RAPID CREEK

MANAGEMENT PLAN

Prepared for

DARWIN CITY COUNCIL
and
GREENING AUSTRALIA

by

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AUGUST 1994
REPRINTED APRIL 2000

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STUDY TEAM

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ACKNOWLEDGEMENTS

The Study Team gratefully acknowledges the role and contribution of the many people and authorities who provided assistance in compiling this Management Plan.

We wish to thank the client representatives - Tim Offor (Greening Australia), Mark Presswell (Darwin City Council) and Bob Morgan (Darwin City Council) who were particularly involved in this study. Their input and direction was valuable in focusing the study, and facilitating the process of public consultation.

Assistance was also provided by people and institutions, individually and at workshops, on a range of subjects, including: Penny Thompson (Friends of Rapid Creek), Joan Dillon, Bill Panton, Neville Murray, Robert Friederick (Northlakes Golf Course).

Other organisations, statutory bodies and government departments who assisted included Barry Renshaw of Aboriginal Areas Protection Authority; Mike Clarke of Greening Australia; Randal Scott, Susan Hickey, Richard Freeman and Brian Delaney of Conservation Commission; Department of Lands, Housing and Local Government; Peter Whelan of Department of Health; Dave Beatson, Richard Willis and Charles Mangion of Royal Australian Air Force Base, Darwin; Power and Water Authority, Federal Airports Commission, National Trust, Northern Territory Fire Service, Marrara Users Group, Australian Trust for Conservation Volunteers and Northern Territory University.

The interest shown by these people, and their knowledge about issues of local concern provided a substantial body of information that could not have been acquired through conventional sources of research.

EXECUTIVE SUMMARY

URBAN CONTEXT

Rapid Creek is a small, relatively natural drainage system located in Darwin's Northern suburbs. The creek extends for a distance of 9.8 kilometres and drains a catchment of aproximately 28 km^2.
Unlike many such drainage lines elsewhere in urban areas, Rapid Creek supports a number of important remnant vegetation communities and the creek channel is virtually undeveloped for its entire length.

Landuse within the catchment has intensified over the past decade and in view of the increasing urban pressures Darwin City Council, Greening Australia and the comunity agree that the creek's remnant vegetation deserves recognition and careful management. The creek corridor is also acknowledged as a major recreation resource, including a visual resource, for the Darwin region.

MANAGEMENT OBJECTIVES, PROBLEMS AND ISSUES

There are a number of indicators that suggest that the creek continues to degrade, with further fragmentation and loss of remnant vegetation. Concerns about deteriorating water quality and loss of this important natural resource has resulted in the preparation of an integrated plan of management for Rapid Creek and its environments which will:

- stimulate greater awareness of the prescence and importance of the area;
- promote increased protection and appropriate management of the whole system;
- encourage government agencies and the community to co-operate in the development of protection and rehabilitation measures for the creek system.

To address these objectives the study has involved:

- analysis of the area's resources, as well as the investigation of existing impacts and likely impacts from future development in the catchment;
- liaison with Government Departments, Statutory Authorities and the local community in determining issues in the creek that are of concern, and the options available to deal with them;
- investigation of Authorities interests, standards and sources of assistance available in relation to the creek's management.

MANAGEMENT PLAN PROPOSALS

As a result of these considerations a series of strategies for Rapid Creek are proposed for orderly, long term implementation.

Central to the success of the Management Plan would be the establishment of a management body who would take the responsibility for adopting and implementing the Plan. This group, should include representatives from Government Departments, Statutory Authorities, community groups and other groups with vested interests in the catchment. Such a group would ideally work within an appropriate legislative framework to support its role. As an alternative, a Management Committee of Council could be established within the existing legislative framework.

Regardless of what form the management body takes, they would be responsible for implementing the plan, by setting up a 10 year programme for actions as defined in this Plan, and based on the level of urgency, the opportunity, achievability and a financial strategy. This programme should then be reviewed annually to assess progress and any required amendments.

The management body would be responsible for co-ordinating and implementing strategies for creek management and rehabilitation. The strategies for creek management and rehabilitation fall into three categories, and some key elements of each are:

- **Water Management**

  - Liaise with major landholders, interest groups and managers to develop a plan for water management having consideration to total catchment management.

  - Undertake a community liaison and education programme to inform residents on the negative impacts of nutrients and low water flows entering the creek.

  - Improve and maintain water quality by installing water management devices and reducing degrading factors in the catchment. Undertake a water monitoring programme and reivew yearly.

  - Undertake erosion control measures within the catchment and implement stabilization works at critical points on the creek banks and at stormwater outlets.

  - Recuce potential for increased flooding in the catchment.

- **Habitat Conservation**

  - Manage the remnant vegetation communities and adjoining open space to optimise their habitat and ecological values through regeneration and revegetation techniques.

  - Implement a weed control programme.

  - Develop a fire management strategy for the different vegetation communities.

  - Facilitate co-operative programmes for plant propogation, replanting and maintenance of indigenous plant material within the catchment.

- **Recreation and Access**

  - Generally upgrade and enhance the Rapid Creek corridor to encourage appropriate use and enjoyment of the creek for low key, passive recreational activities.

  - Instigate programmes that strengthen existing planting structures with use of indigenous plants and provide amenity for passive use (picnic facilities, playgrounds, seating).

  - Develop an interpretive strategy that includes an interpretive centre, defined walks and trails, interpretive boards and brochures, to inform and educate visitors and residents of the environmental and cultural values of the creek.

  - Establish a hierarchy of entrances. Plan and design these entrances to announce the creek.

  - Provide for fire, emergency and maintenance access to the creek corridor. Control vehicle access otherwise.

  - Wherever possible provide facilities and access appropriate for the disabled.

Landscape Character

- Manage the catchment as a coherent landscape element, emphasising the linear complete nature of the creek itself.
- Protect and enhance the natural character of the study area through regeneration and revegetation.
- Extend the landscape character of the creek via an integrated strategy for street tree planting within the creek corridor.
- Establish a coherent design approach for all urban design elements in and bordering the creek corridor.

Open Space Planning and Management

- Establish a management body to co-ordinate and implement the strategies in this plan.
- Formulate and seek endorsement by the Minister for Lands, Housing and Local Government of Land Use Objectives for the catchment area.
- Circulate the Management Plan to Government Departments, Statutory Authorities, Council and other groups for comment and liaison on common and agreed work practices in the creek.
- Seek to transfer ownership of areas of FAC and RAAF lands to public ownership to improve compatibility of management practises.
- Research and review opportunities for State and Federal funding.
- Identify the creek catchment as a distinct regional park under the umbrella name of "Rapid Creek Park".

Community Liaison

- Facilitate community liaison with management authorities, particularly through the management body and a liaison officer.
- Encourage frequent use and surveillance by the public and reporting of ordinance violations, littering and dumping to the liaison officer.
- Identify and circulate the name of an emergency contact officer.
- Develop a programme to inform the community on the creek, the catchment, associated issues and developments, walks and links to other areas.
- Liaise with local schools to establish an educational resource and ease of access to the creek and remmant bushland.

IMPLEMENTATION

The realisation of the proposed strategies will require a committment from Government in establishing an appropriate management body. It will also depend on the continued application of sound concept development and detail design, as well as major initiatives in creek rehabilitation.

A range of typical construction details, suitable materials and plant species are provided to assist this on-going process.

Capital costs in developing aspects of the plan may be substantial. It is stressed, however, that capital costs are not the only aspects that should be considered in evaluating the creek's rehabilitation. Public health benefits, improved safety and recreational values are some of the less tangible, or more far reaching factors that must also be weighed in determining the implementation phases.

To assist with programming of the Management Plan, an assessment of priorities, opportunities and typical costs is provided, complemented by an evaluation of possible sources for additional funding.

1. INTRODUCTION

1.1 BACKGROUND

The Rapid Creek system is a small, relatively intact natural drainage system, fully contained within the urban area of Darwin's Northern Suburbs. The system contains a number of important remnant vegetation communities, which represent a diverse range of ecosystems including mangroves, savannah woodland, riverine monsoon forest, grasslands and paperbark swamps.

The Creek is approximately 9.8 km long, rising in a swampy area to the east of Amy Johnson Avenue and emptying into the sea, at the southern end of Casuarina Coastal Reserve. The total area of the catchment, as defined by the topography, is approximately 28 km^2. (Refer Figure 1.1).

Rapid Creek, like urban creeks and rivers throughout Australia, is under various pressures due to its location within a developing urban area. Rapid Creek, however, is special in that the entire length of the creek channel is virtually undeveloped. Degradations of the natural systems has not yet reached a critical stage and the original natural landscape is still evident.

However, the various urban pressures on the system have resulted in deterioration of the environmental, scenic and recreation values of this resource. The principal evidence of these impacts may be seen in:

Habitat Loss: A number of communities are contracting, and others have undergone substantial structural changes (eg paperbark swamp).

Tree Canopy Changes: Loss of native species in the canopy and lack of canopy continuity has resulted in establishment of weed species, particularly through the mangrove community, on the fringe of the monsoon forest and wetlands.

Erosion: Bottom scouring of the creek, general bank erosion, channelling and sedimentation is occurring in many areas.

Recreation: Uncontrolled access has resulted in soil and vegetation degradation. Recreational opportunities in other areas are limited due to restricted access and lack of facilities.

Water Quality: While water quality in the Creek is relatively good, there is the continuing threat of high pollutant and nutrient loads from stormwater and accidental pollution as the result of the airport operations.

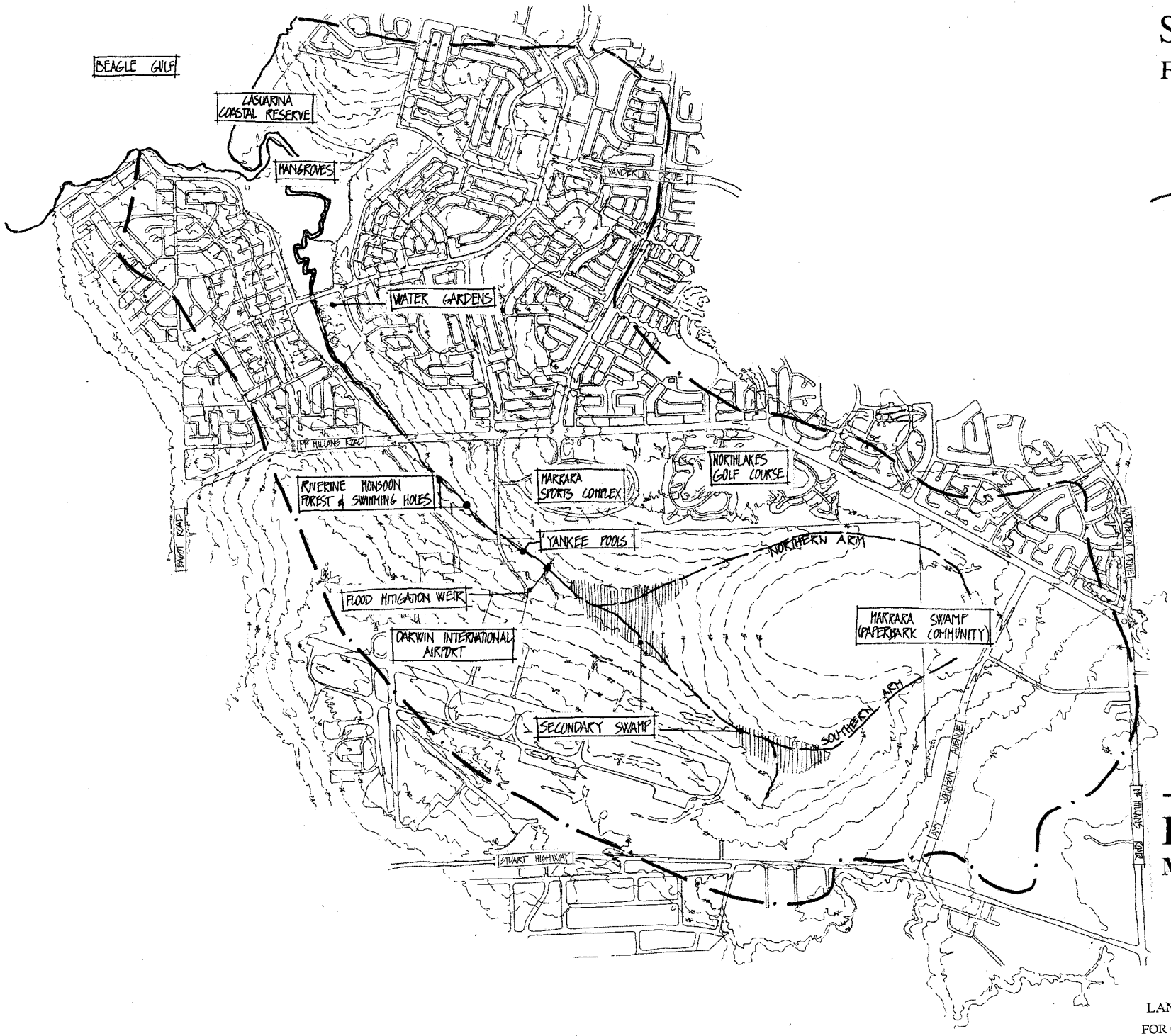
Weeds: A number of invasive grass species and exotic garden escapes are establishing in the catchment, successfully competing with native species.

Dumping: Depositing of garden and other wastes is unsightly, aids spread of weeds and alters soil nutrient balances.

Underlying the many threats that face Rapid Creek are the three key impacts of urbanisation that are common to many of the natural areas within our build landscape - habitat loss, decreased water quality and public/community alienation. Strategies that appropriately address *water management, vegetation management and community involvement* in the care and control of Rapid Creek will ensure the protection and enhancement of this natural resource and thereby become a source of pride and enjoyment both for the local community and the agencies responsible for its management.

SITE FEATURES

Figure 1.1



RAPID CREEK
MANAGEMENT STUDY

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The remnant vegetation communities of Rapid Creek a valuable resource within the Darwin area, however they are threatened by the impacts of urbanisation.

1.2 THE NEED FOR A MANAGEMENT PLAN

Darwin City Council, government agencies, various interest groups and the local community have been aware for some time of the deteriorating conditions of Rapid Creek and its environs. Specific initiatives have been adopted from time to time in an attempt to stop the degradation.

It was this concern for the Creek that prompted Greening Australia, in conjunction with Darwin City Council, to seek Federal funding under the 'Save the Bush' programme, to undertake a management study of Rapid Creek. It was recognized that a coordinated approach was required to address the inter-related and often complex nature of the threats to the health of the creek.

A Management Plan is the appropriate mechanism for such an approach, bringing together the substantial body of information that exists on the creek's natural systems and water quality/management, assessing the inter-relationships of contributing impacts and recreation opportunities, cultural heritage, evaluating community attitudes and perceptions, and setting out clear cut strategies with priorities for action and their implicit costs.

The completed Management Plan then provides a practical working tool for future planning and management within the catchment, guidelines for community involvement and the approaches to be adopted in developing detailed designs and maintenance programmes for recommended projects within the catchment.

In undertaking this study and preparing the Plan, the specific objectives set by the client have been of prime importance. The three objectives summarised in the brief require that an integrated plan of management for Rapid Creek and its environs is developed which will:

- stimulate greater awareness of the presence and importance of the area;
- promote increased protection and appropriate management of the whole system;
- encourage government agencies and the community to co-operate in the development of protection and rehabilitation measures for the creek system.

1.3 THE PLANNING CONTEXT

The open space components of the study area falls under the ownership, care and control of a number of Government agencies including Conservation Commission, Darwin City Council, Federal Airports Commission, Royal Australian Air Force and other public/private bodies, including Northern Territory University, Marrara Sports Complex and Northlakes Golf Course.

The existing planning legislation in the Northern Territory does not clearly identify the level of Government responsibility for adoption and implementation of a catchment management plan within an urban area.

Given this situation, and the minimal planning powers at local Government level, it would appear that the establishment of a Rapid Creek Catchment Management Trust or an effective alternative management body that includes both public and private representation would be the preferred management approach. A fuller discussion of this proposal is contained in Section 4.

1.4 METHODOLOGY AND FORMAT OF THE PLAN

The following brief summary sets out the approach and methodology adopted to achieve the objectives of the Plan and sets out the chosen format. This involved four key stages as follows.

1.4.1 DATA COLLECTION AND SURVEY

This involved the consultant team in site specific document research on flora and fauna, catchment management practises, hydrology and water quality, and other physical features of the area. The information was supported by field checks where appropriate (including vegetation survey; visual character appraisal; recreational use and access), discussions with Council and Government agencies.

1.4.2 COMMUNITY LIAISON, ISSUES ANALYSIS AND REVIEW

Formal workshops were held with representatives of the various Government Departments and agencies, and with the general public. The concerns and issues raised in these meetings, along with detailed evaluation and analysis of surveyed data led to the development of preliminary concepts and draft strategies. These were reviewed by the Steering Committee, comprising Greening Australia and Darwin City Council and Government agencies prior to being placed on public exhibition.

1.4.3 STRATEGY DEVELOPMENT

Following analysis of numerous issues, evaluation of the agencies' objectives and giving regard to community concerns, the team considered a number of options before identifying a broad coordinated concept for the entire creek catchment.

Following on from the preferred option the team has then defined a series of detailed strategies that address the key issues, providing clear guidelines for the future design, implementation and management of specific projects and actions. The strategies are presented in both a written and graphic form.

1.4.4 PRIORITIES, RESPONSIBILITIES AND COSTS

In tandem with the assessment of various options and the subsequent development of preferred options and detailed strategies, the team has assessed the cost benefit of all practical alternatives.

In arriving at final strategies the Plan sets out not only the anticipated costs but identifies priorities for staging the works. Appended to the priorities is an assessment of 'achievability' of given projects, by which the client may assess the relative ease with which a strategy may be implemented (eg without need to acquire land etc) to a clear cost benefit. For each strategy, the authority or group responsible for implementing the works is identified

Finally, the Plan provides details of suitable funding sources for various projects from State and Federal agencies.

2. SITE INVENTORY AND ASSESSMENT

2.1 PHYSICAL ENVIRONMENT

2.1.1 CREEK HYDROLOGY

This study looks at the entire catchment area of the Rapid Creek. The Creek, measured from Marrara Swamp to the mouth at Casuarina Coastal Reserve is approximately 9.8 km in length, draining a catchment of over 28 km^2 as shown in Figure 2.1

Catchment Drainage System

The entire catchment of Rapid Creek has been investigated and a literature review undertaken as part of this study. On this basis, the creek hydrology may be assessed and evaluated. The sources of water in the creek may be broadly classified as urban run-off and natural recharge. The urban run-off has two distinctive flows that relate to the wet and dry seasons. During the wet, urban run-off is typically high flow stormwater with levels and volumes closely linked to rain events. During the dry season, low flow stormwater results from garden irrigation and car washing.

Natural recharge is also related to the two predominant seasons. During the wet season, the swamps fill and begin to discharge into the creek. This, along with overland flow, maintains a significant water volume in the creek during the wet season. Storm events are accompanied by increased waterflows and levels. During the dry season, the effect of storm events is rarely important.

A number of studies indicate that Marrara Swamp and the secondary swamps within the RAAF grounds slowly discharge water and are a major factor in the persistence of streamflows into the dry season. The swamps contain water for much of the dry season and are one probable source of groundwater recharge in the catchment. The swamp also acts as a large detention storage during flood events. (Willing & Partners, 1976; Dwyer, 1980).

The Marrara Swamp overflows into two natural drainage arms - to the north and the south - which are in the most part ill-defined. The southern arm flows into a secondary swamp close to the eastern end of the airport runway, and rejoins the northern arm in another large swampy area, upstream of the existing flood mitigation weir. (Refer Figure 2.1). Below the weir the creek becomes a well defined channel with a moderate gradient and a number of deep pools. In the area downstream of Kimmorley Bridge, the creek comes under tidal influence.

The creek serves an important function as the main element of the catchment drainage system, conveying runoff from the developed areas. A number of open drains and road culverts drain the flat, upper regions of the catchment. Major open drains within the RAAF Base and FAC land empty into the creek, as does an unlined drain behind the caravan park at Karama. Feeding into Marrara Swamp are a number of drains, with culverts under Amy Johnson Avenue.

Downstream of Kimmorley Bridge, the contributing catchment to the creek are highly developed residential suburbs with piped drainage systems, and there are several stormwater outfalls to the creek.

Rapid Creek follows a well defined channel through the riverine monsoon forest, where low flows persist well into the dry season.

The paperbark swamp area on the southern arm of Rapid Creek is an important component in the overall flood mitigation role of the upper catchment.

HYDROLOGY

Figure 2.1

1 IN 100 YEAR FLOOD LEVELS
SOURCES: WILLINGS AND PARTNERS, 1976
CAMERON McNAMARA, 1982
DWYER, 1980

OPEN STORMWATER DRAINS

PIPED OUTLETS

PRIMARY ZONE STORM SURGE

SECONDARY ZONE STORM SURGE

CATCHMENT BOUNDARY

RAPID CREEK
MANAGEMENT STUDY

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Waterflow Characteristics and Flooding

The creek essentially retains its natural form and bank profile for its entire length, although there has been some channelization works east of Amy Johnson Avenue and along the northern arm. Some straightening works were carried out upstream of Trower Road prior to 1980. There is evidence that the creek bed between the flood mitigation weir and Kimmorley Bridge has experienced bottom scouring and bank erosion. It is possible that this is a natural occurrence associated with peak flows along this steeply graded section of creek. However, when comparing the creek profiles of Rapid Creek with other creeks with undeveloped catchments (eg Kings Creek) it becomes clear that the steep banks, overhanging in some places, is atypical. This is supported by photographic evidence (see over) that indicates a slow flowing creek with water lillies established. The literature review was unable to source any data that specifically identified this problem. Given the major drainage channels entering the creek, increased run-off and heightened peak flows, it would appear that the development of the catchment is the most likely cause of the scouring.

As with other watercourses in the Top End, water flows vary greatly as a result of variations in rainfall and evaporation. During the wet season, December - March, creek flow is large and the creek regularly overtops the defined channels. In the area of the swamps and Pandanus communities, the groundwater rises above ground level and extends to cover large areas. Marrara Swamp is often inundated across an area greater than 15 ha.

The swamps, in conjunction with the well-vegetated, ill-defined channels of the north and south arms serve a major role in flood control and mitigation (Cameron McNamara, 1982). The road crossings at McMillans and Trower Roads were designed to a minimum standard that they should not be flooded more frequently than once in 20 years on average. However, with changes in the catchment upstream of Kimmorley Bridge, it is likely that McMillans Road would flood more frequently than this (Cameron McNamara, 1982) and there is anecdotal evidence of this. The same report goes on to note that the upper catchment of Rapid Creek is the major control on reducing peak flows and maximum flood levels. This role is dependent on maintaining the 'unimproved' nature of the creek.

Low flows in the lower reaches of the creek are maintained well into the dry because of the slow drainage of the swamps and the unconfirmed belief that ground water maintains a minor spring in the area of the flood mitigation weir. The upper reaches of the creek including Marrara Swamp, do dry up completely during the dry season. Surface water is retained in the swamp upstream of the flood mitigation weir and the defined channel and deep pools below the weir hold substantial water through to the following wet season .

Low flows from developed areas occur, and are usually the result of excessive water from irrigation or washing down. In some cases, this water enters the constructed stormwater system, but will not reach the creek itself. Such instances have been recorded by the team in the major open unlined drains draining from the Karama residential area, RAC grounds and from the Marrara Sports Complex. However, the large stormwater outlet in the area of Ellengowan Drive and other smaller outlets in the Rapid Creek, Alawa and Milner areas are typical exceptions. These systems drain urban areas and the piped outlets empty directly into a channelized tributary. Figure 2.1 indicates the areas subject to flooding and the major drainage lines and piped outlets in the catchment.

2.1.2 WATER QUALITY

Water Quality Testing and Monitoring

A number of water quality monitoring programmes have been undertaken within the Rapid Creek Catchment since 1980. Several of these have been implemented as a direct response to proposals to expand the Darwin Airport and other developments within the catchment. Prior to 1980, there is very little water quality data available for Rapid Creek, and there is no

comprehensive work on water quality below Kimmorley Bridge. A report prepared by Cameron McNamara (1982) for Transport and Works, identified existing problems and potential threats to water quality associated with proposed developments in the catchment. At that time, there were indications that bacteriological contamination of the waters exceeded accepted criteria for primary contact (swimming). Qualitative assessments were made of pollution sources and likely impacts of existing and proposed developments, recommendations were suggested to ameliorate these impacts.

The recommendations applied to the following pollutants - sediments, oils and grease, BOD and nutrients, bacterial, litter - and were assessed under the 1982 existing situation, and the forecast future situation. The future situation incorporated the various proposed developments within the catchment, including expanding residential areas of Karama and Northlakes, Northlakes Golf Course, Airport extensions and Marrara Sports Complex.

Various recommendations relating to provision of silt traps and control of erosion may have been incorporated during construction, but there is evidence of continuing erosion and siltation occurring. Several potentially incompatible land uses have not proceeded. Removal of buffalo from RAAF grounds has proved sussessful, but their is some evidence of pig activity upstream of the flood mitigation weir.

The large open unlined drains draining the FAC land, Marrara Sports Complex and running parallel to McMillans Road east of Lee Point Road are presently eroding. The flows and velocities in these drains have significantly altered the characteristics of the catchment in these localities. The result has been erosion, both in the drains themselves, and also along the creek.

The Northlakes Golf Course and Marrara Sports Complex makes use of recycled waste water. Recommendations were adopted, but there continues to be problems of nutrients entering the creek during the wet season, when the storage dam overflows. At this time significant volumes of waste water, containing fertilizer, weedicides and fungicides enter the creek.

Grease and oil traps were recommended for the airport site and these have been incorporated in the development, in the form of hay bale arrestors.

Water sampling undertaken by Dames & Moore (1986) over a period of $2^1/2$ years, together with the Department of Transport & Works Water Division records from July 1981 to May 1983, provides an adequate, although limited, range of results from which baseline variability of water quality in the catchment can be assessed.

Seasonal variations in factors such as electrical conductivity (EC), pH, water temperature, dissolved oxygen levels, nitrate variability, ammonia variability and phosphorous levels and sediment loads are typical of a nutrient deficient monsoon environment. (Dames & Moore, 1986). Of particular interest is the low EC values which reflects a very low buffering capacity in the stream to counteract acidic and alkaline effluents of human origin or other natural processes leading to changes in pH (Dames & Moore, 1986). Nitrate levels in the northern arm were high and it was thought this was the result of the greater vegetation clearance and increased urbanisation in this area of the catchment and the use of treated effluent for irrigation at Northlakes Golf Course. Phosphorous levels are highly variable, with definite dry season maximum values consistent with the effects of organic decomposition.

Water quality in Rapid Creek below the flood mitigation weir remains high. This is a result of the thickly vegetated swamp environments acting as a biological filter to remove chemical constituents and particulate matter (Dames & Moore, 1986). Bacteria levels unacceptable for recreational swimming have been recorded following major first flush events, but other health risks from nutrients and toxic chemicals are considered minimal (Dames & Moore, 1986). A report by PAWA (1990) confirmed that concentrations of

E. coli (faecal pollution indicator bacteria) were below the guideline figures used by the N.H and MRC (1988) for primary contact recreation.

The effects of sediments on water quality is significant. Disturbed and cleared sites will contribute to the pollution load since the massive red and yellow earths that are the dominant catchment soil type are classified as moderately high erodibility. (Fogarty *et al*, 1979).

Site disturbance and clearing of vegetation will seriously impact on water quality with increased suspended sediment loads and turbidity (Dames & Moore, 1986).

Sources of Contamination

The upper reaches of the catchment remain in a relatively undeveloped state. Potential sources of pollution are restricted to urban stormwater from Karama subdivision and stormwater from the agricultural areas east of Amy Johnson Avenue. The primary pollutants are likely to be nutrients and chemicals, including low concentration of oils, grease and hydrocarbons off paved areas. The use of treated effluent water at Northlakes Golf Course does release nutrients into the Rapid Creek catchment, and monitoring in the area has indicated raised nitrate levels (Dames & Moore, 1986).

Phosphorous levels are commonly high in urban stormwater. Although the levels in the creek are highly variable, it appears that the dry season values are consistent with the effects of biological decomposition (Dames & Moore, 1986). The swamp environments in the upper catchment are important biological filters and storage areas which collect and attenuate sediment and chemical constituents entering Rapid Creek.

Between the flood mitigation weir and McMillans Road the major source of pollutants is oils, grease and hydrocarbons from the RAAF and FAC grounds, and nutrients from Marrara Sports Complex. Accidental fuel leaks from the airport pose a real threat to the water quality (Kinhill, 1991). Provision has been made to deal with leaks, but this is restricted to hay bale arresters. They are yet to be tested in a real situation, and require regular maintenance. Maintenance programmes at the sports complex can be expected to release chemical nutrients (fertilizers, pesticides, weedicides) and organic material into Rapid Creek.

This area of the catchment is also a significant source of sediments due to the expansive areas of cleared land within the RAAF and FAC lands and the steep gradients of the open unlined drains. Surface flows collect significant sediment loads leading to turbidity within Rapid Creek.

Downstream of McMillans Road, the main sources of pollutants are expected to be urban stormwater and nutrient/animal wastes from the rural living blocks. The potential hazards of urban stormwater have been discussed above. Manure and other animal wastes from the rural living blocks could lead to eutrophication and bacterial contamination of the creek. (Cameron McNamara, 1982).

This lower section of the creek is tidal to approximately 400 metres below McMillans Road and this factor contributes to the regular flushing of the creek, whereby the pollutants may be removed from the system.

2.1.3 LANDFORM AND SOILS

Figure 2.2 illustrates the different land units described by Fogarty *et al* (1979). The report forms the basis for the following description.

Landform

The Rapid Creek catchment has been divided into 4 broad landform divisions essentially on the basis of the continuing process of geological erosion and deposition (Fogarty *et al*, 1979). The landform is the basis for classification of the terrain into units because it has a controlling influence over soils, drainage and vegetation.

These include:

Plateau surface - a flat to gently undulating surface which forms the watershed of the catchment.

Plateau drainage areas - This division covers the slowly draining perennial/annual wetlands and linking spillways in the area of the swamp and north and south arms in the RAAF Base grounds.

Plateau sideslopes and foothills - These areas are usually at gentle to moderate gradients and coincide with the area of Rapid Creek below the flood mitigation weir.

Coastal plains and estuarine flats - the alluvial and marine clays of the mangrove areas and coastal sands of Casuarina Coastal Reserve are typical of this landform. Typically low relief and negligible slope.

Soils

Soils through the catchment vary substantially and often over short distances. The characteristics of the soils are very important for two reasons, firstly they play a critical role in determining the type and location of the vegetation communities, and secondly, they place limitations on development due to drainage, soil depth and susceptibility to degradation (Fogarty et al, 1979)

The catchment, particularly on the plateau surface and sideslopes is characterized by red and yellow massive earths. The depth of these soils vary but are often shallow and they are all easily eroded if cleared of vegetation. Other soils in the catchment include earthy and siliceous sands (found on the lower slopes) and grey cracking clays and marine muds. While the sands are excessively well drained, the clays and muds, due to their location and structure are poorly drained.

2.1.4 VEGETATION

A detailed vegetation survey of the different plant communities using photographic interpretation and field checks was prepared by Clark and Brocklehurst (undated). Additional field survey work has been undertaken by the consultant team as part of this study. This survey work was directed at extending the species list for various communities, field checking the original work where required and identifying management issues. The survey does not attempt to delineate accurately the different communities and their extent. Nor does it aim to be comprehensive in identifying all species present. The details of the sites and transects surveyed appears in Appendix 1. By combining the information obtained in the two surveys, it is possible to summarise the broad vegetation communities as follows (Refer Figure 2.3).

Mangroves

Mangroves extend from the mouth of Rapid Creek to the area adjacent to the Darwin Water Gardens. The community is dominated by *Avicennia marina, Ceriops tagal var. australis* and *Bruguiera exaristata*. At its upstream limit the main mangrove community was *Lumnitzera racemosa*. This community is healthy, comparatively robust and has recovered well both from cyclone damage, clearing and filling during the mid-seventies. Typically of mangroves in the tropics, the community displays a healthy diversity, however, because of the short steep slopes of the estuary, the community is less diverse and not clearly banded as other areas of the Top End. The occurrence of *Acanthus ilicifolius* makes the area almost unique since it is rare in those mangroves that have been classified in the Northern Territory (Dwyer, 1980).

Riverine Monsoon Forest

This community consists of a narrow band of rainforests species that extends from approximately 500 metres downstream of Kimmorley Bridge to just below the flood mitigation weir. In parts the community is little more than a single row of trees on either side of the creek, and in other places it extends to 50 metres wide. Dominant species are *Acacia auriculiformis, Syzygium angophoroides, Carallia brachiata* and *Lophostemon lactiflius.* Other important species include *Pandanus spiralis, Barringtonia acutangula, Alstonia actinophylla, Maranthes corymbosa* and *Euodia elleryana*.

Perhaps the most interesting species in this community is *Syzygium angophoroides* which is indicative of permanent fresh water. It is unusual to find this species so close to the coast and is typical in deep, moist gullies on the escarpment edges of Litchfield and Kakadu.

Pandanus/Transitional

These communities occur in areas where a combination of soil types, slopes and drainage systems results in higher moisture than in the surrounding woodlands. *Pandanus spiralis* is dominant, occasionally in pure stands, but also in association with *Lophostemon lactifluus, Eucalyptus alba* (occasionally) and *Eucalyptus polycarpa*.

Eucalyptus Woodland

This community is restricted to the upper slopes and plateau surface of the RAAF Base. This community while common in the Top End is not well represented in the Darwin area. The community is dominated by *Eucalyptus miniata* and *Eucalyptus tetradonta*. The area within the two arms of the creek has a sparse midstory and ground layer, apart from *Sorghum intrans.* The area north of the creek, behind Marrara Sports Complex and Northlakes Golf Course is relatively healthy, showing moderate regeneration and seedling recruitment. *Terminalia ferdinandiana, Livistona humilis, Acacia aulacocarpa, Cycas armstrongii* and *Erythrophleum chlorostachys* appear as scattered individuals.

Paperbark Swamps

This community is quite restricted within the study area. It is dominated by *Melaleuca viridflora*, often in association with *Pandanus spiralis* and *Grevillea pteridifolia*.

Weeds

Weeds are widespread throughout the catchment and are particularly prevalent through the low lying grassland communities (*Pennisetum polystachion, Andropogan gayanus*) and in cleared/disturbed areas of the mangrove and monsoon forest communities (*Leucaena leucocaphala* and isolated *Mimosa pigra*). Drainage lines from and fringes to residential areas are often infested with garden escapes.

Source: Fogarty et al, 1979

LAND UNITS

Figure 2.2

UPLAND DEPRESSIONS AND DRAINAGE WAYS

- 2a1 EARTHY + SILICEOUS SANDS; GRASSLAND, MINOR WOODLAND
- 2a2 HUMIC GLEYS DOMINANT; MELALEUCA CLOSED FOREST

SIDE SLOPES AND LOW HILLS

- 3a RED AND GRAVELLY RED MASSIVE EARTHS; WOODLAND WITH MINOR CLOSED FOREST.

LOWER FOOTSLOPES

- 5a YELLOW MASSIVE EARTHS MINOR RED MASSIVE EARTHS; OPEN GRAVELLY; OPEN FOREST.
- 5b LAYERED ORGANIC SOILS WITH CLOSED FOREST DOMINANT, OFTEN RAINFOREST.

DRAINAGE FLOORS

- 6b EARTHY SANDS, MINOR HUMIC GLEYS; WOODLAND WITH MINOR CLOSED FOREST.

LITTORAL AREAS

- 8a1 SALINE GREY CRACKING CLAYS; GRASSLAND
- 8a2 RECENT MARINE MUDS FREQUENT ROCK OUTCROP. MANGROVE CLOSED FOREST
- 8b1 CALCAREOUS DUNE SANDS; GRASSLAND/TREES.
- 8b2 STABILISED BEACH RIDGE SYSTEM CLOSED FOREST

LOW PLATEAU SURFACE

- 1a RED MASSIVE EARTHS; OPEN FOREST
- 1b1 RED + YELLOW MASSIVE EARTHS; O.F.
- 1b2 GRAVELLY RED + YELLOW MASSIVE EARTHS; OF.
- 1c LITHOSOLS; WOODLAND TO O.F.
- 1d YELLOW MASSIVE EARTHS + MINOR RED MASSIVE EARTHS; OPEN FOREST

RAPID CREEK
MANAGEMENT STUDY

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VEGETATION COMMUNITIES

Figure 2.3

- MANGROVE COMMUNITIES
- MONSOON FORESTS
- TRANSITION
- PANDANUS COMMUNITIES
- EUCALYPTUS COMMUNITIES
- CLEARED LAND
- GRASSLAND COMMUNITIES
- PAPERBARK COMMUNITIES

SOURCE: 1. CLARK AND BROCKLEHURST VEGETATION MAP
2. J. BROCK, FIELD SURVEY, 1993

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Coffee bush infestation on disturbed land adjoining Northern Territory University and mangrove community.

Healthy pandanus community on northern area of Rapid Creek.

2.1.5 FAUNA

The study team undertook an intensive literature search and limited field survey work to investigate the diversity of fauna in Rapid Creek. This survey does not constitute an intensive fauna survey of the region, but merely attempts to highlight species likely to occur in the region. The details of species lists appear in Appendix 2.1 Terrestrial Fauna, 2.2 Freshwater Fauna and 2.3 Mangrove/Estuarine Fauna.

The literature search did identify a significant absence of any freshwater studies within the Darwin Region. The current knowledge on freshwater environments in the Top End is restricted to the Alligator Rivers region. Current studies on freshwater ecology of the Magela Creek and floodplains will soon be complete and this will provide a good basis from which similar habitats/ecosystems in the Darwin region can be assessed. Due to the size of the Rapid Creek system, it is likely that the diversity of fauna would be reduced. A reconnaissance of the freshwater environment upstream of McMillans Road confirmed that the creek maintains a diverse stream community, with large numbers of crustaceans and fish.

The species lists included in Appendix 2 is compiled from a number of earlier surveys and published reports. In the absence of a detailed field survey, or any specific study of freshwater streams in the Top End, this survey provides a list of species or families which have been encountered in the Top End. A diverse range of organisms utilize freshwater habitats and the fauna in the Northern Territory is not likely to be very different from any other Australian region. While different species will occur, the basic structure of the communities are essentially composed of the same specialized group of animals, including Annelid worms, insects, crustaceans and fish.

Mosquitoes

Mosquitoes are a natural component of most aquatic environments. In the Rapid Creek catchment, the occurrence of mosquito species is of particular concern due to the proximity of the airport. The World Health Organisation has a requirement that mosquito breeding sites are eliminated for a distance of 400 metres from the perimeter of an international transit area. The Northern Territory and Commonwealth Health Departments have extended this zone to 1600 metres, in view of the normal flight range of some of the malaria vector species present.

Control of mosquito breeding is therefore required for health reasons. The residential and recreational areas of Marrara, Northlakes, Malak and Karama could also be expected to benefit from mosquito control as a result of reduced annoyance factors.

The catchment at present does not pose a significant mosquito threat, however, the three swamp areas within the RAAF grounds are potentially major mosquito breeding areas, should the present system be altered. Peter Whelan (pers comm, 1993) has noted that the factors necessary to maintain the above areas relatively free of mosquito breeding include ensuring low nutrient levels in the water, forest canopy cover over creek lines and swamps, the maintenance of good freshwater fish populations in all areas of the swamp, and the maintenance of the relatively small or reduced areas of freshwater semi-aquatic reed species. Peter Whelan (pers comm, 1993) has identified the native rainbow fish populations as effectively controlling mosquito breeding in much of the swamp system. The greatest threat to their continued role in mosquito control would be pollution and loss of their dry season refuges in the lower reaches of the creek and the swamp area at the confluence of the two arms.

In the lower reaches of the creek, the main potential for mosquito breeding is the low flows associated with stormwater drains entering the creek from the airport, Marrara Sports

Complex and residential areas. Further details of the mosquito breeding and control are contained in Appendix 3.

2.1.6 FIRE

Fire has been an inherent factor in the Top End landscape for thousands of years. Fires often start naturally as the result of lightning strikes during the dry season when there is a large fuel supply from grasses, in particular *Sorghum intrans.*

Aboriginals have long used fire as a management tool to clear vegetation and promote new growth. Their intimate knowledge of the natural systems resulted in a patchwork burning matrix in the early dry season.

As Darwin has developed, these two, well established patterns have been eliminated and there have been significant changes to the natural fire regime. Fire is still an important factor in the catchment. While some fires are controlled burns to reduce fuel loads in the early dry season, many of the fires are uncontrolled. These sporadic fires frequently result from itinerant camping, but it is believed motor bike riders and children playing are also responsible.

While no specific study of fire impact has been carried out in the area, observations of long term residents, supported by historical photographs, indicate that there has been significant changes in the vegetation structure and diversity in some communities. While fire is an important aspect of the woodland communities, the paperbark and swamp communities and the monsoon forest community are susceptible to fire damage. (Brock, 1988; Russell-Smith, 1984).

2.2 CULTURAL ENVIRONMENT

The cultural environment of Rapid Creek has drawn on the richness of the natural systems to produce a multi-layered 'fabric' that is a valuable resource to the greater Darwin area. This section describes the different layers, and relates them to the physical environment.

