KOORAGANG WETLAND
REHABILITATION PROJECT

Strategic Landscape Plan

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Extensive consultation has taken place during the feasibility study and the production of this plan. It is a philosophy of this project that public consultation should be an on-going process.

Any interested parties should feel free to comment on the proposals in this document and/or to suggest additional ideas at any time.

This plan is a working document. Continuing investigations taking place on the Project area will provide information to adapt this plan to suit specific situations. Using information from investigations as a basis for responsible land management decisions is a process integral to this Project.
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EXECUTIVE SUMMARY

This Strategic Landscape Plan has been completed by Land Systems EBC on behalf of The Kooragang Wetland Rehabilitation Project Steering Committee to provide a framework for landscape development at Kooragang Island and Tomago - Fullerton Cove. The study was commissioned following the findings of the Kooragang Island Wetland Compensation Project Feasibility Study prepared for NSW Fisheries in 1992. The overall aim of the project is to rehabilitate, restore and create fisheries and other wildlife habitat in suitable areas of the Hunter Estuary. The strategic landscape plan for Kooragang Island and Tomago-Fullerton Cove is designed to provide settings for the various landuses and activities identified in the Feasibility Study.

The direction of the project as stated in the Feasibility Study was reviewed following an early period of consultation. This process included meetings with members of the Steering Committee and consultation with various special interest groups. Many of the major issues were an extension of those addressed in the Feasibility Study. However some new concerns were raised resulting in amendments to its recommendations.

One of the overall objectives of the project has been to develop of visionary concept for the study area which is open-ended allowing the results of on-going investigations to be adopted and implemented within the boundaries of the plan. Many of the issues discussed in the early sections still require research and experimental work especially with regard to hydraulic issues, and the plan has been structured in a way that provides flexibility to adopt new ideas and techniques as necessary. Some of these ideas and techniques may be the result of investigations and research work carried out on the site as an integral part of the project.

The plan addresses both the biophysical and aesthetic structural elements of the landscape at a broad scale to provide an overall Strategic Landscape Plan for the entire study area. The plans show the functional relationships of activities and landuses proposed for the site within the existing biophysical environment. Some precincts of the site are enlarged to show further detail and to indicate the final typical relationship between functional and biophysical components on the site.

Design guidelines have been provided to give typical treatments to specific situations in the study area. These include edge treatments between various vegetation communities and details for pavements, structures, furniture, fencing, soft landscaping and signage. The details are not intended as construction details but provide a guide for future development over the site.
The final section recommends staged implementation of the project over a period of approximately 20 years, although a longer period is likely to be required for the implementation of some features such as the development of a rainforest community. In each of the four stages, sections of the project will be targeted for development whilst existing landuses, such as grazing, in other areas will continue as they have in the past.
1.0. INTRODUCTION

1.1. Background

Land Systems EBC was commissioned by the Kooragang Wetland Rehabilitation Project Steering Committee to prepare a Strategic Landscape Plan for the western portion of Kooragang Island and Hexham Island in January 1994.

Hexham Island was not treated in any more detail than it was in the 1992 Kooragang Island Wetland Compensation Project Feasibility Study. The study area was subsequently extended to include the Tomago - Fullerton Cove area as shown in Figure 1.1.

The preparation of this landscape plan has been based on consultations with all members of the Steering Committee, a number of other interested groups (refer Appendix A) and the licensees living on the island.

1.2. Aim of the Plan

The aim of the strategic landscape plan is to give structure and direction to the successful implementation of habitat development and associated works on the island on a large scale as funds become available.

The aim to the Kooragang Wetland Rehabilitation Project is to rehabilitate, restore and create fisheries and other wildlife habitat in suitable areas of the Hunter estuary. As a result, opportunities will be created for an integrated research program, environment and education program, and outdoor recreation and tourism facilities. The objectives of the strategic landscape plan include the:

- incorporation of findings from biological and physical research as the most effective way to proceed with rehabilitation of the wetlands;
- integration of functional aspects of activities recommended for the site and treatments for adjoining areas to maximise resource potential;
- creation of an attractive setting with a sense of identity based on the island's original vegetation type, healthy wetland systems and rural landscape; and
- development of proposals for the site based on specific design principles and guidelines.
Figure 1.1 Location Plan
1.3. Site Overview

The Kooragang Island study area covers some 760 hectares on the western end of the island, (commonly known as Ash Island) and is in the Newcastle Local Government Area (LGA). (Refer Figure 1.1) It is bounded to the east by the Shortland Electricity 132kV transmission easement and the industrial railway in the south-east and includes Hexham Island to the west. The Tomago-Fullerton Cove area covers an area of approximately 1390 hectares in the Port Stephens LGA.

1.3.1. Kooragang Island

The bulk of the area is owned by NSW Public Works and managed by the Property Services Group. Four licensees use it for livestock grazing. Two of the licensees are resident on the island. Generally speaking, the area is classed by the Department of Agriculture (1983) as not suited to agriculture, comprising poor grazing lands and seasonal grazing capabilities, although the area has been utilised for grazing for many years.

"The southern and eastern portions of the study area are generally low-lying, dominated by mangrove and saltmarsh vegetation, whilst the northern and western portions are relatively more elevated containing freshwater swales and supporting scattered groves of trees, relic littoral rainforest and some areas of vigorous kikuyu pasture. Many of the existing wetland areas have been degraded as a result of alterations to the water regime, grazing livestock and rubbish dumping."

The study area is currently zoned industrial, however an objective of the project will be to obtain a zoning appropriate to the areas use.

Several significant utility easements cross the study area. The island is accessible to vehicles across the single lane Ash Island bridge from the Pacific Highway just south of Hexham Island, or by boat from Tomago, Newcastle Harbour and other areas along the north and south channels of the Hunter River.

1.3.2. Tomago–Fullerton Cove

The eastern part of this study area is in the Kooragang Nature Reserve (owned by NSW National Parks and Wildlife Service) and the western section is owned by Tomago Aluminiun Company Pty Ltd.

A levee and two floodgates separate fully tidal saltmarsh and mangroves along the Hunter River and Fullerton Cove from the wetlands beyond which have become degraded due to lack of tidal flushing.

1.4. Summary of the Kooragang Island Wetland Compensation Project Feasibility Study

The Kooragang Island Wetland Compensation Project Feasibility Study was prepared for NSW Fisheries by Shortland Wetlands Centre Ltd in association with the University of Newcastle Research Associates (TUNRA) in May 1992. It was funded by NSW Public Works, Hunter Catchment Management Trust and Newcastle City Council. The study established an overall concept for the rehabilitation of fisheries habitat and outlined a range of research, educational and recreational opportunities that would be appropriate for the island.

The issues discussed in the feasibility study included the following:

- the scale of engineering works;
- the nature and extent of habitat to be created;
- land use and zoning;
- flood management;
- access;
- spoil disposal;
- nature reserve management and possible expansion;
- education and recreation;
- leases and commercial opportunities;
- mosquitoes;
- heritage and archaeological values;
- water quality and flow characteristics; and
- project management.

The Kooragang Island Advisory Committee (1979) divided Kooragang Island into five areas labelled A – E. (See Figure 1.1). Area A comprises the industrial zone outside the study area, Area B is included in the Kooragang Nature Reserve, Area C is in relatively natural condition and is being considered for inclusion in the Nature Reserve, Area D
comprises leasehold pasture land and Area E is an area in relatively natural although some what degraded condition. These areas are referred to in the following text.

The study formulated a three strand concept as a result of extensive consultation on a range of issues.

1. *Fisheries Habitat Restoration and Research*

The preferred approach will aim to create or rehabilitate some 200 hectares of saltmarsh, mangroves and open water in the existing leasehold area of Ash Island (areas D and E). Apart from providing substantial replacement habitat for that lost to past filling on Kooragang Island, this area will also present opportunities to incorporate research on fisheries habitat and mosquito control.

2. *Integrated Education and Recreation Facilities*

Proposed facilities for a rehabilitated Ash Island will include: a field classroom and educational materials; a bicycle trail linked to the Shortland Wetlands Centre and the Newcastle Cycleway network; possible wharf facilities to link with existing and potential ‘water bus’ services; and a ‘city farm’ development to give Newcastle residents, school groups and other visitors an opportunity to get close to farm animals and experience a farm atmosphere within cycling distance of the city.

3. *An Integrated Hunter Estuary Nature Reserve Complex*

Wetlands within the Hunter Estuary have recognised national and international significance, and it is envisaged that the existing Kooragang and Hexham Swamp Nature Reserves could be expanded to include other valuable remnant areas of estuarine and brackish wetlands. Such an integrated nature reserve complex could include: the existing Kooragang Nature Reserve; Area C and possibly Area E (after some rehabilitation and confirmation of the adequacy of industrial land elsewhere) on Kooragang Island; Hexham Island; and the existing Hexham Nature Reserve. *2*

Commercial opportunities identified included a city farm, bicycle hire, and estuary tour ventures focussing on wildlife features.

The purpose of the strategic landscape plan is to confirm the location of various activities approved by the Steering Committee or in accordance with recommendations for the island as documented in the feasibility study. In addition, this plan will provide design guidelines for specific treatments to different areas of the island, individual precinct plans to demonstrate principles for the resolution of key issues, and a broad strategy for implementation.
BACKGROUND. The Project was initiated to compensate for the loss of fish and other wildlife habitat due to reclamation works in the Hunter estuary. The estuary is important not only to local fisheries but is listed as a Ramsar site (wetland of international importance) due to its use by migratory wading birds.

PURPOSE. The Project's aim is to rehabilitate, restore and create fisheries and other wildlife habitat in suitable areas of the Hunter estuary. As a result, opportunities will be created for an integrated research program, environment education program and outdoor recreation and tourism facilities.

SCOPE. The project area covers over 1,300 hectares: approximately 500 ha on the western end of Kooragang Island and 800 ha in the Tomago-Fullerton Cove area, as well as a wading bird high tide roost near Stockton Bridge. The Project recognises the many opportunities and potential benefits for the community and region that flow from habitat improvement works. The proximity of the sites to established education and recreation facilities in the metropolitan area is also of value.

SIGNIFICANCE. The size and scope of this Project make it one of the major environmental projects in NSW at this time. The Project will result in benefits to the Hunter Region in terms of improved fish and wildlife habitat, restoration of forests as well as establishment of education, recreation and tourism facilities. The Project's research program and proximity to a Ramsar site make the Project internationally significant.

HABITAT REHABILITATION, RESTORATION AND CREATION. These works form the basis of the Project. Major biological objectives are to increase use by fish, prawns, crabs and wading birds; to decrease suitability for mosquito breeding; and to regenerate littoral rainforest.

INTEGRATED RESEARCH PROGRAM. A Project Investigation Zone will provide space for research into the effectiveness of rehabilitation techniques, assessment of methods to minimise mosquito breeding habitat, investigation of food chains (from vegetation and micro-organisms through to fish and birds) and environmental engineering, hydraulic and soil studies. Baseline studies of sites to be rehabilitated are in progress and involve a number of research scientists and honours students.

ENVIRONMENTAL EDUCATION PROGRAM. The Project is developing educational material, guided tours and interpretive sites which will extend the Shortland Wetlands Centre's activities into the brackish wetland ecosystem. On the project site, a visitors centre with displays and arboretum and a City Farm will also provide educational opportunities.

RECREATION FACILITIES. Recreational fishing facilities (including picnic area, barbecue and wharf), bicycle and walking paths, and a canoe trail will be established.

TOURISM. A twin wetland agreement is being established with Kushiro, Japan. Adjacent areas are wetlands covered by three international agreements to protect migratory birds and the Project site provides a link between Kooragang Nature Reserve with Hexham Nature Reserve. Boat services can provide links with Newcastle Harbour.

MANAGEMENT STRUCTURE. The major resource management organisations for the estuary are represented on the Project's steering committee: Hunter Catchment Management Trust, Newcastle City Council, NSW Public Works, NSW National Parks and Wildlife Service, Port Stephens Council and NSW Fisheries. Coordinator for the Project is Peggy Svoboda: PO Box 130, WALLSEND NSW 2287, Ph (018) 683 787, Fax (049) 50 1875.

SPONSORS. The following industries which are resident in the estuary have sponsored the Project and are demonstrating that environmental conservation and modern industry can co-exist: Port Waratah Coal Services (fisheries research), BHP (infrastructure), Pacific Power (education and alternative energy), Brambles (infrastructure) and Gardner-Perrott (industrial cleaning and painting). The University of Newcastle's sponsorship provides partial funding of a research fellow in estuarine ecology.
2.0. HYDRAULICS

2.1. Feasibility Study

It was concluded in the feasibility study that the complex tidal flow patterns in the study area along with the lack of ground level data made it difficult to devise appropriate hydraulic improvement works which would provide more open and intertidal waterway area on the island. The authors of the study recommended upgrading inlets to maximise tidal flows across the island but did not recognise the potential for adverse impacts on flows or water levels in the adjacent nature reserve.

NSW Public Works (PWD), as a consequence of the above study, undertook preliminary monitoring of tidal flows in the study area and photogrammetric assessment of aerial photography to prepare a site topographic plan relative to a known datum.

2.2. Topographic Information

The study area is relatively flat with changes in vegetation occurring over small variations in ground level. There was insufficient ground level control to obtain the required level of contour accuracy from the aerial photography. Additional ground survey is needed to provide a site contour plan of suitable accuracy.

The photogrammetric plotting provided plans of some physical and cultural features on the site. Existing waterlines were plotted to indicate the extent of inundation at the time of the photography. From ground measurements during an extreme high tide (RL 1.0m AHD), the maximum extent of tidal inundation was recorded along with approximate measurement of water levels around the site. There was marked attenuation of the tidal levels in Area E as would be expected due to the small inlet pipe sizes from the South Channel. The attenuation on Cobbans Creek (Area D) was less marked with consistent levels of about 0.6m AHD at the upstream end of the north western tributaries.

2.3. Tidal Monitoring Data

The large number of creeks and culverts and the extensive area did not make it possible to monitor flows at all points simultaneously during the preliminary monitoring. As such, the monitoring results from the four separate days of measurements were drawn together to provide an understanding (albeit incomplete) of the complex tidal behaviour in the study area.
It has been possible to identify the tidal sub-catchments from the monitoring data. These sub-catchments are shown on Figure 2.1. and consist of:

- Area E;
- Creek 3;
- Cobbans Creek (Creek 2) and tributaries connected to Moscheto Creek; and
- Creek 6 (Nature Reserve).

The boundaries of the subcatchments are based on the flow directions observed during the limited monitoring work. Although it is possible that there maybe some cross flows between subcatchments, they form a preliminary structure for assessment of the strategic landscape plan.

The results from the monitoring are presented in tabular form on PWD records and within the 1994 PWD report entitled *Hydraulic Data for the Culverts of Kooragang Island*.

2.4. Study Area Tidal Characteristics

In Area E, the inlet pipe diameters are relatively small and the inverts elevated above low tide levels in the south channel. This causes tidal inflows to be attenuated and induces phase differences in flow patterns within the various ponds in this area. The level and size of culverts within Area E further complicate flows with the direction of flow at each culvert being inconsistent.

The culverts under the main south road along the eastern boundary of Area D significantly influence the water level and flows within the upper areas of Creek 2. This creek is influenced by tidal flows from Cobbans Creek to the west and Moscheto Creek to the east. Prior to washout of the culvert at the inlet to Cobbans Creek (at the south channel) it is likely that Moscheto Creek had the major influence on flows in the upper areas of Creek 2. At present, this situation has changed with a larger influence being exerted by Cobbans Creek due to the removal of the culvert flow restriction at the inlet. However, flows from Cobbans Creek have to pass through two culverts (A and A1) influenced by the A1 culvert. During the monitoring, there was a complex interaction of flow and flow direction within this sub-catchment.

The influence of tidal flushing is proposed to be reintroduced to the wetland area beyond the existing flood levee in the Tomago-Fullerton Cove area. This could possibly be achieved by the demolition of the two existing floodgates which currently control tidal influence to all areas beyond the levee. This work would be subject to an hydraulic study to determine the flooding impacts on the surrounding area. A programme to monitor the impact of increased tidal influence on the wetland should then be implemented.
2.5. South Channel Tidal Range

The tidal planes and ranges in the South Channel near the Cobbans Creek inlet were obtained from a 1955 PWD survey (*Newcastle Harbour Hunter, Paterson, William Rivers, General Plan and Tidal Gradients, Plan 201/41*).

The predicted tidal ranges at both the Newcastle Harbour entrance and opposite Cobbans Creek are presented in Table 2.1.

TABLE 2.1. PREDICTED TIDAL RANGES (m)

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<td>Springs</td>
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There is considerable tidal range in south channel to drive tidal flows into the study area.

The predicted tidal planes at the harbour entrance and in the south channel opposite Cobbans Creek are presented in Table 2.2.

