Supporting information for the Darwin Crocodile Farm EPL application

Porosus Pty Ltd

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1 INTRODUCTION

Porosus Pty Ltd (Porosus) operate the Darwin Crocodile Farm (the DCF) in Noonamah, Northern Territory. The DCF was first established in 1981 as a tourism and farming business for saltwater crocodiles (*Crocodylus porosus*). Over time, the operations have expanded to meet the increasing demand for crocodile products and the farm currently has capacity for more than 70,000 animals.

DCF is a commercial production farm, including a captive breeding program and incubation of eggs to hatching and growing. The animals are harvested on-site and sent to an off-site location for further processing and packaging. The end use markets include raw crocodile skin, meat and by-products. The DCF is no longer open for tourists.

The nature of the farming operation results in the generation of animal effluent, a listed waste under Schedule 2 of the *Waste Management and Pollution Control (Administration) Regulations*. In accordance with the requirements of the NT *Waste Management and Pollution Control Act*, Porosus is applying for an Environment Protection Licence (EPL) to address the storage, recycling and disposal (via irrigation to land) of animal effluent. In the event that DCF implement water treatment as an additional effluent management measure, an amendment to the EPL will be sought to reflect this change in activity.

This document presents information to support the EPL application for this project, and will be included within the online EPL application process.

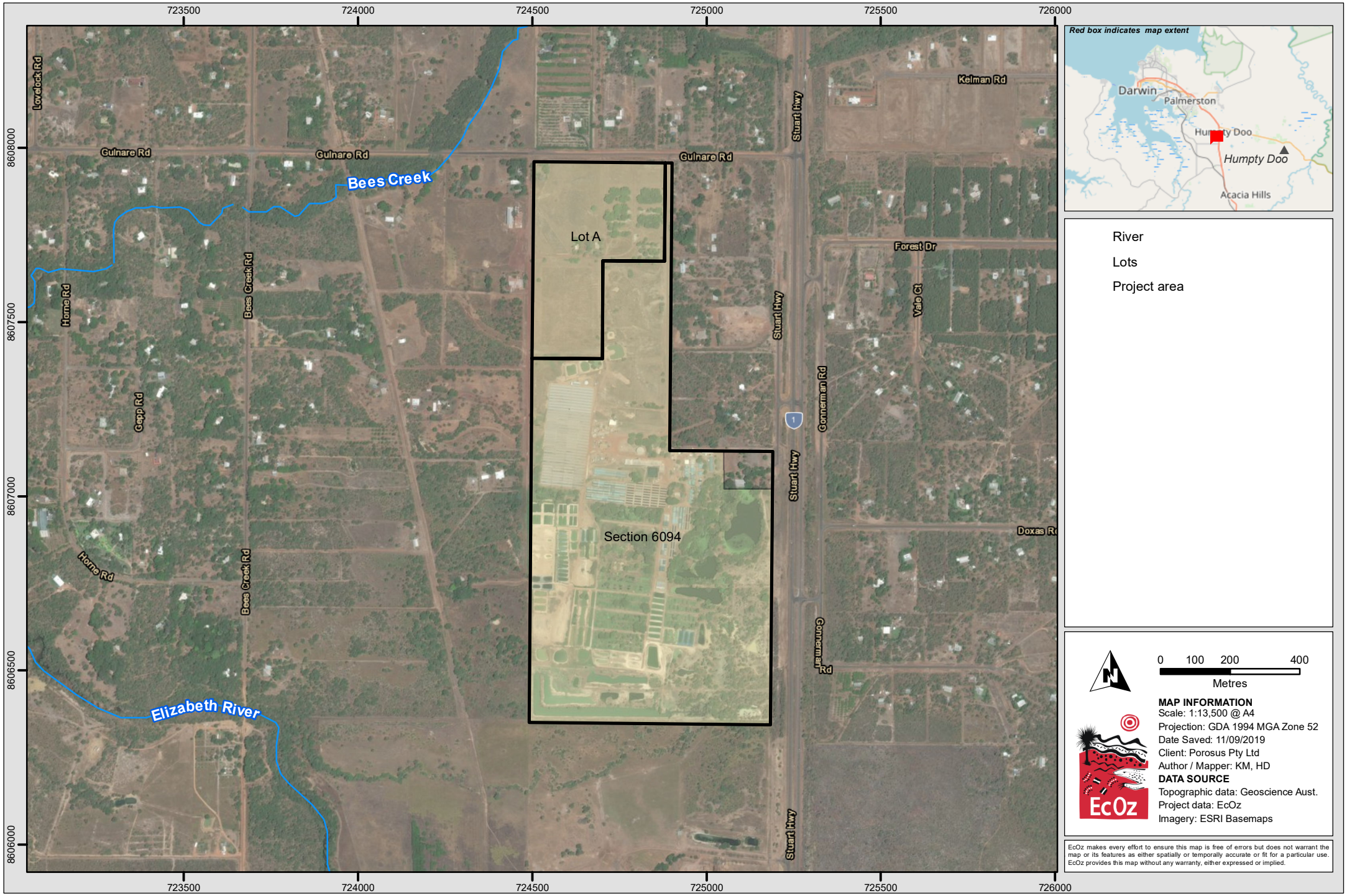
2 PROJECT DESCRIPTION

2.1 Siting, design and layout

DCF is located at Section 6094 and Lot A Hundred of Strangways (1340 Stuart Highway and 45 Gulnare Road, Bees Creek). The DCF occupies the majority of Section 6094, whilst a crocodile processing facility (managed by a separate company) operates within a 1.5 ha area on the eastern boundary. The whole of Lot A is proposed as a future irrigation area (see Figure 2-1). The site (both lots) is currently zoned for commercial tourism and is approximately 85 ha. An amendment to the planning scheme has been submitted to rezone the site to rural living.

Whilst the crocodile processing facility occupies the same lot area, it operates as a separate business and manages its own wastewater through a septic system. This activity and the area occupied by the processing facility have therefore not been included in this EPL application.

The crocodile growth pens and infrastructure occupy approximately 11 ha, whilst a further 40 ha is used for breeding pens and lagoons. There is 20 ha at the northern end of the site that is planned for use as an irrigation area (see Figure 2-2).



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19094 - Darwin Croc Farm EPL\01 Project Files\Figure 2-1. Map showing site location.mxd

Figure 2-1. Map showing site location

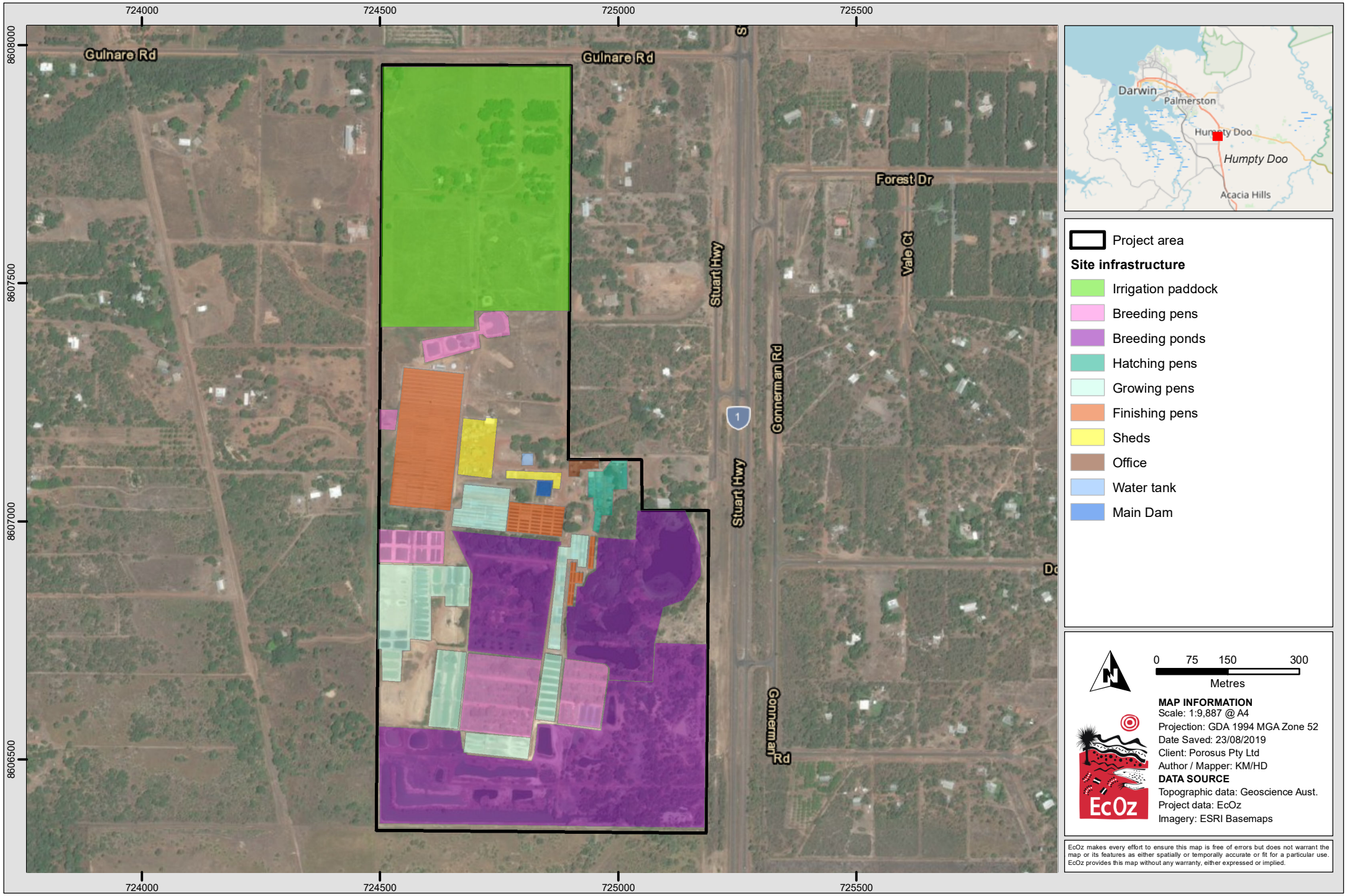


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Figure 2-2. Map showing site layout and infrastructure

2.2 Site operations and activities

2.2.1 Overview

The crocodile production process is summarised as follows:

1. Eggs are collected from breeding pens and lagoons (in addition to wild-collected eggs) and are assessed and cleaned in egg laboratory, with viable eggs transferred to the incubator room
2. Animals hatch in incubator then are immediately transferred to hatchling pens
3. When animals are about one year old, they are transferred to grow-out pens
4. When animals approach a size suitable for market, they are transferred to finishing pens for 6-12 months to ensure best possible skin and meat condition
5. Animals are harvested from the finishing pens, prepared for transport and then sent to separate facility for further processing.

