4. Environmental Impacts

This section outlines the potential effects of the proposal on the physical and biological environment. Potential impacts associated with both the construction and operation phases are discussed.

4.1 Construction

Construction employees will be inducted prior to commencement of work on site. Environmental awareness training will be included in the induction. Construction employees will be informed of all commitments made in the PER as well as their responsibilities under the relevant legislation.

4.1.1 Topography

The topography of the site will change to create the lake – fill that is removed during the process of developing the lake by widening the existing stormwater drain will be removed from the site.

4.1.2 Dust

Dust may be generated during the construction phase from earthworks and movement of vehicles and machinery. Wind erosion on exposed soils may also contribute to dust generation. Dust has the potential to impact on native vegetation, disrupt adjoining land users and residents and cause a nuisance to the on-site workforce and employees and students at the University.

The construction contractor will visually monitor dust levels on site during construction. The construction contractor will take into account:

- nature and location of activities on site including haulage activities
- weather conditions and direction of wind
- potential for dust nuisance on workforce and surrounding land users.

Dust suppression will be employed in the event that:

- dust generation becomes a potential nuisance
- if the potential for dust generation during the day is significant
- complaints are received about dust.

Dust suppression methods may include watering of roads or other exposed areas, covering of truck loads or stockpiles or speed restrictions on exposed areas.

Commitment:

Appropriate dust control measures will be implemented should dust levels prove to be an issue.

4.1.3 Noise

Construction activities have the potential to generate noise from use of heavy machinery and equipment, increased heavy machinery on access roads, and from construction activities such as compacting, building, concrete laying etc.

The construction contractor will ensure that construction activities are carried out in accordance with AS2436-1981. Working hours will be restricted to daylight hours only unless with prior consultation with potentially affected residents or land users. Noise monitoring will be undertaken if required in response to noise complaints.

Commitment:

Any complaints related to noise will be investigated and appropriate corrective action implemented to rectify the situation.

4.1.4 Surface Hydrology

Construction operations have the potential to impact on the water flowing into Rapid Creek downstream from the construction activities. Contamination of the downstream drain and Rapid Creek may result through surface runoff. Contaminants could potentially include suspended material from soil erosion and minor spilt petroleum products from construction vehicles.

Construction activities will be restricted to the dry season so that only minimal stormwater flow will be present in the NTU drain. The stormwater drain system will be diverted around the construction activities and disturbed areas, to enable the low dry season flows to continue into Rapid Creek unimpeded. The construction of a temporary coffer dam will prevent tidal ingress onto the construction site. Therefore, there will be no flow of water from the construction site into the lower reaches of the drain thus preventing suspended material from the construction activities entering Rapid Creek.

As there will be no flow of water from the construction site into the lower reaches of the drain, there will not be a pathway for suspended material from the construction activities to enter Rapid Creek.

Commitment:

All construction activities will be undertaken during the Dry Season.

4.1.5 Soils

Acid Sulphate Soils

Acid sulphate soils are typically encountered within estuarine muds. Initial advice indicates that as the site is located upstream of the estuarine mudflats of Rapid Creek (DLPE Natural Resources pers.com.) it is unlikely that acid sulphate soils will be present. However, prior to construction, testing will be carried out on site to confirm that this is the case. If acid sulphate soils are identified, then an acid sulphate soil management plan will be implemented. The management practices that may be undertaken include:

- Neutralisation of the acid soils with lime during the installation of footings and sub-surface structures;
- Excavation of the acid soils and disposal of them at an appropriate site; and
- The use of a clay liner to prevent the downward percolation of freshwater and prevent exposure to the atmosphere.

Commitment:

Samples of soil from the NTU site will be analysed for acid sulphate potential.

If potential acid forming soils are identified, then an acid sulphate soil management plan will be implemented.

4.1.6 Flora and Fauna

Impacts on flora and fauna due to construction are expected to be minimal.

Some clearing of vegetation will be required during construction. This clearing will be limited to the minimum necessary for construction works. Any trees to be maintained will be clearly identified and marked by the Parks and Wildlife Commission of the Northern Territory to avoid damage to them.