TABLE 2.2. PREDICTED TIDAL PLANE LEVELS m AHD

<table>
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<th>Tidal Plane</th>
<th>Harbour Entrance</th>
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<td>-0.99</td>
<td>-0.73</td>
</tr>
</tbody>
</table>

**ABBREVIATIONS**

- MHHWS: Mean Higher High Water Spring
- MHWS: Mean High Water Spring
- MHWN: Mean High Water Neap
- MTL: Mean Tide Level
- MLWN: Mean Low Water Neap
- MLWS: Mean Low Water Spring
- ISLW: Indian Spring Low Water
Figure 2.1 Tidal Sub-Catchments
2.6. Flooding Behaviour

Upstream of the study area at the Hexham road bridge, severe flood flows are confined mainly to the river channel. At the western end of Kooragang Island, severe flood flows expand across the island. As such, the western end of the island is a major floodway during severe floods. The predicted peak flood levels and velocities over the study area for a range of flood severities are presented in Table 2.3.

<table>
<thead>
<tr>
<th>Flood Severity % AEP</th>
<th>Peak Flood Level m AHD</th>
<th>Peak Velocity m/s</th>
<th>Percentage of Flow over Island</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.5</td>
<td>0.5</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>2.5</td>
<td>0.4</td>
<td>24</td>
</tr>
<tr>
<td>5</td>
<td>2.0</td>
<td>0.3</td>
<td>20</td>
</tr>
<tr>
<td>10</td>
<td>1.5</td>
<td>0.2</td>
<td>11</td>
</tr>
<tr>
<td>20</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
</tr>
</tbody>
</table>

ABBREVIATION

AEP - Annual Exceedance Probability

The study area would be inundated in floods with a severity of about 10% AEP or greater. In a 1% AEP flood, there would be water depths of about 2m over the study area flowing at an average velocity of approximately 0.5m/s.
3.0. OPPORTUNITIES AND CONSTRAINTS

Consultations with members of the Steering Committee and special interest groups consolidated the direction of the project subsequent to the finalisation of the 1992 Feasibility Study. The issues raised during the consultations are discussed in further detail in this summary of opportunities and constraints.

Many issues are an extension of those addressed in the 1992 document but some refinement of the original options has evolved. Most of the issues relate specifically to Kooragang Island and the Tomago–Fullerton Cove area.

A landscape site analysis of Kooragang Island was undertaken and is shown in Figures 3.1 and 3.2 (at end of this section).

Numerous opportunities exist on Kooragang Island for habitat rehabilitation, restoration and creation to compensate for losses elsewhere in the Hunter Estuary. Physical constraints mainly include the existing utilities easements which limit opportunities for planting and earthworks and require access for maintenance purposes. The opportunities and constraints for Kooragang Island are shown in Figures 3.3 and 3.4 (at the end of this section).

Some opportunities and constraints for the Tomago–Fullerton Cove area are also included in the following text.

3.1. Opportunities

Opportunities for the project are summarised below.

3.1.1. Bio–Physical Opportunities

- **Topography**

  The flat landform facilitates many types of recreational use and is suitable for the re-establishment of saltmarsh, mangrove and other vegetation communities once present on the island in accordance with the objectives of the project.

  Existing low lying areas can be developed to create new or extended wetland including permanently wet areas, mangroves and saltmarsh.

  Higher areas can support the original terrestrial woodland and littoral rainforest.
The low lying, primarily saltmarsh area in Area E requires adjustment to alter the existing hydraulic regime providing a unique opportunity for research and experiments in accordance with the requirements of the project for a Project Investigation Zone.

The site also offers the potential to investigate and demonstrate a range of erosion control techniques particularly on channel banks, swales and on disturbed broadacre areas.

- **Hydraulics**

The relatively large tidal range in the south and north channel opposite the study area provides an opportunity to induce tidal flows within island channels and waterways.

An opportunity exists for replacement of the existing culverts controlling the hydraulic system on the island by deletion, enlargement, reduction and change in elevation and/or invert level as required. Detailed hydraulic surveys would be required to size and design culverts in recommended locations.

The provision of a range of wetland zones including fully flushed tidal flats and saltmarshes, and permanent water bodies in the central portion of Area D is possible. These should extend up to the advisory centre which is the focus for public activity.

The large tidal range in the river provides an opportunity to have various tidal conditions in Area E maximising the variety of research programmes and experiments possibly benefiting fishery and wetland resource management.

The removal of floodgates at Tomago would reintroduce tidal influence to existing wetland areas beyond the flood levee.

Existing riverbanks currently scoured and undercut by waves should be stabilised. Various stabilisation treatments should be investigated.

- **Kooragang Island**

Kooragang Island has a complex hydraulic system which influences the existing wetlands and vegetation communities. Continued research is required to obtain an understanding of the operation of the system and the influences on it from outside the study area such as Moscheto Creek in the Kooragang Nature Reserve.

- **Tomago-Fullerton Cove**

The influence of tidal flushing should be reintroduced to the wetland area beyond the existing flood levee.
• **Biology/Ecology**

The increased use by fish, prawns and crabs and water birds could be encouraged in brackish areas.

The enhancement of habitat for frogs and birds could be achieved in freshwater swales.

The existing relic rainforest can provide the base for further rainforest restoration and creation.

A portion of the existing grass on the island could be incorporated within a city farm to help the investigation and demonstration of the grazing/wetland area interface.

The project could help research and develop an integrated pest management plan for mosquito control.

The protection and conservation of relic species and the re-establishment of original terrestrial vegetation communities including littoral rainforest and species which have been cleared due to past agricultural activities is possible. The endangered rainforest vine *Cynachum elegans* has been located on the site by National Parks and Wildlife Service and the project could be part of the recovery plan for that species.

The provision of an area where experimentation and research work can be monitored and assessed with a potential to improve understanding of the wetland and hydrologic system at Kooragang Island, Tomago and other similar ecosystems.

The retention and extension of existing intermittent swamp, saltmarsh communities and tidal flats for use by wading birds for which the area is renowned.

Hexham Island could be included as a nature reserve as an extension to either Hexham Swamp or Kooragang Nature Reserve.

### 3.1.2. *Socio-Economic Opportunities*

The interpretation and highlighting of the cultural history of the study area could be implemented in conjunction with other developments.

• **Pre-History/History**

No archaeological surveys of the site have been completed and no aboriginal data has been documented in the study area to date. However, there may be archaeological resources on site which could be assessed, conserved and interpreted for educational purposes.
Seven sites of European significance have been identified and are discussed in the following text.

- **Radar Station**

Two concrete arch construction buildings are remnants of a World War II radar station. The buildings are two of the few structures on the island.

- **The Old Farmhouse**

Sandstone remnants of one of the original farmhouses on the island are located adjacent to the north arm of the river. The remains demonstrate methods of masonry construction using lime which were favoured in the 1880's and are currently being included on the Heritage Listing with advice from Dr John Turner (historian).

- **The Old Schoolmaster's House**

The old schoolmaster's house is located on the entry road adjacent to the large grove of mangroves immediately south of Ash Island bridge. The building is inhabited by one of the licensees, Norma Ward, and has been assessed by Council’s heritage consultant as having historical heritage value. Originally facilities around the house included a schoolhouse and tennis court. The grounds are now being encroached upon by the tide.

- **Scotts Point**

Scotts Point, located on the north western tip of the island is the site of the homestead of Alexander Walker Scott the original land grant holder of the island. It is possible that the first artesian well constructed in Australia still exists in the vicinity. Two large Norfolk Island pine trees located on the point were landmarks on Scotts Point but no longer exist on this site. Scott established a plantation of orange trees on the farm in the mid 1800's, which has also disappeared.

- **The Dairy**

Remnants of 1940's dairy to the north of the main east-west road exists as a testimony to past dairy farming operations which dominated the island. At one stage, the farming area comprised a number of dairy farms, a grocery store, school, and other facilities supporting a substantial community. The remaining structure is part of a modern dairy farm of the time.

- **The Silo**

A silo is located adjacent to the main access road and is a prominent visual feature on the island.
• **Tomago House**

A National Trust homestead exists on the Tomago Road.

The re-establishment of selected historic features on the island known to exist within the lifetimes of local residents, or through recorded data should be encouraged. These features could include the orange grove and the landmark Norfolk Island pine trees planted by Alexander Walker Scott. Replicas of these features could become part of the historical interpretation on the island.

• **Education/Interpretation**

Ecological themes could be interpreted as major features of the study area. Sites should be established to highlight and interpret bird and aquatic life, the relic rainforest, mangrove communities, tidally influenced mud flats, saltmarsh and other wetland communities, and other natural processes such as erosion and hydrology.

The retention and protection of historical structures remaining within the study area in either complete or remnant condition could be included as interpretive/educational sites along proposed bicycle and pedestrian trails by way of signage and/or guided educational tours.

The establishment of a city farm could provide educational and demonstrative displays of different types of progressive agriculture and agricultural techniques including aquaculture, permaculture, orchard, windbreaks, animal husbandry, land management, recycling of wastes, reversing land degradation, alternative energy, and attractions for the public and school experimental plots. Components of the City Farm should be self-sustaining systems that have no negative effect on the surrounding natural areas.

An educational theme could be based on the industrial activity which is the major landuse on the southern portion of the island adjacent to the study area. Industrial activities here and to the north, adjacent to the Tomago site, are visually prominent and could be interpreted to relate and compare the co-existing industrial and nature reserve/ecological landuses. It is important to demonstrate that environmental, industrial and recreational needs can be serviced together on the island resulting in sensible use of wetland areas in conjunction with the industry that surrounds it.

The establishment of educational displays within the advisory centre could interpret the educational themes of the project and the historical development of the island.
The project also offers the opportunity for a range of community involvement initiatives in the clean up of the island as well as in the rehabilitation works. Organisations to be involved could include local community services groups (eg. Lions, Apex) as well as special interest groups (eg. Society for Growing Australian Plants, Hunter Bird Observers Club).

- **Recreation**

Improvement of existing recreation settings such as fishing, camping, model aeroplane flying, and the provision of picnic areas can be used to promote the project objectives and assist tourism.

Professional and amateur fishing are major activities in the area and recreational fishing on the island is a popular activity. Vehicular access for fishermen needs to be maintained where possible to facilitate continued recreational fishing on the island. The most popular sites are located on the north arm of the river at the end of the vehicular access road and on the south arm along the shoreline adjacent to and northwards of the water pipeline crossing the river.

A paddock located east of the entry road is leased for model aeroplane flying. The Rebel Flying Club pays an annual fee to the Property Services Group.

The provision of a permanently wet area and pedestrian connections to wetland areas influenced by the full range of the tide can be provided for recreation and educational purposes.

The provision of bicycle and pedestrian trails over Kooragang Island and the Tomago–Fullerton Cove area, integrated with the Newcastle City Bicycle Plan, will improve public access and recreation into and around the island and to surrounding areas.

The establishment of a city farm as a commercial attraction and to provide educational and recreational opportunities.

The upgrading of river banks should include a variety of edge treatments such as reeded, woodland and cleared areas to ensure recreational setting diversity and interest.

The improvement of visual quality by the re-establishment of vegetation communities on Kooragang Island to recreate the impression recorded in 1842 by Ludwig Leichhardt on his excursions to the island as follows: "...... a remarkably fine place ...... (with) ...... beauty of nature, a broad shinning river, a luxuriant vegetation.......(and) ........ a great number of plants."
The recreation and educational settings could be enhanced by the provision of boardwalks within wetland and mangrove areas where pedestrian access is not normally available.

- **Research**

The project offers a challenging research opportunity to investigate, analyse and establish the requirements for wetland habitats and the protection and conservation of wetland species.

- **Project Investigation Zone**

An area of approximately 50 hectares is proposed to be set aside as a research and experimental area on Kooragang Island. This area will be used to investigate the effect of modifications within the tidal zone on fisheries habitat, such as length, width and depth of channels, size of ponds, size and depth of culverts etc. The area could be modified periodically to suit experiments and research. An area should be earmarked for this function in the strategic landscape plan allowing the necessary flexibility for research work. Sites for investigating soil and groundwater characteristics could also be included in this zone.

- **City Farm**

A city farm is proposed on Kooragang Island. This should be located centrally to best service and control public activity on the island and provide opportunities for recreation, education and interpretation of progressive agricultural techniques.

- **International Opportunities and Tourism**

The wetlands of the lower Hunter floodplain and estuary are proposed to be affiliated with wetlands near Kushiro, Japan in a twin wetland agreement. This affiliation is similar to a sister cities arrangement and will promote international wetland conservation. Exchanges will encourage better understanding of the value the wetlands have for migratory birds (especially Latham's Snipe) that move between the two countries.

- **Vehicular Access**

  **Tourle Street Bridge**

The Tourle Street Bridge to the south-east of the site provides vehicular access to Kooragang Island from Cormorant Drive within the industrial area adjacent to the eastern portion of the island. This access across the river could be utilised to provide vehicular access to the southern portion of the island.
Entry and Egress

Existing access arrangements onto Kooragang Island need to be improved by upgrading entry and egress from the Pacific Highway to the existing Ash Island bridge and to the proposed combined pedestrian/cycleway adjacent to the water pipe crossing of the south arm of the river.

Provision for car parking is required adjacent to the main activity areas of the study area such as the advisory centre, the fishing area on the north arm of the river, at the entry adjacent to Ash Island bridge, on the Pacific Highway adjacent to the new pedestrian/cycleway crossing, and Tomago House.

Investigations should be made into the possibility of providing vehicular access to the study area from the industrial area to the south. Access would be possible over the Tourle Street bridge and along Cormorant Drive to the study area subject to discussions with the adjacent landowners (BHP). Car parking in the southern portion of the study area may also be possible.

Existing Roads

The existing road layouts can provide a logical boundary to the new functions proposed within the study area both geographically and hydrologically. They can provide the main access routes for vehicular and bicycle access with minor requirements for additional roadworks.

The realignment of the existing access road onto Kooragang Island will provide the opportunity for a more direct route to the main public areas of the project.

Pedestrian/Bicycle/Water Access

Water Supply Pipeline Crossing

A water supply pipeline crosses the south arm of the Hunter River to Kooragang Island from the Pacific Highway. As identified in the Feasibility Study (1992) there is an opportunity to construct a pedestrian/cycleway bridge on the existing piers adjacent to or above the existing pipeline. This would provide pedestrian access to the southern portion of the island and to the popular fishing area on the south channel. This opportunity could be combined with improved car parking adjacent to the Pacific Highway at the end of the pipeline to provide better pedestrian and bicycle access onto the island.
Water Access

The use of canoes and other modes of water transport to, from and around the study area should be encouraged as a major opportunity. This could be achieved by the provision of wharves and boat pull-up sites at locations along the river for tying off fishing boats.

Tomago–Fullerton Cove

Bicycle access could be provided within the Tomago–Fullerton Cove area with links to Tomago Road and Tomago House.

3.2. Constraints

Physical constraints on the site limit possibilities for development. The major constraints to development on the island include the following.

3.2.1. Bio-Physical Constraints

- Topography

The low lying nature of the topography renders the entire area subject to periodic inundation and flooding posing major restrictions to the construction of any structures on the study area.

- Hydraulics

The existence of poorly designed culverts and the construction of a flood levee and flood gates constrict the hydraulic regimes in the study area and have contributed to deterioration of vegetation communities.

Trees will form obstructions to flood flows and may cause increases in upstream flood levels; preliminary modelling of the effects of re-establishing a significant coverage of trees on the island was undertaken by increasing the friction factor (from $n = 0.03$ to $0.1$ over the entire Kooragang Study area) which caused an increase in upstream flood levels by up to 0.3m. A factor value 0.1 is typically used to simulate flows through dense mangrove stands.

The proposed tree cover on the site represents about a 10% – 20% coverage of the study area. This coverage would equate to an equivalent friction factor considerably less than 0.1 as used in the above modelling. The tree plantings have, where possible, been oriented parallel to the flood flows and have clean trunks limiting the obstruction posed to these flows.

Further work is required to investigate the impact of the project on flood levels, however it is unlikely to cause a significant impact.
Buildings on the site should be designed as floodproof structures to minimise the potential for damage during floods and make clean-out of debris following a flood relatively straightforward.

New waterways should be adequately flushed by tidal flows to maintain acceptable water quality; to this end, waterways should gradually shallower with distance away from the river and greatest tidal influence.

Improvements in tidal flows in Area D should be designed with suitable control structures to avoid significant changes in flows in Moscheto Creek which is presently connected to the Cobbans Creek system.

