Irrigation Management Plan (IMP)

Janamba Crocodile Farm

Croc Pac Pty Ltd

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DOCUMENT CONTROL RECORD

Job	EZ19095
Document ID	185621-55
Author(s)	Britanny Crescentino

DOCUMENT HISTORY

Rev	Reviewed by	Approved by	Issued to	Date
1	Emma Lewis	Helen Dwyer	Croc Pac Pty Ltd	20/05/2020
2	Helen Dwyer	Helen Dwyer	Croc Pac Pty Ltd	26/06/2020

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ACRONYMS

ANZECC	Australian and New Zealand Environment and Conservation Council
BoM	Bureau of Meteorology
DEC	Department of Environment and Conservation (NSW)
DENR	Department of Environment and Natural Resources (Northern Territory) – formerly DLRM
DHAC	Darwin Harbour Advisory Community
DLRM	Department of Land Resource Management (Northern Territory) – now DENR
DOEE	Department of the Environment and Energy (Commonwealth)
EC	Electrical Conductivity
ECi	Electrical Conductivity (irrigation)
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act (1999)* (Commonwealth)
EPL	Environment Protection Licence
ESCP	Erosion and Sediment Control Plan
ESP	Exchange Sodium Percentage
LCA	Land capability assessment
LTV	Long-term trigger values
IMP	Irrigation Management Plan
NSW	New South Wales
NTEPA	Northern Territory Environmental Protection Authority
NT	Northern Territory
RL	Rural Living
SAR	Sodium Adsorption Ratio
STV	Short-term trigger values
TSS	Total suspended solids

1 INTRODUCTION

1.1 Background

Croc Pac Pty Ltd (Croc Pac) operates the Janamba Crocodile Farm (Janamba) in Middle Point, Northern Territory (NT). Janamba has been an operational family business for saltwater crocodiles (*Crocodylus porosus*) for approximately 30 years. Over time, the operations have expanded to meet the increasing demand for crocodile products and the farm currently has capacity for more than 30,000 animals.

Janamba is a commercial production farm, including a captive breeding program, incubation of eggs to hatchling stage and growout of individuals to full size for market. The animals are culled 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 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*.

Currently wastewater is being processed through a treatment facility to remove solids only, with the treated wastewater being discharged into a breeding lagoon. Janamba established a sandalwood plantation in 2018 and a portion of the wastewater generated is used to irrigate this crop.

1.2 Purpose and scope

Janamba recognise the importance of finding a solution to manage wastewater produced on site and prevent the discharge of untreated wastewater off-site. As a wastewater management strategy, Porosus propose to expand the current irrigation practices to dispose of the wastewater onto suitable crops.

This Irrigation Management Plan (IMP) has been developed to illustrate the management and reuse of wastewater by Croc Pac at Janamba through irrigation application. This plan is a requirement as part of the Environmental Protection Licence (EPL) application.

2 EXISTING ENVIRONMENT

2.1 Location

Janamba is located at 630 Anzac Parade, Middle Point, within Parcel 1547, Hundred of Guy. The lot is zoned for horticulture purposes. Middle Point is located within the Adelaide River catchment and is immediately adjacent to the Fogg Dam Conservation Reserve (Figure 2-1). Janamba is approximately 65 km from Darwin and can be accessed via the Stuart and Arnhem Highways. The size of the property is 47.5 ha, of which 50% is currently used for different stages within the farming routine (including the breeding lagoon) (Figure 2-2). The current sandalwood irrigation area occupies a further 10 ha whilst the remaining area is currently unused.

Land use surrounding Janamba includes privately owned lots zoned for horticulture to the north and south. To the west of the site on the opposite side of Anzac Parade there is a school and a scientific research village. Directly east of Janamba is the Harrison Dam Conservation Area with Harrison Dam located approximately 350m from the property boundary. The Harrison Dam Conservation Area is adjacent to the Adelaide River, which is approximately 5.8 km east from the closest Janamba boundary. Fogg Dam Conservation Area is also located within 2 km north-west of the Janamba boundary.

The Harrison Dam Conservation Area is utilised for recreational purposes such as walking and hunting, while the Fogg Dam Conservation Area is utilised for walking and bird watching.