2.2.1 LANDSCAPE INVENTORY AND SCENIC ASSESSMENT

Landscape Inventory

This landscape inventory is concerned with those areas within the catchment which retain their natural habitats and vegetation cover, and those other areas adjacent to the creek corridor that are modified landscapes but retain open space characteristics (i.e. well vegetated, limited built structures).

In restricting the inventory to these areas, the landscape may be classified into five main character types : mangrove and estuarine landscape, closed forest landscape, wooded landscape, swamp and drainage area landscape, cultivated landscape.

Within each character type a number of landscape settings have been identified based on water characteristics, vegetation communities, and topographic profile of the creek. These are described and illustrated below. Their location in the catchment is shown in Figure 2.4.

Mangrove and Estuarine Landscape - This character type is quite uniform and corresponds to the lower, tidal waters and flats towards the mouth of the creek. The vegetation is dominated by the closed vegetation of a variety of mangrove species.

Closed Forest Landscape - This character type is quite uniform and corresponds to the narrow corridor of riverine monsoon forest between Trower Road and the flood mitigation weir. The width of the vegetation varies from between 2 and 50 metres on either bank and is closely linked to the contained, relatively fast flowing creek. This type may be divided into two settings degraded Closed Forest (below McMillans Road) and *Acacia auriculiformis/Syzygium angophoroides* dominated Closed Forest (above McMillans Road).

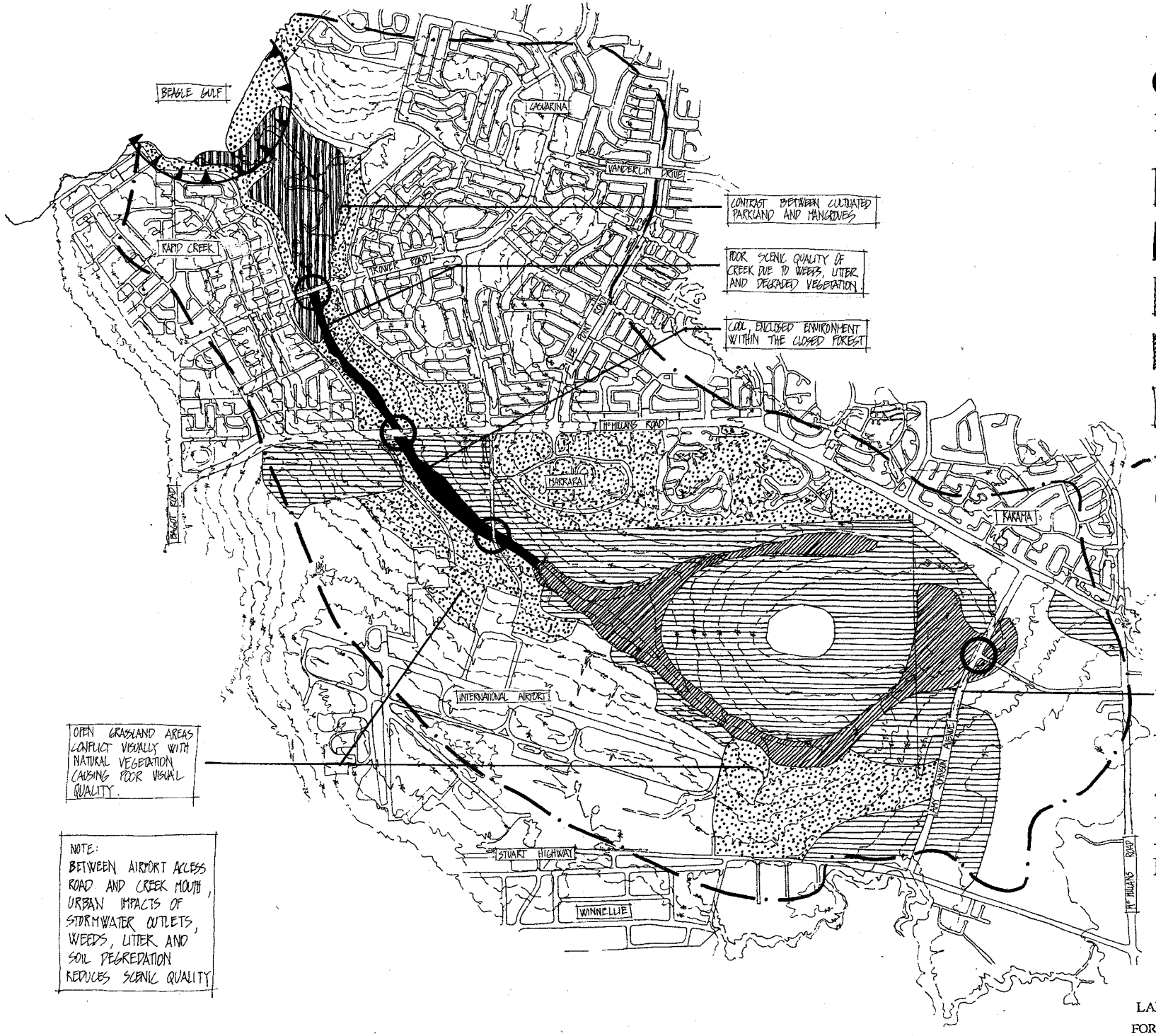
Woodland Landscape - This character type is spread throughout the catchment and is generally found on the higher slopes and plateaus away from the creek itself. There are two settings within this type.

Eucalyptus dominated woodlands occur within the RAAF grounds and also extend east of Amy Johnson Avenue. This setting, while well represented in the Top End, is restricted within the Darwin urban area. It is typically an open, timbered landscape with extensive grass understory. Transition Woodlands occur on the slopes, in closer proximity to the creek. They often exhibit a greater species diversity in the canopy layer and would include *Eucalyptus sp, Pandanus spiralis, Syzygium suborbiculare* and *Lophostemon lactifluus.*

Swamp and Drainage Area Landscape - This character type is located along the drainage lines upstream of the flood mitigation weir. There are a number of settings, that are determined by vegetation. All these settings exhibit major seasonal variations with changes in water levels. Pandanus dominated swamps consist of virtually pure stands of *Pandanus spiralis* which create a distinct form and texture to the area. They are quite dense and sheltered areas.

LANDSCAPE CHARACTER TYPES

Figure 2.4



MANGROVE AND ESTUARINE

CLOSED FOREST

WOODLAND

SWAMP AND DRAINAGE

CULTIVATED LAND

CATCHMENT BOUNDARY

MAJOR ROAD CROSSINGS:
IMPORTANT VIEWING POINTS, BUT RAPID CREEK IS OBSCURED FROM ROAD TRAFFIC.

VIEWS:
HIGH SCENIC QUALITY AT CREEK MOUTH – VIEWS ALONG COAST AND INTO MANGROVE COMMUNITY.

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Melaleuca dominated swamps consist of varied densities of *Melaleuca viridflora*. These swamps are more open than the *Pandanus* swamps, although the plant density is often greater.

Grass dominated swamps are very open, with only scattered or no trees. The grasses create a fine texture and accentuate the flat nature of the landscape. The annual life cycle of the grasses results in a visually dynamic landscape.

Cultivated Landscape - This broad character type includes all modified landscapes and recreation areas which are not dominated by natural communities. They are readily recognized as man-modified and their use and appeal is very much a reflection of the level of maintenance. A number of settings are identified. There is a marked contrast to the remnant natural communities described above. Developed active recreation areas include Marrara Sports Complex, Northlakes and the sports ovals fronting Lakeside Drive. The areas are well maintained with lush green grass throughout the year and a dominance of canopy shade trees (mostly exotic). They are easily recognizable as active recreation areas and are generally well used.

Developed passive recreation areas include those parkland areas adjacent to the natural areas (reserves adjacent to Casuarina Drive and Rapid Creek Road, Darwin Water Gardens). These areas are quite variable in level of maintenance. They are scenic in themselves, but rely for their appeal on their proximity to the creek, coast, and natural vegetation communities.

Other open space areas include those essentially undeveloped areas that tend to be quite open with limited structures. Large areas of the RAAF and FAC grounds fall into this setting, as does Casuarina Coastal Reserve. These areas are very open, undeveloped and have very low levels of maintenance.

Scenic Quality

The diversity of remnant vegetation communities along with the various modified landscapes, has resulted in a rich scenic environment with aesthetic qualities that are generally high. The presence of and views to the water are always important in the Top End. This may be shallow, standing water below the paperbarks alongside Amy Johnson Avenue; the swiftly flowing current through the riverine monsoon forest; or the tidal ebb and flow along the coast and through the estuarine areas.

The seasonal change and ephemeral qualities of the different settings as they reflect the changing water regime and plants flower and fruit contribute to a readily visible natural cycle.

The presence of fish and crustaceans within the creek and banks; noisy bird populations of black cockatoos and crimson lorikeets; quiet patience of the water birds; darting flight of bee eaters and swallows; and bat colonies all add to the rich visual experience of the creek corridor

The visual quality is largely dependent on the natural systems and the maintenance of them is critical. At the same time negative impacts on these systems will reduce the scenic quality. Impacts that detract from the visual quality include:

- Rubbish dumping, in particular littering of cans, bottles and papers.
- Indiscriminate car parking and access tracks, with corresponding loss of ground cover and erosion (sheet, gully, rill).
- Degradation of vegetation, loss of canopy and significant weed invasion.
- Low flows from urban stormwater systems.
- Inappropriate development that is often poorly sited and designed, with inadequate attention given to the necessary rehabilitation of disturbed areas.

Littering, rubbish dumping, poor water quality and weed encroachment all have a negative impact on the scenic quality.

Visual Access

The creek corridor, where the highest quality areas occur has a limited visual access. This is primarily due to the adjoining landuses. The rural blocks near McMillans Road and the restricted access to the RAAF grounds means that large areas are visible only from limited positions and perimeters.

The creek and vegetation communities have a high visibility in the estuarine reaches between McMillans Road and the airport access road, and adjacent to Amy Johnson Avenue. Vehicle and pedestrian access is important in determining the visual significance of the creek.

The linear nature of the creek, from headwaters to the sea, is not clearly interpreted in the present urban setting, since visual access is disjointed. The visual links are not clear.

2.2.2 RECREATION ASSESSMENT

Rapid Creek is an important recreation resource within the Darwin urban area. Its value relates primarily to passive recreational activities that rely to a large extent on the peaceful, scenic qualities of the creek and its vegetation. Active organised sports are also pursued in areas adjacent to the creek. The great majority of users would be residents of Darwin's northern suburbs, however, it would be expected that other Darwin residents, and visitors (NT, Australia & overseas) are also present. No comprehensive recreational studies have been undertaken of the Rapid Creek region. This assessment therefore draws on relevant recreational studies that have been undertaken in the Northern Territory, communications with residents of the area, and team knowledge of the area (surveyed and experience).

Passive Recreation

Passive recreation encompasses a wide range of recreational activities ranging from the more active pursuits of swimming, running and cycling to sunset watching and picnicing. A further recreational value is enjoyed by a part of the population in the knowledge that the natural resource exists and is protected. Other activities include walking, fishing, unstructured play, nature watching and general relaxing.

These activities would not generally conflict so long as the space is available, they can happen in parallel. Facility requirements are minimal, restricted in most cases to park furniture and infrastructure such as paths, seating, bins, barbecues, shelters, play equipment, water, lighting and parking. In the areas where such facilities are provided they are well used. Some of the activities listed above require only the natural setting of the creek.

All activities however do depend on access, and this is well supported by the fact that accessible sites, with appropriate facilities, are generally well used. The major areas of passive recreation are the riverine monsoon forest and in the areas of public access downstream of McMillans Road, including the Darwin Water Gardens and parks fronting Casuarina Drive.

Active Recreation

Active recreational pursuits do not depend on the presence of the creek and generally derive no benefit from it. Active recreation is confined to the Marrara Sports Complex and the Alawa ovals. As an important part of the entire recreational spectrum, it is important that active pursuits are catered for, and as part of the broad open space resource, they will

continue to perform an ancillary role for passive recreation and maintenance of scenic quality.

Conflicting Recreational Uses

A number of recreational pursuits do introduce conflicts. These include motorbike (and BMX) riding, off-road driving and indiscriminate camping. These activities, while generally restricted to areas that have limited access, do conflict with other passive uses, and weaken the amenity of them.

2.2.3 CULTURAL HERITAGE

Rapid Creek has played an important role in the lives and history of both Aborigines and Europeans. A discussion of this cultural heritage follows.

Aboriginal Heritage

Rapid Creek forms part of the traditional lands of the Larrakia people who continue to maintain links with the area. The estuarine area has always been a good camping site with plentiful food, natural spring water and tall shady trees. The area is still a popular area for itinerant campers.

The Larrakia name for the creek - *Gurambai* - means 'elbow' and refers to the shape of the creek at the mouth (Heffernan, 1992). The Aboriginal Areas Protection Authority has two recorded sites within the catchment. The first site is a Banyan (*Ficus virens*) behind the sand dunes in Casuarina Coastal Reserve. This tree has suffered damage in recent years from fire and mistreatment. It is the site of an aboriginal battlefield and also a burial ground (Heffernan, 1992; CCNT, 1991). A second recorded site is a large Banyan on the southern bank of Rapid Creek adjacent to the footbridge. A major sacred site in the area is *Dariba Nunggalinya* (Old Man Rock) which lies to the north west of the creek mouth. Dariba means 'old man' - a term of respect - and Nunggalinya, is the name of the first Larrakia man. *Dariba Nunggalinya* protects Darwin and the Larrakia people and the Aboriginals believe that if he is disturbed a natural calamity will occur. (Heffernan, 1992).

Today, Aboriginals still use the areas around the mouth of the creek and adjacent to the monsoon forest for camp sites. Some traditional food gathering is still carried out. Also the *Pandanus spiralis* fronds are collected for basket weaving and the roots of *Diospyros maritima* is still occasionally utilised to provide yellow dyes.

European Heritage

Rapid Creek has been a popular recreational area for almost 100 years. Picnics, camping, fishing and swimming have always been regular activities on the creek and this use continues today. At the turn of the century and up until the 1920's a trip to Rapid Creek from Darwin for a picnic, swim or to camp was considered a 'big day out'.

Between 1882 and 1891, the Jesuits ran a Catholic Mission in the area (Heffernan, 1992). The main building was located near the corner of Ryland Road and Pinder Street, Millner. The grounds (including agricultural areas) extended down to the creek in the area of the Darwin Water Gardens and out to the coast.

From the 1940's till the 1960's the local Chinese community would celebrate 10/10 day each year with a large picnic near the mouth of the creek. The day included a large feast, playing of traditional Chinese games, fishing and swimming.

During the same period, there was a large Chinese vegetable garden in the area that is now occupied by the Beachfront Hotel. The garden was apparently a viable commercial operation, and Aboriginal people who camped nearby (usually Tiwi Islanders) would sometimes work there.

Another commercial operation in the area was crocodile trapping and skinning, carried out in the area of the mouth and along the Nightcliff coastline during the forties and as recently as the sixties.

The war years saw a large influx of people to Darwin and the creek became an even more important recreational area. It was now also easily accessible. American servicemen used the freshwater section of the creek for swimming and relaxing. The swimming holes through the monsoon forest upstream of Henry Wrigley Drive, are locally known as Yankee Pools, because of this association.

The various cultural features are shown on Figure 2.5

2.2.4 LAND TENURE/LAND ZONING

The present condition of the Rapid Creek catchment and the future management of the resources is closely related to land tenure and land zoning.

Land Tenure

The great majority of land within the catchment is under freehold title. A number of key areas are presently vacant Crown Land and there are opportunities to make positive use of this situation in the management plan. There are also small areas of land that are either Reserve or Land Set Aside.

Land Zoning

The present land zoning, while it retains an undeveloped creek corridor, does not adequately reflect the environmental constraints of vegetation and flooding. The creek corridor is zoned open space, from the mouth through to Henry Wrigley Drive. Marrara Swamp is also zoned open space.

The remainder of the creek corridor falls within RAAF and FAC grounds and is zoned Special Use. The present zonings have been reasonably successful in protecting the creek resource. With increased development and population growth, the present zonings will come under threat in a number of key areas. These include the areas west of Amy Johnson Avenue (Refer Lands and Housing Land Use Policy - Appendix 4), the rural living blocks both sides of the creek downstream of McMillans Road, and the open space area bounded by the creek, McMillans Road and Henry Wrigley Drive.

The land zoning across the catchment are shown on Figure 2.6.

CULTURAL HERITAGE

Figure 2.5

▲ SACRED ABORIGINAL SITE (SOURCE AAPA)

■ RECORDED ABORIGINAL SITE (SOURCE AAPA)

✱ TRADITIONAL/PRESENT DAY CAMP SITE

CATCHMENT BOUNDARY

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LAND ZONING

Figure 2.6

- OPEN SPACE 1
- OPEN SPACE 2
- OPEN SPACE 3
- RESIDENTIAL
- BUSINESS
- COMMUNITY PURPOSE
- FUTURE USE
- CATCHMENT BOUNDARY

SOURCE: NT PLANNING AUTHORITY
DARWIN TOWN PLAN, 1990

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3. ISSUE ANALYSIS

This section describes the Aims, Issues and Principles relating to the areas of specific detailed study. Each study is presented in a consistent format as follows:

- A statement of the Aims
- A summary of the major issues for quick reference
- A fuller description of each topic with background and references to the issues as well as options considered where appropriate
- A statement of the Principles for use in the plan.

The detailed studies are as follows:

3.1 Urban Context, Landuse and Ownership

3.2 Use and Access

3.3 Water Management

3.4 Conservation and Management of Indigenous Vegetation

3.5 Conservation and Management of Native Fauna

3.6 Landscape Character

3.7 Recreation

3.8 Open Space Management

3.1 URBAN CONTEXT, LANDUSE AND OWNERSHIP

Aims

To increase and optimize public ownership and enjoyment of the Rapid Creek corridor to an extent that is compatible with community expectations and in a manner that can absorb and adapt to changes in demands from adjoining development

Issues Summary

Existing ownership along the creek places real restrictions on public use of the creek upstream of the Darwin Water Gardens.

In many instances, the owners of the land are inappropriate, given their needs, areas of expertise and resources. This is particularly true of sections of RAAF and FAC land which may be better managed as public open space while remaining cognisant the landholders requirement for security and freedom to carry out their normal operations

3.1.1 DISCUSSION

The Rapid Creek catchment is within the expanding northern suburbs and is under increasing urban pressures. As vacant land is developed and increased housing densities are pursued, the need for open space will also increase. Rapid Creek requires protection and enhancement if it is to remain a valuable recreational resource.

Previously the diversity of landholders has resulted in an ad hoc, un-coordinated approach to management and maintenance. This situation is not acceptable in a resource that has been in decline for many years. Rationalization of existing ownership along the corridor will ensure those bodies with an interest in maintaining the resource are in a position to effectively manage it.

The RAAF land below the flood mitigation dam continues to be used for recreation, although it is closed to the public. A change of ownership or appropriate lease arrangements would improve security without affecting defence operations. The Marrara Swamp area has also been recently turned over to the RAAF. Given the issues raised in Sections 3.3 and 3.4, it is possible that RAAF are probably not the appropriate management authority for this area.

The present rural blocks below McMillans Road greatly restrict the opportunity for people to utilise this stretch of the creek. Impacts on vegetation and water quality (Sections 3.3 and 3.4) are significant and public enjoyment of the resource, even for its scenic quality, is compromised.

The FAC boundary running parallel to the creek, both above and below Henry Wrigley Drive, extends down to the margin of the riverine monsoon forest, pandanus and paperbark swamp communities. Again, they are perhaps not the appropriate authority to manage these.There are a number of crown land areas within the catchment that are currently leased. (Refer Figure 3.1) Current lease arrangements or requirements for site environmental mangement are generally very limited in scope.

In all discussions of land ownership and management as it relates to RAAF land, it must be clear that safety and security concerns are a major issue, and in most cases this land would not be available for public use. The exception may be the use of Marrara Swamp and other areas for scientific or educational purposes. Visits would be by special arrangement only.

Marrara Swamp, adjacent to Amy Johnson Drive

3.1.2 PRINCIPLES

- Rationalise existing ownership along the creek corridor to increase public ownership of the open space resource, and improve compatibility of management practises.

- Extend open space zonings along the creek corridor and in other important areas of the catchment, such as Marrara Swamp and the rural blocks below McMillans Road.

- Incorporate planting strategies and conditions of development which enhance the indigenous vegetation character.

LAND OWNERSHIP

Figure 3.1

- DARWIN CITY COUNCIL
- CROWN
- RAAF
- PRIVATE
- NT UNIVERSITY
- CONSERVATION COMMISSION NT
- FEDERAL AIRPORT CORPORATION
- CATCHMENT BOUNDARY

RAPID CREEK MANAGEMENT STUDY

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3.2 USE AND ACCESS

Aims

To improve pedestrian access into and through key areas of the Rapid Creek corridor and to control access, in particular vehicle access, in areas that are susceptible to degradation. Ensure access is provided in a manner which is cognizant with the needs and expectations of user groups and management authorities.

Issues Summary

Current use levels along particular stretches of the creek suggest that while some areas experience high levels of use, other areas have very low levels of visitor use. Access to areas downstream of McMillans Road is well controlled with vehicles kept well back from natural areas and only pedestrians and cyclists able to gain access to the creek itself. Upstream of McMillans Road, uncontrolled access has resulted in severe degradation of the monsoon rainforest habitat; and through the RAAF land, present management is directed at excluding all access.

3.2.1 DISCUSSION

Circulation and use of Rapid Creek is presently dictated by the location of public reserves and the ease of access. These reserves are discontinuous, interrupted by major roads (Trower and McMillans Road) and land ownership (RAAF/FAC and private rural blocks). Despite this the park areas are well used and are very popular passive recreation areas. The predominant users are local residents of the northern suburbs. The natural features of the area and the quiet, peaceful character are the main reasons for the popularity of these areas.

Where facilities have been provided for recreation, in particular the areas between Trower Road and the mouth, very high levels of usage are experienced, with little detrimental impact on the natural systems, and high levels of user satisfaction (Brown *et al*, 1987).

The area of monsoon rainforest upstream of McMillans Road is easily accessible, but in the absence of controls or adequate facilities, environmental degradation is occurring and there is real dissatisfaction by many of the users. The present use of the area and low level of management, if allowed to continue, will result in further degradation, and possibly the loss of this unique resource in urban Darwin.

The area between McMillans and Trower Roads does have some impediments to access because of the rural blocks, but in the other accessible areas, the lack of facilities, low levels of maintenance and low scenic qualities means the open space areas are little used. The Darwin Water Gardens do enjoy moderate use, and this reflects the increased levels of maintenance and improved facilities. However, their full potential has not been realised.

Use of the catchment areas upstream of the airport access road is greatly restricted due to the security requirements of the RAAF Base. In some respects, the restricted access has played a role in protecting the woodland, pandanus, transition and paperbark communities, and the water source for the creek. The potential does exist, however, to access parts of this area, that have particular recreation and/or educational value.

As part of an overall, functioning, water catchment area, public access to the various elements, including the headwaters and mangroves needs to be strictly controlled if the natural systems and water quality are to be protected. In some areas this may require exclusion of the public.

Shared cycle paths/footpaths are popular facilities commonly associated with linear parks such as creek lines. Certainly the facility along the Nightcliff shore front and linking up to Brinkin and Trower Road has proved successful. Shared routes are a low key development that provides access, opens up opportunities for education and interpretation, and can foster a sense of ownership in the users. Continuation of such a facility upstream from Trower Road is expected to be well used. Currently, a joint programme is under way involving LEAP funding, the University, Conservation Commission and Greening Australia to improve access along the boundary between the university and Casuarina Coastal Reserve. The improved access will provide for the existing horse riders, but could include an upgraded shared footpath as part of the development.

Access to the mangroves rarely extends further than the immediate margins. The water levels and muds require the construction of boardwalks or causeways to allow access. The opportunity exists to introduce people to this valuable ecosystem by making use of the existing earth fill that follows the drainage line south of the university grounds. The access should exclude vehicles.

Access for disabled people is also an important consideration. The relatively gentle gradients of the catchment are well suited to the provisions of disabled access. Planning and design of access and facilities along the creek should provide for the disabled.

3.2.2 PRINCIPLES

- Encourage greater pedestrian access and circulation into and within public reserves to enhance the enjoyment opportunities for a range of passive recreational activities.

- Strengthen physical and visual links along the creek corridor and establish a contiguous system of reserves, both recreational and environmental.

- Discourage and control access into reserves by public vehicles.

- Plan for and design access routes and facilities for recreation that are compatible with the preferred recreational pursuits and the environmental capability/sensitivity.

- Provide access into some areas that are presently inaccessible by extending the open space resource through land tenure chamges, development controls and other planning means.

- Provide for disabled access, where possible in all future works.

This existing earth bund is an ideal opportunity to introduce people to the mangrove community around the mouth of Rapid Creek.

Uncontrolled access in the monsoon forest can lead to vegetation loss, gully erosion and undercutting of creek banks.

3.3 WATER MANAGEMENT

Aims

To protect the existing hydrological system and bank stability along Rapid Creek. To protect and improve the water quality in the creek and reduce the threats of accidental pollution.

Issues Summary

Rapid Creek presently has a high water quality and this is important in maintaining the recreation value of the creek and is critical in maintaining the biological control of mosquitos in the swamp areas. The existing hydrology is important in supporting the various vegetation communities along the creek and serves a valuable role in flood control.

3.3.1 DISCUSSION

This study has not undertaken any original research on hydrology or water quality, but has drawn on a broad base of previous studies, as well as additional field survey by the team and discussions with PAWA, Peter Whelan (Director, Medical Entomology Branch, Department of Health and Community Services), FAC and RAAF.

The location of Rapid Creek in the urban areas of Darwin's northern suburbs ensures that the natural system will be subject to additional loads in the form of increased stormwater runoff carrying sediment, nutrients and other pollutants. All of these pollutants can markedly affect the stability of the creek and its water quality. As discussed in Section 2.1, the creek presently enjoys a reasonably high water quality (apart from the first major flush in the wet season), but is susceptible to pollution due to its low buffering capability. Also, the relatively undeveloped nature of the upper catchment swamps and corridor generally, has meant minimal change to the creek's hydrology.

Hydrology

A number of studies and reports have confirmed that maintenance of the swamps and slowly draining north and south arms in their natural state is critical in providing flood attenuation downstream, and also to recharge ground water and maintain stream flows till late in the dry season. Developments in the catchment, such as the new airport, various bridge structures and Marrara Sports Complex have resulted in significant increases in peak flows and volumes entering the creek. The increased, concentrated discharges ;have resulted in bank erosion and bottom scouring of the creek below the flood mitigation weir. The increased flows, combined with uncontrolled access to the creek has destabilized the creek banks between Henry Wrigley Drive bridge and the Water Gardens. The increased peak flows had been predicted (Cameron & McNamara, 1982) for the recent developments, however the level of erosion of the creek had not been considered to be significant. The peak flows associated with storm events would be most damaging. It is also assumed that some of the damage that has occurred took place prior to the mid seventies. A qetailed geomorphic study is required to clearly ascertain what has been the effects of development within the catchment. Low flows below the flood mitigation weir well into the dry season are a natural aspect of Rapid Creek. As described in Chapter 2, the slowly draining upper catchment and the seepage of ground water maintains a very low flow in the creek.

Low flows relating to urban stormwater, however, are an important concern in regards to water quality (see below) and mosquito breeding (Refer Section 3.5).

Water Quality

The protection and improvement of water quality in Rapid Creek is important in maintaining the recreational value of the creek, and is critical in maintaining the fauna, in particular the fish populations which are essential in the control of mosquitoes.

The major threat to water quality is the urban stormwater which enters the system from a network of open unlined drains and piped outlets. Urban stormwater has been shown in numerous studies from other Australian cities to be equally or more hazardous than raw sewerage. As well as nutrient loads from vegetable matter and fertilizers, there is a diverse range of pollutants including cleaners, weedicides, pesticides, solvents, hydrocarbons and litter that are commonly found in stormwater. They are also a source of weeds.

Nutrients from the agricultural areas east of Amy Johnson Avenue and Northlakes Golf Course entering the creek have resulted in evidence of increased algal grwth (Whelan, pers. comm.) and are providing suitable conditions for introduced weeds to effectively compete with native plants. Regeneration of trees and shrubs is suppressed and grass weed species are establishing. This structural change in the vegetation will impact on the biological control of mosquitoes in the area. The swamp areas do have a limit to their ability to attenuate nutrients and pollutants, and it is desirable to minimise pollutants to these areas.

The hay bale arrestors installed as part of the new airport are a critical component in protecting the creek's water quality. They require regular maintenance if they are to perform the job they were designed for, ie. intercept oil spillages. In such an event, back up systems should be able to respond very quickly. This is critical given the short distances and steep gradients between fuel storage areas and Rapid Creek. Finally it would appear thta the effectiveness of the hay bale arrestors would be severely restricted if an accidental spill coincided with a storm event.

The public, generally, need to be aware of the entire Rapid Creek catchment and how their actions may effect it. The public must be aware that everything that enters the stormwater system will enter the creek system, thereby having a direct impact on water quality.

The middle and lower reaches of the creek below the flood mitigation weir are the main areas for recreation and water quality in these areas is important. Litter is an important consideration through these areas because of the visual impact and health aspects. On numerous occasions, soiled nappies and human faeces was evident in the area. Pollutants entering the system here are quickly removed because of the water flows (in the wet season) and the tidal flush. If they are continually moving through the system, negative impacts associated with reduced water quality (ie health risks and loss of stream fauna) would result.

The impact of littering will also extend well beyond Rapid Creek itself. Studies elsewhere in Australia, and observations in Darwin indicate that much of the litter that enters Rapid Creek could be expected to land on the beaches of Darwin.

A number of water quality improvement devices are available to maintain water quality in Rapid Creek. Gross pollution traps (GPT) are effective in removing litter and sediments from stormwater. A reduction in nutrient and bacterial pollution is usually most effectively achieved through the use of filter zones or via the construction of water bodies such as water pollution control ponds (WPCP) or wetlands. Due to problems relating to mosquito breeding, WPCP pose problems ad do gross pollutant traps.

Filter strips are most effective for sheet oveland flow and will have particular application in grassed parklands.

Further monitoring is reequired to determine whether devices such as GPTs or WPCPs are required. The final design of such devices should take into account health concerns relating to mosquito breeding.

Of significance to Rapid Creek is the development of an NT Water Quality Management Strategy, currently in draft form. This strategy will provide for an integrated approach to the management of all NT water resources and may provide an appropriate mechanism for the management of the Rapid Creek water resource. Its stated objective is 'to achieve sustainable use of the NT's water resources by protecting and enhancing their quality, while maintaining economic and social development.'

In addition, the NT Waterwatch Program will be undertaking basic catchments/water quality monitoring of Rapid Creek. This is a community based, nationally funded education/awareness program administered locally by Water Resources Division of PAWA. Such a program may be an appropriate vehicle for on-going water quality assessment.

3.3.2 PRINCIPLES

- Water Hydrology: Consider controls on future developments and ensure co-operation of the various landowners in protecting the present hydrology of Rapid Creek. In particular, increased flows from built up areas should be avoided, and the swamps and undeveloped channels upstream of the flood mitigation weir should be protected. Investigate the use of retardation basins to ameliorate damaging peak flows.

- Water Quality: Use planning controls, public education and structures/ devices to improve water quality in the creek, and to protect the creek from accidental pollution.

- Creek Stabilisation: Implement strategies to protect the creek bank that make use of controlled access and revegetation as required. Rock armouring may also have a role in critical locations.

Low flows from urban stormwater systems and increased nutrient load result in negative impacts on water quality.

3.4 CONSERVATION AND MANAGEMENT OF INDIGENOUS VEGETATION

Aims

To protect and manage remnant vegetation whilst maximising natural regeneration capability of sites within the catchment.

To reduce impacts on indigenous vegetation and re-establish appropriate vegetation on sites where natural conditions have been significantly altered.

Enhance the habitat value of remnant bushland.

Issues Summary

Urban influences have substantially altered large areas of the Rapid Creek Catchment, the original vegetation replaced by residential landscapes and parks which bear little resemblance to the former communities.

Along the creek corridor itself, remnant native vegetation still remains, but in many instances it has been degraded and fragmented by recreational use, soil erosion and clearing. Fire, while beneficial in some areas, has been destructive in other areas. Trampling, uncontrolled access and clearing of the canopy have resulted in significant weed infestations. The process required to reverse this situation should rely predominantly on strategies for regeneration, supplemented as required by revegetation. Raised awareness and involvement of the local community, both in the reduction of negative impacts on the creek, such as garden waste dumping, burning and tramping, and also in regeneration and revegetation will be of practical and economic benefit.

3.4.1 DISCUSSION

The remnant vegetation communities in the catchment have been well surveyed (refer Section 2.1) and represent a diverse range of Top End communities. Since the arrival of Europeans, each of the communities has experienced some change, and their present distribution, vegetation structure, species diversity and regeneration capability has been altered. Following is a discussion of each of the communities, the issues / impacts effecting them and an analysis of likely solutions.

The Marrara Swamp, is a critical area within the Rapid Creek System, and it is also the community which has undergone the most serious change. A comparison of recent aerial photographs with photographs from the sixties indicate that the density of *Melaleuca viridiflora* has been reduced by between 30 - 60%. It is believed the original damage was the result of Cyclone Tracy in 1974. With the destruction of the canopy, grasses proliferated in the swamp area and regular late dry season fires have severely restricted regeneration. (Scott, pers comm; Panton, pers comm.) Increased nutrient loads in the system are suspected from the school and orchid farm east of Amy Johnson Avenue, and may have assisted the establishment of dense grass growth. Peter Whelan (pers. comm) has indicated that the reduced canopy cover and increased density of semi-aquatic grasses, can severely restrict the effectiveness of fish predation of mosquito larvae. The other swamps in the area are also subject to increased nutrient loads from residential areas and the airport. Presently, they have effectively dealt with the small loads and the vegetation structure is little changed. However, the widespread weed infestation to the wetland margins is cause for concern. The increased fuel loads does place the communities, both swamp and pandanus at risk from destructive hot fires.

From an ecological perspective, the narrow linear nature of the riverine monsoon forest places it at risk due to the long edge and relatively small area. The community has suffered both fragmentation and incremental loss. This is evident in the various road crossings, and the degradation along the edges. The presence of lush vegetation and clear, flowing water has meant this area has been popular for recreation and camping for many years. The high level of use, in an essentially uncontrolled manner has resulted in trampling and loss of understory and herb species, soil compaction, erosion, and unsightly litter. With the proliferation of grasses, as the result of canopy loss, the community is regularly subject to destructive fires. Below McMillans Road, clearing has severely restricted the extent of the monsoon forest and it is under pressure from weeds and altered soil nutrient levels. Throughout the community, natural regeneration is restricted. Strategies to protect and regenerate the area must be comprehensive and co-ordinated to address each of the various impacts. Replanting will be an essential aspect of this approach.

The woodland and transition communities are not so susceptible to fire as are the swamps and monsoon forests. However, intense late season fires can still be very destructive. Rampant grass weeds are again a problem in these communities preventing regeneration of trees and shrubs and successfully competing with the native grasses. Uncontrolled access has led to a maze of paths in some areas, accompanied by erosion and unsightly litter. Strategies to protect these areas should look at appropriate use of fire and weed management to promote natural regeneration.

A key concern in any use of fire as a management tool is reasons that relate more to community concerns and amenity than ecological parameters. The Darwin public are particular adverse to burning off and the Northern Territory Fire Service receives numerous complaints regarding smoke in the air during the Dry Season. Timing of burns should consider these concerns and, as suggested by the NT Fire Service, maintaining good public relations through education and advice will be critical.

The Northern Territory Fire Service itself has an existing policy which essentially states no burning off in the Darwin Municipality. They are prepared to consider a single burn off if it is justifiable and has an end product. This is clearly a contentious issue which will require further consultation between the various managers and authorities.

The mangrove community is robust and adaptable. Already it has recovered from earlier destructive actions (both natural and man made). Major threats to its health and viability are water quality (especially oil spills) and erosion / sedimentation. Weeds are limited to edges beyond the area of inundation, and cleared / filled areas along sewerage easements. Strategies for protecting the mangrove community should be directed at reduction of weeds along the edges and preventing any further encroachment by filling or clearing and preventing water pollution.

There are numerous areas adjacent to the remnant communities that are now cleared and / or developed recreation areas. Many of these areas are under utilized, and entail significant maintenance costs. Consideration should be given to revegetating these areas to provide buffer zones to the remnant bush, to extend the habitat values of the corridor and to strengthen the visual link of native bush. Levels of maintenance may then be rationalised also, to reflect the level of use and function of the area. Wherever possible, planting in open space areas adjacent to the creek should make use of indigenous species.

While revegetation/regeneration is relatively costly and demanding of time and resources, once established, bushland areas will be cheaper to maintain than grassed parkland.

3.4.2 PRINCIPLES

- **Fire Management**

Develop a fire management programme for the different communities within the catchment,with the purpose of protecting the native vegetation and enhancing the opportunity for natural regeneration. The programme should be based on:

- rotation cycles of burn sites that relate to the community
- early season fires and the use of fire breaks and back burns
- development of a mosaic pattern through the woodland communities
- exclusion of all fires from sensitive communities.

- **Natural Regeneration and Revegetation**

Encourage the potential for natural regeneration of native vegetation through:

- reduction of impacts such as trampling, hot fires, nutrient enrichment and erosion
- reduce occurrences of weed species.

Where the potential for natural regeneration is low, revegetate sites with appropriate native species. Initially consolidate areas of remnant vegetation in conjunction with control of highly invasive weed species.

A programme of regeneration / revegetation strategies is required to adequately address this issue. Personnel experienced in bushland regeneration and revegetation are required to identify and develop appropriate strategies.

Bushland regeneration techniques most appropriate for managing largely unmodified sites:

Bushland Regeneration Process

Reduce Degrading Factors

Factors such as fire, nutrient run-off, dumping, erosion and clearing need to be modified/controlled prior to undertaking work.

Primary Weed Clearance

Major weeds removed from site. Varying degree of weed infestation.

Native Plant and Weed Regeneration Occurs

Maintenance

Preventative weed maintenance of regenerated sites. Undertake fire programmes, control of access and mulching as required.

Secondary Treatment

Intensive weedings of primary sites and mulching as required.

- Remnant vegetation should be consolidated by linking and extending the existing fragments.
- Regeneration work should be undertaken only be trained and experienced regenerators or under supervision by trained regenerators. This is important since many decisions which need to be made in undertaking bush regeneration work on a range of sites can only be adequately made by skilled, perceptive practitioners.
- All weed material should be removed from site and disposed of appropriately.
- Revegetation work may be necessary on bushland / urban boundaries to provide buffering.

Revegetation techniques most applicable to managing vegetation on significantly modified sites:

Revegetation Process

Reducing Degrading Factors

Factors such as fire, nutrient run-off, dumping, mowing practises and clearing need to be controlled prior to under-taking work.

Primary Weed Clearance

Major weeds removed from site. Varying degree of weed infestation.

Monitor for Regeneration

Regeneration of some native species may occur. Regenerating plants should be protected.

Revegetation

Monitor for further regeneration of any native species and protect. Replant with appropriate native species, selection based on degree of change in site conditions.

Secondary Weed Control

Intensive weeding of areas and follow-up weeding of previously treated areas.

Maintenance

Preventative weed maintenance of site. The aim of maintenance weeding is to encourage the development of a new native soil seed bank in preference to weed species. Undertake fire programme, control of access, mulching, grass slashing and further planting as required and appropriate.

- Bushland weed control techniques should be used to remove weeds from these areas. These techniques have been developed to maximise long term effective control.

- Revegetate sites using species suited to higher soil nutrient and moisture levels. Representative species lists for the different areas are included in Appendix 5.

- For revegetation work, use species propagated from nearest naturally occurring source. Include local residents and schools in propogation of plant material, making use of the Council's nursery, or alternative resources such as the Northern Territory University.

- Establish canopy species first, or if resources permit both native canopy and understory species can be established concurrently.

Revegetation work in the area of the monsoon rain forest has relied essentially on the efforts of volunteers. The lack of resources has resulted in mixed results.

The wetland community of the Marrara Swamp is under various threats from fire, weed encroachment and increased nutrient loads.

Many reserves are large, under-utilized areas where a programme of revegetation and landscape development would be appropriate.

The Mangrove community is robust and has recovered from widespread destruction during the 1970's.

3.5 CONSERVATION AND MANAGEMENT OF NATIVE FAUNA

Aims

To protect and enhance populations of native fauna in the terrestrial, freshwater and estuarine environments.

Issues Summary

The native fauna occurring in the catchment is integral to many of the recreational pursuits that occur along the creek.

At the same time, the maintenance of the freshwater fauna is critical to the continued success of biological control of mosquito breeding.

3.5.1 DISCUSSION

Several of the recreation activities enjoyed within the Rapid Creek catchment rely on the presence of a healthy native fauna. Fishing in both the freshwater and estuarine environments depends on a healthy fauna throughout the food chain. Other activities, such as walking, relaxing and bird watching benefits significantly from the presence of bird life, reptiles, mud crabs, jumping fish and the like.

In the evenings the dispersal of the large bat colony roosting in the mangroves opposite the Water Gardens is an exciting sight, and very satisfying to many residents as evidence of a healthy environment. Finally, as discussed in Section 2.1, the maintenance of a healthy freshwater fauna in the middle and upper reaches of the creek is critical to mosquito control in the area. The loss of this fauna would be accompanied by a rapid increase in mosquito breeding, leaving the only option available for mosquito control to be engineering and chemical solutions which would have severe impacts on those communities. Strategies for protecting and managing the native fauna are closely tied into the strategies related to Water Management (3.3) and Native Vegetation (3.4).