The hydraulic behaviour in Moscheto Creek is complicated by its connection to Cobbans Creek and artificial controls in the creek channel. Although the ecology of the creek system is probably adjusting to past changes in its hydraulic behaviour, it is not recommended that it be further compounded by connection to the proposed wetland waterway in Cobbans Creek without knowledge of the likely impacts. Connection may increase the tidal range in Moscheto Creek leading to more extensive areas drying at low tides. Notwithstanding this, with an appropriate understanding of the Moscheto Creek hydraulics and ecology, it may be possible to use increased tidal flows in the proposed Cobbans Creek wetlands to derive benefits in Moscheto Creek.

Technical limitations arising from flooding and the findings of future hydraulic studies are major factors influencing the final development of the study area and will only be fully understood following future investigations and experimental trial works.

Erosion of the river bank is occurring along the southern and northern shores of Kooragang Island where the banks are undercut as a result of the action of waves. Past endeavours to stabilise the river banks by rip rap is apparent in some locations. However this has not been successful and the river bank has continued to erode. The profile is predominantly undercut to a depth of over one metre in places. Alternative measures of stabilisation should be investigated.

- **Biology/Ecology**

A large portion of the study area is now covered by kikuyu pasture established for livestock grazing. This inhibits natural regeneration and is potentially a maintenance problem since there will be no control of kikuyu growth after the removal of livestock from the site. Although grazing can continue during the early stages of the development of the site, and in some form in the city farm, widespread long term grazing by livestock is not considered appropriate to the final strategic landscape plan. Tree planting in parts of the site presently under kikuyu pasture, necessitating exclusion of cattle for tree protection, creates a maintenance problem when kikuyu growth is uncontrolled.
Other weeds present on the site may inhibit rehabilitation works and should be cleared to prevent further spread although existing infestations are not excessive. Weeds identified on the site include Lantana (*Lantana camara*), Blackberry (*Rubus fruticosus*) and Spiny Rush (*Juncus acutus*).

Mosquitos are a constraint to the use and enjoyment of the island and should be the subject of further research to control breeding and other facets of mosquito habitats which influence user comfort etc.

### 3.2.2. Socio-Economic Constraints

**Access**

At present there is only one bridge (Ash Island Bridge) providing public vehicular access to the western end of Kooragang Island. The Tomago area is not accessible to the public.

Public access onto Kooragang Island is a major issue and must be managed to minimise vandalism and damage to existing natural communities and dumping of rubbish, cars and other materials.

Existing vehicular access onto Kooragang Island from the Pacific Highway at Ash Island bridge is hazardous due to the high volume and speed of traffic along the Pacific Highway. Vehicular entry onto and egress from the bridge needs to be addressed to improve safety, and signage is necessary to improve visibility of this major entry.

Vehicular access into the adjacent Kooragang Island Nature Reserve would be restricted to Shortland Electricity and NPWS approved vehicles for special purposes such as research and education.

The access roads across the island are also used by the Maritime Services Board to service signs.

4WD vehicle access routes must be maintained to existing utilities including power, (ie. 330kV Pacific Power, and 33kV and 132kV Shortland Electricity transmission easements), water and gas which cross the study area for maintenance purposes. These easements and their associated service roads create physical boundaries across the site and influence movement, drainage etc.

A water main traverses the site from north to south. This may be a physical constraint to experimental work in the project investigation zone where excavations will be required to create new channels for research purposes where it crosses Creek 3 and when scour valves have to be serviced.
A natural gas pipeline across the site may be a constraint to wetland excavation.

Funding Sources

A primary constraint to the implementation of the project objectives is the availability of adequate funding for implementation of construction works, maintenance and research initiatives.

Security

Vandalism has been identified as a major problem on Kooragang Island which needs to be addressed if the public is to be encouraged to visit the site in the future.

Licence

There are four existing licensees on Kooragang Island two of whom are resident on the island. The resident licensees are to be given the option to remain on the island and the strategic landscape plan is to accommodate grazing activities during the early stages of the development.

Interim measures to ensure the privacy of the Maher house in the north west of the island should be provided.

Industrial Railway

The railway line around the industrial area in the south eastern portion of Kooragang Island is likely to be duplicated. An easement of 70 metres has been established for this purpose.

Fluoride Buffer Zone

Fluoride levels resulting from activities at Tomago to the north should be monitored within the city farm to assess the possible impact on crops, pasture and animals.
KOORAGANG WETLAND REHABILITATION PROJECT
Landscape Site Analysis

Figure 3.2  Dwg No: 2557/92
Issue B October 1994
KOORAGANG WETLAND REHABILITATION PROJECT

Opportunities and Constraints

Figure 3.3 Dwg No: 2557/S3

LAND SYSTEMS EBC

Kooragang
Wetland Rehabilitation Project

ABU ISLAND
RESERVE

KOORAGANG NATURE RESERVE

MODEL AEROPLANE
FLYING AREA

CITY FARM

RAINFOREST

WETLAND

LEGEND

Proposed Hardwood
Existing Casuarina
Proposed Woodland
Existing Mangrove
Proposed Mangrove
Orchard
Vegetables
City Farm Paddock
Salt Marsh
Wetland
Bike Path
Possible Wetland/Waterway/Scrub
Road
Cassette Drying
Flax Weigh Point
Bird Watch Point
Carpark
Pony Starter
End of Study Area
Possible Canoe Areas
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Intermittent Freshwater wetlands
Possible proposed
Wetland areas
Possible future Wetland
along existing HTWZ track.

Figure 3.3

KOORAGANG WETLAND REHABILITATION PROJECT

Opportunities and Constraints

Figure 3.3 Dwg No: 2557/S3

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Figure 3.3 Dwg No: 2557/S3

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Opportunities and Constraints

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KOORAGANG WETLAND REHABILITATION PROJECT

Opportunities and Constraints

Figure 3.4  Dwg No: 2557/54
Issue B  October 1994

LAND SYSTEMS EBC

KOORAGANG WETLAND REHABILITATION PROJECT

Opportunities and Constraints

Figure 3.4  Dwg No: 2557/54
Issue B  October 1994

LAND SYSTEMS EBC

KOORAGANG WETLAND REHABILITATION PROJECT

Opportunities and Constraints

Figure 3.4  Dwg No: 2557/54
Issue B  October 1994

LAND SYSTEMS EBC

KOORAGANG WETLAND REHABILITATION PROJECT

Opportunities and Constraints

Figure 3.4  Dwg No: 2557/54
Issue B  October 1994

LAND SYSTEMS EBC
4.0. STRATEGIC LANDSCAPE PLAN

The strategic landscape plan for Kooragang Island is designed to provide settings for the various landuses and activities identified in the Feasibility Study. Additionally, the functional relationships (circulation, interactions between various activity areas etc.) as well as other matters are dealt with in the plan.

The plan addresses both the biophysical and aesthetic structural elements of the landscape at a strategic scale. Considerable further design development and documentation is necessary to refine details in accordance with the precinct plans and guidelines contained in this document before development takes place.

The landscape settings designated in the plan have been planned in response to the requirements of the activities proposed for the site as well as the particular opportunities and constraints of the site. The intention is to also use the landscape settings to convey to the public important messages associated with the various uses.

The role the landscape plays in providing settings for wetland research and recreation (for example) will be considerable. Kooragang Island presents a valuable opportunity for wetland research that involves using wetland (or other degraded habitat) restoration demonstration sites for manipulative experimentation thus enabling rapid information transfer to the community to improve the way in which restoration is undertaken. It presents an opportunity to develop a close working relationship between the research team and the public ultimately serviced by their activities. A beautiful landscape setting will be an important adjunct to this project, attracting people to the site to enable information transfer, and to foster support for the research work.

The importance of settings for nature based recreation in extensive tidal zones should also not be underestimated. The unsupervised enjoyment of the extensive wetlands in Northern Australia is not available to most people due to their remoteness and the frequent presence of crocodiles. Extensive wetland sites close to major population centres within Australia are rare (eg. St. Kilda Wetlands near Adelaide) or extremely degraded (eg. Port Phillips Bay Salt marshes or the Peel Inlet/Harvey Estuary South of Perth). The unique potential of Kooragang Island for nature based recreation experience in the correct landscape settings is further reinforced by the opportunity to develop rainforest habitats adjacent to those of the tidal zone and wetland areas. With attractive natural settings and responsible land management, the site can provide the population of the nearby urban areas with a wide variety of recreation and educational experiences. The resulting visitation can be used as the starting point for the promotion of support for research programmes, information dissemination and education about natural systems and
people's interaction with the environment. What makes Kooragang Island special in this respect is the diversity and scale of the potential settings available on the site. The recreation value to an urban population of settings such as enclosed rainforest, boardwalks through reed beds, canoe journeys through tidal marsh areas will be immense and of considerable regional value.

The strategic landscape plan has been produced through the synthesis of the opportunities and constraints identified for the project with the objective of creating a landscape similar to that believed to be the original character of the islands and the Tomago–Fullerton Cove area. This understanding is based on recorded data from the early settlers on the island, old photographs, the recollections of local residents, the preliminary hydraulic investigations undertaken as part of this study and research into the likely ecological history of the area and the present functioning of the estuarine ecosystem.

An objective of the plan is to retain much of the existing vegetation communities and microclimatic conditions while rehabilitating, restoring and creating additional wetland habitat for fish and birds in accordance with the primary objective of the project. The Strategic Landscape Plan provides a balance between the retention of existing habitat and the creation of new habitat. (Refer Figures 4.1 - 4.3). Some detail drawings are provided in the Precinct Plans shown in Figures 4.4 - 4.8. These figures are at the end of this section.

The strategic landscape plan does not specifically address Hexham Island and further consideration will be required for this area at a later date.

The strategic landscape plan and precinct plans should be read in conjunction with the design guidelines. These guidelines indicate the typical form, arrangement, materials, dimensions and construction type for the general concepts and specific areas indicated on the strategic landscape plans and precinct plans.

The preparation of the strategic landscape plan has been based on an overview of the physical and cultural resources of the study area and the results of the foregoing Feasibility Study. The findings of the feasibility study were summarised in a three stage concept providing a net increase in wetland and mangrove habitat, research opportunities and improved facilities for low key education and recreation pursuits.

Some recommendations in the strategic landscape plan represent changes to the recommendations of the Feasibility Study. In summary, these are:

• provision of a Project Investigation Zone in Area E which involves the construction of experimental hydraulic configurations for
inclusion of soil and groundwater experimental plots in the Project Investigation Zone;

- relocation of the city farm;

- creation of wetland at Creek 1;

- provision of a substantial area for rainforest species reinstatement in the north west corner of the site;

- addition of car parking facilities at the advisory centre and city farm locations;

- addition of interpretive signs at all historical and ecologically significant locations on the site which have been identified as interpretive sites;

- addition of picnic facilities at the fishing area on the north arm of the river, and

- provision of bicycle and pedestrian trails throughout the site additional to the existing service roads for improved educational interpretation of the island.

4.1. Wetland Rehabilitation

4.1.1. Kooragang Island

Fully Flushed Tidal Areas

Modifications to create the large wetland area proposed in the central part of Area D have increased the area influenced by tidal flushing from the river. These areas are important feeding areas for wading birds and increased tidal flushing is also thought to provide improved nursery habitat for juvenile fish, prawns and crabs. The proposals would create fully flushed areas, mainly from the existing opened culvert (C2) at Cobbans Creek, as recommended in the feasibility study. It is proposed to widen the creek channel to approximately 10m width at the base and excavate as necessary to achieve a mean water depth of 1m. The pond, known as Norma’s Pond No. 1 is to be retained and enlarged slightly with the connecting channel to Cobbans Creek widened to provide full tidal flushing.
Permanent Water Area

The tidal influence to the ponds known as Norma's Ponds No.'s 2 and 3 would be increased by enlarging the channel to Cobbans Creek. The tidal range would be controlled by a new flow control device to maintain an area of permanent water in the lake shown on the Strategic Landscape Plan. The resulting water body would extend to the Advisory Centre where the open water will form a visual feature for public enjoyment and a setting for the proposed buildings and associated development. Assuming a mean tidal range of the Hunter River of about 1m the estimated range in the lake would be about 0.5m. The lake area would need to be excavated where required to achieve a depth of 1m.

Typical cross-sections through the permanent water area are shown in the design guidelines section of this report.

Saltmarsh

The extent of new saltmarsh communities in the wetland area should be finally determined following experimental investigations on the island. It is anticipated at this stage, extension of the saltmarsh community could be achieved by the excavation of existing pasture levels by approximately 200-250mm. An example of this change can be seen along Cobbans Creek where saltmarsh is taking over Buffalo Grass pasture as a result of increased tidal fluctuations/flows over the area. This would render the area subject to irregular tidal flushing, not daily tidal flushing as required by mangroves. A combination of evaporation and transpiration will increase soil salinity to levels unsuitable for mangrove colonisation. Saltmarsh may re-establish naturally on the site or may be established by direct planting of divisions or cuttings or nursery grown stock into mud or water, the efficacy of which is being assessed in a current research project.

4.1.2. Tomago–Fullerton Cove

Wetland rehabilitation is proposed for this area and includes the possible introduction of tidal influence to existing degraded wetlands by the removal of two existing floodgates in the flood levee. The two breached areas of the levee should be extended to provide a break of approximately 10m to allow substantially improved water flow. At this stage, it is believed that this will allow sufficient tidal influence to the wetlands beyond to improve their vigour and to reinstate a stable wetland community. The area should be monitored to assess the impact of increased tidal influence on the wetland area.

The feasibility of this option will need further investigation. Importantly, accurate surface levels need to be determined via a detailed topographic survey and it would have to be shown that other properties adjacent to the study area would not be negatively effected.
It may be necessary to undertake localised bank protection works to prevent scour where the levee bank is breached. The configuration of the drains that run alongside and toward the levee bank should not be changed in the interests of economy. However localised revegetation works may be appropriate subject to the impact of the new tidal regime.

4.2. Vegetation Communities

Re-establishment of vegetation communities is proposed for Kooragang Island. The main vegetation communities on the island will include mangrove forest, saltmarsh, intermittent swamp, reeds, scrub, woodland and littoral rainforest.

Species recommended for each of the communities are listed below. They may be augmented by others derived by research:

**Mangroves**
- *Avicennia marina* var. *australasica*
- *Aegiceras corniculatum*

**Saltmarsh Plants**
- *Sarcocornia quinqueflora*
- *Sporobolus virginicus*
- *Suaeda australis*
- *Triglochin striata*
- *Juncus sp.*

**Intermittent Freshwater Swales**
- *Triglochin procera*
- *Persicaria spp.*
- *Cotula coronopifolia*
- *Samulopsis repens*
- *Schoenoplectus litoralis*
- *Bolboschoenus caldwellii*
- *Elatine gratioloides*
- *Ruppia sp.*

**Reeds**
- *Juncus kraussii*
- *Juncus polyanthemus*
- *Typha orientalis*
Scrub
- *Melaleuca ericifolia*
- *Melaleuca seiberi*

Woodland
- *Casuarina glauca*
- *Melaleuca quinquenervia*
- *Melaleuca styphelioides*
- *Eucalyptus pilularis*
- *Eucalyptus tereticornis*
- *Angophora costata*

Littoral Rainforest
- *Cupaniopsis anacardioides*
- *Podocarpus elatus*
- *Diospyros australis*
- *Breynia oblongifolia*
- *Livistona australis*
- *Elaeocarpus obovatus*
- *Glochidion ferdinandi*
- *Acmena smithii*
- *Pittosporum revolutum*
- *Syncarpia glomulifera*
- *Backhousia myrtifolia*

Grasslands
- *Pennisetum clandestinum*
- native grasses (to be determined)
- *Agrostis aemula*
- *Parapholis incurva*
- *Sporobolus virginicus*

This is not an exhaustive list of plants for the project. Final plant selections will be based on detailed historical and ecological investigations when they are available, particularly for communities of which there are few remaining representative pockets.

Rainforest

Remnants of littoral rainforest, which research indicates to have been a major vegetation community in the area, exist near Ash Island bridge and other sites on Kooragang Island. Some of the remnants include areas of the rare rainforest vine (*Cynachum elegans*). A rainforest is proposed to re-establish some of the vegetation of littoral rainforest that previously existed and to expand the areas of relic rainforest. The rainforest is to
be located in the north-west corner of the site which is elevated slightly above the wetlands and saltmarshes as shown in the Strategic Landscape Plan. Rainforest trees should be extended along the east-west road and the boundary of the city farm linking to the advisory centre. Guided and self guided pedestrian walks should be conducted from the advisory centre through the rainforest as an example of one of the original communities of the area. Educational panels or signs could be used to interpret the features of littoral rainforest. An interpretive site is proposed at the existing remnant area of rainforest.

An arboretum near the advisory centre would display tree specimens representing those of the rainforest and other communities that previously occurred and the island.