The DCF currently harvests 200-250 animals a week for processing to produce raw crocodile skins, meat products and other saleable by-products. The processing is undertaking at a neighbouring processing facility managed by a separate company. Mortality rates are highest in the hatchery at 10% whilst mortality in the grower and finishing pens is less than 1%.

The operations at DCF are permitted under a Parks and Wildlife Commission *Permit to Keep Protected Wildlife in the Northern Territory, To Bring Protected Wildlife into (Import) and Take Protected Wildlife out of (Export) the Northern Territory* (Permit No. 20234), pursuant to section 56 of the *Territory Parks and Wildlife Conservation Act*.

DCF also hold an export permit under the Convention of International Trade in Endangered Species (CITES) of Wild Fauna and Flora (Permit No. PWS2019-AU-000282), pursuant to s303CG of the *Environment Protection and Biodiversity Conservation Act 1999*.

2.2.2 Water supply

The DCF holds a groundwater extraction licence (Licence No: WSF01) with a total maximum extraction entitlement of 700 ML/year from six bores detailed in Table 2-1. The bores are all located within the property boundary and source water from the Wildman Siltstone Formation. Each bore either supplies a particular section(s) of the farm or supplies water to water storage facilities which is then distributed to different farm areas to meet water requirements of general crocodile husbandry.

Table 2-1. Groundwater bore details

Bore	DCF Bore Name	Depth (m)	Yield (L/s)	Average annual extraction (ML)
RN034341	Murwangi	102	8	145
RN038879	Recirculation	109	10	106.4
RN008775	Lindsay's	63	2	19.5
RN026341	Main	80	10	227.4
RN030548	West Wing	112	3	173
RN033646	Hatchery	138	4	21.4
			Total	**692.7**

The primary use of water on site is for regular flushing of the animal pens to maintain hygiene and health of the animals. Due to the high demand of water required during pen cleaning, there are two water storage facilities: a 2.5 ML water tank and a 1.5 ML storage dam. These storage facilities allow the crocodile pens to be cleaned and refilled expediently as crocodiles require access to clean water. On average, water usage is estimated at 1,900 KL/day.

Potable water is used to supply water to the office and administrative facilities (average 770 KL/month).

A map outlining water supply bore locations and wastewater drainage through the different farm areas is included in Figure 2-3.

2.2.3 Farming routine

As the animals move through the different growth stages, the farming routine changes accordingly. Table 2-2 outlines the water, food and cleaning schedules for the three types of growth pens and the breeding lagoons.

Table 2-2. DCF Farming Routine

	Hatching Pens	Grower Pens	Finishing Pens	Breeders
Water input	Bore water			Pen effluent & stormwater
Chlorine	Chlorine dosing on bore inlets			N/A
Food	5 times / week	3-4 times / week	2 times / week	Once / 3-4 weeks
Cleaning	5 times / week	Weekly (excess food collection 2-3 times / week)	Monthly (excess food collection 2 times / week)	N/A
Potassium Permanganate	N/A	N/A	Monthly	N/A

Feed consists of red meat for hatchlings, a combination of red meat and chicken heads for juvenile crocodiles (1-2 years) then finally chicken heads for mature crocodiles. The feed contains food additives to ensure optimal growth of the animals (Unical 20 [calcite], Protexin, and Monsoon Crocodile CH Premium).

Potassium permanganate is added to grower and finishing pens to prevent bacteriological skin conditions that may impact on the quality of the skin as a product.

Antibiotics are only administered in the hatchery to specific animals requiring treatment as opposed to blanket inoculations to the whole cohort. It is very rare that antibiotics are administered to animals in the grow-out or finishing pens as illness is not common and the antibiotics impact on the ability to process the animal for meat products.

2.2.4 Wastewater flows

Bore water is pumped through the hatchery, grower and finishing pens and the effluent from each stage discharges into the numerous breeding pens and lagoons on the property. The water flows through the breeding areas in a southerly direction before being detained in large constructed basins on the southern boundary (see Figure 2-3). The crocodile farming pens are constructed to prevent ingress of stormwater runoff, however the breeding areas are subject to stormwater inundation. As the farm effluent moves through the breeding lagoons and constructed earthen ponds and is subject to dilution from stormwater, it undergoes a level of passive treatment processes.

During wet periods, the storage capacity of the basin adjacent the southern boundary may be exceeded and as a result water is discharged off-site.

2.2.5 Proposed wastewater management

A water and nutrient balance was undertaken on the site wastewater to determine the viability and suitability of irrigation on-site as a disposal solution. The assessment was undertaken in accordance with the *Land Capability Assessment for Onsite Wastewater Management Guidelines 2010* (NT Department of Health and Families) and AS/NZS 1547:2012 *On-site domestic wastewater management*. There is currently 20 ha of available space on the property for irrigation, with potential for further area in neighbouring blocks owned by the company.

As part of the assessment, several water samples were taken from around the farm as well as soil samples from the proposed irrigation area to determine the suitability of land application. The results indicate that nutrient levels in the wastewater from the farm are reduced after passing through the breeding lagoons and reaching the storage basins at the southern end of the site. Assuming wastewater is sourced from the southern basins for irrigation, only 6.8 ha of area is required to ensure sufficient nutrient uptake (as based on wastewater quality at the time of sampling, noting that nutrient concentrations may fluctuate based on farm activities).

Whilst the nutrient uptake is achievable, the volume of wastewater generated daily is currently an inhibitor on irrigation. The water balance calculations indicate that all the wastewater can be sufficiently irrigated over a 20 ha area in the dry season, however from December to March additional storage (approximately 250,000m^3) is required to manage the volumes generated. The amount of additional storage required is not feasible from a constructability aspect, and can only be sufficiently reduced by increasing the irrigation area to at least 60 ha, which is also not currently viable.

The irrigation rate used in the assessment was based on AS/NZS 1547:2012 recommended rates for drip or spray irrigation in conjunction with soil type. There is potential to increase the irrigation rate based on actual site conditions, soil types and crop selection, which would significantly decrease the current storage requirements.

Full details of the water and nutrient balance and other irrigation considerations are included in Appendix A.

Trial irrigation

DCF recognise the importance of finding a solution to wastewater management and preventing the discharge of untreated wastewater off-site. However, given the large capital costs associated with implementing a treatment solution, it is imperative that the most appropriate solution is determined.

Irrigation as a solution for wastewater management is a viable option for at least eight months of the year (based on average climate conditions). As there are potentially only four months that present a challenge for irrigation, it is not necessarily viable to introduce a wastewater treatment solution for this period. DCF will undertake an irrigation trial to determine site-specific irrigation rates and potentially reduce the additional storage requirements. It is also expected that nutrient levels would be lower in the wet season than those used in the nutrient balance calculation, which were collected in June/July, and therefore would not become a limiting factor.

The trial irrigation will be undertaken with a centre pivot irrigation system which is a self-propelled system that rotates around a fixed central point. Quotes and system design information is currently being sourced from the suppliers, and therefore specifics are not currently available. Indicative location of the trial irrigation area is shown in Figure 2-3.

The trial will be undertaken on different crop types to determine the best crop for consuming water. Trial crops will include *Urochloa humidicola* (Tully), *Chamaecrista rotundifolia* (Wyne cassia) and grain sorghum. The crops are to be managed by a local crop farmer, who will be responsible for harvesting.

Commencing an irrigation trial immediately will also create freeboard in the current storage basins in preparation for the 2019/2020 wet season. The trial irrigation will be undertaken over at least 6.8 ha to ensure sufficient nutrient uptake, over a period of one year to gather sufficient data and assess the irrigation capacity in different climatic conditions. The trial data can then be used to establish a permanent solution and a specific Irrigation Management Plan (IMP) will be developed. The IMP will include contingencies for wastewater management during extended wet periods (e.g. adequate storage) when irrigation may not be available.

In the event that the trial indicates that irrigation is not a viable option for wastewater management, water treatment options will be investigated to adequately manage wastewater. An application to amend the EPL will be submitted to include details of the treatment system and associated management controls.

DCF commit to investing in the research and capital infrastructure required to implement a permanent wastewater management solution including the purchase of additional land and construction of storage basins where required. This investment will be undertaken through a staged approach with a complete system implemented by 2024.

2.2.6 Waste

General putrescible waste is stored in lidded waste receptacles around site and removed from site by a waste contractor.

Animal waste and deceased crocodiles from mortalities are stored in closed waste bins and collected and disposed off-site by a licenced waste contractor to a licenced facility.

Waste oils and chemicals from equipment servicing on site is stored in appropriate sealed containers and removed by a licenced contractor.

