

Environmental Management Plan

Territory Wildlife Park Wetlands



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Project Overview

1 Background

1.1 The Wetlands Section and the Aquarium

The Wetlands section of the Territory Wildlife Park showcases and interprets the diversity of aquatic animals and plants of the Top End. According to visitor surveys the aquarium facility is the most popular attraction on the Park; perhaps because it is air-conditioned, diverse, and the fish and other animals are always on display and relatively easy to see.

The journey through the aquarium takes visitors from the escarpment waterways of the Top End, through the fresh and then into the saltwater systems, out to offshore reefs. Aquatic animals that are otherwise difficult or impossible to see in the Top End's normal murky waterways, are showcased with clarity in the aquarium. All plant life in the aquarium is real (not plastic) and all aquatic plants are native and carefully tended by aquarists to enhance exhibit aesthetics and the wellbeing of the fish, crabs, seahorses and other animals on display.

The Park holds a Public Aquarium Licence for the fishery side of its operations, and requires an Environmental Protection Licence for the waste water produced as exhibits are routinely flushed, and for the discharge of storm water.

This Environmental Management Plan will outline the monitoring, reporting and review of water waste discharge for the Park's aquarium and associated wetlands exhibits. The regulation of the discharge will be under the *Waste Management and Pollution Control Act* through an Environment Protection Licence.

1.2 Proponent Details & Roles & Responsibilities

Territory Wildlife Park

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Title	Name	Responsibility
Director	Shael Martin	General oversight of this EMP & Environment Protection Licence
General Manager Life Sciences	Donna Jensen	Oversight of WDL, monitoring, reporting & review
Supervisor Life Sciences Aquatics & Horticulture	Travis Messner	Responsible for monitoring, reporting & review of results in accordance with WDL
Supervisor Technical Services	Peter Beesley	Information about accessibility & site, management & other influences on water quality

2 Monitoring, Reporting & Review

2.1 Water Management Monitoring Program

Background

In accordance with government waste discharge regulations the Territory Wildlife Park has developed a water management monitoring program to be implemented for the full operational life of the public aquarium. The aquarium is located at Section 1786 Hundred of Ayers, 960 Cox Peninsula Road adjacent to Berry Creek in Darwin's rural area. Additional to the public aquarium this monitoring program outlines a broad management and monitoring program for water usage at the Territory Wildlife Park.

The Territory Wildlife Park utilises a combination of surface water extraction and groundwater extraction to maintain the Park's infrastructure, animal displays and potable water requirements. The primary uses for the intercepted water includes cleaning and washing animal enclosures, irrigating landscaped areas, replenishment of moats and billabongs and maintaining constant flow through at the aquarium. Potable water from two bores is also used as a public water supply for visitors and for staff. Much of the water is effectively diverted through water features on the Park and then ultimately discharged into Berry Creek.

Potable water used for a public water supply is tested each year and reported to the Environmental Health section of the Department of Health.

