

***Revised Kooragang Wetland Rehabilitation Project
Management Plan:
Moving from Establishment to Sustainable
Management***

***Revised: 2005
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Preface: Hunter River Estuary

The natural areas of the Hunter River estuary were a source of inspiration to early visitors:

Elizabeth Gould, natural history artist, on Mosquito Island in 1839:

...nature appeared in her wild luxuriance. The Immense parasites twining round the trees taking root some of them at the tops of the trees and hanging down to the ground, others surrounding the trees like a crown – heard the bell bird with his incessant ting ting, the coachwhip bird &c – a heavy shower of rain accompanied by lightning – soon cleared up – every green thing looked more beautiful for its sprinkling.

(Hindwood 1938b:135-6 in Albrecht G & J 1992)

Ludwig Leichhardt, natural scientist and explorer, on Ash Island in 1842:

Last Friday we went to Ash island: it is a remarkably fine place, not only to enjoy the beauty of nature, a broad shining river, a luxuriant vegetation, a tasteful comfortable cottage with a plantation of orange trees, but to collect a great number of plants which I had never seen before.

(Turner 1997)

One day, when the work started by the Kooragang Wetland Rehabilitation Project (KWRP) is done, visitors might again be widely quoted as being in rapture with the estuary's natural areas not knowing what took place to return it to its former glory. Such a reaction would be a tribute to all who have been dedicated to this project over many years to make it a success.

Since 1993, KWRP has brought together local community, industry and all levels of government to transform a once neglected and degraded area with an uncertain future to an internationally recognised, restored conservation area of great ecological significance. The project's commitment to partnerships, adaptive management and community involvement has provided a firm foundation for the on-going sustainable management of the project areas. Volunteers have played a unique role in achieving this success by providing a remarkable level of expertise in a variety of fields.

Wetlands of the Hunter estuary form part of a green corridor of related natural areas in the Lower Hunter which extends from Stockton Bight to the Watagans and beyond. The estuary's wetlands are of particular value locally, regionally and internationally as habitat for fish and crustaceans, migratory shorebirds, frogs, threatened species and endangered ecological communities. In addition, they provide open space for recreation and environmentally-based tourism along the river; and an outdoor laboratory and sustainable agriculture demonstration site for education, training and research. They complement rather than duplicate related initiatives in the estuary.

The Hunter-Central Rivers Catchment Management Authority's Kooragang and Hexham wetland rehabilitation project sites within the Hunter estuary are of key international conservation significance to the biodiversity of the region. As such, management plans for both projects have been developed

to be consistent with each other and to complement other conservation initiatives in the estuary so that benefits resulting from the projects' activities are maximised.

Given the level of modifications made to the estuary, it is a tribute to the resilience and inherent productivity of estuarine ecosystems in general and to the Hunter estuary in particular that world-class natural areas continue to exist adjacent to globally significant industrial facilities. Preserving, conserving and restoring the remaining natural areas of the estuary are matters of urgency in developing the Hunter estuary as a model for management of wetlands in an industrial and urban estuary.

The Kooragang Wetland Rehabilitation Project (KWRP) was initiated in 1993 to partially compensate for the loss of fisheries, shorebird and other wildlife habitat in the Hunter estuary caused by 200 years of draining, filling and clearing. The project seeks to combine habitat enhancement with facilities encouraging wise use of the estuarine ecosystem on sites covering 1,590ha at Ash Island (780ha), Tomago Wetlands (800ha) and Stockton Sandspit (10ha).

The project has the vision of *an estuary in which healthy, restored fisheries, shorebird, threatened species and other wildlife habitat is in balance with a thriving port, the whole providing opportunities for research, education and recreation*. This management plan provides information regarding issues faced and lessons learnt during more than ten years of pursuing this vision through the implementation of a large, integrated, adaptive wetland project. Of particular interest is the experience of resolving issues related to conserving a variety of threatened species and ecological communities in an area that adjoins both a Ramsar site and a major industrial complex.

KWRP has been innovative in developing cost-effective solutions for sustainable wetland management in areas such as managed grazing on Kooragang City Farm, constructed habitat features for threatened species, saltmarsh creation, riverbank stabilisation, reverting kikuyu paddocks to floodplain forest, restoring flows in tidal creeks, mangrove boardwalk construction, photo-voltaic energy systems and weed removal. Other initiatives of KWRP have greatly increased the local community's ability to be involved in on-ground conservation works.

Research linked to management actions has assisted KWRP in assessing and modifying management actions to reflect current understanding of the estuarine ecosystem and biological priorities. Of particular interest is monitoring being implemented by a community group, university students and volunteers.



Figure 1. Lower Hunter Green Corridor – Stockton Bight to the Watagans.

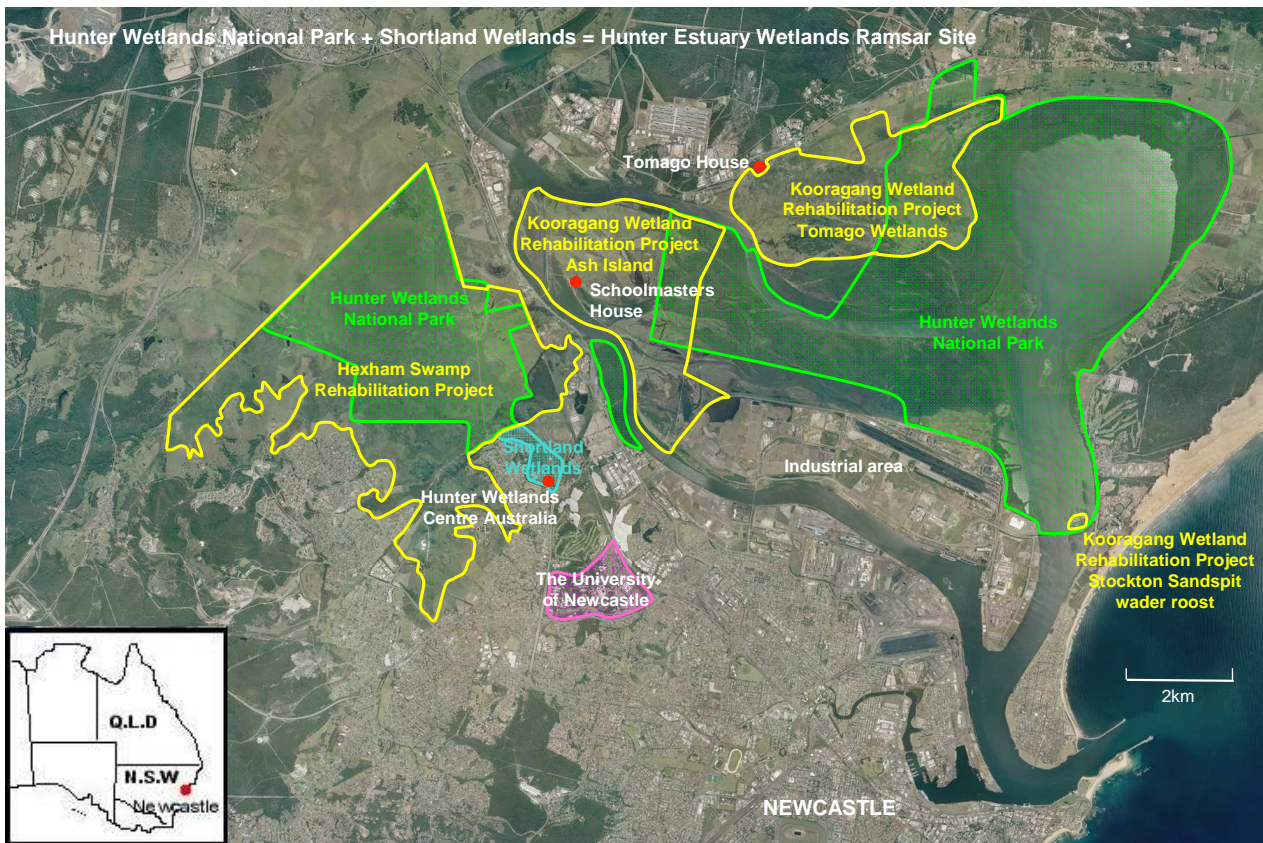


Figure 2. Kooragang Wetland Rehabilitation Project sites: Ash Island, Tomago Wetlands and Stockton Sandspit: Yellow line – KWRP area which covers different land tenures including sections that overlap National Park/Ramsar area; green – Hunter Wetlands National Park (prior to March 2010)/Parks and Wildlife section of Hunter Estuary Wetlands Ramsar site; blue – Hunter Wetlands Centre Australia/Shortland Wetlands section of Hunter Estuary Wetlands Ramsar site.

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1. Purpose of Document

Revised Management Plan

This document is the first revision of the KWRP Management Plan (KWRP 1996a). The revised management plan consists of the project's background, legislative and policy framework, aims and objectives, outcomes, actions, funding, management structure, preferred future management of the project area and reference to the establishment of a wetlands national park in the Hunter River estuary.

Actions have been placed into categories that reflect the project's core activities: strategic, operational, threatened/protected species and communities, water management, vegetation, communication and research and Kooragang City Farm. These works achieve the outcomes presented in graphic form in the project's strategic landscape plan (Land Systems EBC 1994).

Planning and consultation

In 1992, a feasibility study was completed under the project's original name *Kooragang Island Wetland Compensation Project* and focused on Ash Island. Representatives of the major state and regional natural resource management agencies and local government formed the project's steering committee and first met in 1992. In 1993, the committee changed the name of the project to *Kooragang Wetland Rehabilitation Project* and added Stockton Sandspit and Tomago Wetlands to the project area.

Kooragang Wetland Rehabilitation Project was launched in November 1993 as a collaborative, integrated Government/community initiative to rehabilitate and create wetlands in the Hunter River estuary. The project's purpose was to partially compensate for fisheries and other wildlife habitat lost as a result of over 200 years of draining, filling and clearing.

Three sites in the Hunter River estuary were included in KWRP due to their suitability to be rehabilitated as fisheries, shorebird and other wildlife habitat. These sites were Ash Island (780ha), Tomago Wetlands (800ha total; 400ha current working site) and Stockton Sandspit (10ha) (Figure 2) that cover a working area of approximately 1200ha within an original project area of approximately 1590ha. A key feature of KWRP was that it was able to undertake and facilitate rehabilitation activities on a landscape basis working across land ownership (as shown in Fig 2) and management boundaries at each site.

The Landscape plan for all three sites was produced in 1994 (Land Systems EBC 1994; Geering and Winning 1994). The KWRP Management Plan was approved in 1996 following completion of a value management study (NSW PWS 1996) and an economic appraisal (NSW DLWC 1996a). KWRP was made a State Government major capital works project in 1997 with a proposed ten year program.

Consultation was incorporated into the development of each of the project's planning documents and on-going community consultation is a feature of

implementing the project. The project's feasibility study (SWC 1992) included extensive consultation which identified the need and a general strategy to compensate for past losses of fisheries and other wildlife habitat with creation and restoration of wetlands on the western part of Kooragang Island while educating the community on the value of the Hunter estuary as a fishery and biodiversity resource.

The feasibility study's recommendations were further developed and presented visually in the project's landscape plan (Land Systems EBC 1994). Opportunities and constraints were assessed through a lengthy consultation process. The Draft KWRP Management Plan then provided a list of actions required to achieve the landscape design. Prior to the KWRP Management Plan being finalised, the proposed actions were reviewed in a two-day value management workshop attended by key stakeholders.

A diverse and extensive set of stakeholders participated in reviews of the KWRP Management Plan and development of the City Farm Business Plan in 1999, 2000 and 2001 and research and monitoring outcomes (KWRP 1996b; 1997a, b; 2001). In addition, an expert panel was convened to consult with key stakeholders and provide advice on management needs of a suite of threatened species and communities (KWRP Expert Panel 2002). The project team continues to undertake on-going consultation with key community stakeholders in the planning, design, implementation and monitoring of on-ground works.

2. Background

Historical context

For thousands of years Aboriginal people have hunted and gathered food in and around the Hunter River estuary. The various clans of the Worimi and Awabakal peoples thrived on abundant fish, shellfish, waterbirds and other animals; rainforest flourished in non-tidal areas of the islands of the estuary and provided a range of other essential resources to the local people.

Aquatic productivity of the Hunter estuary at European settlement was legendary. European settlers and naturalists in the 1800s noted the almost unbelievable banks of oysters lining the Hunter River estuary, lushness of the floodplain forests, abundant water fowl and the use of these natural resources by aboriginal inhabitants. Lt. Col. Paterson told Governor King in 1801 that:

The quantity of oyster shells on the beaches inland (from the mouth of the Hunter River) is beyond conception: they are in some places for miles. These are four feet deep (later recorded to be up to 18ft deep) without either sand or earth.
(Turner 1997)

The floodplain rainforest on the islands of the Hunter estuary was a source of inspiration to naturalists. On 17 September 1839, natural history artist, Elizabeth Gould waxed lyrical about Mosquito Island (now part of Kooragang Island) where her husband, John Gould, observed and collected birds:

Rose at six dressed hastily got some breakfast and had a pleasant row to the island. Found the tent pitched in a cleared (sic) spot in the midst of the bush where nature appeared in her wild luxuriance. The Immense parasites twining round the trees taking root some of them at the tops of the trees and hanging down to the ground, others surrounding the trees like a crown – heard the bell bird with his incessant ting ting, the coachwhip bird &c – a heavy shower of rain accompanied by lightning – soon cleared up – every green thing looked more beautiful for its sprinkling. (Hindwood 1938b:135-6 in Albrecht and Albrecht 1992)

Ludwig Leichhardt, the German natural scientist and explorer, was a friend of Alexander Walker Scott, naturalist, entrepreneur and first land grant owner of Ash Island. Leichhardt was impressed with the flora of Ash Island as he wrote in letters to a friend in 1842:

Last Friday we went to Ash island: it is a remarkably fine place, not only to enjoy the beauty of nature, a broad shining river, a luxuriant vegetation, a tasteful comfortable cottage with a plantation of orange trees, but to collect a great number of plants which I had never seen before. I saw at once that you must come to roam with me over the island, which is much larger than I thought, containing full 2000 acres of land. The vegetation seems very similar to that of Illawarra if I can judge by the descriptions I heard of the latter district. Climbing Polyodium, the Aerostichum growing on the trees, a great number of creepers, the nettle Tree, the Caper, the native Olive and many others which we will examine together. (Turner 1997)

A. W. Scott moved his family to Ash Island in 1846 where they lived until 1866. His daughters, Harriet and Helena, were professional natural history artists and while on Ash Island, they devoted much of their time to illustrating their father's study of moths, butterflies and plants of the region. Their beautifully detailed illustrations were judged to be equal to any being produced in the world at the time (Ord 1988a, b). Importantly for the project, Helena Scott produced a plant list entitled *Botany of Ash Island* (Scott 1862) which lists, by scientific name, 238 species of plants growing on Ash Island in 1862. Helena's list was published in part by Woolls (1867) and forms the basis of the project's revegetation program and landscaping.

A list of the Hunter estuary's natural areas and their significance is given in Appendix A.

Since 1801, hydrological regimes have been significantly altered resulting in reduced tidal flushing and fragmented habitat. The number of islands in the estuary has been reduced from 20 to 4; the length of shoreline (important waterbird feeding habitat) has been halved (Kingsford and Ferster Levy 1997); 112 culverts, bridges and floodgates, and 77km of drains and levees have been constructed (Williams et al 2000).

Red cedar was harvested from the floodplain rainforest from 1804 to 1822 (Williams et al 2000) with the forest being cleared in earnest for agriculture from the mid-1800s. The oyster banks were mined from 1808 to 1822 and dredged from 1935 to 1945 for production of cement. Since 1910, the river has been dredged to create and maintain facilities for the Port of Newcastle.

Between 1954 and 1994, there was a loss of at least 1428ha of saltmarsh and 344ha of open water and an increase of 400ha of mangroves, that is a net loss of over 1300ha of fisheries habitat and over 1400ha of shorebird habitat (Williams et al 2000). The number of migratory shorebirds declined by at least half since the 1970s and fish species dependent on sea grass dropped out of the commercial catch (Kingsford and Ferster Levy 1995; Williams pers. comm.).

Estimates of broad scale vegetation change in the Hunter estuary between 1750 and 2000 indicate that there has been a loss of 84% (27km²) of saltmarsh; 21% (6km²) of mangroves and 81% (275km²) of non-tidal forests (LHCCREMS mapping in MHL 2003).

In 1993, KWRP was initiated to help reverse this loss of habitat at three sites in the estuary: Ash Island, Stockton Sandspit and Tomago Wetlands.

The KWRP Ash Island site has been State owned since the mid-1950s, most recently registered with the State Property Authority and managed through the Hunter Development Corporation (2007 to 2010). Approximately 600ha was licensed to the Hunter-Central Rivers CMA for the purposes of KWRP. In March 2010, transfer of Ash Island to Parks and Wildlife was announced. New arrangements are being negotiated between the CMA and Parks and Wildlife.

Parks and Wildlife manages Hunter Wetlands National Park which forms most of the Hunter Estuary Wetlands Ramsar site; 160ha of the Ash Island site is within the Park boundary and is Ramsar listed. State Property Authority owns and manages a 20ha parcel of land that is part of the project area but lies outside both the licence and national park areas.

Utilities that have assets and access tracks and/or easements on Ash Island are EnergyAustralia, TransGrid, Hunter Water Corporation, Jemena (gas pipeline), Australia Rail Track Corporation, Rail Infrastructure Corporation and Planning NSW (SP2 Transport Corridor). NSW Maritime maintains navigation beacons on the north bank of Ash Island.

Ash Island is important for shorebird roosting and feeding (both during the day and at night), fisheries production and conservation of threatened species and endangered ecological communities. It provides habitats for over 340 native plant, 183 bird, 67 fish/decapod crustacean, 15 frog and 12 mammal species. The island supports 27 threatened species listed under the NSW Threatened Species Act (one frog, 17 bird, 7 bat and two plant); 37 bird species covered by the JAMBA and CAMBA treaties; and a number of endangered ecological communities (coastal saltmarsh and floodplain wetlands and forests) and a protected vegetation type (mangroves) (Appendix B).