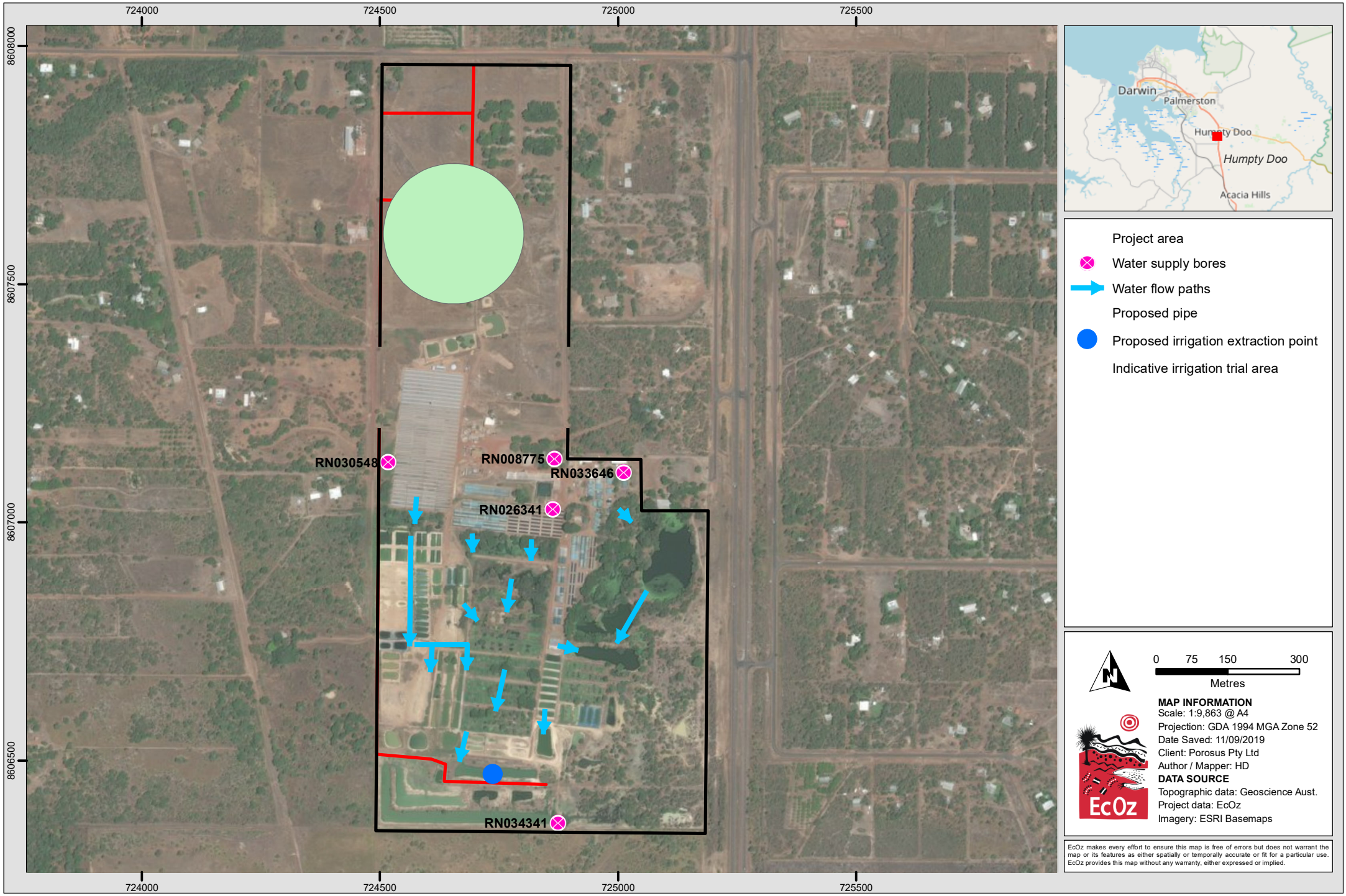
2.2.7 Hazardous materials storage and handling

Chemicals stored on-site for use in farming operations include:

- Diesel (10,000 L)
- LPG (3,000 L)
- Cleaners and disinfectants (maximum of 3,000 L)
    - Chlorfoam, Kwiksan, chlorine, Saniquat, F10 Disinfectant
- Herbicide for weed treatment (maximum of 20 L)
- Pesticide and insecticides (maximum of 40 L)
- Oils/lubricants for farm equipment (maximum of 200 L)
- Paints and thinners (maximum 1,000 L)
- Epoxy sealants (maximum 100 L)

DCF maintain a hazard substances register for the site, which includes storage location, summary of hazardous/dangerous goods status and links to the Safety Data Sheets (SDSs).

All hazardous substances, chemicals and other farm products are stored, used and managed in accordance with their SDSs (including appropriate bunding requirements).



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19094 - Darwin Croc Farm EPL\01 Project Files\Figure XX. Map showing bores and water flow paths.mxd

Figure XX. Map showing bores, water flow paths and proposed irrigation infrastructure

3 SURROUNDING ENVIRONMENTS, LAND USES AND ACTIVITIES

3.1 Climate

DCF experiences a tropical monsoonal climate with distinct wet and dry seasons and little variation in temperature. The wet season is characterised by higher humidity and rainfall, and occurs between October and April. The dry season extends from May to September and is characterised by lower humidity and very little rainfall.

Climate observations are made by the Bureau of Meteorology (BoM). The closest BoM weather monitoring station to the site is Middle Point (station number 014041). Average annual rainfall recorded at this station is 1394 mm with the highest rainfall occurring in February and the lowest in July. Over 84% of annual average rainfall falls between November and March. The average annual regional evaporation is 2,000 mm and exceeds the average annual rainfall. Evaporation is highest in October and lowest in January to March (see Table 3-1). These figures informed the water and nutrient balances for the site, presented in Appendix A.

Table 3-1. Average rainfall and evaporation (BoM)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	347	283	256	89	24	1	1	2	13	57	130	228
Evaporation (mm)	146	126	146	156	161	156	171	189	204	220	189	161

Wind rose data available for the Middle Point station (9am) and the Darwin Airport station (no. 041015, 9am and 3pm) shows that the dry season is dominated by south-easterly and easterly wind directions. During the wet season, wind direction is more varied, particularly in the morning, while the afternoons are dominated by westerly and north-westerly breezes. This has implications for irrigation management, as wind speed and direction will impact the potential for spray drift and odour, and impacts on receptors (i.e. neighbouring properties).

3.2 Surrounding land

DCF is bordered by privately owned lots zoned Rural Living to the north, south and west, with the Stuart Highway bordering the site to the east. Many of the surrounding lots are rural subdivisions, used for rural living, while some lots north and south of DCF are used for horticultural and agricultural purposes. The lots to the north of DCF are separated by Gulnare Road.

The site is located approximately 1.7 km east of the edge of the Darwin Harbour Conservation Area. The Howard sand plains conservation area is located approximately 2.5 km east of DCF on the opposite side of the Stuart Highway.

3.3 Surface and groundwater

Surface water from the operational farm area of the site sheet flows towards the southern boundary of the site. The sheet flow continues into the neighbouring property where any un-retained runoff would enter a minor creek which feeds into the Elizabeth River. The irrigation area sheet flows to the north western boundary of the site towards the drainage lines on Gulnare Road (approximately 300m from site) which feed

into a separate arm of the Elizabeth River. The upper reaches of the Elizabeth River (part of the Darwin Harbour Conservation Area) are located approximately 1.7km west of the site.

There is currently a large stormwater culvert under the Stuart Highway directly adjacent to the south eastern border of the site, which feeds large volumes of stormwater into the site during rain events. Works are currently underway with the relevant stakeholders to relocate this drainage line around the property boundary so the run-on does not have impacts on the site wastewater management.

The property lies within the Darwin Rural Water Control District and groundwater extracted, as granted by the licence, is sourced from the South Alligator groundwater system.

3.4 Soils and vegetation

According to the Greater Darwin Region Landunits (mapped at 1:25000 scale), the property predominately has Hydrosol and Rudosol soils. Hydrosols are seasonally inundated and generally occur on coastal floodplains, swamps and drainage lines. Rudosols are very shallow soils or those with minimal development.

Soil sampling was undertaken in the proposed irrigation area to assist with the water and nutrient balance for wastewater application. The majority of the area contains sandy to sandy loam soils with poor structure (high permeability) and predominately dark brown in colour. A basic soil analysis of sodicity indicates the area is suitable for irrigation and the phosphate sorption rate is sufficient for phosphorus uptake, further detail is provided in Appendix A.

The majority of the site, including the proposed irrigation area, has been previously cleared. There is a small patch of remnant vegetation in the north east irrigation paddock which may require clearing prior to irrigation activities commencing in that paddock. Suitable crops for irrigation will be planted in the irrigation areas as specified in Section 2.2.5.

3.5 Weeds

The majority of the property is grassed and is maintained by mowing/slashing. Some weed species are present, including the declared Class B (NT *Weed Management Act*) weeds Hyptis (*Mesosphaerum suaveolens)* and Common Sida (*Sida rhombifolia*). Weeds are routinely sprayed with herbicide.

4 CONCEPTUAL SITE MODEL

A conceptual site model (CSM) has been developed to identify key sources, pathways and receptors of potential contaminants and include the following considerations:

- Potential contaminants
- Inferred sources
- Pathways and mechanisms for transport
- Potential sensitive receptors.

4.1 Potential contaminants

The contaminants of concern that could result from the operations of the DCF include:

- Nitrates, phosphates, ammonia, bacteria and pathogens (i.e. *E.coli*, enterococci or faecal coliforms) from the farming of animals.
- The use of cleaning products in the pens include multipurpose cleaners and disinfectant sanitisers which contain chlorine and ammonium based compounds.
- The storage of bulk hazardous chemicals such as diesel and liquid chlorine.
- The generation of airborne contaminants and nuisance odour.

The release of these contaminants could result in an increased biochemical oxygen demand, reduced dissolved oxygen, changes in pH, increased electrical conductivity, turbidity or total suspended solids, an increase in chlorophyll-a and/or an increase in hydrocarbons.

4.2 Sources

Sources of potential contaminants include feed inputs, faecal matter, cleaning products used in pens, the storage of bulk hazardous chemicals and airborne molecules from irrigation activities.

4.3 Pathways and transport

Controlled and uncontrolled discharges to surface waters, and vertical migration through watercourses and soil into groundwater. Irrigation activities generating molecules with the potential to become windborne.

4.4 Receptors and fate

Receptors include the receiving surface water, groundwater and neighbouring properties. Those receptors affected by discharges include adjacent properties, Elizabeth River and recreational users; as well as terrestrial and aquatic organisms along the river such as fish and shellfish. Those receptors affected by migration of potential contaminants to groundwater include neighbouring properties that utilise groundwater. Neighbouring properties would also be impacted by nuisance odour from the farm activities and the irrigation of wastewater.

5 ENVIRONMENTAL RISK ASSESSMENT

The potential environmental risks associated with operational activities of the DCF have been assessed. The likelihood and consequence categories adopted in the aspects and impacts register are provided in Table 5-1 and Table 5-2, and have been combined to derive an overall risk rating using the matrix in Table 5-3. The environmental risk assessment table is included as Table 5-4.