There is an opportunity to link Rapid Creek to the extensive habitat areas of Casuarina Coastal Reserve. Revegetation to restore the dune communities along Casuarina Beach would result in a valuable link.

Introduced species are also a threat to the native fauna (and vegetation communities). Previously, buffalo and pigs have been a problem in the upper catchment, but this now seems to be under control although there is some evidence of pig activity upstream of the flood mitigation weir. The major threats now are domestic and feral cats and dogs. Strategies directed at educating owners and removing stray animals will need to be implemented. Darwin City Council are presently investigating options relating to cats. They should consider their impact on native species during the course of their deliberations.

3.5.2 PRINCIPLES

- Adopt and implement strategies as described in Sections 3.3 and 3.4, that will protect native fauna and reduce negative impacts. Pursue regeneration and vegetation strategies to extend and protect habitats.

- Develop strategies to reduce negative impacts of domestic and feral animal populations.

3.6 LANDSCAPE CHARACTER

Aims

To strengthen the visual identity of the creek, emphasizing its natural characteristics.

To maximise opportunities for the public to appreciate the visual qualities of the creek from within and without the corridor.

Issues Summary

The creek corridor has an established natural character and this is significant in the developed areas of the catchment. The natural character should be reinforced through regeneration and revegetation programmes that will firmly establish the creek as an important landscape feature within the urban context.

The upper areas of the creek have limited access and there is little indication from surrounding areas of the creek's extent. Visual links through these areas and across other barriers, such as roads and areas where the creek is constricted, are important in identifying the creek in its entirety.

3.6.1 DISCUSSION

Rapid Creek has maintained significant areas of native vegetation along its entire course. Some of this vegetation is under threat from various impacts and there is clear evidence of degradation. Despite this, the creek continues to be identified as a natural system within Darwin's urban fabric. In developing areas, and perhaps more so in the tropics, this link with nature is important. A strong landscape character established along the creek course is a valuable visual resource and extends the recreational value of the creek corridor.

Establishment and maintenance of the indigenous tree canopy is an integral aspect of reinforcing the natural character. Strategies for regeneration and revegetation as described in Section 3.4 will be utilised.

The natural character of the creek corridor could be extended through the catchment, particularly in those areas which retain visual links with the corridor itself. A programme of street tree planting that makes use of indigenous tree species from the woodland and monsoon communities will improve the amenity of the residential areas as well as strengthen the overall natural character. Where roads cross the creek corridor, planting should clearly announce the presence of the creek. The adoption of revegetation, regeneration and street tree planting strategies will establish a strong visual link and further understanding in the community of the creek corridor over its entire length. A broader appreciation of the different communities and their place in the system is to be engendered.

At the smaller scale, attention to design detail and use of a selected palette of materials provides a consistency and readily recognizable identity to the Rapid Creek open space system.

3.6.2 PRINCIPLES

- Strengthen the visual identity of Rapid Creek as a prominent natural landscape feature by undertaking a judicious planting programme, along its route and within the catchment, that utilises indigenous species.

- Introduce a consistent vocabulary of construction materials and treatments common to all elements of the creek system.

- Improve open space address and access points through good planning and design, incorporating appropriate planting and selected materials.

Planting and landscape works can strengthen the existing natural character of the creek.

3.7 RECREATION

Aims

Enhance recreation opportunities within public reserves along Rapid Creek which are compatible with the low key, passive nature of the resource and the sentiment of local residents.

Recreation must be compatible with the continued protection of the natural character and systems.

Issues Summary

Present recreational use of the creek corridor is predominantly low key, passive use, that relies to a large extent on the natural character of the area. Levels of use vary greatly, commonly reflecting the ease of access and type of facilities provided.

Some areas, while under-utilised, are degrading due to uncontrolled access and lack of facilities.

There are opportunities to enhance recreation within the creek corridor, so that the resource is protected. An important aspect of the recreational activities should be education and interpretation of key elements of the creek and vegetation.

3.7.1 DISCUSSION

The areas of open space within the Rapid Creek Corridor are extensive, and present use is reasonably well dispersed throughout. The facilities provided cater for the passive activities of picknicking, relaxing, sunset viewing and movement orientated activities such as cycling, walking and jogging. Facilities for active, organised sports are located within Northlakes, Marrara Sports Complex and the ovals adjacent to Lakeside Drive.

Other important activities within the catchment include swimming, fishing and horse riding, and apart from access, limited provision is made for them.

Facilities for passive recreation are limited to the Darwin Water Gardens and the parkland adjoining Rapid Creek Road. In respect of level of maintenance, these facilities enjoy high levels of usage. This is particularly so in the area of the mouth and Casuarina Coastal Reserve. (Brown *et al*, 1987).

Other sections of the creek corridor have the potential to provide for the local recreational demand, but require minimal facilities to enhance the recreational experience and to control degrading impacts. Where facilities are absent, littering, soil degradation and damage to plant communities is evident.

- **Site Specific Recreation Issues**

Marrara Swamp and Headwaters

This area receives very little recreational use, but unfortunately, much of this is destructive. Motorbike and BMX riders are regular users of the area. Their activities result in erosion, the proliferation of tracks and litter. It is also believed they are often the cause of uncontrolled fires in the area. The area is also marked by the dumping of fill and rubble,

household rubbish and car bodies. Other activities in the area include walking and exercising of dogs by nearby residents, including those from the adjoining Caravan Parks. These low key activities are compromised by noise and reduced visual amenity resulting from the motorbike and BMX riders. The area is zoned open space and has recently come under the control of the RAAF. Future use of the area will likely alter as a result. Opportunity exists to protect this critical area of the catchment and provide for limited passive recreation and education. The informal viewing area at the south eastern end of the airport, off Amy Johnson Avenue, is periodically a popular location for viewing the airforce operations. The open, dusty expanse is unsightly and would contribute to sediment loads in the southern arm of the creek.

Riverine Monsoon Forest

The monsoon forest, stretching in a narrow corridor from the Darwin Water Gardens to the flood mitigation weir is popular for swimming, fishing and camping. While the present level of use is low, the uncontrolled nature of the activities has resulted in sever degradation, evident in bank destabilisation, soil erosion, loss of vegetation and unsightly litter. The area requires the provision of limited facilities to control access, and protect the resource. Given the susceptibility of the area to erosion, and the long vulnerable edge, any development should be planned and designed to limit level of usage and provide discrete pedestrian entry / access points to the creek itself that are suitably hardened. This area would benefit from the provision of a shared path linking to the open space areas downstream.

The open space resource in this area is divided into two separate portions. A corridor between McMillans Road and Henry Wrigley Drive, and extending from Charles Eaton Drive to approximately 150 metres on the NE side of the creek (Prop Sec 4295) was recently vested with Darwin City Council as part of the NT Governments and Councils 1990 agreement over rationalisation of functions. The remaining triangular portion between McMillans Rd and Henry Wrigley Drive (Prop Sec 4294) would be a logical extension to the monsoon forest and would serve as a valuable buffer zone and educational resource. A formal approach to the NT Government would be required to allow incorporation of this portion into the open space resource.

RAAF Grounds

The RAAF grounds are closed to public access and their only recreational role is presently a visual one. Management of the creek however, does impact on recreational use downstream through the maintenance of water quality for fishing and swimming.

Opportunities do exist to provide limited access in a manner that recognizes the linear nature of the creek corridor. A shared path along the northern boundary, in the area of the northern arm would provide a continual link, and a major recreational route from the suburbs of Karama and Malak to Casuarina Coastal Reserve. Such a proposal would require concessions from RAAF in making land available and relocation of security fencing.

Darwin Water Gardens

The Water Gardens are an important recreation area, centrally located close to major residential areas and the monsoon and mangrove communities. The facilities provided are comprehensive, with a range of passive activities well catered for. Unfortunately, poor planning and design has meant the full recreational opportunity of the area has not been realised. An information centre in the gardens could be a focus linked to interpretative walks leading out to the nearby communities.

Casuarina Coastal Reserve

The reserve is managed by the Conservation Commission and has a current management plan. The areas of mangroves and the coastal dune system enjoy significant levels of passive recreation. Access to the mangroves is not formalised and demand for such facilities are low, restricted to local fishers. An unformed area of fill, adjacent to the drainage line from the University, is used by pedestrians, cyclists and occasionally vehicles to gain access to the creek. This offers a good opportunity for controlled access to the area, but will require upgrading.

The dune area is more a movement area, with the creek mouth and the beach itself being the focus for recreation. Opportunity does exist to develop low key facilities in the cleared area behind the dunes, and interpretative information would be valuable for this area and the mangroves.

Parkland adjoining Rapid Creek Road

The parkland is heavily used downstream of Trower Road with walkers, joggers, cyclists and skaters using the shared path that links with the Rapid Creek footbridge, residential areas and other open space areas. The current landscape treatment is scattered trees, palms and cycads within large grassed (occasionally) irrigated areas. The edge to the mangroves contains weeds and naturalised tree species. Apart from the shared pathway, there are few facilities and the area serves little recreational function. The opportunity exists to enhance the recreational use of the area, including visual amenity, reduce weed problems, and rationalise existing maintenance programmes. Revegetation and 'pocket parks' that relate to a particular natural feature or intended use should be pursued.

Access and circulation is critical in optimising recreational use.

Many recreational activities depend on the proximity to the creek, coast and natural areas.

3.7.2 PRINCIPLES

- Generally facilitate recreation opportunities along the creek corridor by developing facilities that are compatible with the sentiment of local residents and cognizant of the environmental capability.

- Develop a network of shared pathways that link the length of the creek with other open spaces and residential areas.

- Adopt the following site specific principles to enhance recreation opportunities:

  - *Marrara Swamp and Headwaters*
    Discourage inappropriate use of the area and undertake strategies to rehabilitate degraded areas. Pursue opportunities for providing restricted access onto RAAF land for passive recreation and education.

  - *Riverine Monsoon Forest*
    Restrict vehicle access to the area and provide for more formalised pedestrian access. Pursue opportunities to rationalise existing management of the area. Undertake revegetation and regeneration of the forest and adjacent transition communities. Cater for appropriate, passive recreation at the existing low levels. Promote 'visibility' of the area to reduce the incidence of degrading activities such as fire, littering and trampling.

  - *RAAF grounds*
    Encourage the co-operation and assistance of RAAF to incorporate appropriate land management practises to protect and enhance the indigenous vegetation. Pursue opportunity to provide a shared pathway link along their northern boundary.

  - *Darwin Water Garden*
    Encourage greater use levels / opportunity for recreation within the Gardens. Develop area as a focus for information and interpretation of the entire creek system, including paths linking to the mangrove and monsoon forest communities.

  - *Casuarina Coastal Reserve*
    Maintain the current low key passive use but extend the recreational opportunities to more fully use the hind dune area and interpret the dune and mangrove communities while restricting access to them. Discourage active use and control vehicle access.

  - *Parkland Adjoining Rapid Creek*
    Enhance the natural character of the corridor through revegetation. Pocket parks that relate to particular natural features or intended uses should be developed to complement the movement corridor and to optimize recreational opportunities.

3.8 MANAGEMENT

Aims

To extend public land and rationalise existing management structures. To maintain the land in a manner which sustains and enhances the dominance of the natural communities while enabling an appropriate level of recreational use.

Issues Summary

The various areas of the catchment are managed for different outcomes. Some areas well suited for recreation / education / interpretation are excluded from the public domain (RAAF, FAC lands).

Management of the Rapid Creek catchment should be initially directed at protecting the natural resources of the system, and secondly in consolidating those same resources while incorporating appropriate recreational opportunities. The existing open space areas do receive a significant level of maintenance, but with some modifications and clearer directions, the standard and character of the reserves could be improved substantially.

3.8.1 DISCUSSION

Maintenance of the open space areas throughout the catchment varies according to the priorities, procedures and needs established by the different authorities.

Conservation Commission, Darwin City Council, Northern Territory University, Federal Airports Commission and RAAF are all responsible for significant areas of open space along the creek corridor. The type of land they mange and the intended use is the prime consideration in determining the maintenance programme. Tasks are dominated by grass control, be that slashing, regular mowing or burning of natural areas. Weed control is required in all areas but is evidently inadequate, and only undertaken in an ad hoc fashion. The lack of follow up treatment and expertise in carrying out the work, therefore, results in only marginal or even questionable long term improvement in the weed problem. Revegetation and planting works often lack clear purpose and with limited resources have been only marginally successful to date. Public ownership of reserves could be extended to include valuable input from local residents and volunteers in maintenance and management of the resource.

Establishment of a Catchment Management Trust may be the appropriate management option to encourage a broader input from residents. Such a trust would be able to avail itself of various funding sources and a broad base of capital, plant, labour and technical advice from the various authorities.

Management of the catchment must also address the issues of urban stormwater and the negative impacts it can have on the natural systems and recreational use of the creek.

3.8.2 PRINCIPLES

- Review management practises of the various authorities and encourage them to adopt programmes and strategies that will maintain and enhance the natural communities.

- Ensure management programmes are cost effective and achievable, taking a long term view on issues of recreation and weeds.

- Pursue the establishment of management bodies that involve the public in management of the resource.

- Encourage education programmes that inform the public on the impacts of their activities on the creek.

Management practices must recognise the ecological systems of the different vegetation communities.

4. CONCEPT PLAN

By adopting design and planning principles identified through the analysis of the Rapid Creek catchment above, a detailed plan can be developed that accurately reflects both immediate opportunities and long term responsibilities in the protection and rehabilitation of the creek.

Although the area of the creek catchment is relatively small, the extent of principles that must be respected and the breadth of issues which must be matched with management underlines the complexity of an urban creek system. It is necessary, and helpful, in such cases to express the intent of the management plan as a simple concept prior to considering the strategies required to bring it into effect.

The **Concept Plan** for Rapid Creek envisages a central corridor of rehabilitated bushland that is legible from surrounding areas. The creek will retain its natural character and ecological roles, and become a valuable natural asset in its urbanized catchment. (Refer Figure 4.1).

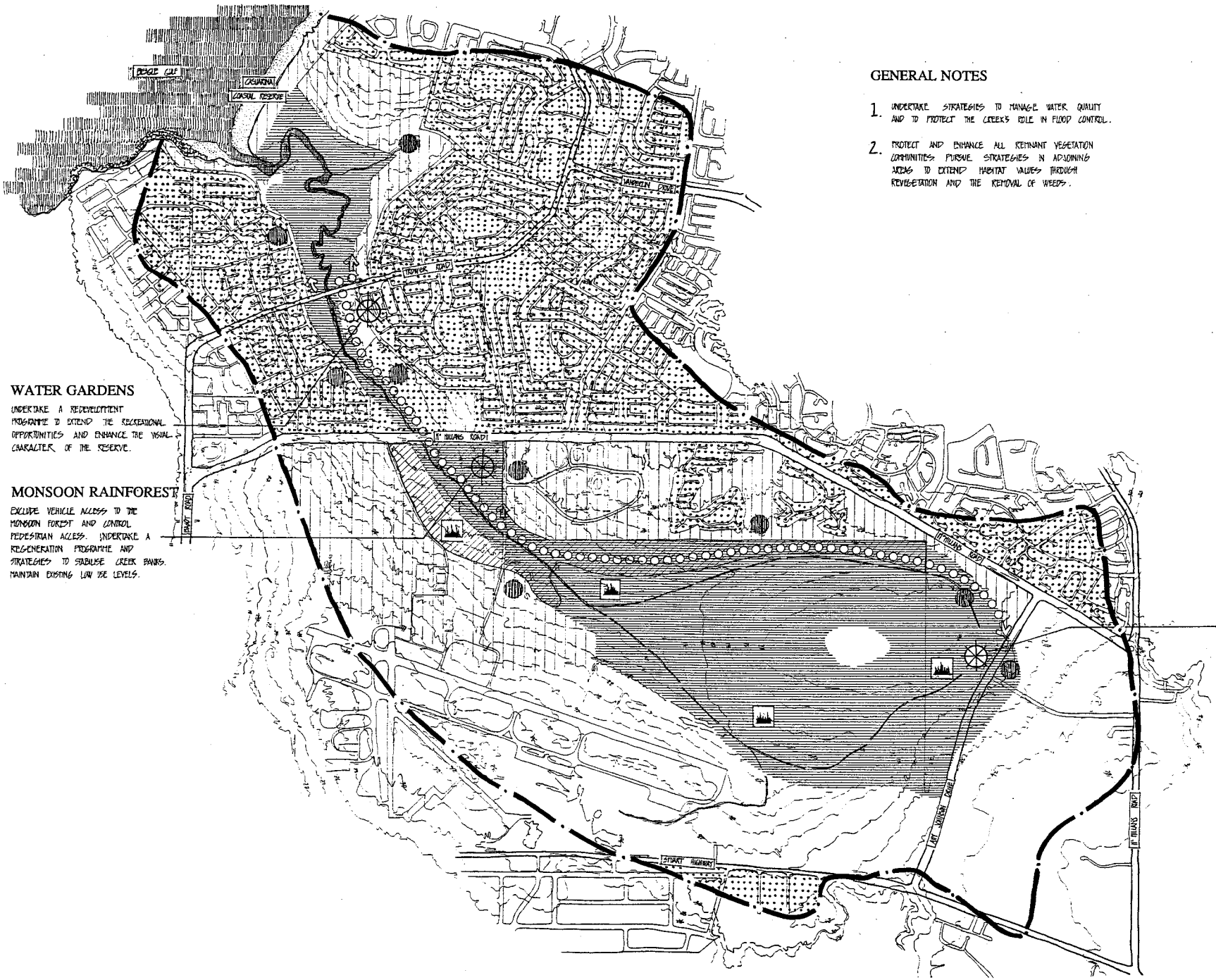
Opportunities to optimise recreational activities in the creek, will be pursued. The type of activities to be catered for will be low key and passive in keeping with the natural character of the creek and the sentiment of the local community. The corridor should be viewed as a single open space resource and with varying levels of use and access depending on the capability of the natural systems. The linear nature of the creek corridor will be emphasised and the provision of a secure, all weather pathway linking the headwaters at Marrara Swamp with the creek mouth will be an important component.

The concept promotes effective management and maintenance that is directed primarily at protecting and enhancing the natural systems, and secondly at providing for compatible recreation. The local community will be encouraged to participate in the management and maintenance of the creek.

Beyond the creek corridor the Plan relies on strategies related to planting, water quality and runoff management, community education and development control to extend the direct strategies for protection and rehabilitation.

In all this, the Concept Plan is seen as a consideration of three fundamental criteria in planning, namely **feasibility, desirability** and **affordability**, but remains a challenging and exciting proposal that will contribute to the landscape quality of Darwin.

CONCEPT PLAN
Figure 4.1



GENERAL NOTES

1. UNDERTAKE STRATEGIES TO MANAGE WATER QUALITY AND TO PROTECT THE CREEK'S ROLE IN FLOOD CONTROL.
2. PROTECT AND ENHANCE ALL REMNANT VEGETATION COMMUNITIES. PURSUE STRATEGIES IN ADJOINING AREAS TO EXTEND HABITAT VALUES THROUGH REVEGETATION AND THE REMOVAL OF WEEDS.

LEGEND

- REVIEW EXTENT OF EXISTING OWNERSHIP WITH THE AIM OF INCREASING PUBLIC OWNERSHIP AND IMPROVE COMPATIBILITY OF MANAGEMENT PRACTICES.
- SPECIFIC RECREATION / MANAGEMENT AREA. REFER NOTES ON DRAWING.
- SHARED PATHWAYS / CYCLEWAYS WHICH LINK UP WITH EXISTING PATHWAYS
- UNDERTAKE A COMMUNITY LIASON PROGRAMME AND PROVIDE INFORMATION ON THE CREEK AND ITS NATURAL SYSTEMS. INFORM RESIDENTS AS TO HOW THEY CAN REDUCE NEGATIVE IMPACTS ON THE CREEK. PROMOTE POSITIVE ACTIONS AND APPROPRIATE USE OF THE CORRIDOR.
- CENTRAL CORRIDOR OF REMNANT VEGETATION TO BE REHABILITATED IN ORDER TO STRENGTHEN THE VISUAL PERCEPTION OF THE CREEK AS A VALUABLE ECOLOGICAL AND EXPERIENTIAL NATURAL ASSET.
- STRATEGIES TO IMPROVE WATER QUALITY
- ENHANCE HABIT CONSERVATION STATUS AND VISUAL VALUES OF RESERVES AND SPECIAL USE AREAS.
- DEVELOP A FIRE MANAGEMENT PLAN FOR THE VARIOUS VEGETATION COMMUNITIES GIVING CONSIDERATION TO THE ECOLOGICAL ROLE OF FIRE.
- CATCHMENT BOUNDARY

WATER GARDENS

UNDERTAKE A REDEVELOPMENT PROGRAMME TO EXTEND THE RECREATIONAL OPPORTUNITIES AND ENHANCE THE VISUAL CHARACTER OF THE RESERVE.

MONSOON RAINFOREST

EXCLUDE VEHICLE ACCESS TO THE MONSOON FOREST AND CONTROL PEDESTRIAN ACCESS. UNDERTAKE A REGENERATION PROGRAMME AND STRATEGIES TO STABILISE CREEK BANKS. MAINTAIN EXISTING LOW USE LEVELS.

MARRARA SWAMP

EXCLUDE PUBLIC ACCESS FROM THE SWAMP, EXCEPTING EDUCATIONAL VISITS. FORMULATE STRATEGIES TO PROTECT WATER QUALITY AND PROMOTE REGENERATION OF THE PAPERBARKS.

RAPID CREEK
MANAGEMENT STUDY

CLOUSTON

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4.1 MANAGEMENT STRUCTURE FOR RAPID CREEK

In other States of Australia, management plans of this type would be prepared for, adopted, administered and implemented by Local Government as identified in the relevant Local Government Act. Such legislation is not available in the Territory, and the Local Government has minimal planning powers. Given the existing situation and the diversity of landholders, stakeholders and other groups with an interest in or responsibility for open space within the catchment, it would appear that the preferred direction, in a planning context, would be the establishment of a management body, comprising representatives from NT Government, Darwin City Council, the general community and landowners. Such a body may take various forms. One possible model, which is worthy of detailed investigation is that of a Catchment Advisory Committee. A fuller description of a possible structure and terms of reference for such an follows. It is based on Total Catchment Management as prepared and used by the New South Wales Government (Refer Appendix 4).

RAPID CREEK CATCHMENT ADVISORY COMMITTEE

Catchment management is concerned with providing management direction for a catchment and having everybody within a catchment consider the impact of their activities on others and on the catchment itself. The important features of catchment management that will assist in sustainable use of resources and protect and rehabilitate Rapid Creek are:

- Co-operation between government and the community
- A co-ordinated approach to natural resource management
- Consideration of the impacts activities have on the creek
- An understanding of the ecosystems within the catchment
- Community involvement in identifying priorities, developing programmes, and implementing strategies and actions

The Rapid Creek Catchment Advisory Committee would be responsible for adopting and implementing the Plan as described here. The Committee will use this guidance to set up a 10 year programme for actions defined in these strategies, based on the level of urgency, the opportunity, achievability and a financial strategy. This programme would then be reviewed annually to assess progress and any required amendments.

The Catchment Advisory Committee would be established under the appropriate Legislation. The Committee would be established at the recommendation of the Minister for Conservation and Tourism and would act as a corporation which can raise revenue. The formation of the Committee must have the clear support of the various land holders, management authorities and the community.

The Catchment Advisory Committee would consist of trustees, appointed by the Chief Minister on the recommendation of the responsible Minister. The trustees will include:

- landholders or landusers within the catchment area, who are to constitute the majority of the trustees;

- persons from the community and environmental groups who in the responsible Minister's opinion have an interest in environmental matters within the catchment area;

- persons who are officers of government departments or authorities having responsibility for natural resource use or management within the catchment area.

The Catchment Advisory Committee would be responsible for the total catchment management of the creek. The Committee may:

- provide, construct, operate, manage and maintain works and buildings;

- purchase, exchange, take on hire or lease, hold dispose of, manage, use or otherwise deal with real or personal property;

- enter into contracts, including consultancy contracts;

- enter into cost sharing or other arrangements in connection with the carrying out of works;

- exercise any other functions that relate to the purpose of protecting and managing the natural resources of the catchment.

As described above the Catchment Advisory Committee will prepare a Corporate Plan, based on this Management Plan, to guide the implementation the catchment management strategies and programmes.

An option for generating revenue may be via a levying system applied to all landowners within the catchment. Such an approach is likely to be controversial and would clearly require further analysis and public consultation. The Committee would levy a catchment contribution on any land within the catchment area. All such monies would be available for funding programmes under the approved Corporate Plan. It is important to ensure that the rates levied equitably reflect the degree of benefit likely to accrue to land within the catchment area. The basis for the levy catchment contributions may be one or more of the following:

- land value of the land;

- the area of the land;

- the degree of benefit that accrues to land as a result of the Trust's programmes.

Ownership of the land would remain with the landowner, apart from particular instances where the Trust may assume control of Crown Land where this would rationalise management operations (Refer Section 5.3). Day to day maintenance and management of the land resource would remain with the property owner.

MANAGEMENT COMMITTEE TO COUNCIL

The alternative to the Catchment Advisory Committee would be the establishment of a Management Committee to Council, as provided for under the Local Government Act. While such a committee would have a similar role to that of the Trust, their terms of reference would be restricted. The Management Committee would not have the authority to raise revenue, or allocate funds and resources to particular programmes or projects. The integrity of the Management Plan and implementation of the proposed strategies requires continuity and commitment over many years. Changes within Council (Councillors, Council staff, resources and priorities) have the potential to seriously compromise the long term implementation programme.

5. CATCHMENT STRATEGIES

INTRODUCTION

The following section describes in detail the strategies that derived from the development of planning and management principles for Rapid Creek.

The strategies are intended to provide clear guidelines for the future planning, design and management of the creek.

STRATEGIES

The strategies are collated under three common headings and should be read in conjunction with the corresponding drawings:

- *Water Management and Habitat Conservation* (refer Figures 5.1 and 5.2)
- *Recreation, Access and Landscape Character* (refer Figure 5.3)
- *Open Space Planning and Management* (refer Figure 5.4)

ROLE AND RESPONSIBILITIES

Under each heading the specific strategies are documented in detail with a corresponding indication of the parties that should be responsible for implementation or further development. Explanations of abbreviations used are provided below.

PRIORITIES AND OPPORTUNITIES

At the end of each strategy, an abbreviation in bold letters indicates the *priority* and *opportunity* for implementation. This is based on a combination of the urgency of implementing the strategy and the opportunity to do so. Thus, whilst an action may be urgent, the opportunity to implement it immediately may be precluded by lack of opportunity (e.g. land unavailable).

The first letter represents *priorities*
H high (requires action as soon as possible)
M medium (requires action in the short to medium term)
L low (not urgent but should be undertaken as part of the programme)

The second letter represents *opportunity*

N achievable now (can/should be undertaken in years 1-2)
S achievable soon (can/should be undertaken in years 2-5)
E achievable in the long term (can/should be undertaken in years 5-10 or later)
X achievability dependent on workforce, budget and an agreed programme

Thus by way of example:
H/N action can and should be undertaken now or within the next 2 years
H/E action should be undertaken as soon as the constraint is removed
M/S action should be taken in years 2-5
L/N action can be taken now but is not a high priority.

ABBREVIATIONS FOR STAKEHOLDERS AND INTEREST GROUPS

AAPA	Aboriginal Areas Protection Authority
ATCV	Australian Trust for Conservation Volunteers
DCC	Darwin City Council
DEF	Defence
DIA	Darwin International Airport
DLPE	Department of Lands, Planning and Environment
ECNT	Environment Centre NT
FN	Field Naturalists
FRS	Fire and Rescue Service
GANT	Greening Australia NT
KAB	Keep Australia Beautiful
NGC	Northlakes Golf Course
NTU	Northern Territory University
PAWA	Power and Water Authority
PWCNT	Parks and Wildlife Commission of the Northern Territory
RCCAC	Rapid Creek Catchment Advisory Committee
RCLG	Rapid Creek Landcare Group
TENPS	Top End Native Plant Society
THS	Territory Health Services
TW	Transport and Works

5.1 WATER MANAGEMENT AND HABITAT CONSERVATION

5.1.1 WATER MANAGEMENT

(To be read in conjunction with Figure 5.1)

Manage water in Rapid Creek in a manner compatible with its landscape/bushland context and to provide a high quality water as an integral aspect of the natural systems, pursuing the following strategies in conjunction with all other strategies listed elsewhere:

Generally

Establish links with adjoining major landholders and interest groups. Agree common strategies on water management and integrated water management planning and design. Concentrate on upstream influences and downstream effects. **(H/N)**	Govt Departments/ Authorities/ Community Groups **RCCAC**
Develop a catchment management plan for Rapid Creek having consideration to total catchment management. **(H/N)**	Govt Depts Authorities Community Groups **RCCAC**

Information and Management Advice

Undertake a community liaison programme informing residents of the need to reduce nutrient inputs into the stormwater and creek system by encouraging them to: - reduce fertilizer inputs and prevent runoff - undertake washing of vehicles, boats etc on lawns rather than the streets - stop dumping of garden wastes into drainage lines Furthermore, inform residents of the negative impacts of low flows from the stormwater system into the creek and advise on actions to prevent this. **(H/N)**	DCC **RCCAC**

Water Quality

Improve and maintain water quality by:

- Establish a monitoring program that extends that done by DIA and PAWA between 1990 and 1993. Determine application role of Waterwatch and similar community based prgrammes to include monitoring in the area of the Rapid Creek mouth and at the major inlet points to the upper catchment. **(H/N)**	Community Groups PAWA
- Investigating the need for gross pollutant traps at stormwater inlets to remove litter and coarse to medium sediments. **(M/N)**	DCC DIA/DEF PAWA
- Establishing vegetation filter strips (minimum 5 metres wide) where possible incorporating low profile mounding in Northlakes Golf Course, Marrara Sports Complex, DIA, DEFENCE and in other developed park areas. **(M/N)**	NGC DIA DEF DCC NTU
- Undertake a joint review of the water quality monitoring and assess success of other programmes on a yearly basis. Amend or extend programmes as required. **(M/N)**	DCC DIA/DEF PAWA **RCCAC**

Creek Stability

Improve creek stability by implementing rock armouring at critical locations identified. **(M/N)**	PWCNT DCC

Erosion Control

Undertake erosion control measures and prevent sediment runoff from all building and development sites in the catchment. **(H/N)**	Govt Depts DIA Authorities DCC
Stabilize any eroding areas at the outlets of all stormwater drains. **(M/N)**	DCC

Flooding

Reduce the potential for increased flooding in the catchment by:	
- undertaking detailed flood impact assessment as it relates to any development proposals within the catchment (on-going) **(H/N)**	DLPE
- maintaining wetlands and slow flow areas in upper catchment in the present undeveloped state **(H/N)**	DEF
- removing choking weeds and debris from creek below McMillans Road as part of an on-going maintenance program **(M/N)**	DCC

5.1.2 HABITAT CONSERVATION
(To be read in conjunction with Figure 5.2)

Conserve the natural systems of Rapid Creek catchment in a manner compatible with the natural attributes, pursuing the following specific strategies:

Vegetation Management

Manage the remnant vegetation communities and adjoining open space to optimise their habitat and ecological values through the following actions:

- Consolidate and expand healthy remnant bushland areas into areas that are degraded. Stabilize degraded areas and undertake spot removal of highly invasive weed species (eg *Mimosa pigra*). Undertake all works by applying regeneration and revegetation techniques as described in 3.4 **(H/X)**	Govt Dept Authorities Community Groups **RCCAC**
- Implement a weed control programme for gradual removal of all weed species from remnant vegetation, based on regeneration/revegetation techniques and incorporating other actions described here. This can be undertaken concurrently with the action above but should not precede them **(H/X)**	Govt Dept Authorities Community Groups **RCCAC**
- Install a formal boundary/maintenance edge between cultivated grass areas and bushland areas (eg shared pathway) **(M/S)**	DCC PWCNT DIA NTU DEF
- Rationalise existing open space along Rapid Creek Road and Lakeside Drive and undertake revegetation using indigenous species where appropriate **(L/N)**	DCC NTU
- Implement a programme of tree and shrub planting in open space areas that uses plant material that will provide habitat value to native fauna **(L/N)**	Govt Depts Authorities Community Groups

RAAF Base

Greening Australia, DCC and PWCNT to liaise with the Defence in preparing a detailed conservation plan, incorporating the strategies described here, for protecting the upper catchment **(M/N)**	DCC PWCNT GANT DEF **RCCAC**

Fire Management

Develop a fire management strategy and plan for the different vegetation communities as described in 3.4, and implement the plan **(H/N)**	PWCNT DCC GANT FRS DEF **RCCAC**

Human Resources

Establish formal planning meetings between management authorities maintenance contractors and volunteers to co-ordinate habitat conservation work in the catchment through the RCCAC. **(H/X)**	Govt Depts Authorities Community Groups **RCCAC**
Develop forward plans for the use of employment programme schemes **(H/X)**	DCC **RCCAC**

Nursery and Seed Bank

Establish indigenous seed bank and undertake collection of seed material from remnant vegetation in the catchment **(HN)**	DCC Community Groups
Establish a nursery as a community resource to support the propagation of locally indigenous species for regeneration revegetation and landscape treatments **(M/S)**	PWCNT DCC NTU Community Groups

Public Information / Neighbouring Residents

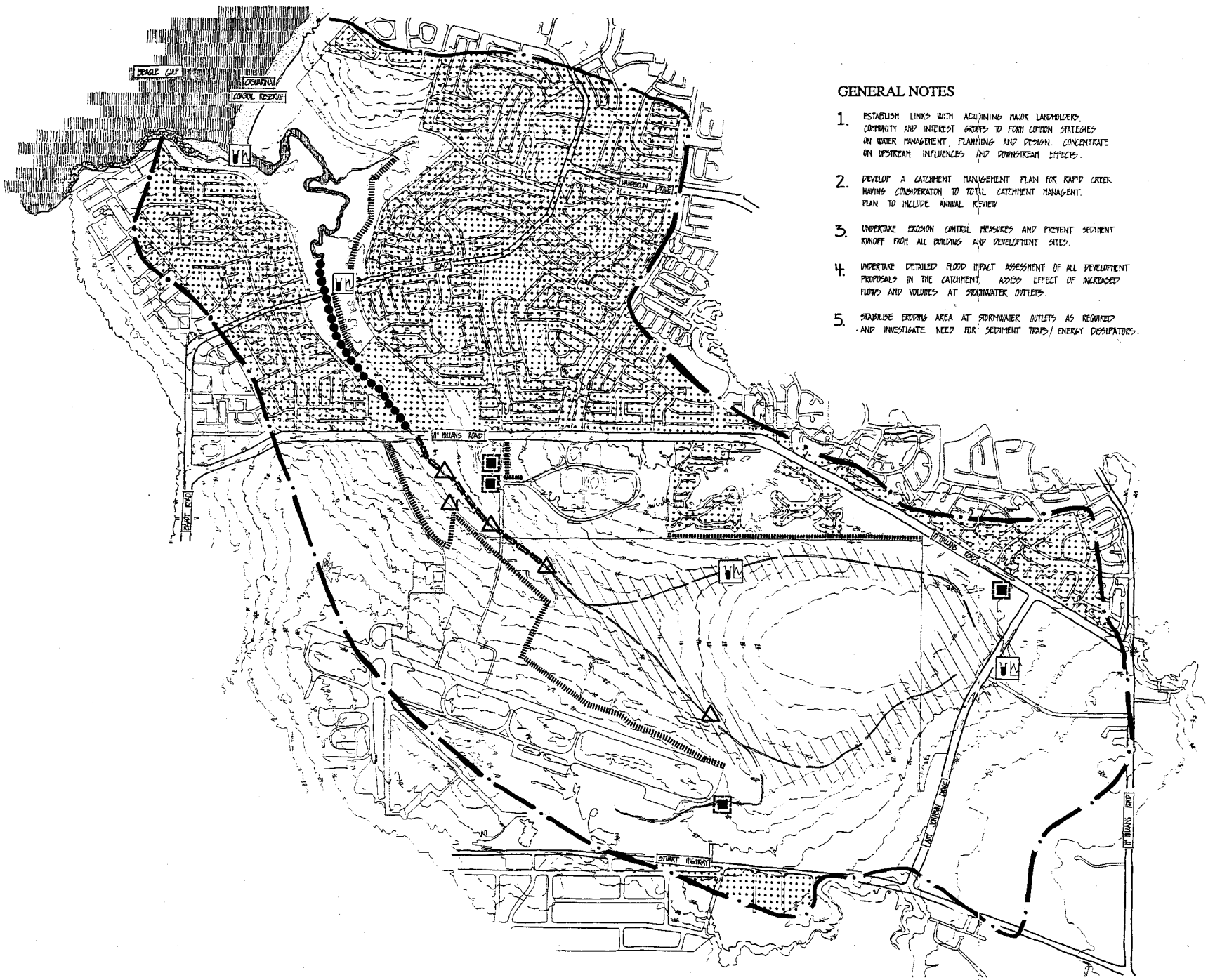
Establish an information brochure free to the public and circulated to local residents containing information on the conservation value of the creek, reasons for and locations of access and footpaths, and means by which individual property owners and Rapid Creek users may reduce negative impacts in the catchment **(M/N)**	DCC **RCCAC**

Fauna Study

Undertake formal fauna study or develop and co-ordinatea community based monitoring programme similar to that undertaken by Australian National Conservation Agency (Urban Wildlife Survey) **(L/N)**	PWCNT DCC Community Groups **RCCAC**

WATER MANAGEMENT

Figure 5.1



GENERAL NOTES

1. ESTABLISH LINKS WITH ADJOINING MAJOR LANDHOLDERS, COMMUNITY AND INTEREST GROUPS TO FORM COMMON STATEGIES ON WATER MANAGEMENT, PLANNING AND DESIGN. CONCENTRATE ON UPSTREAM INFLUENCES AND DOWNSTREAM EFFECTS.
2. DEVELOP A CATCHMENT MANAGEMENT PLAN FOR RAPID CREEK HAVING CONSIDERATION TO TOTAL CATCHMENT MANAGEMENT. PLAN TO INCLUDE ANNUAL REVIEW
3. UNDERTAKE EROSION CONTROL MEASURES AND PREVENT SEDIMENT RUNOFF FROM ALL BUILDING AND DEVELOPMENT SITES.
4. UNDERTAKE DETAILED FLOOD IMPACT ASSESSMENT OF ALL DEVELOPMENT PROPOSALS IN THE CATCHMENT. ASSESS EFFECT OF INCREASED FLOWS AND VOLUMES AT STORMWATER OUTLETS.
5. STABILISE ERODING AREA AT STORMWATER OUTLETS AS REQUIRED AND INVESTIGATE NEED FOR SEDIMENT TRAPS / ENERGY DISSIPATORS.