Creation of true rainforest is likely to be an extremely slow process and the final product is unlikely to replicate original species diversity and structure. However, it is possible to re-establish many rainforest species on the island over a large area to recapture the lush vegetation character and increase the range of habitats to a level approaching that which once existed on the island. The reinstatement of an ecologically correct rainforest structure will require additional research and experimentation to fully understand the required micro-climatic conditions for this community.

4.3. Plant Establishment

Due to the large numbers of plants involved in the rehabilitation works it is likely that a combination of direct seeding and broadacre tubestock planting techniques will be used in association with the encouragement of natural recolonization. In order to minimise costs it would be prudent to avoid irrigation. With adequate programming of construction packages it should be feasible to initiate planting/seeding programmes during Spring and Autumn. However contingency plans should incorporate the provision of water cart access points to all planted areas in the case of extended dry or excessively hot weather.

A designated high volume water supply point should be provided on the island for water cart and fire truck filling in emergency situations.

4.4. Pasture Grass and Weed Eradication

Successful re-vegetation of the island will require a co-ordinated pasture grass eradication programme. Creation of the new wetland areas by bulk earthworks should eliminate large areas of existing kikuyu pasture. In areas where no earthworks are proposed an intensive pasture grass eradication programme will be required to facilitate re-vegetation of the area by indigenous, terrestrial trees, shrubs and grasses.

The success of the pasture grass eradication programme and other weed control measures will require a long term commitment to the weed
management and control practices.

4.5. Project Investigation Zone

The Project Investigation Zone is proposed in Area E in the south-east of Kooragang Island in the existing low lying wetland area comprising primarily permanent water areas and saltmarsh. Currently, service easements and a service road traverse the site in a north-south direction parallel with the south channel of the river.

Development on these easements is restricted to low plantings, and service access for 4WD vehicles needs to be maintained to the transmission towers at all times. The existing overhead transmission lines are a visual intrusion to the wetland environment. However, visual quality in the project investigation zone is less critical than in areas with more concentrated public activity.

The low lying topography provides maximum opportunity for experimental work involving excavation of channels and ponds for fisheries research, and provides immediate access to the south arm of the river. Existing ponds can be incorporated into research programme designs to minimise excavation and the need for spoil disposal.

The isolated nature of this portion of land from the rest of the study area lends itself well to use as an investigation zone since the requirement for public access is less critical than for other areas of the site. It is not intended, however, that the project investigation zone be treated in isolation to the northern part of the island, but rather that public access be controlled from the advisory centre as part of the educational/interpretive aspect of the project. The project investigation zone could, for instance, be included in guided tours from the advisory centre.

The scheme shown on the strategic landscape plan shows conceptually the opportunity to provide three braided channels, three long channels to large ponds, and three short channels to smaller ponds. Varying tidal ranges could be provided to each at, say, ranges of 0.25m, 0.5m and 0.75m. These parameters would require the following controls:

- flow control structures (not culverts necessarily) at the inlet channels to the waterways with the lowest tidal range;
- appropriately sized channels for the waterway with higher tidal ranges, these may be able to control the upstream tidal range without a requirement for flow control structures;
- new culverts under the access road to suit the required channel flow cross-sectional area (where flow control structures are required they could be located at the culverts for construction
varying types of flow control structures may be necessary depending on the flow conditions required for various investigations; and

- channel extensions into the mangroves as necessary to achieve the higher tidal ranges on the island of 0.5m and 0.75m should these be required.

The detail design of the project investigation zone should be based upon the work undertaken by the project research scientist and include definitive parameters for required channel widths, depths, cross sectional area and tidal range etc.

4.6. City Farm

The city farm is located north of the east–west road adjacent to the radar stations. The layout shown on the Strategic Landscape Plan is indicative only and should be finally resolved as part of an integrated city farm plan. Features of the city farm may include:

Exhibits

- wetland management on farms;
- aquaculture;
- permaculture;
- orange grove;
- market garden;
- animal holding pens, eg. chicken, goats, lambs etc;
- experimental plots for schools;
- grazing livestock; and
- research plots for desalination, salt tolerant species etc.

(These exhibits should be designed to be self-sustaining with no negative effects on the surrounding natural areas).

Attractions

- tractor rides (for children);
- agricultural demonstrations;
- interpretive facilities/display material; and
- historical farmhouse.

Energy Efficient Measures

- water harvesting/recycling;
- composting;
- windbreak; and
- alternative energy on farms.
Buildings

- office and storage facilities.

Other Facilities

- walking/cycling trails;
- picnic facilities; and
- a wildlife corridor.

Buildings for a farm office and storage would be required. These would need to be flood resistant structures possibly elevated or constructed in a pavilion-type style which would resist damage during flood events. The final farm-layout would be developed in accordance with a detailed city farm plan prepared as part of a separate study.

A fluoride monitoring programme may be required to ensure there is no detrimental effect on vegetation and animals.

4.7. Advisory Centre

The advisory centre is proposed to be located in the former radar station buildings at the end of the main east-west road of Kooragang Island thus taking advantage of one of the few existing remaining structures on the island. Such an approach reduces the requirements for construction of new structures on flood prone land where there are numerous limitations. The radar stations are located near the boundary of the study area, but are located centrally in relation to the ecology of the island and provide the opportunity to interpret and highlight the existence of the adjacent Kooragang Island Nature Reserve. Alternatively, this could be achieved by the inclusion of an interpretive site at the end of the east-west road which would address the adjacent reserve area.

The radar stations are also located centrally in relation to the topography and ecology of the island being adjacent to the low lying wetland in the central part of Area D and to a relatively high area north of the main east-west road. The development of various wetland and terrestrial communities or other facilities are possible adjacent to each other with the opportunity to interpret and co-ordinate these uses as the focal area for public activity.

Basic services such as water and power supply should be provided to the advisory centre. It would be appropriate to incorporate self-composting toilet facilities to avoid the need for sewage connection.

An arboretum is proposed adjacent to the advisory centre as a means of exhibiting rare rainforest and other species believed to have once occurred in the area. This would be a significant education feature by interpreting the original communities which made up the island. An
amphitheatre or 'outdoor' room could be created for the purpose of outdoor education. (Refer Figure 4.7 at the end of this section).

4.8. Recreation

4.8.1. Road/Bicycle/Pedestrian/Water Links

Five categories of linkages have been identified on the strategic landscape plan. These are described below.

Access Roads

One main road link has been retained in the plan to provide access from the Ash Island bridge to the advisory centre. This would follow the existing road except where it has been realigned at the entry to provide a more direct route and would include the link to the north arm of the river. The recommended surface is bituminous concrete (hotmix).

Service Trails

These will provide access to maintain services on the island. They all follow existing two or four wheel-drive trails, currently of stabilised earth and gravel construction and are usually grassed over. These should be maintained as 3m width 4WD tracks and also be used for bicycle access.

Dual Pedestrian/Cycleways

Additional dual pedestrian and cyclist trails are required over and above the alignments already provided along existing service tracks and have been added to facilitate access to the various facilities and interpretive sites in the study area. These include a trail link through the Tomago-Fullerton Cove area along the existing flood levee and back to Tomago House. All dual pedestrian and cyclist trails should be 2500mm wide, minimum.

Pedestrian Trails

1200mm wide pedestrian trails are proposed through the wetland, rainforest and city farm to link interpretive sites and facilitate access around the site. A concentric arrangement of trails from the advisory centre will allow short and long walks depending on the requirements of the users.
Water Links

Boat links around the island have been indicated on the strategic landscape plan. Access should be encouraged to the following areas:

• canoe access to the Shortland Wetlands Centre via Ironbark Creek by the inclusion of a portage point for people to lift their canoes around the floodgates;

• canoe access to the west of Hexham Island where the existing submerged walls make the area unsuitable for boats;

• canoe and/or boat access up Dunn’s Creek and Creeks A and B into the Tomago area including the provision of a small beach or timber ramp for boat pull up and the removal of existing floodgates to allow entry into the wetlands beyond the levee;

• canoe access along Cobbans Creek possibly to Moscheto Creek to the east including the provision of a portage or launching point over the existing watermain;

• possible tourist boat access from the Hexham, Sandgate, Tomago and Newcastle Harbour facilitated by the provision of wharves to the north of Kooragang Island and in the Tomago area at the start of the levee bank; and

• general motor boat access for fishermen facilitated by the provision of wharves and small stone beaches for boat pull-up on the south arm adjacent to the watermain pipeline crossing of the south arm of the river.

4.8.2. Fishing

Additional facilities for recreational fishing have been provided at the north and south arm to ensure continued access and activities on the island. These include picnic facilities (picnic shelters, barbecues) grassed open space areas, car parking, picnic tables, and a wharf on the north arm for tying up boats. This is intended to encourage future reliance on boating as a method of access to the island from surrounding areas. The construction of a pedestrian/cycleway bridge across the water main pipeline to the southern portion of the island from the Pacific Highway will ensure continued access to the main fishing area in the south.

It may be appropriate in intensively used fishing spots to incorporate bank protection works to prevent the deterioration of the banks by overuse or erosion.
HUNTER RIVER
SOUTH ARM

New carparking

Table arrangements

Boulder beach provides access for fishing whilst protecting the shoreline. Maximum distance 15m.

New 2.5m width dual pedestrian/cycleway with Interpretive Sites.

Interpretive Site with bench seating and signage

Possible future mangrove walk/boardwalk

LEGEND

- New Fencing
- Existing Fencing
■ Table Arrangements
■ 2.5m Width Pedestrian/Cycleway
■ Wheelstop/Vehicle Barrier
■ Barbecue
■ Picnic Shelter
■ Rainforest
■ Boulder Beach
■ Existing Saltmarsh
■ Shrub Planting
■ Feature Trees
■ Kikuyu
■ Woodland Planting
■ Mangrove
■ Native Grassland

KOORAGANG WETLAND REHABILITATION PROJECT
PRECINCT 1 - ASH ISLAND BRIDGE ENTRY

Figure 4.4 Dwg No: 2557.58
October 1994
KOORAGANG WETLAND REHABILITATION PROJECT

PRECINCT 2- ASH ISLAND BRIDGE ENTRY AND DIRECTORY SIGNBOARD

Figure 4.5

Dwg No: 2557/8a
October 1994
Lay back bank and stabilise with reno-mattresses, reeds and shrub planting.

Proposed timber wharf, (avoid existing small groves of mangroves).

Proposed timber bridge creek crossing.

Retain existing boat launching area.

Retain existing river edge

Lay 3m wide road

Existing mangroves to be retained.

Proposed City Farm boundary fence.

2.5m wide cement stabilised gravel dual pedestrian / cycleway.

Cement stabilised gravel car park.

Retain existing fenceline and repair as necessary to form new City Farm boundary.

Existing road

Shrub planting to max height 4m under easement.

Native grass understorey.

KOORAGANG WETLAND REHABILITATION PROJECT
PRECINCT 3 - NORTH ARM WHARF AND PICNIC AREA

Figure 4.6

LEGEND

Native Pasture
New Fencing
Table Arrangements
2.5m Width Pedestrian / Cycleway
Wheelstop / Vehicle Barrier
Barbecue
Picnic Shelter
Existing Kikuyu
Shrub Planting
Woodland Planting
Mangrove

October, 1994
Regrade bank to achieve max 1:5 grade embankment. Stabilise with reeds and woodland planting in groups.

Boulder beach provides access for fishing whilst protecting the shoreline. Maximum distance 15m.

Water pipeline.

Dual pedestrian / cycleway bridge.

LEGEND
- Native Pasture
- Bicycle Path
- Table Arrangements
- Picnic Shelter
- Barbecue
- Boulder Beach
- Existing Saltmarsh
- Proposed Saltmarsh
- Reeds
- Kikuyu
- Woodland Planting
- Mangrove
5.0. DESIGN GUIDELINES

The objective of the detailed landscape works for the project will be to establish a character and theme which will provide a structural framework for future development of the site and which facilitates the integration of various structural components into a unified wetland development.

Essentially, detail resolutions should be low key, simple and robust resulting in structures and treatments which suit the natural character of the project.

The guidelines should be read in conjunction with the strategic landscape and precinct plans to provide further detail concerning the style, materials and dimensions of key developments.

These guidelines have been prepared on the basis of limited site information with respect to soil conditions, water table, etc. They are provided for information as to the scope and style of development only and shall not be used for construction under any circumstances.

All guidelines are subject to detailed engineering and landscape design.

Typical design solutions for each element are described in the following text and where applicable are shown graphically at the end of this section.

5.1. Habitat Creation

5.1.1. Earthworks

Earthworks are intended primarily in two zones shown on the strategic master plan. These include the wetland zone and the project investigation zone. Based on the current understanding of wetland systems, opening these areas to increased tidal flushing will extend available fish breeding areas and create, rehabilitate and restore valuable wetland for bird wader feeding and roosting habitat in line with the major objectives for the project.

It is probable that the requirement for excavation will considerably exceed that for filling, and that the disposal of excess fill will become a major issue.

Earthworks in the project investigation zone would be undertaken in a highly structured and controlled manner to enable scientific research into environmental influences on fish breeding habitat. Accordingly, a range of topics will be studied and excavation in this zone will be governed by experimental parameters set up specifically for fisheries research as part of an integrated experimental/research plan.
In all areas, earthworks generated within the study area must ensure the retention of the existing flood regime on the flood plain during large storm events.

Earthworks on the island should be confined to the following work:

- widening and deepening of existing channels and ponds;
- shallow scraping of existing dry pasture land in wetland zones, and
- regrading of riverbanks for stabilisation.

**Channels and Ponds**

Proposed channel and pond dimensions for the wetland zone have been discussed in 4.2. Wetland Rehabilitation. Banks should be constructed to maximum grade 1:8 up to high tide level in order to minimise the area of intertidal influence and hence control mangrove colonisation within the wetland zone. A minimum grade of 1:5 could be achieved with soil stabilisation treatment and reed planting.

The proposed channels and ponds have been located along the existing creek alignments to minimise the required excavation volumes. The channels and ponds would have a mean water depth of about 1m. Water depths would generally decrease in an upstream direction to aid flushing of the sediment areas. These waterways would be excavated using land based excavators placing sediment directly into trucks for disposal. Excavation would be below the natural water table and would proceed in distinct stages with isolation using bunds or silt curtains to prevent turbid waters entering existing or completed waterways.

The channel and lake dimensions would be sized to ensure the beds would not be exposed at low tidal levels and flow velocities were sufficiently low to avoid scour. The channel side slopes would be designed to be stable given the subsoil sediment characteristics. The establishment of mangroves on the channel sides would assist to stabilise these slopes. Following further design it may be necessary to provide localised short term protection of lake and channel edges using environmental matting. This may be required on the margins of the larger ponds and channels to provide protection against wave damage.

It will be necessary to undertake suitable investigations to obtain an understanding of the existing hydrodynamic behaviour within the study area. This understanding will enable appropriate design of the proposed channels, lakes and control structures. It will also be necessary to identify the potential impacts on waterways in adjacent areas. The investigations required will include a survey of the site with an accuracy of 0.1m which is readily achievable using ground survey techniques. Monitoring of tidal conditions simultaneously at each control structure within each tidal sub-catchment will be required over a range of river
tidal conditions. It will be necessary to monitor water level and flow variations and establish energy losses through control structures. Measurements will also be required within Moscheto Creek in order to predict potential impacts on this system and enable design of appropriate control structures at the boundary between the Cobban and Moscheto Creek systems. This aspect is important because it is understood that the NPWS has proposed improvements of tidal flows in this creek as well as in the study area.

Dry Pasture Areas

The existing dry pasture areas within the wetland zone shown on the strategic landscape plan require modification in order to extend the existing saltmarsh/wetland community. At this stage it is believed this could be achieved by stripping and disposing of the existing kikuyu pasture to reduce existing levels by 200–250mm. In the feasibility study (1992) the following elevations were established to differentiate wetland communities:

- open water/mangrove boundary 0m AHD
- mangrove/saltmarsh boundary 0.35m AHD
- saltmarsh/pasture boundary 0.7m AHD

By reducing the existing level of kikuyu pasture to the levels colonised by saltmarsh and subject to periodic inundation native saltmarsh communities could be established and encouraged.

Minor drainage lines would be required over the new saltmarsh areas to ensure positive drainage to minimise possible ponding of water in stagnant pools. These pools provide ideal breeding conditions for mosquitos and should be eliminated wherever possible. The drainage lines should be minor depressions with a minimum longitudinal fall of 1:200. Bulk earthworks in the new saltmarsh areas should be graded in such a way to ensure positive drainage to the drainage lines, channels and ponds.

The installation of drainage lines should be minimised to areas where adequate falls for positive drainage cannot be achieved by surface grading. Where longitudinal falls of drainage swales are not sufficiently steep possible ponding of water and creation of stagnant pools will provide habitat for breeding mosquitos. Where possible pathways should be built up from surrounding areas so that drainage swales are not required alongside them and sufficient drainage away from the path can be achieved by surface grading.
The extent of excavation has been estimated approximately due to the lack of a site survey to a suitable level of accuracy. The excavation would be undertaken using bulldozers and front end loaders. The most economical method will depend on locally available equipment and subsurface sediment characteristics.