Stockton Sandspit is owned by the State Government and is managed by Parks and Wildlife as part of the Hunter Wetlands National Park. Access to the site and area under the Stockton Bridge is the responsibility of Newcastle City Council. KWRP and the Hunter Bird Observers Club (HBOC) work with Parks and Wildlife to maximise the site's use by shorebirds and with Council to maintain appropriate access to the site. The Sandspit is currently one of the most important high tide roosts for shorebirds in the Hunter Estuary (Herbert 2007) and therefore it is one of the most important in NSW and eastern Australia (Lane 1987, Smith 1991, Geering and Winning 1993).

Tomago Wetlands is owned by the State Government with approximately half in the Hunter Wetlands National Park and half purchased by the State for industrial development in 2003. Of the area purchased about half has been sold to private companies and half remains owned and managed by HDC. Parks and Wildlife is the proponent and consent authority for rehabilitation activities within the national park boundary. These activities consist of increasing tidal inundation by opening floodgates, building a levee to protect private property and controlling mangroves. A Review of Environmental Factors was prepared by Parks and Wildlife as part of the approval process which follows on from two previously prepared Environmental Impact Statements (Patterson and Britton 1998, 2000).

Tomago Wetlands had been identified as shorebird roosting and feeding habitat prior to installation of floodgates in 1976 and construction of the levee, ring drain and canal system in 1980 as part of the Hunter Valley Flood Mitigation Scheme (Moss 1983; NSW PWS 1987). The management priority is to open floodgates to restore tidal inundation and control mangroves so that shorebird roosting and feeding habitat (shallow open water, mudflats and saltmarsh) can be restored. In the process of re-instating the shorebird habitat, fisheries nursery habitat will also be enhanced. Restoration activities will be restricted to the national park in the first instance while the future of the HDC managed lands is being decided.

3. Relationship to Legislative and Policy Framework

Key policies and legislation related to strategic direction of the project are listed in this section. See Appendix C for a more complete list of legislation relevant to the project.

- ***Hunter-Central Rivers Catchment Action Plan: 2006-2016***

The Hunter-Central Rivers Catchment Action Plan (CAP) sets 31 management targets for five themes of natural resource management in the region: biodiversity, aquatic health, soils, estuarine health and marine health. KWRP helps achieve management targets related to protecting and regenerating native terrestrial and native riparian vegetation; protecting and enhancing wetlands; conserving threatened species; restoring fish passage; treating weeds and animal pests; managing nutrient run-off; sustainable grazing management; and management of Aboriginal cultural and heritage landscapes. Achievement of recreation and

research objectives is dependent on establishing and maintaining partnerships with groups that have those interests as management priorities.

- ***NSW Wetlands Management Policy (NSW DLWC 1996b); component of State Estuaries and Rivers***

This policy provides for ecologically sustainable use, management and conservation of wetlands in NSW for the benefit of present and future generations; wise use, best management practice and rehabilitation of wetlands: Principle 2: Land use and management practices that maintain or rehabilitate wetland habitat and processes will be encouraged; Principle 6: Natural wetlands should not be destroyed, but when social or economic imperatives require it, the rehabilitation or construction of a wetland should be required; Principle 7: Degraded wetlands and their habitats and processes will be actively rehabilitated as far as practical; Principle 8: Wetlands of regional or national significance will be conserved (particularly if a Ramsar nomination is sought); Principle 9: The adoption of a stewardship ethos and cooperative action between land and water owners and managers, government authorities, non-government agencies and the general community is necessary for effective wetlands management.

- ***International treaties and agreements protecting migratory shorebirds and their habitat.***

China/Australia Agreement for the Protection of Migratory Birds and their Environment (CAMBA); Japan/Australia Agreement for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (JAMBA); and Convention on Wetlands of International Importance (Ramsar Convention) commit signatories to wise use of wetlands and protection of migratory bird habitat.

Legislation related to operational activities of the project:

- ***National Parks and Wildlife Service Act 1974***

Provides a framework for managing national parks and reserves as well as providing mechanisms to conserve and manage cultural and natural heritage

- ***State Environmental Planning Policy 14 Coastal Wetlands***

SEPP 14 provides for the protection of coastal wetlands.

- ***SP 2 – Infrastructure (Major Projects)***

SP2 identifies a major project corridor across Ash Island.

- **Newcastle City Council Local Environment Plan 2003**

Ash Island site is zoned as a conservation area with retention of general industrial zoning in a strip across Ash Island for a proposed transport corridor.

- **Port Stephens Council Local Environment Plan**

Tomago site outside the Hunter Wetlands National Park is zoned for rural activities.

- **NSW Threatened Species Conservation Act 1995**

Establishes a process for classifying and protecting endangered species and critical habitats; assesses potential impact of proposals on threatened fauna and flora.

- **Commonwealth Environment Protection and Biodiversity Conservation Act 1999**

Lists nationally threatened species; regulates activities for enhancement of migratory bird habitat; wise-use of Ramsar sites.

4. Vision, Aim & Objectives

The vision, policy statement and guiding principles for KWRP are presented in Appendix D and have been developed to be consistent with the Hexham Swamp Rehabilitation Project (Fig 2).

Vision

An estuary in which healthy, restored fisheries, shorebird, threatened species and other wildlife habitat is in balance with a thriving port, the whole providing opportunities for research, education and recreation for people.

Aims

- Help redress the loss of fisheries, shorebird, threatened species and other wildlife habitat in the Hunter Estuary due to clearing, draining and filling over the past 200 years by conserving, restoring and continuously improving Kooragang and Tomago wetlands and Stockton Sandspit for nature conservation;
- Maintain viability of the estuarine ecosystems including threatened ecological communities and critical habitat for migratory shorebirds and threatened species; and
- Link applied research to wetland management and develop and promote complementary opportunities for environmental education, outdoor recreation and nature-based tourism and demonstrate that environment conservation and local industry can work together to their mutual benefit.

Objectives

Numbers indicate the relevant action plans (see Appendix E): 1=strategic, 2=operational, 3=threatened/protected species, 4=water management, 5=vegetation, 6=communication and promotion, 7=Kooragang City Farm; and 8=Research.

Nature Conservation and Management

1. Protect threatened/protected species and communities along with other species and communities of conservation significance (3, 5);
2. Enhance habitat for estuarine flora, in particular saltmarsh, and fauna, in particular migratory shorebirds, fish and crustaceans (4, 5);
3. Increase flushing of tidal creeks which have become stagnant and restore creek beds, taking into account habitat requirements for threatened and protected species and maintaining saltmarsh (4);
4. Manage floodgates at Tomago Wetlands to reinstate shorebird roost and feeding habitat (4);
5. Enhance riverine corridor vegetation for biodiversity and riverbank stability (5);
6. Manage pest and weed species (5);
7. Develop Kooragang City Farm as a demonstration site and training facility for sustainable agriculture, farming in harmony with wetlands and management based on holistic decision-making (7);
8. Consider the contribution of KWRP to the larger estuarine wetland complex of the Hunter Estuary in the development of a long-term management framework for the Green Corridor and regional network of protected natural areas (1);
9. Assist research initiatives through facilitating collaborative projects and providing research sites (6, 7);
10. Assess rehabilitation/creation success and guide management actions of this and other rehabilitation projects through applied research (6);
11. Protect Aboriginal and European cultural heritage values (5, 6).
12. Contribute to the promotion of the value of the Lower Hunter Estuary wetlands.

Community Involvement

13. Facilitate community involvement and training activities through an education and extension program that features Kooragang City Farm (6, 7);
14. Encourage use of Kooragang and Tomago wetlands and Stockton Sandspit for educational purposes (6);
15. Enhance opportunities for passive outdoor recreation, nature appreciation and environmentally based tourism (6, 7);
16. Promote the Hunter Estuary as a centre of excellence in sustainable wetland management (6);
17. Maintain international profile of wetlands of the Hunter River estuary (6).

Related Objectives

Partnerships

18. Manage mosquitoes (4, 6);
19. Maintain access and infrastructure for visitors in consultation with utilities (2);
20. Facilitate day to day management of the project (2).

In the current revision process, the project's objectives have been reviewed so that they reflect the following:

- shift from project development to on-going management
- goals of the project;
- changes agreed upon in earlier reviews;
- achievability of original aims and objectives;
- other conservation initiatives in the estuary;
- changes in planning instruments and land ownership; and
- priorities in relevant Government policy documents.

5. Performance against Previous Management Plan Actions

Completed actions from the 1996 KWRP Management Plan are listed in Appendix F.

Outcomes that have been achieved as a result of these actions include:

- increased fish abundance and diversity in opened tidal creeks; best outcomes are in creeks that maintain a mixture of open water, mangroves and saltmarsh; Cobbans Creek was allowed to self-design after a culvert collapsed circa 1990; Crabhole Creek has enhanced fisheries habitat after a culvert was replaced with a bridge; Fish Fry Creek has achieved this outcome over after a culvert was replaced with a bridge (Williams et al 1995; Williams pers. comm.); over 350ha of fisheries habitat (including mangroves, saltmarsh and open water) have been protected, enhanced and created;
- increased use of roost sites on Stockton Sandspit and Ash Island by shorebirds with removal of mangroves, bitou bush and *Juncus acutus* and herbaceous weedy cover and increased available area of shallow, brackish open water; this outcome was achieved on Stockton Sandspit by construction of a tidal lagoon, removing weeds, followed by Parks and Wildlife removing 0.5ha of fringing mangroves that were creating a barrier to shorebirds' line of sight between the river and Sandspit; on Ash Island, mangroves were removed from key areas and expanses of wet saltmarsh were maintained; a high tide roost covering approximately 25ha was created and restored for migratory shorebirds; HBOC has proposed and reviewed works at the Sandspit and has tracked trends in bird use through monthly bird surveys. Data collected by HBOC indicates that there has been an order of magnitude increase in shorebird use of the Sandspit from 100s before to 1000s of birds after the mangroves were removed; shorebird habitat enhancement assists Australia in meeting its obligations under international agreements with Japan, China and South Korea protecting migratory bird habitat. KWRP is unique in its large scale creation of saltmarsh via excavation of degraded pasture and assessment of the work through a monitoring program using a control/impact/reference research design;
- protected over 8km of riverbank by removing cattle, re-establishing local, native riparian vegetation, removing weeds and installing bollards and cable to keep vehicles from damaging adjacent wetlands;
- protected over 32ha of ephemeral freshwater/brackish swales on Ash Island by constructing traditional and solar powered fencing to manage cattle; the outcome has been the conservation of biodiversity by protecting and enhancing the full range of habitats that occur on Ash Island;

- conserved and extended lowland floodplain rainforest and achieved significant biodiversity gains by linking and extending remnants with the planting of more than 150,000 plants of over 80 rainforest and riparian local, native species with most grown from locally collected seed; some 30 species that once grew on the island have been re-introduced, thereby increasing the habitat of endangered species such as the rainforest vine, White Cynanchum (*Cynanchum elegans*); the result has been the establishment of over 12ha of new wildlife corridor and over 4ha of revegetated riverbank; the outcome being sought is to increase the number of fauna species on Ash Island that are tied to lowland floodplain rainforest and therefore increase biodiversity; in fact, two species of bird are found on the island because of the presence of the rainforest vegetation (Black-faced Monarch and Rufous Fantail); the increase in cover is to a point now that animals like the swamp wallaby (*Wallabia bicolor*) that used to occur on the island could survive if it was re-colonised; sign and one sighting of swamp wallaby have been recorded in recent years, the first since the 1800s;
- protected and conserved threatened species by supporting ecological research and modifying management actions based on results of that research; approximately 1.5ha of frog ponds have been created on Ash Island to provide 'stepping stones' for Green and Golden Bell Frog (*Litoria aurea*) between two known bell frog localities on Ash Island; further studies have been completed which will provide the basis for further habitat protection and enhancement; the outcome achieved is that threatened species and communities on project sites are now protected and habitat is being actively conserved and enhanced;
- decreased mosquito habitat resulting from increased tidal flushing of approximately 100ha on project sites and removal of cattle from intertidal wetlands;
- increased community access to and appreciation of the estuarine ecosystem through construction of 5km of cycleway, 3km of pathway, 730m of boardwalk and 9 bridges, improved access and amenity resulting in a large increase in visitor numbers at most popular fishing spots; visitation to Ash Island in 2003 was estimated to be 38,000 visits per annum and has increased significantly since that time; the outcome sought and achieved has been the changed behaviour of the visiting public to a more appropriate use of Ash Island and Stockton Sandspit. Use of Ash Island has shifted from primarily being subjected to inappropriate motor vehicle use and frequented by rubbish dumpers with the occasional fisher and bird observer to currently being visited primarily for the appreciation of its natural values, that is for fishing, observing birds, frogs and plants, walking, cycling, picnicking, studying and reminiscing; this transformation has been nothing short of remarkable. At Stockton Sandspit, vehicles are now kept off the main roost area and there is an awareness and appreciation amongst the fishers and the wider community of the importance of the site for shorebirds;

- developed visitor facilities on Ash Island: the restored 1890s Schoolmasters House includes visitor information, library, public display area, project offices, landscaped grounds with picnic areas and composting and portable toilet facilities; a WWII 131 Radar Station includes repaired buildings, estuarine ecosystem display, solar power lighting and disabled access composting toilet facilities; shed includes field office, workshop, plant and equipment storage; information bay on approach to island; 2km improved roads to Cobbans Creek Mangrove Walk car park and part of Milhams Road; 14km of graded road; 6 car parks; bench seating at key points along paths; 3 gazebos; community garden storage and work area;
- developed visitor information and education programs: guidance and worksheets for school groups (K-12), student research and projects, summer program of estuary boat tours for shorebird observation and history of the Hunter River islands, land-based tours for special interest groups and general public, 19 interpretive sites, 30 plant name, 10 precinct and 5 regulatory signs, 2 display areas, brochures and a website;
- involved the community through Kooragang Landcare: assistance with implementation of project works and day to day management of the site; approximately 200 people are on the volunteer register; with approximately 30 regularly attending the monthly planting days (3rd Sunday of the month), other volunteers assist during the week with the Community Garden, bush regeneration; maintenance; library, communication and administration; over 16,000 hours were contributed in 2006/2007 and 2007/2008;
- established Kooragang City Farm to demonstrate sustainable agriculture and farming in harmony with wetlands: City Farm including the Community Garden is widely recognised as a centre of expertise within the agricultural and environmental community; it is used by a range of groups for field days, study of grazing regimes and holistic management, school education and community work; City Farm has also established a unique resource for ongoing educational and research into farm management practices in coastal wetland areas; also delivers on AG funding priorities regarding improving soil carbon and provides a long term, holistically managed site with adjacent control site that can be used for monitoring and evaluation of soil carbon.
- provided opportunities for project sites to be used as outdoor laboratories for ecological research including mangrove hydrology, eco-hydraulics of shorebird habitat, shorebird ecology, green and golden bell frog conservation and fisheries habitat; assisted research with technical assistance and on-ground works, including support construction of an experimental saltmarsh scrape for a PhD study and an array of 24 mid-sized ponds for green and golden bell frog (*Litoria aurea*) research; field assistance for mosquito runnelling experiment, aerial photographs for remote sensing to track vegetation change;

- produced a body of information through project-related research that assists the project as well as other similar projects; over 80 reports, studies, theses, book chapters and books have been written containing a wealth of information that assists in modifying and improving management practices through an adaptive process (Appendix G); general fact sheets for public and landholder consumption are in preparation; this information and associated databases are kept in a library which is maintained by volunteers and open to the public at the Schoolmasters House;
- established and maintained partnerships with estuary-based industries demonstrating how conservation and industry can work together to their mutual benefit; the outcome has been continued sponsorship of KWRP and development of collaborative research projects;
- assisted in the promotion of Newcastle as a Clean and Green City by showcasing the transformation that has occurred through rehabilitating degraded habitat and developing rehabilitated areas into features worthy of a visit when in the area;
- established an international profile for the project through hosting delegations from countries interested in viewing rehabilitation in progress and exchange of information through the sister wetland affiliation with Kushiro Wetlands (Hokkaido, Japan); in 2003, the KWRP project manager was invited to present the keynote address to an international forum on wetland rehabilitation hosted by the Kushiro International Wetlands Centre; in November 2004 the sister wetland affiliation agreement was reaffirmed by local governments associated with Kushiro Wetlands, Newcastle City Council and Port Stephens Council on the 10 year anniversary of the first signing; a large, high level delegation from Kushiro visited Kooragang Wetlands in 2007;

Achievements and acknowledgements

The overall project has been recognised especially for its planning, partnerships and community involvement: 1995 RiverCare 2000 Gold Award for Community Projects; 1996 Metro Pride Award for Waterways and Foreshore Protection; Newcastle City Council Environmental Achievement Awards for 1995, 1996, 1998, 1999 Community Partnerships; 1997, 2001 Community Initiatives-Land Restoration; 2008 Newcastle City Council Service Award (Kooragang volunteers) and Newcastle Community Volunteer Award (Kooragang volunteers); 2009 regional Landcare Community Group award for major restoration project (Kooragang volunteers) and the 2009 regional Landcare Legend award to Kooragang volunteer Bea Brooks.

Kooragang City Farm is widely recognised as a demonstration site for farming in harmony with wetlands and for a best practice integrated grazing operation in a coastal area. Awards received by City Farm include the following: 1999 Kooragang City Farm: Community Initiatives-Rehabilitation & Restoration Category Winner; 2000 Hunter Farmer of Year – Highly Commended Open Agriculture; 1999 Readers Digest Environment Awards – Finalist; Greenhouse Allies Program Partner; Cattlecare Accreditation to 2009.

The project helped the then Hunter Catchment Management Trust (now Hunter-Central Rivers CMA) to receive the prestigious Thiess National River Prize which was presented at the International River Symposium (part of Brisbane's River Festival, September 2003). The award acknowledged the excellent work done by the former Trust regionally to improve the Hunter River.