LEGEND

- COMMUNITY LIASON AND EDUCATION PROGRAMME INFORMING RESIDENTS ON IMPACTS OF NUTRIENTS AND OTHER POLLUTANTS WITH LOW WATER FLOWS ON THE HEALTH OF THE CREEK.
- RE-ESTABLISH FAUNA WATER QUALITY MONITORING.
- ADDITIONAL WATER QUALITY MONITORING.
- INVESTIGATE NEED FOR GROSS POLLUTANT TRAPS AT MAJOR DRAIN OUTLETS.
- IMPLEMENT STRATEGIES TO STABILISE BANKS AT CRITICAL LOCATIONS.
- CONSTRUCT VEGETATED FILTER STRIPS AS REQUIRED TO INTERCEPT AND FILTER OVERLAND FLOWS
- MAINTAIN WETLANDS AND SLOW FLOW AREAS IN UNDEVELOPED STATE TO PREVENT FLOODING.
- REMOVE WEEDS AND OTHER DEBRIS FROM CREEK CHANNEL
- CATCHMENT BOUNDARY

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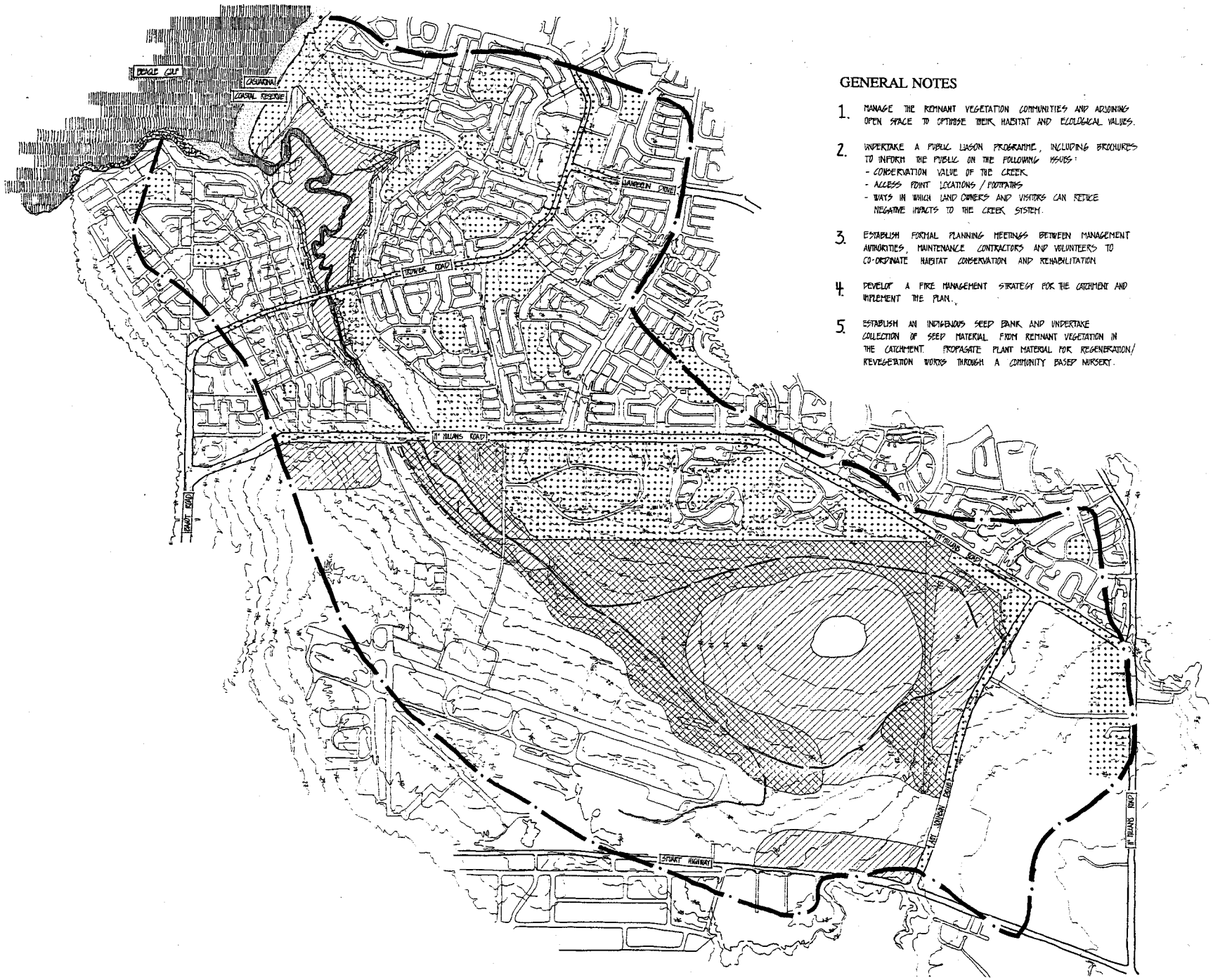
HABITAT CONSERVATION

Figure 5.2



GENERAL NOTES

1. MANAGE THE REMNANT VEGETATION COMMUNITIES AND ADJOINING OPEN SPACE TO OPTIMISE THEIR HABITAT AND ECOLOGICAL VALUES.
2. UNDERTAKE A PUBLIC LIASON PROGRAMME, INCLUDING BROCHURES TO INFORM THE PUBLIC ON THE FOLLOWING ISSUES:
   - CONSERVATION VALUE OF THE CREEK.
   - ACCESS POINT LOCATIONS / FOOTPATHS
   - WAYS IN WHICH LAND OWNERS AND VISITORS CAN REDUCE NEGATIVE IMPACTS TO THE CREEK SYSTEM.
3. ESTABLISH FORMAL PLANNING MEETINGS BETWEEN MANAGEMENT AUTHORITIES, MAINTENANCE CONTRACTORS AND VOLUNTEERS TO CO-ORDINATE HABITAT CONSERVATION AND REHABILITATION
4. DEVELOP A FIRE MANAGEMENT STRATEGY FOR THE CATCHMENT AND IMPLEMENT THE PLAN.
5. ESTABLISH AN INDIGENOUS SEED BANK AND UNDERTAKE COLLECTION OF SEED MATERIAL FROM REMNANT VEGETATION IN THE CATCHMENT. PROPAGATE PLANT MATERIAL FOR REGENERATION/ REVEGETATION WORKS THROUGH A COMMUNITY BASED NURSERY.

LEGEND

- CONSOLIDATE AND EXPAND HEALTHY REMNANT VEGETATION COMMUNITIES, INCLUDING SPOT REMOVAL OF INVASIVE SPECIES AND UTILISING REGENERATION/ REVEGETATION TECHNIQUES
- AS ABOVE; TOGETHER WITH WEED CONTROL PROGRAMME.
- RATIONALISE EXISTING OPEN SPACE AND UNDERTAKE REVEGETATION USING INDIGENOUS SPECIES WHERE APPROPRIATE.
- IMPLEMENT A PROGRAMME OF TREE AND SHRUB PLANTING IN OPEN SPACE AREAS OF HABITAT VALUE TO NATIVE FAUNA.
- FORMALISED BOUNDARY / MAINTENANCE EDGE BETWEEN CULTIVATED LANDSCAPES AND REMNANT VEGETATION.
- CATCHMENT BOUNDARY

RAPID CREEK
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5.2 RECREATION, ACCESS AND LANDSCAPE CHARACTER

(To be read in conjunction with Figure 5.3)

5.2.1 RECREATION AND ACCESS

Generally upgrade and enhance the Rapid Creek Corridor to encourage appropriate use and enjoyment of the creek for low key recreational activities. These strategies will ensure a heightened sense of community ownership and encourage greater casual surveillance and reporting of incompatible activities.

Bushland Generally

The primary concerns for remnant vegetation will be conservation (refer 5.1.2), however low key recreational use and access will be permitted as described below. The remnant vegetation will be monitored and details of use and access reviewed annually **(M/N)**	DCC PWCNT Community Groups **RCCAC**

The Gurambai Centre

As a demonstration project, and to serve as a focus for education and interpretation of the Rapid Creek environs, develop the Gurambai Centre, including vehicle access and parking, interpretive centre, walking paths and interpretive signage, dual-use pathway links, planting and rehabilitation. This proposal would be subject to the appropriate transfer of land, since portions of the site are presently under NT Government control and reserved for future use. (Refer to Figure 6.12) **(H/S)**	PWCNT DCC DLPE Community Groups **RCCAC**

Marrara Swamp

Public access to this important area will be excluded apart from strictly controlled guided visits for scientific and educational reasons.Interpretative information would be provided at the location shown. Extend security fence to prevent uncontrolled access **(H/N)**	**RCCAC** DEF

RAAF Base (between Marrara Swamp and flood mitigation weir)

For security reasons, public access to this area of the catchment would be excluded. However ,the NT Government should seek a lease arrangement for a portion of Defence land, along their northern boundary to provide for a shared pathway link from the lower to the upper catchment **(M/S)**

DLPE
DEF
RCCAC

Monsoon Rainforest

Instigate a programme of planning, design and management proposals to provide for limited recreational use of this area, without compromising the strategies outlined in 5.1. The following strategies will form part of such a programme:

DCC
Community Groups
RCCAC

- control vehicle access and provide for parking well clear of creek bank and monsoon rainforest. **(H/X)**

- provide shared pathway link through the area in an appropriate location to provide access and for service vehicles. **(M/S)**

- allow restricted access to the creek itself, for swimming, fishing and relaxing, in such a manner as to minimise degrading impacts and allowing for regeneration and revegetation as outlined in 5.1 **(H/X)**
- provide for boardwalk creek crossings above and below Henry Wrigley Drive in locations shown. **(M/S)**
- develop an information and interpretative centre in the location shown and provide interpretative trails out from this centre and linking with the major shared pathway **(M/S)**

Darwin Water Gardens

Upgrade the existing facilities to enhance the recreational value of this centrally located reserve and include the following proposals in the redevelopment programme:

DCC
RCCAC

- strengthen existing planting structure with use of indigenous plants where appropriate

- define the recreational spaces and provide visual link to mangroves by reprofiling western boundary

- investigate options for upgrading the water features themselves to a level suitable for swimming and develop a more sympathetic solution to safety fencing

- develop a major information / interpretation centre with trails linking to mangrove and monsoon rainforest when the level of use supports such expenditure **(M/X)**

Local Reserves

Improve the recreational potential of all local reserves by enhancing their landscape character to generate greater attractiveness for use (and thereby remove pressures from more sensitive areas) and modifying layouts to cater for a particular range of recreational pursuits. As a rule, only passive non-organised pursuits should be encouraged with some facilities for unstructured active recreation, if the reserve can accommodate them without compromising other users.

PWCNT
Community Groups
DCC
NTU

- Instigate a programme of improvement of seating, play equipment, shade trees, revegetation to extend bushland areas, and boundary planting definitions in the reserves fronting Rapid Creek Road, Casuarina Drive and Lakeside Drive **(L/X)**

Casuarina Coastal Reserve

- Instigate a programme of planning, design and management proposals for the reserve to provide for improved access and recreation facilities for the Rapid Creek Open Area, as described in the Casuarina Coastal Reserve Management Plan (PWCNT, 1991) **(L/X)**	PWCNT
- Provide for limited pedestrian access to the mangrove areas. facilities to be provided would include marked walking tracks, interpretative materials and possibly boardwalks. The area of mangroves to the north of Rapid Creek, zoned future determination in the Casuarina Coastal Reserve Management Plan (PWCNT, 1991) should be fully protected and utilised as an educational resource since it contains the richest diversity in the mangrove habitat **(H/N)**	PWCNT
- Upgrade existing access route along boundary with NTU, linking Alawa Sports Ovals with Casuarina Coastal Reserve and Brinkin **(M/X)**	PWCNT NTU

Play Equipment

Rationalise locations to avoid inappropriate provision or local over/under supply. Improve and extend equipment to meet varying age range needs and provide ancillary facilities, such as seating and drinking fountains wherever possible **(M/N)**	DCC

Access

Extend and improve access and circulation within the catchment for pedestrians and cyclists, and strictly control vehicle access, as described above. Improve the network by adopting the following strategies also:

- Develop a major shared pathway for the entire length of the catchment, linking the different vegetation communities with residential areas and other recreational areas. The major linear route will be complimented by cross links and circuit paths as appropriate **(M/X)**	DIA DCC DEF PWCNT **RCCAC**
- Establish a hierarchy of entrances appropriate to their location and level of use. Use design features and planting for identification of major entrances (entrance feature, directional signage and planting), secondary entrances (directional signage and planting) and minor entrances (planting) **(M/N)**	PWCNT DCC **RCCAC**
- In bushland areas identify incompatible access points and circulation routes that are leading to degradation and fragmentation. Close off such areas and incorporate regeneration/revegetation strategies as outlined in Section 5.1 **(H/N)**	PWCNT DCC DIA DEF **RCCAC**
- Maintenance and firebreak/ access routes should be easily and readily available to service and manage the open space resource. Ensure security of all such entry points by providing padlocked gates including at Casuarina Coastal Reserve, monsoon rainforest, Defence grounds and parks facing Lakeside Drive, Rapid Creek Road and Casuarina Drive **(H/N)**	PWCNT DCC DIA NTU DEF **RCCAC**
- Provide facilities, including paths, parking and lay back kerbs wherever possible to cater for access by the disabled and prams to the open space resource **(H/N)**	PWCNT DCC NTU DEF **RCCAC**

5.2.2 LANDSCAPE CHARACTER

Manage the creek corridor to enhance the existing natural character of the creek corridor by optimising existing landscape features and undertake all new development works based on a theme emphasising the natural qualities of the creek environment. All enhancement measures to be developed in concurrence with strategies described in Section 5.1. The specific strategies to include:

Generally

Manage the catchment as a coherent landscape element emphasising the linear, complete nature of the creek itself and identifying the discrete landscape character types and settings as identified in Section 2.2.1 and discussed in Section 3.6 **(M/N)**	PWCNT DCC DIA DEF **RCCAC**

Native Vegetation

Protect and enhance existing remnant bushland to strengthen natural character by incorporating strategies described in Section 5.1 **(H/X)**	PWCNT Community Groups DCC DIA DEF **RCCAC**

Entrances and Road Crossings

Heighten the sense of special place that the creek corridor constitutes to residents and local road users by strategies for entrances (see 5.2.1 Recreation and Access) **(M/N)**	PWCNT DCC DIA DEF TW **RCCAC**

Street Planting

Develop an integrated strategy for native street tree planting for streets within a minimum street block of the creek corridor emphasising the presence of the creek **(M/S)**	DCC TW
Undertake substantial boundary planting of native species to 'open' boundaries at: - Rapid Creek Road - Casuarina Drive - Freshwater Road - Lakeside Drive **(M/S)**	DCC NTU

Urban Design Vocabulary

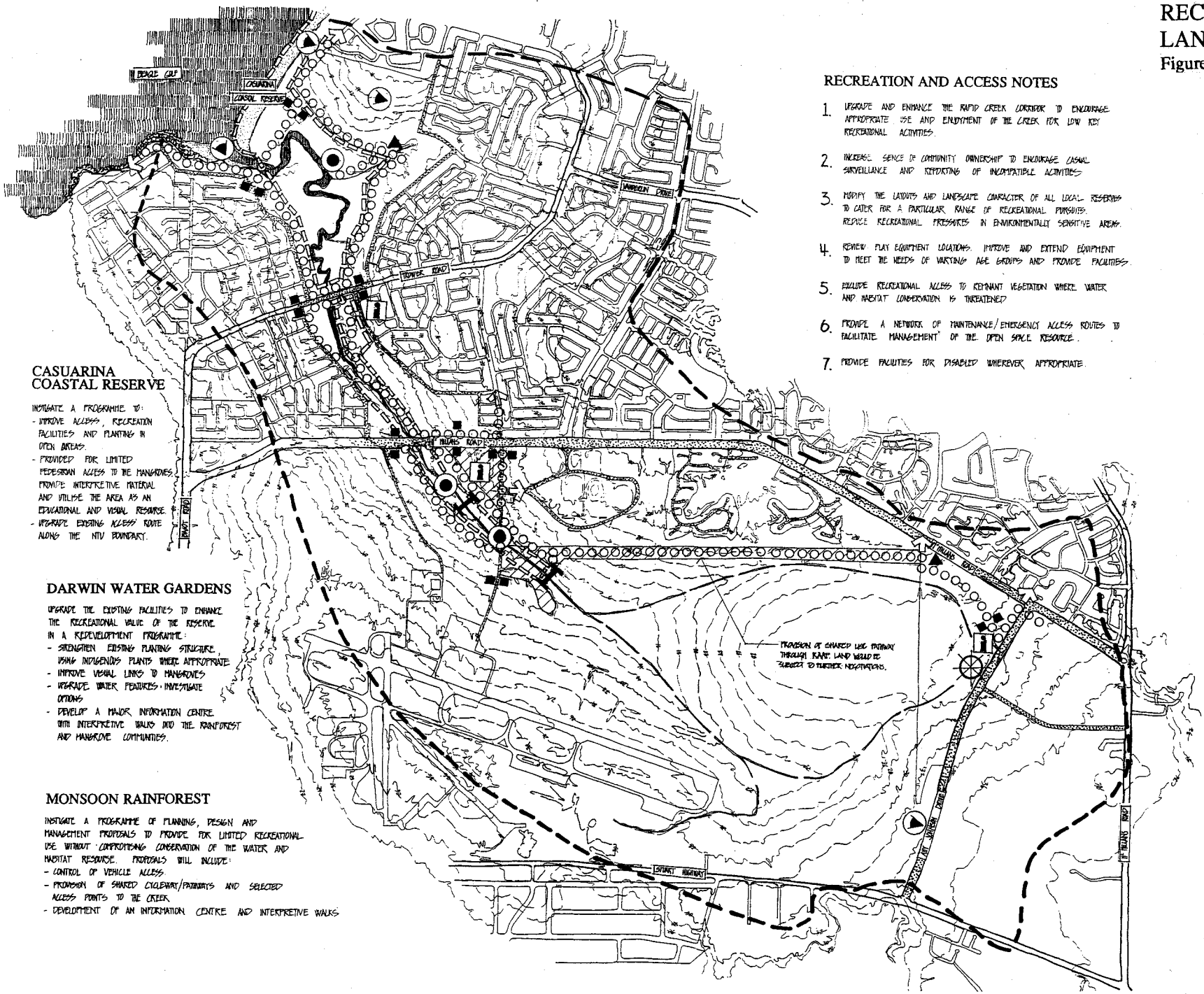
Establish a coherent design approach for all urban design elements in and bordering the creek corridor Make use of appropriate materials in keeping with the natural character of the creek. Elements to include: - Rapid Creek Logo - Signage and interpretation panels - Structures / construction - Paving and furniture **(H/N)**	PWCNT DCC NTU **RCCAC**

Visual Appreciation

Maintain existing vistas and views into and within the creek corridor, particularly long views at:	PWCNT DCC
- Casuarina Coastal Reserve along the beach and out from the footbridge	PWCNT
- down the runway from Amy Johnson Avenue	DEF
- high points within the Darwin Water Gardens and Northern Territory University	DCC NTU
and enclosed views at: - creek crossing on Henry Wrigley Drive, and - within the various remnant communities **(M/N)**	

RECREATION, ACCESS AND LANDSCAPE CHARACTER

Figure 5.3



RECREATION AND ACCESS NOTES

1. UPGRADE AND ENHANCE THE RAPID CREEK CORRIDOR TO ENCOURAGE APPROPRIATE USE AND ENJOYMENT OF THE CREEK FOR LOW KEY RECREATIONAL ACTIVITIES.
2. INCREASE SENCE OF COMMUNITY OWNERSHIP TO ENCOURAGE CASUAL SURVEILLANCE AND REPORTING OF INCOMPATIBLE ACTIVITIES
3. MODIFY THE LAYOUTS AND LANDSCAPE CHARACTER OF ALL LOCAL RESERVES TO CATER FOR A PARTICULAR RANGE OF RECREATIONAL PURSUITS. REDUCE RECREATIONAL PRESSURES IN ENVIRONMENTALLY SENSITIVE AREAS.
4. REVIEW PLAY EQUIPMENT LOCATIONS. IMPROVE AND EXTEND EQUIPMENT TO MEET THE NEEDS OF VARYING AGE GROUPS AND PROVIDE FACILITIES.
5. EXCLUDE RECREATIONAL ACCESS TO REMNANT VEGETATION WHERE WATER AND HABITAT CONSERVATION IS THREATENED
6. PROVIDE A NETWORK OF MAINTENANCE/EMERGENCY ACCESS ROUTES TO FACILITATE MANAGEMENT OF THE OPEN SPACE RESOURCE.
7. PROVIDE FACILITIES FOR DISABLED WHEREVER APPROPRIATE.

LEGEND

- EXISTING RECREATIONAL AREA STRATEGIES REFER NOTES ON DRAWING.
- SPECIFIC RECREATION / LANDSCAPE CHARACTER STRATEGIES : REFER NOTES ON DRAWINGS
- SHARED USE PATHWAY SYSTEM LINKING WITH EXISTING NETWORK.
- INFORMATION AND INTERPRETIVE BOARDS.
- ESTABLISH APPROPRIATE LEASE ARRANGEMENTS TO ALLOW PUBLIC USE AND ACCESS TO R.A.A.F. P.A.C. AND CROWN LAND.
- MAJOR ENTRANCES TO RAPID CREEK CORRIDOR.
- MINOR ENTRANCES TO RAPID CREEK CORRIDOR.
- DEVELOP STRATEGY FOR INDIGENOUS STREET TREE PLANTING
- MAINTAIN / ENHANCE LONG VIEWS AND VISTAS.
- MAINTAIN / ENHANCE ENCLOSED VIEWS.
- CREEK CROSSINGS

CASUARINA COASTAL RESERVE

INITIATE A PROGRAMME TO:
- IMPROVE ACCESS, RECREATION FACILITIES AND PLANTING IN OPEN AREAS.
- PROVIDED FOR LIMITED PEDESTRIAN ACCESS TO THE MANGROVES, PROVIDE INTERPRETIVE MATERIAL AND UTILISE THE AREA AS AN EDUCATIONAL AND VISUAL RESOURCE.
- UPGRADE EXISTING ACCESS ROUTE ALONG THE NTU BOUNDARY.

DARWIN WATER GARDENS

UPGRADE THE EXISTING FACILITIES TO ENHANCE THE RECREATIONAL VALUE OF THE RESERVE IN A REDEVELOPMENT PROGRAMME:
- STRENGTHEN EXISTING PLANTING STRUCTURE, USING INDIGENOUS PLANTS WHERE APPROPRIATE
- IMPROVE VISUAL LINKS TO MANGROVES
- UPGRADE WATER FEATURES - INVESTIGATE OPTIONS
- DEVELOP A MAJOR INFORMATION CENTRE WITH INTERPRETIVE WALKS INTO THE RAINFOREST AND MANGROVE COMMUNITIES.

MONSOON RAINFOREST

INITIATE A PROGRAMME OF PLANNING, DESIGN AND MANAGEMENT PROPOSALS TO PROVIDE FOR LIMITED RECREATIONAL USE WITHOUT COMPROMISING CONSERVATION OF THE WATER AND HABITAT RESOURCE. PROPOSALS WILL INCLUDE:
- CONTROL OF VEHICLE ACCESS
- PROVISION OF SHARED CYCLEWAY/PATHWAYS AND SELECTED ACCESS POINTS TO THE CREEK.
- DEVELOPMENT OF AN INFORMATION CENTRE AND INTERPRETIVE WALKS

LANDSCAPE CHARACTER NOTES

1. MAINTAIN THE NATURAL QUALITIES OF THE CREEK CORRIDOR. ALL NEW WORKS ARE TO EMPHASISE THE EXISTING NATURAL CHARACTER OF THE CREEK ENVIRONMENT
2. URBAN ELEMENTS WITHIN AND BORDERING THE CREEK CORRIDOR MUST BE IN KEEPING WITH A COHERENT DESIGN APPROACH FOR THE CREEK, UTILISING APPROPRIATE MATERIALS FOR THE NATURAL CHARACTER OF THE CREEK.

MARRARA SWAMP

PUBLIC ACCESS TO BE RESTRICTED TO GUIDED EDUCATIONAL AND SCIENTIFIC VISITS.
UPGRADE AND EXTEND SECURITY FENCE.
INTERPRETATIVE INFORMATION BOARDS TO BE PROVIDED.

RAPID CREEK MANAGEMENT STUDY

0 100 200 300 400 500 METRES

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FOR GREENING AUSTRALIA AND DARWIN CITY COUNCIL

5.3 OPEN SPACE PLANNING, MANAGEMENT AND COMMUNITY LIAISON

(To be read in conjunction with Figure 5.4)

5.3.1 OPEN SPACE PLANNING AND MANAGEMENT

Adopt the following specific planning and management strategies:

Catchment Management Body

Instigate the necessary actions to establish the required legislation to empower a group, to be known as Rapid Creek Catchment Advisory Committee. The Committee would comprise representatives from Council various Government departments and authorities, other groups with a vested interest in the catchment, and community groups. Establish an agreed structure for the trust and a programme for regular formal and informal liaison and meetings. The Committee would co-ordinate the major strategies relating to habitat conservation and water management (Section 5.1), community liaison and education programmes. If considered appropriate, consultative sub-groups would be established for:

- bushland planning and management
- water management
- community liaison
- education programmes

The Committee would advise on these matters on a catchment wide basis, and would be the body to adopt and implement the Management Plan **(H/N)**

ATCV
PWCNT
DCC
DLPE
DLPE
NTU
FN
GANT
DIA
DEF
NGC
RCLG
RCCAC

Planning Structure and Objectives

The Parks and Wildlife Commission NT will prepare a detailed proposal for establishment of the Catchment Advisory Committee, to present to the Minister for Conservation and Tourism **(H/N)**

PWCNT

Establish Landuse Objectives for "Residential Developments Neighbouring Bushland" following strategies developed in this Management Plan. Such an instrument would particularly apply to the rural blocks downstream of McMillans Road. Matters for consideration in the assessment of a development application may include all or any of the following criteria:

DLPE
RCCAC

- Height, scale and relationship with adjacent buildings
- Setbacks from creek boundaries
- Extent of earthworks required
- Extent of vegetation to be cleared
- Finished levels above the flood line
- Extent of proposed open space
- Landscape treatment and removal of weeds
- Dedication of land along creek corridor to management authority
- Impacts on site run-off and stormwater disposal

(M/N)

Establish Landuse Objectives for the area east of Amy Johnson Avenue, as an extension to the existing landuse policy. The primary consideration for assessment of development applications will be:

DLPE
RCCAC

- Impacts on site run-off and stormwater disposal
- Protection of downstream areas from erosion and sediment (during and after construction)
- Impacts on nutrient load entering Marrara Swamp
- Extent of vegetation to be cleared

(H/N)

Statutory Authorities

Circulate all authorities with a copy of the Management Plan for comment and liaison on common and agreed work practises in the creek **(H/N)**

(DCC)
RCCAC

Council Departments

Circulate the Management Plan to all Council departments for their information, drawing attention to agreed departmental roles, responsibilities and coordination **(H/N)**	(DCC) **RCCAC**

Land Ownership

Seek to transfer ownership of the following land to a public body or establish appropriate lease arrangements to improve compatibility of management practices:

- Liaise with Defence to transfer the land area enclosing Marrara Swamps to Council control (or RCCAC) **(L/S)**	(DCC) DEF **RCCAC**
- Liaise with Defence to transfer the land along their common boundary with Marrara Sports Complex and Northlakes Golf Course to Council control (or RCCAC) **(L/S)**	(DCC) DEF **RCCAC**
- Liaise with DIA to transfer land enclosing the monsoon rainforest and transitional communities between McMillans Road and the flood mitigation weir to Council control (or RCCAC) **(H/S)**	(DCC) DIA **RCCAC**

Leases

Wherever possible, new leases issued in close proximity to Rapid Creek to include provisions consistent with the principles of the Management Plan. As for other private landholders, an education process will also play a part.	DLPE **RCCAC**

Redevelopment of Existing Properties

Ensure that all forms of redevelopment of existing properties along the creek line including subdivisions, dual occupancies or building renovations comply with the principles set out in the Management Plan by a process of public information and education **(M/S)**	DLPE **RCCAC**

Funding

Undertake a research / review of Federal funding/grant opportunities to be directed to Rapid Creek (see also Section 6, Funding Alternatives) **(M/N)**	PWCNT DCC **RCCAC**

Rapid Creek Park

Consider identifying the creek catchment study area under the umbrella name of "Rapid Creek Park" or similar, and establishing it as a distinct regional park in Darwin's open space inventory **(H/N)**	PWCNT DCC DIA DEF **RCCAC**

5.3.2 COMMUNITY LIAISON

A number of initiatives should be instigated to assist Council / authorities / community liaison.

Catchment Advisory Committee

Establish the Rapid Creek Catchment Advisory Committee as described above as the primary vehicle for liaison and co-ordination **(H/N)**	Government Departments Community Groups

Management Officer

Identify an officer from the Advisory Committee to oversee the implementation of strategies for a fixed period to ensure that momentum for this work is maintained and to facilitate community liaison **(M/N)**	(DCC) **RCCAC**

Ordanance/Surveillance

Encourage frequent use and casual surveillance of the creek and corridor by users through the strategies outlined in this Plan and encourage reporting of ordanance violations, littering and dumping to management officer **(M/N)**	Community **RCCAC**

Emergency Contact Officer

Identify and circulate the name of a contact officer for rapid response to urgent / emergency concerns in the creek corridor, reported by community **(M/N)**	(DCC) **RCCAC**

Council Meeting

Provide adequate notice and agenda to RCCAC and other interested individuals / groups of any full Council or Council Committee meetings at which issues concerning Rapid Creek Catchment are to be raised, and provide opportunity for a member of RCCAC to make a presentation if appropriate or necessary **(H/N)**	DCC

Interpretation and Information

Develop an integrated programme of signage, information leaflets, interpretation panels and media releases to inform, interpret and educate creek users and the local community including:

- Directional Information: Signage and pamphlets for various lengths of walks within the creek corridor and links to other path systems, including cycling and disabled access information **(M/S)** — DCC, PWCNT, **RCCAC**

- Interpretation: Pamphlets (as above and readily available) and display panels to interpret the natural environment and local heritage. This could be an extension of Greening Australia's present programme **(M/N)** — GANT, DCC, PWCNT, **RCCAC**

Education Resource

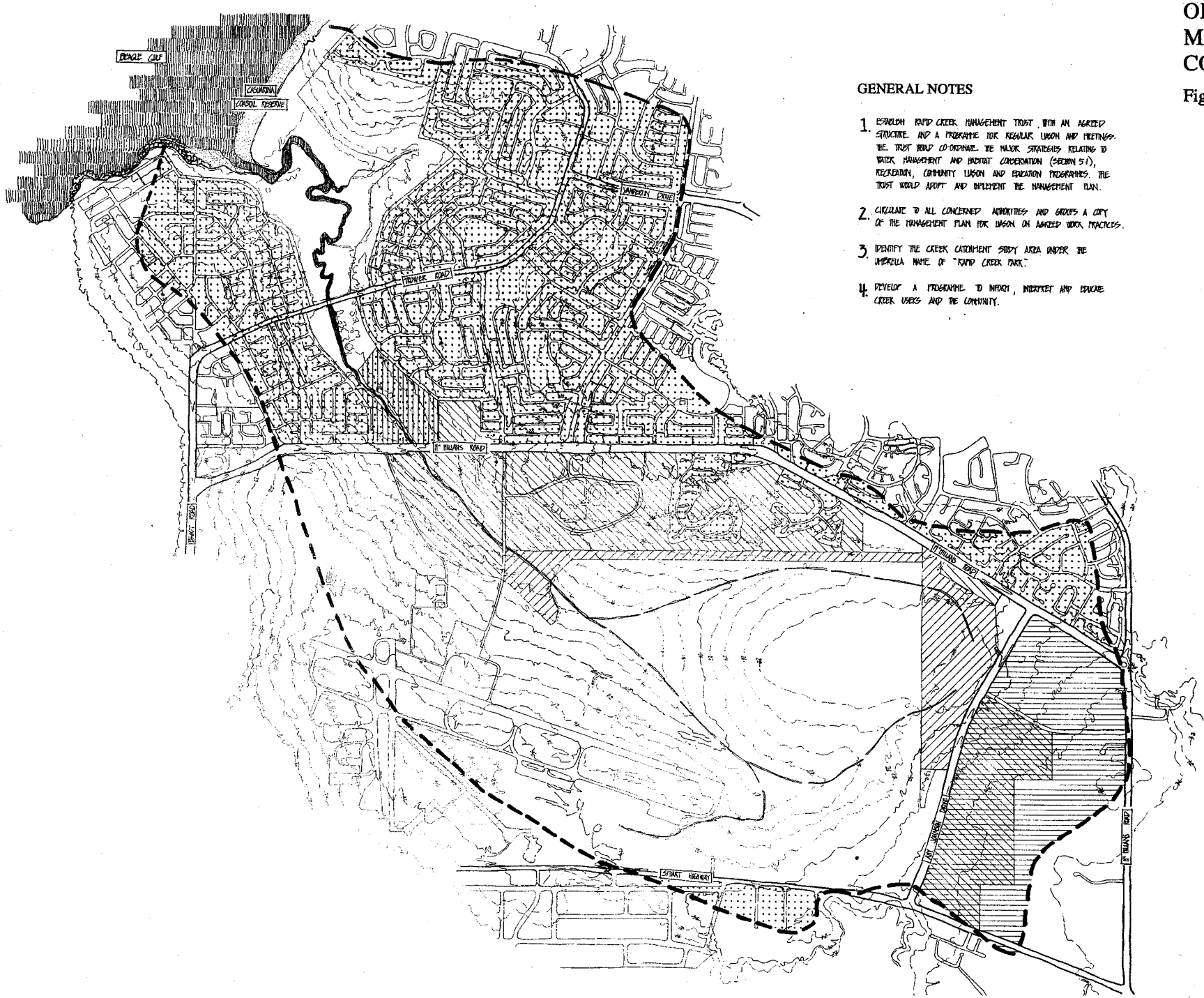
Liaise with local schools to establish an educational resource and ease of access to the creek and remnant bush. Involve school children and local residents in the active management of the creek corridor. Guided walks, field trips, monitoring programmes and survey exercises are legitimate educational activities **(M/N)** — GANT, DCC, PWCNT, **RCCAC**

Further Historical Investigation

Carry out a coordinated oral history based on interviews and walks with local residents, particularly those who have lived in the vicinity for substantial periods of time. Compile a written record of the interviews, summarising the key events, developments, personalities (This programme would continue on from work already performed by Sean Heffernan (1991) **(L/S)** — DCC, GANT, DLPE, **RCCAC**

OPEN SPACE PLANNING, MANAGEMENT AND COMMUNITY LIAISON

Figure 5.4



GENERAL NOTES

1. ESTABLISH RAPID CREEK MANAGEMENT TRUST WITH AN AGREED STRUCTURE AND A PROGRAMME FOR REGULAR LIAISON AND MEETINGS. THE TRUST WOULD CO-ORDINATE THE MAJOR STRATEGIES RELATING TO WATER MANAGEMENT AND HABITAT CONSERVATION (SECTION 5.1), RECREATION, COMMUNITY LIAISON AND EDUCATION PROGRAMMES. THE TRUST WOULD ADOPT AND IMPLEMENT THE MANAGEMENT PLAN.
2. CIRCULATE TO ALL CONCERNED AUTHORITIES AND GROUPS A COPY OF THE MANAGEMENT PLAN FOR LIAISON ON AGREED WORK PRACTICES.
3. IDENTIFY THE CREEK CATCHMENT STUDY AREA UNDER THE UMBRELLA NAME OF "RAPID CREEK PARK."
4. DEVELOP A PROGRAMME TO INFORM, INTERPRET AND EDUCATE CREEK USERS AND THE COMMUNITY.

PREPARE LANDUSE OBJECTIVES FOR "RESIDENTIAL DEVELOPMENTS NEIGHBOURING BUSHLAND" FOLLOWING STRATEGIES DEVELOPED IN THIS MANAGEMENT PLAN.

PREPARE LANDUSE OBJECTIVES FOR THE INTER-CATCHMENT GIVING PARTICULAR CONSIDERATION TO WATER QUALITY AND MANAGEMENT.

SEEK TO TRANSFER MANAGEMENT OF CROWN LAND TO A PUBLIC BODY TO IMPROVE COMPATIBILITY OF MANAGEMENT PRACTICES.

DRAFT NEW LEASE ARRANGEMENTS TO MEET THE STRATEGIES IN THE MANAGEMENT PLAN, TO BE IMPLEMENTED AT LEASE RENEWAL. (WHERE APPLICABLE).

FACILITATE COMMUNITY LIAISON AND CO-ORDINATION OF PUBLIC INPUT, THROUGH THE RAPID CREEK CATCHMENT MANAGEMENT TRUST.

RAPID CREEK MANAGEMENT STUDY

0 50 100 200 300 500 METRES

CLOUSTON

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6. IMPLEMENTATION

This section sets out a range of ways and means for pursuing the strategies for conservation and management of the creek and catchment. The initial action should be to establish the Rapid Creek Catchment Advisory Committee, who would adopt and implement the Plan. A programme of works, based on the strategies described in Section 5, would then be established.

The suggested priorities and opportunities for implementing the various strategies have been described. This, along with the summary of major project components of high priority, listed in Figure 6.1 for ease of reference, would form the basis of a work programme. The work programme would be prepared by the Advisory Committee (if in existence) or through a series of co-ordination meetings between the various Government authorities and community groups.

This section also includes broad details relating to the implementation works under the following headings:

6.1 *Corridor Controls*. Suggested boundary and corridor controls along the creek line.

6.2 *Design and Material Guidelines*. Typical details and construction techniques for use in rehabilitation works.

6.3 *Costing*. A guide to the relative costs for specific projects and rates for general treatments throughout the creek catchment.

6.4 *Alternative Funding Sources.* Summary of grants available from State and Local Government, statutory authorities and other agencies that may be sought to assist with project developments arising from this Plan.

FIGURE 6.1

MAJOR PROJECT COMPONENTS OF HIGH PRIORITY

1. Establish the Rapid Creek Catchment Advisory Committee to adopt and implement the Plan.

2. Develop a broad-based education and information strategy aimed at increasing the communities awareness of Rapid Creek and the natural systems within the catchment. Aspects to be covered would include water quality, vegetation communities, pathways (including links to other areas), views and the need for appropriate care when in the creek corridor.

3. Develop and implement programmes for regeneration and revegetation of areas of remnant bushland, particularly within the monsoon forest and Marrara Swamp communities. A weed control programme will be implemented at the same time.

4. Improve water quality within the creek and protect the creek's flood mitigation role by:

   -reducing nutrient and sediment through a programme of education and use of gross pollutant traps, filter strips and erosion control measures

   - continue and expand existing water quality monitoring programme

   -protect and maintain the upper catchment in its present undeveloped nature which is a key component in flood control

5. Prepare a fire management strategy as part of the habitat conservation programme for the different vegetation communities.

6. Establish a dual-use pathway network that links Marrara Swamp and the upper catchment with the creek mouth and include cross links with adjoining paths and reserves; control access to Marrara Swamp and improve access to the mangrove communities in the area of Casuarina Coastal Reserve and Northern Territory University. Restrict vehicle access within the corridor to emergency and maintenance vehicles only.

7. Rationalise ownership and improve compatibility of management practices in Defence and DIA grounds.

8. Establish a coherent design approach to urban design elements and identify the creek catchment under the umbrella term of 'Rapid Creek Park'.

9. Following representation to the NT Government, and assuming land ownership issues are resolved develop the area of Crown Land adjacent to McMillans Road and Henry Wrigley Drive as a catchment interpretive centre and trail head. This project could be a focal point for the on-going protection and enhancement of the creek and could be known as The Gurambai Centre.

6.1 CORRIDOR CONTROLS

Following from the strategies, there will be several planning, design and creek management initiatives that apply along the whole length of the creek, particularly where these have a direct relationship to water levels, or the need for management access, for example.

Illustrated in Figure 6.2 are controls that should be pursued in the immediate and long term to ensure conservation of the natural resources of the creek corridor. They are intended to control the type and location of development along the corridor and should form the basis of Land Use Objectives under the New Planning Act (Section 8).

Understanding that the Planning Act does not have force over Federal Lands, the controls would require the co-operation of both Defence and DIA.

The various components of the corridor controls, as described in the Land Use Objectives, will be:

- **Natural Creek Corridor** - conservation of habitat

  A continual corridor along the creek that is determined by the extent of both the remnant vegetation community and the 1 in 100 year flood levels. The primary action in this area would be regeneration of the remnant community. Access would be restricted to pedestrians only, and landscape works would be confined to bank stabilization, path provision and interpretative information as required and where appropriate.

- **Landscape Buffer** - species selection guidelines and maintenance corridor

  A band adjacent to the creek corridor in which canopy tree planting is particularly encouraged and any vegetation introduced is limited to indigenous species that relate to the natural areas. These works would be undertaken as part of a revegetation programme.

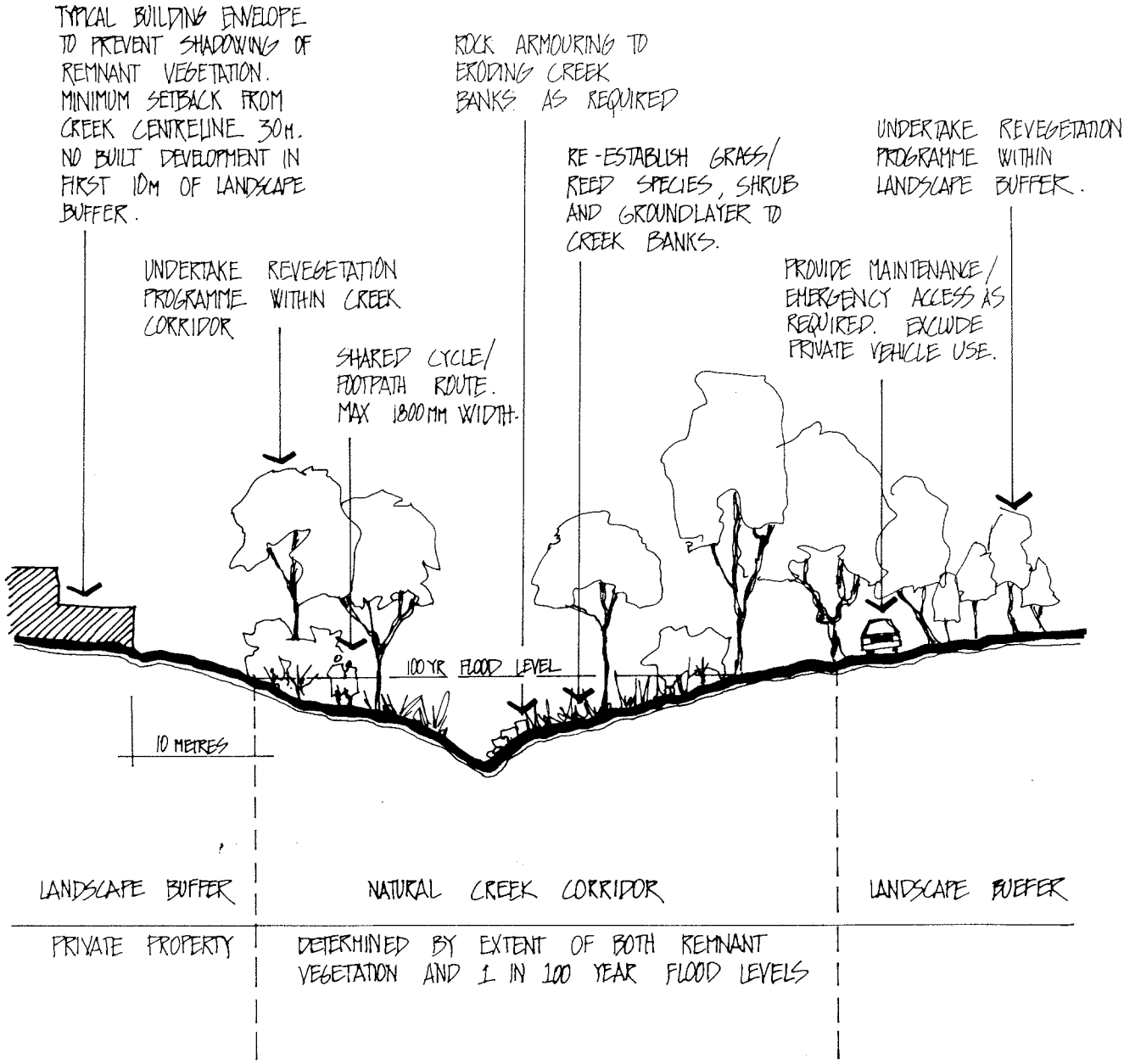
  A corridor will be provided to allow maintenance / emergency access as required. The access route is important in defining the extent of varying maintenance regimes and would also function as a fire break.

