3. Existing Environment

This section describes the existing environmental characteristics of the area to be affected by the proposal. Particular attention is focused on components of the environment that would either have a direct bearing on the proposal or could be most affected by it.

3.1 Topography

The proposed lake development site overlies an existing concrete lined stormwater drainage channel that services the surrounding northern suburbs. We assume the drain overlies a former small arm of Rapid Creek into which the drain now discharges. At the upstream end of the drain there is a series of large stormwater pipes (**Figure 3.1**). Downstream of the culverts the channel drops some 30cm in height (**Figure 3.2**), and during the dry season there is a small flow of freshwater over this step. From there the stormwater drain flows through University ground (lawn areas) and then through thickets of coffee bush (*Leucaena leucocephala*) after which it drains into Rapid Creek **(Figures 3.3 – 3.5**). Rapid Creek is a mangrove-lined estuarine creek that flows through Darwin's northern suburbs and empties into the Timor Sea, at the southern end of Casuarina Coastal Reserve. The creek extends for a distance of 9.8km and drains a catchment of 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 (Darwin City Council, 1994). The creek has been subject to high levels of disturbance in the past. Prior to 1974 much of the mangrove around the creek was cleared for development and has since regenerated (Guinea, 1988).

The drain is also tidal with seawater moving in and out directly from Rapid Creek. The stormwater drainage system discharges urban freshwater runoff from northern suburbs. In the dry season flow from the stormwater pipes is minimal, (**Figure 3.1**) and this would mostly result from urban activities such as car washing. In the summer rainy season, heavy pulses of freshwater flows enter the drain during storm events.

3.2 Climate

Darwin has a tropical climate which is characterised by a hot, humid Wet Season (typically December to March) and a hot, Dry Season (typically May to September) separated by relatively short transitional periods (typically April – the Dragonfly Season and October/November - the Build-Up).

The NTU campus is one of the sites used by the Bureau of Meteorology to measure Darwin's climate since 1996. The mean annual rainfall of 1,659 mm, is highly seasonal, and reliable, reflecting both the coastal position of the site, and the location in the monsoon tropics. Monthly rainfall varies from an average of 404mm in January, the peak of the Wet Season, to 1mm in July, the middle of the Dry Season. High rainfall rates are typical during storms in the Wet Season and during monsoon events.

■ **Figure 3.1: Upstream end of concrete lined drain showing culverts. Note low dry season flow.**

■ **Figure 3.2: Step in drain downstream of culverts. Note presence of film of algae on substrate above and below step.**

■ **Figure 3.3: View looking downstream toward footbridge at low tide, dry season.**

■ **Figure 3.4: View of lower end of formed drain on rising tide, with lower footbridge in distance. Note thickets of coffee bush on both banks.**

■ **Figure 3.5: View looking upstream from lower footbridge. Here the substrate is a mixture of sand, gravel and rocks with some pieces of timber and rotting vegetation.**

Humidity varies from the Wet Season to the Dry Season as well as over the period of a day, with higher humidity in the Wet Season. For example humidity at 9am in June is a low of 62% to a high of 84% in February with humidity for later in the day, 3pm, being a low of 30% in June and a high of 71% in February.

Temperatures tend to remain within a relatively narrow range throughout the year. Ranging from a mean daily minimum of 19.2°C (July) to 25.2°C (November) and a mean daily maximum being 30.3°C (July) to 33.1°C (November).

Synoptic winds during the Dry Season tend to be dominated by the south-east trade winds, while light west to north-westerlies predominate during the Wet Season. Sea breezes from the north-west occur on most afternoons throughout the year.

Tropical cyclones are frequent in the Darwin region. Australian Standard AS 1170 Part 2-1989 specifies likely maximum gusts during cyclonic events in Darwin for purposes of structural designs. The standard indicates likely maximum gusts of 180, 205 and 252 km/h for cyclones having mean return periods of 20, 100 and 1000 years respectively (Sinclair Knight Merz, 1999 p26).

3.3 Surface and Sub-surface Hydrology

The gently sloping and evenly graded topography of the university campus provides for a dispersed drainage pattern over most of the area. Runoff is generally collected on the lower slopes by pits, drains or basins from where it is piped or channelled into Rapid Creek.