An outcome of the on-going consultation and research reviews conducted has been the modification and deletion of some actions (see Appendix F for list of completed actions and list of deleted actions

Outstanding actions have been assessed as to their appropriateness according to the revised objectives and effectiveness given the success of past works. Actions that are still to be included in the project have been entered into the action plans in this document with comments as to whether they are modified from the previous management plan or newly formulated based on increased knowledge about the site (see Appendix E).

6. Actions (Strategic Management Direction for Project)

The core of the first KWRP Management Plan (1996) consisted of a list of actions that were required to achieve the on ground outcomes presented in the KWRP landscape design (1994). An estuary management program major capital works grant was awarded in 1997 to cover 40% of the estimated cost of the actions presented in the 1996 management plan.

Outstanding actions from the 1996 list and additional actions identified as being necessary to achieve the revised objectives of the project have been placed into the following action plan with seven categories as described below. Specific actions related to each category are presented in Appendix E.

1. Strategic

Strategic actions aim to ensure the security of tenure for KWRP sites as part of a larger conservation area. This includes establishing how site management will continue to be funded and administered and what management framework will oversee the planning and provide a line of accountability

The major capital works estuary management program grant that underpinned the establishment phase of KWRP was completed in 2006/2007. Additional estuary management program funding is sought on an annual basis. Negotiations are being held with Parks and Wildlife to consider operation and management of the project sites as they enter into the next phase of development. Funding to manage project sites during this transition phase will be sought from the CMA as well as local, State and Australian governments and local industry.

2. Operational

Operational actions include non-specialist staffing, reporting, weed and pest control, flood, fire and risk management, occupational health and safety and routine maintenance.

3. Water management

Water management includes setting tidal flows and retaining stormwater where appropriate. In the intertidal areas, flows will be adjusted to encourage the establishment of saltmarsh and habitat for migratory shorebirds whilst protecting threatened species that live in the area. Increasing tidal flows for enhancement of habitat for fish and crustaceans and management for mosquitoes is still desirable and is done so that threatened species and ecological communities are protected. Management of access roads and monitoring are important related actions.

4. Threatened/protected species and ecological communities

Actions in this section are those designed to extend or enhance specific threatened species or ecological communities. Many other project activities would directly or indirectly assist in achieving this objective especially those in the water management and vegetation sections.

5. Vegetation

Actions in this section primarily are aimed at linking and extending dry, littoral rainforest, open woodland and riparian vegetation in the more upland areas. The biological basis for much of this work is to conserve an endangered rainforest margin species, White *Cynanchum* (*Cynanchum elegans*). Other vegetation actions include wetland planting, landscaping, weed control and provision of access into revegetated areas and some wetland planting.

6. Kooragang City Farm

City Farm actions are used as a management tool for controlling kikuyu, improving soil condition, reducing biomass of grass in saltmarsh migration zones and improving selected wetlands for Latham's Snipe. City Farm also functions as a demonstration site for sustainable agricultural practices that are in harmony with rivers and wetlands. Practices include holistically managed grazing; off-stream watering; restored riverbank, wetlands and floodplain forest providing habitat, windbreaks and shelter; wet pasture management; community gardens incorporating permaculture and organic gardening methods; and mixed eucalypt farm forestry plantation.

Other important City Farm activities include preserving aspects of the social and natural history of the island; providing research opportunities (e.g. effect of grazing on wetlands); developing networks (e.g. Hunter Harvest, holistic decision-making); and communicating lessons learnt (e.g. field days, teaching).

City Farm encapsulates what the entire project is about and provides the vehicle through which the project sites can be managed into the long term.

7. Communication and promotion

Communication actions aim to ensure that visitors enjoy the site and learn about the value of estuaries in the process. Actions include providing guidance and resources to school groups, establishing training programs; providing support for Kooragang Landcare volunteers; developing and maintaining the project's website, signage and infrastructure for encouraging appropriate use and appreciation of the project sites; producing educational and communication resources (e.g. environmental history of the estuary, brochures); monitoring changes (e.g. photo survey, community survey); providing opportunities for tourism and outdoor education.

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8. Research

Research actions are aimed at providing sites for experimental ecological research as part of an adaptive management process; forming collaborative research ventures; assisting in establishing a GIS system to collate technical information gathered in the estuary; supporting efforts to form a research advisory committee for the estuary.

Issues:

Numerous delays have been encountered in the course of implementing this project. A few of the more significant factors include the following:

- Process of re-zoning Ash Island to conservation status;
- Kooragang International Airport proposal;
- Steelworks proposals; and
- Catchment Management Authority re-structure.

7. Management Structure

Project Management

The project was administered by the Hunter Catchment Management Trust from 1993 to 2004. In January 2004 the State Government brought in legislation that replaced the Trust with the Hunter-Central Rivers Catchment Management Authority (CMA). Under the Trust structure, the KWRP steering committee resolutions were presented to the Trust for approval. The Trust reported to the relevant State Minister which is the same line of accountability for the new CMA structure. The connection between this project and the related Hexham Swamp Rehabilitation Project is via the CMA as the administrator of both projects and attendance at the meetings of both by the project managers.

The project is managed through a steering committee currently made up of representatives of the CMA, Department of Environment and Climate Change and Water, Industry and Investment NSW, Newcastle City Council, Port Stephens Council, Hunter Water Corporation, Hunter Wetlands Centre and Hunter Bird Observers Club, along with community representatives.

Staff implements the project according to the management plan and resolutions of the KWRP steering committee that are put to the CMA Board for approval. Currently, KWRP staff consists of project manager, farm manager, public relations officer and conservation field officer. Much of the on-ground work especially planting, weeding and maintenance of vegetation and some office work is done by the Kooragang Landcare volunteer group and training program participants.

8. Future Management Options

Various long term management options have been considered for the Ash Island site in a number of forums since 2000 and are presented in Appendix K. Discussions have been held with major stakeholders as part of the current management plan revision process. The generally preferred option for Ash Island is that it be added to the national park estate and managed as part of a Hunter estuary conservation area capable of supporting the land uses and initiatives of KWRP as outlined in this document, especially with regard to Kooragang City Farm and community involvement.

The preferred option has been adopted and discussions are being held between CMA and Parks and Wildlife to confirm the on-going management of the site. Short term actions proposed to achieve the establishment of a long term management structure include resolving lease arrangements and logistics of administration, identifying sources of funding and monitoring the political environment to ensure the preferred option remains feasible and appropriate.

A transitional arrangement is required that incorporates the completion of the project and establishment of a long term management framework that ensures continuity of KWRP's conservation initiatives.

It is proposed that the current arrangement for managing the site through the CMA be maintained. Transitional funding will be applied for on an annual basis until the commencement of a long term management arrangement. Emphasis remains on maintaining volunteer and training group involvement, brokering sponsorship from industries that have a physical link to the estuary and generating funds from sales, tour and training fees and donations.

9. Monitoring, Evaluation and Reporting

The project has been documented and monitored (particularly through the use of photopoints) and research has been established to study wetlands and rehabilitation activities to improve management practices. Research partnerships have been large scale, long term, integrated and collaborative, resulting in a significant body of research.

Studies by undergraduate, Honours and PhD students from the University of Newcastle and other universities, research scientists and consultants provide current information on biophysical and socioeconomic aspects of the project. The project area provides field sites and other support for a range of research into estuarine ecosystem function. Of particular interest is the monitoring of shorebirds by HBOC, a created intertidal wetland by students (Laegdsgaard 2002) and water quality by volunteers.

Results of monitoring and other project related information is held in the KWRP library in the Schoolmasters House on Ash Island.

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KWRP was selected as one of the top 25 restoration projects in Australasia and is included in the Society of Ecological Restoration International's Global Restoration Network based in large part on the use of science in the restoration process.

In 2008, KWRP was selected as one of a few projects nationally and the only project in NSW to trial the Australian Government's Performance Story Reporting process. As part of this process, many interviews were conducted and a scientific panel reviewed evidence presented in numerous project-related studies and reports (see References and Appendix G) and assessed the project's achievement of its objectives.

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11. Abbreviations

AG	Australian Government
ANCA	Australian Nature Conservation Agency
DECCW	NSW Department of Environment and Climate Change and Water
CAMBA	China-Australia Migratory Bird Agreement
CAP	Catchment Action Plan
CMA	Hunter-Central Rivers Catchment Management Authority
DIPNR	NSW Department of Infrastructure, Planning and Natural Resources
DLWC	NSW Department of Land and Water Conservation
DPI	NSW Department of Primary Industries
Fisheries	NSW Fisheries
HCMT	Hunter Catchment Management Trust
H-CR CMA	Hunter-Central Rivers Catchment Management Authority
HSRP	Hexham Swamp Rehabilitation Project
HVRF	Hunter Valley Research Foundation
HWC	Hunter Water Corporation
HWCA	Hunter Wetlands Centre Australia
JAMBA	Japan-Australia Migratory Bird Agreement
KBR	Kellogg Brown and Root Pty Ltd
KWRP	Kooragang Wetland Rehabilitation Project
LHERP	Lower Hunter Estuary Rehabilitation Program (through DECCW)
LEP	Local Environmental Plan
LGA	Local Government Area
LHCCREMS	Lower Hunter and Central Coast Regional Environmental Management Strategy
MHL	Manly Hydraulics Laboratory
NCC	Newcastle City Council
NPWS	NSW National Parks and Wildlife Service
NSW	New South Wales
PSC	Port Stephens Council
PWS	NSW Public Works and Services (now Dept. of Commerce)
Ramsar	Ramsar Convention for Wetlands of International Significance
RLMC	Regional Land Management Corporation
SEPP	State Environmental Planning Policy

Appendix A Conservation significance of the Hunter River Estuary

- 'Wetland of International Importance' under the Ramsar Convention for its value as migratory shorebird habitat (Kooragang Nature Reserve in 1984 combined with the Shortland Wetlands as the Hunter Estuary Wetlands cluster in 2003); this is one of 12 listings in NSW;
- One of 8 localities in Australia named as sites on the East Asian-Australasian Shorebird Network;
- Habitat for 38 (NSW DPW 1979) species of migratory birds; habitat for these species is protected by international treaties with Japan and China (Japan-Australia Migratory Bird Agreement (JAMBA) and China-Australia Migratory Bird Agreement (CAMBA));
- Habitat for almost a quarter of Australian bird species (NSW DPW 1979);
- Most important estuary in NSW and the fifth most important in Australia for migratory shorebirds (NPWS 2001);
- Habitat for at least 27 threatened species (1 frog; 17 bird; 7 mammal; 2 plant);
- Regionally significant population of green and golden bell frog (*Litoria aurea*);
- Protected ecosystems (mangroves; littoral rainforest; proposal for saltmarsh to be listed as an endangered ecological community);
- Habitat for waterbirds;
- Significant areas of fisheries habitat (open water; mangroves; saltmarsh); extent of tidal wetland vegetation in 1979 comprised about 6% of similar remaining vegetation in NSW (NSW DPW 1979); fish species that make up 64% of the commercial catch in NSW are dependent on estuaries for some stage of their life cycle (Copeland and Pollard 1995);
- Listed on the Australian Heritage Commission's Register of the National Estate (Hunter Estuary Wetlands; Hexham Swamp Nature Reserve; SEPP 14 Coastal Wetlands bounded by 151 degrees 36 minutes 43 seconds in the west, 151 degrees 49 minutes 08 seconds in the east,
- Listed in the Directory of Important Wetlands in Australia (ANCA 1996);
- Kooragang Nature Reserve and Hexham Swamp Nature Reserve;
- Unique geomorphologic feature of Fullerton Cove (1,536ha) which provides critical feeding habitat for shorebirds when expanses of mudflats are exposed at low tide; Fullerton Cove is the largest of 30 Marine Protected Areas declared as parts of National Parks and Nature Reserves in NSW;

- Remnants of once extensive and commercially important floodplain littoral rainforest which has decreased by over 80% since European settlement.

Threats and losses to natural areas in the Hunter River estuary:

- As early as 1970, over 60% of the habitat most important for waterfowl had been lost or degraded (Goodrick 1970);
- Between 1954 and 1994, over 1300ha of fisheries habitat (loss of 1428ha saltmarsh and 344ha open water; gain of 400ha mangroves) have been lost in the Lower Hunter (not including losses in Hexham Swamp) and many estuarine and floodplain wetlands have been alienated from the river and are substantially degraded (Williams et al 2000);
- Diversity of estuarine habitat has declined due to losses in shoreline length, saltmarsh and open water. At least 18 of the 33 species of migratory wading birds using the estuary have declined in numbers, and the estimated mean number fell by nearly 50% between the 1970's and 1990's. (Kingsford and Ferster Levy 1997; Williams et al 2000).
- Estimates of habitat change between 1750-2000 (LHCCREMS mapping in MHL 2003) indicate that vegetation losses in the estuary include 84% (27km²) of saltmarsh; 21% (6km²) of mangroves and 81% (275km²) of non-tidal forests. One of the first industries in the estuary was the harvesting of commercially important timber (e.g. Red Cedar and Ash) from the floodplain rainforest which was then cleared for agriculture leaving only remnants of indigenous vegetation.
- Modifications have affected the hydrology and therefore the flora and fauna of the estuary. The number of structures increased from 0 in 1801 to in 1995 there being 42 bridges, 59 culverts, 11 floodgates, 57km of drains and 20km of levees (Williams et al, 2000).
- Flood mitigation scheme at Tomago consisted of 12km canals, 9.5km levees and 3 floodgates; the floodgates were installed in 1976 and the levee and Fullerton Cove ring drain were constructed in 1980 (HVFM-PW Plan 1987).
- Early filling of the Spectacle Islands to form Walsh Island, the Kooragang Island scheme and flood mitigation works has resulted in the number of islands being reduced from 20 to 4, the shoreline index being halved between the 1970's and 1990's (Kingsford and Ferster Levy 1997), and more than 1300ha of fisheries habitat (open water, mangroves and saltmarsh) being lost between 1954 and 1994 (Williams et al 2000).
- Numbers of shorebirds in the estuary have decreased by 50 to 75%. The number of migratory shorebirds were estimated to be approximately 8,000 (Kingsford and Ferster Levy 1997) to 16,000 (pers. comm. local bird observers) in the 1970's with numbers decreased to approximately 3600 in 2003 (HBOC pers. comm.). This reduction has been accompanied by a documented loss in shorebird roost sites throughout the estuary due to direct and indirect modification and the associated encroachment by mangroves and exotic weeds.

Policy references to the significance of Hunter River estuary's natural areas:

NSW Healthy Rivers Commission Inquiry (2002)

The condition of river corridors, river flows and water quality should be improved, to support a modified ecosystem. In the estuary typical actions would be to protect near-natural wetlands and foreshores, water quality and tidal flows; and to rehabilitate degraded but potentially valuable floodplain wetlands and estuarine habitat where practical, including restoration of some river-floodplain connectivity. (paraphrased from Table 4.1, p. 19)

The Commission believes that repair of the landscape, especially the river corridors (including the estuary), is the most important component of a strategy for achieving long term river health in the Hunter Valley. (p. 37).

Coastal Policy 1997:

Seagrass, mangrove, saltmarsh and other wetland associated species will be conserved and managed as valuable components of the coastal ecosystem by effectively implementing existing controls (eg SEPP 14, Fish Habitat Protection Plans, Ramsar listing of important wetlands) and through controlling runoff, sedimentation and other water quality impacts. (p. 43)

Objective 1.5

Local government and (DIPNR), through programs such as Landcare, Coastcare and Rivercare, will continue to involve the community in implementing measures to protect and rehabilitate natural areas;

Catchment management committees and trusts will continue to play an influencing role in protection and restoration of coastal environments.

Lower Hunter Conservation – Issues Paper, Draft, Version B (NPWS 2001):

The estuary and wetlands in the lower catchment of the Hunter River are widely regarded as the most significant area of migratory wader habitat in NSW and the fifth most important in Australia. The lower catchment also contains important remnants of littoral rainforest, old growth forest, threatened fauna and flora species, and a diverse range of Aboriginal cultural heritage sites.

