, SMCMA, TSN	2009-2011
6.4 RTA and Boyd Cook Cove appointed GGBF managers to conduct, in a collaborative manner, monitoring of GGBFs at existing RTA breeding ponds and any compensatory habitat to be created south of the M5 East.	Action 12.3.1	RTA, Boyd Cook Cove	Undetermined	Development Cost	2008 - 2011
6.5 Conduct a review of GGBF genetic studies that examined Rosebery, Arncliffe, Greenacre and Kurnell provenance material at the very least to determine variability within and between provenances and inform captive breeding and reintroduction or management decision making. GGBFs to have evolutionary significant units reassessed, and inform possible future strategies and definitive baseline data (Link to Action 1.4).	Action 12.3.2 / PAS 26	Expert conservation geneticist	\$5,000	COC, CMA, TSN, DECC	2009 - 2011



<b>ACTION</b>	<b>RECOVERY PLAN LINKS / PAS LINKS</b>	<b>RESPONSIBILITY<sup>†</sup></b>	<b>COST*</b>	<b>FUNDING SOURCES</b>	<b>TIMEFRAME</b>
6.6 Investigate issues, constraints, and benefits of linking GGBFs at Rosebery with the population at Arncliffe.	Action 12.3.2	DECC, Consultants	\$5,000	COC, Env Trust, TSN, CMA	2009 - 2011
6.7 Investigate options and likely corridors that could be used to ultimately link GGBF key populations in the Cooks River valley at Arncliffe and Greenacre (link to Action 2.2).	Action 12.3.2	DECC, Consultant	\$8,000	COC, Env Trust, TSN, CMA	2009 - 2011

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**Strategy 7: Coordination and communication between stakeholders, land managers and the community**

<b>ACTION</b>	<b>RECOVERY PLAN LINKS / PAS LINKS</b>	<b>RESPONSIBILITY<sup>†</sup></b>	<b>COST*</b>	<b>FUNDING SOURCES</b>	<b>TIMEFRAME</b>
7.1 DECC to ensure that any transfer of responsibility of the RTA GGBF breeding ponds preserves the original consent conditions or those that reiterate the need and accountability for long term habitat management and monitoring	Actions 10.3.1, 11.3.1 / PAS 1	DECC, RTA	Negligible	In-kind	2008 - 2011
7.2 DECC to continue to liaise with landholders in relation to GGBF conservation concerns on private lands.	Action 10.3.1 / PAS 1, 9, 18	DECC	Negligible	In-kind	2008 - 2011
7.3 DECC to continue to liaise with RCC, CBBC, and CSC regarding future development proposals on current and potential GGBF habitat. This will ensure that GGBF is adequately considered in any future development proposals.	Actions 10.3.1, 11.3.1 / PAS 1	DECC, RCC, CBBC, CSC	Negligible	In-kind	2008 - 2011
7.4 RTA to forward annual reports regarding the implementation of the Arncliffe GGBF breeding habitat management plan, as set out in the original M5 consent conditions (link to 7.1).	Action 10.3.1	RTA, DECC	Negligible	In-kind	2008 - 2011
7.5 Rockdale City Council to provide results of the Bio Links study for the Rockdale LGA to inform the DECC of the extent of wetlands and vegetation corridors and subsequent possibilities for GGBF habitat linkages (link to Actions 2.2, 6.6, 6.7)	Action 10.3.1	RCC, DECC	Negligible	In-kind	2008 - 2011
7.6 Creation of an electronic email forum that will facilitate coordination of Lower Cooks River GGBF Management Plan.	Action 14.3.2 / PAS 24	DECC, SMCMA	Minimal	In-kind	2009
7.7 The formation of a lower Cooks River GGBF 'Friends' group will be explored and promoted amongst stakeholders.	Action	DECC, RCC, CCC, SMCMA, other stakeholders	Minimal	In-kind	2009

**\*Note: Costs are indicative only and subject to available funding; <sup>†</sup> lead organisation or group responsibility in bold**

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## Appendices

### Appendix 1: Frog Hygiene Protocol

Individuals studying or surveying frogs often travel and collect samples of frogs from multiple sites. Green and Golden Bell Frogs can be particularly sensitive to the introduction of infectious pathogens, such as the frog chytrid fungus. Therefore, it is important that frog workers recognise the boundaries between sites and undertake measures that reduce the likelihood of spreading infection. Detailed procedures, measures and background are provided in the *“Hygiene Protocol for the Control of Disease in Frogs”*, which can be obtained from the Department of Environment and Climate Change, or downloaded from:

<http://www.nationalparks.nsw.gov.au/pdfs/hyprfrog.pdf>

## Appendix 2: GGBF Captive Breeding and Translocation

The Department and Environment and Climate Change is currently guided by a Policy for the Translocation of Threatened Fauna in NSW that will apply to all proposals to translocate threatened fauna species (see NPWS 2001 - Policy and Procedures Statement No. 9). This Policy outlines four possible justifications for translocation of threatened fauna that include: species recovery, biodiversity reconstruction, emergency transfer and research.

The merits and usefulness of captive breeding and translocation for GGBFs to supplement or re-establish a population as a conservation measure have also been identified in the draft GGBF Recovery Plan. Whilst captive breeding and reintroduction or supplementation may be deemed a desirable initiative as part of this Management Plan, *in situ* conservation of the existing population is always a priority, even if later focus is drawn to reintroduction or supplementation initiatives. In any event all proposals for reintroduction/supplementation will have to be subject to the Policy for the Translocation of Threatened Fauna in NSW. It should not be assumed that such measures will be a simple solution to the decline or disappearance of a local population or population sub-unit and gain automatic approval from the DECC.

Several trials have already been undertaken to determine the feasibility and merits of undertaking captive breeding and release as reintroduction or supplementation exercises. Such trials have been undertaken both in concert with habitat creation/enhancement measures as well as without any habitat manipulation. To date there have been several reintroduction failures where releases of tadpoles or juvenile frogs have shown initial promise and survived to transformation or early adult stage but have then failed to survive to maturity and establish a self sustaining population e.g. Sir Joseph Banks Reserve, Botany and Long Reef Golf Course, Dee Why. Other sites have had supplementation releases of captive bred stock but where there was also a remaining residual element of the population in that area. At such sites releases have appeared to initially benefit the local population. However because releases have also been in concert with habitat creation initiatives it is difficult to determine whether the habitat creation has benefited and boosted breeding success of the remnant population, or if apparent increases can be attributed to recruitment of released captive bred specimens e.g. Arncliffe M5 East site and Edgewood site Woonona.

It should be emphasised here that the Policy for the Translocation of Threatened Fauna in NSW indicates that in no way should translocation be considered as a mitigative measure when determining the significance of a proposal on a local population of a threatened species. The NSW DECC has prepared Environmental Impact Assessment (EIA) Guidelines that provide guidance to development proponents, consultants and consent authorities. These guidelines further reaffirm the DECC position on translocation and the general inappropriateness of it being considered as a component of development proposals.

Ultimately decisions to conduct GGBF translocations and captive breeding are at the NSW DECC's discretion and will be assessed on merit and on a site-by-site basis. Factors such as the provenance of translocated individuals, whether threatening processes continue to operate at a site, as well as costs and an ability to monitor outcomes for an extended period will all be considerations for the benefit of improved understanding and future proposals.