In the eastern half of the campus drainage falls southward and is collected by the stormwater system of the existing campus development. From here it is fed into the open drain or NTU Drain, along the southern boundary before entering Rapid Creek.

To the west, the undeveloped portion of the campus drainage is shed in a west and southwesterly direction. Much of it is directed into a broad natural basin on the western edge of the campus from where it enters Rapid Creek via a natural drainage course.

The drainage patterns outside the existing campus are major physical features on the landscape and influence the character of the University. Rapid Creek terminates into a large natural delta just south of the campus before entering the Timor Sea. The total creek covers a catchment area extending 28km inland and is, therefore, of regional significance.

The large open drainage line along the southern edge of the campus is a significant feature of the University landscape. The drain carries stormwater from adjacent suburbs as well as the campus, and discharges into Rapid Creek. The large scale of the drain, the nature of its contents, and the lack of a natural riparian corridor, make for a feature of little visual appeal.

Smaller open drains and stormwater pipes discharge runoff into Rapid Creek or the large open drain. **Figure 3.6** shows the end of a stormwater drain that discharges into the larger NTU drain in the area where the proposed lake will be sited.

Figure 3.7 shows a unformed drainage channel with erosional features that drains a small patch of disturbed forest before entering the NTU drain just upstream of the lower footbridge.

■ **Figure 3.6: The largest formed stormwater drain that discharges into the NTU drain. Note brown stain of algae growing in effluent stream.**

■ **Figure 3.7: Large drainage channel discharging into lower end of NTU drain just upstream of lower footbridge. Note evidence of erosion of banks and presence of rubbish.**

The smaller channels are typically steep sided and deep, providing optimum conditions for weed growth and mosquito habitat if water ponds during periods of low flow. They are, therefore, undesirable features in the landscape.

The water table fluctuates widely during the wet and dry seasons. However, analysis of water extracted from surface bores indicates that the ground water has a high salt content and is not potable water.

3.4 Soil Characteristics

Lateritic soils are the dominant soil type of the campus. The soil is of variable thickness and is characterised by a significant proportion of gravel, poor nutrient content and minimal organic matter.

3.5 Flora and Fauna

3.5.1 Vegetation Communities

The vegetation of the site has previously been mapped and described as part of the NTU Landscape Master Plan (Clouston, 1992). That document identified the broad pattern of vegetation distribution, delineating areas of mangroves, disturbed and poorly managed vegetation and patches of significant native plant communities. However, a more detailed examination and assessment of the existing vegetation was conducted as part of the requirements for this PER. Results of the survey are presented in **Appendix C**, and summarised below.

Existing vegetation mainly comprises dense infestations of coffee bush (*Leucaena leucocephala*). A native of Central America, *Leucaena leucocephala*is is now well established in coastal settlements of the Northern Territory. Although coffee bush is a common woody weed in the Darwin region with the potential to cause serious environmental problems, it is not a declared noxious weed (Smith, 1995). It is a species characteristic of disturbed or degraded land, especially around settlements.

Overall, five main vegetation communities were distinguished within the area of interest as indicated in **Figure 3.8**.

Planted Open Parkland
Much of the area between the southern NTU ring road and Lakeside Drive is planted open parkland in which scattered trees and plantings occur amongst maintained grassland. The area includes two grassed ovals with planted trees including both native and exotic species. In general, trees in the open parkland area appear to be relatively young (< 20 years old), typically ranging from 9 to 14m in height and presumably represent the cumulative product of landscape works since Cyclone Tracey in 1974.

The upstream section of the draining reserve is lined with scattered *Acacia auriculiformis* (Darwin Black Wattle) with occasional Red River Gums *(Eucalyptus camaldulensis*) and Banyan Fig trees (*Ficus virens*). Exotic trees are more numerous in this area with *Khaya senegalensis* (African Mahogany), *Gmelina arborea*, *Pterocarpus indicus* (Rosewood) and *Alstonia scholaris* (Cheesewood).

Approximately 48% of the area to be cleared for the proposed lake currently comprises planted open parkland. No native or exotic species of conservation significance occur within the boundary of the proposed lake.