Appendix B Threatened species and communities in KWRP area

Common name	Scientific name	TSC Act			FM Act	EPBC Act				CAMBA/JAMBA	Locality A=Ash Is S=Stockton Sandspit T=Tomago	Comments
						Thr	Mig-wet	Mig-terr	Marine			
		1	2	3		Thr	Mig-wet	Mig-terr	Marine			
Amphibians												
Green and Golden Bell Frog	<i>Litoria aurea</i>	E				V					A	Kooragang Is population listed as a key population in the Hunter Valley in NSW NPWS Draft GGBF Recovery Plan (R. Wellington)
Birds												
Common Sandpiper	<i>Actitis hypoleucos</i>									CJ	A	
Magpie Goose	<i>Anseranas semipalmata</i>		V								A	
Fork-tailed Swift	<i>Apus pacificus</i>									CJ	A	
Great Egret	<i>Ardea alba</i>									CJ	A	
Cattle Egret	<i>Ardea ibis</i>									CJ	A	
Ruddy Turnstone	<i>Arenaria interpres</i>						x		x	CJ	A	
Australasian Bittern	<i>Botaurus poiciloptilus</i>		V								A	
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>									CJ	A	
Sanderling	<i>Calidris alba</i>		V								A	
Red Knot	<i>Calidris canutus</i>									CJ	A	
Curlew Sandpiper	<i>Calidris ferruginea</i>						x		x	CJ	A	
Pectoral Sandpiper	<i>Calidris melanotos</i>									J	A	
Red-necked Stint	<i>Calidris ruficollis</i>									CJ	A	
Great Knot	<i>Calidris tenuirostris</i>									CJ	A	
Greater (Large) Sand Plover	<i>Charadrius leschenaultia</i>		V							CJ	A	
Lesser Sand-plover, Mongolian Plover	<i>Charadrius mongolus</i>		V				x		x	CJ	A	
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	E									A	
Latham's Snipe, Japanese Snipe	<i>Gallinago hardwickii</i>						x		x	CJ	A	

Common name	Scientific name	TSC Act			FM Act	EPBC Act				CAMBA/JAMBA	Locality A=Ash Is S=Stockton Sandspit T=Tomago	Comments
						Thr	Mig-wet	Mig-terr	Marine			
		1	2	3				x	x	C	A	
White-bellied Sea Eagle	<i>Haliaeetus leucogaster</i>							x	x	C	A	
Grey-tailed Tattler	<i>Heteroscelus brevipes</i>									CJ	A	Previously known as <i>Tringa brevipes</i>
Wandering Tattler	<i>Heteroscelus incanus</i>									J	A	Previously known as <i>Tringa incana</i>
White-throated Needletail	<i>Hirundapus caudacutus</i>							x	x	CJ	A	
Black Bittern	<i>Ixobrychus flavicollis</i>		V								A	
Broad-billed Sandpiper	<i>Limicola falcinellus</i>		V				x		x	CJ	A	
Asian Dowitcher	<i>Limnodromus semipalmatus</i>									CJ	A	
Bar-tailed Godwit	<i>Limosa lapponica</i>						x		x	CJ	A	
Black-tailed Godwit	<i>Limosa limosa</i>		V				x		x	CJ	A	
Black-faced Monarch	<i>Monarcha melanopsis</i>							x	x		A	
Yellow Wagtail	<i>Motacilla flava</i>									C	A	
Eastern Curlew	<i>Numenius madagascariensis</i>						x		x	CJ	A	
Whimbrel	<i>Numenius phaeopus</i>						x		x	CJ	A	
Blue-billed Duck	<i>Oxyura australis</i>		V								A	
Osprey	<i>Pandion haliaetus</i>		V								A	
Ruff	<i>Philomachus pugnax</i>									CJ	A	
Pacific Golden Plover	<i>Pluvialis fulva</i>						x		x		A	<i>Pluvialis fulva</i> to be added and <i>Pluvialis dominica</i> to be removed from JAMBA by end 2002.
Grey Plover	<i>Pluvialis squatarola</i>									CJ	A	
Rufous Fantail	<i>Rhipidura rufifrons</i>							x	x		A	
Painted Snipe	<i>Rostratula benghalensis</i>	E					x		x	C	A	
Little Tern	<i>Sterna albifrons</i>	E								CJ	A?	Draft Recovery Plan available from NSW NPWS website; (Hunter Estuary; not sure if on Ash Is)
Caspian Tern	<i>Sterna caspia</i>									CJ	A	
Freckled Duck	<i>Stictonetta naevosa</i>		V								A	
Wood Sandpiper	<i>Tringa glareola</i>									CJ	A	
Greenshank, Greenshank	Common <i>Tringa nebularia</i>						x		x	CJ	A	

Common name	Scientific name	TSC Act			FM Act	EPBC Act				CAMBA/JAMBA	Locality A=Ash Is S=Stockton Sandspit T=Tomago	Comments
		1	2	3		Thr	Mig-wet	Mig-terr	Marine			
Little Greenshank, Marsh Sandpiper	<i>Tringa stagnatilis</i>						x		x	CJ	A	
Buff-breasted Sandpiper	<i>Tryngites subruficollis</i>									J	A	
Grass Owl	<i>Tyto capensis</i>		V									
Masked Owl	<i>Tyto novaehollandiae</i>		V								A	June 2002 - roadkill on Ash Is bridge
Terek Sandpiper	<i>Xenus cinereus</i>		V				x		x	CJ	A	
											A	
Mammals											A	
Little Bentwing-bat	<i>Miniopterus australis</i>		V								A	
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>		V								A	
Eastern Freetail-bat	<i>Mormopterus norfolkensis</i>		V								A	
Large-footed Myotis	<i>Myotis adversus</i>		V								A	
Grey-headed Flying fox	<i>Pteropus poliocephalus</i>					V					A	
Yellow-bellied Sheathtail-bat	<i>Saccolalmus flaviventris</i>		V								A	
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>		V								A	
											A	
Plants											A	
White Cynanchum	<i>Cynanchum elegans</i>	E									A	
	<i>Zannichellia palustris</i>	E									A	

Threatened ecological communities related to Kooragang Wetland Rehabilitation Project area

Community	Loss in Hunter estuary	Listing	Status on KWRP area	Comments
Hunter River estuary floodplain forest				
Sydney Coastal Estuary Swamp Forest in the Sydney Basin Bioregion		Endangered Ecological Community, TSC Act	Some species in common; similar geographic area; same bioregion	11 of 30 plant species that characterise the community are found Ash Is.
Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast bioregions		Endangered Ecological Community, TSC Act	Some species in common; similar geographic area; same bioregion	Maitland, Cessnock, Port Stephens, Muswellbrook and Singleton; most generally open forest with most common canopy tree species being <i>Eucalyptus tereticornus</i> and <i>Eucalyptus punctata</i>
Lowland Rainforest on Floodplain in the New South Wales North Coast bioregion		Endangered Ecological Community, TSC Act		Number of shared species to be checked
Mangroves		FM Act		Part 7, Division 4 - Protection of mangroves and certain other marine vegetation
Coastal saltmarsh		Endangered Ecological Community, TSC Act		
? Sydney Freshwater Wetlands in the Sydney Basin bioregion			Not relevant to Kooragang Island	7 species found (possibly 11 species - to be confirmed); soil characteristics are likely not to be the same (KWRP Expert Panel report)

Key threatening processes relevant to KWRP area

Key Threatening Process	Status on KWRP sites	Comments
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	Widespread	
Predation by <i>Gambusia holbrooki</i> (Plague Minnow or Mosquito Fish)	Widespread	
Invasion of native plant communities by exotic perennial grasses	Widespread	Buffalo grass (<i>Cenchrus ciliaris</i>); and kikuyu (<i>Pennisetum clandestinum</i>)

Appendix C Relevant legislation, policies, strategies and plans

Legislation or Policy	Purpose
Local	
Development Control Plan 41: Kooragang Port and Industrial Area (1999)	
Hunter Estuary Management Plan (2009)	
Newcastle Biodiversity Strategy (2006)	
Newcastle City Council's Economic Development Strategy (2000)	
Newcastle City Council's Management Plan	
Newcastle Community Plan (2006-2010)	
Newcastle Environment Management Plan (2003)	
Newcastle Green Spaces Strategy	
Newcastle LEP 2003	Zoning
Newcastle Tourism: Tourism Development Plan	
Port Stephens LEP	Zoning
Regional	
Hexham Swamp Rehabilitation Project Management Plan	
Hunter-Central Rivers Catchment Management Authority Catchment Action Plan (2006-2016)	Management targets for five themes of natural resource management
Kooragang Wetland Rehabilitation Project Management Plan (1996)	
New South Wales	
Catchment Management Authorities Act 2003 (repealed Catchment Management Act 1989)	Provides for a management framework to achieve better integrated and-use management in catchments
Crown Lands Act 1989	Provides a regime for the ownership and management of Crown Land
Drainage Act 1939	Enables landowners to join together to carry out drainage works, or works to mitigate the effects of floods or tides
Environment Operations Act 1997	
Environmental Planning and Assessment Act 1979	Establishes processes and requirements for assessment of development consents
Estuary Management Manual (1992)	General principles for estuary management
Fisheries Management Act 1994 (amended 2001)	Establishes responsibility for management and protection of marine, estuarine and freshwater fish and mangroves
Fire Brigades Act 1989	Provides for the protection of persons and property from fire and hazardous incidents
Floodplain Management Policy	Provides for the reduction of flooding impacts and flood liability by flood mitigation works and

Legislation or Policy	Purpose
	measures, and by effective planning and development controls
Heritage Act 1977	Defines permissible work in sites of Historic Heritage
Hunter River: Independent Inquiry into Hunter River System	Ar8.1 Trust developed 'river friendly' approaches to stream rehabilitation adopted; AR9.1 A more holistic approach should be followed in design and delivery of agricultural research and extension programs (City Farm); AR9.3 All agencies managing 'public' property should set an example in land management by integrating explicit biodiversity and river health goals with their core business goals for the land; KR5 A comprehensive development and environmental management plan for Newcastle Harbour...to deals with the significant and complex interactions between commercial and environmental goals for the port/estuary
Hunter Valley Flood Mitigation Act 1956 (repealed and most provisions incorporated into the Water Management Act 2000)	Provides for flood mitigation and streambank stabilisation activities to be carried out in the Hunter Valley
Kooragang Nature Reserve and Hexham Swamp Nature Reserve Plan of Management (1998)	
Local Government Act 1993 (amended 2000)	Allows Local Government to undertake a range of functions and responsibilities
National Parks and Wildlife Service Act 1974 (amended 2001)	Provides a framework for managing national parks and reserves as well as providing mechanisms to conserve and manage cultural and natural heritage
Native Vegetation Conservation Act 1997	Provides for the protection of native vegetation except mangroves
Noxious Weeds Act 1993	Provides for control and removal of noxious weeds
Occupational Health and Safety Act 2000	Provides for health, welfare, and safety in the workplace
Pipelines Act 1967	Provides for the construction, operation and maintenance of pipelines; and for purposes connected therewith
Protection of the Environment Operations Act 1997	Provides for the prevention of environmental degradation, involving pollution prevention, cleaner production, reduction to harmless levels of discharge, recycling, and progressive environmental improvements
Public Health Act 1991	Relates to the maintenance of proper standards of health for the public (eg in relation to mosquito borne diseases)
Regional Environmental Plan	Indicates conservation areas
Rivers and Foreshores Improvement Act 1948	Regulates the excavation and removal of material from land within 40m of a water body
Rural Fires Act 1997	Defines permissible work with regard to fire risk
Soil Conservation Act 1938	Protects sensitive areas from tree removal
State Emergency and Rescue Management Act 1989	Provides for the management of State emergency and rescue operations (eg in relation to floods)
State Environmental Planning Policy 14	Provides for the protection of coastal wetlands
State Environmental Planning Policy 26	Provides for the protection of littoral rainforest
State Environmental Planning Policy 71	Provides for the co-ordinated planning of coastal lands
State Environmental Planning Policy 74	Provides for an approval process for steelworks at Tomago wetlands, transport corridor across Ash Island and ancillary works in Hunter River
Threatened Species Conservation (TSC) Act 1995	Establishes a process for classifying and protecting endangered species and critical habitats
Water Act 1912	Provides for water rights, water and drainage, drainage promotion, and artesian wells
Water Management Act 2000 (amended 2002)	Provides for the management of water resources, including administrative process to manage surface and subsurface water (incl. wetlands), and Hunter Valley Flood Mitigation activities
Wetlands Management Policy (NSW DLWC 1996b); component of State Estuaries and	Provides for ecologically sustainable use, management and conservation of wetlands in NSW for the

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Legislation or Policy	Purpose
Rivers Policy	benefit of present and future generations; wise use, best management practice and rehabilitation of wetlands
Commonwealth	
China/Australia Agreement for the Protection of Migratory Birds and their Environment (CAMBA)	
Convention on Wetlands of International Importance (Ramsar Convention)	
Environment Protection and Biodiversity Conservation Act 1999	
National Strategy for Ecologically Sustainable Development	
Japan/Australia Agreement for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (JAMBA)	
Shorebird Network Action Plan	Identifies important sites on the shorebird flyways
Wetlands Policy of the Commonwealth Government of Australia	Supports conservation, repair and wise management of wetlands

Appendix D Vision, policy statement and guiding principles

Vision

An estuary in which healthy, restored fisheries, shorebird, threatened species and other wildlife habitat is in balance with a thriving port, the whole providing opportunities for research, education and recreation for people.

Policy Statement

Recognising:

- that Kooragang Wetlands (including Ash Island and Stockton Sandspit) and Tomago Wetlands are vital components of the natural environment of the Hunter Region and have a special role in relation to the regional way of life;
- that Kooragang and Tomago wetlands are unique within the region and their ecological characteristics have intrinsic values;
- that Kooragang and Tomago wetlands play a critical role in the management of water resources, the functioning of the lower Hunter River catchment and the health of the estuary;
- that Kooragang and Tomago wetlands provide an important link in the natural corridor extending from the coast at Stockton Bight through to Hexham Swamp and the forested Sugarloaf Range and Watagan Mountains;
- that steps must be taken to stop the degradation and destruction of Kooragang and Tomago wetlands while recognising that there will be ongoing human uses of these areas that must be managed for long-term ecological sustainability;
- that we have the technical capacity to repair these wetland areas and such rehabilitation is an integral part of managing this region in the long-term interests of the environment, the economy and our way of life;
- that effective management of Kooragang and Tomago wetlands requires cooperation between Government and the community; and
- that project activities comply with Federal, State and Local legislation, regulations and policies.

Guiding Principles

Guiding principles are designed to assist in the decision making process and used as a filter by the Kooragang Wetland Rehabilitation Project when embarking on major activities. In addition, the decision making process for all major project activities includes sufficient communication and consultation and use of the best information available.

The following guiding principles were developed with the assistance of an expert panel (KWRP Expert Panel 2002), as well as with significant input from community and agency representatives at the Creek 3 workshop held in October 2003 (Peterkin & Assoc. 2003):

- Focus on ecosystem processes rather than individual species within the limits of relevant legislation; use balanced approach to consider all ecological units and aim for holistic management of the site.
- Apply the precautionary principle and concept of managing for sensitive end points when considering threatened species and communities.
- Manage in a risk adverse manner while implementing adaptive management where practicable.
- Recognise and respect existing ecological processes, including hydrologic regimes, and that the whole system is already highly modified and a return to "natural" conditions might be difficult or impossible.
- Recognise and respect ecological processes in place prior to human modification.
- Acknowledge the dynamic nature of the estuarine ecosystem, especially with regard to hydrological processes (global warming/sea level rise, port dredging, increased catchment influences from development, etc).
- Avoid fragmentation and compartmentalisation of habitats.
- Set achievable and quantifiable objectives for actions.
- Monitor and evaluate all works to determine success of the activity or to detect any adverse impacts as they arise.
- Ensure that decisions and actions are reversible or that contingency plans are in place before an activity is undertaken to deal with any unforeseen or adverse circumstances arising from that activity.
- Give preference to soft engineering options.

Decision Making Process

- Identify the decision to be made
- Refer or present to stakeholders for input
- Refer for expert opinion
- Document and collate all information and input
- Make all information and input freely available to interested parties
- Refer to KWRP Steering Committee for decision
- Present decision and justification to stakeholders

References:

Kooragang Wetland Rehabilitation Project Expert Panel. 2002. Management of threatened species and ecological communities on Ash Island: recommendations of an expert panel. Report prepared for the Kooragang Wetland Rehabilitation Project (October 2002).

Peterkin & Assoc. Pty Ltd. 2003. Creek 3 Rehabilitation Plan workshops. Report prepared for Kooragang Wetland Rehabilitation Project (October 2003).

Appendix E Kooragang Wetland Rehabilitation Project action plan

NB: Regular font indicates outstanding actions from KWRP Management Plan (1996); italics indicate on-going or new actions;
 S=Staff; AD&S = Administration & Staff; C=Communication; MER=Monitoring, evaluation & reporting; CF=City Farm; Crabhole Ck=CK1; Cobbans Ck=Ck2; Dead Mangrove Ck=Ck3; Wader Ck=Ck4; Fish Fry Ck=Ck5; Mosquito Ck=Moscheto Ck; Ent=Entrance precinct; RP=Riverside Park; SPT=Scotts Point; SS=Stockton Sandspit; TW=Tomago Wetlands SH=Schoolmasters House; RB=Radar Buildings; WP=whole project; KWRP=Kooragang Wetland Rehabilitation Project; HCRCMA=Hunter-Central Rivers Catchment Management Authority; DECCW=Department of Environment, Climate Change and Water; DC=Department of Commerce; HDC=Hunter Development Corporation; HBOC=Hunter Bird Observers Club; NCC=Newcastle City Council; Vol=Kooragang Landcare volunteers

1. Strategic activities

Objective	Description of activity	Comments
8.	Consider the contribution of KWRP to the larger estuarine wetland complex of the Hunter Estuary in the development a long-term management framework for the Green Corridor and regional network of protected natural areas	
Initial action	Annex Hexham Island and Area C to Hunter Wetlands National Park	Under consideration by DECCW as part of Lower Hunter Regional Strategy
	<i>Establish long-term sustainable management structure for Ash Island based on KWRP objectives and achievements</i>	

2. Operational activities

Objective	Description of activity	Comments
18.	Maintain access and infrastructure for visitors in consultation with utilities	
14.	Enhance opportunities for passive outdoor recreation and nature appreciation	
Initial action	<i>S: Conservation Field Officer (on-going)</i>	Minimum requirement for maintaining Ash Island site; supervises and provides materials and services to volunteers
	<i>WP: On-going maintenance</i>	Volunteers; community programs
	<i>SH: Security for house and shed site (on-going)</i>	Back to base system
	<i>WP: Flood, fire and risk management plans</i>	Flood plan to be finalised; fire plan commenced
	<i>Signage: Dead Mangrove, Wader, Fish Fry cks, WP (20%)</i>	
19.	Facilitate day to day management of the project	
Initial action	<i>S: Project Manager (on-going)</i>	
	<i>S: Farm Manager (on-going)</i>	Planning/design/implementation; works supervision

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3. Threatened/protected species activities

Objective	Description of activity	Comments
1.	Protect threatened/protected species and communities along with other species and communities of conservation significance	
Initial action	<i>Modified</i> – Wader and Fish Fry cks: Wetland creation feasibility, survey & concept layout to maintain saltmarsh as shorebird habitat, to retain peripheral swales as GGBF habitat and to maintain fish passage consistent with other biological objectives	Completed: Ecohydrology PhD completed; shorebird ecology and GGBF PhDs; recommendations based on research results for management of water flows finalised
	<i>Modified</i> – Dead Mangrove Ck: Open culvert 3 & establish pedestrian crossing; replace remaining culverts (see comments); revised plan based on increased knowledge of creek and surrounds aims to protect GGBF habitat and saltmarsh flats for shorebirds whilst restoring flows within defined creek line	Completed: Flow into creek from South Arm kept the same with dropboard structure; Expert panel, stakeholder workshop, rehabilitation plan, EPBC referral determination, DA submitted to NCC; Director-General requirements letter, consultant selected for EIS. Reconvene key stakeholders to agree on action plan. Completed: Construct boardwalk across creek (away from mouth) for pedestrians and cyclists; quotes for construction received
	<i>Modified</i> – Dead Mangrove Ck: Interpretive sites No. 7 investigation zone; No. 8 nature in an industrial area; No. 9 <i>Typha</i> swamp; No. 10 remnant woodland	More appropriate site found to combine messages at elevated site, Crakes Corner
	<i>Modified</i> - Interpretive site No. 11 fresh water swamp (originally to be at Dead Mangrove Ck	Will be located at Cabbage Tree Rd at fresh and brackish crossing; no actual freshwater swamps at Dead Mangrove Ck
Monitoring	<i>GGBF surveys; water quality and level monitoring</i>	
Corrective action	<i>Implement Creek 3 (Dead Mangrove Creek) Rehabilitation Plan</i>	Adaptive strategy identifies list of actions that can achieve both preserve GGBF and shorebird habitat and a healthier creek
	<i>WP: Implement recommendations of Expert Panel report</i>	Guiding principles; investigation, design; works
Initial action	<i>Confirm - SS: Construct mangrove boardwalk</i>	Confirm views of Parks and Wildlife
Monitoring	<i>Monthly estuary shorebird survey</i>	HBOC
Corrective action	<i>Shorebird habitat enhancement and maintenance in wider estuary</i>	