The proposed saltmarsh areas would be inundated during the higher high tides and hence excavation of these areas would have to be appropriately staged to permit excavation in the dry and allow excavation of the channels before the saltmarsh areas. One method which could be adopted would be excavation of the proposed channel initially starting from the upstream areas. Following construction of about a 200m length of channel or waterway, a bund would be placed across the downstream end to prevent the escape of any tidal flows. The saltmarsh area would then be excavated in the dry. The bund would then be removed in the excavation of the subsequent length of channel. The construction sequence would continue down to the south arm in each development area with planting of vegetation immediately following excavation in each sub area.

In the feasibility study it was suggested that a tidal pump could be used to minimise the required excavation volumes to establish the saltmarsh areas. It is understood that the tidal pump refers to an outlet at the south arm with an invert level just below the lower level at which saltmarsh is believed to exist i.e. RL 0.35m AHD. (However, the tidal pump principal requires two entrances with one experiencing the full tidal range and the second only allowing entry of the higher high tides. This induces a nett circulation flow assisting with the flushing of the waterway. It is not certain how this was to be implemented in the proposals within the feasibility study although channels are discussed as having inlets to both the north and south arms). The elevated inlet invert level would result in tidal inflows on an irregular basis and the channel inverts would only have to be excavated down to the inlet invert level. However, the strategic landscape plan has identified open water as an integral component of the improvement works. It is considered that with limitations on the water depth, the tidal flow from the south arm would be sufficient to achieve adequate flushing of the proposed waterways. Also, it is considered that with an elevated inlet invert level (tidal pump as interpreted from the feasibility study), the tidal inflow would be unable to propagate sufficiently upstream to inundate the proposed saltmarsh areas. The option would still be available, if necessary in the future, to link the proposed waterway just south of the visitors centre with a channel and half tide weir to the north arm to introduce a tidal pump to provide increased flushing effect.

The saltmarsh area would have a minimum slope of about 0.5% if the stated characteristic levels are found to be appropriate. It will be necessary, following gross excavation, to undertake a final grading using laser controlled graders. Rills are proposed at regular intervals through
the saltmarsh area to achieve effective drainage and alleviate extensive ponding of water and potential problems with mosquitos.

The saltmarsh area would be inundated during the higher high tides to limited water depths. The tidal flows would be minimal with limited potential for scour of the newly formed areas following establishment of saltmarsh vegetation.

*Riverbanks*

The existing erosion of the island river banks along the north and south arms of the river is caused by a combination of natural river meandering, flooding, and wind and boatwake waves. In the north arm the effect of wind and boatwake waves is more pronounced with typical benching of the bank around mean to high tidal levels. In these areas, a hard solution type would be most appropriate using rocks or boulders to dissipate wave energy without bank erosion. At locations where this wave attack was minimal, a more visually acceptable solution would be to use reno mattress, blankets overlain by topsoil with reed and grass planting. However the extent of this work can only be determined following site specific investigation and design.

5.1.2. *Spoil Disposal*

The following options for the disposal of excess spoil could be considered within the study area:

- earthmounding;
- disposal off site at an approved dumping location;
- disposal on adjacent sites such as BHP in accordance with possible future agreements with relevant landholders.

Earthmounding could be located strategically as a means of spoil disposal in the areas where rainforest establishment is proposed. This would elevate the existing lowlying land to a level more appropriate for the establishment of a complex vegetation community. The alignment and extent of mounding, however must be determined in a manner which does not adversely effect the existing hydrologic/flooding regime. In addition, levees could be formed to protect or found future buildings.

Disposal of spoil at an approved dumping location is likely to be an expensive option unless an agreement can be successfully negotiated with an outside party to accept the excess material at minimal or no cost.
5.1.3. **Drainage Structures**

There is up to about 1 m tidal range available in both the south and north arms to drive flows into and out of the proposed channels and lakes on Kooragang Island. In the central wetland area it is proposed to allow full tidal penetration into the channels to maximise flushing within the channels and lakes. The average water depths would be limited to about 1 m to ensure that adequate flushing would occur. It is estimated that the tidal range at the upstream end of the central wetland would be approximately 0.5 m. Based on the tidal prism ratio method, it is estimated that these waters would be flushed in about one day. While this method typically underestimates the flushing time, it does indicate that flushing would occur within a relatively short period.

It will be necessary to isolate the potential increased tidal flows in the proposed central wetland from Moscheto Creek until the hydraulic behaviour of this creek system is understood. Then it may be possible, depending on the likely impacts on the aquatic ecology, to connect the two systems to improve flows in the creek. It may be possible to introduce a half tide weir between the two systems in order to induce tidal pumping of flows through the creek. This would increase the unidirectional flushing of the creek with a limited increase in tidal range.

Within the investigation zone the control structures can be designed to suit the required tidal conditions within the waterway. These conditions may involve different tidal ranges, different water depths at low tide or an ability to readily vary the tidal conditions on a regular basis. These requirements will govern the type of control structures necessary and their characteristics.

Numerous bicycle and pedestrian paths are proposed in order to provide adequate public access around the site. Special consideration will be required at the junctions of these paths with drainage lines within the study area. Two alternative solutions would be applicable for the project comprising a piped and culvert solution for permanent water courses and a concrete paved ford for intermittent channels.

Headwalls will be required at drainage outlets to creeks and at inlets to wetlands. In public areas, raw engineering structures should be concealed to give a natural appearance. This could be achieved using rocks or boulders or by shaping and colouring concrete to provide artificial rockwork with a natural appearance.
5.2. Pavements

5.2.1. Car Parking

Informal car parking should be provided at the locations shown on the strategic landscape plan for Kooragang Island and the Tomago-Fullerton Cove Areas. These include the entry at Ash Island bridge, the fishing area on the north arm of the river, and at Tomago House. These would be small car parking areas for 5-10 cars only.

The car parks should be of cement stabilised gravel construction with flush edges. The boundaries of the car parks would be defined using timber vehicular barriers.

Formal car parks are proposed at the major facilities on the island including the advisory centre, the city farm and at the water pipeline crossing adjacent to the Pacific Highway. The viability of the car park on the Pacific Highway would need to be determined following discussions with the RTA. The advisory centre and city farm car parks should be of asphalt construction and large enough for 10-20 cars with over flow parking for a similar number of cars.

5.2.2. Access Roads

Main vehicular roads include the east-west connection to the advisory centre and access to the north arm of the river for fishing. Sections of the existing roads are already asphalt sealed. The remaining unsealed sections should be upgraded with a similar finish.

Stormwater runoff from the road pavement should be directed to and along swales along the road side.

Roadworks along the Pacific Highway are recommended at Ash Island bridge and at the proposed pedestrian/cycleway crossing at the water pipeline across the south arm of the river. These would include acceleration and deceleration lanes to both access points to ease the hazard of accessing the island to and from the high volume and high speed of traffic along the Pacific Highway. The details of these roadworks and the car parking area proposed at the water pipeline crossing should be resolved following discussions with the RTA and Newcastle City Council.

5.2.3. Service Trails

Service trails should be constructed to 3m width to allow maintenance access for two or four wheel drive vehicles to all utilities easements. These roads would also be included in the network of cycleways over the island. They would be of cement stabilised gravel construction to match pedestrian trails and dual pedestrian/cycleways.
5.2.4. *Dual Pedestrian/Cycleways*

A network of cycleways would be developed over the island to facilitate public access. The network would include a connection through the adjacent Kooragang Island Nature Reserve between the advisory centre and the project investigation zone. The cycleways would connect with the Newcastle regional network proposed for development by the Newcastle City Council to enhance the overall plan for the city of Newcastle. A cycleway is also proposed in the Tomago area to the north of the island as shown on the Tomago-Fullerton Cove Strategic Landscape Plan. This would follow the existing levee with connection from Tomago Road at both ends of the levee and a loop through the existing pasture areas.

5.2.5. *Pedestrian Trails*

Pedestrian trails have been provided within the city farm, the wetland zone and the rainforest to maximise public access at these strategic sites. These are co-ordinated with various interpretive sites throughout the study area to enable detailed and accurate interpretation of the natural, cultural and social histories of the island. At these locations signage and bench seating facilities would also be provided.

Pedestrian trails should be 1.2m width and constructed of cement stabilised gravel with timber edging on both sides. The gravel should be gravel selected from a local quarry to minimise transportation costs.

5.3. *Structures*

5.3.1. *Minor Buildings, Amenities*

The style of minor site buildings such as kiosks, sheds and amenities blocks should co-ordinate throughout the site to form an attractive suite of built elements. A palette of colour and materials should be selected and used consistently in attractive designs to establish a high level of amenity for the public and staff. The designs should be simple and robust with recognisable forms to provide an individual site identity and landscape features in harmony with the surrounding natural character of the island. In all cases the basic methods of passive thermal design should be employed including:

- natural ventilation;
- thermal mass; and
- insulation.

Structures generally should be assessed based on their low maintenance, high durability, and floodproof qualities.
Kooragang Wetland Rehabilitation Project

Strategic Landscape Plan

- **Structural Guidelines**

All minor buildings should be constructed with consideration to the likelihood of periodic inundation by flooding. It is recommended that structures be designed to prevent inundation during a 1:20 year flood event. This could be achieved by the following two alternative approaches:

- construction of a levee around minor buildings to the height necessary to resist a 1:20 year flood event (2.0m AHD), and

- elevation of structures on stilts or earth mounding to the same level.

In both cases it is recommended that all buildings be located in areas within the study area with a level of at least 1.0m AHD. This would necessitate a maximum levee, earthmound or stilt height of approximately 1.0m. Levee construction would provide an opportunity for fill disposal should the material excavated from the wetland areas be considered suitable. A levee, to 1.0m height could be designed to be sensitively disguised by planting and gentle grading or to provide a prominent landform feature as required. Some consideration would be required to ensure adequate access for pedestrians and the disabled. Levee construction would be an appropriate way to prevent frequent flood damage. Levee construction around the advisory centre, for instance, may include a prominent bank or amphitheatre to enclose outdoor space for outdoor education activities as desired.

Within the city farm office facilities for permanent and residential use may be required for a farm manager. This structure should be elevated above the 1:100 year flood level to allow safe storage of official documents and records. In this instance a two-storey structure would be applicable with an open pavilion type design below which is unaffected by flooding, and an office building above at 3.6m AHD.

All buildings should be floodproofed to minimise damage in severe floods.

**Materials**

Materials need to be hard wearing and durable due to the public location, long term user requirements and minimal maintenance provisions. Rough hewn timber finishes, galvanised mild steel fixtures or cast aluminium fixtures are all materials appropriate for the site conditions development. Once selected these materials should be used consistently throughout all the built elements as discussed. In all cases where built structures are prone to flood damage consideration should be given to the selection of flood resistant materials such as brick and concrete. Glazed windows below 3.6m AHD should also be avoided to ensure minimal damage during a storm event.
Amenities Blocks

No sewerage service is currently available on the site. Accordingly an enviro-cycle or self contained type system would be the most appropriate. A self contained system is probably the cheaper solution and would be appropriate for the project.

Amenities blocks should be provided at the advisory centre and city farm sites.

5.3.2. Timber Boardwalks/Bridges/Viewing Platforms/Bird Hides

Timber bridges for bicycles would be required in two locations to bridge gaps in the levee in the Tomago area, and across Cobbans Creek on Kooragang Island.

Timber boardwalks, viewing platforms and footbridges are proposed over wetland and mangrove areas for viewing of water fowl and aquatic life and for pedestrian access across wetlands and mangroves. These should be of strong, simple, timber construction. Provision for interpretive signage should be incorporated in the rail or balustrade detail where applicable to allow interpretation of the natural, cultural or social features of each location or interpretive site.

5.3.3. Water Pipeline Bridge Crossing

As recommended in the Kooragang Island Wetland Compensation Project Feasibility Study (1992) a dual pedestrian/cycleway is proposed on the existing water main crossing of the south arm of the river. This crossing should be designed in consultation with the Hunter Water Corporation and will provide a direct link between the project investigation zone and adjacent fishing area and the Pacific Highway at Sandgate. From the highway it would be possible to establish a safe bicycle connection to the Shortland Wetlands Centre along the existing Sandgate Road.

5.4. Furniture and Fencing

5.4.1. Furniture

Furniture for the project should be developed as a co-ordinated suite of materials and designs as for the minor buildings and structures.

Furniture should be low key but elegant with robust timber materials used throughout, in keeping with the natural character of the project.

Picnic facilities including shelters, table arrangements, barbecues and litter bins should be located at the two fishing areas shown on the strategic landscape plan, one on the north and one on the south arm of the river. Additional picnic areas may be located within the study area at
a future date.

Bench seating would be appropriate at some of the interpretive sites in association with signage. These would be of similar simple, robust timber construction. Some may be incorporated within bird hides or on timber boardwalks.

5.4.2. Vehicle Barriers and Bollards

Timber vehicular barriers should be provided around car parking areas to prevent vehicular access beyond. Removable barriers should be provided for maintenance vehicles as required.

Timber bollards are recommended in areas where free pedestrian access is required and vehicular access is restricted. This would include entries to pedestrian walks and bicycle trails.

5.4.3. Fencing

Fencing should be used only where necessary because it can form a significant obstruction in floods with debris trapped between the wires.

Fencing is required within the study area for security and to contain cattle in areas proposed to remain under grazing during the early stages of the project. A new fence will be required along the boundary of the Kooragang Nature Reserve initially to contain grazing cattle and ultimately to control public access.

Temporary fencing around existing private structures such as the homes of existing licence holders, should be of similar, simple construction. Visual screening of the properties can be achieved using vegetative screens as desired. Screen vegetation should be selected from the native palette of species. Melaleucas, casuarinas and other dense foliage native plants would be appropriate.

Security gates should be located as shown on the Strategic Landscape Plans for Kooragang Island and the Tomago-Fullerton Cove area. All gates should be lockable and suitable for vehicular access.

5.4.4. Agistment Fencing

Where it is necessary to redefine existing grazing land or to temporarily relocate cattle due to construction activities it will be necessary to provide new agistment fencing. This should be of sturdy construction using cattle high tension wire and steel and timber fence posts.
5.5. **Site Identification and Signage**

The purpose of these guidelines is to establish a co-ordinated graphic style which provides identification and information in a distinctive and aesthetically pleasing manner. The size and placement of all signs should be considered an integral part of the site development.

Signs should be designed as a co-ordinated suite with consistency of form, material, colour, finish and typeface. They should be integrated with the design of other site elements such as bollards and site furniture and should be complementary to the scale of other structures.

The general layout of signs is shown on the strategic landscape plans. The layout is to be ordered using a hierarchical system of size. Four levels of signage should be incorporated to establish a sense of arrival and a logic of direction throughout the site:

- Project signs.
- Directory sign.
- Identification signs.
- Interpretive signs.

5.5.1. **Project Signs**

The project signs will be located at the two major entrances to the project from the Pacific Highway at Ash Island bridge and at the proposed dual pedestrian/cycleway crossing at the water pipeline at Sandgate.

For ease of viewing the signs should be placed perpendicular to approaching vehicular traffic along the highway and should not obscure sight lines along the highway.

These signs would display the name and nature of the project, a map and the major facilities within with a logo and/or graphic image as required.

The height of the signs should be large enough to display information which can be seen by approaching traffic, having a maximum height of 4.5m.

**Directory Signs**

These signs would be located at the eastern end of Ash Island bridge and at the start of the mangrove walk to the proposed new crossing at the water pipeline at Sandgate.
These signs would provide directional information, a list of the facilities within the project and possibly a map. Directions for deliveries and dispatch, opening times, entry fees and charges, details on car parking, locations etc. would be included on these signs. At Ash Island bridge, this sign should be set back off the road allowing space for a layback in the road. This will allow vehicles to pull out of the flow of traffic onto the island to take in the directory information.

Identification Signs

Identification signs should be erected to announce the location of specialist facilities such as the city farm and the advisory centre at the relevant entry points. These should display the name of the facility, entry and car parking information and any other specialist functions such as markets, special exhibits etc. In the case of the city farm the layout of the farm and major functions and facilities would be displayed.

Interpretive Signs

Interpretive signs will be located at all interpretive sites to describe and interpret the historical, natural and social features of the project. The signs should again be developed as a suite of elements to provide recognisable consistency between all the interpretive sites. Considerable research will be required both to adequately interpret each of the sites within the context of the island and project, and to display the information in a succinct, appealing and legible manner. The materials used could include timber or etched anodised aluminium plaques or other suitable material depending on budgetary constraints.
Kooragang Wetland Rehabilitation Project

**Native Grass or Kikuyu**

Continue Reno-Mattress for 1.5m at top & toe of bank.

