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

0 500 1000 M

CLOUSTON

LANDSCAPE ARCHITECTS • LANDSCAPE PLANNERS

FOR GREENING AUSTRALIA AND DARWIN CITY COUNCIL

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.