4. Water management activities

Objective	Description of activity	Comments
2.	Enhance habitat for estuarine flora, in particular saltmarsh, and fauna, in particular migratory shorebirds, fish and crustaceans	
Initial action	<i>Modified</i> – Crabhole Ck: Wetland creation, survey & concept layout, approvals (SOE, 8-Part Test, ASS plan, EPBC), earthworks	Rainwater has been allowed to collect in this former paddock and it has self-designed into wet meadow with increased <i>Juncus usitatus</i> , <i>Typha</i> and other native wetland species; Grass Owl has been reported in north eastern section of this area; about 20% of site will be assessed for suitability for wetland creation, possibly for GGBF.
	<i>Modified</i> – Dead Mangrove Ck: Replace remaining culverts; Wader Creek: Open culvert 4 & bridge crossing; Wader Ck: Replace remaining culverts, wetland creation survey & concept layout; Fish Fry Ck: Replace remaining culverts	See comment for Area E and Dead Mangrove Ck for threatened/protected species.
	<i>Modified</i> - TW: Re-introduce tidal flushing – open gates; <i>no removal of levee</i>	Parks and Wildlife is proponent and consent authority for current actions; SmartGates installed and trial openings completed; culverts have failed twice (2009,2010) at northern end of 10 Foot Drain; gates shut until culverts are repaired.
	TW: Maintenance	
Monitoring	<i>TW: Hydrology, vegetation, birds, mosquitoes, fish, water quality</i>	
Initial action	Mosquito Ck: Cobbans and Dead Mangrove cks connection feasibility, survey & modelling	Initial consideration by individuals from community
	Mosquito Ck: Electricity service road access feasibility study	Completed: Repairs done by EnergyAustralia
3.	Increase flushing of tidal creeks which have become stagnant and restore creek beds, taking into account habitat requirements for threatened and protected species and maintaining saltmarsh	
17.	Manage mosquitoes	
Initial action	<i>Modified</i> – Open culverts in Wader and Fish Fry cks <i>as per recommendations from ecohydraulic study</i>	Original hydrologic actions in Area E (Wader and Fish Fry cks) replaced with new recommendations from PhD study Completed: Hydrologic control structure constructed by NCIG
Monitoring	<i>HBOC monthly estuary shorebird surveys</i>	
Corrective action	<i>Manage water flows</i>	

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5. Vegetation activities

Objective	Description of activity	Comments
1.	Protect threatened/protected species and communities along with other species and communities of conservation significance	
2.	Enhance habitat for estuarine flora, in particular saltmarsh, and fauna, in particular migratory shorebirds, fish and crustaceans	
6.	Manage pest and weed species	
11.	Protect Aboriginal and European cultural heritage values	
Initial action	<i>WP: Maintenance (on-going)</i>	
	<i>Modified (on-going) - Spt: Establish areas 3 & 4; Scotts Point revegetation to establish native understorey and groundcover and extend rainforest and woodland where appropriate</i>	Establishing core of rainforest corridor, grading to open woodland then to wetland; more appropriate for landscape; volunteers and training groups
	<i>Vegetation plan</i>	Database completed; draft document produced
	<i>Establish native grass pasture at Radar Building; Scotts Point and other appropriate areas</i>	In progress: Native grass pasture in eastern paddocks on City Farm by HWC as restoration of ASS treatment site for Tomago Trunkmain pipeline replacement
5.	Enhance riverine corridor vegetation and riverbank stability	
Initial action	Spt: Interpretive site No. 6 Scott's Point including cabbage tree palms	
	<i>Confirm</i> – TW: Re-vegetation – preparation, control & planting	As per Parks and Wildlife REF for current Tomago actions

6. Kooragang City Farm activities

Objective	Description of activity	Comments
7.	Develop Kooragang City Farm as a demonstration site for farming in harmony with wetlands and management based on holistic decision-making	
9.	Assist research initiatives through facilitating collaborative projects and providing research sites	
Initial action	<i>City Farm Manager (on-going)</i>	
	<i>Improve pasture (on-going)</i>	
	<i>Modified - Develop experimental research program</i>	Opportunities provided for research into sustainable land management (natural resource management/wetlands/agriculture)
	<i>Use cattle to manage remaining kikuyu pastures and selected wetland areas</i>	In progress: Managed grazing being trialled as a method of enhancing an area for Latham's Snipe.
Monitoring	<i>Ecocheck monitoring program (on-going)</i>	
11.	Protect Aboriginal and European cultural heritage values	
12.	Facilitate community involvement activities through an education and extension program that features Kooragang City Farm	
14.	Enhance opportunities for passive outdoor recreation and nature appreciation	
Initial action	<i>Develop educational material & events (on-going)</i>	Signage at Community Garden and Bush Food Garden gazebos; brochures, websites and displays
	<i>Interpretive site No. 5 Milham's farmhouse</i>	Draft sign produced; Achieves objectives 11, 12, 13; possible tertiary level archaeology project; collaborative with communications officer
	<i>Community garden/orchard/bush food garden (on-going)</i>	

7. Communication and promotional activities

Objective	Description of activity	Comments
12.	Facilitate community involvement activities through an education and extension program that features Kooragang City Farm	
Initial action	<i>S: Communications officer (on-going)</i>	Schools, tours, events, newsletters, updates, website
Monitoring	<i>C: Community awareness (on-going)</i>	Survey
13.	Encourage use of Kooragang and Tomago wetlands for educational purposes	
11.	Protect Aboriginal and European cultural heritage values	
Initial action	<i>Ent: Install Gateway/Hunter Wetlands National Park sign</i>	Completed
	<i>SH: Signs about the farming families of the estuary islands</i>	
	<i>SPT: Interpretive site No. 3 remnant dairy</i>	Draft sign completed
	<i>RB: Install display in building 2 opportunity for historical or Aboriginal cultural display linked to Mur-rung Korung</i>	
	<i>Modified - RB: Design and build additional displays – student</i>	Considering how second room is best used
	<i>Modified - WP: Interpretive site No. 4 (Hunter Wetlands National Park Gateway sign at Entrance)</i>	Completed: Gateway sign finalised and installed on Ash Island
	<i>Modified - WP: Interpretive site No. 14 Juncus wetland</i>	Relocate to more accessible site; former site of No. 13; layers of intertidal vegetation
	<i>Confirm - WP: Erect interpretive sites along national park track</i>	Confirm with Parks and Wildlife
	<i>Confirm - TW: Interpretive site No. 18 Tomago House</i>	Tomago actions require Parks and Wildlife and HDC approval
	<i>Confirm - TW: Interpretive site No. 19 mangrove & saltmarsh ecology</i>	
<i>Confirm - TW: Interpretive site No. 20 tide gates</i>		
<i>Confirm - TW: Interpretive site No. 21 migratory wading birds</i>		
14.	Enhance opportunities for passive outdoor recreation and nature appreciation	
Initial action	<i>Implement recommendations from recreation and tourism resource assessment (Markwell 2006)</i> <i>Implement revised Entrance Precinct landscape plan (Milne Home 2008)</i> <i>Implement other revised plans including Riverside Park landscape plan (in prep)</i>	Commenced (Upgrade information bays - completed; relocate shed – in progress; upgrade Ash Is Br car park; construct Discovery Boardwalk – DA submitted) In progress (DA received; CC imminent) DA application submitted
	<i>Modified - RB: Construct shelter (to do), bird hide (to do) & tower for school and other groups (observation mound)</i>	Mounds constructed in place of tower; bird hide at Nev's Nook

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Objective	Description of activity	Comments
	WP: Upgrade service trail/bike path through nature reserve	Part of access road upgraded by EnergyAustralia
	WP: Design project wide cycleway incl links to HWCA (partial)	Include in 'Gateway' planning
	<i>Investigate possible canoe paths on Ash Island</i>	
	<i>Confirm - WP: Design & approve bicycle & canoe link to HWCA</i>	Include in 'Gateway' planning
	<i>Confirm - Establish ped/bicycle paths stage 3</i>	National Park link; need Parks and Wildlife approval and HBOC support
	<i>Confirm - Design, approve & construct ped/bike crossing at pipeline</i>	More costly than original estimate; need strategic link
	<i>Confirm - TW: Design pedestrian/bicycle paths to link interpretive sites</i>	Tomago actions require Parks and Wildlife and HDC approval
	TW: Construct path network – buffer zone	
	TW: Construct path network – nature reserve	
	TW: Construct bird hide	
	TW: Design & construct mangrove boardwalk	
	TW: Design & construct wharf	
SS: Maintenance (on-going)	Rubbish removal	
15.	Promote the Hunter Estuary as a centre of excellence in sustainable wetland management	
16.	Maintain international profile of wetlands of the Hunter River estuary	
Initial action	<i>Modified - C: Publish book on history of the estuary – recoup by sales; self-publish in chapters as they are completed; place on website</i>	In preparation with volunteer assistance
	<i>Develop series of fact sheets on outcomes of project</i>	Commenced
	<i>Host site inspections by international groups (on-going)</i>	
	<i>Give presentations at international forums</i>	Presentation at SERI conference (Perth 2009)

8. Research activities

Objectives	Description of activity	Comments
9.	Assist research initiatives through facilitating collaborative projects and providing research sites	
10.	Assess rehabilitation/creation success and guide management actions of this and other rehabilitation projects through applied research	
Initial action	MER: Research equipment & scholarships (on-going)	Funding application for bat study; anabat purchased
	MER: Biological & physical process experimental studies (on-going)	Weekly water quality monitoring
13.	Encourage use of Kooragang and Tomago wetlands for educational purposes	
Initial action	<i>University and TAFE lecturers use site for courses related to natural resource management</i>	

Appendix F

Completed actions, 1995 - 2007

Kooragang Wetland Rehabilitation Project actions completed, 1995 – 2007; actions required to be on-going are indicated.

NB: Regular font indicates outstanding actions from KWRP Management Plan (1996); italics indicate on-going or new actions;

S=Staff; AD&S = Administration & Staff; C=Communication; MER=Monitoring, evaluation & reporting; CF=City Farm; Crabhole Ck=CK1; Cobbans Ck=Ck2; Dead Mangrove Ck=Ck3; Wader Ck=Ck4; Fish Fry Ck=Ck5; Mosquito Ck=Moscheto Ck; Ent=Entrance precinct; RP=Riverside Park; SPt=Scotts Point; SS=Stockton Sandspit; TW=Tomago Wetlands SH=Schoolmasters House; RB=Radar Buildings; WP=whole project; KWRP=Kooragang Wetland Rehabilitation Project; HCRCA=Hunter-Central Rivers Catchment Management Authority; DECCW=Department of Environment, Climate Change and Water; DC=Department of Commerce; HDC=Hunter Development Corporation; HBOC=Hunter Bird Observers Club; NCC=Newcastle City Council; Vol=Kooragang Landcare volunteers

Area	Activity	Comment
Ck1	Open Culvert 1 & establish bridge	Constructed free-spanning log bridge; creek vegetation allowed to self-design
Ck1	Signage	
Ck1	Reveg upland to west	Planted floodplain rainforest species
Ck1	Fencing for cattle protection	Initially constructed fence to protect wetlands and revegetation area from sub-licensees' cattle; removed fence when cattle were removed from area
Ck1	Maintenance (<i>on-going</i>)	On-going part of rehabilitation: removed rubbish and weeds; tended plantings and paths; much of it done by volunteers and through training programs
Ck2	Fence S half of area D & E	Constructed fence to protect wetlands from licensees' cattle; removed fence when cattle were removed from area
Ck2	Upland planting south of mouth	Planted riparian woodland species to help stabilise eroding riverbank
Ck2	Signage	
Ck2	Interpretive site No. 12 mangroves	Installed signs at more appropriate location (on mangrove boardwalk near Schoolmasters House)
Ck2	Interpretive site No. 13 saltmarsh	Installed sign at more appropriate location (near Kooragang Wetlands Interpretive Centre)
Ck2	Interpretive site No. 15 wading birds & aquatic life	Installed sign at more appropriate location (Swan Pond on Wader Creek); additional information in bird hide at Stockton Sandspit)
Ck2	Maintenance (<i>on-going</i>)	On-going part of rehabilitation: removed rubbish and weeds; tended plantings and paths; much of it done by volunteers and through training programs
Ck2	Obtain DA for experimental scrape	Obtained DA from Newcastle City Council
Ck2	Experimental earthworks - creek 2 saltmarsh	Excavated experimental plot for study of saltmarsh creation; included in Peter

Area	Activity	Comment
		Nelson's PhD (the University of Newcastle) which has been completed and printed
Ck2	Wetland creation – survey, modelling & concept layout	10ha saltmarsh, mudflats, peripheral ephemeral fresh/brackish non-tidal swales
Ck3	Replace remaining culverts (<i>partial</i>)	Removed slag causeway; replaced one set of pipes with log bridge; more modification required as per Creek 3 Rehabilitation Plan which includes protection of adjacent Green and Golden Bell Frog habitat
Ck3	Rivers Reborn interpretive site	Installed signs about mangroves, riverbanks and Cobbans Creek; benches
Ck3	Upland planting along access road (<i>on-going</i>)	Natural regeneration after cattle removed; weed tree removal
Ck3	Riparian planting along Fishers Bend	Rivers reborn woodland planting
Ck3	Erosion control – bank protection	Cattle removed; natural mangrove regeneration
Ck3	Cattle exclusion plot	P. Nelson, Univ. Newcastle, masters study completed
Ck4	Maintenance (<i>on-going</i>)	On-going part of rehabilitation: removed rubbish and weeds; tended plantings and paths; much of it done by volunteers and through training programs
Ck4	Experimental plot feasibility	Three PhDs: Ecohydraulics of shorebird habitat completed; ecology of shorebirds nearing completion; chytrid fungus, water solutes and Green and Golden Bell Frog nearing completion
Ck4	Cattle exclusion plot	Cattle excluded from river bank; regrowth of mangroves documented
Ck4	Wetland creation – survey, tidal modelling & concept layout	Report produced with survey and preliminary tidal modelling; concept layout presented in ecohydraulics PhD
Ck5	Open culvert 5 & bridge crossing	Culvert removed; free-spanning log bridge built; bridge slumped in June '07 long weekend floods and being replaced
Ck5	Creeks 4&5 separation fence – stage 1	Temporary fence to trial effectiveness for research; not suitable for long-term
Ck5	Experimental plot feasibility	Area to be used to test results of ecohydraulics PhD on how to set hydrology to retain saltmarsh as shorebird habitat and avoid mangrove encroachment
WC	Design wetland areas (<i>partial</i>)	Intertidal; frog ponds; Riverside Park; saltmarsh migration zones
WC	Earthworks EIS – augment existing EIS	DA; acid sulfate soil mgt plan; SOE
WC	Site preparation, grading and earthworks – 15ha	Completed
WC	Planting – 15ha	Managed hydrology and allowed vegetation to self-design; intertidal wetlands developed into mosaic of native vegetation, mudflat and open water; peripheral non-tidal fresh/brackish swales self-designed; some target weeding required; habitat features planted in GGBF wetlands at Scott's Point and Radar Building

Area	Activity	Comment
		frog ponds
WC	Maintenance	On-going part of rehabilitation: some slashing; weed control
SPt	Fence north bank & plant trees (2.2km)	Completed (series of revegetation grants)
SPt	Area 1 – fence, weed, plant	TCM; BHP; Green Corps 'Filling the Gap'
SPt	Area 2 – fence, weed, plant	Relocated to west of Radar Buildings; GGBF documented on Scott's Pt and migratory shorebirds using area, so planting reduced at Scotts Point for threatened and protected species conservation priority
SPt	Establish areas 3 & 4 (<i>modified</i>)	Mosaic of rainforest and open woodland to provide habitat for <i>Cynanchum elegans</i> which is an edge species; suitable areas for rainforest planting more restricted than shown on original plan
SPt	Signage	
SPt	Interpretive site No. 16 rainforest	Selected species identification/information along rainforest path
SPt	Rainforest pedestrian trail	Location modified; loop established; additional work required to make it an all weather track
SPt	Maintenance (<i>on-going</i>)	On-going part of rehabilitation: weed control; path; cycleway; shelter
Ent	Area 1 – fence, weed, plant	Fence repaired to keep licensee's cattle out of revegetation area; then taken down when cattle removed; floodplain rainforest species used for planting
Ent	Construct entrance boardwalk - section 1	Constructed by training groups, including This Way Up and LEAP
Ent	Interpretive site No. 2 Schoolmaster's house & landscaping	
Ent	Interpretive site No. 17 relic rainforest	Relocated to mangrove boardwalk near fig tree
Ent	Initiate discussions with NCC & RTA re Pacific Highway	
Ent	Erect highway signage for Ash Is. Br. & carpark	
Ent	Facilitate modifications to Pacific Highway	
Ent	Erect Project sign on the island	
Ent	Establish car park & lay-by to E of Ash Is. Br.	
Ent	Maintenance (<i>on-going</i>)	On-going part of rehabilitation: vegetation; paths
CF	Design farm & appoint coordinator	City Farm Manager
CF	Establish internal pedestrian paths	Modified from original landscape plan due to landscape constraints