**Compact Subgrade**

Reno-mattress filled with selected fill pegged at top and bottom of bank.

*Filter fabric with top and toe keyed into the subgrade.*

**Reno Mattress - Section 1:100**

Not for construction

---

**Existing Planting**

Round out tops & toes of banks over a distance of 1m (M.H.)

**Compact Subgrade**

Imported local boulders set into excavated bank & secured

**Reed Margin Within the Intertidal Zone**

Provide plantings pockets between boulders filled with topsoil.

**Water Edge Treatment - Section 1:100**

Not for construction

---

DESIGN GUIDELINE

River Bank Stabilisation

Land Systems EBC
**Typical Pond Profile 1:100**

- **Saltmarsh Above 0.35m AHD**
- **Reed Margin Established for Stabilisation, Possible Future Vascular Colonisation**
- **Pond Varies Up to 150m**
- **Reed Margin**
- **Saltmarsh Above 0.35m AHD**

**Round Out Tops & Toes of All Embankments.**

**Not for Construction**

---

**Typical Edge Treatment 1:20**

- **Reed Margin in the Interstitial Zone**: Possible Future Colonisation by Mangroves
- **Lay Bank Stabilisation Blanket Horizontally Along Pond Edge. Overlap Adjoining Blanket 100mm and Staple Through Both Layers at 150mm Centres.**
- **Compact Subgrade Humus Layer**
- **Bury Edges of Stabilisation Blanket in Trench. Backfill & Compact After Stapling.**
- **Planting**: Cut 100x100mm (Max) Cross Sections in Blanket & Plant Reeds, Firm Down Cut Sections After Planting.

**Not for Construction**
Kooragang Wetland Rehabilitation Project

Strategic Landscape Plan

Typical Creek Profile 1:100

Typical Edge Treatment 1:20

Design Guideline

Typical Creek Edge Details

Land Systems EBC
Kooragang Wetland Rehabilitation Project

Strategic Landscape Plan

Plan 1:500
Typical Path Intersection

Not for Construction

Woodland Tree Planting
Native Grassland Understorey

 Timber Edge

Obstruction Free Zone ↑
1000
1200 or 2500 mm

Obstruction Free Zone 1000 ↓

Compacted Subgrade

Section 1:50

Design Guideline

Pedestrian/Bike Path

Lead & stage: E20
Kooragang Wetland Rehabilitation Project

Strategic Landscape Plan

PEDESTRIAN / BIKEPATH 1:50
INTERMITTENT FLOW
NOT FOR CONSTRUCTION

NOTE: FINAL STORMWATER PIPE SIZE, DEPTH TO ENGINEERS DETAIL

PEDESTRIAN / BIKEPATH 1:50
PERMANENT FLOW
NOT FOR CONSTRUCTION

Drainage Crossing

Land Systems EBC
Kooragang Wetland Rehabilitation Project

Strategic Landscape Plan

SEALED VEHICULAR ROAD 1:50 NOT FOR CONSTRUCTION

GRAVEL ACCESS ROAD 1:50 NOT FOR CONSTRUCTION

DESIGN GUIDELINE Road Pavements

Land Systems EBC
Kooragang Wetland Rehabilitation Project

ELEVATION 1:50

PLAN 1:50

NOTE: ALL DIMENSIONS SUBJECT TO GEOTECHNICAL AND STRUCTURAL CERTIFICATION

DESIGN GUIDELINE

Timber Bridge/Boardwalk

Land Systems EBC
Kooragang Wetland Rehabilitation Project

SOFT OR HARDWOOD POST WITH 5mm BEVELLED EDGE

HARDWOOD DECKING FIXED TO EACH JOIST

HARDWOOD JOISTS

BLOCKING PIECE.

WOOD BEARERS FIXED WITH 2x12 MM GALV. BOLTS TO 60X60X3 PLATE HEADS

COMPACTED SUBGRADE

COMPACTED QUARRY REBUSE OR GRAVEL FILL AROUND MASS CONCRETE FOOTING.

CONCRETE FOOTING.

Dowel Bar

NB WHERE FINISHED GROUND LEVEL IS GREATER THAN 3M BELOW DECK LEVEL BUILD UP FOOTING FOR POSTS, ALLOW FOR BEACING AS NECESSARY.

SECTION 1:20

DESIGN GUIDELINE

Timber Bridge/Boardwalk

Land Systems EBC
TIMBER BIRD HIDE
SIMILAR CONSTRUCTION
TO BRIDGE & BOARDFALK.

ELEVATION (NTS) NOT FOR CONSTRUCTION

MANGROVES
REEDS

DESIGN GUIDELINE
Timber Bird Hide
Kooragang Wetland Rehabilitation Project

SECTION 1:50

PLAN DESIGN GUIDELINE

HARDWOOD HIP RAPETERS

PRE-FINISHED ZINCALUME ROOF CLADDING

HARDWOOD BATTENS

SALV. STEEPIC HOLDING DOWN EACH RAPETER.

BEARDSMOUTH MAX 1/2 RAPETER DEPTH.

HARDWOOD FASCIA.

SOUTHERN EMBANKMENT

HAZ. PITCHING BEAM
DECORATIVE BANDING TRIM.

SOFT OR HARDWOOD POST WITH 5mm BEVELED EDGES.

SALV. BOLT FIXINGS TO SALV. STEEL BLADE FIXING PLATE.

600mm SQUARE FOOTING

CONCRETE SLAB TO ENG. FINAL DETAIL.

WOOD TIMBER TABLE ARRANGEMENT LOCATED CENTRALLY WITHIN SHELF.

WOOD FLOAT FINISH TO CONCRETE SLAB WITH 60mm TROUGLED EDGE TO PERIMETER.

REINFORCED PAD FOOTING.

SOFT OR HARDWOOD POST

250mm BRICK EDGE. ALIGN WITH OUTSIDE EDGE OF POST.

NOT FOR CONSTRUCTION

6000

PLAN 1:50

NOT FOR CONSTRUCTION

DESIGN GUIDELINE

Picnic Shelter

Land Systems EBC
Koonagang Wetland Rehabilitation Project

EAST FACADE (n.t.s.)

WEST FACADE (n.t.s.)

DESIGN GUIDELINE

Schoolmaster's House

Land Systems EBC
Kooragang Wetland Rehabilitation Project

NORTH FACADE (n.t.s)

- Resheet existing roof with galvanised iron.
- Repair existing timber extension.
- Remove existing fence.
- Remove debris & rubbish around building.

SOUTH FACADE (n.t.s)

- Remove existing sheds and outhouses.
- Resheet existing roof with galvanised iron.
- Repair existing timber extension.
- Clean existing brickwork.

DESIGN GUIDELINE

Schoolmaster's House

Land Systems EBC
ALTERNATIVE USE PRECAST SLAB ON COMPACTED SUBGRADE WITH 4 LOADING HUBS GROUT BIN INTO POSITION.

ALTERNATIVE BASE

PAINT CONCRETE PIPE:
- UNDERCOAT SOLVER OIL LATEX
- PAINT SOLVER WEATHERFLEX LOW GLOSS ACRYLIC OR SIMILAR APPROVED

2mm METAL LID SECURED TO CONCRETE PIPE WITH 2 SPRELS, METAL FIXINGS.
DRILL HOLES IN CONCRETE PIPE FOR 2X10MM Ø G.I. DOWELS FIXED WITH NON-SHRINKABLE GROUT LID SECURED BY PUSHING DOWNS OVER DOWELS & TWISTING INTO LOCK POSITION. ALTERNATIVELY LOCK BINS WITH A STAINLESS STEEL HASP & PADLOCK.

HANDLES (2 NO)

LITTER SIGN PAINTED ON CONCRETE PIPE.

CLASS B CONCRETE PIPE: PLAIN FINISH SUITABLE FOR PAINTING.

OIL DRUM

25mm DRAINAGE HOLE

20mm Ø WASHED GRAVEL BLOCKING

WEEP HOLES (2 NO)

CONCRETE SLAB WITH CENTRAL REINFORCING ON COMPACTED SUBGRADE

NOT FOR CONSTRUCTION

SECTION

DESIGN GUIDELINE

Litter Bin

Kooragang Wetland Rehabilitation Project

Strategic Landscape Plan
Kooragang Wetland Rehabilitation Project

Strategic Landscape Plan

REINFORCED CONCRETE SLAB OR TO ENGINEERED FINAL DETAIL.

HARDWOOD BEARERS FIXED TO 100 X 100mm HWG POSTS WITH 12mm Ø GALV. COACH BOLTS, 2 PER POST (SAME PLATE AGAINST BEARERS, RECESS NUTS).

HARDWOOD BATTERS FIXED TO BEARERS WITH 75X8mm Ø GALV. C/C SCREWS & WASHERS, RECESSED HEADS, 3 SCREWS TO EACH BATTER, 4 5mm C distributes TO ALL BATTERS.

HARDWOOD POSTS WITH 4 5mm BEVEL BOLT TO GALV. STEEL PLATE AS SHOWN.

NOTCH POSTS 15mm TO TAKE BEARERS

COMPACTED SUBGRADE

DESIGN GUIDELINE

Table Arrangement

Land Systems EBC
Koongang Wetland Rehabilitation Project

Strategic Landscape Plan

- HARDWOOD BEARERS FIXED TO BEARERS WITH GALVANISED COACH SCREWS AND WASHERS, RECESSED HEADS, 8 SCREWS TO EACH BATTEN AND 3MM ROUNDED CORNERS TO ALL BATTERIES.

- HARDWOOD BEARERS FIXED TO HARDWOOD TIMBER POSTS WITH GALVANISED COACH BOLTS, 2 PER POST (DOMED FLAT AGAINST BEARERS, RECESS NUTS.)

- GAUDI STEEL PLATE SUPPORT.

NOTES:

- TIMBER: USE HARDWOOD TIMBER, LEAVE TIMBER UNFINISHED OR USE TWO COATS OF AN APPROVED TIMBER STAIN, 5MM BEVEL TO POSTS.

- CONCRETE: SLAB SIZE IS NOMINAL ONLY 3 MAY NEED TO BE REDESIGNED FOR VARIOUS SOIL TYPES. PROVIDE 2% FALL.

- WORKMANSHP - DEFORM Thread on all bolts to prevent removal of nuts. Remove all sharp projections or threaded protrusions of bolts.

- HARDWOOD BEARERS

- 3mm GAPS BETWEEN BEARERS.

PLAN

NOT FOR CONSTRUCTION

DESIGN GUIDELINE
Kooragang Wetland Rehabilitation Project

SECTION 1:10

GALV. STEEL BLADE BOLTED THROUGH TO BASE OF POST.

GROUND LEVEL

CONCRETE PAD FOOTING TO ENG. FINAL DETAIL.

TIMBERS: 4000x350x275mm HWD TIMBER LENGTHS ON END SET OVER 3 NO. PINS 25x25mm ARRIS TO TOP EDGES.

SECTION 1:20

DESIGN GUIDELINE

Timber Bollard and Vehicular Barrier

Land Systems EBC
NOTE

1. MILD STEEL GRILL PLATE WITH GAS OR ELECTRIC POWER SUPPLY.

2 MILD STEEL FRAME TO BE REMOVABLE FOR SERVICING AND THE DOOR FRAME TO BE SEPARATED FROM THE MAIN FRAME

3 CONCRETE: USE PORTLAND GREY CEMENT OR OTHER AS SPECIFIED SLAB SIZE IS NOMINAL ONLY & MAY NEED TO BE REDESIGNED ACCORDING TO SOIL TYPES
SECTION 1:20

DESIGN GUIDELINE

Pedestrian Access Through Fence

Kooragang Wetland Rehabilitation Project

Strategic Landscape Plan

Land Systems EBC

NOT FOR CONSTRUCTION
SOFT LANDSCAPING
Kooragang Wetland Rehabilitation Project

DISH MULCH TO BASE OF PLANT

75mm MULCH AS SPECIFIED
CULTIVATE EXISTING TOPSOIL

150mm PLANT. PROVIDE MULCH OVER 500mm AREA.
DISH TO BASE OF PLANT.

5L PLANT.
DISH MULCH TO BASE OF PLANT.

BACKFILL WITH EXCAVATED MATERIAL

BREAK UP BASE AND SIDES OF HOLE
CULTIVATE IN NEW TURF AREAS

NOT FOR CONSTRUCTION

DESIGN GUIDELINE

5 Litre and Tubestock Planting

Land Systems EBC
SECTION 1:20

NOT FOR CONSTRUCTION

DESIGN GUIDELINE

25 Litre Tree Planting
Kooragang Wetland Rehabilitation Project

TYPICAL WOODLAND SETOUT

(AV. 1 TREE PER 10 SQ.M.)
Rows at 3-5m centres in broad curves roughly accentuating contours (where applicable). Suggest initial curvature be set out by traker.

TREES SPACED AT [1m-3m-3m-3m-3m] - ROW 1. AND [3m-3m-3m-1m-5m] EACH ALTERNATE ROW, WITH STARTING POINT OF ROWS IN RANDOM PATTERN.

DETAIL SHOWING SMALLER GROUP

SET OUT 2m TRIANGULAR GRID
ADJUST GRID TO ACCOMMODATE CURVES. DEPTH OF BECT VARIES PLANTING RATE 3 PCY 10 SQ.M.

TYPICAL LARGE SHRUB PLANTING
NOT FOR CONSTRUCTION

DESIGN GUIDELINE

Typical Planting Setout

Land Systems EBC
SIGNAGE
Kooragang Wetland Rehabilitation Project

Kooragang Wetland Rehabilitation Project

**Strategic Landscape Plan**

**Kooragang Wetland Rehabilitation Project Graphic to all Signs**

**Map of Site**

**Background Text**

**Phased Timber or Aluminium Sign with Colour Graphics**

**PHS Supplier Sizes to be Determined, According to Final Design**

**Elevation 1:50**

**Project Sign**

**Elevation 1:50**

**Directory/Identification Sign**

**Elevation 1:10**

**Interpretive Sign**

**Section 1:10**

**Support Set in Concrete**

**Photo-Imprinted Aluminium Sign**

**Photo-Imprinted Aluminium Sign**

**Design Guideline**

**Signage**
**Kooragang Wetland Rehabilitation Project**

**Strategic Landscape Plan**

**BICYCLE PATH ENDS USE ROAD**

**BICYCLE PATH SIGNAGE**

- **Size:** 680 x 480mm
- **Colours:**
  - Blue lettering on white background
  - Blue border line

**Sections**

- **Plastic End Cap**
- **3 x M8 Galv. Round Head Bolts**

**Design Guideline**

*Signage*

Land Systems EBC
6.0. IMPLEMENTATION AND OTHER ISSUES

6.1. General

Implementation of the landscape development of the study area is likely to be staged over a period of approximately 20 years. Some features, such as the re-establishment of littoral rainforest, may span over a period of as long as 50 years, or more, depending on the nature of the work.

Implementation is recommended in four stages as shown on the Staging Plans illustrated in Figures 6.1 to 6.4. In each stage sections of the project will be targeted for development whilst existing landuses such as grazing in other areas will continue as they have in the past.

6.2. Staging Programme

It is anticipated that each of the four stages will be implemented over a period of approximately five years giving an approximate time frame for the development as follows.

<table>
<thead>
<tr>
<th>Stage One</th>
<th>Stage Two</th>
<th>Stage Three</th>
<th>Stage Four</th>
</tr>
</thead>
</table>

A programme for landscape development could be geared for construction around these times. The staging plans have been developed to graphically document the recommended scope of works for each stage. These should be read in conjunction with the strategic landscape plans and the development guidelines for a comprehensive understanding of each stage. The plans should be regarded as a conceptual rather than specific framework within which future anticipated and unknown requirements can be reasonably accommodated. The ramifications of changes at the detail level will require further consideration at the appropriate time.

6.3. Review of the Document

One of the major features of the project is the experimental nature of the work to be undertaken. All aspects of hydraulic improvements and wetland rehabilitation should be subject to constant monitoring and assessment of the impact of activities. Implementation in the first instance should be determined based on detailed investigations and research studies for specific areas. The general approach to all stages of work should be a flexible one allowing works to respond constantly to
new requirements which may effect the project. These may include changes in government policies, new technical information, data and research, new functional requirements on the site, budgetary constraints or new priorities.