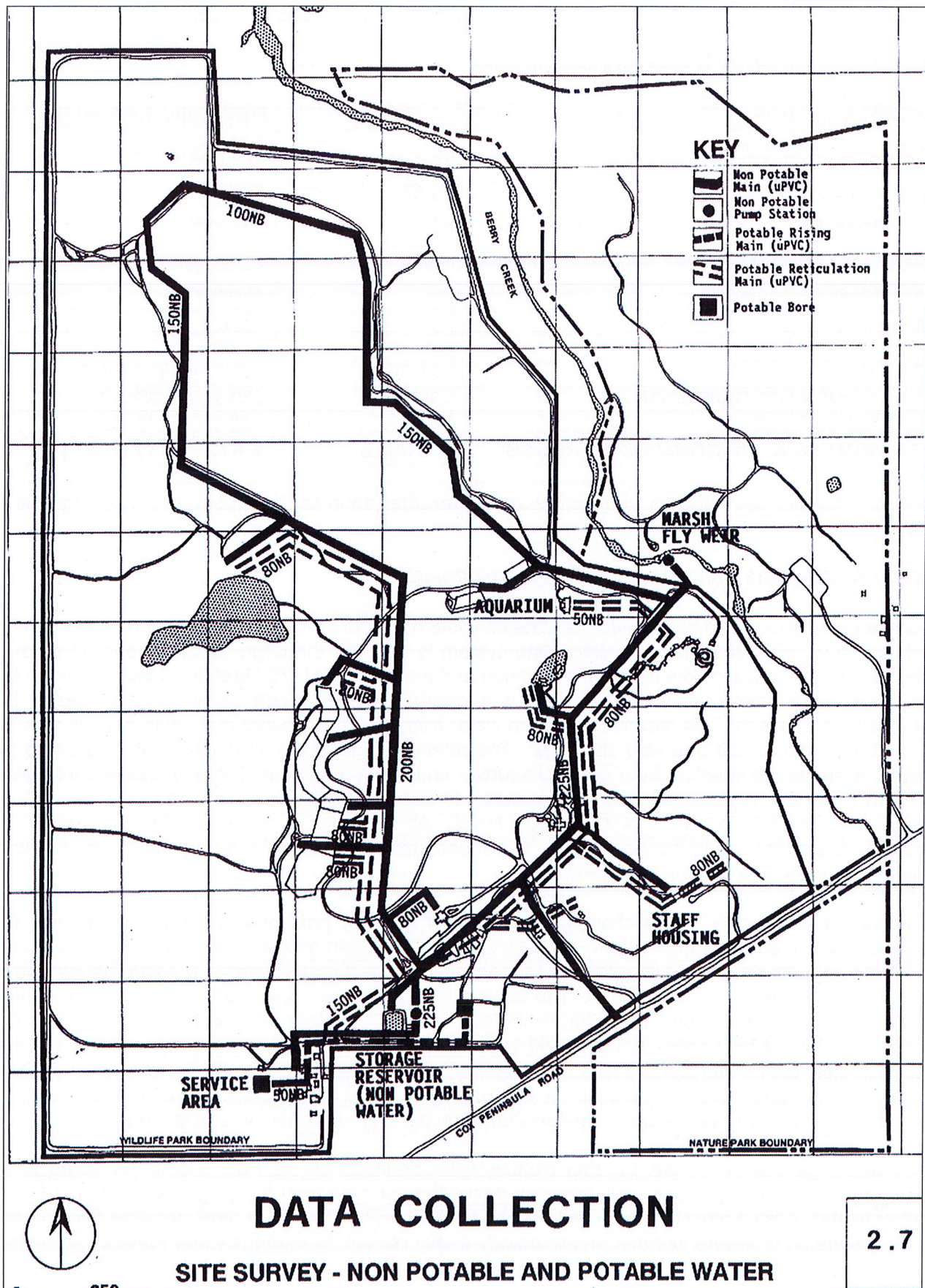
Territory Wildlife Park – Water Extraction and Water Usage

The Territory Wildlife Park utilises a Dual Sarlin SI-074-H1 pump to draw non-potable water out of Berry Creek immediately upstream of Marsh Fly Weir. The pump delivers water via a 225 NB uPVC rising main to a reservoir sited near the service area. The storage reservoir is constructed from a small earth wall dam and stores non-potable water only. Internal banks are lined to reduce seepage losses and the dam has a nominal capacity of approximately 6900kL. A dual pump station draws water from the reservoir and pumps directly into the reticulation (pipes are generally Class 9 uPVC), providing a total capacity of 40L/s at a nominal pressure of 450kPA. The station also houses a mains failure generator set to provide security of supply during a power outage.

Flow rates for non-potable water supply for the various displays are provided as estimates and are therefore only indicative of total use. Supply of non-potable water to the Billabong is estimated at 50,000 L/day, the Dingo enclosure at 50,000 L/day and the Oolloo Sandbar pool at 100,000 L/day.

The Territory Wildlife Park's potable water supply is drawn from a Grundfos production bore RN: 21427 which is located about 500m south of the service area. It is equipped with an electric submersible pump and is supplemented by a secondary standby bore (RN: 26856) situated near the service area. This bore is also equipped with an electric submersible pump. Average bore depth is approximately 27m. Potable water is delivered to two 80kL elevated tanks within the service area to provide operating pressure for reticulation. The reticulated potable water extends to the staff village in the south and to the aquarium in the north. Potable water reticulation is piped via uPVC material ranging in size from 50NB to 150NB.

Diagram 1: Main Water Reticulation System



Flow rates for potable water supply extracted from groundwater to the various staff quarters and offices and the aquarium displays are provided as estimates and are therefore only indicative of total use. The Territory Wildlife Park has no water meters to enable more accurate reporting of water use.