- **Building Setback** - visual and shadow impact

  The intention of this component is to control the visual quality of the resource and prevent shadowing and physical encroachment on the creek corridor. The rear land of the buffer may be developed in line with the relevant Land Use Objectives for conditions of site coverage, side boundary building setbacks etc but with a consistent building height envelope.

FIGURE 6.2

CORRIDOR CONTROLS



6.2 DESIGN AND MATERIAL GUIDELINES

Continuing management of the creek should aim for a high standard of appearance and aesthetic control in all construction and rehabilitation works. To this end, the following guidelines suggest materials, techniques and details that are suitable for Rapid Creek bank treatments, structures, planting and pollution control measures.

For ease of interpretation this section is largely illustrative. The details are guidelines only and cannot be applied without specific site investigation and detailed design. They are intended to demonstrate the scale, character and relative impact / costs of appropriate treatments.

FIGURE 6.3

PRINCIPLES FOR CONSOLIDATING REMNANT VEGETATION

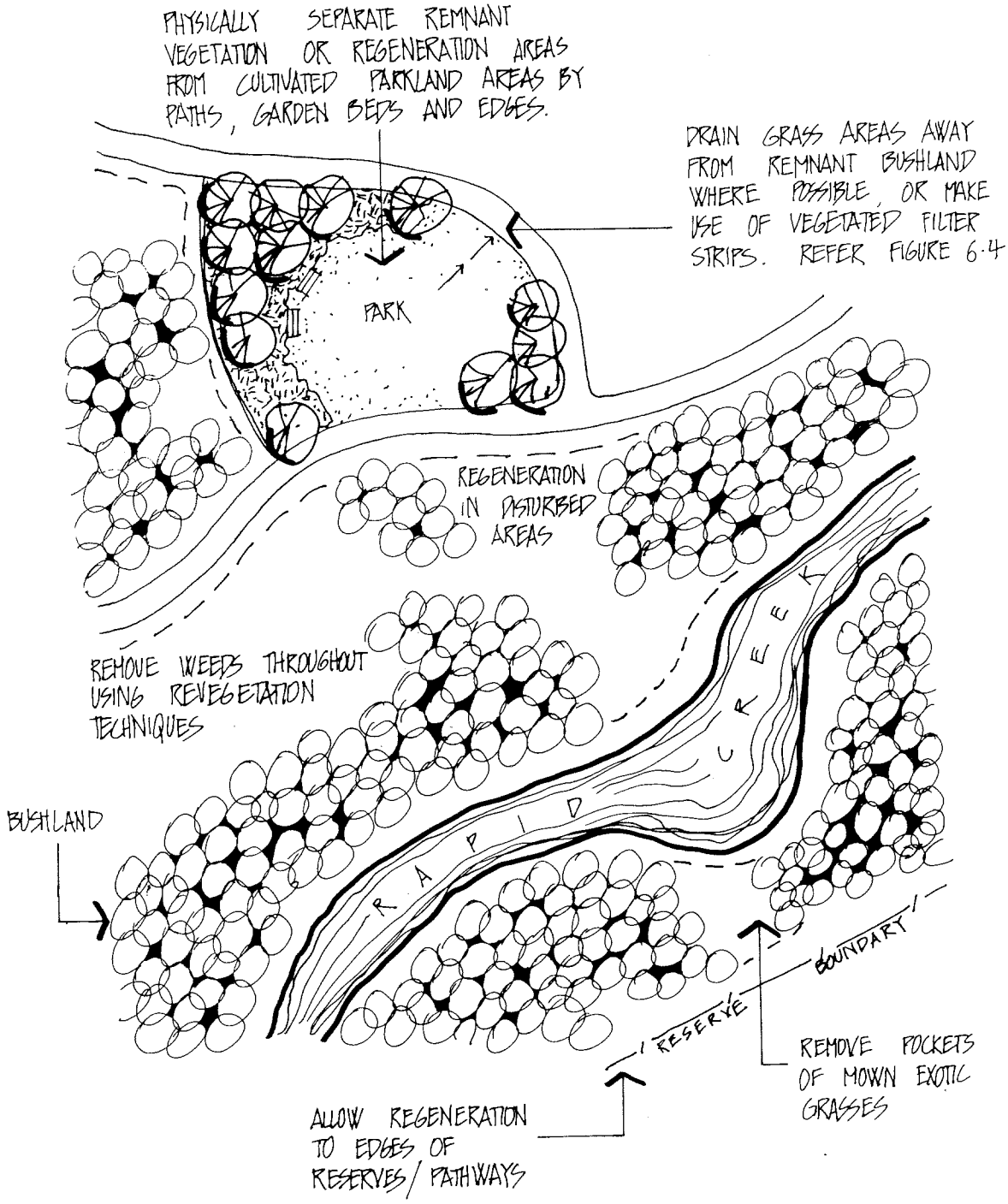
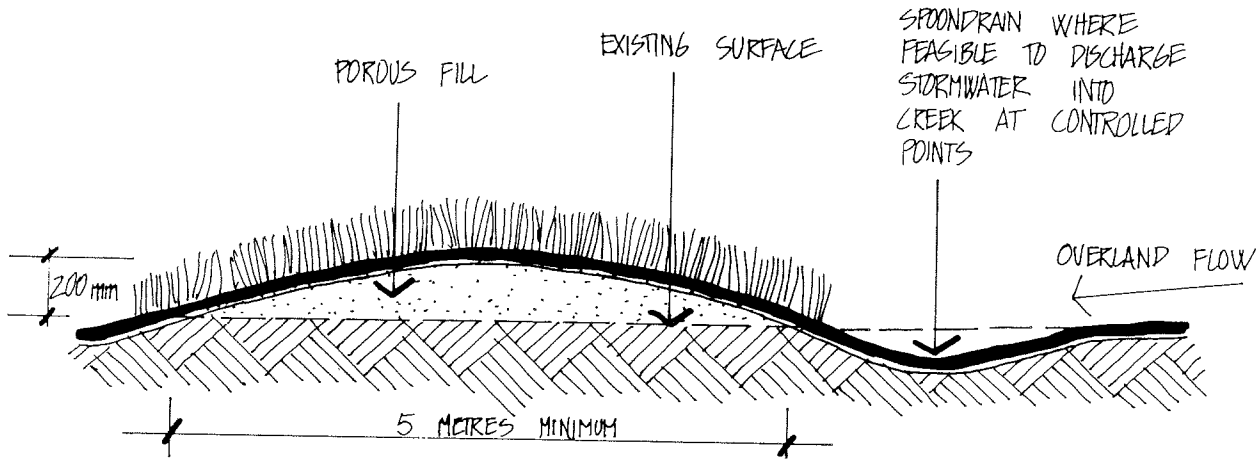


FIGURE 6.4

CONCEPT FOR VEGETATED FILTER STRIP



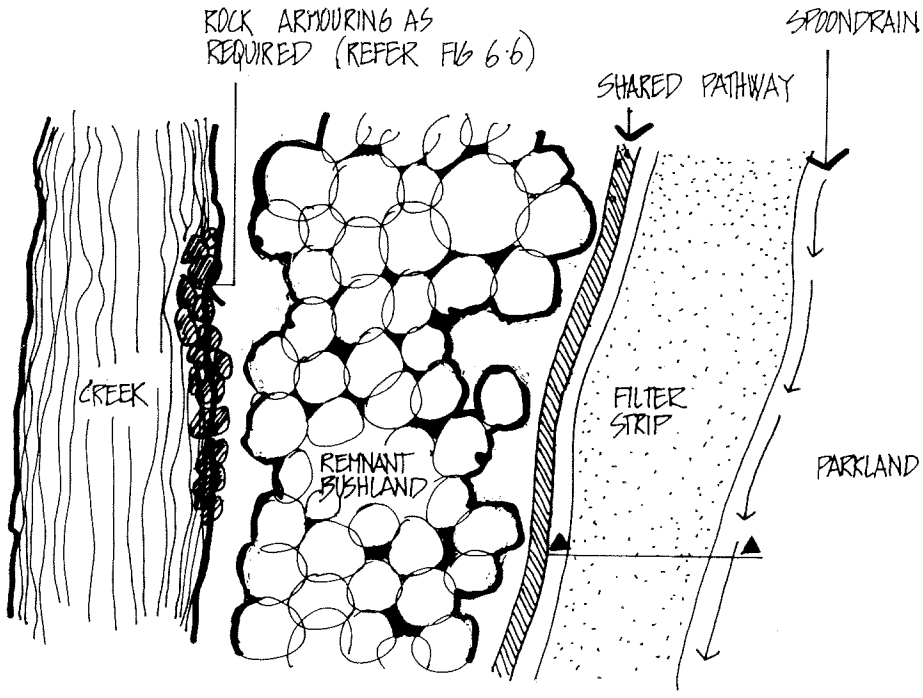
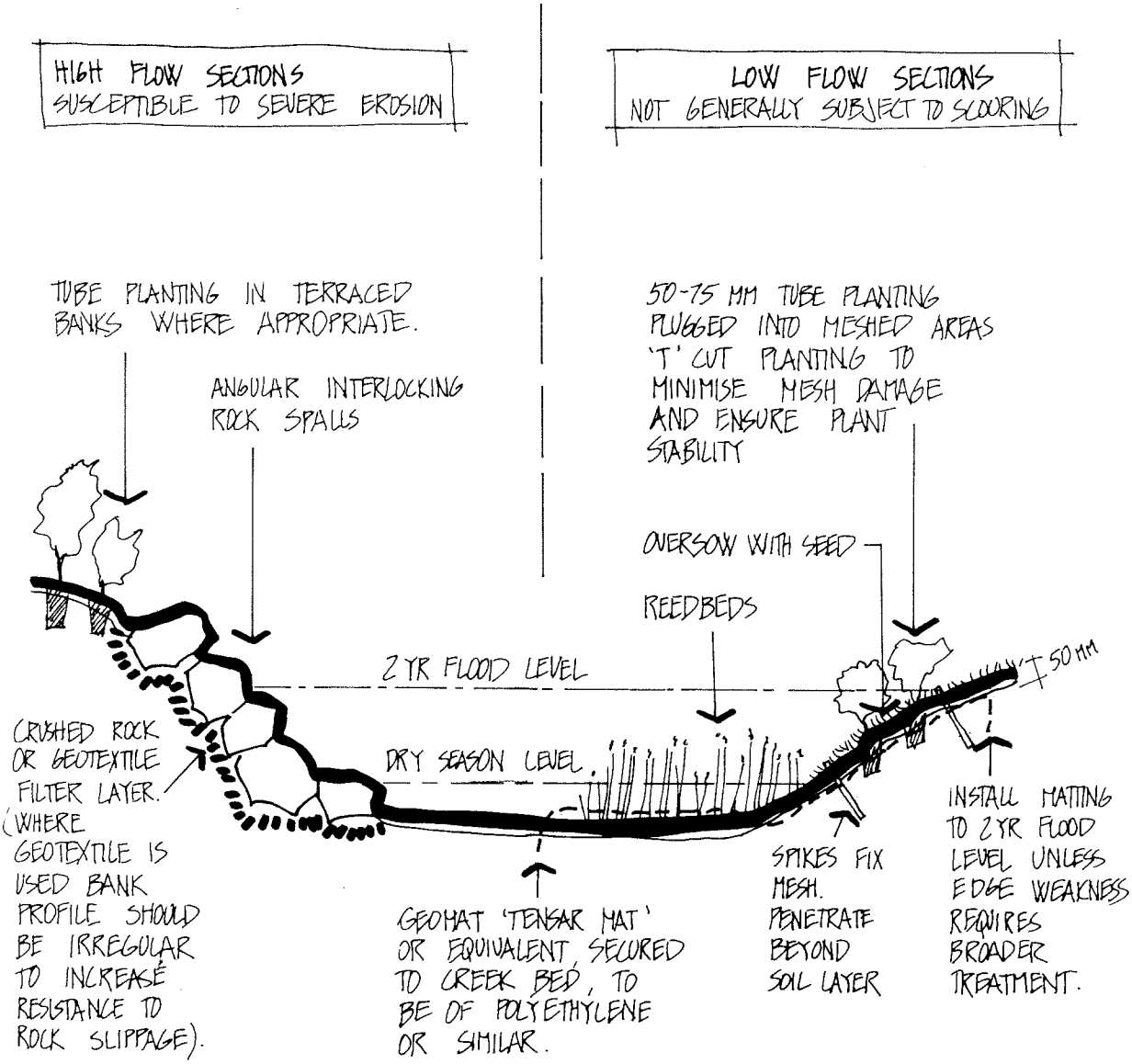


FIGURE 6.5

STABILISATION OF CREEK BANKS, VEGETATION MANAGEMENT



GENERAL NOTE:

FOR UPSLOPE PLANTING WEED CONTROL (FOLLOW REVEGETATION PROCESS):—
IF GREATER THAN 1:4 SLOPE, USE COCONUT MAT. OTHERWISE USE LEAF MULCH, WITH TUBESTOCK PREFERABLY.
ALL BANK STABILIZATION TREATMENTS ARE SUBJECT TO DETAILED INVESTIGATION/DESIGN.

FIGURE 6.6

CONCEPT FOR ARMOURING ERODING BANKS

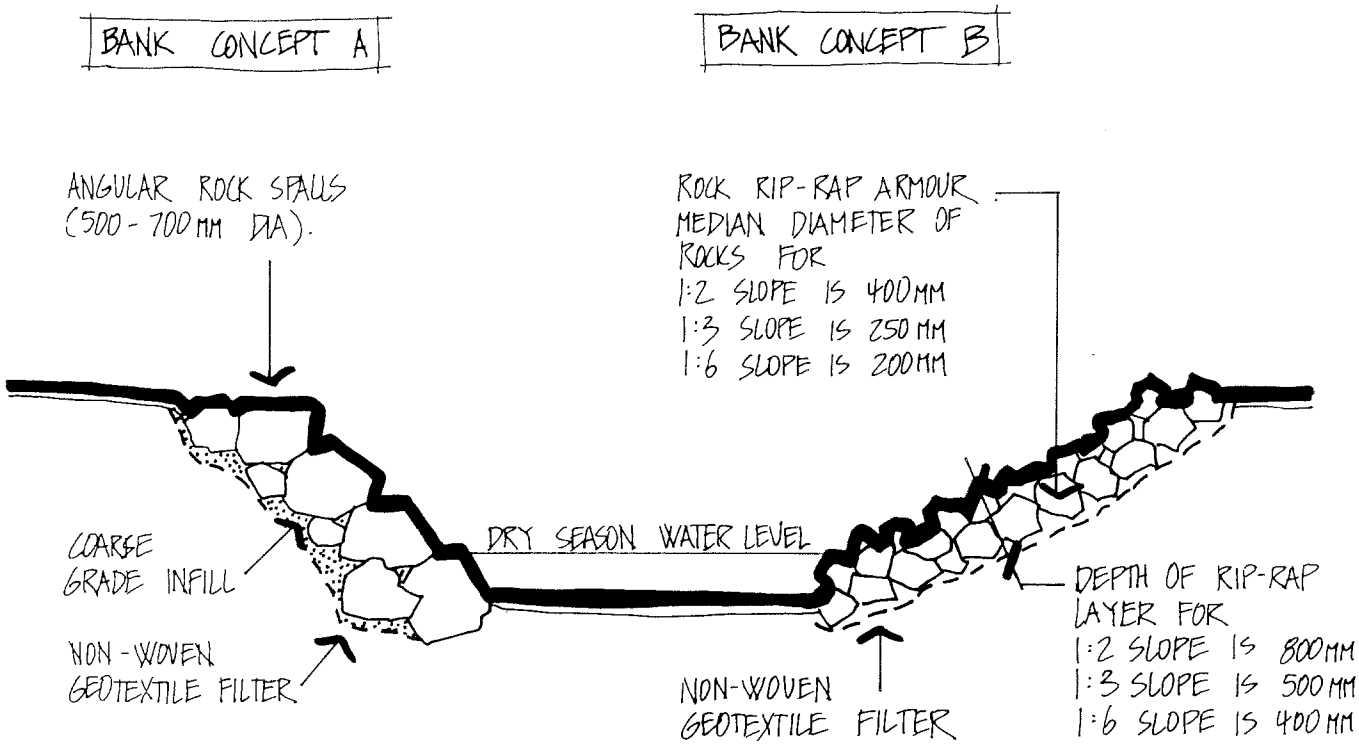


FIGURE 6.7

DUAL-USE PATHWAY CONSTRUCTION
(Major Linear Path and Cross-links

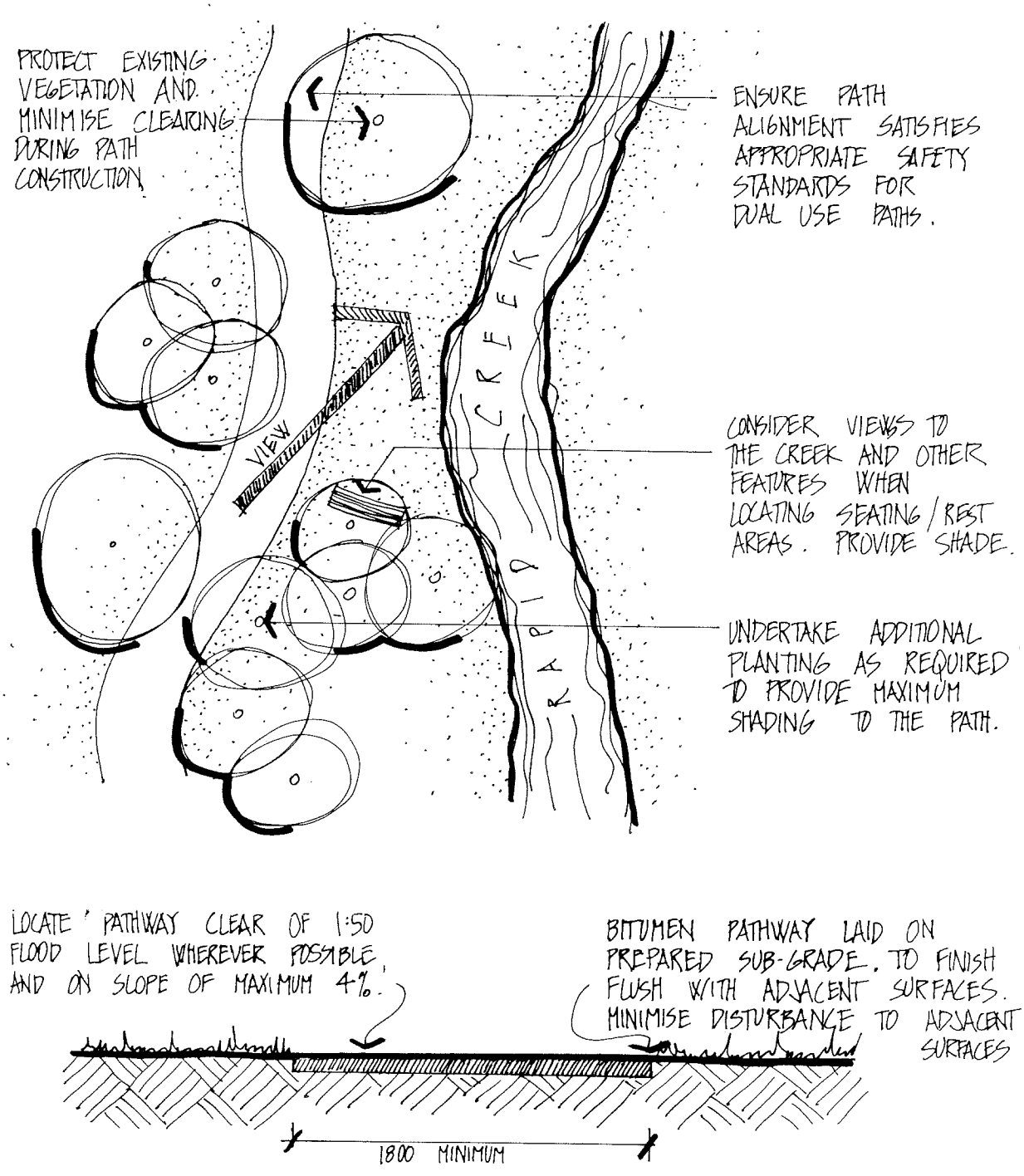


FIGURE 6.8

STABILISED GRAVEL PATH
(Minor Pedestrian Access Routes)

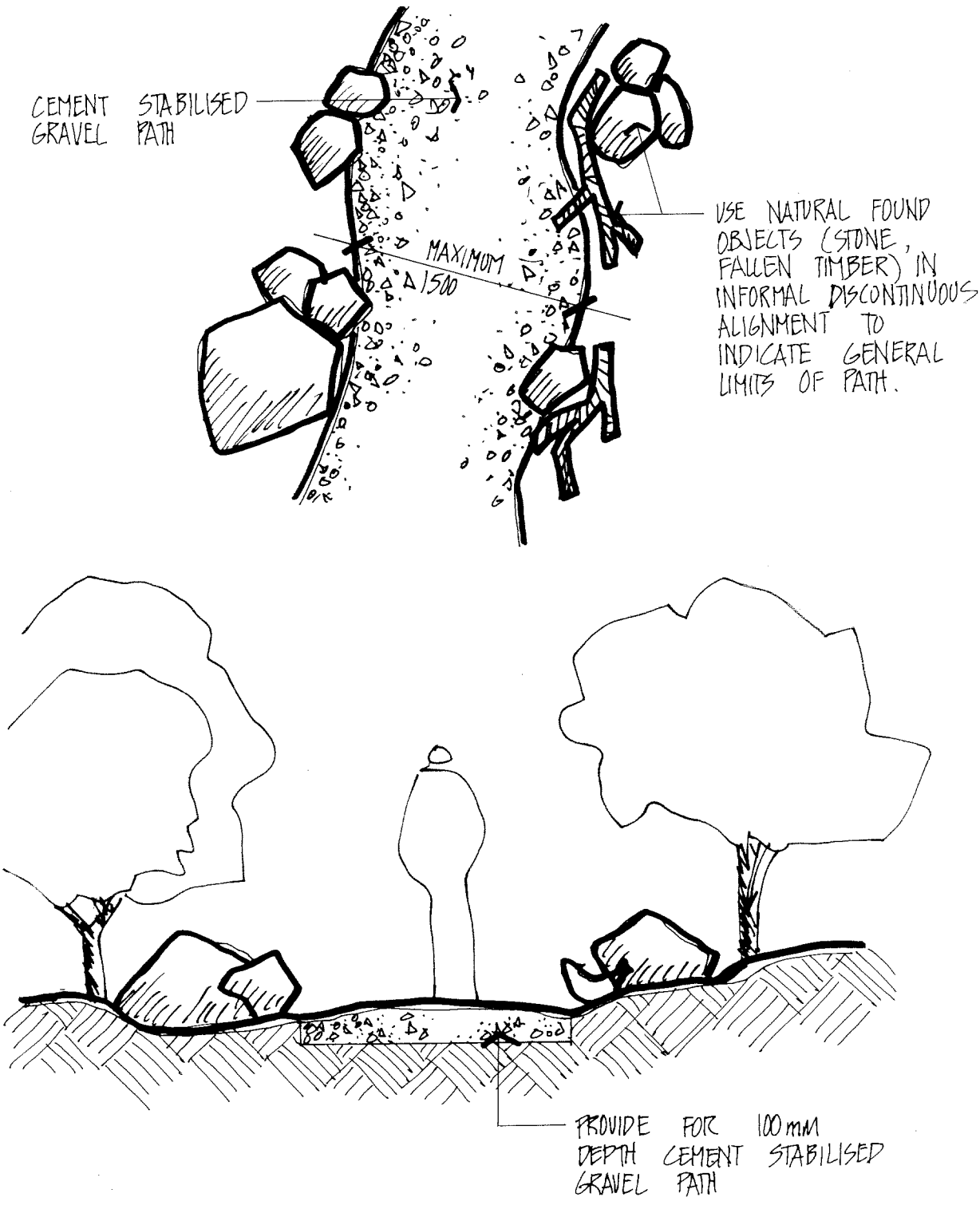
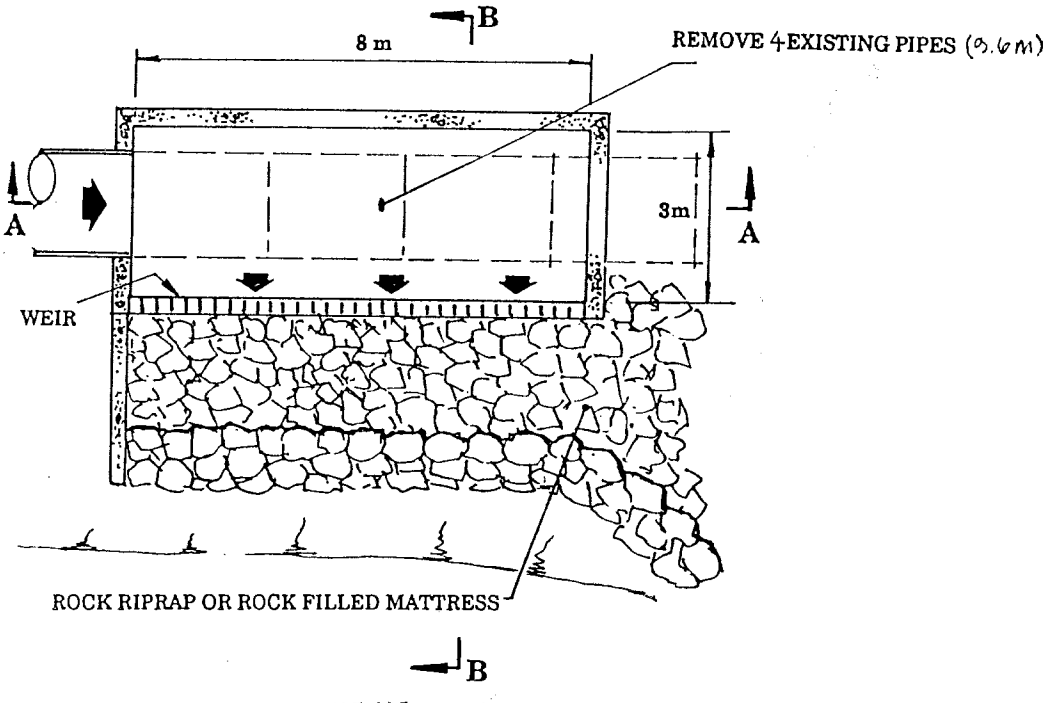
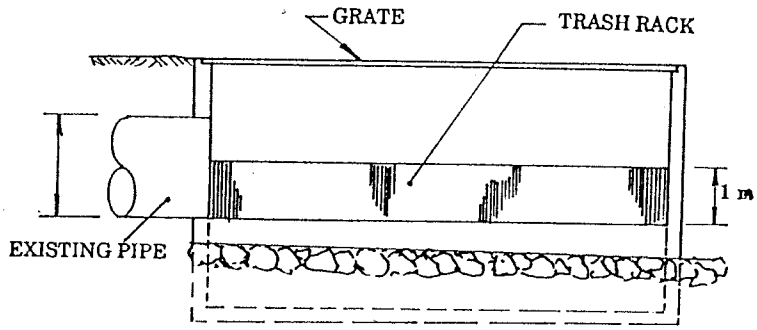


FIGURE 6.9

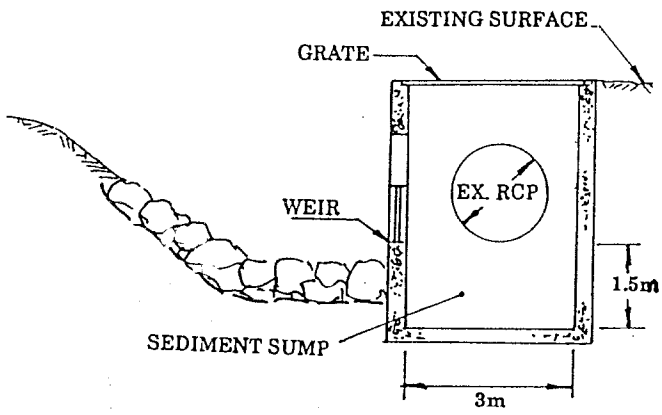
CONCEPT DESIGN FOR MINOR GROSS POLLUTANT TRAP



PLAN



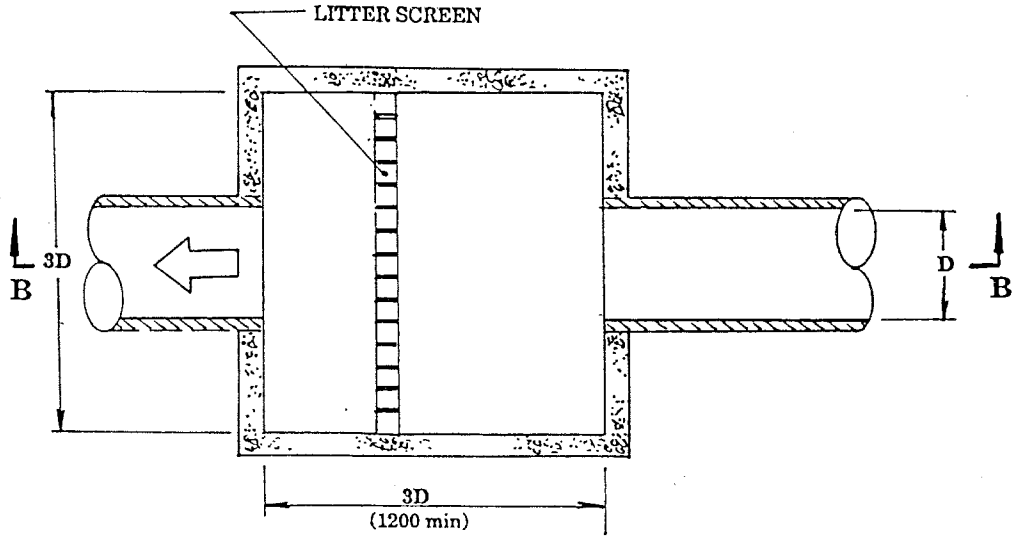
SECTION A -A

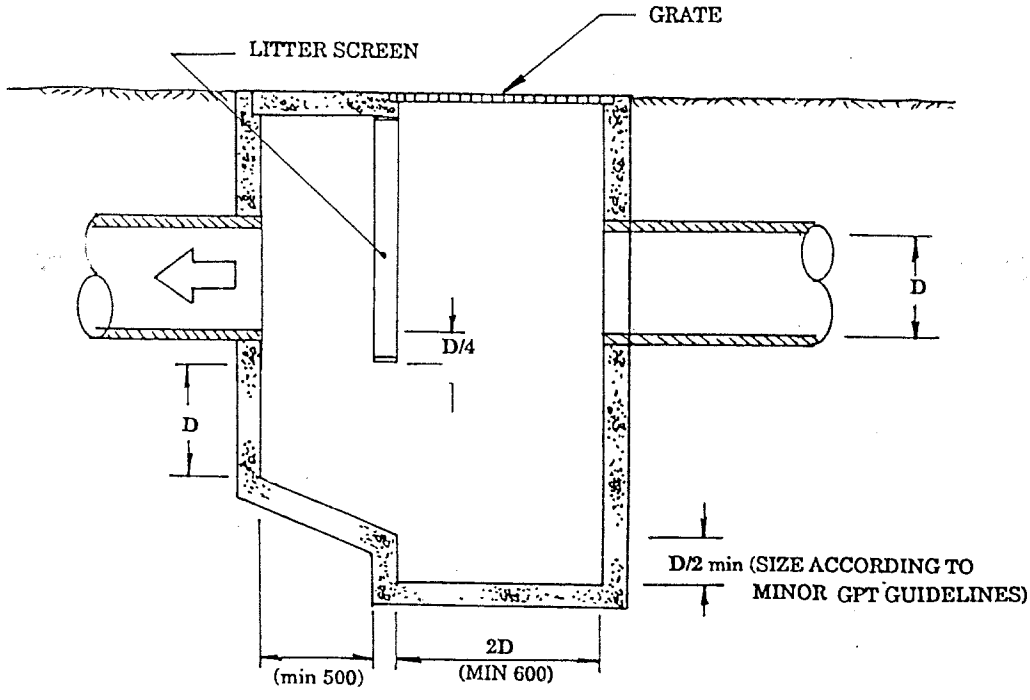


SECTION B - B

FIGURE 6.10

CONCEPT DESIGN FOR MINI GROSS POLUTANT TRAP

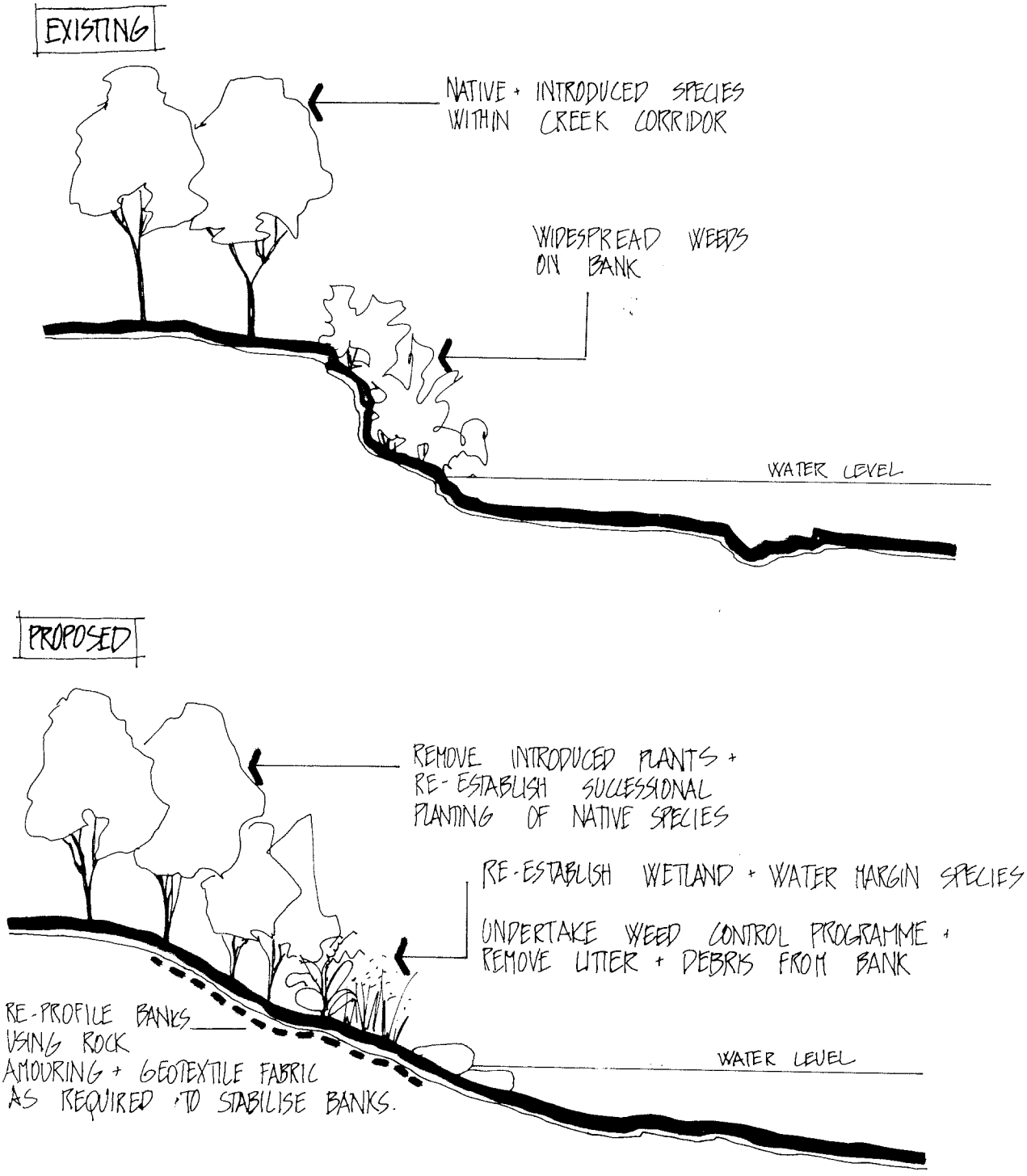




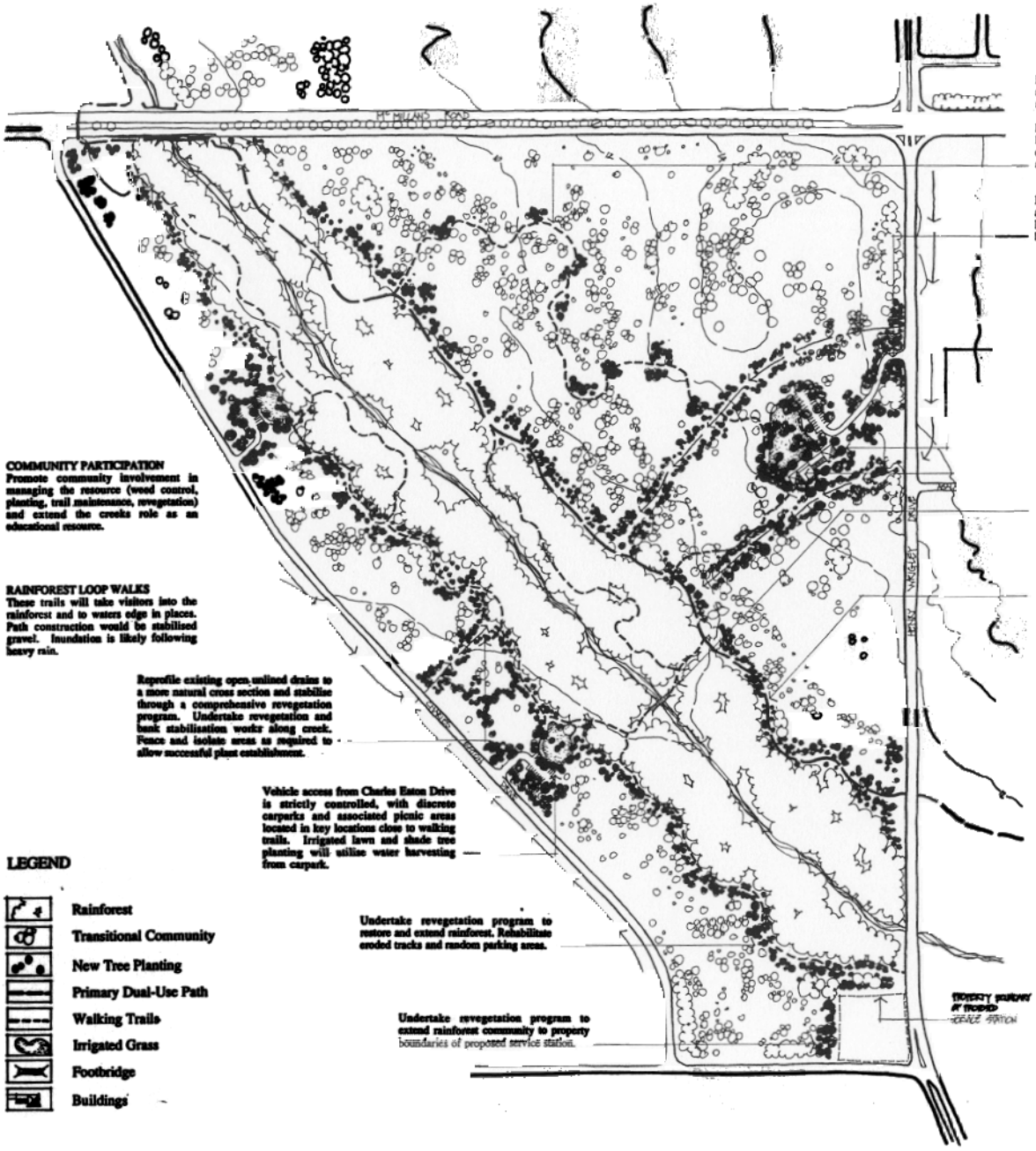
SECTION B- B

FIGURE 6.11

PRINCIPLES FOR EDGE PROFILE TREATMENT
(eg Darwin Water Gardens and Other Locations As Applicable)



GURAMBAI CENTRE
Figure 6.12




INTERPRETIVE SITE


TRAIL HEAD AND PICNIC AREA.