Mangrove ecosystems are of recognised conservation significance due to their value as a natural, scientific and educational resource. The proposed development will not involve clearing in mangrove areas. Several mangrove trees lining the downstream tidal channel will be removed but the weir will be located 80 m distant from the main intertidal areas and therefore alterations of tidal flows will not impinge on mangrove habitats. The design of the proposed carpark will ensure that an adequate buffer exists between construction areas, the mangrove fringe and adjacent remnant littoral woodland.

The area designated for the proposed lake, the weir and immediately downstream of the spillway does not contain vegetation of conservation significance. Indeed, aside from landscaped areas, the majority of the site is disturbed and poorly maintained, largely comprising monospecific stands of Coffee Bush (*Leucaena leucocephala*). The presence of Coffee Bush species detracts from the environmental quality of the area and creates management problems. Consequently, clearing of this species will improve the amenity and visual quality of the upper Rapid Creek area.

Apart from a small pocket of remnant vegetation which occurs within the proposed carpark area, no rare or endangered species or plant communities of restricted distribution were found to occur within the site. The major potential impact on flora from the proposed development will involve clearing of dense *Leucaena* thickets and scattered specimen trees planted around the open drain. Overall, the removal of the *Leucaena* infestations will have a positive effect on the ecological and aesthetic value of the area.

An 8m high Banyan Fig located next to the main bridge (leading to carpark) has the potential to become an outstanding landscape tree. Attractive specimen trees such as this Banyan, located within the proposed lake area, could potentially be relocated to the lake edge during construction works.

Commitments:

Clearance of vegetation will be limited to the extent necessary for construction works and trees and plants to be retained will be clearly identified by the Parks and Wildlife Commission of the Northern Territory and protected during construction.

Construction will be managed so as to avoid impacts to mangrove communities.

Weeds and Introduced Species

The weed *Leucaena leucocephala* (coffee bush) which is found on the site will be targeted for removal as part of the landscaping of the site which will include native flora in keeping with the NTU Landscaping Master Plan. *Leucaena* produces vast quantities of seed and further weed control measures will be undertaken after clearing.

Regular visual inspections by the construction contractor to ensure existing weeds are removed and no new weeds become established or spread due to construction activities on the site.

Commitments:

Coffee Bush and any other noxious weeds will be removed wherever possible during construction and burnt to kill seeds and prevent potential re-growth.

A weed control program will be developed prior to construction for the duration of the construction phase. As part of this program, the site will be regularly visually inspected for the spread or establishment of weed species.

Aquatic Fauna

Construction will primarily involve clearing, excavating and concreting. These activities will produce loose material (eg. sediment/concrete powder). The main concern relating to marine fauna during construction is the possible downstream flux of such construction materials/effluent into the Rapid Creek system as a result of tidal flushing or during rain events (runoff). This would result in turbid plumes and silting which would affect water quality and benthic habitat (silting) in downstream locations. This in turn could be detrimental to marine fauna.

The works will be undertaken during the dry season to minimise runoff and erosion of materials into Rapid Creek. Surplus materials will be removed from the site. Clearing will be minimised to the extent necessary to construct the works thus limiting areas of loose top soil. The NTU stormwater drain system will be diverted around the construction activities and disturbed areas, to enable the low dry season flows to continue into Rapid Creek without being contaminated by suspended material. Furthermore, the construction of a temporary coffer dam will prevent tidal ingress onto the site during construction activities. Therefore, there will be no pathway to enable sediment generated by construction activities to enter Rapid Creek.

Biting Insects

One of the most significant impacts of construction in or adjacent to tidal areas is the creation of new sources of pest and potential disease causing mosquitoes. However, due to the nature of the project all major works for the lake, bridges, weir, road, footpath and bikepath are to be constructed during the Dry Season. Thus preventing ponding of rainwater and storm runoff. The stormwater drain system will be diverted around the construction activities to enable the low dry season flows to continue into Rapid Creek unimpeded.