Area	Activity	Comment
CF	Construct access, car park & visitor facilities	Visitors focus at Community Gardens
CF	Construct farm sheds	One large shed constructed at Schoolmaster's House site
CF	Establish shelter belt	Existing shelterbelts might need extending or enhancing if grants are received for the work
CF	Fence cattle from north bank & wet areas	
CF	Internal fencing	
CF	Signage	
CF	Improve pasture (<i>on-going</i>)	Achieved through managed grazing program
CF	Establish Milham's Farm historic site	Replica of original fence constructed; garden re-established; additional work could include archaeological dig of farm building's foundations and stabilisation of ruins
CF	Establish wildlife corridor	
CF	Establish woodlot (<i>completed</i>) & nut grove (<i>trialled and deleted; not appropriate for site</i>)	Farm Forestry plantings established; nut grove not a priority activity
CF	Farm equipment	
CF	Develop educational material & events (<i>on-going</i>)	City Farm brochure; website; field days; school groups
CF	Develop experimental research program (<i>on-going</i>)	Established and on-going; excavated experimental ponds; student projects;
CF	Develop monitoring program (<i>on-going</i>)	Ecocheck program with Univ. Sydney, Orange
RB	Obtain DA for visitors centre car park	Displays and amenities at Radar Buildings; visitors centre and office established at the restored Schoolmaster's House
RB	Construct car park	
RB	Repair rendering on buildings	
RB	Paint mural in building 1	
RB	Install TransGrid solar generator	
RB	Signage	
RB	Internal paths and landscaping	
RB	Install main display in building 1	
RB	Pave paths and erect vehicle barriers	Gravel and mown paths
RB	Secure building 2	

Area	Activity	Comment
RB	Construct shelter & tower for school groups <i>(modified)</i>	Viewing mounds constructed; shelters established at Community Gardens, Bush Food Garden and Scotts Point
RB	Construct amenities block for visitors	
RB	Construct main administration & farm house building	Relocated to Schoolmaster's House
RB	Move solar panels to top of tower	Moved solar panels to top of amenities block; currently being moved to shed at Schoolmasters House as part of CSIRO research project
RB	Arboretum – stage 1	
RB	Arboretum – stage 2	
RB	Maintenance <i>(on-going)</i>	
RP	Fencing & landscaping	
RP	Picnic facilities	
RP	Carpark	
RP	Design & construct wharf	
RP	Maintenance <i>(on-going)</i>	
WP	Commence DA for all of Ash Island	
WP	Obtain DA for all of Ash Is. (access, flood & acid soils)	
WP	Repair fence along N/S water pipeline	Fence was originally repaired to keep licensee's cattle in paddock and then removed when cattle were removed and used for wetland creation.
WP	Car parking feasibility	
WP	Upgrade roads-bridge to Visitors Ctr. & Riv/s Park	Roto-mill, bitumen, Steelstone; constrained by watermain beneath road
WP	Develop interpretive plan	Educ. material, brochures, signage, estuary tours, photographic material
WP	Interpretive site No. 4 Kooragang Nature Reserve	Site changed; Nature Reserve interpretive signs placed at Stockton; identification sign only at original site for No. 4; now need to be updated to national park signs
WP	Signage roads and paths	80% completed
WP	Restore Schoolmaster's House	
WP	Provide interpretive signs	
WP	Approve property plan/pasture mgmt strategy	

Area	Activity	Comment
WP	Design Project wide cycleway incl links to HWCA (<i>partial</i>)	Link using water pipeline across South Arm of Hunter River more costly than original estimate; possibility for future
WP	Establish ped/bicycle paths stage 1	Scott's Pt to Riverside Park
WP	Establish ped/bicycle paths stage 2	Through City Farm; north bank of South Arm
WP	Upgrade service road – pipeline to visitors cntr. (<i>partial</i>)	Regular grading and additional gravel; to be used as construction road for water pipeline replacement
WP	Retain model aeroplane facility in area D (<i>on-going</i>)	
Ad&S	Security to 1997	
Ad&S	Security 1998 on	Back to base system
Ad&S	Project Manager (<i>on-going</i>) & Works Supervisor (<i>secondment completed</i>)	City Farm Manager and Conservation Field Officer supervising on-ground works; Works Supervisor no longer seconded from Newcastle City Council
Ad&S	Project Officer, Design Coordinator & Education Officer	Communication Officer on-going; Project Officer and Design Coordinator positions completed
Ad&S	Biological process experimental studies (<i>on going</i>)	
Ad&S	Biological process monitoring (<i>on-going</i>)	
Ad&S	Physical process experimental studies (<i>on-going</i>)	
Ad&S	Physical process monitoring (<i>on-going</i>)	
Ad&S	Research Associate, equipment & scholarships	Research Associate position discontinued; support of selected studies continues
Ad&S	Field assistance (<i>on-going</i>)	Volunteers; students
Ad&S	Conference attendances	
Ad&S	Insurance (<i>on-going</i>)	
Ad&S	Communication (<i>on-going</i>)	School groups, tours, special events
Ad&S	Community awareness monitoring	HVRF Community Omnibus survey
Ad&S	Contingent valuation study	Published paper
Ad&S	Publish book on ecosystem management – recoup by sales	
TW	Options for restoring tidal influence	Patterson Britton modelling; Dept. Comm. prepared options; Will Glamore provided final option
TW	EIS for proposed restoration works; REF produced	EIS (1998) finalised by KWRP; not allowed to go to public consultation; draft revised EIS (2000) not finalised for release by Premier's; DECCW became

Area	Activity	Comment
		proponent and consent authority; produced REF; implemented Will Glamore's SmartGate option with funding support from CMA
TW	Earthworks to protect private property and other identified areas	Completed by DECCW
TW	TW: Restore high tide roost – site prep	Completed by DECCW; modified actions included a series of pipes fitted with one-way flaps culverts with flaps to contain increased flows to a selected area of the site; smart gates and boom as barrier to mangrove propagules installed
SW	Remove exotic plants & excavate lagoon	
SW	Remove regrowth of bitou bush & spiky rush	
SW	Maintenance (<i>on-going</i>)	Rubbish removal; removal of <i>Juncus acutus</i> and bitou bush regrowth; HBOC volunteer team maintaining site
SS	Obtain DA for access road & car park	
SS	Upgrade access road & car park	
SS	Establish path	
SS	Landscape path, car park & access road	
SS	Construct bird hides	One built; construction of second bird hide not supported by DECCW
SS	Maintenance (<i>on-going</i>)	

Actions deleted from list of works for Kooragang Wetland Rehabilitation Project , 1995 – 2007.

Area	Activity	Comment
CF	Powerline corridor planting	Not appropriate given proximity to intertidal area and other wetlands
CF	Install alternative power / amenities	No longer required; facilities established at Schoolmasters House
RB	Install wind turbine on old tower	Proposed turbine no longer available through sponsor
WP	Provide car parking on Pacific Highway @ pipeline	HWC built pumphouse on site; pipeline crossing a long term proposal
TW	DA for Tomago activities from PSC	Replaced with REF prepared by Parks and Wildlife as proponent and consent authority

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Appendix H Expert panel executive summary

The Steering Committee for the Kooragang Wetland Rehabilitation Project initiated a review by an independent panel in response to concerns about impacts on threatened species. The review was to provide a sound basis for managing threatened species in the context of achieving the KWRP aim of rehabilitating, restoring and creating fisheries and other wildlife habitat. Works carried out in October 2001 on the entrance to Creek 3 on Kooragang Island, designed to increase available habitat for fish, prawns and crabs, were followed by a period of exceptionally high tides, one of which was the seventh highest tide recorded in Newcastle. The conditions that followed were perceived as a threat to the habitat of Green and Golden Bell Frogs. The Panel met in Newcastle with some 35 members of the community at a morning workshop and an afternoon field trip to Ash Island on Tuesday 30th July 2002. The Panel held private discussions on Wednesday 31st July 2002 assisted by Nick Sheppard, Threatened Species Officer, NSW National Parks and Wildlife Service. The Panel reviewed the material presented at the workshops, the information made available during the field trip, and technical reports made available to it by KWRP staff. Recommendations were made by the Panel addressing eight key areas:

1. An urgent response to protect the northern swale "core" habitat areas for Green and Golden Bell Frogs from inundation by extreme high tides during the 2002 –2003 breeding season.
2. The need to base future major interventions on adequate environmental impact assessment, including consideration of threatened species and communities, and the consequences of altering the existing hydrological regime.
3. The creation of additional Green and Golden Bell Frog habitat close to the present core habitat areas using advice from the combined local skills and knowledge of frog specialists and other stakeholders.
4. The maintenance of the existing hydrological regime, the establishment of new saltmarsh habitat, the protection of mangrove trees, and the removal new propagules from core bird feeding areas.
5. The development of a vegetation management plan that identifies high interest areas, threatened communities, and plant communities.
6. Investigation of the feasibility and utility of installing the major control structure on Creek 3 at a point further upstream than the entrance.
7. The development of a set of "Guiding Principles" to be used as a filter when embarking on major activities.
8. Review of the objectives of the KWRP in the light of current circumstances, and revision of the Management Plan.

Reference:

Kooragang Wetland Rehabilitation Project Expert Panel. 2002. Management of Threatened Species and Ecological Communities on Ash Island: Recommendations of an expert panel. Report prepared for Kooragang Wetland Rehabilitation Project. October 2002

Appendix I Flora species list

Species in Kooragang Wetland Rehabilitation Project plant database.

Family	Plant Species	Common name
Native species indigenous and planted		
Fabaceae	<i>Acacia binervata</i>	Hickory Wattle
Fabaceae	<i>Acacia decurrens</i>	.
Fabaceae	<i>Acacia elongate</i>	.
Fabaceae	<i>Acacia falcate</i>	.
Fabaceae	<i>Acacia falciformis</i>	.
Fabaceae	<i>Acacia floribunda</i>	Sunshine Wattle
Fabaceae	<i>Acacia implexa</i>	.
Fabaceae	<i>Acacia irrorata</i>	.
Fabaceae	<i>Acacia longifolia</i>	Sydney Golden Wattle
Fabaceae	<i>Acacia maidenii</i>	Maidens Wattle
Fabaceae	<i>Acacia melaloxylon</i>	.
Fabaceae	<i>Acacia sophorae</i>	Coastal Wattle
Myrtaceae	<i>Acmena floribunda</i>	.
Myrtaceae	<i>Acmena smithii</i>	Lillypilly
Rutaceae	<i>Acronychia oblongifolia</i>	Lemon Aspen
Adiantaceae	<i>Adiantum aethiopicum</i>	Rough Maidenhair
Adiantaceae	<i>Adiantum formosum</i>	Maidenhair
Adiantaceae	<i>Adiantum hispidulum</i>	.
Myrsinaceae	<i>Aegiceras corniculatum</i>	.
Poaceae	<i>Agrostis avenacea</i>	.
Poaceae	<i>Agrostis billardieri</i>	.
Sapindaceae	<i>Alectryon coriaceus</i>	Beech Alectryon
Sapindaceae	<i>Alectryon subcinereus</i>	; Wild Quince
Casuarinaceae	<i>Allocasuarina paludosa</i>	.
Araceae	<i>Alocasia brisbanensis</i>	Cunjevoi
Rhamnaceae	<i>Alphitonia excelsa</i>	Red Ash
Zinbigeraceae	<i>Alpinia caerulea</i>	Native Ginger
Amaranthaceae	<i>Alternanthera denticulata</i>	.
Amaranthaceae	<i>Amaranthus</i> sp.	Amaranth
Loranthaceae	<i>Amyema congener</i>	.
Loranthaceae	<i>Amyema gaudichaudii</i>	.
Loranthaceae	<i>Amyema pendulum</i>	.
Loranthaceae	<i>Amyema</i> sp.	Mistletoe
Cunoniaceae	<i>Aphanopetalum resinosum</i>	.
Apiaceae	<i>Apium prostratum</i>	.
Anthericaceae	<i>Arthropodium</i> sp.	Vanilla Lily
Aspleniaceae	<i>Asplenium australasicum</i>	.
Aspleniaceae	<i>Asplenium flabellifolium</i>	.
Chenopodiaceae	<i>Atriplex cinerea</i>	.
Avicenniaceae	<i>Avicennia marina</i> ssp <i>australisica</i>	.
Myrtaceae	<i>Backhousia myrtifolia</i>	Grey Myrtle
Proteaceae	<i>Banksia integrifolia</i>	.
Cyperaceae	<i>Bolboschoenus caldwellii</i>	.
Ophioglossaceae	<i>Botrychium australe</i>	.
Sterculiaceae	<i>Brachychiton populneus</i>	Kurrajong
Euphorbiaceae	<i>Breynia oblongifolia</i>	Coffee Bush
.	<i>Callicoma serratifolia</i>	Black Wattle
Myrtaceae	<i>Callistemon salignus</i>	White Bottlebrush
Convolvulaceae	<i>Calystegia marginata</i>	.
Rubiaceae	<i>Canthium coprosmoides</i>	Coast Canthium
Capparaceae	<i>Capparis arborea</i>	Native Pomegranate

Family	Plant Species	Common name
Capparaceae	<i>Capparis mitchellii</i>	Native Capers
Cyperaceae	<i>Carex</i> sp.	Sedge
Celastraceae	<i>Cassine australis</i>	Red Olive Plum
Lauraceae	<i>Cassytha glabella</i>	Devils Twine
Lauraceae	<i>Cassytha pubescens</i>	Devils Twine
Lauraceae	<i>Cassytha</i> sp.	Devils Twine
Casuarinaceae	<i>Casuarina glauca</i>	Swamp Oak
Vitaceae	<i>Cayratia clematidea</i>	Slender Grape
Celastraceae	<i>Celastrus australis</i>	.
Celastraceae	<i>Celastrus subspicatus</i>	.
Poaceae	<i>Cenchrus</i> sp.	Spiny Burr Grass
Gentianaceae	<i>Centarium spicatum</i>	
Apiaceae	<i>Centella asiatica</i>	Centella; Pennywort
Cunnoniaceae	<i>Ceratopetalum gummiferum</i>	.
Sinopteridaceae	<i>Cheilanthes austrotenuifolia</i>	.
Sinopteridaceae	<i>Cheilanthes distans</i>	Bristly Cloak Fern
Sinopteridaceae	<i>Cheilanthes siberia</i>	.
Chenopodiaceae	<i>Chenopodium glaucum</i>	.
Chenopodiaceae	<i>Chenopodium opuliflorum</i>	.
Poaceae	<i>Chloris truncata</i>	.
Poaceae	<i>Chloris ventricosa</i>	.
.	<i>Choricarpia leptopetala</i>	.
Vitaceae	<i>Cissus antarctica</i>	Water Vine
Vitaceae	<i>Cissus hypoglauca</i>	Small? leaf Water Vine
Vitaceae	<i>Cissus opaca</i>	.
Pittosporaceae	<i>Citriobatus pauciflorus</i>	; Orange Thorn
Ranunculaceae	<i>Clematis aristata</i>	Old Mans Beard
Verbenaceae	<i>Clerodendrum floribundum</i>	.
Verbenaceae	<i>Clerodendrum tomentosum</i>	Hairy Clerodendrum
Euphorbiaceae	<i>Cloaxolon australe</i>	.
Commelinaceae	<i>Commelina cyanea</i>	Scurvy Weed
Sterculiaceae	<i>Commersonia fraseri</i>	Native Hemp
Asteraceae	<i>Cotula australis</i>	.
Asteraceae	<i>Cotula coronopifolia</i>	.
Amaryllidaceae	<i>Crinum pedunculatum</i>	Spider Lily
Euphorbiaceae	<i>Croton verreauxii</i>	Native Cascarilla
Lauraceae	<i>Cryptocarya glaucescens</i>	Jackwood
Lauraceae	<i>Cryptocarya laevigata</i>	Red Fruited Laurel
Lauraceae	<i>Cryptocarya microneura</i>	.
Lauraceae	<i>Cryptocarya obovata</i>	.
Lauraceae	<i>Cryptocarya rigida</i>	Ridge Laurel
Lauraceae	<i>Cryptocarya triplinervis</i>	.
Sapindaceae	<i>Cupaniopsis anacardioides</i>	Tuckeroo
Orchidaceae	<i>Cymbidium suave</i>	.
Asclepiadaceae	<i>Cynanchum elegans</i>	White Cynanchum
Boraginaceae	<i>Cynoglossum australe</i>	.
Cyperaceae	<i>Cyperus gracilis</i>	.
Cyperaceae	<i>Cyperus leiocaulon</i>	.
Cyperaceae	<i>Cyperus procerus</i>	.
Cyperaceae	<i>Cyperus tetraphyllus</i>	.
Alismataceae	<i>Damasonium minus</i>	.
Apiaceae	<i>Daucus glochidiatus</i>	.
Davalliaceae	<i>Davallia pyxidata</i>	.
Amaranthaceae	<i>Deeringia amaranthoides</i>	.
Orchidaceae	<i>Dendrobium aemulum</i>	Ironbark Orchid
Orchidaceae	<i>Dendrobium linguiforme</i>	.
Orchidaceae	<i>Dendrobium speciosum</i>	.
Orchidaceae	<i>Dendrobium teretifolium</i>	.