Table 1: Estimated Water Usage (dry season only)

NON-POTABLE USE	L/s	Peak daily demand (L)
General enclosure cleaning	2	172,800
Park irrigation	17	750,000
Dingo enclosure	0.57	50,000
Oolloo Sandbar	1.1	100,000
Billabong	1.1	50,000
POTABLE USE	L/s	Peak Daily Demand (L)
Flow through aquarium	2	180,000
Staff housing	1	86,400
General use and consumption	2	172,800
TOTAL USE	27.3L/s	2,362,000 [2.36ML]
TOTAL SEWERAGE DIVERSION	3L/s	259,200 [0.26ML]
TOTAL DISCHARGE	4.9L/s	430,000 [0.43ML]
TOTAL EVAPORATIVE/CONSUMPTIVE LOSS	19.36/Ls	1,672,800 [1.67ML]

A process flow diagram showing aquarium water/stormwater sources, treatment and discharges is at Appendix 1.

Territory Wildlife Park - Discharge and Discharge Points

The aquarium utilises a number of different filtration systems in the on-site management of water quality. A high pressure sand filtration backwash waste system is used for the large aquarium and all water is filtered through biological media for NH₃ conversion and then through HPS filtration. These systems are backwashed three times weekly and the waste is discharged. Flow through systems are utilised for the other smaller aquariums. This means that stored water from the groundwater extraction point is allowed to flow through the exhibit at a very slow rate. The retention time in the aquarium is around 24 hours. Saltwater systems are supplied from external sources and these aquariums run at seawater strength of approximately 35ppt. Approximately 1/3 of the water is changed in these aquariums every week. Total seawater consumption is approximately 4,000L/week. All seawater is mechanically, chemically and biologically filtered for use in the aquariums. The reason for water changes is to minimise the levels of nitrates in the system to support coral growth.

The aquarium facility has two discharge points located in close proximity to the aquarium. The first discharge point infrequently drains the freshwater sand filtered main aquarium at a rate of approximately 2,000L/day and utilises ground absorption and natural filtration prior to entering a small tributary creek which drains ultimately into Berry Creek. The second discharge point drains a series of aquarium floor, sump and controlled drains plus park stormwater and other water features including the billabong. This includes a mixture of freshwater, brackish and saltwater displays. The discharge enters a small tributary which ultimately drains into Berry Creek some 300m downstream of the March Fly weir. Both of these discharge points have been in operation for approximately 20 years. The estimated flow rate from the small tributary to Berry Creek is approximately 200,000L per day equivalent to 2.3L/second.

A third discharge point is central to other excess water drainage on the Park and is measured at the discharge point into Berry Creek. This primarily drains the overflow from the dingo moat and the Oolloo Sandbar exhibit utilising natural absorption and overland flow. This discharge rarely reaches Berry Creek, with the exception of severe weather and unusually heavy rainfall. Both of the water features are largely natural systems with very limited inputs and discharge is limited to wet season overflows when natural rainfall dictates volumes.

Table 2: Types of Waste Water & Sampling Sites

Water Source	Discharge Points & Locations
Freshwater – Exhibit 12. High pressure sand filtration backwash waste. The larger aquarium freshwater exhibits are filtered through biological media for NH ₃ conversion and then through the high pressure sand filter. This system is backwashed daily and the waste discharged.	<u>Discharge Point 1</u> Artificial Creek adjacent to aquarium <u>Location</u> 12° 42'09.0S 130° 59'36.4E
Freshwater “flow through systems” – stored water from our ground extraction system (bores into reservoir into storage tank into aquarium reticulations system) flows through exhibits at a slow rate. The retention rate of each quantity of water is approximately 24 hours. The overflow from these systems is discharged.	<u>Discharge Point 2</u> Downstream from Discharge Point 1 (approx. 60m) into the artificial creek <u>Location</u> 12° 42'06.9S 130° 59'37.4E
Salt water systems – these exhibits operate using seawater obtained from the Darwin Aquaculture Centre. This water has been mechanically, chemically and biologically filtered at the Centre for use in aquaculture and the Park's aquarium. Approximately 1/3 or 3,000 litres of salt water is changed over in these exhibits each week. The reason for water changes is to reduce levels of nitrates.	<u>Discharge Point 2</u> Downstream from Discharge Point 1 (approx. 60m) into the artificial creek <u>Location</u> 12° 42'06.9S 130° 59'37.4E

Territory Wildlife Park - Monitoring Program

The Territory Wildlife Park will monitor physical water quality parameters at three discharge points on a monthly basis for an initial 12 month period and then quarterly for a further twelve months to establish trend data in consultation with the Water Resources division of the Department of Environment and Natural Resources.