Coffee Bush Infestations
Approximately 52% of the area to be cleared for the proposed lake comprises monospecific stands of *Leucaena leucocephala* (Coffee Bush). Construction of the weir and spillway will involve further clearing of dense Coffee Bush. This species tends to exclude native vegetation and forms thickets to 6m high that extend right to the edge of the intertidal zone and overhang the canal. (See **Figure 3.9)**

Poorly managed and disturbed native vegetation
Small areas of native vegetation showing various degrees of prior disturbance occur within the survey area. These areas are characteristically *Eucalyptus* dominated woodland habitat (including *Eucalyptus miniata*, *E. papuana* and *E. confertiflora*) with a sparse understorey layer. This community is relatively species rich with a total of 46 species recorded in this habitat. Common mid-stratum species include *Pandanus spiralis* and *Planchonia careya* above a dense grass layer. Mission grass (*Pennisetum polystachion*), an introduced noxious weed, is common in these areas along with other native and exotic grass species. A layer of smothering introduced vines that exclude native species (eg *Passiflora foetida*, *Centrosema pubescens*, *Calopogonium muconoides*) is common in this habitat. The high proportion of introduced species (28%) is indicative of disturbance to the native vegetation from frequent fire, clearing and terrain disturbance.

Remnant vegetation containing valuable specimen trees.
The mangrove fringe on the southern boundary of the NTU campus comprises a narrow band of remnant vegetation. Tree species include mature *Melaleuca leucadendra* (Paperbark), *Eucalyptus papuana* (Ghost Gum) and tall *Acacia auriculiformis* (Darwin Black Wattle) in the upper stratum. Other species of interest include *Diospyros calycantha*, *Diospyros littorea*, *Guettarda speciosa* and *Timonius timon*. (See **Figure 3.10)** The vegetation in this area forms a natural buffer for mangroves in the adjacent intertidal zone and future development of the lake and carpark should maintain the integrity of this remnant littoral woodland.

A pocket of remnant vegetation including a tall stand of Ghost Gums (*Eucalyptus papuana*) and native species associated with monsoon vine forest habitats occurs close to the mangrove margin and within the proposed carpark area. It is however, surrounded by a mix of exotic species (*Khaya senegalensis*, *Leucaena leucoephala*), plantings of native species (*Ficus benjamina*, *Melaleuca* spp.), and native vegetation in disturbed condition.

Although occupying only a small area, the healthy stand of Ghost Gums occurs amongst Paperbarks (*Melaleuca leucadendra*) and tall *Acacia auriculiformis*, forming an attractive pocket of native vegetation. (See **Figure 3.11)** Beneath the canopy formed by the Eucalypts, saplings of *Carallia brachiata*, *Carpentaria acuminata*, *Terminalia microcarpa* and *Wrightia saligna* occur. This pocket of vegetation contains valuable specimen trees and should be retained as a landscape feature, providing shade to the carpark area.

■ **Figure 3.9: Coffee Bush *(Leucaena Leucocephala)* infestation.**

■ **Figure 3.10: Remnant vegetation containing valuable specimen trees.**

■ **Figure 3.11: Ghost Gums *(Eucalyptus papuana)* in the vicinity of the proposed carpark.**

Mangroves
Mangroves occur either as a thin band often only one tree in width, or as sporadic trees/shrubs along the main tidal channel as far upstream as the current foot bridge. Common mangrove species recorded in this habitat include *Lumnitzera racemosa*, *Avicennia marina*, *Acrostichum speciosum* and *Excoecaria ovalis*. Upstream of the bridge the margins of the channel are more formalised and mangroves do not occur in this area.

The upper reaches of Rapid Creek support extensive mangroves that extend up to the southern boundary of the NTU campus. These mangroves are dense closed canopy forests to 7m high, typically comprising a landward fringe of *Lumnitzera racemosa*, *Diospyros littorea*, *Ceriops australis*, *Acanthus ilicifolius* and *Scyphiphora hydrophyllaceae.*

3.5.2 Aquatic Fauna

A visual survey of marine fauna along the drain system was undertaken (21/05/01). Seven species of fishes were observed within the drain (**Table 3.1**). Mullet were the dominant species, with many schools of small individuals observed along the length of the drain. The observed fauna appeared to consist of non-resident species of opportunistic feeders moving upstream with the incoming tides.

Table 3.1. Fish species observed during a visual inspection of marine fauna in the drain leading to Rapid Creek.