Commitment:

Regular site inspections for potential biting insect breeding areas will be conducted during construction. Larvicides will be used where necessary to control breeding

Bats

To reduce the potential environmental impact on bats that might roost in the NTU stormwater drain further survey of the bat colonies will be carried out prior to final design and commencement of construction. Travelling up the drains in search of roost sites is not recommended due to health and safety issues, and would require the use of breathing apparatus. Trapping at the entrance will provide sufficient indication of the species and breeding biology.

If bats are identified as roosting in the drains, further survey work will be carried out during, and for a period of time after, the works are completed, to determine if the development is having any effect on the bat colonies.

Works such as drilling and associated vibrations, which may travel along the concrete structure may disturb the bat colonies. Disturbing bats during the day may lead to them flying out of the drain where they are easy targets for birds of prey. Therefore, if it is confirmed that bats are roosting in either the main or subsidiary drains, appropriate measures will be taken during construction to limit disturbance either directly or indirectly through noise. Such actions may include the timing of such works to later in the day.

Commitments:

Further research to confirm the existence of the bat colonies will be carried out prior to final design and commencement of construction.

If the existence of bats is confirmed then:
- the presence and potential impact on them will be carefully monitored during the construction phase; and
- timing of construction works will take account of potential impacts on bats.

4.1.7 Storage and Handling of Materials and Waste

Wastes likely to be generated during construction include:

- Inert waste such as excess fill
- General refuse and domestic waste such as plastics, cardboard and food scraps
- Some fluids such as waste oils
- Green waste

All waste will be removed from site and disposed of in a manner acceptable to the DLPE.

All hazardous materials will be transported and stored in accordance with relevant legislation and standards.

Commitments:

All hazardous materials will be stored and disposed of in accordance with relevant standards and legislation.

All waste materials will be removed from sites and disposed of in a manner acceptable to the DLPE.

4.1.8 Social and Recreational Issues

Construction activities have the potential to disrupt University employees and students and surrounding land users and residents through changes to access, traffic and parking patterns, as well as impacts arising from construction such as dust and noise generation.

The construction contractor will inform potentially affected persons in advance of any potential disruption during construction.

All public complaints received during construction will be responded to promptly and where necessary corrective actions put in place to ameliorate any impacts.

Commitments:

Local residents and NTU employees will be kept informed of any disruptions to access, traffic deviations, or changes to parking arrangements during construction.

Any complaints will be investigated and responded to promptly.

4.1.9 Aboriginal Heritage

No historic, archaeological or sacred sites have been identified on the proposed development site. The Aboriginal Affairs Protection Authority has issued an Authority Certificate for the construction of the lake and associated works.

In the event that a site of potential Aboriginal heritage significance is discovered during construction, all works will cease in the vicinity of the site pending consultation with the Aboriginal Areas Protection Authority and the Heritage Conservation Branch of the DLPE.

Commitment:

In the event that a site of potential Aboriginal heritage significance is discovered during construction, all works will cease in the vicinity of the site pending consultation with the Aboriginal Areas Protection Authority and the Heritage Conservation Branch of the DLPE.

4.2 Operational

The construction of the ornamental lake and associated infrastructure will be of benefit to the existing environment. The removal of the *Leucaena* infestations will have a positive effect on the ecological and aesthetic value of the area, and the installation of pollution control devices will minimise the debris and contamination travelling along the drain into Rapid Creek.

4.2.1 Hydrological Conditions of Rapid Creek

The existing partially concrete lined NTU stormwater drain currently flows through the south – eastern corner of the campus and empties into Rapid Creek. The drain itself is tidally flushed with seawater moving in and out directly from Rapid Creek. The stormwater drainage system discharges urban freshwater runoff from the northern suburbs. In the dry season, flow from the stormwater pipes is minimal, and this would mostly result from urban activities such as car washing. In the summer rainy season, heavy freshwater flushes enter the drain during storm events.

The lake will receive inflow of sea-water from Rapid Creek during high tides and fresh water from the stormwater drain during periods of rain and base flow conditions.