Table 3: Sampling Sites for Waste Water Discharge

Sample Sites	Location
Discharge Point 1: Exhibit 12 discharge into artificial creek adjacent to the aquarium	12° 42.09.0S 130° 59.36.4E
Discharge Point 2: All other discharge into artificial creek adjacent to the aquarium, downstream from Discharge Point 1	12° 42'06.9S 130° 59'37.4E
Ambient Discharge Point: discharge at March Fly Weir, Berry Creek	12° 42'04.83S 130° 59.43.64E

A map showing discharge points is at Appendix 2.

Physical parameters to be regularly monitored will include temperature, dissolved oxygen, pH, total conductivity and salinity, total nitrogen and phosphorous, and *ecoli* and *entrococci*. Total Suspended Solids [TSS] will also be assessed using an appropriate meter to be purchased.

Table 4: Water Monitoring Program

Surface Water Monitoring Program		
Parameter	Sample location	Monitoring Site
Discharge flow rate (L/s)	In-situ	1
Berry Creek Flow Data	Gauge (DENR)	Upstream
pH	In-situ	1, 2, 3
Temperature in Celsius	In-situ	1, 2, 3
Salinity PPT	In-situ	1, 2, 3
Conductivity ($\mu\text{S}/\text{cm}$)	In-situ	1, 2, 3
Dissolved Oxygen (mg/L)	In-situ	1, 2, 3
Turbidity	In-situ	1, 2, 3
Total phosphates (mg/L)	In-situ	1, 2, 3
Total nitrates (mg/L)	In-situ	1, 2, 3
<i>Ecoli & Entrococci</i>	Laboratory	2

Analysis of discharge and Berry Creek water quality

In the past, comparisons of the discharge water quality and Berry Creek water quality against water quality standards, guidelines and criteria indicated that there were minor elevations for TN and TP were evident at the discharge point, however ambient concentrations were in line with what we could be expected as close to reference.

The past results for temperature, pH, conductivity and dissolved oxygen were found to be within accepted water quality standards. Similarly, the results for total suspended solids (2.5mg/L) and total volatile suspended solids (1.5mg/L) were considered well below water quality standards.

Until regular monitoring data is re-established over the course of a 12 month period it is difficult to compare these to current water quality objectives. An appropriate approach is to evaluate an annual median against the water quality objective. An elevated value above a guideline does not necessarily indicate an immediate breach but more a trigger indicating the need for further investigation.

In considering other significant users and discharges upstream along Berry Creek, the Lakes Holiday Cabins facility partially intercepts Berry Creek and there are a number of small rural properties that have common boundaries with the water feature. However, Berry Creek becomes a poorly defined series of drainage floors and minor tributaries upstream of the Territory Wildlife Park.

Records do not indicate that there are any significant discharge points occurring upstream and a review of satellite imagery does not suggest that there are any industrial uses occurring in the upper reaches of the creek's catchment. There is a small sewerage plant located opposite the Territory Wildlife Park in the Berry Springs Nature Park which treats effluent from the Territory Wildlife Park, staff quarters and associated ablution facilities at the Berry Springs Nature Park but this does not discharge back to the creek.

The majority of the flow in Berry Creek is directly linked to the underlying geological fault which creates the well-known Berry Springs, rather than from a significant upstream catchment. Downstream of Berry Creek is a largely uninhabited estuarine environment with no further extraction or discharge points. Approximately 6 kilometres downstream from the Territory Wildlife Park is a large aquaculture development located on Darwin River.