TYPICAL SECTION THROUGH CARPARK AND PICNIC AREA

RAPID CREEK
MANAGEMENT STUDY

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FOR GREENING AUSTRALIA AND DARWIN CITY COUNCIL

6.3 COSTING

The following opinions of probable cost have been prepared as a guide only in order to assist the management bodies with budgeting. It must be noted that a more accurate estimate for works will be necessary in association with design development. Costs do not account for professional fees or inflation

6.3.1 MAJOR PROJECT COSTS

- **The Gurambai Centre**

  The Gurambai Centre (See Figure 6.12) may be broadly broken down as follows:

-	Road works, including access off Henry Wrigley Drive, carparking area and bollards	$48 000
-	Gross pollutant control structures and rehabilitation/reprofiling of existing drainage structures	$80 000
-	Interpretive Centre - Free standing, open structure, including Clivus Multrum toilet, water supply and lighting	$150 000
-	Pathway network, including signage and interpretation	$80 000
-	Park furniture, including lighting	$35 000
-	Planting and bushland rehabilitation	$85 000
-	Creek bank stabilisation works	$120 000
-	On-going maintenance	$30 000 per annum

6.3.2 MINOR PROJECT COSTS

•	**Education and Information Programmes**	
-	Extend existing programmes of both PAWA and Darwin City Council	$10 000 - $20 000
-	Rapid Creek Brochure prepared by Advisory Committee and widely distributed (foldout A4 format)	$25 000
•	**Rehabilitation and Upgrading of Reserves**	
-	Tree and shrub planting	$75- $180 each (depending on size)
-	Upgrade and consolidate play equipment in key locations (Playgrounds adjoining Rapid Creek Road and Freshwater Road)	$8 000 - $30 000
-	Signage (Interpretation and Identification)	$800 each
•	**Rapid Creek Park Entrances**	
-	Major entrances at Amy Johnson Drive, Henry Wrigley Drive, Nightcliff shore front and Casuarina Coastal Reserve (including entrance structure, signage, interpretation and planting)	$15 000 each
-	Minor entrances at Malak Caravan Park, Northlakes, Marrara complex and Northern Territory University (including signage and planting)	$5 000 each
•	**Street Tree Planting**	
-	Typical costs per tree including 12 months maintenance, planting and staking of advanced stock	$180 each
•	**Pathway Construction**	
-	Bitumen pathway including clearing and ground preparation (1 800 mm width)	$80/lm
-	Stabilised gravel path including clearing and ground preparation (1 200mm width maximum)	$30/lm
•	**Creek Crossings**	
-	Low profile bridge structure to provide pedestrian crossings in area of monsoon forest	$20 000 each

6.3.3 WATER MANAGEMENT COSTS

Cost Estimates for Selected Control Devices

- Gross Pollutant Traps. Capital costs will vary depending on the site conditions, but may be expected to be in the order of $3 000 to $4 000 per square metre of plan area. Clearing costs using a backhoe and truck will be in the order of $70/m^3.

- The indicative cost for the GPT's at the major drainage outlets at Northern Territory University and behind the social clubs at McMillans Road would be $160 000 and $120 000 respectively.

- Mini Gross Pollutant Traps. Where large numbers of these devices are to be constructed costs may be reduced by standardising sizes and adopting reusable concrete formwork. for a single structure typically 1 200mm x 1 200mm x 1 500mm deep the estimated cost would be in the order of $8 500.

- Rock Armouring. The cost of rock armouring will depend greatly on the availability of suitable rocks. All up construction costs using "quarry run" rip-rap would be in the order of $400 - $600/m2.

- Reconstruction of Minor Drain Outlets. Where GPT's are not appropriate, reconstruct outlets to minimise localised ponding and erosion, and to reduce visual impact in natural areas. Depending on extent of works, costs could range from $4 000 - $10 000 each.

- Filter Strips. Construct filter strips between cultivated parkland areas and remnant bushland. All up costs for strips 5 000m width would be approximately $60/lm, including grass establishment costs.

- Removal of Weeds and Debris. Costs would vary depending on access and nature of debris. Typically, 2 labourers working with a backhoe and operator would cost $1 000 - $1 500/day. Clearance of $50m3 per day would be a reasonable work rate.

6.3.4 BUSHLAND MANAGEMENT COSTS

Costs for bushland management and revegetation are clearly dependant on the nature of work force concerned. This may be contracted bushland regeneration teams, salaried council staff or volunteers. However, as a guide, trained regenerators could be expected to charge at an hourly rate of $18.00 - $25.00 per hour.

Bushland regeneration is a labour intensive activity and use of alternative labour sources such as volunteer groups, prison internees and other people under LEAP programmes may be appropriate. The major cost here would be training and supervision costs of the teams.

6.4 ALTERNATIVE FUNDING SOURCES

To assist in the funding of works involved in the management plan there are a range of Commonwealth Government Grants available. These funds are usually only for capital works which may include professional planning and documentation fees. Grants usually have to be matched by Council or the appropriate Management authority, with a commitment to carry out ongoing maintenance of constructed works.

Commonwealth Grants are now all amalgamated under the National Landcare Programme. Relevant Grants are listed below in the following table with a brief description and where appropriate, possible applications.

Limited funding is available for re-current works, however, as is already the case, agencies such as Greening Australia can provide assistance in setting up Community Groups willing to participate in ongoing bushland management.

The Territory Government, although not in the practise of giving grants for such project, does have a number of current programmes through which funds may be available. These include the Urban Enhancement Programme and the Tourism Development Initiative. In each case funds may be available for both professional fees, as well as capital works.

NAME OF GRANT	PURPOSE	ADMINISTRATING AGENCY	SCOPE AND LIMITS OF ASSISTANCE
1. National Landcare Programme Save the bush	Remnant bushland management, revegetation, establishment of faunal corridors	Australian Nature Conservation Agency	Bushland revegetation. Typical grant $1 000 - $5 000 occasionally up to $10 000. Must be broad community support for the project.
2. National Landcare Programme One Billion Trees	Standard re-vegetation strategies	Greening Australia	Typical grant approx. $1 000.
3. National Landcare Programme National Soil Conservation Programme	Works directed at soil management	Department of Conservation and Land Management	Maybe of limited applications in Rapid Creek but worth investigating. Grants directed specifically at combating soil erosion. dollar for dollar grant. Max $#30 - $40 000.
4. Job Skills	Over 21 year old trained labour for re-vegetation work	Department of Employment and Training	Labour to assist in documented revegetation work. Job skills programme already in place with the Council. a new programme could be established specifically for work and projects on Bardwell Creek. Grant covers funding for a co-ordinator and approx. 20 trainee staff for about 26 weeks.
5. Landcare and the Environment Action Programme (LEAP)	Under 21 year old trained labour for re-vegetation work	Department of Employment and Training	Same as Job skills, except no programmes are yet in place with Council.
6. Special Projects	funding for specific projects related to the Job Skills Programme	Department of Employment and Training	Grant to $20 000 to supplement the Job Skills Programme. Must be matched by Council. Be of community benefit and endorsed by the unions.

RAPID CREEK MANAGEMENT PLAN
VEGETATION SURVEY

For the purposes of the survey, Rapid Creek was divided into 4 sections:

A Rapid Ck. mouth to Trower Rd bridge
B Trower Rd. bridge to Kimmorley bridge
C Kimmorley bridge to new Airport bridge
D New airport bridge to headwaters (RAAF Land)

* indicates any naturalised exotic (weed) species

Section A - Mouth to Trower Rd bridge

Site A.1 - near the creek mouth, at the end of the cycle/walking path on the western (Darwin) side of the creek near the footbridge (map loc. 702440E; 8631040N).

Narrow band of stunted coastal vine-thicket 2-3m high on slightly raised laterite fringing the mangroves beside the creek mouth. The mangrove community consists mainly of *Avicennia marina* with some *Ceriops tagal var. australis* and *Bruguiera exaristata*

Species
Acacia auriculiformis (Black Wattle)
Allophylus cobbe
Bridelia tomentosa
Capparis sepiaria
Celtis philippensis
Hibiscus tiliaceus
**Lantana camara*
Pongamia pinnata
Premna acuminata
Premna serratifolia
Secamone elliptica
Sterculia quadrifida
Vitex acuminata

Site A.2 - western side of creek, mangroves beside creek channel, track/drainage access at rear of PAWA chlorine facility on Rapid Ck. Rd. (map loc. 702656E; 8630456N).

Major mangrove communities are *Avicennia marina* and *Ceriops tagal var. australis*

NB: Area here identified as Monsoon Forest type 49 on Vegetation Communities of Rapid Creek (Clark and Brocklehurst) was not found. However dense infestations of exotic *Leucaena leucocephala* (Coffee Bush) were located around the chlorine facility and road drainage area.

Species
Aegialitis annulata
Aegiceras corniculatum
Avicennia marina
Bruguiera exaristata
Bruguiera parviflora
Ceriops tagal var. australis
Osbornia octodonta
Rhizophora stylosa
Sesuvium portulacastrum
Sonneratia alba

Weed Site - large stormwater drain off Rapid Ck. Rd. opposite Rossiter St. and Holland Pl. Several weeds of major concern were located here and at other similar drainage channels. Of particular concern is Coffee Bush which was found at most disturbed areas in the lower reaches of the creek.

Species
* *Clitorea ternatea* (legume vine with compound leaves and purple or sometimes white peaflowers)
* *Gossypium hirsutum* (Cotton)
* *Leucaena leucocephala* (Coffee Bush)
* *Merremia dissecta* (convolvulus vine with white flowers and palmate leaves)
* *Ruellia tuberosa* (naturalised garden escape)

Site A.3 - eastern side of creek, mangroves beside creek channel; access track at rear of PAWA chlorine facility on Lakeside Drive (map loc. 702696E; 8630456N). This site is effectively opposite Site A.2.

Species
Avicennia marina

Bruguiera exaristata
Ceriops tagal var australis
Cynanchum carnosum(vine)
Excoecaria ovalis
Gymnanthera nitida(vine)
Halosarcia indica(shrub)
* *Leucaena leucocephala*
Lumnitzera racemosa
Scyphiphora hydrophylacea
Sesuvium portulacastrum(herb)
Suaeda arbusculoides(sub-shrub)
Thespesia populneoides

Site A.4 - NB - Large stormwater drain between northern end of Alawa sports complex and southern end of NTU Casuarina campus (map loc. 703000E; 8631000N). Area marked here as Monsoon Forest type 49 on Clark and Brocklehurst not found. Instead dense infestation of closed Coffee Bush located.

Section B - Trower Rd. bridge to Kimmorley bridge

Site B.1 - western side of creek, near intersection of Rapid Ck. Rd. and Aldridge Rd., margin of mangroves and beginning of cleared parkland (map loc. 702832E; 8629560N).

The main mangrove community was *Lumnitzera racemosa*

Species
Acacia auriculiformis
Acanthus ilicifolius
Acrostichum speciosum
Barringtonia acutangula
* *Clitoria ternatea*
* *Cynodon dactylon*(Couch)
Flagellaria indica
Gymnanthera nitida
Hibiscus tiliaceus
Ipomoea macrantha
Ipomoea pes-caprae
Ipomoea triloba
* *Leucaena leucocephala*
Lumnitzera racemosa
Malachra fasciata

Melaleuca cajuputi
* *Merremia dissecta*
* *Mimosa pigra*
* *Pennisetum pedicillatum* (annual *Pennisetum*)
* *Wedelia trilobata* (Singapore Daisy)

Transect B.2 - following creek from Kimmorley Bridge downstream for approx. 500m. A very narrow band of rainforest community consisting of barely a single row of trees lining each creek bank.

Species
Acacia auriculiformis
Barringtonia acutangula
Carallia brachiata
Carpentaria acuminata (2 mature palms located, possibly garden escapes?)
Maranthes corymbosa
Syzygium angophoroides
* *Pennisetum polystachion* (Mission Grass)

B.3 - Weed Site - Kimmorley Bridge. Of particular concern here is Candle Bush, which can rapidly invade watercourses and wet areas

Species
* *Clitorea ternatea*
* *Crotalaria goreensis* (a Rattlepod)
* *Gmelina arborea*
* *Leucaena leucocephala*
* *Macroptilium atropurpureum*
* *Merremia dissecta*
* *Senna alata* (formerly *Cassia alata* - Candle Bush)

Section C - Kimmorley Bridge to new Airport bridge.

Transect C.1 - following creek upstream from Kimmorley Bridge approx. 1.5km to the new Airport bridge. A narrow band of rainforest community ranging in width from about 50m to sometimes less than 10m. Canopy heigh of about 10-13m. Main species are *Acacia auriculiformis*, *Syzygium angophoroides*, *Carallia brachiata* and *Lophostemon lactifluus*, with *Pandanus spiralis* and *Barringtonia acutangula*

Species

Acacia auriculiformis
Alphitonia excelsa
Alstonia actinophylla(Milkwood)
Antieris toxicaria
Barringtonia acutangula(Freshwater Mangrove)
* *Bauhinia galpinii*(garden shrub escape)
Breynia cernua
Calophyllum soulattri
* *Calopogonium mucunoides*(Calopo, legume vine with brown-hairy trifoliate leaves)
Canarium australianum
Carallia brachiata
Carpentaria acuminata(a few seedlings)
Clerodendrum castetum
Cupaniopsis anacardioides
Cryptocarya cunninghamii
Denhamia obscura
Dianella adorata
Dicranopteris linearis
Diospyros calycantha
Dysoxylum oppositifolium
Elaeocarpus arnhemicus
Erythrophleum chlorostachys(Ironwood)
Euodia elleryana
Ficus opposita
Ficus scabina
Flagellaria indica
*Galactia*sp. ? *tenuiflora*
Gymnanthera nitida
Helicia australasica
Ipomoea trilaba
Ixora klanderana
* *Leucaena leucocephala*
Litsea glutinosa
Lophostemon lactifluus
Lygodium flexuosum
Maranthes corymbosa
Melaleuca leucadendra
Melaleuca viridiflora
Memecylon pauciflorum
Nauclea orientalis(Leichhardt Tree)
Opilia amentacea
Pandanus spiralis
* *Passiflora foetida*(Wild Passionfruit)
* *Pennisetum pedicillatum*(annual *Pennisetum*)
* *Pennisetum polystachion*(Mission Grass)

Pittosporum melanospermum
Planchonella pohlmaniana
Pleomele angustifolia
Pouteria sericea
Smilax australis
* *Stachytarpheta* spp.
* *Stylosanthes hamata*
Syzygium angophoroides
Timonius timon
Trema tomentosa
Urena lobata
Uvaria hoitzei
Waltheria indica

Site C.1 - western side of creek, just west of airport bridge (map loc. 704080E; 8627960N). *Sorghum* grassland with dense weed infestations.

Species
* *Calopogonium mucunoides*
Hibiscus meraukensis
* *Hyptis suaveolens*
* *Passiflora foetida*
* *Pennisetum pedicillatum*
* *Pennisetum polystachion*
Sorghum intrans

Site C.2 - eastern side of creek, west of airport entrance road (map loc. 703920E; 8628360N). Transition *Pandanus*/*Lophostemon* woodland with dense grassy understorey. The *Pandanus* community interspersed with some mixed eucalypt grassy woodland covered most of this area bounded by the creek, Macmillans Rd. and the aiport entrance road.

Early control burns in this area in 1992, before *Pennisetum polystachion* had flowered, had greatly reduced the density of this grass in the current year (Mike Clark pers. comm.)

Species
Eucalyptus alba (occasional)
Eucalyptus polycarpa
Heteropogon triticeus
Lophostemon lactifluus
Pandanus spiralis
* *Pennisetum polystachion*

Section D - new Airport bridge to headwaters (RAAF land)

D.1 - Eucalypt woodland enclosed by the two upper arms of the creek and the catchment area - RAAF land. Regeneration *Eucalyptus tetrodonta/ E. miniata* woodland with sparse midstorey and little ground layer other than *Sorghum intrans*. This community is subject to severe annual or biannual fires and shows substantial degradation in tree density and structure as a result. *Terminalia ferdinandiana, Livistona humilis, Acacia aulacocarpa* and *Cycas armstrongii* are found as scattered individuals.

Site D.3 - near south-eastern corner of Northlakes Golf Course (map loc. 706000E; 8627960N)

Large infestation of wetland grass weed *Brachiaria mutica* (Para Grass) covering margins of extensive *Melaleuca viridiflora* swamp - the swamp being part of the system of paperbark swamps enclosing the headwaters of the main (northern) arm of Rapid Ck.

Site D.4 - creek crossing on minor (southern) arm of Rapid Ck. near end of main airport runway (map loc. 705880E; 8626480N). No substantial Paperbark Community type 12 was found here as indicated on the Veg. Map.

Species
Acacia holosericea
Alphitonia excelsa
Dicranopteris linearis
Melaleuca viridiflora
Pandanus spiralis

Site D.6 - eastern side of Airport bridge, eucalypt woodland bound on the north by Marara Sports Complex and Northlakes Golf Course and by the creek on the south (map loc. 705000E; 862720N)

A substantial community of *Eucalyptus miniata* and *E. tetrodonta* woodland - open forest, relatively healthy habitat with good-sized canopy trees, and moderate regeneration and seedling recruitment. Boundaries on most sides lined with dense belts of grassland dominated by the weed *Pennisetum polystachion* (Mission Grass), however the community appears to be a good representative type, worthy of management protection.

Species
Acacia dimidiata
Acacia mimula
Alphitonia excelsa
Ampelocissus acetosa
Astonia actinophylla
Brachychiton diversifolius
Brachychiton megaphyllus
Buchanania obovata
Cycas armstrongii
Denhamia obscura
Erythrophleum chlorostachys
Eucalyptus miniata(Woollybutt)
Eucalyptus tetrodonta(Stringybark)
Grevillea heliosperma
Pandanus spiralis
* *Pennisetum polystachion*
Persoonia falcata
Planchonia careya(Cocky Apple)
Sorghum intrans
Syzygium suborbiculare(Red Bush Apple)
Terminalia ferdinandiana(Billy Goat Plum)

Site D.7 - headwaters of minor southern arm of creek (map loc. 706560E; 8626320N). No substantial Paperbark community type 12 was located as indicated on the Veg. Map. The main community consisted of *Pandanus spiralis* interspersed with *Lophostemon lactifluus* and *Grevillea pteridifolia*.

D.8 NB - approx. 1km upstream from airport bridge on southern (minor) arm of creek (map loc. 705240E; 8627240N) - area marked as Monsoon Forest type 29 on veg. map not located. The main communities along this section of the creek are *Pandanus spiralis* interspersed with *Lophostemon lactifluus*, and some closed *Pandanus spiralis*.

Management Issues

1. Mangrove communities

These communities occupy the saline-influenced tidal zone from near the mouth of the creek to upstream of the Trower Rd. bridge.

Impact on the mangroves largely coincides with major stormwater drains where *Leucaena leucocephala* (Coffee Bush) in particular has invaded. Erosion channels are common at these sites sometimes right down to the creek bank edges.

2. Rainforest

A narrow continuous belt of monsoon rainforest occurs along the creek from approx. 500m downstream of Kimmorley Bridge through to the airport bridge. From there upstream to 'Yankee Pool' the creekside vegetation consists mostly of *Pandanus spiralis*. Another patch of rainforest occurs approximately 800-900m upstream from the airport bridge on the northern (main) arm of the creek. This community is impacted throughout by erosion, bank degradation, car and human traffic, land clearing, weeds and fire. The boundaries in particular have been subject to regular hot fires with consequent loss of much regeneration and ground layer vegetation. Besides the dominant species (see transect C.1), population size of many species is low, and often consists of few individual plants. This area is in need of urgent management measures to stabilise and rehabilitate the remnant rainforest corridor.

3. Transition and grassland communities

These mixed woodland communities comprising amongst others scattered *Eucalyptus*, *Pandandus*, *Acacia* and *Lophostemon* species (e.g. site C.1) are found on both sides of the creek, intergrading with expanses of weed-infested grassland (predominantly *Pennisetum polystachion*), forming ill-defined boundaries between one community and the next. Mid- and shrub layer vegetation is virtually absent, most likely a consequence of regular uncontrolled fires.

4. Weeds

Mimosa pigra - one or two small plants located near site B.1 on cleared recreation land beside Rapid Ck Rd. opposite the water gardens. High priority noxious weed to be eliminated.

Pennisetum polystachion - widespread, particularly edges of eucalypt forest/woodland and lower-lying grassland and pandanus communities. A pervasive weed which produces more dry matter than the native *Sorghum intrans* and dries later in the year potentially facilitating hotter more severe fires towards the end of the dry season.

Andropogon gayanus (Gamba Grass) - few outbreaks only located during survey in vicinity of site D.6 amongst low-lying grassland. A extremely vigorous weed to be eliminated and controlled. Even more than *P.*

polystachion it produces massive quantities of potential dry fuel for uncontrolled fires.

Leucaena leucocephala - mostly present in the lower reaches of the creek especially around the mangroves.

Other serious weeds
Calopogonium mucunoides - already serious infestations.
Brachiaria mutica (Para Grass)
Senna alata
Lantana camara
Wedelia trilobata

Less serious:
Clitorea ternatea
Stachytarpheta spp.
Ruellia tuberosa
Gossypium hirsutum
? Desmanthus virgatus (Mimosaceae small shrub)

- Classifact of R.F. wrt RF Key (Russell-Smith)
- ~~Co~~ Recommended spp for Rehab: if anything
- 'Source' of main creek adj. to Kalymnos & Trimmers Club. — ~~g~~ totally degraded.

Fauna of The Rapid Creek Region of Darwin

This study aims to introduce the diversity of animals in Rapid Creek . It does not constitute an intensive fauna survey of the region, but pools existing information for the purposes of management. The list includes fauna which could be encounted in the freshwater zone of Rapid Creek. Other habitats (mangrove, estuarine) have been briefly reviewed to update the current fauna list.

1. Literature Review

There have been a number of reports on the area covering hydrology, water quality, drainage, recreational (the Brinkin lake proposal) and landscaping developments. An environmental study which was conducted in the Leanyer and Marrara swamps in 1978, provides a tentative list of invertebrates occurring in the Buffalo Creek mangroves. Dwyer and Associates (1980) provide a good assessment of the vertebrates (birds, reptiles and mammals) and invertebrates (benthic fauna) occurring in Rapid Creek mangroves. This is supplemented with a list of the fish fauna utilising the mangroves and estuary (CCNT 1991).

Studies on the freshwater habitats of Darwin have not yet been initiated. Current knowledge of lentic and lotic environments stem from faunal collections in the Alligator River Region by the CSIRO (Midgley, 1972) and the Office of the Supervising Scientist (Marchant, 1982; Tyler and Crook, 1987; Bishop *et.al.* 1986). Current studies on freshwater ecology of Magela Creek in Kakadu National Park are nearing completion and will soon be published. These will provide a good basis from which similar ecosystems in Darwin can be assessed.

The apparent dearth of aquatic studies results from the lack of basic research. Animal groups such as the Platyhelminthes, Nemertea, Nematoda, etc. require careful taxonomic identification, while in other cases the relevant identification keys do not exist for Australian species. A large proportion of aquatic animals in lentic and lotic environments are immature insects and crustaceans. Full descriptions of some species utilise adult and immature specimens. Few adults have been linked to their immature aquatic forms and the immature forms have not been described. The taxonomy of aquatic insect larvae is therefore limited, and keys are scattered or in a state of revision. Most of the Northern Territory Museum's collection remains undescribed, and will remain so until a complete revision of the relative orders within Australia have taken place.

2. Rapid Creek Fauna Survey

2.1 Region of Investigation

An assessment of Rapid Creek for a plan of management requires the inclusion of all abiotic and biotic components affecting the system. The area in this study encompasses the whole catchment, an area of 28 square kilometres. The size of the freshwater region (the swamp and stream) varies seasonally with the annual wet. Drainage of the wetland is slow and springs maintain a good flow of water in the creek for most of the year. A rich and diverse range of aquatic organisms are able to live there.

To adequately describe the fauna, the habitats have been separated into terrestrial and aquatic. The latter has been grossly divided into freshwater (swamp and stream) and brackish/saline (mangroves and estuary) habitats. A degree of overlap does occur through tidal influence but this has been ignored in this review.

2.2 Terrestrial Fauna

A rich and diverse fauna utilise the region. Dwyer and Associates assessed the variety of mammals, birds and reptiles in 1980. The Casuarina Recreation Reserve Management Plan published by the CCNT, and a current list from their Biological Data Base. form a basis for this survey. Species most likely to occur in the whole region are listed in Appendix 1.1.

2.3 Freshwater fauna

A diverse range of organisms utilise freshwater habitats. The fauna in the Northern Territory is not likely to be very different from any other Australian region. While different species will occur, the basic structure of the communities are essentially composed of the same specialised groups of animals. This survey provides a list of species which have been encountered in the Top End.

Annelid worms

The diversity of fauna living in freshwater is unknown and can only be assessed when the fauna list is provided from the museum (Dr Russell Hanley). There is a large fauna list for mangrove and estuarine habitats, compiled from EIS studies conducted in the N.T.

Snails and Mussels

Australia's aquatic molluscs have been well documented. An comprehensive list of most of the species occurring within Northern Australia, has been compiled from the Museum and Smith (1992). (Appendix 2.1)

Insects

Some of the insects have been identified from adult specimens located within the Darwin region. The Order Odonata (Dragonflies) and Trichoptera (Caddis-flies) have been described Australia wide. Specimens in the Northern Territory have been identified from adults captured within a 50 km radius of Darwin. The museum collection has very few specimens from the other Orders identified; these include the Collembola, Hemiptera, Diptera, Coleoptera, Megaloptera, and Neuroptera. The fauna list is compiled from the N.T. Museum, the Department of Primary Industry and published reports of species occurring in the Alligator Rivers region (Magela Creek). (Appendix 2.1)

Crustaceans

A brief reconnaissance of the freshwater stream revealed the presence of a large number of crustaceans. Many of these species have a wide distribution throughout Northern Australia. Julli (1986), Marchant (1982) and Williams (1979,1980) provided the basis for assembling this list. (Appendix 2.1)

Aquatic vertebrates (Fish)

They have been no previous surveys in Rapid Creek . The list (Appendix 2.2) is suggestive of species most likely to be encounted in streams or swamps This has been compiled from Larson & Martin (1990), and species located within Howard Springs (CCNT 1992) and Magela Creek. (Marchant 1982). It is probable that the diversity of fish within Rapid Creek would be reduced because of its small size.

2.4 Mangrove and Estuarine Fauna

The Invertebrate benthic and littoral fauna were surveyed by Dwyer and Associates. in 1980 (Appendix 3.1). The Conservation Commission compiled a list of vertebrates occurring in the mangroves and estuary of Casuarina in 1991 (Appendix 3.2).

3. Environmental Impact on biological communities

In Darwin, man has many direct affects on the natural ecosystems and the biological communities within and surrounding the metropolitan area. While this surveys primary aim is to provide a guide to the diversity of animals living within the different habitats of Rapid Creek. Brief field observations in the area have highlighted a number of factors having noticeable impacts on terrestrial and aquatic biological communities This brief list is provided to assist in developing management strategies to maintain the biodiversity of animal communities within the region

3.1 Terrestrial

Environmental Impacts on the Terrestrial Habitats

1. The continued habitat loss through development.
   The maintenance of habitat diversity (Botanical Assessment) is of primary importance
2. The impact of feral animals (eg. feral pig, domestic dog and cat)
   -The feral pig is known to have a significant effect of river catchments, damaging water bodies and destroying vegetation. The domestic dog and more importantly the cat have a large impact on native reptiles, birds and mammals.
3. The effect of land fill and refuse
   - Habitat Loss.
4. Human and recreational impact
   - Unknown.
5. Fire Management
   -Effect on animal communities is unknown. It must influence the viability of small populations of reptiles, birds and mammals in the area.

Fauna of The Rapid Creek Region of Darwin

Appendix 1.1 Terrestrial Invertebrates of Rapid Creek

Order Lepidoptera	Butterflys
Family: Papilionidae	
Cressida cressida cassandra	
Graphium euryplus lycaon	Pale Green Butterfly
Papilio canopus canopus	Northern Citrus Butterfly
Family: Pieridae	
Appias paulina ega	
Catopsilia scylla etesia	
Catopsilia pomona pomona	Cassia Butterfly
Delias argenthona fragalactea	
Elodina perdita walkeri	
Eurema hecabe phoebus	
Family: Nymphalidae	
Cethosia penthesilia paksa	
Danaus affinis affinis	
Danaus chrysippus petilia	Lesser Wanderer Butterfly
Danaus hamatus hamatus	
Euploea core corrina	Oleander Butterfly
Hypocystaadiante antirius	
Hypolimnas bolina nerina	
Hypolimnas missipus	
Junonia hedonia zelina	
Junonia orythyia albicincta	
Melanitis leda bankia	Evening Brown Butterfly
Phalantha phalantha araca	
Family: Lycaenidae	
Candalidea erinus erinus	

CCNT (1991)

Appendix 1.2 Terrestrial Vertebrates of Rapid Creek

Class: Amphibia	
Family: Hylidae	
Cyclorana australi	
Litoria bicolor	Northern Dwarf Tree Frog
Litoria caerulea	Green Tree Frog
Litoria dahlii	
Litoria inermis	
Litoria microbelos	
Litoria nasuta	Rocket Frog
Litoria rothii	
Litoria rubella	Desert Tree Frog
Litoria tornieri	

Family: Leptodactylidae	
Limnodynastes convexiusculus	Marbled Frog
Limnodynastes ornatus	Ornate Burrowing Frog
Notaden melanoscaphus	Northern Spadefoot Toad
Platyplectron omatus	
Ranidella bilingua	
Uperoleia inundata	
Uperoleia lithomoda	

CCNT (1992); Tyler and Davies (1986)

Class: Reptilia	
Family: Agamidae	
Chamydosaurus kingii	Frilled Lizard
Diporiphora bilineata	Two-Lined Dragon
Lophognathus gilberti	
Lophognathus temporalis	Northern Water Dragon
Family: Boidae	
Bothrochilus olivaceus	Olive Python
Liasis childreni	Children's Python
Liasis mackloti	
Morelia spilota	Carpet Python
Family: Colubridae	
Amphiesma mairii	Freshwater Snake
Boiga irregularis	Brown tree Snake
Dendrelaphis punctulatis	Common tree Snake
Fordonia leucobalia	White bellied Mangrove Snake
Myron richardsoni	Mangrove Snake
Family: Elapidae	
Cryptophis pallidiceps	Northern Small-Eyed Snake
Demansia olivacea	Whip Snake
Furina diadema	Red-Naped Snake
Pseudonaja nuchalis	Western Brown Snake
Cererus australis	
Family: Gekkonidae	
Hemidactylus frenatus	House Gecko
Heteronotia binoei	Bynoe's Gecko
Oedura rhombifer	
Family: Hydrophiidae	
Hydrelaps darwinensis	
Hydrelaps elegans	
Family: Pygopodidae	
Delma botea	Legless Lizard
Lialis burtonis	Burton's Snake-Lizard
Family: Scincidae	
Carlia amax	
Carlia foliorum	
Carlia gracilis	Four-Fingered Skink
Carlia rufilatus	
Ctenopus essingtoni	

Family: Scincidae (cont.)	
Sphenomorphus crassicaudus	
Sphenomorphus isolepis	
Tiliqua scincoides	Eastern Blue-tongued Lizard
Family: Varanidae	
Varanus gouldii	Gould's Goanna
Varanus mitchelli	Mitchell's Water Monitor
Varanus timorensis	Spotted Tree Monitor
	CCNT (1993)
Class Avies	Birds
Family:Acanthizidae	
Gerygone chloronata	Green-Backed Gerygone
Gerygone laevigaster	Mangrove Gerygone
Gerygone magnirostris	Large- Billed Gerygone
Gerygone olivacea	White-Throated Gerygone
Smicrornis brevirostris	Weebill
Family:Accipitridae	
Accipiter cirrhocephalus	Collared Sparrowhawk
Accipiter fasciatus	Brown Goshawk
Aquila audax	Wedge Tailed Eagle
Aviceda subcristata	Pacific Baza
Circus approximans	Marsh Harrier
Circus assimilis	Spotted Harrier
Elanus notatus	Black-shouldered Kite
Haliaeetus leucogaster	White Bellied Sea-eagle
Hamirostra melanosternon	Black-breasted Buzzard
Milvus indus	Brahminy Kite
Milvus migrans	Black Kite
Milvus sphenurus	Whistling Kite
Pandion haliaetus	Osprey
Family: Aegothelidae	
Aegotheles cristatus	Australian Owlet Night-jar
Family: Alaudidae	
Mirafra javanica	Singing bushlark
Family:Alcedinidae	
Alcedo azurea	Azure Kingfisher
Alcedo pusilla	Little Kingfisher
Dacelo leachii	Blue-winged Kookaburra
Halcyon chloris	Collared Kingfisher
Halcyon pyrrhopygia	Red-backed Kingfisher
Todiramphus macleayii	Forest Kingfisher
Todiramphus sancta	Sacred Kingfisher
Family: Anatidae	
Anas gibberifrons	Grey Teal
Anas superciliosa	Pacific Black Duck
Anseranas semipalmata	Magpie Goose
Aythya australis	Hardhead
Dendrocygna arcuata	Wandering Whistling duck

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CCNT (1993)

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Aythya australis	Hardhead
Dendrocygna arcuata	Wandering Whistling duck

Family: Anatidae (cont.)	
Dendrocygna eytoni	Plumed Whistling Duck
Nettapus pulchellus	Green Pygmy-goose
Tadorna radjah	Radjah Shelduck
Family: Anhingidae	
Anhinga melanogaster	Darter
Family: Apodidae	
Apus pacificus	Fork-tailed Swift
Family: Ardeidae	
Ardea alba	Great Egret
Ardea garzetta	Little Egret
Ardea ibis	Cattle Egret
Ardea intermedia	Intermediate Egret
Ardea novaehollandiae	White-faced Heron
Ardea pacifica	Pacific Heron
Ardea picata	Pied Heron
Ardea sacra	Eastern Reef Egret
Ardea sumatrana	Great-billed Heron
Ardeola striatus	Striated Heron
Ixobrychus flavicollis	Black Bittern
Nycticorax caledonicus	Rufous Night Heron
Family:Artamidae	
Artamus leucorhynchus	White-breasted Woodswallow
Family: Burhinidae	
Burhinus grallarius	Bush Thick-knee
Esacus magnirostris	Beach Thick-knee
Family: Campephagidae	
Coracina novaehollandiae	Black-faced Cuckoo-shrike
Coracina papuensis	White-bellied Cuckoo-shrike
Coracina tenuirostris	Cicadabird
Lalage leucomela	Varied Triller
Lalage sueurii	White-winged Triller
Family:Caprimulgidae	
Eurostopodus argus	Spotted Nightjar
Caprimulgus macrurus	Large-tailed Nightjar
Family: Charadriidae	
Charadrius leschenaultii	Large Sand Plover
Charadrius mongolus	Mongolian Plover
Charadrius ruficapillus	Red-capped Plover
Charadrius veredus	Oriental Plover
Erythrogonys cinctus	Red-kneed Dotterel
Pluvialis dominica	Lesser Golden Plover
Pluvialis squatarolua	Grey Plover
Vanellus miles	Masked Plover (Lapwing)
Family: Ciconiidae	
Ephippiorhynchus asiaticus	Black-necked Stork (Jabiru)
Family: Columbidae	
Chalcophaps indica	Emerald Ground-dove
Columba livia	Feral Pigeon

Family: Columbidae (cont.)	
Ducula bicolor	Torresian Imperial Pigeon
Geopelia humeralis	Bar-shouldered Dove
Geopelia placida	Peaceful Dove
Ptilinopus regina	Rose-crowned Fruit-dove
Family: Corvidae	
Corvus orru	Torresian Crow
Family: Cracticidae	
Cracticus nigrogularis	Pied Butcherbird
Cracticus quoyi	Black Butcherbird
Family: Cuculidae	
Cuculus variolosus	Brush Cuckoo
Centropus phasianinus	Pheasant Coucal
Chrysococcyx basalis	Horsfield's Bronze-cuckoo
Chrysococcyx minutillus	Little Bronze-cuckoo
Cuculus pallidus	Pallid Cuckoo
Cuculus saturatus	Oriental Cuckoo
Eudynamys scolopacea	Common Koel
Scythrops novaehollandiae	Channel-billed Cuckoo
Family: Dicaeidae	
Dicaeum hirundinaceum	Mistletoe Bird
Family:Dicruridae	
Dicrurus bracteatus	Spangled Drongo
Family: Falconidae	
Falco berigora	Brown Falcon
Falco cenchroides	Australian Kestrel
Falco longipennis	Australian Hobby
Falco peregrinus	Peregrine Falcon
Falco subniger	Black Falcon
Family: Fregatidae	
Fregata ariel	Least Frigatebird
Fregata minor	Great Frigatebird
Family: Glareolidae	
Glareola maldivarum	Oriental Pratincole
Stiltia isabella	Australian Pratincole
Family: Grallinidae	
Grallina cyanoleuca	Australian Magpie-lark
Family: Gruidae	
Grus rubicundus	Brolga
Family:Haematopodidae	
Haematopus ostralegus	Pied Oystercatcher
Family:Hirundinidae	
Hirundo ariel	Fairy Martin
Hirundo nigricans	Tree Martin
Family: Jacanidae	
Irediparra gallinacea	Comb-crested Jacana
Family: Laridae	
Chlidonias hybrida	Whiskered Tern
Chlidonias leucoptera	White-winged Tern

Family: Laridae (cont.)	
Larus novaehollandiae	Silver Gull
Sterna albifrons	Little Tern
Sterna anaethetus	Bridled Tern
Sterna bengalensis	Lesser Crested Tern
Sterna bergii	Crested Tern
Sterna caspia	Caspian Tern
Sterna dougallii	Roseate Turn
Sterna hirundo	Common Teal
Sterna nilotica	Gull-billed Tern
Family: Maluridae	
Cinclorhamphus cruralis	Brown Songlark
Malurus melanocephalus	Red-backed Fairy-Wren
Family: Motacillidae	
Anthus novaeseelandiae	Richard's Pipit
Motacilla flava	Yellow Wagtail
Family: Megapodiidae	
Megapodius reinwardt	Orange-footed Scrubfowl
Family: Meliphagidae	
Conopophila albogularis	Rurous-banded Honeyeater
Entomyzon cyanotis	Blue-faced Honeyeater
Lichenostomus unicolor	White-gaped Honeyeater
Lichmera indistincta	Brown Honeyeater
Manorina flavigula	Yellow-throated Miner
Meliphaga albilineata	White-lined Honeyeater
Melithreptus albogularis	White-throated Honeyeater
Myzomela erythrocephala	Red-headed Honeyeater
Myzomela obscura	Dusky Honeyeater
Philemon argenticeps	Silver-crowned Friarbird
Philemon buceroides	Helmeted Friarbird
Philemon citreogularis	Little Friarbird
Ramsayornis fasciatus	Bar-breasted Honeyeater
Family: Meropidae	
Eurystornus orientalis	Dollarbird
Merops ornatus	Rainbow Bee-eater
Family: Muscicapidae	
Colluricincla megarhyncha	Little Shrike-thrush
Eopsaltria pulverulenta	Mangrove Robin
Microeca flavigaster	Lemon-bellied Flycatcher
Myiagra alecto	Shining Flycatcher
Myiagra inquieta	Restless Flycatcher
Myiagra rubecula	Leaden Flycatcher
Myiagra ruficollis	Broad-billed Flycatcher
Pachycephala simplex	Grey Whistler
Rhipidura leucophrys	Willie Wagtail
Rhipidura rufiventris	Northern Fantail

Family:Oriolidae	
Oriolus flavocinctus	Yellow Oriole
Oriolus sagittatus	Olive-backed Oriole
Sphecotheres viridis	Figbird
Family: Otididae	
Ardeotis australis	Australian Bustard
Family:Pardalotidae	
Pardalotus striatus	Striated Pardalote
Family:Pelecanidae	
Pelecanus conspicillatus	Australian Pelican
Family: Phalacrocoracidae	
Phalacrocorax carbo	Great Cormorant
Phalacrocorax melanoleucos	Little pied Cormorant
Phalacrocorax sulcirostris	Little black Cormorant
Phalacrocorax varius	Pied Cormorant
Family:Phasianidae	
Coturnix chinensis	King Quail
Coturnix australis	Brown Quail
Family:Pittidae	
Pitta iris	Rainbow Pitta
Family: Plataleidae	
Platalea flavipes	Yellow-billed Spoonbill
Platalea regia	Royal Spoonbill
Plegadis falcinellus	Glossy Ibis
Threskiornis aethiopica	Sacred Ibis
Threskiornis spinicollis	Straw-Necked Ibis
Family:Ploceidae	
Lonchura castaneothorax	Chestnut-Breasted mannikin
Lonchura flaviprymna	Yellow-rumped Mannikin
Neochmia phaeton	Crimson Finch
Poephila acuticauda	Long-tailed Finch
Taeniopygia bichenovii	Double-barred Finch
Family: Podargidae	
Podargus strigoides	Tawny Frogmouth
Family: Podicipedidae	
Tachybaptus novaehollandiae	Australian Grebe
Family: Procellariidae	
Puffinus pacificus	Wedge-tailed Shearwater
Family: Psittacidae	
Aprosmictus erythropterus	Red-winged Parrot
Cacatua galerita	Sulphur-crested Cockatoo
Cacatua roseicapilla	Galah
Cacatua pastinator	Little Corella
Calyptorhynchus banksii	Red-tailed Black-cockatoo
Leptolophus hollandicus	Cockatiel
Platycercus venustus	Northern Rosella
Psitteuteles versicolor	Varied Lorikeet
Trichoglossus rubritorquis	Red Collared Lorikeet