The tidal inflow will vary with the tidal cycle. Tides within Darwin Harbour are semi-diurnal (i.e. two highs and two lows per day) with a diurnal inequality (difference between successive highs and successive lows). The dominance of the semi-diurnal tides (i.e. 12 hour period) persists even at neap tides. The weir has been designed such that sea-water will flow into the lake for tide heights in excess of 2.6 m AHD. A review of the tide height data for Darwin Harbour indicates that such tides occur, on average, 15 days per month.

Stormwater recharge is seasonally dependent (wet and dry seasons). Flows during the dry months of the year will be almost zero. The base flow that does occur will originate from garden irrigation and domestic activities such as car washing etc. and potentially could carry contaminants high in hydrocarbons, heavy metals, pesticides and nutrients.

During the wet season minor storm events (1 in 2 years) are expected to generate average flows into the lake of 50 m^3/s. Major storm events (1 in 100 years) are expected to generate peak flows into the lake of 160 m^3/s.

Therefore, during the dry season, sea-water inflow from Rapid Creek will dominate. Fresh water flow from the stormwater drain will dominate during the wet season.

4.2.1.1 Water Quality

The potential water quality issues associated with the lake and/or the lower reaches of Rapid Creek are:

- high turbidity due to heavy sediment loads associated with major storm events during the wet season;
- litter;
- contamination by a range of chemicals particularly during the dry season and the first flush of the wet season;
- eutrophication of the lake during the dry season due to insufficient tidal flushing.

The existing stormwater drainage system is designed such that run-off from a minor storm is carried underground and excess run-off from a major storm is carried overground. As such, flow associated with major storms will have a high turbidity with a heavy sediment load. Similarly, there is the potential for large quantities of litter to be carried by the storm water.

Overflow from the lake will be formalised by a concrete spillway. Permanent erosion prevention structures will be constructed to prevent additional silt from erosion entering the lower drainage system and ultimately the lower reaches of Rapid Creek. A silt trap will be installed in the lower reaches of the main stormwater drain prior to the flow entering the lake.

The University will manage litter entering the lake through the stormwater drain through the use of gross pollutant traps (GPT's) which will be emptied each week during the height of the Wet Season and after every heavy rainfall at the start and end

of the Wet Season. Periodical checks will be carried out during the Dry Season as well. This regime is in keeping with current Darwin City Council GPT management.

The Darwin City Council is currently undertaking monitoring of different types of GPT's that have been placed at different points in Darwin. The Baramy GPT in Doctor's Gully area is the most similar to the NTU site with a pipe of 1050mm and a catchment of 16ha. Over the 1999/2000 Wet Season (September to May) 1,550kg of rubbish was trapped by this GPT. Almost half of that was vegetation, with just over half being sand and gravel, the remainder was paper 2%, plastic 1.3% and metal 0.7% (DCC GPT's unpublished data).

If the Darwin City Council data is used to estimate the amount of litter likely to enter the NTU stormwater drain (from Catchment Area A) the following could be anticipated each Wet Season based on an averaging of litter collected at different Council GPTs:

Total litter:	25,603kg	
Vegetation:	54.1%	(13,851kg)
Paper:	3.4%	(871kg)
Plastic:	4%	(1,024kg)
Metal:	1.3%	(333kg)
Sand/gravel:	37%	(9,473kg)

The NTU is unable to control the litter that enters the stormwater drainage system. A pro-active strategy of the NTU in conjunction with the Council could be to organise street cleaning (which Council already undertakes) with a community information strategy before the commencement of the Wet Season. This would assist with reducing the load on GPT's at the beginning of the Wet Season where the buildup of litter during the Dry Season ensures that the first heavy rainfall brings this litter into the stormwater drainage system – filling GPT's with extra-heavy loads.

Although the lake will be designed with a hard edge to prevent the growth of marginal semi aquatic reed and mangrove growth, there will still be a requirement for maintenance by removal of stormwater and tidal inflow flotsam that may accumulate in margin areas.