However, in order to establish or measure the changes following works, it is necessary to understand existing behaviour, both hydraulically and ecologically. Studies which will be required to establish the existing behaviour, investigate the most effective range of improvement works and monitoring of the impacts of works are:

- detailed survey to establish topographic information;
- monitoring of existing hydraulic behaviour;
- hydraulic investigations to design improvement works and predict impacts of works;
- detailed historical investigations into original rainforest species and other communities of the study area;
- water quality investigations;
- soil quality studies and assessment of the distribution and amelioration of acid– sulphate soils;
- pest management report on mosquito breeding habitats;
- fine tuning of the existing NPWS report on bird roosting and feeding areas and general requirements for bird life in the study area;
- fine tuning of the existing NSW Fisheries investigations of the fish, prawn and crab communities;
- an archaeological survey to determine if there are any aboriginal sites or artefacts on the site;
- discussions with the RTA regarding modifications and car parking requirements on the Pacific Highway;
- research into the ramifications of removing the floodgates at Tomago, and
- constant monitoring of works implemented in wetland areas in the study area.
This document should be viewed as a flexible, dynamic working paper to be updated and amended in response to the future directional changes. It is recommended that a 5 year review period be adopted for the plan. A formal review each five years will enable changes in direction and response to intervening events and new technological data to be undertaken. Notwithstanding this, it will be necessary to prepare plans and review progress on an annual basis to ensure progress is being made.

6.4. Indicative Schedule of Rates

An indicative schedule of rates has been prepared as a guide only to the likely costs associated with the various work components required under the strategic landscape plan. (Refer Appendix C).

Given the indeterminant scope of works at this stage these rates must be considered to be very preliminary and to be used with considerable care in preparing budgets. It is recommended that all cost planning assume a generous contingency allowance to allow for design changes resulting from further site investigations, and future adjustments to the scope of detailed work components.
KOORAGANG WETLAND REHABILITATION PROJECT
IMPLEMENTATION PLAN - STAGE 1

Figure 6.1  Dwg No: 25077972
October 1994
Rainforest
- continue rainforest regeneration
  (stage 2)
- formalise lake path adjacent to road
- provide interpretive signage

Fishing Area
- construct wharf
- develop picnic area
- provide strip landscaping along existing road fenced from intrusions by cattle.
- provide car parking.
- construct portion of dual pedestrian/cycleway
- provide interpretive signage.

City Farm
- develop the main facilities and carpark.
- provide strip landscaping along the existing road fenced from intrusion by cattle.
- erect Identification Sign.
- formalise bike path adjacent to road.

Ash Island Bridge
- erect Directory Sign
- establish carpark and lay-by to the east of the bridge.
- upgrade Ash Island bridge.
- provide strip landscaping along roads formed from intrusion by cattle.
- formalise cycleways adjacent to road.
- provide interpretive signage.
- formalise cycleway adjacent to road.

Water Main Pipeline Crossing
- erect Directory Sign
- provide car parking on the Pacific Highway.
- provide link to the highway and construct dual pedestrian/cycleway bridge over the south arm.

Advisory Centre
- commence second stage of arboretum
- erect model aeroplane flying area

KOORAGANG ISLAND NATURE RESERVE

PROJECT INVESTIGATION ZONE
- continue experimental/research work
- exclude cattle from the area.

Fishing Area
- upgrade service road/cycleway from the Advisory Centre.
- develop picnic area.
- begin erosion control measures along the river bank including boulder beaches.

KOORAGANG WETLAND REHABILITATION PROJECT
IMPLEMENTATION PLAN - STAGE 2

LEGEND
- Existing mangroves to be retained
- Erosion control work along the river bank
- New fencing to contain cattle
- Retain and repair existing fencelines as necessary
- Install Project Signs
- Install Direction Signs
- Install Identification Signs
- Install Interpretive Signs
- Stage Two works including weeding and site clean up
- Extent of Grazing
- Kooragang Island Nature Reserve boundary
- Pedestrian Trail
- Dual Pedestrian/Cycleway
- Cycleway/Upgrade existing services road
- Existing creek line

Figure 6.2
Dwg No: 2557/S13
October 1994
Rainforest
- continue rainforest regeneration.
  (stage 3) fenced from intrusion by cattle.
- commence woodland / shrubland regeneration.
- provide pedestrian trail.
- provide interpretive signage

City Farm
- continue development of the City Farm.
- repair existing fencing as necessary.
- provide circular pedestrian trail.

Tomago - Fullerton Cove
- main bicycle access along existing fence
  and loop back to Tomago House.
- possible link to Tomago Road in the north
  east corner subject to negotiation with
  private landowners.

KOORAGANG ISLAND NATURE RESERVE
- upgrade service trails across the nature reserve
  - provide interpretive signage.

KOORAGANG WETLAND REHABILITATION PROJECT
IMPLEMENTATION PLAN - STAGE 3

LEGEND

- Existing mangroves to be retained
- Erosion control work along the river bank
- New fencing to contain cattle
- Retain and repair existing fencelines as necessary
- Install Project Signs
- Install Direction Signs
- Install Identification Signs
- Install Interpretive Signs
- Stage Three works including weeding and
  site clean up
- Extent of Grazing
- Pedestrian Trail
- Dual Pedestrian/Cycleway
- Cycleway/Upgrade existing services road
- Existing creek line

KOORAGANG WETLAND REHABILITATION PROJECT
IMPLEMENTATION PLAN - STAGE 3

Figure 6.3
Dwg No: 2537/514
October 1994
Hexham Island
- nature reserve extended to include Hexham Island.

Possible final model aeroplane flying area.

City Farm
- complete development of the City Farm.

Tomago - Fullerton Cove
- provide mangrove boardwalk and bird watching facilities.
- construct wharf.
- provide interpretive signage.

KOORAGANG ISLAND NATURE RESERVE

Schoolmasters' House
- restore school masters' house.
- formalise cycleway adjacent to road.
- provide interpretive signage.

Weiland
- creation of weiland habitat based on detailed topographical information and modelling.
- provide erosion control measures along the river bank.
- provide cycleway to Scotts Point.

KOORAGANG WETLAND REHABILITATION PROJECT
IMPLEMENTATION PLAN - STAGE 4

LEGEND

Existing mangroves to be retained
 existing mangrove boardwalk and bird watching facilities.
- construct wharf.
- provide interpretive signage.

KOORAGANG WETLAND REHABILITATION PROJECT
IMPLEMENTATION PLAN - STAGE 4

Figure 6.4
Dwg No: 2557/515
October 1994
7.0. REFERENCES


KOORAGANG WETLAND REHABILITATION PROJECT
CONCEPTUAL DEVELOPMENT PLAN

STAKEHOLDERS AND SPECIAL INTEREST GROUPS/ADDRESSES

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SEAHAM NSW 2324
APPENDIX B

FORMAL RESPONSES RECEIVED
KOORAGANG WETLAND REHABILITATION PROJECT

We would like to bring to your attention our current activities regarding the above project at Kooragang Island. The Kooragang Island Wetland Compensation Project Feasibility Study (1992) described a visionary concept for the rehabilitation of several hundred hectares of wetland on the western end of Kooragang Island for the improvement of fisheries habitat. As you are aware, the feasibility study recommended that the project combine fisheries and habitat restoration, creation and research with education and recreation facilities within the framework of an integrated Hunter Estuary Nature Reserve Complex.

In accordance with the above recommendations we have commissioned Land Systems EBC Pty Ltd, landscape architects, to produce a Conceptual Development Plan to co-ordinate all aspects of the project, optimise the attributes of the site, and to upgrade the staged development of the project as funding becomes available. The services of Patterson Britton and Partners Pty Ltd, hydraulics consultants have also been enlisted to advise on the complicated hydrologic issues inherent on the site.

The consultants have undertaken to fulfil the following aims:

- To foster an attractive setting with a sense of identity in regard to the island's original vegetation type, healthy wetland systems and rural values.
To develop proposals researched for the site following properly considered design principles and guidelines which strengthen the aims of the present study.

To integrate functional aspects of activities recommended for the site as well as adjoining areas to maximise resource potential.

To allow for the incorporation of findings from biological and physical research as the most effective way to proceed with rehabilitation of the wetlands.

At this early stage it would be valuable to include your input into the data review period. The consultants are currently canvassing the concerns, goals and objectives of various stakeholders and special interest groups associated with the island. Should you wish to discuss any relevant issues or put forward any concerns with regard to the project please contact Peggy Svoboda, Project Co-ordinator, Kooragang Wetland Rehabilitation Project, Shortland Wetlands Centre, Tel: (049) 516 466, Fax (049) 501 875 so that she can forward the information to the consultants.

We look forward to your response.

Yours faithfully

Peggy Svoboda
Project Co-ordinator
Reference L 93/95988
12th April, 1994

Ms Peggy Svoboda
Project Co-ordinator
Kooragang Wetland Rehabilitation Project
C/- The Wetlands Centre
PO Box 130
WALLSEND NSW 2287

Dear Peggy

KOORAGANG WETLAND REHABILITATION PROJECT

Thank you for your letter of 5th April, 1994.

As Business Land Group is responsible for management of the project area and the balance of Kooragang Island (excluding the Coal Loader) I would welcome the opportunity to meet with your consultants to discuss the proposed investigation.

I think it would also be worthwhile for your consultant to meet with representatives of Hunter Ports Authority (which Authority manage the Coal Loader lease) the State Rail Authority and Hunter Development Corporation.

We are also awaiting advice from Peter Drury of Public Works that the lease of the wetlands area to Hunter Catchment Management Trust is to proceed.

I would appreciate early advice in this matter so that lease documents can be prepared.

Yours faithfully

GEFF COHEN
Acting General Manager
15 May, 1994

Dear Peggy,

As Environment Officer for the Regional Advisory Council representing commercial fishermen in the Newcastle area I would like to submit some thoughts on the Kooragang Wetland rehabilitation scheme.

Firstly, the Commercial Fishing Advisory Committee (CFAC) has a policy of supporting rehabilitation of wetland and marine habitat. The slogan NO HABITAT = NO FISH has been adopted by our members. With this in mind one can only give our full support to genuine estuarine rehabilitation projects such as yours.

Without trying to be a pseudo-marine biologist I would like to present some points that you might take on board that I have learnt about fish habitat. Firstly, one must be careful, when reconstructing habitat, that no “ponding” occurs when the tide recedes. This can trap fish and prawns and leave them vulnerable to predation from man and beast. Another factor in restoration works is that gradient levels on shoreline areas be kept at largest possible levels to maximise the euphotic zone and encourage the regrowth of seagrasses.

Thirdly, I understand sections of the project will be open to the public for recreation and education purposes. If this is the case I hope that a balanced approach is taken and that none of the sensitive restoration work is sacrificed to make areas more amenable to the general public.

I wish you well with the project and look forward to following the progress of the rehabilitation works.

Yours Sincerely,

Don Cameron
R.A.C. (4)
P.O. Box 76
Adamstown NSW 2289

Peggy Svoboda—
Project Co-ordinator
Kooragang Wetland Rehabilitation Project
C/- The Wetlands Centre
P.O. Box 130
Wallsend NSW 2287

23 May, 1994

Dear Peggy

On behalf of the Committee of the Newcastle Group of the Society for Growing Australian Plants, I would like to thank you for your request for our input into the data review period.

Our main aim in the project would be that the area allocated for restoration and other areas be planted with species of plants indigenous to the area. You have already indicated in your talk to the Society that you will be making every endeavour to follow that aim. We wish you well in the project and will be interested to help in any way we can.

We look forward to hearing from you as you progress through the stages of the project.

Could you please check in your data base of addresses that my address is correct.

Yours sincerely,

Phil Hughes
Secretary.
Wallsend 2287
9th April, 1994

Dear Deborah,

Thank you for your consideration of opinions regarding the Kooragang Wetland Rehabilitation Project. I am very interested in the project and willing to contribute in any way, and would like to be kept informed of progress as it occurs.

The brief given to the consultants includes the aim to 'foster an attractive setting with a sense of identity in regard to the island's original vegetation type, healthy wetland systems and rural values'. I would like to see this aim extended to all landscaped areas as well as the rehabilitation areas. Landscaping around the radar station and other interpretive sites with indigenous species would be of great educational value, particularly during the initial rehabilitation activities. This could act as an arboretum of all species planned to be reintroduced as well as existing remnants.

At present 5 schools have been actively involved in propagating plants through a regional Department of School Education programme, 'Operation Propagation', initiated by the Awabakal Field Studies Centre during 1993.

With the erection of a shade house at the Shortland Wetlands Centre, we are hoping to extend this programme during 1994 and 1995 and include the involvement of the Newcastle group of the Society for Growing Australian Plants. A list of suitable plant species for this project would be appreciated as soon as possible.

Yours faithfully,

Carolyn Gillard
19 April, 1994

Ms Peggy Svoboda  
Koorangang Wetland Rehabilitation Project  
C/- The Wetlands Centre  
P.O. Box 130  
WALLSEND NSW 2287

Dear Ms Svoboda,

Thank you for bringing to my attention the Koorangang Wetland Rehabilitation Project. I had heard indirectly that a project was underway but I am unaware of any details of how the project is to be implemented or at what stage the project is. The Hunter Estuary is a major concern of the NSW Wader Study Group as it is the most important wader habitat in NSW. Koorangang Island attracts large numbers of migratory waders of which a major proportion roost on the retaining wall, originally built to facilitate filling the foreshore, on the western shore of the east arm of the river. Another artificial site previously used by a large proportion of waders is near Stockton Bridge but has now degraded to the stage where it is no longer used by many waders.

Several areas on Koorangang Island are currently used by significant numbers of waders for feeding. These include species of significant importance on a national or international scale such as Greenshank, Marsh Sandpiper, Sharp-tailed Sandpiper, Curlew Sandpiper, and Pacific Golden Plover. Salt-marshes on the island are also used by large numbers of Eastern Curlew and Greenshank as roost sites. These wetlands are used intermittently when conditions of flooding are right. With careful management the feeding and roosting sites on Koorangang Island could be enhanced to provide highly productive habitat attracting birds which have been displaced over years of habitat degradation in the Hunter Estuary.

It is important that management of the habitat utilised by the waders mentioned previously is designed in such a way that tidal regimes are such that intertidal flats are created or enhanced. However this needs to be done in such a way so that these important salt-marshes are not overgrown with mangroves. Obviously mangroves are an important part of the ecology of the Hunter Wetland system but inappropriate management can result in the loss of the few productive saltmarshes left.

A comprehensive understanding of salt-marsh ecology seems to be generally lacking but it is hoped that during the
establishment of this project relevant wetland ecologists are involved in the rehabilitation and ongoing management.

If we can be of any assistance in respect to the proposed project please let me know.

Yours faithfully,

Phil Straw
Chairman
Dear Peggy,

Thank you for your letter of 5th April bringing the Club up to date with your project. Thank you also for the chance to have input into the consultants report during the data review period. We have nothing specific to put at this time: the project seems to be on track and we are of course particularly pleased at those aspects of the project that will increase bird habitat.

On Sunday May 22, we are visiting Ash Island and will probably be led by David Geering. We meet at MacDonalds at Hexham at 8.00 am. If you can find the time to join us it may be mutually beneficial. We are willing to contribute our recent bird records of the area and to undertake regular bird surveys during the project. Even if you can't attend please keep us in touch with this most exciting project and let the Club know if there is any way we can assist.

Yours sincerely

Peter Phillips
Hon. Secretary.
Dear Ms Svoboda

KOORAGANG WETLAND REHABILITATION PROJECT

A refer to your letter of 5 April 1994 and the project the Centre is undertaking into the future use of portions of Kooragang Island.

The Authority is currently conducting a study into the future expansion of Port facilities on Kooragang Island. At this stage we do not envisage commercial port operations that would extend:

(a) up the South Arm of the Hunter River past the Tourle Street Bridge; or

(b) up the North Arm of the Hunter River past the Stockton Bridge.

There will be a need for back-up land for port related industry in the area. We believe that there will be a need for duplication of the rail track and the actual boundaries shown on the map should be set with suitable allowance for the additional track.

Ideally any restoration works carried out in various areas should not be such that would create new or additional restrictions on the use of the existing heavy industry areas down stream from the restoration works.
We were pleased to see a hydraulics consultant engaged as any major diversion (say >5% total river flow) of the flow of the Hunter River from one arm to the other has the potential to significantly change siltation patterns in the commercial port areas and hence lead to increased maintenance dredging costs. Under these circumstance we would suggest detailed hydrological studies would be required.

Please contact our Strategic Planning Manager, Bill Pope, on 272453 if you wish to follow up on any of the above.

Yours faithfully

Geoff Connell
MANAGING DIRECTOR
TO: Peggy Svoboda
FROM: Phil Straw
RE: Wader Habitat at Ash/Kooragang Island

A field visit was carried out recently (10/6/94) to look at existing wader habitat. This visit together with observations made on previous visits were used to compile this short report.