Family:Ptilonorhynchidae	
Chlamydera nuchalis	Great Bowerbird
Family:Rallidae	
Amaurornis olivacea	Bush-hen
Eulabeornis castaneoventris	Chestnut Rail
Gallirallus philippensis	Buff-banded Rail
Poliolimnas cinereus	White-browed Crake
Porphyrio porphyrio	Purple Swamphen
Porzana pusilla	Baillon's Crake
Family: Recurvirostridae	
Himantopus himantopus	Pied Stilt
Family:Scolopacidae	
Actitis hypoleucos	Common Sandpiper
Arenaria interpres	Ruddy Turnstone
Calidris acuminata	Sharp-tailed Sandpiper
Calidris alba	Sanderling
Calidris canutus	Red knot
Calidris ferruginea	Curlew Sandpiper
Calidris minuta	Little Stint
Calidis ruficollis	Red necked Stint
Calidis tenuirostris	Great Knot
Gallinago megala	Swinhoe's Snipe
Gallinago stenura	Pin-tailed Snipe
Limosa lapponica	Bar-tailed Godwit
Limosa limosa	Black-tailed Godwit
Numenius madagascariensis	Eastern Curlew
Numenius minutus	Little Curlew
Numenius phaeopus	Whimbrel
Tringa brevipes	Grey-tailed Tattler
Tringa glareola	Wood Sandpiper
Tringa incana	Wandering Tattler
Tringa nebularia	Greenshank
Tringa stagnatilis	Marsh Sandpiper
Xenus cinereus	Terek Sandpiper
Family: Strigidae	
Ninox connivens	Barking Owl
Ninox noveseelandiae	Southern Boobook
Family:Sulidae	
Sula leucogaster	Brown Booby
Family: Sylviidae	
Acrocephalus arundinaceus	Great reed-Warbler
Acrocephalus stentoreus	Clamorous Reed Warbler
Cisticola exilis	Golden-Headed Cisticola
Cisticola juncidis	Zitting Cisticola
Megalurus timoriensis	Tawny Grassbird
Family: Turnicidae	
Turnix maculosa	Red-backed Button-quail
Turnix pyrrhothorax	Red-chested Button-quail

E

Family: Tytonidae	
Tyto alba	Barn Owl
Family:Zosteropidae	
Zosterops lutea	Yellow White Eye

CCNT (1993); Simpson & Day (1989)

Class: Mammalia	
Family: Bovidae	
Bubalus bubalus	Water Buffalo
Family: Canidae	
Canis familiaris	Dog, Dingo
Family:Dasyuridae	
Dasyurus hallucatus	Northern Quoll
Family: Emballonuridae	
Taphozous flaviventris	Yellow-bellied Sheathtail Bat
Family: Equidae	
Equus caballus	Feral Horse
Family: Felidae	
Felis catus	Feral Cat
Family: Macropodidae	
Macropus agilis	Agile Wallaby
Macropus antilopinus	Antilopine Wallaroo
Family: Megadermatidae	
Macroderma gigas	Ghost Bat
Family Molossidae	
Chaeophon jobensis	Northern Mastiff-bat
Family Muridae	
Hydromys chrysogaster	Water Rat
Melomys burtoni	Grass Melomys
Melomys littorali	Grassland Melomys
Mesembriomys gouldii	Black Footed Tree Rat
Mus musculus	House Mouse
Rattus colletti	Dusky Rat
Rattus rattus	Black Rat
Rattus tunneyi	Pale Field-Rat
Family: Peramelidae	
Isoodon macrourus	Northern Brown Bandicoot
Family: Petauridae	
Petaurus breviceps	Sugar Glider
Family: Phalangeridae	
Trichosurus arnhemensis	Northern Brushtail Possum
Family: Pteropodidae	
Macroglossus lagochilus	Northern Blossom-Bat
Pteropus alecto	Black Flying-fox
Pteropus scapulatus	Little Red Flying fox
Family: Suidae	
Sus scrofa	Feral Pig

Family: Tachyglossidae	
Tachyglossus aculeatus	Short-beaked Echidna
Family: Vespertilionidae	
Chalinolobus gouldi	Gould's Wattled Bat
Chalinolobus nigrogriseus	Hoary Bat
Eptesicus pumulis	Little cave Eptesicus
Miniopterus schreibersii	Common Bent-wing Bat
Myotis adversus	Large-footed Mouse Eared Bat
Nycticeius greyii	Little broad-nosed Bat
Nyctophilus arnhemensis	Arnhem Land Long-eared Bat
Nyctophilus geoffroyi	Lesser Long-eared Bat

CCNT (1993)

Appendix 2.1 Freshwater Macro-invertebrates of Rapid Creek

Phylum: Porifera	Sponges
Pectispongilla botryoides	
Phylum Annelida	
Class: Hirudinea	Leeches
Glossiphoniidae sp.A	
Richardsonianidae sp.A	
Phylum: Chelicerata	
Class: Arachnida	Spiders
Order: Araneae	
Family:Pisauridae	
Dolomedes sp.	
Class: Crustacea	
Subclass: Branchiopoda	
Order: Cladocera	Water Fleas
Family: Bosminidae	
Bosmina meridionalis	
Bosminopsis deitersi	
Family:Chydoridae	
Alona davidi	
Alona monacantha	
Alonella clathratula	
Australochydorus aporus	
Biapertura karua	
Biapertura kendallensis	
Biapertura macrocopa	
Biapertura rigidicaudis	
Biapertura verrucosa	
Camptocerus australis	
Chydorus eurynotus	
Dadayamacrops	
Dunhevedia crassa	
Ephemeroporus barroisi	

Family:Chydoridae (cont.)
Euryalona orientalis
Graptoleberis testudinaria
Kurzia longirostris
Leydigia acanthocercoides
Oxyurella singalensis
Family:Daphniidae
Ceriodaphnia cornuta
Scapholeberis kingi
Simocephalus latirostris
Simocephalus serrulatus
Family:Macrothricidae
Echinisca triserialis
Echinisca williams
Ilyocryptus spinifer
Macrothrix hystrix
Macrothrix spinosa
Streblocerus serricaudatus
Family:Moinidae
Moina micrura
Moinodaphnia macleayi
Family: Sididae
Diaphanosoma excisum
Diaphanosoma sarsi
Latonopsis australis
Latonopsis brehmi
Latonopsis fasciculata
Pseudosida bidentata

Subclass:Copepoda
Order: Calanoida — Calanoid Copepods
Family:Calanidae
Calamoecia ultima
Family: Diaptomidae
Diaptomus australis
Diaptomus lumholtzi
Order: Cyclopoida — Cyclopoid Copepods
Family:Cyclopoidae
Ectocyclops sp.
Mesocyclops aspericornis
Mesocyclops decipiens
Mesocyclops leuckarti
Microcyclops varicans

Julli (1986)

Subclass: Malacostraca
Order: Decapoda
Family: Atyidae — Freshwater Shrimps
Caridina sp. A

Family: Palamonidae Freshwater Prawns
Macrobrachium rosenbergii
Macrobrachium sp. A
Macrobrachium sp. B
Palaemon spp.
Family: Parastacidae
Cherax quadricarinatus Redclaw
Family: Sundathelphusidae
Holthusiana transversa Freshwater Crab
Marchant (1982)

Phylum: Uniramia
Order: Ephemeroptera Mayflies
Family: Baetidae
Atalonella sp.A
Baetis sp.A
Centroptilum sp.A
Cloeon fluviatile
Thraulus sp.A
Family:Caenidae
Tasmanocoenis sp.A
Tasmanocoenis sp.B
N.T.Museum
Order: Odonata Dragonflies
Family:Coenagrionodae
Agriocnemis pygmaea
Austrognacantha heterogena
Ceriagrion aeruginosum
Ischnura heterosticta heterosticta
Ischnura pruinescens
Pseudagrion microcephalum
Family: Aeshnidae
Anax guttatus
Hemianax papuensis
Family: Gomphidae
Ictinogomphus australis
Family: Corduliidae
Pentathemis membranulata
Family: Libellulidae
Aethriamanta circumsignata
Agrionoptera insignis allogenes
Brachydiplax denticauda
Crocothemis nigrifrons
Diplacodes bipunctata
Diplacodes haematodes
Diplacodes nebulosa
Diplacodes trivialis
Hydrobasileus brevistylus
Nannodiplax rubra

E

Family: Libellulidae (cont.)
Neurothemis stigmatizans stigmatizans
Orthetrum caladonicum
Orthetrum sabina sabina
Pantala flavescens
Potamarcha congener
Rhodothemis lieftincki
Rhodothemis braganza
Rhodothemis graphiptera
Tholymis tillarga
Trapezostigma loewii N.T. Museum

Order: Trichoptera Caddisflies
Family: Philopotamidae
Chimarra uranka
Chimarra sp. A
Chimarra sp. B
Chimarra sp. C
Family: Hydroptilidae
Tricholeiochiton bifurca
Family: Calamoceratidae
Anisocentropus banghaasi
Anisocentropus muricat
Family: Leptoceridae
Leptocerus atsou
Family: Ecnomidae
Ecnomus miriwud
Ecnomus tropilus
Ecnomus ancisus
N.T. Museum

Order: Hemiptera
Family: Corixidae Water Boatmen
Agraptocorixa halei
Agraptocorixa sp. A
Agraptocorixa sp. B
Family: Belastomatidae Giant Water Bugs
Lethocerus distinctifemyr sp.
Lethocerus insulanus sp.
Lethocerus sp. A
Diplanychus sp. A
Family: Gerridae Water Striders
Limnogonus sp.
Rhagadotarus sp.
Rheumatometra sp.
Family: Hydrometridae
Hydrometra sp.
Family: Naucoridae
Naucoris sp. A

Family: Nepidae — Water Scorpion
Ranatra diminuta

Family: Notonectidae — Backswimmers
Nychia marshalli
Anisops paracrinita
Anisops spinloa
Anisops stali
Anisops nasuta
Enithares spinola
Enithares loria
Enithares sp. A
Enithares sp. B
Enithares sp.C

Family: Pleidae
Plea brunni

Family: Veliidae
Rhagovelia sp.

Dep. I Industories, N.T.Museum; Marchant (1982)

Order: Diptera — Flies & Mosquitoes
See Appendix

Order: Coleoptera — Beetles
Family: Dytiscidae — Water Beetles
Hydronatus rufoniger
Hydroparini porroster sp.
Liodessus sp.

Family: Gyrinidae — Whirligig Beetles
Dineutus neohollandiscus
Gyrinus convexiusculus

Family: Haliplidae
Haliplus sp. A

Family: Hydrophilidae — Water Beetles
Amphiops australicus
Berosus australiae
Berosus debilipennis
Berosus pycepiens
Berosus pulchellus
Berosus trisha
Berosus macumbensis
Helochares clypeatus
Helochares lowrye
Helochares tatei
Hydrochos sp.
Hydrophilus brevispinna

Family: Hygribiidae
Hygrobia maculata

Family: Noteridae
Hydrocanthus australasiae

Family: Spercheidae
Spercheus platycephalus
Family: Staphylinidae — Rove Beetles
Gyrophaena sp.
Aleochara sp.
Oxytelus sp.
Bledius sp.

NT Museum; Dep I Ind; Marchant (1982)

Order: Neuroptera
Family: Sisyridae — Sponge-flies
Sisyra sp.

Phylum: Mollusca
Class: Bivalvia
Family: Hyriidae — Freshwater Mussels
Velesunio angisii
Velesunio wilsonii

Class: Gastropoda — Freshwater Snails
Family: Ancylidae
Ferrissia petterdi
Family: Lymnaeidae
Austropeplea lessoni
Family: Planorbidae
Amerianna bonushenricus
Amerianna cumingi
Isodorella newcombi
Glyptophysa badia
Helicorbis meniscoides
Family: Thiaridae
Melanoides (Melanoides) tuberculata
Thiara amarula
Family: Viviparidae
Notopala essingtonensis
Notopala waterhousii

N.T.Museum; Marchant (1982);Smith (1992)

Appendix 2.2 Freshwater Vertebrates of Rapid Creek

Class: Pisces — Fish
Family: Megalopidae
Meyalops cyprinoides — Ox-eye Herring
Family: Clupeidae
Nematalosa erebi — Bony Bream
Family: Ariidae
Arius graeffei — Blue Catfish

Family: Plotosidae	
Neosilurus hyrtlii	Hyrtl's Catfish
Porochilus rendahli	Rendahl's Catfish
Family: Belonidae	
Strongylura kreffti	Freshwater Longtom
Family: Melanotaeniidae	
Melanotaenia nigrans	Black-Banded Rainbow Fish
Melanotaenia splendida australis	Red-Tailed Rainbow Fish
Family: Pseudomugilidae	
Pseudomugil tenellus	Delicate Blue-eye
Family: Atherinidae	
Craterocephalus stercusmuscarum	Fly-specked Hardyhead
Family: Chandidae	
Ambassis agrammus	Sail-fin Glassfish
Denariusa bandata	Penny Fish
Family: Centropomidae	
Lates calcarifer	Barramundi
Family: Terapontidae	
Leiopotherapon unicolor	Spangled Grunter
Amniataba percoides	Banded Grunter
Family: Apogonidae	
Glossamia aprion	Mouth Almighty
Family: Toxotidae	
Toxoles chatareus	Common Archerfish
Family: Scatophagidae	
Selenotoca multifasciata	Striped Scat
Family: Gobiidae	
Glossogobius giuris	Flathead Goby
Family: Eleotrididae	
Hypseleotris compressa	Empire Gudgeon
Mogunda mogurnda	Purple-spotted Gudgeon
Oxyeleotris lineolata	Sleepy Cod
Oxyeleotris nullipora	Dwarf Gudgeon
Oxyeleotris sp.	Black-banded Gudgeon

Larson and Martin (1990)

Appedix 3.1 Invertebrates of Rapid Creek Mangroves and Estuary

Class: Polychaeta

Amaena trilobata
Laonome sp.
Leitoscoloplus simplex
Lumbrinereis sp.
Lysilla sp.
Magelon sp.
Marphysa sanquinea
Nephtys vikingensis
Owenia sp.
Phyllodoce sp.

E

Class: Polychaeta (cont.)	
Sigalion sp.	Dwyer (1980)
Class: Crustacea	
Order: Thoracica	Barnacles
Balanus sp.	
Tetraclita sp.	
Class Malacostraca	
Order: Tanaidacea	
Apseudes estuarius	
Order Isopoda	
Family:Sphaeromidae	Sand Lice
Order: Decapoda	
Family: Alphidae	Pistol Shrimps
Alpheus sp.	
Family: Callianassidae	Mud Shrimps
Callianassa sp.	
Family: Diogenidae	Hermit Crabs
Clibanarius virescens	
Family: Grapsidae	Shore Crabs
Helice leachii	
Helice sp.	
Metapograpsus messor	Broad-fronted Mangrove Crab
Metapograpsus sp.	
Sesarma guttata	Mangrove Crabs
Sesarma meinerti	
Sesarma semperi	
Sesarma smithii	
Family: Mictyridae	Soldier Crabs
Mictyris longicarpus	
Family: Ocypodidae	Stalk-eyed Crabs
Cleistostoma wardii	
Macrophthalmus depressus	Sentinel Crab
Macrophthalmus pacificus	
Macrophthalmus sp.	
Heloecius cordiformis	Semaphore Crab
Scopimera inflata	Sand Bubbler
Uca bellator	Fiddler Crabs
Uca coarctata	
Uca dussumieri	
Uca lactea	
Uca seismella	
Family:Porcellanidae	Porcellain Crabs
Petrolisthes sp.	
Family: Portunidae	Mud Crab
Scylla serrata	

Family: Thalassinidea	Mangrove Lobster
Thalassina anomala	

Dwyer (1980)

Class: Gastropoda	
Family: Amphibolidae	Air Breathers
Salinator fragilis	
Family: Cerithiidae	Creepers
Cacozeliana lacertina	
Clypeomorus dorsuosus	
Family: Ellobiidae	Air-breathing Ear Shells
Cassidula angulifera	
Cassidula rugata	
Ellobium aurisjudae	
Pythia scarabeus	
Family: Littorinidae	Periwinkles
Littorina scabra	
Family: Muricidae	Murex Shells
Pterynotus permeatus	
Family: Nassariidae	Dog Whelks
Nassarius sp.	
Zeuxis dorsalis	
Family: Neritidae	Nerites
Nerita lineata	
Family: Onchidiidae	Air-breathing Sea Slugs
Onchidium damelii.	
Family:Potamididae	Mudwhelks
Telescopium telessopium	
Terebralia pelustris	
Telrebralia sulcata	
Cerithidia anticapata	
Family: Scalidae	Wentle-traps
Clathrus minora	
Family: Trochidae	Top Shells
Umbonium sp.	
Family: Turbinidae	Turban Shells
Turbo pentholatus	

Dwyer (1980)

Class: Bivalvia	
Family: Corbulidae	Basket Shells
Corbula sp.	
Family: Hiatellidae	Rock Borers
Hiatella australis	
Family: Laternulidae	Lantern Shells
Laternula creccina	
Laternula gracilis	
Family: Limopsidae	False Dog Cockles
Austrosarepta sordida	

Family:Mactridae	Trough Clams
Notospisula trigonella	
Spisula trigonella	
Family: Mesodesmatidae	Wedge Shells
Atactodea striata	
Family: Mytilidae	Mussels
Modiolus sp.	
Family: Tellinidae	Tellins
Tellina tenulata	
Tellina sp.	
Family:Trapeziidae	
Fluviolanatus amaris	
Family: Ostreidae	Oysters
Saccostrea sp.	
Family:Veneridae	Venus Shells
Eumarcia fumigata	
Gafrarium tumidum	
Periglypta resticulata	Dwyer (1980)

Appendix 3.2:Vertebrates of Rapid Creek Mangroves and Estuary

Class: Pisces	Fish
Family: Acanthuridae	
Acacthurus grammoptilus	Surgeon Fish
Family: Apogonidae	
Apogon angustata	Cardinal Fish
Apogon cooki	
Apogon opercularis	
Apogon rupellii	Gobbleguts
Fowleria aurita	
Family: Atherinidae	
Allanetta mugiloides	Hardyhead
Paraplotosus albilabrus	Common Catfish
Family: Batrachoididae	
Halophryne diemensis	Toadfish
Family: Blenniidae	
Omobranchus germaini	Blenni
Omobranchus punctatus	Rocky-Reef Blenni
Omobranchus rotundiceps	
Salarias spaldingi	Blenni
Family: Centropomidae	
Ambassis sp.	Glass Perch
Family:Chaetodontidae	
Chelmon marginalis	Coral Fish
Parachaetodon ocellata	Butterfly Fish
Family: Eleotridae	
Bostrycus sp.	Gudgeon

Class: Pisces (cont.)	
Family: Ephippidae	
Platax batavianus	Humphead Batfish
Family: Gerreidae	
Gerres sp.	Silverbiddy
Family: Gobiidae	
Acentrogobius viridipunctatus	Goby
Amblygobius bynoensis	Bynoe's Goby
Bathygobius fuscus	Goby
Cryptocentrus insignitus	Goby
Cryptocentrus sp.	
Drombus triangularis	
Eviota queenslandica	
Favonigobius melanobranchus	
Gnatholepsis sp.	
Gobiopsis sp.	
Istigobius ornatus	
Mugilogobius sp.	
Palutris sp.	
Priolepsis nuchifasciatus	
Valenciennea muralis	
Yongeichthys criniger	
Family: Labridae	
Choerodon cyanodus	Tusk Fish
Halichoeres dussumieri	Wrasse
Family: Lutyanidae	
Lutyanus monostigmus	Snapper
Family: Mugilidae	
Valamugil buchanani	Blue-Tail Mullet
Family: Nemipteridae	
Scaevius millii	Thread-Fin Bream
Family: Oxudercidae	
Boleophthalmus birdsongi	Mud Skipper
Periophthalmus argentilineatus	Silver Mud Skipper
Periophthalmus novaeguineaensis	Orange-Spot Mud Skipper
Family: Platycephalidae	
Platycephalus indicus	Flat Head
Family: Plotosidae	
Euristhmus sp.	Cat Fish
Family: Pomacentridae	
Abudefduf bengalensis	Bengal Sargeant-Major
Amphiprion rubrocinctus	Red Anemone Fish
Dischistodus fasciatus	Damsel Fish
Pomacentrus littoralis	Damsel Fish
Family:Pseudochromidae	
Congrogadus subducens	Eel Blenny
Family:Syngnathisae	
Choeroichtys brachysoma	Pipe Fish

Class: Pisces (cont.)	
Family: Scorpaenidae	
Scorpaena sp.	Scorpion Fish
Sebastapistes sp.	Scorpion Fish
Family: Serranidae	
Diploprion fasciatus	Soap Fish
Epinephelus corallicola	Coral Cod
Epinephelus quoyanus	Grouper
Epinephelus suillus	
Family: Sillaginidae	
Sillago sp.	Whiting
Family: Soleidae	
Phyllictthys sclerolepsis	Tough Sole
Family: Synodontidae	
Synodus saganeus	Grinner
Family: Teraponidae	
Amniataba caudovittata	Flag-Tail Grunter
Terapon jarbua	Target Fish
Class: Reptilia	
Family: Cheloniidae	
Chelodina mydas	Green turtle
Chelodina depressa	Flat-back turtle
Family: Crocodylidae	
Crocodylus porosus	Salt water crocodile
Family: Hydrophiidae	
Parahydrophis mertoni	Mertons sea snake
	CCNT (1991)
Class: Mammalia	
Family: Dugongidae	
Dugong dugon	Dugong
	CCNT (1991)

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DEPARTMENT OF HEALTH
AND COMMUNITY SERVICES

NORTHERN TERRITORY OF AUSTRALIA

Your Ref:

Our Ref:

4 August, 1993

Mr Tony Cox
Senior Landscape Architect
Clousten
GPO Box 1118
DARWIN NT 0801

Dear Tony,

RE:RAPID CREEK MANAGEMENT STRATEGY

Further to the meeting 27/7/93, I am enclosing mosquito monitoring data from three trap sites around Mararra Swamp for 1992, plus a check list of the mosquito species recovered from the swamp area, and information on the common mosquito species. Also included is a paper on the mosquito habitats in the swamp system.

This data, with due acknowledgement, could form part of the base line information on the fauna of the area, as well as part of the health information. We have maintained the same trap sites in this area for 10 years and it forms part of a monitoring system to detect mosquito problems, both local and exotic, as conditions change.

The condition of the upper reaches of Rapid Creek, from the confluence of the two arms of Mararra Swamp to the catchment limits is critical with regard to mosquito breeding. It is in the three major subsections of the swamp system, namely the round Melaleuca Swamp, the South east end of the airstrip, and the old Rifle Range area at the confluence of the two arms of the swamp, where the greatest potential for increased mosquito breeding exists.

If significant mosquito breeding begins in these areas it may be necessary to carry out engineering rectification measures for public health reasons, so maintaining the system in a healthy state is in the interests of all concerned bodies.

Central Office: Telephone: (089) 89 2400 Facsimile: (089) 89 2700
Darwin District — Urban: Telephone: (089) 22 7499 Facsimile: (089) 22 7482
— Rural: Telephone: (089) 22 8317 Facsimile: (089) 22 8940

All correspondence to: Secretary
Department of Health
and Community Services
PO Box 40596
CASUARINA NT 0811

Factors necessary to maintain the above areas relatively free of mosquito breeding include ensuring low nutrient levels in the water, forest canopy cover over creeklines and swamps, the maintenance of good freshwater fish

populations in all areas of the swamp, and the maintenance of the relatively small or reduced areas of freshwater semi aquatic reed species such as Eleocharis and Typha. There are already signs of increased nutrient levels in the round Melaleuca swamp area, with green filamentous algae adjacent to Amy Johnston Avenue. The likely source of these nutrients is from the orchid farm or the nearby school grounds. The return of a dense Melaleuca stand in this area after the considerable damage of Cyclone Tracy would assist in reducing semi aquatic reed growth in future. The semi aquatic reed growth is conducive to mosquito breeding by protecting mosquito larvae from fish and other aquatic predators.

The round Melaleuca swamp is regarded as having the greatest potential for increased mosquito breeding by reason of its area, the vulnerability to increased nutrient levels and subsequent reed growth, and the possibility of disruption of access for fish recolonization.

The area at the south east end of the airstrip has increased channelization due to the new RAAF facilities, and former mosquito drainage works to reduce the area of flooded reeds. There is still a possibility for mosquito breeding in this area if siltation blocks the channels or there is disturbance of the margins by vehicles, animals or soil and sand "borrowings". There may be a future need to carry out maintenance or rectification works in this area to ensure the relatively free draining nature is maintained.

The area at the confluence of the two arms of the swamp, and the lower reaches of Rapid Creek are vital in maintaining the native rainbow fish populations that effectively control mosquito breeding in much of the swamp system. The greatest threat to these fish populations is pollution or elimination of their refuge areas in the late dry season.

Organic pollution of the confluence area is not significant at present but the threat of increased organic loads is present from the storm water drainage system at the rear of the caravan park on Mc Millan's Road, and nutrients from the golf course. There is an additional minor threat to this area by storm water, if

areas of the airport upstream of the present development are further developed.

It is vital that there are good vegetation filters in the area upstream of the northern arm of the confluence area to reduce the effect of this organic and nutrient pollution. It is also important to prevent increased low flows from the stormwater drains and golf club entering this area. Any perennial low flows that develop in future pose a great potential for increased mosquito breeding.

The lower reaches of Rapid Creek below the confluence area are not so significant mosquito breeding areas because of the discrete nature of the creek. There are areas of concern, however. There are a number of large storm water drains entering the creek with perennial low flows from the airport, Mararra Sports Stadium, and the suburban areas. Any public education and other measures to reduce these low flows is seen as essential in preserving the creek. There may be additional engineering works necessary to pipe or channel these flows to the creek to prevent mosquito breeding in the drains themselves.

There is a great deal of silt accumulation in the main channel of the creek from the Water Gardens down to Trower Road bridge. If this process continues and leads to cut off pools or flooding problems, it may be necessary to carry out maintenance operations in this section

I hope these comments are helpful. Best regards.

Yours sincerely'

PETER WHELAN
DIRECTOR
MEDICAL ENTOMOLOGY BRANCH
SCIENTIFIC SERVICES

MARRARA ROUND SWAMP	Jan	Jan	Jan	Jan	Feb	Feb	Feb	Feb	Mar	Mar	Mar	Mar	Mar	Apr	Apr	Apr	Apr	May	May	May	May	Jun	Jun	Jun	Jun	Jun	Sub/tot
	7	14	22	29	5	11	18	25	3	10	17	24	31	7	14	22	28	6	12	19	26	2	10	16	24	30	1st 1/2
Ae.daliensis		NIL																									0
Ae.alternans																											0
Ae.elchoensis																											0
Ae.funereus																											0
Ae.britteni																											0
Ae.kochi				1	1	4		2	1	2	11	8	2	3	1					1	1						38
Ae.notoscriptus						1			2	1	5			1													10
Ae.pecuniosus																											0
Ae.phaecasiatus																											0
Ae.reesi			1	3		1				1	1					1											8
Ae.tremulus																											0
Ae.vigilax	14		1		14						1		4			9					1	8		3			55
Ae.lineatopennis												1				15	1										17
Ae.normanensis					1	1																					2
Ae.alboscutellatus																1											1
Ae.species 76																											0
Ae.species 121			1																								1
Ae.species 160																											0
An.amictus																											0
An.annulipes							1				1		3	1								4	1	1	1	2	15
An.bancroftii												1	1		2	3	3	3	12		42	39	3		2	1	112
An.farauti									1			1			4	2	1		4	1	1	1	2				18
An.hilli											1							1				1					3
An.meraukensis				1	5	2	3	10	3	13	2	7	30	47	18	122	113	40	288	43	94	94	12	1	1		949
An.novaguinensis								1		1			1	1			1					8	3	1			17
An.powelli																											0
Cx.annulirostris	4		3		3	2	3	5	4	14	5	7	22	13	37	5	2	3	2	2	3	10	11	2	6	12	180
Cx.bitaeniorhynchus													2														2
Cx.quinquefasciatus																									3	1	4
Cx.pullus															4												4
Cx.sitiens	2			1																							3
Cx.squamosus																											0
Cx.vicinus																						1					1
Cx.species 32															1												1
Cx. vishnui grp.																	1										1
Cx.cubiculi																											0
Cx.hilli																											0
Cx.species 155																											0
Cx.species 167															1												1
Ad.catasticta														1									1				2
Cq.xanthogaster									1			1	3	15	19			5		1	30	48	68	4	70	45	310
Ho.species 157																											0
Ma.uniformis	1			1						1				6	2	1	1				8	8	2	3			34
Mi.elegans																											0
Tp.magnesianus																											0
Ur.albescens																											0
Ur.argyrotarsis																											0
Ur.lateralis																											0
Ur.moresbyensis																											0
Ur.nivipes																								1			1
Ur.novaguinensis																											0
Ur.species 49																											0
Ur.species (unid)																											0
Totals	21	0	6	7	24	11	7	18	12	33	27	26	68	88	89	159	123	52	306	48	180	222	103	16	83	61	1790
1/7/92																											1790

(1)
Marrara Round Swamp 1992.

MRS292.XLS

DARWIN ADULT MOSQUITO MONITORING PROGRAM

	Jul 6	Jul 14	Jul 21	Jul 28	Aug 6	Aug 11	Aug 18	Aug 25	Sep 1	Sep 8	Sep 16	Sep 22	Sep 29	Oct 6	Oct 13	Oct 21	Oct 27	Nov 4	Nov 10	Nov 18	Nov 24	Dec 1	Dec 7	Dec 15	Dec 22	Dec 30	Sub/tot 2nd 1/2	Sub/tot 1st 1/2	ANNUAL TOTAL	% OF TOTAL
Ae.daliensis																	nil	nil	nil		nil	nil					0		0	.
Ae.alternans																	mos	mos	mos		mos	mos					0		0	.
Ae.elchoensis																											0		0	.
Ae.funereus																											0		0	.
Ae.britteni																											0		0	.
Ae.kochi																								1	1		2		2	.57
Ae.notoscriptus							1													1			2	1			5		5	1.425
Ae.pecuniosus																											0		0	.
Ae.phaecasiatus																											0		0	.
Ae.reesi																									2		2		2	.57
Ae.tremulus																									1		1		1	.285
Ae.vigilax						1	1	1		13	11	3	3	16	16					1			1		1	5	73		73	20.798
Ae.lineatopennis																											0		0	.
Ae.normanensis																								1	1		2		2	.57
Ae.alboscutellatus																											0		0	.
Ae.species 76																											0		0	.
Ae.species 121																											0		0	.
Ae.species 160																											0		0	.
An.amictus																											0		0	.
An.annulipes		1	1				1	2	1																		6		6	1.709
An.bancroftii		1																									1		1	.285
An.farauti		1																									1		1	.285
An.hilli		1																									1		1	.285
An.meraukensis																											0		0	.
An.novaguinensis																											0		0	.
An.powelli																											0		0	.
Cx.annulirostris	1	1	4	5	5	2	4	8	9	6		1	2										1	1		10	60		60	17.094
Cx.bitaeniorhynchus																											0		0	.
Cx.quinquefasciatus		1	1				2	1	2		1	1	1							1							11		11	3.134
Cx.pullus																											0		0	.
Cx.sitiens				1					1		1	4		1		3				1							12		12	3.419
Cx.squamosus																											0		0	.
Cx.vicinus																											0		0	.
Cx.species 32																											0		0	.
Cx.vishnui grp					1																						1		1	.285
Cx.hilli																											0		0	.
Cx.species 155																											0		0	.
Cx.species 167																											0		0	.
Ad.catasticta																											0		0	.
Cq.xanthogaster	2	77	6	45	14		6	19	1		1	1	1														173		173	49.288
Ho.species 157																											0		0	.
Ma.uniformis																											0		0	.
Mi.elegans																											0		0	.
Tp.magnesianus																											0		0	.
Ur.albescens																											0		0	.
Ur.argyrotarsis																											0		0	.
Ur.lateralis																											0		0	.
Ur.moresbyensis																											0		0	.
Ur.nivipes																											0		0	.
Ur.novaguinensis																											0		0	.
Ur.species 49																											0		0	.
Ur.species (unid)																											0		0	.
Totals	3	83	12	51	20	3	15	31	14	19	14	10	7	17	16	3	0	0	0	4	0	0	2	3	4	20	351	0	351	100
																											351			

(2)

Mapatta Swamp. South East End of Airstrip

MSE192.XLS

DARWIN ADULT MOSQUITO MONITORING PROGRAM

(1)

MARRARA SOUTH EAST	Jan	Jan	Jan	Jan	Feb	Feb	Feb	Feb	Mar	Mar	Mar	Mar	Mar	Apr	Apr	Apr	Apr	May	May	May	May	Jun	Jun	Jun	Jun	Jun	Sub/tot
	7	14	21	29	4	11	18	25	3	10	17	24	31	7	14	22	28	6	12	19	26	2	10	16	24	30	1st 1/2
Ae.daliensis																											0
Ae.alternans																											0
Ae.elchoensis																											0
Ae.funereus															2												2
Ae.britteni																											0
Ae.kochi		1	5	4	41	12	8	38	25	15	43	43	99	21	11	11	17	19	6	14	10	9	3		2	8	465
Ae.notoscriptus			1	1	3				1		1					1				1							9
Ae.pecuniosus																											0
Ae.phaecasiatus																											0
Ae.reesi					1												2	5									8
Ae.tremulus																											0
Ae.vigilax	10			3	5		1			1	2					12	5				1	3		2			45
Ae.lineatopennis													1			1		1									3
Ae.normanensis											1					1											2
Ae.alboscutellatus																											0
Ae.species 76																											0
Ae.species 121																											0
Ae. (mac). unid								1																			1
Ae.species 160																											0
An.amictus																											0
An.annulipes												1				1				1	1					3	7
An.bancroftii														4	2		3	6	2	2	26	43	16	9	19	15	147
An.farauti								1	4	9	11	16	29	23	16	38	46	27	30	30	21	11	14	7	14		347
An.hilli					1								8											1			10
An.meraukensis				1				2		1	2	2	4		7	6	5	11	21	15	11	16	6	8	5	10	133
An.novaguinensis										1			2	4	6			2	2		2	3	2	2	1		27
An.powelli																											0
Cx.annulirostris	5	3	3	5	1	1	9	2		9	10	25	113	476	108	36	41	24	1	6	11	39	28	14	24	44	1038
Cx.bitaeniorhynchus																						1					1
Cx.quinquefasciatus																						1				1	2
Cx.pullus													1		4	7	3			1		3	1	1		2	23
Cx.sitiens				1		4	1				1							1			1						9
Cx.squamosus																						2					2
Cx.vicinus																						1		1			2
Cx.species 32															4												4
Cx. vishnui grp.																			1	2	1	5				8	17
Cx.cubiculi																						1					1
Cx.hilli																											0
Cx.species 155																										7	7
Cx.species 167															1												1
Ad.catasticta																											0
Cq.xanthogaster							1	1			1	3	7	558	56		17	20	1	6	32	179	122	7	130	105	1246
Ho.species 157																											0
Ma.uniformis	1			2	8					2	2	3	1	16	5		4	6	3	4	21	15	5	7	12	8	125
Mi.elegans																											0
Tp.magnesianus																											0
Ur.albescens																											0
Ur.argyrotarsis																											0
Ur.lateralis																											0
Ur.moresbyensis																											0
Ur.nivipes														1													1
Ur.novaguinensis																											0
Ur.species 49																											0
Ur.species (unid)																											0
Totals	16	4	9	17	60	17	20	44	27	33	72	88	244	1117	229	92	135	141	64	82	147	342	194	65	201	225	3685

CO2 baited EVS trap run overnight.

Figures are number of female mosquitoes per trap night.

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Marara Swamp South East End & Airstrip Site 1992

(2)

MSE292.XLS

DARWIN ADULT MOSQUITO MONITORING PROGRAM

	Jul	Jul	Jul	Jul	Aug	Aug	Aug	Aug	Sep	Sep	Sep	Sep	Sep	Oct	Oct	Oct	Oct	Nov	Nov	Nov	Nov	Dec	Dec	Dec	Dec	Dec	Sub/tot	Sub/tot	ANNUAL	% OF
	6	14	21	28	6	11	18	25	1	10	16	22	29	6	13	20	27	4	10	18	24	2	7	15	22	30	2nd 1/2	1st 1/2	TOTAL	TOTAL
Ae.daliensis																											0		0	.
Ae.alternans																											0		0	.
Ae.elchoensis																											0		0	.
Ae.funereus																											0		0	.
Ae.britteni																											0		0	.
Ae.kochi	2		1		3			3	2		6	5	1	1		5		1	1		1			3	5	1	41		41	4.096
Ae.notoscriptus	1				1																1			1		1	5		5	.5
Ae.pecuniosus																											0		0	.
Ae.phaecasiatus																											0		0	.
Ae.reesi															-							1	1		4		6		6	.599
Ae.tremulus																									2		2		2	.2
Ae.vigilax		1		1			4	1		52	9	1		23	23	3	1	3	2				1		1		126		126	12.587
Ae.lineatopennis																											0		0	.
Ae.normanensis																									3		3		3	.3
Ae.alboscutellatus																											0		0	.
Ae.species 76																											0		0	.
Ae.species 121																											0		0	.
Ae.species 160																											0		0	.
An.amictus																											0		0	.
An.annulipes					1																						1		1	.1
An.bancroftii	14	17	2	4	3			6																			46		46	4.595
An.farauti	6	1		3			1																				11		11	1.099
An.hilli																											0		0	.
An.meraukensis	1	3	1	5	1																						11		11	1.099
An.novaguinensis	1	4	2	2			2	1																			12		12	1.199
An.powelli																											0		0	.
Cx.annulirostris	4	32	4	45	33	5	13	95	20	6	3	12		3	4	3		4			3	1				6	296		296	29.57
Cx.bitaeniorhynchus																											0		0	.
Cx.quinquefasciatus		2			1	1		4	2			1	1	2		4	1										19		19	1.898
Cx.pullus				5	4	1	1																				11		11	1.099
Cx.sitiens									2		4	3								2							11		11	1.099
Cx.squamosus																											0		0	.
Cx.vishnui grp	1			1		1																					3		3	
Cx.vicinus																											0		0	.
Cx.species 32																											0		0	.
Cx.cubiculi																											0		0	.
Cx.hilli																											0		0	.
Cx.species 155				2						1																	3		3	.3
Cx.species 167										1		1						1									3		3	.3
Ad.catasticta																											0		0	.
Cq.xanthogaster	14	132	17	132	23	3	8	45		1				1													376		376	37.562
Ho.species 157																											0		0	.
Ma.uniformis	2	9		1	1		1																				14		14	1.399
Mi.elegans																											0		0	.
Tp.magnesianus																											0		0	.
Ur.albescens																											0		0	.
Ur.argyrotarsis																											0		0	.
Ur.lateralis																											0		0	.
Ur.moresbyensis																											0		0	.
Ur.nivipes															1												1		1	.1
Ur.novaguinensis																											0		0	.
Ur.species 49																											0		0	.
Ur.species (unid)																											0		0	.
Totals	46	201	27	201	71	11	30	155	26	61	22	23	2	30	28	15	2	9	3	2	5	2	2	4	15	8	1001	0	1001	99.7003
																											1001			

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8/1/93

DARWIN ADULT MOSQUITO MONITORING PROGRAM

MARRARA RIFLE RANGE	Jan	Jan	Jan	Jan	Feb	Feb	Feb	Feb	Mar	Mar	Mar	Mar	Mar	Apr	Apr	Apr	Apr	May	May	May	May	Jun	Jun	Jun	Jun	Jun	Sub/tot
	7	14	21	29	4	11	18	25	3	10	18	24	31	7	14	22	28	6	12	19	26	2	10	16	24	30	1st 1/2
Ae.daliensis																											
Ae.alternans																					Trap						0
Ae.elchoensis																					fail						0
Ae.funereus																					x 2						0
Ae.britteni																											0
Ae.kochi	8	30	36	43	43	36	18	135	11	8	17	26	29	6		9	13	13	4	3		3	1				492
Ae.notoscriptus			1		1						4			1				1									8
Ae.pecuniosus																											0
Ae.phaecasiatus																											0
Ae.reesi				3	1							1				14	4	12									35
Ae.tremulus										1			1												1		3
Ae.vigilax	3	1	1		8				1	1			1			4	4							1			25
Ae.lineatopennis														1		1	1	4									7
Ae.normanensis																											0
Ae.alboscutellatus																											0
Ae.species 76																											0
Ae.species 121																											0
Ae.species 160																											0
An.amictus																											0
An.annulipes																											0
An.bancroftii																											0
An.farauti										1		2			4	1	3	7	1	7		8	9	6	6	4	52
An.hilli																7	12	26	6	8		10	2	4	1	1	84
An.meraukensis												1		1		2	1	5		4			4				18
An.novaguinensis																		1					1				2
An.powelli																								1			1
Cx.annulirostris	15	6	1	1		1	3	9		2			3	9	1	4	13	9		3		5	3		2	9	99
Cx.bitaeniorhynchus																											0
Cx.quinquefasciatus		1					1															1	12	4	15	15	49
Cx.pullus																											0
Cx.sitiens	1							1																			2
Cx.squamosus																											0
Cx.vicinus																									1		1
Cx.species 32														1													1
Cx.cubiculi																1											1
Cx.hilli																											0
Cx.species 155																											0
Cx.species 167																							1				1
Ad.catasticta																									1		1
Cq.xanthogaster														18	4		3	3		2		47	20	4	24	9	134
Ho.species 157					1						1			5			2	1		1		2	1	2	1	1	18
Ma.uniformis																											0
Mi.elegans																											0
Tp.magnesianus																											0
Ur.albescens																											0
Ur.argyrotarsis																											0
Ur.lateralis																											0
Ur.moresbyensis																											0
Ur.nivipes																											0
Ur.novaguinensis																											0
Ur.species 49																											0
Ur.species (unid)																											0
Totals	27	38	39	47	54	37	22	145	12	13	22	30	34	41	10	43	56	82	11	28	0	76	54	22	52	39	1034
																											1034

1/7/92

Marrara Rifle Range Site (old) near FAC buildings at confluence of two arms of swamp. At swamp edge. 1992.