A water quality monitoring program was established in 1995 to assess the water quality of the catchment and identify possible issues affecting the health of Rapid Creek. The monitoring program includes a sampling location downstream of the NTU Drain. These results are included in **Table 4.1 – Monitoring Results from the NTU Drain**. Monitoring results indicate high median values of nitrate and phosphorous during the wet seasons, particularly following the first rains in October (Darwin Regional Waterwatch, 1997). Sources of these nutrients include soil, sewage, fertiliser, herbicide and pesticide runoff, detergents in stormwater and animal wastes. Increased phophorous values increase the chance of an algal bloom whereas nitrogen increases the chance of bacteriological pollution. Although some of these contaminants would have entered Rapid Creek upstream, comparison with upstream concentrations indicate that the flow from of the NTU Drain makes a significant contribution.

Table 4.1. Monitoring Results from the NTU drain.

Date	pH	EC (mS/cm)	T (°C)	Dissolved O_2 (mg/L)	Dissolved O_2 (% sat'n)	Reactive P (mg/L)	Nitrate (mg/L)	Turbidity (NTU)
15/4/96	7.0	19850	32.0	6.0	90	0.07	0	<15
24/6/96	7.0	52300	27.0	6.0	75	0.03	0.009	<20
9/7/96	7.0	54100	29.0	5.0	70	0.03	0.018	<12
12/8/96	7.0	37500	25.0	4.0	50	0.00	0	<20
10/9/96	8.5	50200	29.0	-	-	0.10	0	<12
16/10/96	8.6	54400	29.9	5.5	65	0.10	0	<10
31/10/96	7.9	40000	29.2	5.9	70	3.50	1.5	<13
12/11/96	9.3	57000	36.4	9.0	120	1.00	0.5	<5
28/11/96	8.3	57900	34.6	7.8	95	0.50	0.5	<6

The lake will provide a degree of 'filtering/dilution' of urban runoff and associated contaminants prior to entry into the Rapid Creek system.

The lake and weir will act as a runoff water storage area and there is likely to be some accumulation of the contaminants and nutrients from urban runoff in both the water and sediments on the lake bottom. Being a relatively large water body, it is possible that the lake may act as a filter and have a cleansing effect on outcoming water (flowing into Rapid Creek) from the suburbs by containing these contaminants and diluting them into the large water body. In contrast, the existing drain system would have a limited holding capacity for nutrients and contaminants with continuous release into the aquatic environment of Rapid Creek.

During the wet season (November to March) heavy rains will result in large water volumes to enter the lake via the stormwater pipes. The outlet pipes have a large capacity and at such times could cause significant flushing from the lake over the weir. At such times and particularly for the earlier rains, there may be a higher than normal levels of contaminant release over the weir that will ultimately enter Rapid Creek and coastal waterway systems. While contaminant release is a feature of the present system, the erection of the weir may result in occasional stronger pulses of contaminant release than prior to the development.

Therefore, it is likely that the lake will improve water quality entering Rapid Creek by diluting urban runoff.

The weir will allow tidal flushing and therefore gradual dilution of contaminated water.

A review of tidal prediction data for Darwin Harbour for 1999 indicates that sea water recharge of the lake will occur an average 10 days per month. On average during four of those days, sea-water inflow will occur twice per day. For the worst case, inflow only occurs on six days per month, and the longest period without sea-water inflow is 24 days. Analysis of tide heights suggests that approximately 23,000 m^3 of sea-water will flow into the lake in any tidal cycle (i.e. 24.5 hours). Making allowance for mixing of incoming flows with the water already resident in the lake, this inflow equates to a 50% replacement of water per tidal cycle. If prolonged periods without sea-water coincide with the dry season, then artificial flushing may be required to prevent eutrophication.

Monitoring of water quality will be undertaken to ensure eutrophication of the lake does not create an environment for algae to grow. Details of the monitoring program will be included as part of the Environmental Management Plan (EMP). Monitoring will be undertaken both pre and post construction. At this stage the parameters to be assessed are likely to include dissolved oxygen, phosphorus, nitrate, pH, selected heavy metals and petroleum hydrocarbons. Water quality will be assessed against appropriate Australian standards.