Table 5-1. Likelihood categories

Categories	Score	Likelihood Description
Rare	A	Highly unlikely; will only occur in exception circumstances
Unlikely	B	Could occur at some time, but unlikely
Moderate	C	Might occur at some stage; has previously occurred
Likely	D	Known to occur or will probably occur; has occurred several times
Almost certain	E	Common or repeating occurrence; is expected to occur in most circumstances

Table 5-2. Consequence categories

Categories	Score	Consequence Description
Insignificant	1	No/low measureable impact on the environment
Minor	2	Some, minor, temporary environmental impact
Moderate	3	Contained temporary, or permanent minor, localised environmental damage
Major	4	Severe environmental damage
Catastrophic	5	Environmental disaster

Table 5-3. Risk matrix

		Consequence				
		1	2	3	4	5
Likelihood	A	Low (1)	Low (3)	Low (6)	Moderate (10)	High (15)
	B	Low (2)	Low (5)	Moderate (9)	High (14)	High (19)
	C	Low (4)	Moderate (8)	High (13)	High (18)	Extreme (22)
	D	Low (7)	Moderate (12)	High (17)	Extreme (21)	Extreme (24)
	E	Moderate (11)	High (16)	High (20)	Extreme (23)	Extreme (25)

Table 5-4. Environmental aspects and impacts register

Aspect	Potential impact	Initial risk			Management and mitigation controls (overview)	Residual risk		
		L/hood	Cons	Risk		L/hood	Cons	Risk
Extraction of groundwater	Reduction in groundwater availability	3	2	**Low (6)**	• Extract water within permitted volumes. • Meter and monitor water extraction rates to ensure volumes are within permit.	2	2	**Low (4)**
Discharge of waste water to neighbouring properties (active or passive) and receiving waterways.	Reduction in water quality downstream of discharge point (addition of nutrients), and subsequent impacts on aquatic ecosystem health downstream of discharge point.	6	3	**High (18)**	• Provide adequate waste water storage for wet season runoff events. • Establish irrigation area (vegetated and actively managed) for discharge of waste water. • Irrigation design to incorporate appropriate irrigation rates to prevent surface water ponding and generation of runoff. • Establish a monitoring program.	4	3	**Mod (12)**
Discharge of waste water into groundwater aquifers	Reduction in water quality of underlying aquifers.	4	3	**Mod (12)**	• Provide adequate waste water storage for wet season runoff events. • Establish irrigation area (vegetated and actively managed) for discharge of waste water. • Irrigation design to incorporate appropriate irrigation rates to prevent groundwater infiltration. • Establish a monitoring program	2	3	**Low (6)**
Overspray/mist generation	Impacts on comfort of neighbouring properties Windborne particles spreading potential contaminants	4	3	**Mod (12)**	• Irrigation design to include provision for large droplet size to prevent mist generation. • Irrigation activities confined to approved irrigation areas and appropriate buffers maintained.	2	3	**Low (6)**

Aspect	Potential impact	Initial risk			Management and mitigation controls (overview)	Residual risk		
		L/hood	Cons	Risk		L/hood	Cons	Risk
Spills of chemicals, hydrocarbons or hazardous substances	Uncontrolled discharge of dangerous goods or hazardous substances. Contamination of pens, and discharge of contaminated water into receiving environment. Reduction in water quality downstream of discharge or spill point, and subsequent impacts on aquatic ecosystem health downstream of discharge point. Reduction in water quality of underlying aquifers.	3	2	**Mod (8)**	• Training and site inductions provided to all employees. • Appropriate hazardous substance storage and handling procedures. • Spill kits will be onsite, adequately sized and stocked to respond to a spill if required. • Chemical register is kept up to date for all chemicals, their volumes and storage locations. • Following the 3 C's (contain, communicate, clean-up).	2	2	**Low (4)**
Storage of waste	Poorly managed site attracting native fauna and pests Contamination to land/soils	3	1	**Low (3)**	• Ensure waste is stored/disposed of in appropriate containers for waste type prior to disposal. • Removal of waste products by licenced waste contractors. • Monitoring of waste disposal areas.	2	1	**Low (2)**
Operating farm equipment	Degredation of air quality, including dust and emissions	3	1	**Low (3)**	• Maintenance of equipment to minimise air emissions as far as possible. • Avoid activities generating excessive dust and if required, implement dust mitigation measures.	2	1	**Low (2)**

Aspect	Potential impact	Initial risk			Management and mitigation controls (overview)	Residual risk		
		L/hood	Cons	Risk		L/hood	Cons	Risk
Excessive odours	Disturbance/nuisance to neighbouring properties	3	1	**Low (3)**	• Adherence to pen cleaning schedule and general farm housekeeping and cleaning procedures. • All putrescible waste to be stored appropriately prior to removal from site by a licenced waste contractor. • Irrigation design to include provision for large droplet size to minimise mist and odour generation. • Irrigation activities confined to approved irrigation areas and appropriate buffers maintained. • Irrigation to be managed to avoid ponding or runoff, which can increase odour	2	1	**Low (2)**
Movement of vehicles and equipment	Spread of weeds	3	2	**Low (6)**	• Regular inspections of farm for weed occurrence. • Regular control of weeds by herbicide spraying. • Regular slashing.	2	2	**Low (4)**
Creation of mosquito breeding habitat	Impacts on comfort of employees/neighbours and increased disease risk	3	1	**Low (3)**	• Minimise any stagnant water by ensuring containers are kept out of rain. • Adherence to pen cleaning schedule. • Regular inspections of site to identify areas of ponding water and subsequent rectification.	2	1	**Low (2)**
Mortality	Quarantine issues or spread of diseases.	3	1	**Low (3)**	• Established quarantine practices. • Established monitoring and surveillance program to identify any potential disease outbreak.	1	1	**Low (1)**

6 ENVIRONMENTAL MANAGEMENT PLAN

This Environmental Management Plan (EMP) provides a consolidated plan for environmental management to mitigate the environmental risks identified in Section 5. Table 6-1 identifies the potential impacts of the DCF operations on the environment and includes environmental objectives, management and mitigation measures, performance criteria and target indicators, corrective actions and contingencies, monitoring and reporting and record-keeping mechanisms for each aspect.

6.1 Table of provisions

Table 6-1. Environmental management summary

ACTIVITY	POTENTIAL IMPACT	OBJECTIVE / OUTCOME	MANAGEMENT ACTION	TARGET / PERFORMANCE INDICATOR	MONITORING	CORRECTIVE ACTIONS AND CONTINGENCIES	REPORTING AND RECORD-KEEPING
Filling and replenishing pens	• Reduction in groundwater availability	• No reduction in groundwater availability due to extraction.	• Extract water within permitted volumes.	• No exceedance of licenced groundwater extraction volumes	• Meter and monitor water extraction rates to ensure volumes are within licence.	• Revise meter monitoring procedure and introduce a more frequent meter reading schedule. • Review potentials for water reuse. • Assess extraction limits and investigate potential to increase extraction volumes.	• Water usage is recorded in the Water usage database • Groundwater usage detailed in Annual Report
Discharging waste water (effluent)	• Reduction in water quality downstream of discharge point (addition of nutrients), and subsequent impacts on aquatic ecosystem health downstream of discharge point.	• No reduction of water quality in receiving environments.	• Establish irrigation area (vegetated and actively managed) for discharge of wastewater • Irrigation design to incorporate appropriate irrigation rates to prevent surface water ponding and generation of runoff • Provide adequate wastewater storage for wet season runoff events • Irrigation of stored water during dry periods to maximise storage capacity through wet periods.	• No exceedance of approved trigger levels • No recorded incidents of wastewater runoff from irrigation area	• Establish a monitoring program, which incorporates monitoring quality of waste water prior to and following irrigation. • Monitor and record irrigation volumes.	• Review irrigation system capabilities and opportunities for improvement. • Review potentials for water reuse • Review alternative treatment methods • Review monitoring program to allow for further detection of potential contaminants	• Record all water quality results in a database and compare to guideline values and historic/ baseline data. • Record and respond to any complaints received in regards to discharges. • Reporting undertaken through Monitoring Report and Annual Return
	• Reduction in water quality of underlying aquifers.	• No reduction of water quality in underlying aquifers.	• Establish irrigation area (vegetated and actively managed) for discharge of wastewater • Irrigation design to incorporate appropriate irrigation rates to prevent groundwater infiltration • Provide adequate wastewater storage for wet season runoff events • Irrigation of stored water during dry periods to maximise storage capacity through wet periods.	• No change in quality of inlet water from bores in comparison to historical data, particularly bores GW7 and GW5, inferred to be representative of down-gradient quality from irrigation area and farm ponds respectively.	• Establish a monitoring program, which incorporates monitoring quality of groundwater. • Monitor and record irrigation volumes.	• Review irrigation system capabilities and opportunities for improvement. • Review potentials for water reuse • Review alternative treatment methods • Review monitoring program to allow for further detection of potential contaminants	• Record all water quality results in a database and compare to guideline values and historic data. • Record and respond to any complaints received in regards to discharges. • Reporting undertaken through Monitoring Report and Annual Return