Species	Common name	Abundance
Mugil or Liza spp.	Mullet	Common
Torquigener pallimaculatus	Toadfish	Present
Marilyna darwinii	Toadfish	Present
Selenotoca multifasciata	Scat	Present
Scatophagus argus	Scat	Present
Amniataba caudovittatus	Yellowtail trumpeter	Present
Terapon jarbua	Crescent perch	Present

It is likely that a number of other fish and crustacean species (not seen in this survey) inhabit the drain at times. A variety of fishes such as Gobies commonly inhabit small tidal creeks such as this one, and there was some suitable cover available for these small cryptic species. Similarly, a variety of small invertebrates including species of crabs and shrimps are probably also present. A large number of fishes and crustaceans also move upstream in shallow tidal creeks either daily with the tide, or in response to seasonal cues, such as increased freshwater flows. It is possible that crocodiles could also move upstream. Crocodiles are currently retrieved from Rapid Creek when sighted.

The section of the creek examined did not contain a high diversity of habitat types and was sandy with large pieces of gravel below the formed concrete part of the drain. The lack of aquatic macrophytes and the general lack of cover reduces the diversity of fauna that might otherwise be associated with the creek.

The drain empties directly into Rapid Creek and there is no obstruction to fish movement between the creek and drain, except for the step just downstream of the culverts at the upper end of the drain. At low tide and low flows this creates a barrier for the movement of fauna upstream and into the culverts.

A high diversity of fishes inhabit estuarine mangrove creeks in the Darwin region. Larson and Williams (1997) provide a checklist of fishes recorded in the Harbour. They list 415 species which highlights the high levels of marine diversity in the area. **Appendix D** lists species officially recorded from Rapid Creek (Larson and Williams 1997), in addition to families (representative species only shown) which these authors have recorded from estuarine Creeks and inlets in the Darwin Harbour area. These are species that could also be expected to inhabit Rapid Creek. From **Appendix D** it is evident that the diversity of marine fauna in Rapid Creek is likely to be high, but it is anticipated that many of the sedentary species recorded from Rapid Creek would not be found in the NTU drain because of a lack of suitable habitat.

Very large numbers of invertebrate species are also present in Rapid Creek and comprise two groups of species. Resident species are found in various habitats in the creek and comprise organisms such as fiddler crabs, barnacles, oysters, polychaetes, isopods, amphipods, sipunclids and echinoderms. The other large group of species migrate up and down (and into and out of) the creek with the tide, and with increased freshwater flows during the wet season.

Prawns (penaeidae) and brachyuran crabs (eg mud crab *Scylla serrata*) are common elements of tidal inlets and estuaries in the Darwin Harbour and would be likely to migrate into the drain on high tides and during significant freshwater flows. However, the lack of suitable cover, and food suggests the drain is a marginal habitat for these species. Molluscs such as *Terebralia spp* may also be present at the downstream end of the drain, and **Figure 3.12** shows a small midden of these species found in coffee bush thickets alongside the drain. Typically these animals are associated with mangroves and on the day of survey a group of aboriginal people were observed eating these species alongside the mangrove lined creek further downstream.

There is a possibility for crocodiles to enter the lake with the tide. At present, crocodiles could travel up most drains in Darwin and the open water of the lake is not likely to attract them any more than currently with the open drain. In the first instance, a sign indicating the possible presence of crocodiles will be erected and if frequent sightings are noted, a trap will be installed below the weir to capture them.

■ **Figure 3.12: Remains of the molluscs Terebralia spp and Telescopium telescopium in a coffee bush thicket along side the drain.**

3.5.3 Bats

The knowledge of microchiropteran (insectivorous) bats in the NT is quite limited. Records are patchy and there is little comprehensive information for many species – even relatively common ones.

Microchiropteran bats in the Top End feed nightly and do not appear to enter into torpor or hibernation as bats from other regions do. They have high metabolic rates and need to feed each night.

Microchiropteran bats are long lived with some individuals living more than 20 years. Large Bentwing Bats *Miniopterus schreibersii* (Family Vespertilionidae) and Large-

footed Myotis *Myotis moluccarum* (Family Vespertilionidae) are common inhabitants of stormwater drains in the Darwin area. Leaving their roosts on dusk, bats are noticeably active throughout the night.