2.2 Climate

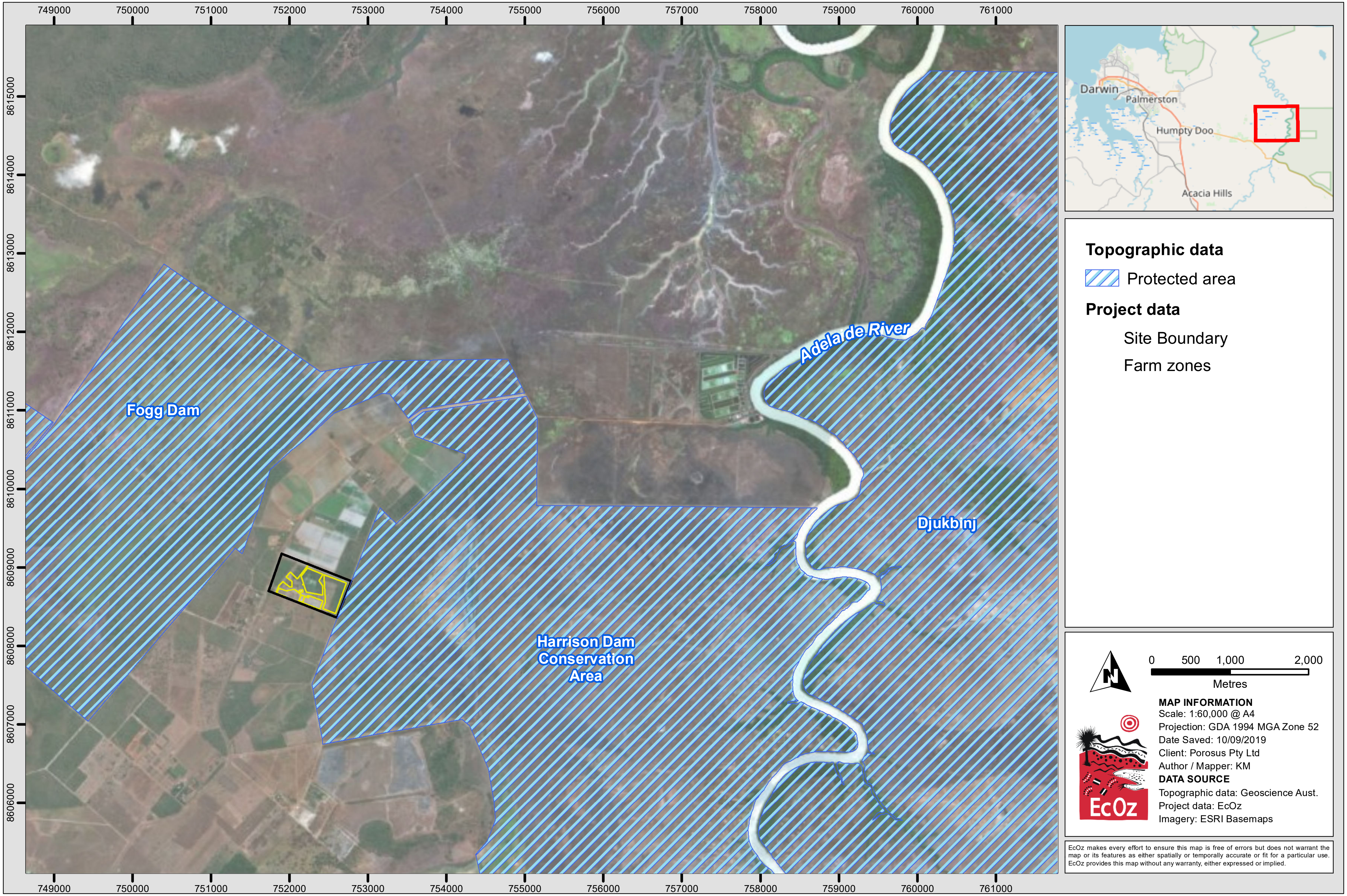
Janamba experiences a tropical monsoonal climate with distinct wet and dry seasons and little variation in temperature. The wet season is characterised by higher humidity and rainfall, and occurs between October and April. The dry season extends from May to September and is characterised by lower humidity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

Table 2-1. Average rainfall and evaporation (BoM)