ACTIVITY	POTENTIAL IMPACT	OBJECTIVE / OUTCOME	MANAGEMENT ACTION	TARGET / PERFORMANCE INDICATOR	MONITORING	CORRECTIVE ACTIONS AND CONTINGENCIES	REPORTING AND RECORD-KEEPING
Irrigation of waste water	• Overspray/mist generation	• No impacts on neighbouring properties from overspray/mist during irrigation	• Irrigation design to include provision for large droplet size to prevent mist generation. • Irrigation activities confined to approved irrigation areas and appropriate buffers maintained (>50m from neighbouring properties). • Irrigation restrictions pending weather conditions (rain)	• No complaints received in relation to mist generation	• Establish a monitoring plan which incorporates visual inspections of irrigation areas for overspray/mist	• Review Irrigation Management Plan, including irrigation rates, areas and timing	• Record and respond to any complaints received • Reporting undertaken through Monitoring Report and Annual Return
	• Odour generation	• No impacts on neighbouring properties from odour during irrigation	• Irrigation design to include provision for large droplet size to prevent odour generation. • Irrigation activities confined to approved irrigation areas and appropriate buffers maintained (>50m from neighbouring properties). • Irrigation restrictions pending weather conditions (wind)	• No complaints received in relation to odour	• Establish a monitoring plan which incorporates odour monitoring by site staff • Establish a monitoring program, which incorporates monitoring quality of waste water prior to and following irrigation	• Review Irrigation Management Plan, including irrigation rates, areas and timing • Review water quality and implement additional treatment if required (e.g. to reduce odour from BOD, oil and grease, bacteria)	• Record and respond to any complaints received • Reporting undertaken through Monitoring Report and Annual Return
Storage and use of chemicals, hydrocarbons and hazardous substances	• Uncontrolled discharge of dangerous goods or hazardous substances. • Contamination of ponds, and discharge of contaminated water into receiving environment. • Reduction in water quality downstream of discharge or spill point, and subsequent impacts on aquatic ecosystem health downstream of discharge point. • Reduction in water quality of underlying aquifers.	• No contamination to farm water, sediments or surface water as a result of chemical, hydrocarbon or hazardous substance spill.	• All refuelling of vehicles occurs within a designated area. • No hazardous chemicals are added to the ponds from which discharge occurs. • Fuel storage within self-bunded container • All other chemicals stored in designated bunded area • Training and site induction provided to all employees • Appropriate spill kits kept on-site and stocked in chemical storage and refuelling areas	• No indication of spills of chemicals or hazardous substances. • Any spill of stored product is contained and remediated through the spill response procedure. • No leaks from equipment.	• Regular inspections of chemical and hazardous substance storage areas through operational activities. • Water quality will be monitored through the monitoring program.	• Review storage and handling practices for chemicals and hazardous substances. • Increase the amount of bunding and containment for chemical and hazardous substance storage areas. • Increase the number, capacity or type of spill kit materials.	• Incident reporting records • Water quality database • Reporting undertaken through the Monitoring Report and Annual Return • Chemical and SDS register maintained • Hazardous material tracking undertaken through invoicing process
Waste generation	• Poorly managed site attracting native fauna and pests • Contamination to land/soils	• No introduction of pest species or increase in native fauna as a result of poor waste management practices • No contamination as a result of poor waste management practices	• Ensure waste is stored/disposed of in appropriate containers for waste type prior to disposal. • Removal of waste products by licenced waste contractors.	• No recorded incidents of pests or native fauna accessing waste • No indication of land/soil contamination	• Monitoring of waste disposal areas.	• Review waste handling and disposal practices	• Inspection records • Incident reporting records
Farming of live animals	• Quarantine issues or spread of diseases.	• No introduction or spread of disease across the farm or into the receiving environment.	• Established quarantine practices within DCF.	• No recorded incidents of disease spread/outbreak	• Established monitoring and surveillance program to identify any potential disease outbreak.	• Review quarantine practices • Review monitoring program	• Inspection records • Incident reporting records

General farm operations	• Degradation of air quality, including dust and emissions from operating farm equipment	• Minimise air emissions	• Maintenance of equipment to minimise air emissions as far as possible. • Avoid activities generating excessive dust and if required, implement dust mitigation measures.	• No complaints in relation to air quality	• Maintenance regime for all plant and equipment. • Visual monitoring during periods of dry weather and high winds.	• Review maintenance regime • Review dust control measures and implementation	• Record and respond to any complaints received
	• Disturbance to neighbouring properties associated with excessive odours	• Minimise odour	• Adherence to pen cleaning schedule • General housekeeping around farm to reduce odour sources. . • All putrescible waste to be stored appropriately prior to removal from site by a licenced waste contractor. •	• No complaints in relation to odour	• Daily pen inspections. • Inspections of waste management areas. •	• Review of cleaning schedule • Review of waste management practices •	• Record and respond to any complaints received •
	• Spread of weeds	• To prevent spread of established weeds within and off the property • To prevent introduction of new weed species to the property	• Regular control of weeds by herbicide spraying. • Regular slashing.	• No increase in the distribution of existing weed species. • No introduction of new weed species.	• Undertake regular weed outbreak inspections.	• Review weed control activities and frequency	• Inspection records • Incident reporting records
	• Creation of mosquito breeding habitat impacting on comfort of employees/neighbours and increased disease risk	• To prevent mosquito breeding opportunities • To reduce the potential for contact between mosquitoes and people	• Minimise any stagnant water by ensuring containers are kept out of rain. • Adherence to pen cleaning schedule.	• No prolonged areas of ponding water on-site • No incidence of mosquito borne disease	• Regular inspections of site to identify areas of ponding water and subsequent rectification.	• Review stormwater controls and site flow paths. • Review inspection regime.	• Inspection records • Record and respond to any complaints received

6.2 Roles and responsibilities

Unless otherwise specified, the provisions within this EMP are the responsibility of the Farm Manager.

6.3 Induction, communication and training

A daily pre-start meeting is held where all issues, including those pertaining to the environment, are discussed. Staff members are able to raise any concerns or issues.

All new site personnel, contractors, and unaccompanied visitors will be presented with a site induction package featuring essential environmental management information. Inductees will also be required to complete an Induction Questionnaire to demonstrate understanding of the induction presentation. Induction and training activities will be reviewed regularly to ensure they contain the most up-to-date information and procedures.

Scheduled regular toolbox meetings will keep employees informed of environmental issues, as well as safety awareness and hazards in the workplace. This will ensure that personnel are continually aware of environmental management activities on the site, and enable any issues to be identified and resolved.

Relevant staff will have training provided so that they are able to undertake the environmental management and monitoring activities specified in this plan. In-house training will be provided by relevant contractors (consultants) in specific environmental monitoring tasks.

6.4 Non-conformance and corrective actions

The specific environmental actions stipulated in this section provide the overarching performance indicators for the site, against which management methods can be assessed. If it is identified that the safeguards are not being met, or unexpected issues arise, a process must be in place to implement corrective actions and adapt management methods.

Any non-conformance will be documented through site inspections/audits stating the nature of the non-conformance and the mechanisms implemented to correct the incident.

The Farm Manager should be notified of any non-conformance within 24 hours of it occurring. Corrective/preventative action should be completed within a timely manner (e.g. within seven days of the event occurring) to ensure that the incident is addressed. Records will be kept of all environmental incidents that occur, and corrective actions implemented. If management controls are not implemented and completed in the designated manner, additional training may be required for the Site Manager, employees and/or subcontractors.

7 ENVIRONMENTAL MONITORING PLAN

7.1 Inspections and audits

Internal and external audits are undertaken on a yearly basis. These audits include occupational health & safety and environmental aspects of the operation. The auditor reports findings to the Farm Manager and the Managing Director.

Pen areas are inspected daily and any issues are recorded in a daily report. Inspections include the following environmental aspects:

- Water levels in pens and input requirements
- Wastewater outbreaks or leaks
- Animal health and potential disease outbreaks

Visual inspections of the irrigation area for mist/overspray, odour and potential runoff will be undertaken daily during irrigation activities.

7.2 Water & soil monitoring

Once a full irrigation system is designed, a rigorous irrigation management plan and monitoring regime will be developed in accordance with the conditions of the EPL. For the purpose of the irrigation trials, the monitoring program will reflect the recommended sampling frequency in the *Environmental Guidelines – Use of effluent by irrigation (DEC 2004)* for low strength effluent.

7.2.1 Sampling locations

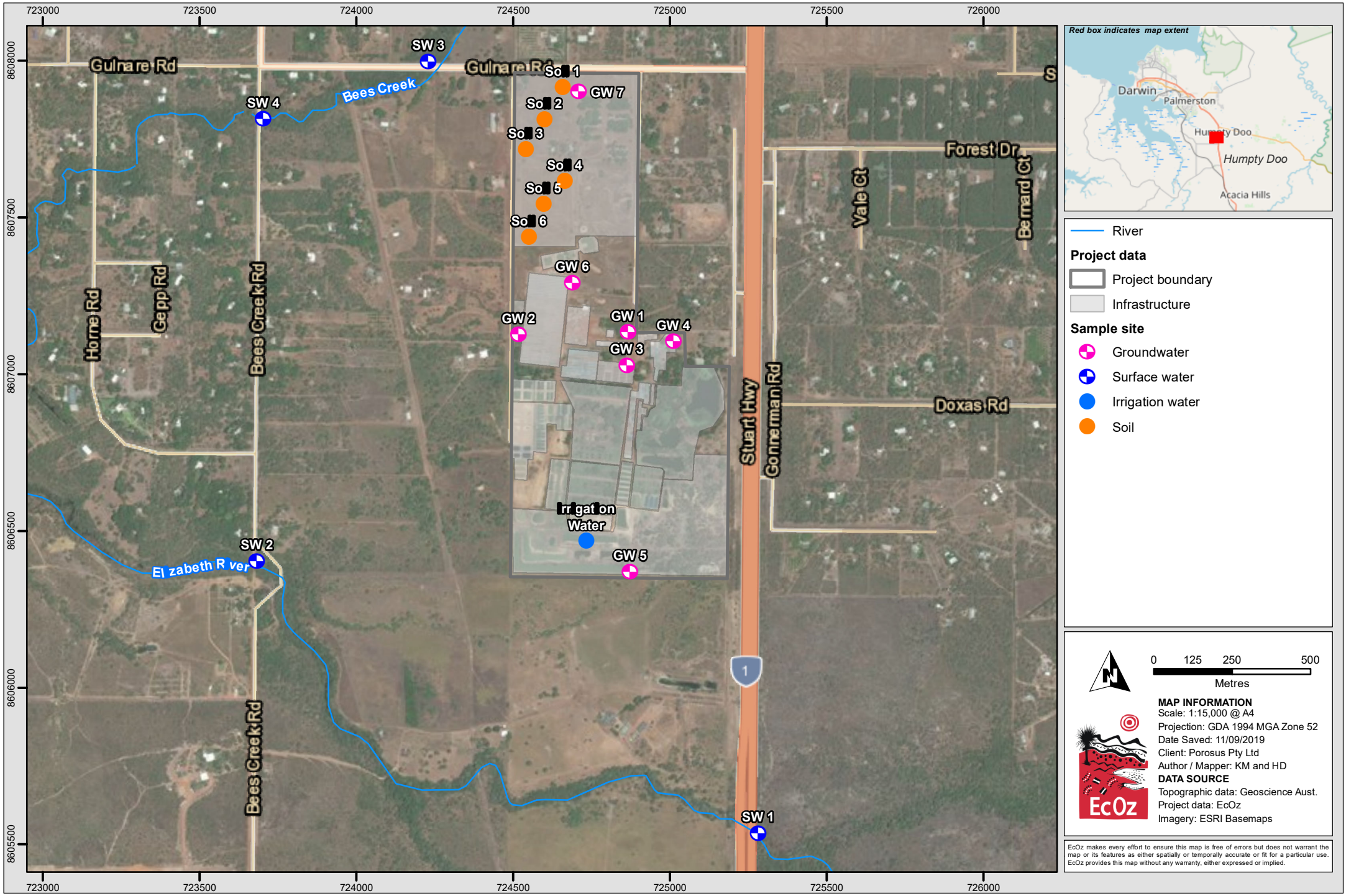
The surface water monitoring sites were selected based on accessibility for sampling, as the receiving waters closest to the site are located on private land. Safe access around crocodile breeding lagoons was also taken into consideration. The sampling locations represent upstream and downstream locations of the receiving waterways to determine any potential impacts from site operations.