Should monitoring indicate additional oxygen is required for the lake, a fountain could be constructed creating an aesthetically pleasing feature to the lake as well as assisting with weed management and the creation of fish habitat. It is however, envisaged that the regular tidal flushing of the lake will address such issues in the Dry Season and in the Wet Season both large volumes of stormwater and regular tidal flushing will address these issues.

Commitments:

A water monitoring program will be developed to ensure that lake water does not become contaminated or depleted in oxygen.

Gross pollutant traps will be used to ensure stormwater entering the lake is free from litter and other gross pollutants.

4.2.2 Stormwater Drainage System

The Lake will not adversely effect the operation of the existing stormwater drain.

Currently surface water runs into the existing stormwater drain, which before construction of the northern suburbs was a natural drainage channel, or is absorbed into the soil. This will continue with the construction of the lake.

The location of the lake is within the primary storm surge area but outside the area of 1 in 100 year flood levels (DCC & Greening Australia 1994). As the lake will be constructed for tidal water movement, water levels will be no higher than the weir, enabling any storm water to be channelled away from the lake as currently occurs.

Sub-surface hydrology does not include any aquifiers, and as such no bores exist on the site. The nearest bore is a saltwater non-potable bore drilled by NTU for aquaculture study purposes (DLPE Darwin Hydrology Map and pers.com.DLPE Natural Resources).

Gross Pollutant Traps will filter the incoming stormwater removing litter including vegetation, sand and gravel, paper, plastic and metal. A run-off channel will also collect other contaminants such as oils. These measures will improve the quality of the surface water in the lake as compared to the existing stormwater channel where there are no GPT's. The design of the GPTs are not certain at this stage, however they will be designed and constructed such that they achieve the intended outcomes of filtering pollutants and consideration of bat movements.

Stormwater management will be undertaken in consultation, and to the approval, of Darwin City Council which is the responsible authority for the stormwater drainage system that feeds the lake. Additionally the Department of Transport and Works, will have responsibilities for the stormwater drainage easement that will lie over the lake,

and again stormwater management for this area will be undertaken in consultation, and to the approval, of DT&W. All drains leading to the lake will be properly maintained and constructed to cope with high tides and storm influx.

4.2.3 Flora and Fauna

4.2.3.1 Vegetation

Landscaping will be carried out in accordance with the *Northern Territory University Landscaping Master Plan 1992*.

Commitment:

All cleared areas will be rehabilitated and landscaped in accordance with the Landscape Master Plan.

4.2.3.2 Weeds and Introduced Species

Management of weeds such as coffee bush will be part of the ongoing maintenance of the landscaped grounds at the NTU.

Commitment:

The site will be regularly visually inspected for the spread or establishment of terrestrial or aquatic weed species during operation.

4.2.3.3 Aquatic Fauna

The development of the ornamental lake is not considered to be a source of significant environmental impact on existing aquatic fauna.

The existing concrete drain contains a small number of transient elements of the aquatic fauna from Rapid Creek. Transient fish and crustacean species entering the drain are likely to consist of a small number of opportunistic feeders. The drain offers minimal habitat to aquatic organisms (it is largely a narrow, shallow, concrete-lined system) and providing little in the way of food and shelter compared to mangroves which have soft substrate and overhangs, prop roots.

The proposed lake will be approximately 350m long, 47m wide with a depth of 1.2 m. Thus it will be a much larger, more stable body of water than the existing system. Given the greater area and depth of the lake it can be considered to represent an increase in available habitat for marine fauna. Given the differences in habitat availability, the lake may promote a greater abundance of resident species and possibly develop a different suite of marine fauna than presently inhabits the site.
Water quality and salinity in the lake will influence the type and abundance of fauna therein.