Family	Plant Species	Common name
Urticaceae	<i>Dendrocnide excelsa</i>	.
Urticaceae	<i>Dendrocnide photinophylla</i>	Stinging Tree
Phormiaceae	<i>Dianella caerulea</i>	Paroo Lily
Phormiaceae	<i>Dianella laevis</i>	Flax Lily
Phormiaceae	<i>Dianella longifolia</i> var. <i>longifolia</i>	Flax Lily
Poaceae	<i>Dichelachne micrantha</i>	.
Convolvulaceae	<i>Dichondra repens</i>	Kidney Weed
Convolvulaceae	<i>Dichondra</i> sp. A	Kidney Weed
Poaceae	<i>Digitaria parviflora</i>	.
Ebanaceae	<i>Diospyros australis</i>	Native Persimmon
Sapindaceae	<i>Dodonaea triquetra</i>	Hop Bush
Sapindaceae	<i>Dodonaea viscosa</i> ssp. <i>angustifolia</i>	Hop Bush
Blechnaceae	<i>Doodia aspera</i>	Rasp Fern
Blechnaceae	<i>Doodia caudata</i>	Sickle Fern
.	<i>Doryphora sassafras</i>	Native Sassafras
Solonaceae	<i>Duboisia myoporoides</i>	Corkwood
Meliaceae	<i>Dysoxylum fraserianum</i>	Rosewood
Poaceae	<i>Echinopogon</i> sp. (?*)	.
Ehretiaceae	<i>Ehretia acuminata</i>	Koda
Chenopodiaceae	<i>Einadia hastata</i>	Berry Saltbush
Elaeocarpaceae	<i>Elaeocarpus obovatus</i>	Ash; Hard Quandong
Elaeocarpaceae	<i>Elaeocarpus reticulatus</i>	Blueberry Ash
Elatinaceae	<i>Elatine gratioides</i>	.
Sapindaceae	<i>Elattostochys nervosa</i>	.
Sapindaceae	<i>Elattostochys xylocarpa</i>	.
Onagraceae	<i>Epilobium billardierianum</i>	.
Poaceae	<i>Eragrostis leptostachya</i>	.
Myrtaceae	<i>Eucalyptus camaldulensis</i>	River Red Gum
Myrtaceae	<i>Eucalyptus grandis</i>	Flooded Gum
Myrtaceae	<i>Eucalyptus longifolia</i>	Woolybutt
Myrtaceae	<i>Eucalyptus maculata</i>	Spotted Gum
Myrtaceae	<i>Eucalyptus punctata</i>	Grey Gum
Myrtaceae	<i>Eucalyptus robusta</i>	Swamp Mahogany
Myrtaceae	<i>Eucalyptus saligna</i>	Sydney Blue Gum
Myrtaceae	<i>Eucalyptus tereticornis</i>	Forest Red Gum
Eupomatiaceae	<i>Eupomatia laurina</i>	Bolwarra
Luzuriagaceae	<i>Eustrephus latifolius</i>	Wombat Berry
Santalaceae	<i>Exocarpos cupressiformis</i>	.
Moraceae	<i>Ficus coronata</i>	Creek Sandpaper Fig
Moraceae	<i>Ficus fraseri</i>	Sandpaper Fig
Moraceae	<i>Ficus macrophylla</i>	Moreton Bay Fig
Moraceae	<i>Ficus obliqua</i>	Small-leaved Fig
Moraceae	<i>Ficus rubiginosa</i>	Port Jackson Fig
Moraceae	<i>Ficus superba</i> var. <i>heneana</i>	.
Cyperaceae	<i>Fimbristylis ferruginea</i>	.
Flagellariaceae	<i>Flagellaria indica</i>	Whip Vine
Cyperaceae	<i>Gahnia</i> sp.	.
Rubiaceae	<i>Galium</i> sp. (<i>propinquum</i> ?)	Maori Bedstraw
Rutaceae	<i>Geigera salicifolia</i>	Narrow-leaved
Rutaceae	<i>Geijera latifolia</i>	Broad-leaved
Luzuriagaceae	<i>Geitonoplesium cymosum</i>	Scrambling Lily
Geraniaceae	<i>Geranium homeanum</i>	Geranium
Euphorbiaceae	<i>Glochidion ferdinandi</i>	Cheese Tree
Fabaceae	<i>Glycine clandestina</i>	Glycine
.	<i>Gmelina leichhardtii</i>	White Beech
Sapindaceae	<i>Guioa semiglauca</i>	Guioa
Fabaceae	<i>Hardenbergia violacea</i>	.
Poaceae	<i>Hemarthria uncinata</i>	.

Family	Plant Species	Common name
Malvaceae	<i>Hibiscus heterophyllus</i>	Native Rosella
Malvaceae	<i>Hibiscus splendens</i>	.
Apiaceae	<i>Hydrocotyle penduncularis</i>	Pennywort
Pittosporaceae	<i>Hymenosporum flavum</i>	Native Frangipani
Dennstaedtiaceae	<i>Hypolepis regulosa</i>	.
Poaceae	<i>Imperata cylindrica</i>	.
Fabaceae	<i>Indigofera australis</i>	Australian Indigo
Oleaceae	<i>Jasminum volubile</i>	.
Juncaceae	<i>Juncus krausii</i> ssp. <i>australiensis</i>	.
Juncaceae	<i>Juncus polyanthemus</i>	.
Juncaceae	<i>Juncus</i> sp.	.
Juncaceae	<i>Juncus usitatus</i>	.
Fabaceae	<i>Kennedia rubicunda</i>	Dusky Coral Pea
Brassicaceae	<i>Lepidium</i> sp. (<i>*africanum?</i>)	Common Peppergrass
Arecaceae	<i>Livistona australis</i>	Cabbage Tree Palm
Lobeliaceae	<i>Lobelia alata</i>	.
Lomandraceae	<i>Lomandra longifolia</i>	Mat Rush
Onagraceae	<i>Ludwigia peploides</i>	.
Lamiaceae	<i>Lycopus australis</i>	.
Moraceae	<i>Maclura cochinchinensis</i>	Cockspur Thorn
Euphorbiaceae	<i>Mallotus phillippensis</i>	.
Asclepiadaceae	<i>Marsdenia suaveolens</i>	.
Celastraceae	<i>Maytenus cunninghamii</i>	.
Celastraceae	<i>Maytenus silvestris</i>	.
Myrtaceae	<i>Melaleuca armillaris</i>	Honey Bracelet
Myrtaceae	<i>Melaleuca bracteata</i>	.
Myrtaceae	<i>Melaleuca decora</i>	.
Myrtaceae	<i>Melaleuca ericifolia</i>	Swamp Paperbark
Myrtaceae	<i>Melaleuca linariifolia</i>	Snow in Summer;
Myrtaceae	<i>Melaleuca nodosa</i>	.
Myrtaceae	<i>Melaleuca sieberi</i>	.
Myrtaceae	<i>Melaleuca styphelioides</i>	Prickly Tea Tree
Meliaceae	<i>Melia azedarach</i>	White Cedar
Rutaceae	<i>Melicope micrococca</i>	Doughwood
Poaceae	<i>Microlaena stipoides</i> var. <i>stipoides</i>	Weeping Grass
Scrophulariaceae	<i>Mimulus repens</i>	Creeping Monkey-flower
Rubiaceae	<i>Morinda jasminoides</i>	.
Polygonaceae	<i>Muehlenbeckia adpressa</i>	.
Polygonaceae	<i>Muehlenbeckia gracillima</i>	Slender Lignum
Myoporaceae	<i>Myoporum acuminatum</i>	Boobialla
Myoporaceae	<i>Myoporum insulare</i>	.
Lauraceae	<i>Neolitsea dealbata</i>	.
Oleaceae	<i>Notelaea longifolia</i>	Mock Olive;
Oleaceae	<i>Notelaea ovata</i>	.
Menyanthaceae	<i>Nymphoides geminatum</i>	.
Amaranthaceae	<i>Nyssanthes diffusa</i>	.
Amaranthaceae	<i>Nyssanthes</i> sp. (<i>?erecta</i>)	Barbwire Weed
Oleaceae	<i>Olea paniculata</i>	Native Olive
Euphorbiaceae	<i>Omalthus nutans</i>	Bleeding Heart
Rubiaceae	<i>Opercularia varia</i>	.
Poaceae	<i>Oplismenus imbecillis</i>	Beadgrass
Bignoniaceae	<i>Pandorea pandorana</i>	Wonga Vine
Poaceae	<i>Panicum pygmaeum</i>	.
Fabaceae	<i>Pararchidendron pruinosum</i> var. <i>pruinosum</i>	Snow-wood
Urticaceae	<i>Parietaria debilis</i>	.
Apocynaceae	<i>Parsonsia straminea</i>	Common Silkpod
Poaceae	<i>Paspalum vaginatum</i>	.
Passifloraceae	<i>Passiflora herbertiana</i>	Native Passionfruit

Family	Plant Species	Common name
Sinopteridaceae	<i>Pellaea falcata</i>	Sickle Fern
Peperomiaceae	<i>Peperomia leptostachya</i>	.
Peperomiaceae	<i>Peperomia tetraphylla</i>	.
Polygonaceae	<i>Persicaria ?hydropiper</i>	.
Polygonaceae	<i>Persicaria ?lapathifolia</i>	.
Polygonaceae	<i>Persicaria</i> sp. (?*)	Smartweed/Knotweed
Pittosporaceae	<i>Pittosporum revolutum</i>	Roughfruit Pittosporum
		Mock Orange; Sweet
Pittosporaceae	<i>Pittosporum undulatum</i>	Pittosporum
Sapotaceae	<i>Planchonella australis</i>	Black Apple
Polypodiaceae	<i>Platycterium bifurcatum</i>	.
Lamiaceae	<i>Plectranthus parviflorus</i>	.
Podocarpaceae	<i>Podocarpus elatus</i>	Plum Pine
Convolvulaceae	<i>Polymeria calycina</i>	.
Araliaceae	<i>Polyscias elegans</i>	Celerywood
Araliaceae	<i>Polyscias murrayi</i>	Pencil Cedar
Araliaceae	<i>Polyscias sambucifolia</i>	Native Elderberry
Lobeliaceae	<i>Pratia purpurascens</i>	Whiteroot
Acanthaceae	<i>Pseuderanthemum variabile</i>	Pastel Flower
.	<i>Psychotria lonceroides</i>	Hairy Psychotria
Dennstaedtiaceae	<i>Pteridium esculentum</i>	Bracken
Pteridaceae	<i>Pteris tremula</i>	Soft Bracken
Orchidaceae	<i>Pterostylis longifolia</i>	.
Orchidaceae	<i>Pterostylis nutans</i>	Nodding Greenhood
Ranunculaceae	<i>Ranunculus sessiflorus</i>	Buttercup
Myrsinaceae	<i>Rapanea howittiana</i>	Muttonwood
Myrsinaceae	<i>Rapanea variabilis</i>	.
Chenopodiaceae	<i>Rhagodia candolleana</i>	.
Myrtaceae	<i>Rhodomyrtus psidioides</i>	Native Guava
Sapindaceae	<i>Rhysotoechia bifoliolata</i>	Twin-leaf Tuckeroo
Ripogonaceae	<i>Ripogonum album</i>	.
Brassicaceae	<i>Rorippa gigantea</i>	.
Ruppiaceae	<i>Ruppia ?polycarpa</i>	.
Sambucaceae	<i>Sambucus gandichaudiana</i>	Native Elderberry
Primulaceae	<i>Samolus repens</i>	.
Orchidaceae	<i>Sarcochilus falcatus</i>	.
Chenopodiaceae	<i>Sarcocornia quinqueflora</i>	Glasswort
	<i>Sarcomelicope simplicifolia</i> (Endl.) ssp. <i>simplicifolia</i>	Yellow Lilly Pilly
Rutaceae	<i>Sarcopetalum harveyanum</i>	Pearl Vine
Menispermaceae	<i>Schoenoplectus litoralis</i>	.
Cyperaceae	<i>Scolopia braunii</i>	Flintwood
Flacourtiaceae	<i>Sheffieldia incana</i>	.
Primulaceae	<i>Sicyos australis</i>	.
Cucurbitaceae	<i>Solanum aviculare</i>	Kangaroo Apple
Solanaceae	<i>Solanum caspicoides</i>	Native Capsicum
Solanaceae	<i>Solanum laciniatum</i>	.
Solanaceae	<i>Solanum pungetium</i>	.
Solanaceae	<i>Solanum stelligerum</i>	.
Poaceae	<i>Sporobolus elongata</i>	.
Menispermaceae	<i>Stephania japonica</i>	.
Moraceae	<i>Streblus brunonianus</i>	Whalebone
Chenopodiaceae	<i>Suaeda australis</i>	Seablite
Fabaceae	<i>Swainsona galegifolia</i>	.
Myrtaceae	<i>Syncarpa glomifera</i>	.
Myrtaceae	<i>Syzygium paniculatum</i>	.
Myrtaceae	<i>Syzygium australe</i>	Brush Cherry
Aizoaceae	<i>Tetragonia tetragoniodes</i>	Warrigal Cabbage
Vitaceae	<i>Tetrastigma nitens</i>	.

Family	Plant Species	Common name
Lamiaceae	<i>Teucrium argutum</i>	.
Meliaceae	<i>Toona ciliata</i>	Red Cedar
.	<i>Trema (aspera) tomentosum</i>	Peach Poison
Juncaginaceae	<i>Triglochin procera</i>	.
Juncaginaceae	<i>Triglochin striata</i>	.
Myrtaceae	<i>Tristaniopsis laurina</i>	Water Gum
Typhaceae	<i>Typha orientalis</i>	.
Araceae	<i>Typhonium eliosorum</i>	Arum Lily
Urticaceae	<i>Urtica incisa</i>	.
Scrophulariaceae	<i>Veronica plebeia</i>	.
Violaceae	<i>Viola hederacea</i> ssp. <i>hederacea</i>	.
Campanulaceae	<i>Wahlenbergia communis?</i>	Bluebell
Campanulaceae	<i>Wahlenbergia stricta</i> subsp. <i>stricta</i>	Tall Bluebell
.	<i>Wilkiea huegeliana</i>	Veiny Wilkiea
Weeds and/or questionable species		
Asteraceae	* <i>Ambrosia artemisiifolia?</i>	Annual Ragweed
Primulaceae	* <i>Anagallis arvensis</i>	.
Chenopodiaceae	* <i>Atriplex patula</i>	.
Chenopodiaceae	* <i>Atriplex prostrata</i>	.
Apiaceae	* <i>Berula erecta</i>	.
Asteraceae	* <i>Bidens pilosa</i>	Cobblers Pegs
Poaceae	* <i>Bromus</i> sp. (?)	.
Chenopodiaceae	* <i>Chenopodium album</i>	<i>C. triangulare</i> is now <i>C. opulifolium</i> , found near Adelaide only is very similar to <i>C. album</i> .
Lauraceae	* <i>Cinnamomum camphora</i>	Camphor Laurel
Asteraceae	* <i>Cirsium vulgare</i>	Spear Thistle
Rutaceae	* <i>Citris</i> sp.	.
Asteraceae	* <i>Conyza bonariensis</i>	.
Poaceae	* <i>Cynodon dactylon</i>	Couch
Asteraceae	* <i>Delairea odorata</i>	Cape Ivy
Poaceae	* <i>Digitaria ciliaris</i>	.
Poaceae	* <i>Ehrharta erecta</i>	Panic Veldtgrass
Euphorbiaceae	* <i>Euphorbia peplus</i>	Petty Surge
Asteraceae	* <i>Gnaphalium</i> sp.	.
Asclepiadaceae	* <i>Gomphocarpus fruticosus</i>	Narrow leaf Cottonbush
Asteraceae	* <i>Hypochoeris radicata</i>	Catsear
Juncaceae	* <i>Juncus acutus</i>	.
Juncaceae	* <i>Juncus effusus</i>	.
Verbenaceae	* <i>Lantana camara</i>	Lantana
Poaceae	* <i>Lolium</i> spp.	.
Malvaceae	* <i>Modiola caroliniana</i>	.
Cactaceae	* <i>Opuntia</i> sp.	Prickly Pear
Oxalidaceae	* <i>Oxalis corniculata</i>	Creeping Oxalis
Poaceae	* <i>Paspalum dilatatum</i>	Paspalum
Passifloraceae	* <i>Passiflora subpeltata</i>	White Passionfruit
Poaceae	* <i>Pennisetum clandestinum</i>	Kikuyu
Poaceae	* <i>Pennisetum glaucum</i>	.
Phytolaccaceae	* <i>Phytolacca octandra</i>	Inkweed
Plantaginaceae	* <i>Plantago lanceolata</i>	.
Plantaginaceae	* <i>Plantago major</i>	.
Poaceae	* <i>Poa annua</i>	.
Portulacaceae	* <i>Portulacca oleracea</i>	Pigweed
Rosaceae	* <i>Rosa bracteata</i>	Macartney Rose
Rosaceae	* <i>Rubus fruticosus</i>	Blackberry
Polygonaceae	* <i>Rumex brownii</i>	Swamp Dock
Asteraceae	* <i>Senecio madagascariensis</i>	Fireweed

Family	Plant Species	Common name
Malvaceae	* <i>Sida rhombifolia</i>	Paddys Lucerne
Solanaceae	* <i>Solanum erianthum</i>	.
Solanaceae	* <i>Solanum nigrum</i>	Blackberry Nightshade
Solanaceae	* <i>Solanum pseudocapsicum</i>	Madeira Winter Cherry
Asteraceae	* <i>Sonchus oleraceus</i>	Common Sowthistle
Poaceae	* <i>Sporobolus africanus</i>	.
Poaceae	* <i>Sporobolus indicus</i>	.
Lamiaceae	* <i>Stachys arvensis</i>	.
Caryophyllaceae	* <i>Stellaria media</i>	.
Poaceae	* <i>Stenotaphrum secundatum</i>	.
Asteraceae	* <i>Tagetes minuta</i>	Stinking Roger
Commelinaceae	* <i>Tradescantia albiflora</i>	Wandering Jew
Fabaceae	* <i>Trifolium repens</i>	.
Urticaceae	* <i>Urtica urens</i>	.
Verbenaceae	* <i>Verbena bonariensis</i>	.
Verbenaceae	* <i>Verbena officinalis</i>	.
Caryophyllaceae	?* <i>Lychnis coronaria</i>	.
Malvaceae	? <i>Abutilon oxycarpum</i>	Lantern Bush
Fabaceae	? <i>Acacia obtusifolia</i>	.
Fabaceae	? <i>Desmodium varians</i>	Slender Tick-trefoil
Poaceae	? <i>Dichanthium sericeum</i>	Blue Grass
Poaceae	? <i>Echinopogon ovatus</i>	Hedgehog Grass
.	? <i>Kalanchoe spp</i>	.
Loranthaceae	? <i>Lysiana subfalcata</i>	.
Poaceae	? <i>Oplismenus sp.</i>	.
Poaceae	? <i>Panicum sp.</i>	.
Polypodiaceae	? <i>Pyrrosia rupestris</i>	.
Poaceae	? <i>Sporobolus virginicus</i>	.
Viscaceae	? <i>Viscum articulatum</i>	.