Although no site-specific surveys have been conducted, it is likely that permanent colonies of both Large Bentwing Bats and Large-footed Myotis are present all year round in the NTU stormwater drain. In addition Orange Leaf-nosed Bats *Rhinonycteris aurantius* (Family Hipposideridae) may be found. These three species of bat are not considered threatened in the NT.

Large Bentwing Bats *Miniopterus schreibersii*
With a distribution throughout the Top End and Eastern Australia, the Large Bentwing Bat is a common inhabitant of stormwater drains and other built structures. Trapping records from the stormwater drains in Leanyer, located in the northern suburbs of Darwin (Webber, unpublished) indicate that colonies may exist in the 1000's. In July 1991 a harp-trap placed over one of four drain exits caught 375 individuals in less than 30 minutes, and in May 1992 over 500 bats were trapped in under one hour. Adult male and females have been caught in reproductive and non-reproductive condition. Juveniles have been caught, but exploration up the drains for approximately 400m did not reveal the roosting sites, or any evidence of a maternal colony. It is reasonable to assume that the roosting and maternal sites are further up in the drain system.

Large-footed Myotis *Myotis moluccarum*
With a range from the Kimberley in WA to Southern Australia, Large-footed Myotis are known to choose roost sites close to water where they feed. Although not occurring in such great numbers as the Large Bentwing Bat, the Large-footed Myotis has been present at each trapping. Adult male and females have been caught in reproductive and non-reproductive conditions (Webber, unpublished). It is thought that this species may breed all year round in the Top End.

Orange Leaf-nosed Bat *Rhinonycteris aurantius*
A third species of bat, the Orange Leaf-nosed Bat *Rhinonycteris aurantius* (Family Hipposideridae) has been trapped at the Leanyer site (Webber, unpublished). Males in non-reproductive condition were trapped in July 1991 and males recorded from this site in April 1995. Males are known to mate in July, with females giving birth in December and January. With a distribution that is restricted to the northern parts of the NT and WA, these bats are dependent on roost sites with particular climate conditions. If removed from their roost sites they die within hours, and if disturbed enough they will abandon the site. Disturbance of known roost sites should be avoided at all costs.

If Orange Leaf-nosed Bats find the Leanyer stormwater drains suitable to roost in, then the NTU storm water drains may also be a suitable roost site for them as well.

3.5.4 Biting Insects

Mosquitoes are a natural component of most aquatic environments.

Some species of mosquito are disease vectors and therefore present a hazard to human health. In addition biting insects, specifically mosquitoes and biting midges, can present a severe nuisance to residents and visitors to areas where they are present, which includes Darwin.

Of the some 100 or so species of mosquitoes found in the Northern Territory, 15 are considered to be carriers of disease or a general pest. They breed in the intertidal mangrove zone and low-lying zone between mangroves and terrestrial open forest from 3.3m AHD to 1.0m above maximum high tide at various times of the year (Whelan, 1988).

Biting midges, sometimes erroneously called “sandflies”, are small two winged flies of the genus *Culicoides* in the Family Ceratopogonidae. They have aquatic or semi aquatic larval stages and breed in a variety of habitats from rotting vegetation to marine mud. The various species seek blood from preferred hosts with only a few species in Australia being serious pests of people. Previous investigations conducted around Darwin indicate that C. ornatus is the principal species biting humans.

. Our observations during a field survey demonstrated the presence of biting midges at the present foot bridge over the lower end of the drain. Presumably these animals originated from populations associated with the nearby muddy banks of the tidal creek.

Further upstream no evidence of either mosquitoes or biting midges was observed and no suitable breeding habitat observed.

The main potential for the breeding of biting insects within the current stormwater drains at the University is associated with the low dry season flows. If such flows are allowed to pond rather than be free-draining, then mosquito breeding grounds can result.

3.6 Sites of Significance

No historic, archaeological or sacred sites have been identified on the current site. The area has been highly disturbed during the development of the surrounding suburbs which included the construction of the existing stormwater drain, Alawa oval and development of the NTU facilities.

The Aboriginal Areas Protection Authority has issued an Authority Certificate for the construction of the lake and ceremonial entrance to the university campus. A copy of the certificate is presented in **Appendix E**.

No Declared Places or Objects under the *Heritage Conservation Act 1991* exist on the site or have been nominated.