The soil sampling locations are based on the sites selected during the baseline study for irrigation suitability. Soil samples will be only be taken from the sites where irrigation is actually occurring during the trial period. The number of soil sampling sites will increase when the irrigation area is increased for the full-scale system.

Groundwater samples will be taken from the six bores currently supplying water to the farm as well as an additional bore located at the northern end of the irrigation area (RN025932 – GW7). Assuming groundwater follows a similar preferential pathway to the surface water, the location of GW7 bore will detect any potential migration of contaminants from the irrigation water to the groundwater. Similarly, the location of GW5 bore on the southern boundary will detect migration of contaminants from the farm activities to the groundwater as a result of seepage.

The irrigation water is sampled from the irrigation source pond, which is also representative of any uncontrolled discharges of wastewater over the southern boundary.

The sampling locations for irrigation water, soil, surface water and groundwater are shown on Figure 7-1.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19094 - Darwin Croc Farm EPL\01 Project Files\Figure 7-1 Map showing monitoring locations.mxd

Figure 7-1. Map showing monitoring locations

7.2.2 Sampling methodology and quality assurance

All sampling and handling of samples is to be undertaken in accordance with the relevant standards and guidelines as outlined below:

- Australian Standard on Water Quality Sampling - *Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples* (AS/NZS 5667.1:1998);
- Australian Standard on Water Quality Sampling – *Part 6: Guidance on sampling of rivers and streams* (AS/NZS 5667.6:1998);
- Australian Standard on Water Quality Sampling – *Part 10: Guidance on sampling of waste waters* (AN/NZS 5667.10:1998)
- Australian Standard on Contaminated Soil Sampling – *Guide to the sampling and investigation of potentially contaminated soil – Part 1: Non-volatile and semi-volatile compounds* (AS4482.1-2005)
- ANZECC & ARMCANZ 2000, *Australian Guidelines for Water Quality Monitoring and Reporting*, National Water Quality Management Strategy Paper No 7, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.
- ANZECC & ARMCANZ 2000, *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

All samples are to be analysed at a National Association of Testing Authorities (NATA) approved laboratory, with the exception of field parameters such as pH and EC.

7.2.3 Monitoring parameters and frequencies

Irrigation water

The monitoring parameters and frequencies of sampling for the irrigation water are outlined in Table 7-1. The guidelines recommend that Total N and Total P be sampled biannually, however this has been increased to quarterly based on it being one of the main contaminants of concern.

Table 7-1. Monitoring parameters and frequencies for irrigation water

Parameter	Sampling frequency
Field parameters	
pH	Quarterly
EC	Quarterly
TDS	Quarterly
Laboratory Parameters	
Total P	Quarterly
Total N	Quarterly
NH_3	Quarterly
BOD	Quarterly
Cations & anions	Quarterly
E.coli, *Enterococci*, Total coliforms	Quarterly

Parameter	Sampling frequency
Oil and grease	Biannually
Total Metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn)	Annually
Herbicides (Glyphosate)	Annually

Soil

The monitoring parameters and frequencies of sampling for soil in the irrigation area are outlined in Table 7-2. Soil sampling locations are based on the initial sampling undertaken to establish baseline conditions.

Table 7-2. Monitoring parameters and frequencies for soil

Parameter	Sampling frequency
Field parameters	
pH	Annually
EC	Annually
Laboratory Parameters	
Total P	Annually
P sorption capacity	After 3 years
Total N	After 3 years
Nitrate + nitrite (NO_x)	Annually
ESP	Annually
Total Metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn)	After 10 years

Surface water

Surface water sampling is to be undertaken through the wet season when site runoff is generated. Sampling shall be undertaken at upstream and downstream locations each sampling event, when the sites are flowing (not stagnant). The monitoring parameters and frequencies of sampling for surface waters are outlined in Table 7-3.

Table 7-3. Monitoring parameters and frequencies for surface waters

Parameter	Sampling frequency
Field parameters	
pH	3 times during the wet season (start, during, end)
EC	
DO	
Laboratory Parameters	
Total P	3 times during the wet season (start, during, end)
Total N, NOx, NH3	
BOD	
E.coli, *Enterococci*, Total coliforms	If increases are evident in irrigation waters

Groundwater

The monitoring parameters and frequencies of sampling for groundwater are outlined in Table 7-4.

Table 7-4. Monitoring parameters and frequencies for groundwater

Parameter	Sampling frequency
Field parameters	
pH	Quarterly
EC	Quarterly
Laboratory Parameters	
Total P	Annually
Total N	Annually
Nitrate	Annually
Cations & anions	Annually

7.3 Assessment criteria

Irrigation water

The current quality of the irrigation water has been deemed suitable for irrigation as per the assessments undertaken (Appendix A). Ongoing monitoring will be undertaken to ensure that the quality remains within the acceptable limits for irrigation in the nominated area. Total nitrogen and phosphorus concentrations are limiting factors to the available irrigation area, therefore site specific trigger values for these parameters have been determined (Table 7-5) (based on maximum irrigation volumes identified in the water balance and a 20.2 ha irrigation area).

For other parameters, trigger values were derived from current baseline conditions (used for the irrigations assessment), the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Volume 3 – Chapter 9 – Primary Industries* (ANZECC, 2000) guidelines and the *Environmental Guidelines – Use of Effluent by Irrigation* (DEC, 2004). Where there are significant increases in the parameters measured, further assessment will be undertaken to determine the impact on irrigation.

Table 7-5. Trigger values for irrigation water

Parameter	Trigger value	Source
pH	6 - 9	ANZECC, 2000
EC	400 – 500 µs/cm	Baseline levels
TDS	200 – 300 mg/L	Baseline levels
Total P	0.9 mg/L	Site modelling
Total N	6 mg/L	Site modelling
NH_3	1 mg/L	Baseline levels
BOD	40 mg/L	DEC, 2004
Cations & anions (Ca, Mg, Na, K, SO_4, Cl, $CaCO_3$)	30 mg/L ($CaCO_3$ - 220 mg/L)	Baseline levels
E.coli, *Enterococci*, Total coliforms	> 1,000 cfu/100mL (fodder)	ANZECC, 2000
Oil & Grease	> 5 mg/L (presence/absence)	Laboratory limit of reporting (LOR)

Parameter		Trigger value	Source
Total Metals	As	2.0 mg/L	ANZECC, 2000 Short-term trigger values
	Cd	0.05 mg/L	
	Cr	1 mg/L	
	Cu	5 mg/L	
	Hg	0.002 mg/L	
	Ni	2 mg/L	
	Pb	5 mg/L	
	Zn	5 mg/L	
Herbicides (Glyphosate)		1 mg/L	ADWG, 2019*

*In the absence of any other guidelines outlining trigger values for glyphosate, *Australian Drinking Water Guidelines 6, 2011 Version 3.5 (Updated August 2018)* were used as a guide.

Soil

Soil quality will be compared against baseline conditions outlined in Table 7-6. Where there are significant increases in the parameters measured, further assessment will be undertaken to determine the impact on irrigation.

Table 7-6. Irrigation area soil baseline conditions

Parameter	Trigger value*
pH	6 – 8
EC	10 µs/cm
Total P	80 mg/kg
P sorption capacity	376 mg/kg
Total N	347 mg/kg
Nitrate + nitrite (NOx)	5 mg/kg
ESP	2 %
Total Metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn)	Baseline laboratory samples to be undertaken for comparison

*based on average B horizon results

Surface water

Water quality from downstream locations will be compared against the upstream locations to determine any significant changes in quality that may be attributable to site operations. Baseline conditions at each site will be determined prior to irrigation commencing (pending actual water flow in system). For all ongoing monitoring, where the results indicate a difference of 10% or greater, the Darwin Harbour Water Quality Objectives for freshwater rivers and streams will be used as a guidance for trigger values (Table 7-6). If the results indicate contamination from site, further investigation is to be undertaken and the NT EPA notified under the conditions of the EPL.

If baseline monitoring determines existing conditions exceed the 10% threshold, alternative trigger limits will be determined for the affected parameters.

Table 7-7. Darwin Harbour water quality objectives for freshwater rivers and streams

Parameter	Trigger value
pH	6.0-7.5
EC	<200 µS/cm
Total P	<0.01 mg/L
Total N	<0.23 mg/L
NOx	<0.008 mg/L

Groundwater

Groundwater quality will be compared against baseline conditions (historical and current data). The Hazen percentile calculator was used to calculate 80th percentile parameters across the bores from the current data available, in order to develop trigger values for comparison (Table 7-8). Where there are significant increases in the parameters measured, further assessment will be undertaken to determine potential sources of contamination.

Table 7-8. Groundwater trigger values

Parameter	Trigger value
pH	7.47
EC	526 µs/cm
Total P	0.02 mg/L
Total N	3.85 mg/L
Nitrate	3.37 mg/L
Cations & anions (Ca, Mg, Na, K, SO_4, Cl, $CaCO_3$)	30 mg/L ($CaCO_3$ - 260 mg/L)

7.4 Reporting and records

7.4.1 Internal

The EMP will be reviewed annually to reflect any changes in operations at the LCF.