EXISTING WETLANDS

There are a number of sites which attract waders and other waterbirds on Kooragang/Ash Island. These areas are mainly shallow lagoons or periodically flooded saltmarsh. Areas marked on the accompanying map are the main sites used by birds as determined from observations made. Other areas of saltmarsh are used as roost sites by a number of waders and no doubt as feeding habitat under certain flood conditions. Waders observed on the Ash Island Wetlands on 10 June 1994 and on previous visits include Marsh Sandpiper, Greenshank, Sharp-tailed Sandpiper, Eastern Curlew, Pacific Golden Plover, Black-fronted Plover, Red-kneed Dotterel, Red-capped Plover, Black-winged Stilt and Red-necked Avocet.

HABITAT LOSS ON OTHER PARTS OF THE ISLAND

Large numbers of waders have been observed using other sites on Kooragang Island which have been degraded or filled in or are in the process of being destroyed. The lagoons between the Mayfield to Stockton road and the railway line attracted large numbers of waders until recently. These include Curlew Sandpiper, Sharp-tailed Sandpiper, Red-capped Plover, Red-necked Avocet and Black-winged Stilt as well as large numbers of teal, swans, grebes, gulls, cormorants, gulls and terns. These lagoons are in the process of being filled in as part of the extension of a coal loader.

Other wetlands which were of importance in the past include several lagoons in Kooragang Nature Reserve which are now largely overgrown with dense Cumbungi and unsuitable for most waterbirds.

POTENTIAL FOR EXTENDING HABITAT

The recent loss of habitat on Kooragang Island highlights the need for creation or restoration of wader feeding and roosting habitat. Saltmarsh and grassland on the island would be suitable for enhancement as wader habitat with minimal earthworks and minor flood control systems.

The carrying capacity of the wetlands in the vicinity to Ash Island could be significantly increased by creating shallow scrapes with earth moving equipment within the grassland areas.
adjacent to existing saltmarsh. These techniques have been highly successful in Europe and in particular the UK (Becker and Sills, 1988; Hill et al., 1988; Wilson, 1991; and RSPB 1987). Similar work is being carried out at Homebush Bay with the cultivation of saltmarsh plant species and landscaping.

The limited observations made by myself and members of the NSW Wader Study Group need to be followed up by regular monitoring in the coming seasons when migratory waders are present to better assess habitat usage. A more detailed survey needs to be carried out of the area as a whole to determine the importance other parts of the island to waders and other waterbirds.

The NSW Wader Study Group is particularly concerned about the dramatic loss of wader habitat in the Hunter Estuary and particularly on Kooragang Island. High priority should be given to safeguarding saltmarshes from invasion of mangroves and further loss from landfill and other forms of degradation.

REFERENCES CITED


RSPB (1987) Salt Marshes & Intertidal Areas Symposium. RSPB Sandy

Most of the grassland would be left to run after being raised on flooding.
KOORAGANG WETLAND REHABILITATION PROJECT
INDICATIVE SCHEDULE OF RATES

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Unit</th>
<th>Materials Components</th>
<th>Labour/ Machinery Component</th>
<th>Rate</th>
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</thead>
<tbody>
<tr>
<td>1.0.</td>
<td>HABITAT CREATION</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1.1.</td>
<td>Excavation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1.1.</td>
<td>Cut and fill (in sandy loam) by machine (2000m³ minimum)</td>
<td>m³</td>
<td>--</td>
<td>$3.00</td>
<td>$3.00</td>
</tr>
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<td>1.1.2.</td>
<td>Excavate (in sandy loam) by machine, load, transport and dispose off site with 10km (2000m³ minimum)</td>
<td>m³</td>
<td>--</td>
<td>$20.00</td>
<td>$20.00</td>
</tr>
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<td>1.1.3.</td>
<td>Laser controlled grading in saltmarsh areas.</td>
<td>m³</td>
<td>--</td>
<td>$1.00</td>
<td>$1.00</td>
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<td>1.1.4.</td>
<td>Control structures (project investigation zone)</td>
<td>m²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 0.25 tidal range</td>
<td>ea</td>
<td>30,000</td>
<td>$20,000</td>
<td>$50,000</td>
<td></td>
</tr>
<tr>
<td>- 0.5 tidal range</td>
<td>ea</td>
<td>40,000</td>
<td>$30,000</td>
<td>$70,000</td>
<td></td>
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<tr>
<td>- 0.75 tidal range</td>
<td>ea</td>
<td>60,000</td>
<td>$40,000</td>
<td>$100,000</td>
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<td>1.1.5.</td>
<td>Construct ground water experimental bore holes (say 2).</td>
<td>ea</td>
<td>--</td>
<td>$5,000</td>
<td>$5,000</td>
</tr>
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<td>1.2.</td>
<td>Site Preparation</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>1.2.1.</td>
<td>Clear, transport and dispose off site (10km) existing rubbish including car bodies, litter and other debris.</td>
<td>m³</td>
<td>--</td>
<td>$50.00</td>
<td>$50.00</td>
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<td>1.2.2.</td>
<td>Eradication of pest plants (per application).</td>
<td>m²</td>
<td>$0.10</td>
<td>$0.15</td>
<td>$0.25</td>
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<td>1.2.3.</td>
<td>Eradication of kikuyu (allow 2 applications)</td>
<td>m²</td>
<td>$0.20</td>
<td>$0.40</td>
<td>$0.50</td>
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<td>1.2.4.</td>
<td>Supply and spread soil conditioner to subgrade. (assume 50mm compost)</td>
<td>m³</td>
<td>$1.00</td>
<td>$1.25</td>
<td>$2.25</td>
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<td>1.2.5.</td>
<td>Special soil amelioration to rainforest (assuming reuse existing site topsoil and 50mm compost).</td>
<td>m²</td>
<td>$1.00</td>
<td>$3.00</td>
<td>$4.00</td>
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<tr>
<td>1.2.6.</td>
<td>Cultivate to 150mm depth (assume min 1ha)</td>
<td>m²</td>
<td>--</td>
<td>$0.05</td>
<td>$0.05</td>
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<td>1.2.7.</td>
<td>Supply and install mulch layer to 75mm depth.</td>
<td>m²</td>
<td>$2.25</td>
<td>$1.25</td>
<td>$3.50</td>
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<tr>
<td>Item</td>
<td>Description</td>
<td>Unit</td>
<td>Materials Component</td>
<td>Labour/Machinery Component</td>
<td>Rate</td>
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<tr>
<td>1.3.</td>
<td>Bank Stabilisation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3.1.</td>
<td>Re-grade existing banks and lay back at maximum 1:3 grade, on-site spoil disposal.</td>
<td>m^3</td>
<td>--</td>
<td>$20.00</td>
<td>$20.00</td>
</tr>
<tr>
<td>1.3.2.</td>
<td>Supply and place rock and/or boulder armouring to river edge.</td>
<td>m^3</td>
<td>$30.00</td>
<td>$30.00</td>
<td>$60.00</td>
</tr>
<tr>
<td>1.3.3.</td>
<td>Supply and install stabilisation blanket.</td>
<td>m^2</td>
<td>$15.00</td>
<td>$15.00</td>
<td>$30.00</td>
</tr>
<tr>
<td>1.3.4.</td>
<td>Supply and install reno mattresses.</td>
<td>m^2</td>
<td>$40.00</td>
<td>$30.00</td>
<td>$70.00</td>
</tr>
<tr>
<td>2.0.</td>
<td>PAVEMENTS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1.</td>
<td>Renovate existing hot mix roads as necessary.</td>
<td>m^3</td>
<td>$10.00</td>
<td>$5.00</td>
<td>$15.00</td>
</tr>
<tr>
<td>2.2.</td>
<td>Upgrade existing gravel road with new hot mix surface including levelling, grading to falls, re-compaction of sub-grade, FCR layer patching.</td>
<td>m^3</td>
<td>$25.00</td>
<td>$15.00</td>
<td>$40.00</td>
</tr>
<tr>
<td>2.3.</td>
<td>Upgrade existing service trails including levelling, grading to falls, compaction and surface stabilisation as necessary.</td>
<td>m^3</td>
<td>$10.00</td>
<td>$20.00</td>
<td>$30.00</td>
</tr>
<tr>
<td>2.4.</td>
<td>Construct 2.5m width dual pedestrian/cycleway including levelling, grading to falls, compaction of subgrade and cement stabilised gravel surface course.</td>
<td>m^3</td>
<td>$15.00</td>
<td>$15.00</td>
<td>$30.00</td>
</tr>
<tr>
<td>2.5.</td>
<td>Construct 1.2m width pedestrian trail including levelling, grading to falls, compaction of subgrade and cement stabilised gravel surface course.</td>
<td>m^3</td>
<td>$15.00</td>
<td>$15.00</td>
<td>$30.00</td>
</tr>
<tr>
<td>2.6.</td>
<td>375mm ø stormwater pipe assume min 8000mm length.</td>
<td>m</td>
<td>$130.00</td>
<td>$100.00</td>
<td>$130.00</td>
</tr>
<tr>
<td>2.7.</td>
<td>Artificial rock work.</td>
<td>m^3</td>
<td>$100.00</td>
<td>$150.00</td>
<td>$250.00</td>
</tr>
<tr>
<td>2.8.</td>
<td>100mm timber edge step.</td>
<td>m</td>
<td>$7.00</td>
<td>$7.00</td>
<td>$14.00</td>
</tr>
<tr>
<td>2.9.</td>
<td>Construct – hotmix car park including levelling, grading to falls, compaction of subgrade, FCR layer – no kerbs/drainage.</td>
<td>m^3</td>
<td>$20.00</td>
<td>$30.00</td>
<td>$50.00</td>
</tr>
<tr>
<td>2.10.</td>
<td>Construct gravel car park, including levelling, grading to falls, compaction of sub-grade and cement stabilised gravel surface course.</td>
<td>m^3</td>
<td>$15.00</td>
<td>$20.00</td>
<td>$35.00</td>
</tr>
<tr>
<td>Item</td>
<td>Description</td>
<td>Unit</td>
<td>Materials Component</td>
<td>Labour/ Machinery Component</td>
<td>Rate</td>
</tr>
<tr>
<td>------</td>
<td>-----------------------------------------------------------------------------</td>
<td>------</td>
<td>---------------------</td>
<td>----------------------------</td>
<td>------</td>
</tr>
<tr>
<td>3.0</td>
<td><strong>STRUCTURES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Supply and install timber picnic shelter (including detail design of concrete footings and all associated works).</td>
<td>ea</td>
<td>$3,500</td>
<td>$1,500</td>
<td>$5,000</td>
</tr>
<tr>
<td>3.2</td>
<td>Supply and install timber wharf/jetty suitable for boat/canoe tie up, (including concrete footings and all associated works).</td>
<td>m²</td>
<td>$300.00</td>
<td>$150.00</td>
<td>$450.00</td>
</tr>
<tr>
<td>3.3</td>
<td>Supply and install timber boardwalk with rails to both sides.</td>
<td>m²</td>
<td>$300.00</td>
<td>$150.00</td>
<td>$450.00</td>
</tr>
<tr>
<td>3.4</td>
<td>Remove and dispose existing floodgates.</td>
<td>ea</td>
<td>--</td>
<td>$2,000</td>
<td>$2,000</td>
</tr>
<tr>
<td>3.5</td>
<td>Upgrade existing radar stations.</td>
<td>ea</td>
<td>$20,000</td>
<td>$10,000</td>
<td>$30,000</td>
</tr>
<tr>
<td>4.0</td>
<td><strong>FURNITURE AND FENCING</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>Supply and install timber table/seat arrangements (including concrete footings and all associated works).</td>
<td>ea</td>
<td>$900.00</td>
<td>$600.00</td>
<td>$1,500</td>
</tr>
<tr>
<td>4.2</td>
<td>Supply and install timber bench seating at interpretive sites (per bench).</td>
<td>ea</td>
<td>$300.00</td>
<td>$200.00</td>
<td>$500.00</td>
</tr>
<tr>
<td>4.3</td>
<td>Supply and install litter bins.</td>
<td>ea</td>
<td>$300.00</td>
<td>$100.00</td>
<td>$400.00</td>
</tr>
<tr>
<td>4.4</td>
<td>Supply and install timber bollards</td>
<td>ea</td>
<td>$100.00</td>
<td>$150.00</td>
<td>$150.00</td>
</tr>
<tr>
<td>4.5</td>
<td>Supply and install timber vehicle barriers</td>
<td>lm</td>
<td>$200.00</td>
<td>$150.00</td>
<td>$250.00</td>
</tr>
<tr>
<td>4.6</td>
<td>Supply and install electric barbecue (excluding power supply)</td>
<td>ea</td>
<td>$200.00</td>
<td>$3,000</td>
<td>$3,500</td>
</tr>
<tr>
<td>4.7</td>
<td>Supply and install 1200mm high tensile wire fencing with timber posts and strainers.</td>
<td>lm</td>
<td>$15.00</td>
<td>$10.00</td>
<td>$25.00</td>
</tr>
<tr>
<td>4.8</td>
<td>Renovate existing fencing.</td>
<td>lm</td>
<td>$5.00</td>
<td>$5.00</td>
<td>$10.00</td>
</tr>
<tr>
<td>4.9</td>
<td>Supply and install galvanised weld mesh vehicular gates.</td>
<td>ea</td>
<td>$150.00</td>
<td>$50.00</td>
<td>$200.00</td>
</tr>
<tr>
<td>5.0</td>
<td><strong>SOFT LANDSCAPING</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>5.1</td>
<td>Direct seeding.</td>
<td>m²</td>
<td>$0.50</td>
<td>$1.00</td>
<td>$1.50</td>
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<tr>
<td>5.2</td>
<td>Direct planting of divisions/cuttings into mud or water.</td>
<td>m²</td>
<td>$1.50</td>
<td>$1.00</td>
<td>$2.50</td>
</tr>
<tr>
<td>5.3</td>
<td>Transplanting of established mangrove seedlings on site 600mm height (@ av. 4 per sq.m)</td>
<td>m²</td>
<td>--</td>
<td>$6.00</td>
<td>$6.00</td>
</tr>
<tr>
<td>Item</td>
<td>Description</td>
<td>Unit</td>
<td>Materials Components</td>
<td>Labour/Machinery Component</td>
<td>Rate</td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
<td>------</td>
<td>-----------------------</td>
<td>---------------------------</td>
<td>------</td>
</tr>
<tr>
<td>5.4.</td>
<td>Planting of viro-cell stock for grasses (@ 4 per sq.m)</td>
<td>m²</td>
<td>$0.70</td>
<td>$0.80</td>
<td>$1.50</td>
</tr>
<tr>
<td>5.5.</td>
<td>Supply and plant tubestock (@ 1 per sq.m)</td>
<td>ea</td>
<td>$2.00</td>
<td>$2.00</td>
<td>$4.00</td>
</tr>
<tr>
<td>5.6.</td>
<td>Supply and plant 5L plants (@ 1 per sq.m)</td>
<td>ea</td>
<td>$7.00</td>
<td>$5.00</td>
<td>$12.00</td>
</tr>
<tr>
<td>5.7.</td>
<td>Supply and plant specimen trees (25L size)</td>
<td>ea</td>
<td>$25.00</td>
<td>$15.00</td>
<td>$45.00</td>
</tr>
<tr>
<td>5.8.</td>
<td>Renovate existing kikuyu turf.</td>
<td>m²</td>
<td>$1.00</td>
<td>$1.00</td>
<td>$2.00</td>
</tr>
<tr>
<td>6.0.</td>
<td>SIGNAGE (including artwork)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.1.</td>
<td>Supply and install project sign.</td>
<td>ea</td>
<td>$7,000</td>
<td>$1,000</td>
<td>$8,000</td>
</tr>
<tr>
<td>6.2.</td>
<td>Supply and install directory sign.</td>
<td>ea</td>
<td>$4,000</td>
<td>$1,000</td>
<td>$5,000</td>
</tr>
<tr>
<td>6.3.</td>
<td>Supply and install identification sign.</td>
<td>ea</td>
<td>$1,000</td>
<td>$1,000</td>
<td>$2,000</td>
</tr>
<tr>
<td>6.4.</td>
<td>Supply and install interpretive sign.</td>
<td>ea</td>
<td>$650.00</td>
<td>$500.00</td>
<td>$1,150</td>
</tr>
<tr>
<td>6.5.</td>
<td>Supply and install cycleway sign.</td>
<td>ea</td>
<td>$200.00</td>
<td>$50.00</td>
<td>$250.00</td>
</tr>
</tbody>
</table>

**Assumptions**

- Preparation of the above schedule of rates has been based on the following assumptions.
- Large volumes/areas/units - however rates will vary up to down depending on total.
- Off site disposal is within 2kms.
- Normal commercial rates are applied.
- Acid sulphate correction to existing soils has not been included.
- Extreme caution is required when handling and applying herbicide in a marine environment. Further study of application techniques would be required in order to minimise the possibility of causing damage to aquatic life.
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42. Scott and Furphy Pty Ltd 1990, Engineered Waterways Design Guidelines, Interim Territory Planning Authority.


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