(i)

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Mareena Swamp at Rifle Range Site (near FAC building at edge of swamp at confluence of two arms) 1992

(2)

MARRARA...S

DARWIN ADULT MOSQUITO MONITORING PROGRAM

	Jul 6	Jul 14	Jul 21	Jul 28	Aug 6	Aug 11	Aug 18	Aug 25	Sep 1	Sep 8	Sep 16	Sep 22	Sep 29	Oct 6	Oct 13	Oct 20	Oct 27	Nov 4	Nov 10	Nov 18	Nov 24	Dec 1	Dec 7	Dec 15	Dec 23	Dec 30	Sub/tot 2nd 1/2	Sub/tot 1st 1/2	ANNUAL TOTAL	% OF TOTAL
Ae.daliensis																											0		0	.
Ae.alternans																										1	1		1	.321
Ae.elchoensis																											0		0	.
Ae.funereus																											0		0	.
Ae.britteni																											0		0	.
Ae.kochi	1			1	2	1													1		2		1		4	8	21		21	6.731
Ae.notoscriptus													2							1		1				2	6		6	1.923
Ae.pecuniosus																											0		0	.
Ae.phaecasiatus																											0		0	.
Ae.reesi																											0		0	.
Ae.tremulus	1																				1	1					3		3	.962
Ae.vigilax							1			5	4		2	5	4		1	1	5						4	1	33		33	10.577
Ae.lineatopennis																											0		0	.
Ae.normanensis																											0		0	.
Ae.alboscutellatus																											0		0	.
Ae.species 76																											0		0	.
Ae.species 121																											0		0	.
Ae.species 160																										1	1		1	.321
An.amictus																											0		0	.
An.annulipes		1				1																					2		2	.641
An.bancroftii	5	2						1																			8		8	2.564
An.farauti	1			1																							2		2	.641
An.hilli																											0		0	.
An.meraukensis						1																		1			2		2	.641
An.novaguinensis																											0		0	.
An.powelli																											0		0	.
Cx.annulirostris	1	1		3	1	2	1	3	1	6	6			1						2	1					2	31		31	9.936
Cx.bitaeniorhynchus																											0		0	.
Cx.quinquefasciatus	2	7	5	24	3	34	4	1	6	11	7	3	2				3										112		112	35.897
Cx.pullus																											0		0	.
Cx.sitiens									1	1	6	5									1						14		14	4.487
Cx.squamosus									1	1																	2		2	.641
Cx.vicinus	1																										1		1	.321
Cx.species 32																											0		0	.
Cx.cubiculi																											0		0	.
Cx.hilli																											0		0	.
Cx.species 155																											0		0	.
Cx.species 167					1																						1		1	.321
Ad.catasticta												1															1		1	.321
Cq.xanthogaster	4	10	5	21	3	1	6	12	3			1					1			1							68		68	21.795
Ho.species 157																											0		0	.
Ma.uniformis	1							1		1																	3		3	.962
Mi.elegans																											0		0	.
Tp.magnesianus																											0		0	.
Ur.albescens																											0		0	.
Ur.argyrotarsis																											0		0	.
Ur.lateralis																											0		0	.
Ur.moresbyensis																											0		0	.
Ur.nivipes																											0		0	.
Ur.novaguinensis																											0		0	.
Ur.species 49																											0		0	.
Ur.species (unid)																											0		0	.
Totals	17	21	10	50	10	40	12	18	12	25	23	10	6	6	4	0	5	1	6	4	5	2	1	1	8	15	312	0	312	100
																											312			

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Check list of the Mosquito Species recorded from trap sites in Marapna Swamp 1989-1993.

Ae.daliensis
Ae.alternans
Ae.funereus
Ae.kochi
Ae.notoscriptus
Ae.phaecasiatus
Ae.reesi
Ae.tremulus
Ae.vigilax
Ae.lineatopennis
Ae.normanensis
Ae.alboscutellatus
Ae.species 76
Ae.species 121
Ae.species 160
An.amictus
An.annulipes
An.bancroftii
An.farauti s.l. (most likely sp 3 of sibling species complex)
An.hilli
An.meraukensis
An.novaguinensis
An.powelli
Cx.annulirostris
Cx.bitaeniorhynchus
Cx.quinquefasciatus
Cx.pullus
Cx.sitiens
Cx.squamosus
Cx.vicinus
Cx.species 32
Cx.cubiculi
Cx.hilli
Cx.species 155
Cx.species 167
Ad.catasticta
Cq.xanthogaster
Ma.uniformis
Mi.elegans
Ur.albescens
Ur.argyrotarsis
Ur.lateralis
Ur.nivipes
Totals 43

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27/7/93

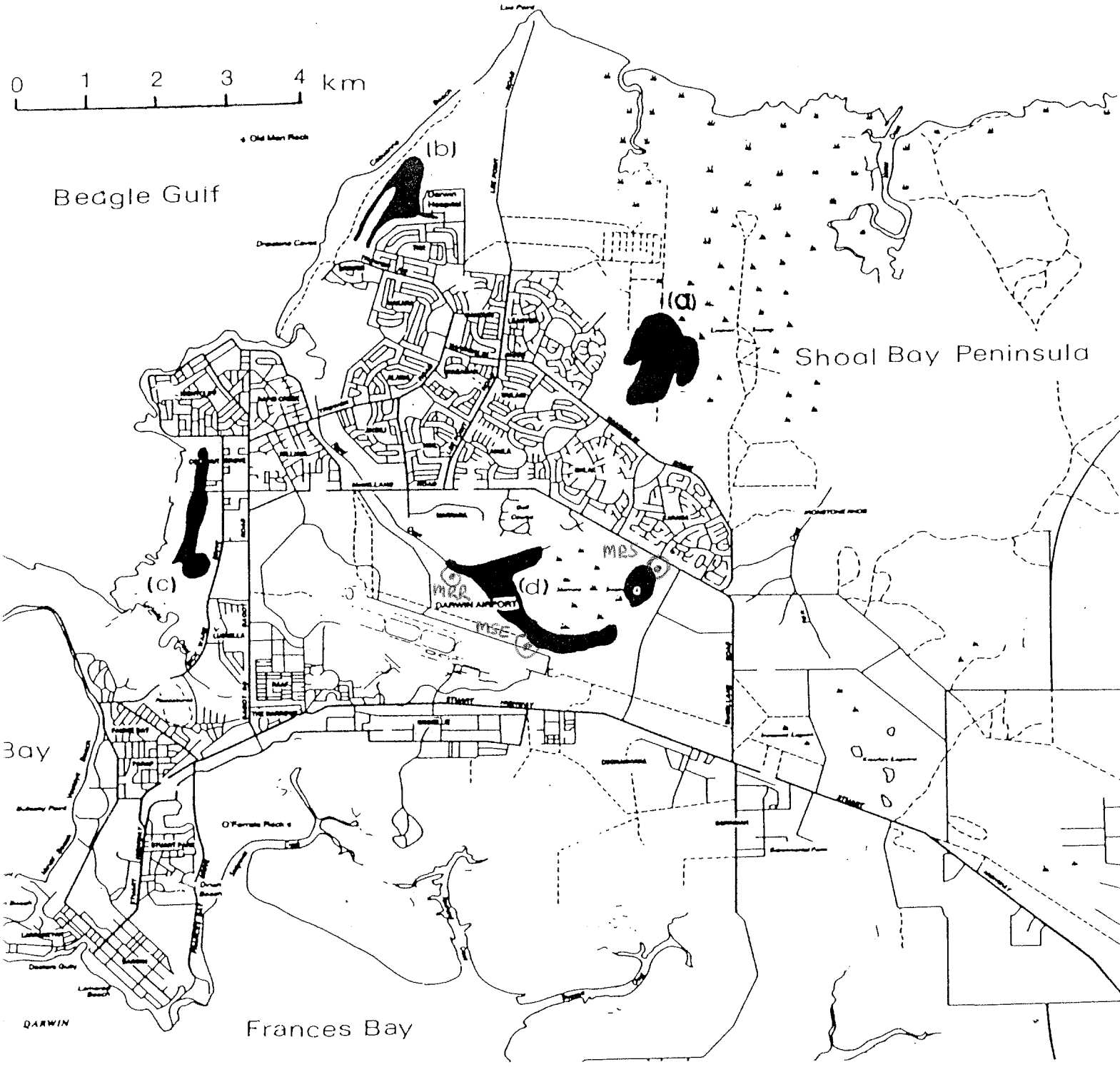

FIG. 1. Darwin. The northern suburbs and the four major mosquito breeding areas (full black shading): (a) Leanyer Swamp; (b) Casuarina Swamp; (c) Coconut Grove Swamp; (d) Marrara Swamp.

⊙ Mosquito Monitoring Sites Ma ra Swamp.
MRS – Marara Round Swamp. MRR – Marara Rifle Range. MSE – South East End of Airstrip.

THE POTENTIAL MOSQUITO VECTORS AT THE PROPOSED DARWIN AIRPORT TERMINAL WITH RECOMMENDED VECTOR CONTROL MEASURES

MEDICAL ENTOMOLOGY SECTION
NORTHERN TERRITORY DEPARTMENT OF HEALTH

1. INTRODUCTION

There have been three proposed sites for the new International Airport Terminal at Darwin Airport. One of the important factors that needs to be involved in the choice of a site is the implication of the International Health Regulations governing the prevention of the transport and establishment of exotic insect vectors and their diseases. The Northern Territory Department of Health maintains mosquito monitoring sites in the Darwin area, and a summary of these results for 1980 are presented, to indicate the potential mosquito problem that could be encountered at each site. The possible control measures necessary to reduce these potential vectors and their diseases are discussed.

2. CURRENT MOSQUITO SITUATION

A total of 55 mosquito species have been recorded by the Northern Territory Health Department from the Darwin area. Of these 33 have been recorded from the Marrara area by trapping methods during 1980. (See Table 1). This list includes potential vectors of disease, including Anopheles farauti and Anopheles hilli which are vectors of malaria, Culex annulirostris, which is a vector of Murray Valley Encephalitis virus, Kunjin virus and Ross River virus, and Aedes vigilax, which is a vector of Ross River virus.

NB
43 of 1993

Other possible vectors include Culex quinquefasciatus, Mansonia uniformis, Anopheles annulipes, and Anopheles bancroftii.

Mosquitoes occur in very large numbers adjacent to certain areas of urban Darwin and some of the major sources of these mosquitoes are within the flight range of some of the proposed sites for the International Terminal. Extensive collections of insects from overseas aircraft arriving in Darwin over the last few years have indicated a high potential for transporting insect vectors in aircraft. It is important that the mosquito breeding sites near the International Terminal are eliminated in order to reduce the potential for introducing exotic vectors, as well as insuring that the terminal surrounds are not sources for the introduction of local vectors and their diseases to other countries.

3.0 RESULTS OF THE MOSQUITO MONITORING PROGRAM

A summary of the relevant mosquito monitoring results is shown in Table 2. A more complete result for the Marrara monitoring site is shown in Appendix 1. The figures in Table 2 show the maximum number of mosquitoes trapped at a particular site per trap night during 1980. The mosquito monitoring sites and their relationship to the proposed terminal sites and to the major mosquito sites is shown on Map 1. The Coconut Grove and the Marrara monitoring sites have relevance to proposed Site 3 and Site 1, while the Palm Creek, Marrara and Leanyer monitoring sites are of relevance to Site 2.

The three monitoring methods used are complimentary to each other to enable an accurate assessment of relative mosquito numbers. From Table 2, the light trap detected 31 species; the CO2 trap detected 25 species and the man biting collections detected 16 species of mosquitoes. The relevance of these monitoring sites to the proposed terminal sites is discussed below.

3.1 SITE 1

The trap results from the Marrara site are most relevant to Site 1 due to the similarity in vegetation and the mosquito breeding sites nearby. There is a continuous dense forested area between the Marrara monitoring site and Site 1, which facilitates mosquito movement and provides ideal mosquito harbouring sites. From the monitoring results at Marrara it is evident Site 1 will have very high numbers of Culex annulirostris, Aedes vigilax and Anopheles bancroftii. The maximum number of Anopheles farauti detected, while low compared with the other species, is quite high for this species as it is regarded as a very efficient vector of malaria. Site 1 is likely to experience only relatively small numbers of Anopheles hilli.

3.11 Location of the Nearest Mosquito Breeding Grounds to Site 1

There would be mosquioto breeding grounds within 400 metres of this proposed site. Culex annulirostris would be the most frequently encountered species breeding in this vicinity.

Other significant species would be Anopheles farauti, Anopheles bancroftii, Aedes kochi and Coquillettidia xanthogaster (See Appendix 1). The majority of the mosquito breeding occurs in the shallow vegetated edges of Rapid Creek and Marrara Swamp, particularly as the area dries out after the wet season. The fresh water section of Rapid Creek where the creek is well defined is not a major source of mosquitoes, as is the body of Marrara Swamp at the convergance of the two arms of the swamp, due to the predation of mosquito larvae by the native rainbow fish. The mosquito monitoring program detected high numbers of Aedes vigilax but this species does not breed in this area.

Both Anopheles hilli and Aedes vigilax have relatively long flight ranges and originate from the brackish/salt water breeding areas at Leanyer Swamp and Coconut Grove. The dense forested areas of Marrara Swamp and along Rapid Creek are ideal harbouring sites for mosquitoes during the day and this would lead to an accumulation of mosquitoes in these areas. These harbouring areas would lead to the increased longevity of mosquitoes in this area and hence increase their vector potential. There are a number of open earth drains entering Rapid Creek and Marrara Swamp in the vicinity of Site 1 and these would be sources of mosquitoes, particularly during the dry season when pooling in these drains occurs.

3.12 Rectification Measures Needed Around Site 1

To conform with International Health Regulations, a sanitary zone of 400 metres round this site would need to be established, in which all mosquito breeding was eliminated.

It is not recommended that insecticidal mosquito control measures be solely relied on to maintain this zone mosquito free, due to the likelihood of the control measures not being carried out as regularly and as efficiently as necessary, and because it would introduce a large continuing cost. Any mosquito breeding within the 400 metre perimeter would need to be engineered in such a way that the area was free draining and required the minimum of maintenance. Lined concrete drains with dry season flow inverts emptying into formalised streams or stormwater drains would be the preferred measure to reduce this mosquito breeding. All drains should be constructed so that no pooling can occur in the drains. Those margins of Rapid Creek and Marrara Swamp that have shallow marginal areas where pooling occurs, would need to be contoured and formalised so that the margins were free draining.

It is recommended that the mosquito breeding areas outside the 400 metre sanitation zone and within flight range of the most important vectors be rectified. The accepted flight range of 1.6 kilometers for Anopheles farauti would be regarded as a minimum distance from the sanitation zone in which these measures should be carried out. For Site 1 this would involve draining some of the areas on the south side of Marrara Swamp and insuring that the margins of the swamp are free draining into the body of the swamp. The drain on the north-east side of Marrara Swamp would need to be extended to drain the shallow marginal areas of the round Melaleuca Swamp at the east end of Marrara Swamp. The major mosquito breeding areas near Coconut Grove will be within flight range of the proposed terminal and it is recommended that source reduction measures be carried out in this area.

This would involve the draining of the shallow fresh water reed swamp to the daily flushed mangrove creek, and the formalisation of the drains between Bagot Road and Dick Ward Drive. The ill draining sections of the creek in this area would also need to be rectified. Marrara Swamp will still be a breeding ground for some species of mosquitoes, and it will remain a mosquito harbouring area. It is recommended that an all weather access track be constructed all around the swamp and on both sides of the creek so that vehicle mounted vector control operations can be carried out when necessary. These control operations would need to be based on a mosquito monitoring program. This program would need to be carried out by a special section of suitably trained and equipped officers who would also be responsible for the maintenance and control measures.

3.2 Site 2

The trap results from the Marrara Site are most relevant to Site 2 due to its proximity and to the similarity to breeding sites nearby. The comments on the mosquito situation at Site 1 would apply equally to Site 2 except that the Coconut Grove breeding areas would not influence this site to as large an extent and there would be a large influence from the Palm Creek and Leanyer areas as indicated by the Leanyer Dump and the Palm Creek monitoring sites. The Palm creek site indicates that Site 2 is likely to have much higher numbers of Aedes vigilax, Anopheles bancroftii, Culex annulirostris and Anopheles hilli while the Leanyer Dump site indicates that Site 2 will have a large Aedes vigilax problem.

3.21 Location of the Nearest Mosquito Breeding Sites to Site 2

Site 2 would have considerable areas of shallow marginal swamp within the 400 metres sanitation zone. The main area of this type of habitat would be on the south side of the round Melaleuca Swamp at the east end of the swamp. The main species breeding in this habitat would be Culex annulirostris, Anopheles meraukensis and Anopheles bancroftii. The body of the round Melaleuca Swamp is not a large source of mosquito for most of the year due to the presence of predaceous fish. Site 2 is in close proximity to the Palm Creek/Holmes Jungle Complex as well as being nearer to the major mosquito breeding area of Leanyer Swamp. The Palm Creek Holmes/Jungle mosquito breeding sites are not separated from Site 2 by residential areas and so would be expected to be a major source of Anopheles hilli and Aedes vigilax, while Leanyer Swamp area would be a considerable source of Aedes vigilax.

3.22 Rectification Measures Necessary Around Site 2

Those measures that were mentioned for Site 1 would apply for Site 2 with more emphasis on formalisation of the round Melaleucu Swamp at the east end of the Marrara Swamp and the draining of the south-east corner of Marrara Swamp. A large open unlined earth drain on the north side of Marrara Swamp would need to be extended eastward to drain the marginal areas of the round Melaleuca Swamp and this drain would need to be concrete lined and include dry season flow inverts to ensure that the drain is relatively maintenance free.

The Palm Creek/Holmes Jungle area would pose serious problems for mosquito reduction measures, due to the fact that Holmes Jungle is a Reserve. There are measures already proposed to partially reduce the mosquito breeding in Leanyer Swamp, and these measures would need to be carried out thoroughly if the numbers of Aedes vigilax were to be reduced at Site 2.

3.3 Site 3:

The trap results from the Coconut Grove monitoring site are most relevant to this site. This is due to its proximity and to the relatively undeveloped nature of the area in between Coconut Grove and Site 3. Site 3 would be expected to have considerable numbers of Anopheles bancroftii, Aedes vigilax, Anopheles hilli and Culex annulirostris and significant numbers of Anopheles farauti.

3.3 The location of the nearest mosquito breeding grounds.

There are only minor mosquito breeding areas within the 400 metre sanitation zone at Site 3. This includes the unlined stormwater drains from Bagot Road to Dick Ward Drive. These would be a source of Culex annulirostris during the dry season. However the nearby Coconut Grove area has a considerable range of mosquito breeding sites ranging from the shallow ephemeral fresh water swamp to the salt water inundated areas.

There are also considerable areas of dense forest which would provide ideal mosquito harbourage. The Coconut Grove area is a major source of Aedes vigilax and Anopheles hilli in the upper reaches of the ill draining mangrove creek. Culex annulirostris is found breeding in the cut-off creeks, borrow pits and the fresh water swamp while Anopheles bancroftii breeds in the shallow fresh water swamp areas that are partially shaded. Anopheles farauti has been found breeding in considerable numbers in the brackish water areas of the upper reaches of the mangrove creek.

3.32 Elimination of the Mosquito Breeding Grounds

The elimination of the major mosquito grounds at Coconut Grove would be strongly recommended if Site 3 is selected as the terminal site as the mosquito breeding grounds are within flight range of Site 3. The fresh water swamp would need to be drained to the lower reaches of the mangrove creek. The upper reaches of the mangrove creek would need to be free draining to the lower reaches to eliminate the pooling that now occurs. Numerous borrow pits in the area would need to be filled and the drainage lines from the area would need to be formalised and made free draining. There may be problems in carrying out the necessary mosquito breeding reduction measures due to private land ownership in this area. At the moment there are access problems through the area, both of a physical and ownership nature, that prevents the necessary vector control measures being carried out.

4.0 Conclusions

1. All the proposed sites will experience considerable numbers of important vector mosquitoes.

2. Site 1 would be the site of choice, due to its distance from the major mosquito breeding areas and the likelihood of rectifying the mosquito breeding areas in the sanitation zone and within flight range of the mosquitoes.

3. All sites would need a 400 metre sanitary zone surrounding the terminal in which all mosquito breeding is eliminated by engineering methods. In particular all drains in the area would need to be concrete lined with dry season inverts and constructed so that no pooling would occur that would lead to mosquito breeding.

4. It is strongly recommended that, due to the high susceptibility of Darwin to the introduction of malaria and other insect vector borne diseases and their vectors, and the proximity to local vector breeding sites that all major mosquito breeding sites within 1.6 kilometers of the terminal perimeter be engineered to reduce mosquito breeding.

5. It will be necessary to establish a vector monitoring and control section to monitor and maintain the 400 metre sanitary zone around the terminal and to maintain and carry out vector control measures outside the 400 metre sanitary zone. This section would need to consist of at least two officers, suitably trained and equipped and it is expected that they would maintain liaison with the NT Department of Health.

6. If Site 1 is chosen -

(a) it will be necessary to establish an all weather track around both sides of Marrara Swamp and Rapid Creek, as close as possible to the margins, so that vector control operations can be carried out when necessary.

(b) The mosquito breeding areas at the east end and the south-east end of Marrara Swamp and the major mosquito areas of Coconut Grove be either drained, filled or formalised to eliminate these areas as sources of vector mosquitoes and to make these areas less susceptible to the introduction of exotic mosquitoes.

P. Whelan
SENIOR MEDICAL ENTOMOLOGIST
1981

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MOSQUITO SPECIES COLLECTED BY ADULT TRAPPING
AT MARRARA MONITORING SITE DARWIN 1980

SPECIES	Trap Method INCAND	CO^2	M/B
An. annulipes		x	x
An. bancroftii	x	x	x
An. farauti	x	x	x
An. hilli		x	x
An. powelli	x	x	x
An. meraukensis	x	x	x
An. novaguinensis		x	x
Ae. lineatopennis		x	x
Ae. kochi	x	x	x
Ae. funereus	x		
Ae. notoscriptus	x	x	x
Ae. vigilax	x	x	x
Ae. reesi	x	x	x
Ae. tremulus	x	x	x
Cx. annulirostris	x	x	x
Cx. pullus	x	x	
Cx. hilli	x		
Cx. squamosus	x	x	
Cx. bitaeniorhynchus	x	x	x
Cx. quinquefasciatus	x	x	
Cx. fraudatrix-annulata	x		
Cx. sitiens	x	x	
Cx. Sp. 167	x	x	
Mi. metallica	x		
Ur. hirsutifemora	x		
Ur. novaguinensis	x		
Ur. lateralis	x		
Ur. nivipes	x		
Fi. elegans	x	x	
Ad. catasticta	x	x	
Ho. Sp No. 157		x	
Cq. xanthogaster	x	x	
Ma. uniformis	x	x	x

TABLE II

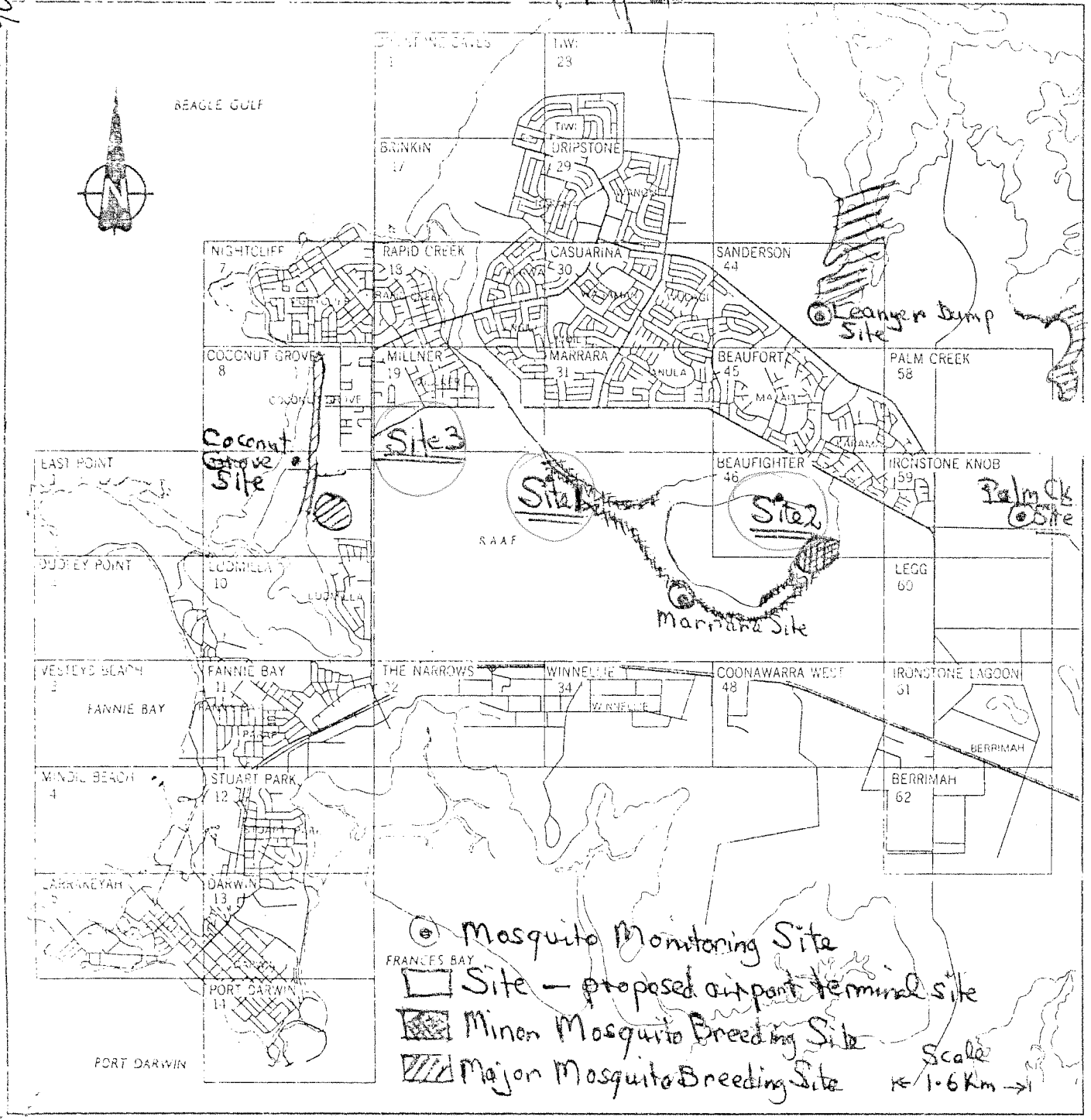
MOSQUITO TRAPPING AT MONITORING SITES DARWIN 1980

Maximum numbers of mosquitoes per trap night by three trapping methods

	MARRARA			LEANYER DUMP			PALM CREEK			COCONUT GROVE		
	LT	CO^2	M/B	LT	CO^2	M/B	LT	CO^2	M/B	LT	CO^2	M/B
Selected Species												
An. farauti	46	30	30	22	7	24	4	15	108	5	43	6
An. bancroftii	33	248	246	157	115	336	26	460	624	12	473	120
An. hilli	1	2	24	65	104	768	90	56	144	5	81	132
Ae. vigilax	75	360	318	54	915	378	125	1000	408	42	840	228
Cx. annuli-rostris	204	587	270	430	233	1044	188	1100	1020	47	283	612
	359	1227	888	728	1374	2550	433	2631	2304	111	1720	1098
Total No. of Species	31	25	16	29	22	17	30	25	16	23	25	15

Light trap and Carbondioxide trap figures are the maximum number of female mosquitoes per trap night.

Man biting figures are the number of female mosquitoes biting per man hour. CO^2 trap results are only for a 7 month period from June to December.



SHEET ASSEMBLY GREATER DARWIN

APPENDIX 4

TOTAL CATCHMENT MANAGEMENT, NEW SOUTH WALES

The TCM Approach

A Catchment

A catchment is the area supplying surface water to a common watercourse. Each catchment is separated by hills or ridges which direct the flow of water.

A catchment may be as small as a single watercourse and its watershed or may be as large as the Murray-Darling Basin which is the amalgamation of many smaller catchments in New South Wales, Queensland, Victoria and South Australia, all feeding the River Murray.

Catchment boundaries do not usually match government, administrative or social boundaries across the State and there are often decisions, activities or natural phenomena that are not restricted by catchment boundaries. Nevertheless, most natural processes and environmental disturbances have their greatest impact within the boundaries of a catchment.

Management

Management is the process of planning, coordinating and directing human activities. Successful businesses depend on good management which includes consideration of inputs and outputs and the various operations to achieve the business goals. In a catchment, there are many businesses with a wide range of management styles and goals, but these are connected in some way by sharing or influencing each other's resources. The natural resources of land, water, vegetation and air are used by individuals, primary, secondary, and tertiary industries. This makes them vital, requiring special management, across all users.

Environmental damage or pollution pays no heed to artificial boundaries that we impose. Management strategies and remedial works are more effective if planned and implemented over a whole catchment.

Strategies should consider all the impacts and relationships between human involvement, land, water, vegetation and fauna.

Understanding the catchment resource is a key element of TCM.

TCM

Total Catchment Management

Community And Government Working Together

Regional and state strategies for natural resource management

Catchment Management Committees are developing regional catchment strategies that contain detailed action plans to address natural resource management issues. Preparation of regional strategies, which are consistent with the guiding principles of sustainable natural resource management, will involve all sectors of the community and integrate across a range of disciplines such as soil, water, vegetation and economics.

Catchment Strategies provide a framework for fostering cooperation and coordination between landholders and other resource users, community groups, local government and state agencies. Strategies recognise the complex interactions that exist within natural systems and the need for a coordinated catchment wide approach to address resource management issues. They establish a long term vision for the future, acknowledging the importance of sustainability whilst recognising the need to integrate social, economic and environmental values.

The State Strategy for Natural Resource Management pulls together actions identified in existing policies, regional catchment management strategies and other initiatives. The Strategy describes in clear terms the specific actions, responsibilities, performance indicators and priorities needed to bring about sustainable natural resource management in New South Wales. The State Strategy will help identify potential gaps and overlaps in proposed actions and will assist in establishing funding priorities for natural resource management projects.

Regional and statewide natural resource management strategies will form the blueprint for action at state, regional and local level and will focus on what the community and government can achieve when the actions of many individuals, groups and agencies are planned and coordinated. These strategies will be flexible and dynamic to meet the requirements of a changing physical, economic and social environment.

One of the most important aspects of these natural resource management strategies is that both the community and the government are actively and meaningfully involved in their preparation, aware of their objectives and sees itself as part of the solution.

Implementation/funding assessment

The underlying theme of the TCM process is the community and government working together to achieve sustainable natural resource management. The implementation of TCMs within each catchment is the joint responsibility of the Catchment Management Committee or Trust together with the local community and resource management organisations.

Landcare groups form the basis for active community involvement in resource management and are already implementing activities that are consistent with the resource management strategies developed by Catchment Management Committees. Groups established to address natural resource management issues are eligible for financial assistance through funding programs, such as the National Landcare Program and SALT ACTION. These programs enable the implementation of community actions identified in catchment management strategies.

An important function of Catchment Management Committees is the assessment of community and government agency funding applications. Committees assess all applications to check that the necessary guidelines have been met and that the proposed activities, as detailed in the applications, are consistent with the regional catchment strategy. Funding applications are prioritised by the Committees, again in accordance with the strategy, to ensure that funds are directed towards effective actions.

Project applications are then referred to the State Assessment Panel. This Panel, comprising Catchment Management Committee Chairpersons and the Natural Resources Program Coordinating Committee, further assess the funding applications and prioritise projects in accordance with the NSW State Strategy for Natural Resource Management.

Following evaluation by the State Assessment Panel, recommended projects are referred to the Commonwealth Government who announce successful grants shortly after the Federal Budget.

Total Catchment Management (TCM)

TCM is not about controlling your activities in a catchment but rather about providing management direction for a catchment and having everybody within a catchment considering the impacts of their activities on others and on the catchment itself.

The important features of TCM that will assist in the sustainable use of resources are:

- Co-operation between governments, businesses and the community generally;
- A coordinated approach to natural resource management;
- Consideration of the impacts activities have on others;
- Provision of a forum to resolve natural resource management conflicts;
- An understanding of the ecosystems within the catchment;
- Community identification of catchment issues and involvement in strategies to address the priority issues;
- Community access to government resources, such as the National Landcare Program (N.L.P.), which enables implementation of community action..

How does TCM Work

An important component of TCM is community involvement. Neighbours may come together as a group to tackle a common local issue (e.g. landcare groups) or may provide representatives to a Catchment Management Committee which has a broader catchment perspective. Groups established to address catchment management issues are eligible for assistance to implement their actions through competitive funding grants and technical assistance from government departments, such as the Department of Conservation and Land Management, Department of Water Resources, NSW Agriculture, the Environment Protection Authority and Local Government.

There are four elements of TCM that require attention if the goals of managing for our future needs are to be achieved:

1. Look at the whole situation, as well as the parts.
2. Involve all members of the community, including government and the general public.
3. Cooperation between all parties.
4. Plan for the future, as well as meet the needs of today.

Involvement of all interested people is a key element of TCM.

Membership of Catchment Management Committees

Catchment Management Committees consist of the following members who are appointed by the responsible Minister:

(a) persons who are land holders or land users within the catchment area, who are to constitute the majority of the members;

(b) persons who, in the responsible Minister's opinion, have an interest in environmental matters within the catchment area;

(c) persons selected from a panel of 2 or more persons nominated by local government authorities within the catchment area; and

(d) persons who are officers of government departments or authorities having responsibility for natural resource use or management within the catchment area.

The responsible Minister is to appoint one of the members of the Catchment Management Committee to be the Chairperson and another to be the Deputy Chairperson of that Committee and may remove either member from the office and appoint another member as Chairperson or Deputy Chairperson at any time.

Catchment Management Trusts

Catchment Management Trusts are also recognised in the Act. A Trust is a corporation and can raise revenue. It is established at the recommendation of a particular Minister when:

(a) the degradation of natural resources within the area concerned is adversely affecting the community;

(b) the land holders, land users and the community who utilise and derive benefit from those resources have a joint responsibility to deal with the degradation;

(c) the formation of a Trust is the most appropriate means of achieving equitable cost sharing; and

(d) there is clear support by the land holders, land users and the community for the formation of a Trust.

Membership of Catchment Management Trusts

Catchment Management Trusts consist of trustees appointed by the Governor on the recommendation of the responsible Minister.

The trustees recommended by the responsible Minister must include:

(a) landholders or landusers within the Trust area, who are to constitute the majority of the trustees;

(b) persons who in the responsible Minister's opinion have on interest in environmental matters within the Trust area;

(c) persons selected from a panel of 2 or more persons nominated by local government authorities within the Trust area; and

(d) persons who are officers of government departments or authorities having responsibility for natural resource use or management within the Trust area.

Functions of Catchment Management Trusts

Catchment Management Trusts have the total catchment management purpose prescribed in relation to the Trust area described in the regulations. Trusts may for the purpose for which they are established:

(a) provide, construct, operate, manage and maintain works and buildings;

(b) purchase, exchange, take on hire or lease, hold, dispose of, manage, use or otherwise deal with real or personal property;

(c) enter into contracts, including consultancy contracts;

(d) enter into cost sharing or other arrangements in connection with the carrying out of works;

(e) generate revenue by levying and recovering catchment contributions;

(f) provide assistance to mitigate the effects of flood, drought, fire or other emergency, including assistance with funds, personnel or equipment;

(g) effect and maintain insurances;

(h) exercise any other functions prescribed by the regulations; and

(i) do anything incidental to the achievement of the purpose for which it was established.

If the responsible Minister so decides, a Trust may also exercise within its Trust area any or all of the functions of a Catchment Management Committee.

Within one year of the first meeting of a Trust, a Corporate Plan is to be prepared for the achievement of the purpose for which it was established. The Corporate Plan is to contain a detailed written scheme of the natural resource management strategies and programs to be implemented by the Trust within its Trust area.

Responsible Minister

Under the Catchment Management Act, 1989 various Ministers have responsibilities as follows:

(a) for the SCMCC; the Minister for Conservation and Land Management;

(b) for a Catchment Management Committee; the Minister who makes the order for establishing the Committee;

(c) for a Catchment Management Trust; the Minister who recommends to the Governor the establishment of the Trust.

The Ministers for Natural Resources, Environment, Agriculture and Conservation & Land Management are all empowered under the Act, to make an order establishing a Catchment Management Committee.

TCM and The Future

TCM links the community with government to achieve sustainable natural resource management. The future with TCM means less soil erosion, enhanced water quality, improved productivity, maintenance of biodiversity and a healthier environment.

Specifically, the TCM organisational structure will:

- coordinate actions to ensure that the community's collective impact on the environment is positive.
- allow for conflict resolution.
- increase the efficiency with which we use our resources, making sure that money is directed towards effective actions.
- ensure that research is targeted towards genuine needs and is consequently used.
- encourage management strategies that minimise environmental problems.
- raise awareness of and deal with environmental problems whilst they are still in their infancy and cost less to remedy.
- enable local responsibility and allow people to have a say in their future.
- provide feedback to government and influence policy.
- improve everybody's quality of life in a healthy environment.

Natural resource management involves us all.

In the past we have often relied on simple remedies to try to repair environmental damage. Whilst in many instances we have become quite good at this, we have not been nearly as successful at coming to terms with the complex environmental and social causes underlying these problems. Filling erosion gullies, dredging harbours of silt, and dumping human and industrial effluent further out to sea are classic examples of short-term "fixes" that do not address the causes.

There is nothing wrong with any of these activities, if a harbour has silted up it often makes good sense to dredge it. Often a strategy such as this is the only practical one available at the time. Looking at the situation from a wider perspective, however, it is clear that despite the amount of resources we have devoted to activities such as soil conservation, the overall situation has not appreciably improved. Our approaches have relied heavily on engineering or works orientated actions without adequate consideration of broader social, economic, biological and management issues of the real long-term solution.

We need to continue addressing immediate concerns in the short-term, but with consideration of the wider environment in which these problems occur, and for the future. Better strategies are necessary. They need to do more to address the underlying causes of problems, and must recognise the interactions between different problems and activities. We need, in other words, to take a more holistic integrated approach.

TCM allows us to start addressing natural resource management issues now. In the short term TCM presents the opportunity to achieve many practical outcomes. In the long term it presents an opportunity to reshape natural resource management practices and community relationships in ways that reflect the ethos of TCM.

The TCM approach deals constructively with difficult questions and conflicts. All of these things will lead to a healthier environment while maintaining the quality of life for everyone.

TCM

Total Catchment Management

Community And Government Working Together

TCM Legislation

The NSW Government formalised a TCM Policy in 1984. An operational and legislative framework for TCM was created by the passing of the Catchment Management Act in 1989. TCM has bipartisan support.

1. The objectives of the Act are to:
   (a) coordinate policies, programs and activities as they relate to total catchment management;
   (b) achieve active community participation in natural resource management;
   (c) identify and rectify natural resource degradation;
   (d) promote the sustainable use of natural resources; and
   (e) provide stable and productive soil, high quality water and protective and productive vegetation cover within each of the State's water catchments.
2. In order to achieve these objectives, the Act:
   (a) provides for a network of Catchment Management Committees, coordinated by a State Catchment Management Coordinating Committee, and linking the Government and the community to achieve the objectives of total catchment management; and
   (b) provides for Catchment Management Trusts to replace Catchment Management Committees in some situations in order to raise revenue for particular total catchment management purposes.

Objective of the State Catchment Management Coordinating Committee

The objective of the State Catchment Management Coordinating Committee (SCMCC) is to provide a central coordinating mechanism for the purpose of total catchment management throughout New South Wales. Total Catchment Management (TCM) is defined as the coordinated and sustainable use and management of land, water, vegetation and other natural resources on a water catchment basis, so as to balance resource utilisation and conservation.

Functions of SCMCC

The functions of the SCMCC are to:

(a) coordinate the implementation of total catchment management strategies;
(b) monitor and evaluate the effectiveness of total catchment management strategies;
(c) advise the responsible Minister or other Ministers on any aspect related to total catchment management;
(d) coordinate the functioning of Catchment Management Committees and to maintain liaison with Catchment Management Trusts;
(e) undertake any other functions relating to total catchment management as are directed by the responsible Minister.

Objectives of Catchment Management Committees

Catchment Management Committees oversee and coordinate natural resource management activities at a regional or entire river valley level.

Functions of Catchment Management Committees

Within its catchment area, the functions of a Catchment Management Committee (CMC) are to:

(a) promote and coordinate the implementation of total catchment management policies and programs;
(b) advise on and coordinate the natural resource management activities of authorities, groups and individuals;
(c) identify catchment needs and prepare strategies for implementation;
(d) coordinate the preparation of programs for funding;
(e) monitor, evaluate and report on progress and performance of total catchment management strategies and programs;
(f) provide a forum for resolving natural resource conflicts and issues; and
(g) facilitate research into the cause, effect and resolution of natural resource management issues, and
(h) undertake any other functions relating to total catchment management as are directed by the State Coordinating Committee.

APPENDIX 5

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