Details of environmental incidents, non-conformances or other relevant information are included in daily reports which are issued to the Managing Director. Records of all incidents, inspections and reports are maintained through an electronic filing system.

All environmental monitoring records will be maintained in a water and soil quality database.

An annual report is also prepared which details and reviews annual water usage, waste generation and energy use across the farm.

7.4.2 External

DCF will report any non-compliance with the EPL by completing a Non-Compliance Notification via the NT EPA website within 24 hours of the event.

An Annual return will be submitted to the NT EPA on the anniversary date of the EPL to summarise the activities and outcomes of the previous 12 months. Additionally, a Monitoring Report will be prepared and submitted with the Annual Return that includes a trend analysis of the water quality monitoring data and an assessment of any environmental impacts from the DCF operations.

8 EMERGENCY RESPONSE PLAN

Emergency response planning includes responses to environmental emergencies, and operational actions that cause an environmental incident. This Emergency Response Plan (ERP) outlines the environmental emergency risks, emergency preparedness, mitigation and reporting requirements specifically relating to environmental incidents for DCF.

8.1 Emergency incidents

Emergency incidents that may occur within DCF include:

- **Extreme weather event** (i.e. cyclone) resulting in damage to farm facilities, and/or flooding that leads to uncontrolled discharges to the surrounding properties
- **Flooding** as a result of high rainfall events leading to uncontrolled discharges to the surrounding properties
- **Lightning strike** that may disrupt power sources and impact on farm operations
- **Disease outbreak** that leads to crocodile mortalities and large scale quantities of biological wastes
- **Fuel or chemical spill** that may contaminate water or soils
- **Fire** as a result of bushfire or accidental fire as a result of operations.

8.2 Emergency contacts

The Farm Manager is the contact person for all emergencies and environmental incidents. All incidents which cause or have the potential to cause material or serious environmental harm, will be reported to NT Environment Protection Authority (NT EPA) as soon as the Farm Manager becomes aware of the incident, or in any case within 24 hours as required under Section 14 of the NT *Waste Management and Pollution Control Act*.

The details of the designated contact persons responsible for on-site environmental management are included in Table 8-1. Also included are emergency contacts for reporting pollution incidents (including non-urgent problems such as dust/noise) and contacts for provision of advice.

Table 8-1. Emergency contact details

Contact	Details
Farm Manager	Tanya Hollamby (08) 8988 1491 0438 807 642 tanya@biznt.com
NT EPA Pollution Hotline / Pollution Reporting	GPO Box 3675, Darwin NT, 0801 Pollution Hotline: 1800 064 567 pollution@nt.gov.au
EcOz Environmental Consultants	70 Cavenagh Street, Darwin NT, 0801 08 8981 1100 ecoz@ecoz.com.au
NT Police	131 444

Environmental conditions are monitored as part of the Environmental Monitoring Plan presented in Section 7, as well as by the Site Manager through the Bureau of Meteorology website, NT Police, Fire and Emergency Services announcements, social media and local radio emergency.

8.3 Objectives, targets and indicators of the ERP

The objectives, targets and indicators of this ERP are summarised in Table 8-2.

Table 8-2. Emergency objectives, targets and indicators summary

Objectives	Targets	Indicators
• Protect people, property and the environment	• No incidents of harm to people, property or the environment from activities associated with an environmental emergency	• Number of incidents recorded
• Identify potential environmental emergency risks	• All risks identified and management controls are in place	• Audits and inspection findings
• Identify and implement management and mitigation controls to reduce the residual risk		
• Ensure emergency response equipment requirements are able to be identified and are available	• All risks are identified and management controls are in place. • Emergency response scenarios have been identified	• Audits and inspection findings
• Ensure a high level of preparedness is maintained		
• Facilitate efficient response to emergencies to limit the impacts to the environment		
• Ensure emergency response training is relevant for the types of emergencies that DCF may experience	• Training for all employees	• Training records

8.4 Emergency response procedures

8.4.1 General emergency preparedness

DCF commit to continuous emergency preparedness through the following actions:

- Ensure that all personnel including management have received a site induction that specifically covers emergency response procedures.
- The Farm Manager will regularly liaise with staff to ensure that they are competent in responding to emergencies
- Conduct regular inspections on all emergency response equipment and ensure that all equipment is in good working order
- Following an emergency event, undertake an incident debrief and provide all staff with training into improved emergency response procedures or actions.

When advice is issued by authorities (i.e. cyclone watch, cyclone warning, evacuation order, etc.), the Farm Manager will ensure that the following steps will be undertaken:

- All employees and contractors will report to the designated evacuation point, and receive further instructions regarding preparations for the emergency or evacuation.
- Where there is sufficient preparation time (i.e. in the event of a cyclone watch issued by the Bureau of Meteorology),
    - All essential vehicles will be fuelled, if required to evacuate employees, and non-essential vehicles will be parked and secured.
    - All potentially mobile items will be secured, tied down and/or stored and locked in the site office.

8.4.2 Spills response procedure

In the case of any spills the following procedure is to be implemented:

- Locate the source to identify volume and type of spill
- Assess the risk to workers and environment to ensure appropriate PPE and measures to be implemented.
- Control and contain the spill by isolating or removing source.
- Clean the spill using spill kit and absorbent material or installing bunds.
- Dispose of contaminated spill control material appropriately.
- Report significant spills or spills that have entered stormwater to NT EPA Pollution Hotline (1800 064 567).

Spill containment equipment kits will be available in works areas. All personnel on site will be trained how to use these spill kits

9 CONSULTATION & COMMUNICATION PLAN

9.1 Relevant stakeholders and consultation

The DCF engages regularly with a broad range of stakeholders and interested parties. The stakeholders relevant to this EPL and their relationship to DCF is summarised in Table 9-1.

Should any further stakeholders or interested parties arise, they will be added to the list of relevant stakeholders and included in communications and consultations into the future.

Table 9-1. Summary of relevant stakeholders

Stakeholder	Relationship to DCF
Government	
Department of Environment and Natural Resources – Water Resources	Groundwater usage regulation
NT EPA	Issuer and regulator of the EPL and its compliance
Parks and Wildlife Commission	Issuer and regulator of wildlife permits
DCF	
Employees	DCF workforce
Site contractors	DCF workforce
Industry bodies	
Crocodile Farmers Association NT	Crocodile farming industry body for NT

Consultation with stakeholders is undertaken directly through written (letters, emails) or verbal communication (meetings, phone calls).

9.2 Complaint management

For any complaints received regarding the operations of the farm or associated activities, a register of complaints will be kept that records:

- Date and time of complaint
- Method by which complaint was made (i.e. telephone, letter, meeting, etc.)
- Name, address, contact telephone number of complainant
- Details of complaint
- Action taken in response to the complaint, including follow up contract with the complainant
- Any monitoring to confirm the complaint has been satisfactorily resolved
- If no action was taken, the reason for no action being taken.

An example of the complaints register is included in Table 9-2.

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Table 9-2. Example complaints register

Complaint number	Name of recorder	Personnel responsible for responding to complainant	Date/time complaint received	Complainant contact details	Details of complaint	Corrective action summary	Reasons for no action taken

APPENDIX A IRRIGATION CONSIDERATIONS AND WATER BALANCE

IRRIGATION CONSIDERATIONS

The quality of water to be used for irrigation is summarised in Table 1.

Table 1. Irrigation water quality

pH	EC	TDS	BOD	O&G	NH3	TN	TP	*E.Coli*	Total Coliforms
-	*µS/cm*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*CFU/100ml*	*CFU/100ml*
7.9	396.7	202	3.0	<5	0.1	2.1	0.2	96	96

Table 1 above shows the current effluent irrigation water quality for TN, TP, BOD, TSS, oil and grease, pH and *E.Coli*. If these concentrations are assessed based on the criteria used in Table 3.1 of the NSW EPA *Environmental Guidelines - Use of Effluent by Irrigation* (DEC 2004), the current wastewater concentration is classified as "low" strength (Table 2).

Table 2. Classification of effluent based on DEC 2004 criteria

	Current irrigation water quality	Strength (average concentration mg/L)		
		Low	Medium	High
Total Nitrogen	2.1	<50	50-100	>100
Total Phosphorus	0.2	<10	40-1500	>1500
BOD	3.0	<40	40-1500	>1500
TDS	202	<600	600-1000	>1000

Organic content

The average maximum daily organic loading rate is calculated from the irrigation rate and the BOD (mg/L) concentration of the applied effluent. The *Environmental Guidelines – Use of effluent by irrigation* (DEC 2004) suggest that an average loading rate of 1,500 kg/ha/month can be taken as the maximum organic loading for most soils.

The current median BOD content of the wastewater for irrigation is 3 mg/L. The minimum irrigation area required based on organic loading can be estimated as follows:

A = CQ / (1,000 x Lc)

Where:

A = irrigation area (ha)

C = concentration of BOD5 (mg/L)

Q = average effluent flow rate (kL/month)

Lc = critical loading rate of constituent (kg/ha/month)

For DCF:

A = 3 mg/L x 60,000 kL / month / (1,000 x 1,500 kg/ha/month)

A = 0.12 hectares

Therefore, the current nominated irrigation area of 20.2 ha is sufficient in regards to organic content loading.

pH

The *Environmental Guidelines – Use of effluent by irrigation (DEC 2004)* suggest effluent with a pH between 5.0 and 8.5 is generally acceptable for use in irrigation. If the effluent is very acidic (pH less than 5), or very alkaline (pH greater than 8.5), it may need to be neutralised before application as soil pH affects the availability of nutrients and other elements to plants.

Metals

ANZECC (2000) Guidelines, Volume 3, Section 9.2.5 identify the maximum concentrations of metals in irrigation waters considered acceptable for continuous use. The current concentration of metals in the wastewater is shown below (Table 3) along with the long-term trigger value (LTV) and short-term trigger value (STV) guidelines adapted from the Guidelines. The current metal levels in the wastewater are mostly below the detectable limit and are therefore well below the LTV.