Appendix J Fauna species lists

Non-marine Molluscs Species List

List of non-marine molluscs of Ash Island as surveyed by Michael Shea in 1999.

Selected Bibliography:

Cox, J.C. 1868. A Monograph of Australian Land Shells. Sydney NSW.

Benthic Infauna Species List

(Genders 1997)

Fish and Crustaceans Species List

Preliminary list of species taken at the Tomago site (West) and Fullerton site (East) in the Tomago-Fullerton phase of the NSW Fisheries studies in the KWRP. For further details contact R Williams or D Sullings at the Fisheries Research Institute, Cronulla.

Family	Taxon	Common Name
ELOPIDAE	<i>Elops hawaiiensis</i>	giant herring
ANGUILLIDAE	<i>Anguilla australis</i>	short-fin eel
ANGUILLIDAE	<i>Anguilla reinhardtii</i>	long-fin eel
CLUPEIDAE	<i>Hyperlophus vittatus</i>	Sandy sprat
ENGRAULIDAE	<i>Engraulis australis</i>	Australian anchovy
GALAXIIDAE	<i>Galaxias maculatus</i>	common jollytail
CYPRINIDAE	<i>Carassius auratus</i>	goldfish
PLOTOSIDAE	<i>Cnidoglanis macrocephala</i>	estuary catfish
ANTENNARIIDAE	<i>Antennarius striatus</i>	striped angler fish
POECILIIDAE	<i>Gambusia holbrooki</i>	mosquito fish
MELANOTAENIDAE	<i>Pseudomugil signifer</i>	blue-eye
SCORPAENIDAE	<i>Centropogon australis</i>	fortesque
PLATYCEPHALIDAE	<i>Platycephalus fuscus</i>	dusky flathead
CHANDIDAE	<i>Ambassis jacksoniensis</i>	Port Jackson glassfish
CHANDIDAE	<i>Ambassis marianus</i>	Ramsay's glassfish
TERAPONTIDAE	<i>Pelates quadrilineatus</i>	trumpeter
TERAPONTIDAE	<i>Terapon jarbua</i>	crescent perch
SILLAGINIDAE	<i>Sillago ciliata</i>	sand whiting
POMATOMIDAE	<i>Pomatomus saltator</i>	tailor
GERRIDAE	<i>Gerres subfasciatus</i>	silver biddy
SPARIDAE	<i>Acanthopagrus australis</i>	yellowfin bream
SPARIDAE	<i>Rhabdosargus sarba</i>	Tarwhine
MONODACTYLIDAE	<i>Monodactylus argenteus</i>	silver batfish
GIRELLIDAE	<i>Girella tricuspidata</i>	Luderick
SCATOPHAGIDAE	<i>Selenotoca multifasciata</i>	striped scat
MUGILIDAE	<i>Liza argentea</i>	flat-tail mullet
MUGILIDAE	<i>Mugil cephalus</i>	sea mullet
MUGILIDAE	<i>Mugil georgii</i>	fantail mullet
MUGILIDAE	<i>Myxus elongatus</i>	sand mullet
GOBIIDAE	<i>Acanthogobius flavimanus</i>	Oriental goby
GOBIIDAE	<i>Arenigobius bifrenatus</i>	Bridled goby
GOBIIDAE	<i>Arenigobius frenatus</i>	half-bridled goby
GOBIIDAE	<i>Cristatogobius gobioides</i>	Oyster goby
GOBIIDAE	<i>Favonigobius exquisites</i>	exquisite sand goby
GOBIIDAE	<i>Favonigobius tamarensis</i>	Tamar River goby
GOBIIDAE	<i>Gobiopterus semivestitus</i>	Glass goby
GOBIIDAE	<i>Gobiopterus sp</i>	Unknown goby

Family	Taxon	Common Name
GOBIIDAE	<i>Mugilogobius paludis</i>	Mangrove goby
GOBIIDAE	<i>Mugilogobius stigmaticus</i>	checkered mangrove goby
GOBIIDAE	<i>Pseudogobius olorum</i>	blue-spot goby
GOBIIDAE	<i>Redigobius macrostoma</i>	large-mouth goby
ELEOTRIDIDAE	<i>Gobiomorphus australis</i>	striped gudgeon
ELEOTRIDIDAE	<i>Gobiomorphus coxii</i>	Cox's gudgeon
ELEOTRIDIDAE	<i>Hypseleotris compressus</i>	empire fish
ELEOTRIDIDAE	<i>Philypnodon grandiceps</i>	flathead gudgeon
ELEOTRIDIDAE	<i>Philypnodon sp.</i>	dwarf flathead gudgeon
GOBIOIDIDAE	<i>Taenioides mordax</i>	Mud goby
BOTHIDAE	<i>Pseudorhombus arsius</i>	Large-tooth flounder
SOLEIDAE	<i>Synaptura nigra</i>	black sole
MONACANTHIDAE	<i>Meuschenia freycineti</i>	six-spine leatherjacket
MONACANTHIDAE	<i>Meuschenia trachylepis</i>	yellow-finned leatherjacket
TETRAODONTIDAE	<i>Tetractenos hamiltoni</i>	common toadfish
PENAEIDAE	<i>Metapenaeus macleayi</i>	school prawn
PENAEIDAE	<i>Penaeus plebejus</i>	eastern king prawn
PENAEIDAE	<i>Metapenaeus bennettae</i>	greasyback prawn
SERGESTIDAE	<i>Acetes australis</i>	acetes
PALAEEMONIDAE	<i>Macrobrachium intermedium</i>	grass shrimp
PALAEEMONIDAE	<i>Macrobrachium novaehollandiae</i>	Long-armed prawn
ALPHEIDAE	<i>Alpheus euprosyne</i>	snapping prawn
MYSIDACEA	<i>Mysid sp</i>	unknown mysid
UNKNOWN	<i>Unknown</i>	unknown shrimp 2
UNKNOWN	<i>Unknown</i>	unknown shrimp 3
HYMENOSOMATIDAE	<i>Halicarcinus ovatus</i>	spider crab
HYMENOSOMATIDAE	<i>Halicarcinus spp</i>	unknown
PORTUNIDAE	<i>Portunus pelagicus</i>	blue swimming crab
GRAPSIDAE	<i>Paragrapsus laevis</i>	mottled shore crab
GRAPSIDAE	<i>Sesarma erythroductyla</i>	red-fingered marsh crab
OCYPODIDAE	<i>Australoplax tridentata</i>	stripe-faced crab

Frog Species List

Common Name	Scientific Name	Ash Is	Tomago Wetlands	Stockton Sandspit	Source
Common Froglet	<i>Crinia signifera</i>	✓			1
Ornate Burrowing Frog	<i>Limnodynastes ornatus</i>	✓			1
Striped Marsh Frog	<i>Limnodynastes peronii</i>	✓			1
Spotted Marsh Frog	<i>Limnodynastes tasmaniensis</i>	✓			1
Green and Golden Bell Frog	<i>Litoria aurea</i>	✓			1
Green Tree Frog	<i>Litoria caerulea</i>	✓			1
Bleating Tree Frog	<i>Litoria dentata</i>	✓			1
Eastern Dwarf Tree Frog	<i>Litoria fallax</i>	✓			1
Jervis Bay Tree Frog	<i>Litoria jervisiensis</i>	✓			1
Broad-palmed Frog	<i>Litoria latopalmata</i>	✓			1
Peron's Tree Frog	<i>Litoria peronii</i>	✓			1
Verreaux's Tree Frog	<i>Litoria verreauxii</i>	✓			1
Tyler's Tree Frog	<i>Litoria tyleri</i>	✓			1
Green-thighed Frog	<i>Litoria brevipalmata</i>		✓		2
Smooth Toadlet	<i>Uperoleia laevigata</i>	✓			1

Sources:

- 1 Andrew Hamer, PhD student at the University of Newcastle, presence surveys, 1999-2002; copies held by KWRP.
- 2 Neville McNaughton pers. comm.

Ash Island Bird List: Species recorded between 1980 – 2008

Based on Hunter Bird Observers Club 2003 bird list with additional sightings included as reported by HBOC members and/or Kooragang Wetlands staff.

Brown Quail	Black-tailed Godwit	Superb Fairy-wren
Magpie Goose	Bar-tailed Godwit	Striated Pardalote
Blue-billed Duck	Little Curlew	White-browed Scrubwren
Musk Duck	Whimbrel	Brown Gerygone
Freckled Duck	Eastern Curlew	Mangrove Gerygone
Black Swan	Marsh Sandpiper	Brown Thornbill
Australian Shelduck	Common Greenshank	Yellow-rumped Thornbill
Australian Wood Duck	Lesser Yellowlegs	Yellow Thornbill
Pacific Black Duck	Terek Sandpiper	Red Wattlebird
Australasian Shoveler	Common Sandpiper	Little Wattlebird
Northern Shoveler	Grey-tailed Tattler	Striped Honeyeater
Grey Teal	Ruddy Turnstone	Noisy Friarbird
Chestnut Teal	Red Knot	Noisy Miner
Pink-eared Duck	Red-necked Stint	Yellow-faced Honeyeater
Hardhead	Pectoral Sandpiper	Brown Honeyeater
Australasian Grebe	Sharp-tailed Sandpiper	White-cheeked Honeyeater
Hoary-headed Grebe	Curlew Sandpiper	Eastern Spinebill
Darter	Ruff	White-fronted Chat
Little Pied Cormorant	Painted Snipe	Rufous Whistler
Pied Cormorant	Black-winged Stilt	Grey Shrike-thrush
Little Black Cormorant	Banded Stilt	Black-faced Monarch
Great Cormorant	Red-necked Avocet	Leaden Flycatcher*
Australian Pelican	Pacific Golden Plover	Restless Flycatcher
White-faced Heron	Grey Plover	Magpie-lark
Little Egret	Red-capped Plover	Rufous Fantail
White-necked Heron	Double-banded Plover	Grey Fantail
Great Egret	Black-fronted Dotterel	Willie Wagtail
Intermediate Egret	Red-kneed Dotterel	Spangled Drongo
Cattle Egret	Banded Lapwing	Black-faced Cuckoo-shrike
Striated Heron	Masked Lapwing	White-winged Triller
Nankeen Night Heron	Silver Gull	Olive-backed Oriole
Black Bittern	Gull-billed Tern	Figbird
Australasian Bittern	Caspian Tern	White-breasted
Glossy Ibis*	Crested Tern	Woodswallow
Australian White Ibis	Whiskered Tern	Grey Butcherbird
Straw-necked Ibis	White-winged Black Tern	Pied Butcherbird
Royal Spoonbill	Rock Dove	Australian Magpie
Yellow-billed Spoonbill	Spotted Turtle-Dove	Pied Currawong
Black-necked Stork	Crested Pigeon	Australian Raven
Osprey	Peaceful Dove	Torresian Crow
Black-shouldered Kite	Bar-shouldered Dove	Skylark
Black Kite	Galah	Richard's Pipit
Whistling Kite	Sulphur-crested Cockatoo	Yellow Wagtail
Brahminy Kite	Yellow-tailed Black	House Sparrow#
White-bellied Sea-Eagle	Cockatoo*	Red-browed Finch
Spotted Harrier	Rainbow Lorikeet	Chestnut-breasted
Swamp Harrier	Scaly-breasted Lorikeet*	Mannikin
Brown Goshawk	Eastern Rosella	European Goldfinch#
Collared Sparrowhawk	Red-rumped Parrot	Mistletoebird
Wedge-tailed Eagle	Pallid Cuckoo	Welcome Swallow
Brown Falcon	Fan-tailed Cuckoo	Tree Martin
Black Falcon	Horsfield's Bronze-Cuckoo	Fairy Martin
Australian Hobby	Shining Bronze-Cuckoo	Clamorous Reed-Warbler
Peregrine Falcon	Channel-billed Cuckoo	Tawny Grassbird
Nankeen Kestrel	Common Koel	Little Grassbird
Buff-banded Rail	Southern Boobook	Rufous Songlark
Lewin's Rail	Masked Owl	Brown Songlark
Baillon's Crake	Grass Owl*	Golden-headed Cisticola
Australian Spotted Crake	Barn Owl	Silvereye
Spotless Crake	White-throated Needle-tail	Common Starling#
Purple Swamphen	Azure Kingfisher	Common Myna#
Dusky Moorhen	Laughing Kookaburra	No. of native species= 183
Black-tailed Native Hen	Sacred Kingfisher	* Species added after 2003
Eurasian Coot	White-throated	# Introduced species
Latham's Snipe	Treecreeper	Updated by KWRP: 30/6/08

Bird species that occur on the KWRP Ash Island Site that are subject to international agreements (Japan–Australia Migratory Bird Agreement (JAMBA), China–Australia Migratory Bird Agreement (CAMBA)) or listed as endangered (Schedule 1) or vulnerable (Schedule 2) under the NSW Threatened Species Conservation Act (NSW TSC). Sources: HBOC, KWRP, NSW National Parks and Wildlife Service and Environment Australia. Taxonomic nomenclature follows Christidis and Boles (1994). Table from expert panel report (KWRP Expert Panel 2002).

Scientific Name	Common name	JAMBA listed	CAMBA listed	NSW TSC Act Schedule 1	NSW TSC Act Schedule 2
<i>Anseranas semipalmata</i>	Magpie Goose				✓
<i>Oxyura australis</i>	Blue-billed Duck				✓
<i>Stictonetta naevosa</i>	Freckled Duck				✓
<i>Ardea alba</i>	Great Egret	✓	✓		
<i>Ardea ibis</i>	Cattle Egret	✓	✓		
<i>Botaurus poiciloptilus</i>	Australasian Bittern			✓	
<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork			✓	
<i>Pandion haliaetus</i>	Osprey				✓
<i>Haliaeetus leucogaster</i>	White-bellied Sea Eagle		✓		
<i>Gallinago hardwickii</i>	Latham's Snipe	✓	✓		
<i>Limosa limosa</i>	Black-tailed Godwit	✓	✓		✓
<i>Numenius minutus</i>	Little Curlew	✓	✓		
<i>Numenius phaeopus</i>	Whimbrel	✓	✓		
<i>Numenius madagascariensis</i>	Eastern Curlew	✓	✓		
<i>Tringa stagnatilis</i>	Marsh Sandpiper	✓	✓		
<i>Tringa nebularia</i>	Common Greenshank	✓	✓		
<i>Xenus cinereus</i>	Terek Sandpiper	✓	✓		✓
<i>Actitis hypoleucos</i>	Common Sandpiper	✓	✓		
<i>Heteroscelus brevipes</i>	Grey-tailed Tattler	✓	✓		
<i>Arenaria interpes</i>	Ruddy Turnstone	✓	✓		
<i>Calidris ruficollis</i>	Red-necked Stint	✓	✓		
<i>Calidris melanotos</i>	Pectoral Sandpiper	✓			
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	✓	✓		
<i>Calidris ferruginea</i>	Curlew Sandpiper	✓	✓		
<i>Philomachus pugnax</i>	Ruff		✓		
<i>Postratula benghalensis</i>	Painted Snipe				✓
<i>Pluvialis dominica</i>	Pacific Golden Plover	✓	✓		
<i>Pluvialis squatarola</i>	Grey Plover	✓	✓		
<i>Sterna caspia</i>	Caspian Tern		✓		
<i>Sterna bergii</i>	Crested Tern	✓			
<i>Chlidonias leucopterus</i>	White-winged Black Tern	✓			
<i>Tyto novaehollandiae</i>	Masked Owl				✓
<i>Motacilla flava</i>	Yellow Wagtail	✓	✓		

Appendix K Future management options

**Strategic Workshop
Management Options for KWRP Ash Island Site
21 June 2000
1:00pm - 4:00pm
Glendarra, CB Alexander Agricultural College, Tocal**

Attendance:

Peggy Svoboda	KWRP Project Manager
Heather Holder	KWRP Project Officer
Sue Rostas	KWRP Communications Officer
Craig Manhood	KWRP
Craig Copeland	NSWF, KWRP Steering Committee
Evelyn Elfick	Community representative, KWRP Steering Committee
Stuart Ellery	NCC, KWRP
Glenn Evans	HCMT, KWRP Steering Committee
Ross Cooke	DLWC, KWRP Steering Committee
Su Morley	KWRP
Anthony Marchment	KWRP, Vegetation Officer
Carl Fulton	KWRP
Robert Quirk	NPWS
Rob Henderson	KWRP, Kooragang City Farm Manager
Frank Rigby	Community representative/patron/KWRP Steering Committee
Geoff Tregenza	Wallsend Employment and Training Services
Sharon Vernon	HCMT
Frank Cosgrove	Newcastle City Council
Paul DuBow	The University of Newcastle, KWRP Research Associate
Rob Gibbs	NPWS
Chris Morris	The Wetlands Centre, Australia

Apologies:

Cr Helen Brown, Cr Lorraine Yudaeff, Janet Dore, Cr John Tate, Meredith Laing.

Introduction:

X Most of project completed in next 3 years; management plan goes to 2005.

Main question:

X How should the Ash Island Site be managed after the end of the project?

Identify options:

KWRP Steering Committee should make recommendations to Government through the Hunter Catchment Management Trust.

Feasible options (according to group):

- NPWS Regional Park (transfer of land from PWS to NPWS)
- Crown land (transfer of land from PWS to DLWC)

- Community trust/Council trust
- Newcastle City Council (land owned by Council)
- Hunter Catchment Management Trust continues to manage the site
- Corporate/environmental

Options not feasible according to group:

- NPWS National Park
(based on the view that it would not be able to accommodate full range of KWRP activities; needs to be reviewed with advice from NPWS)
- NPWS Nature Reserve
- Marine Park
- Aquatic Reserve
- Vacant crown land
- Corporate structure/statutory authority (e.g. Honeysuckle; Hunter Water Corporation; Newcastle Port Corporation; Sydney Catchment Authority)
- Aboriginal land
- Corporate/developed
- Revert to current land owners (NSW Dept. Public Works and Services)