Table 5: Water Management Specifications

Established:	1986
Property details:	Section 1786, Hundred of Ayers Cox Peninsula Rd – Berry Springs
Facility location coordinates:	52L 0716428E 8594949N
Building Approval:	Permit no. 045 1786 20 Issued on: 26/02/2001
No. of exhibits within the aquarium:	24
No. of species:	Approximately 80
Volume of water under display	440,850 litres
Groundwater Extraction Permit no.	TBA
Groundwater Extraction volume	TBA
Filter System:	150KL/hr sand filter and pollutant sump network
No. waste discharge points:	3
Location of discharge point 1:	12° 42.09.0S 130° 59.36.4E
Location of discharge point 2:	12° 42'06.9S 130° 59'37.4E
Location of ambient discharge point 3:	12° 42'04.83S 130° 59.43.64E
Environmental Protection Licence no.	TBA
Volume of discharge	180,000L/day
Average discharge temperature*	27°C
Average discharge pH	7.74
Average discharge conductivity	333
Average discharge dissolved oxygen	7.3mg/L
Average discharge turbidity	0.68mg/L
Average discharge total nitrogen	0.32mg/L
Average discharge total phosphorous	0.025mg/L
Average total suspended solids	2.5mg/L
Average volatile suspended solids	1.5mg/L
Sample monitoring intervals	Monthly (12 months) then Quarterly at 4 locations
DISCHARGE POINT 1:	Exhibit 12 into artificial creek
Water Temperature °C range	22° to 32°
Water pH stabilised	7.70
Water Dissolved Oxygen mg/L range	7 to 8.0 mg/L
DISCHARGE POINT 2:	All other exhibits into artificial creek
Water Temperature °C	27
Water pH	7.74
Water Dissolved Oxygen mg/L	7.3
AMBIENT DISCHARGE POINT 3:	Berry Creek downstream of March Fly Weir
Water Temperature °C	28.6
Water pH	7.66
Water Dissolved Oxygen mg/L	7.43
Total nitrogen	0.11mg/L
Total Phosphorous	0.015mg/L

2.2 Reporting

Reporting will be undertaken in accordance with an Environment Protection Licence, issued under section 74 of the *Water Act*. The terms of the licence outline the sampling regime and conditions required for reporting.

Monthly data will be recorded in an excel spreadsheet formatted as below:

SAMPLE SITE: AQUARIUM DISCHARGE / BERRY CREEK / MARCH FLY WEIR										
Month & Year	Temp	pH	Dissolved O2	Salinity	Specific conductivity	Total N	Total P	Turbidity	Ecoli & Entroccoci	Notes
Jan										
Feb										
Mar										
Apr										
May										
Jun										
Jul										
Aug										
Sept										
Oct										
Nov										
Dec										

2.3 Review

The Park's monitoring program will be reviewed annually in accordance with an Environmental Protection Licence.

3 Evaluating Risk

3.1 Likelihood and Consequence

Risk identification and assessment has been carried out in accordance with *AS/NZS ISO 31000:2018 Risk management – Guidelines* (Standards Australia 2018).

Each risk has been given a rating in terms of likelihood and consequence using the criteria in the tables below. These ratings are then combined using the table in section 3.2 to generate a risk rating of low, medium, high or severe.

Qualitative measure of likelihood (how likely is it that this event/issue will occur after control strategies have been put in place)

Highly likely	Is expected to occur in most circumstances
Likely	Will probably occur during the life of the project
Possible	Might occur during the life of the project
Unlikely	Could occur but considered unlikely or doubtful
Rare	May occur in exceptional circumstances

Qualitative measure of consequences (what will be the consequence/result if this issue does occur rating)

Minor	Minor incident of environmental damage that can be reversed
Moderate	Isolated but substantial instances of environmental damage that could be reversed with intensive efforts
High	Substantial instances of environmental damage that could be reversed with intensive efforts
Major	Major loss of environmental amenity and real danger of continuing
Critical	Severe widespread loss of environmental amenity and irrecoverable environmental damage

	Consequence				
	Minor	Moderate	High	Major	Critical
Highly Likely	Medium	High	High	Severe	Severe
Likely	Low	Medium	High	High	Severe
Possible	Low	Medium	Medium	High	Severe
Unlikely	Low	Low	Medium	High	High
Rare	Low	Low	Low	Medium	High

3.2 Identified Risks, Rating & Treatment

Identified Risk	Possible Treatment Options	Risk BEFORE Treatment	Risk AFTER Treatment	Consequence rating	Responsible Person	Notes
Accidental high acid discharge	Dilution, telemetry in place			1	Travis Messner	Distance from discharge point to Berry Creek is approx. 150 metres.
Accidental high levels of discharge (ie. if pump or valve fails, pipe breaks)	Isolate system, repair			1	Travis Messner Peter Beesley	Discharge from pump or valve is generally stable pH and water quality.
Accidental discharge of contaminated water	Follow required treatment options, isolate system			1	Travis Messner	Two levels of filters – biological and mechanical.

4 Appendices

Appendix 1: Diagram showing Water Flow Schematic for the Aquarium

Appendix 2: Map showing location of waste water discharge water monitoring sampling sites