Table 3. Summary of irrigation water long-term trigger value (LTV) and short-term trigger value (STV) guidelines for heavy metals and metalloids

Metal	LTV in irrigation water (mg/L)	STV in irrigation water (mg/L)	DCF wastewater quality
As	0.1	2.0	0.002
Cd	0.01	0.05	<0.0001
Cr(VI)	0.1	1	<0.001
Cu	0.2	5	<0.001
Pb	2	5	<0.001
Hg	0.002	0.002	<0.0001
Ni	0.2	2	<0.001
Zn	2	5	<0.005

Mineral salts and specific ions

The Electrical Conductivity (EC) and concentration of salts and specific ions (sodium, chloride, alkalinity etc) in the wastewater are relatively low (see Table 4). The aim is to protect soil structure and downstream surface and groundwater, and to not exceed the salt tolerance of pasture grasses.

Table 4. Salt and ion concentrations in irrigation water

Ca	Mg	Na	K	SO4	Chloride	Alkalinity
mg/L	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*
24	27	15	5	3	24	171

Oil and grease

The levels of oil and grease in the wastewater are currently below detection limits. These low levels will not present problems in regards to clogging irrigation systems or coating leaf surfaces of irrigated crops.

Pathogens

The concentration of *E.coli* and other pathogens in the wastewater for irrigation is significantly lower than the wastewater coming directly out of the crocodile pens. This is likely due to the pathway of water through the

breeding lagoons. Bacterial movement through soils is extremely limited and the harsh sunlight and climatic conditions typical of Australia rapidly diminish viable populations of bacteria. The irrigation area is also off-limits to the public, therefore any pathogens in the wastewater are not expected to cause any harm to human receptors.

Nutrients

Irrigation of treated effluent aims to balance nutrients applied with their uptake and removal by plants and soil through crop (pasture) growth and subsequent harvest and removal. This ensures that excess nutrients do not build up overtime and leave the site in runoff or groundwater flows. A nutrient balance was undertaken to determine the irrigation area required to ensure suitable uptake of nitrogen and phosphorus in the wastewater. A number of parameters from the *Land Capability Assessment for Onsite Wastewater Management Guidelines* (2010) (LCA Guidelines) were utilised in the calculations.

The following input data was used in the nutrient balance:

Input Data		
Hydraulic load	L/day	Based on irrigation volumes in water balance
Effluent N concentration	mg/L	2
N lost to soil	-	0.2 (standard multiplier from LCA guidelines)
Effluent P concentration	mg/L	0.2
Design life of system	Years	50 (standard design life)
Crop N uptake	kg/ha/year	220 (from LCA guidelines)
Crop P uptake	kg/ha/year	50 (from LCA guidelines)
P-sorption rate	mg/kg	376 (based on sampling results)
Bulk density	g/cm3	1.3 (conservative from LCA guidelines)
Depth of absorbing layer	m	0.4
% of P sorbed	%P	0.75 (standard multiplier as per LCA guidelines)

The results of the nutrient balance indicate that current nitrogen levels in the wastewater for irrigation will require a maximum area of 6.8 ha to ensure sufficient uptake.

The current phosphorus levels in the wastewater for irrigation will require a maximum area of 4.6 ha to ensure sufficient uptake.

Whilst the current nutrient levels are manageable in the 20.2 ha irrigation area, the nutrient levels will continue to be monitored to ensure sufficient nutrient uptake capacity in the irrigation area.

Salinity & sodicity

Salinity

In order to assess the suitability of water and soil for irrigation, the quality of the irrigation water, characteristics of the soil to be irrigated and the salt tolerance of the crop to be grown must be considered. Electrical conductivity (EC) is a measure of the total soluble salts in water. Some general irrigation electrical conductivity (ECi) ratings (DERM 2009) for water are shown in Table 4. The current average EC of the wastewater for irrigation is 0.4 dS/m, which is considered low for irrigation.

Table 5. Salinity ratings for water (ANZECC 2000)

ECi (ds/m)	Water salinity rating
<0.65	Low
0.65-1.3	Moderate
1.3-2.9	High
2.9-5.2	Very high
>5.2	Extremely high

Sodicity

Sodic soils have a range of adverse properties including poor soil structure and stability, surface crusting, poor aggregation, increased runoff and erosion, poor seedling emergence and slow water infiltration. Soil sampling was undertaken in the proposed irrigation area and the exchangeable sodium percentage (ESP) was less than 2.6%.

Soils with an ESP between 6 and 15% are considered sodic, and an ESP greater than 16% is considered strongly sodic. Soils with an ESP less than 6% are considered non-sodic.

High concentrations of sodium in irrigation water can result in the degradation of soil structure. The potential for this excess sodium on soils is commonly assessed using the sodium adsorption ratio (SAR). The sodium adsorption ratio is used to predict the potential for sodium to accumulate in the soil, which would result from continued use of sodic water.

The SAR in the wastewater for irrigation was found to be 0.5 which is not considered an issue, as outlined in Table 5.

Table 6. Sodicity classes for irrigation water

SAR	Sodicity class
<3	No sodium problem
3-6	Low sodium, few problems except with sodium sensitive crops
6-8	Medium sodium, increasing problems
8-14	High sodium, not generally recommended
>14	Very high sodium - unsuitable

Source: *QLD DPI&F Notes: Interpreting water analysis for crop and pasture*

Relationship

Based on the low salinity rating of the soil and the low SAR for the irrigation water, it is not expected that irrigation will have an impact on the soil structure. The levels also fall within the “stable soil structure” area on the EC/SAR relationship graph detailed in the ANZECC 2000 guidelines and below (Figure 1).

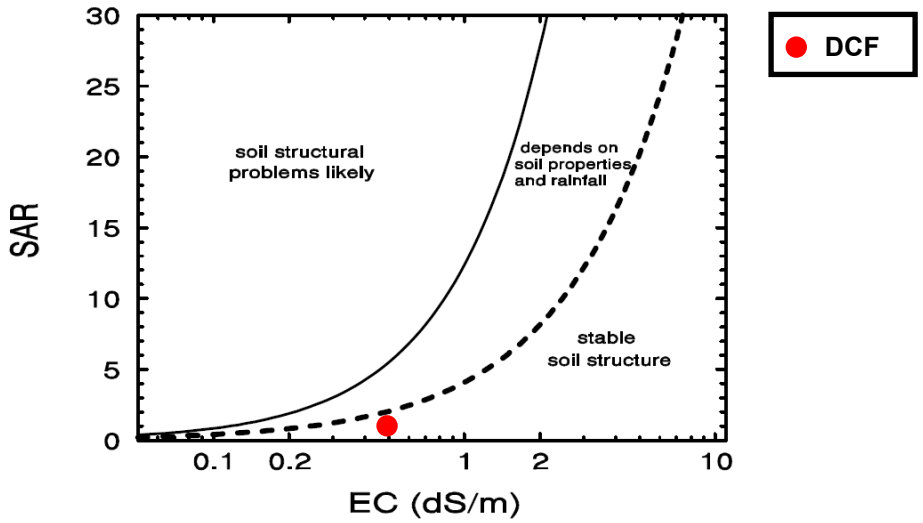

Figure 1. Relationship between SAR and EC of irrigation water for prediction of soil structural stability

WATER BALANCE

The following input data was used in the water balance:

Input Data		
Monthly water usage	L/day	Client supplied data
Design Irrigation Rate	mm/day	5
Nominated Land Application Area	m^2	202000
Crop Factor	unitless	0.8-0.9
Retained Rainfall	unitless (most conservative)	0.5
Rainfall Data	mm/month	BOM mean for Middle Point Rangers
Evaporation Data	mm/month	BOM mean for Middle Point Rangers
Pen area (shade cloth cover)	m^2	62742
Pond area (no cover)	m^2	351856

The total inputs, outputs, percentage wastewater lost, total volume remaining and storage requirements by month are detailed in Table 7.

Irrigation rate

The design irrigation rate was set at 5 mm per day as recommended by the Australian Standard for *On-site domestic wastewater management* (AS/NZS 1547:2012) for drip or spray irrigation. The site irrigation trial is being undertaken to determine a site specific irrigation rate based on the site conditions and selected crops. Increasing the irrigation rate decreases the storage requirements through the wet season as outlined in Table 8.

Nominated land application area

The current available area on-site for irrigation is 20.2 hectares, which is the basis of the water balance. There is potential to increase the irrigation area into surrounding properties, which would also decrease the storage requirements in the wet season (Table 9).

Crop factor

The LCA Guidelines stipulate a crop factor of 0.8-1.0 would be appropriate for irrigation design purposes, based on the generally high year-round daytime temperatures in the NT. For this assessment a crop factor of 0.8 was used for the dry season months and 0.9 for the wet season.

Retained rainfall

A factor of 0.5, or 50%, was used based on the *Draft NT Effluent Irrigation Areas Standard Sizing and Design* (2007), a supplement to the *NT Code of Practice for Small On-site Sewage and Sullage Treatment Systems and the Disposal or Reuse of Sewage Effluent* (1996).

Pen and pond areas

A proportion of the crocodile pens are covered with a thick shade cloth material during the wet season, which decreases evaporation and rainfall infiltration. To account for this cover, a rainfall infiltration factor of 10% and evaporation factor of 20% was assumed for these areas. The remaining pens and breeding lagoons are uncovered and therefore experience full rainfall infiltration and evaporation rates.

Table 7. DCF site water balance and storage requirements

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total water inputs (usage + rainfall)	m3/day	6728.7	6484.7	5478.4	3277.5	2466.9	2331.4	2245.9	2114.7	2093.8	2575.9	3772.9	4970.6
Total outputs (irrigation + evaporation)	m3/day	3736.8	3651.8	3745.5	3937.2	3956.5	3976.2	4126.6	4426.7	4776.2	5060.6	4629.4	4009.9
% wastewater lost	%	56%	56%	68%	120%	160%	171%	184%	209%	228%	196%	123%	81%
Total volume remaining	m3/day	2991.8	2832.9	1732.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	960.7
Cumulative storage	m3/mnth	122528	201848	255565	235774	189595	140251	81949	10277	-70193	-147219	-172914	29782

Legend

	Maximum storage required
	Complete irrigation of stored volume

Table 8. Storage requirements vs irrigation rates (over 20.2 ha)

Irrigation rate (mm/day)	Storage required
5	255,000
10	135,000
15	53,000
20	0

Table 9. Storage requirements vs irrigation area (at 5mm irrigation rate)

Irrigation area (ha)	Storage required
20.2	255,000
40	150,000
60	82,000
100	0

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