Presently there is no restriction of access for marine fauna except that caused by decreasing depth of the drain toward the stormwater pipes, and the presence of the step in front of the culverts. Following construction of the lake, there will be some reduction of access upstream of the proposed weir. However, movement into and out of the lake will still be possible for marine fauna due to the design of the weir that allows tidal intrusion approximately 15 times per month.

The height of the weir has been calculated to provide adequate opportunities for fish and other organisms moving upstream with the tide to exit the lake. Typically, fishes such as mullet, the most common species observed on the day of survey, move upstream with the rising tide. They will gather downstream of the proposed weir until the rising tide allows them to cross it and move upstream. Once in the lake, these species will disperse over the lake area and feed, typically on the algae growing a film on hard substrates. Similarly during strong pulses of freshwater flow, predatory fishes such as tarpon and barramundi may also move up and over the weir.

All these species commonly move up and down tidal channels with the rise and fall of the tide and will do so in the drain. However, the presence of the weir will tend to trap fish upstream, as on the falling tide, the water will quickly drop until the top of the weir is exposed. Many of the fish that move upstream will not have responded to the turn of the tide by moving downstream as they will still be in water of more than a metre depth. The combination of a short period of falling tide and the depth of water will mean many fish are trapped inside the lake by the falling tide.

Given the potential presence of large numbers of fish trapped within the lake between tides, the issue of water quality during these periods becomes important. The original proposed weir height of RL 3m would have produced periods during the late dry season when tides would not over top the weir for as long as 10 days. During these periods, schools of fish trapped within the weir would be vulnerable to impacts on water quality such as spills of contaminants, and low oxygen levels. With a reduction in weir height to RL 2.6 AHD the maximum length of time between tides overtopping the weir is reduced to a few days.

Contaminants entering the system from the northern suburbs drainage system will always be a point of some concern. During storm events when large volumes of water flush through the lake there may be pulses of higher than normal contaminant discharge into aquatic environs downstream.

The existing drain is a narrow relatively shallow system with strong tidal/marine influence. The development of the lake will create a new type of aquatic habitat with probable differences in water quality, water chemistry and flow regime.

Commitment:

The weir will be built to a height that allows tidal intrusion thus permitting fish movement, aiding water mixing and assisting in the maintenance of a brackish water habitat.

4.2.3.4 Mammals - Bats

Advice from the Darwin City Council indicates that the proposed gross pollutant traps (GPTs) would be the first ones to be introduced into stormwater drains that are known roost sites of bats in the Darwin area. As such the GPT's will be designed to take into account movement of bats and a monitoring program of the colony will be developed to determine the impact of the works.

Commitment:

A monitoring program will be implemented following construction to determine the impact of the development on roosting bat communities.

4.2.3.5 Biting Insects

Design considerations will generally prevent the creation of new breeding sites for mosquitoes. Careful attention will be given to the design and maintenance of the drainage systems and lake surrounds to ensure that isolated pools are not formed and the creation of habitat areas for breeding mosquitoes avoided.

Concrete hard edging will be provided to the sides of the lake above RL 2.4 AHD. The hard edges will extend to any open unlined stormwater drains into the lake, as far upstream in the drain where a stable lake level will occur. This will prevent marginal semi-aquatic reed growth and mangrove growth that may lead to mosquito breeding.

Commitment:

The lake and surrounds will be monitored regularly following construction to identify any potential biting insect breeding habitat.

4.2.4 Social and Recreational

Potentially, the new access to the NTU could impact on the traffic on the current traffic using Lakeside drive.

Assessment of the project's impact on traffic in the area indicates that the new entrance, and closure of the existing entrance, will reduce the amount of traffic along Lakeside Drive from the proposed new entrance to Dripstone Road. Similarly, along the section of Lakeside Drive –from Trower Road to the new entrance – no increase in traffic is likely.

The traffic projected for Ceremonial Drive is in the order of 220 vehicles per hour (total for both directions) in the afternoon peak. The impact on the existing road network is minimal when traffic enters the network at Lakeside Drive via the proposed roundabout, with a high level of service. Negligible effect on external traffic flows to 2009, is anticipated.

A full traffic study report is presented in **Appendix B.**