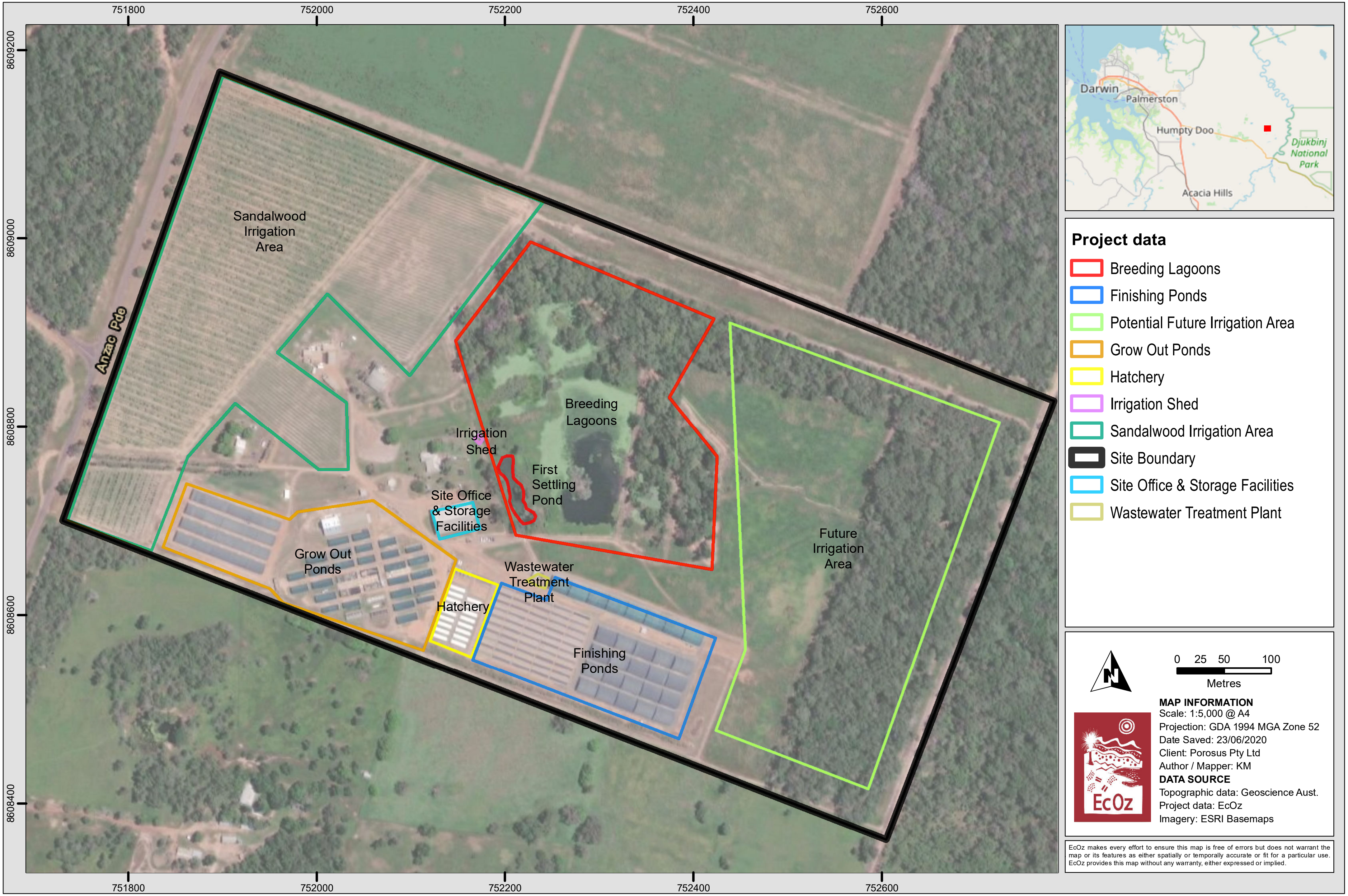
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	347	283	256	89	24	1	1	2	13	57	130	228
Evaporation (mm)	146	126	146	156	161	156	171	189	204	220	189	161
Temperature (°c)	33.4	33.5	33.8	34.2	33.4	32.3	32.8	34.2	36.5	37.4	36.4	35.0

Wind rose data is available for the Middle Point (9am) and the Darwin Airport station (no. 041015, 9am and 3pm) which 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 afternoons are dominated by westerly and north-westerly breezes. This has implications for irrigation management, as wind speed and direction will impact the potential spray drift and odour, and impacts on sensitive receptors (i.e. neighbouring properties).



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19095 - Janamba Croc Farm EPL\01 Project Files\Figure 2-1. Map showing site location.mxd

Figure 2-1. Map showing site location



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19095 - Janamba Croc Farm EPL\01 Project Files\Figure 2-2. Map showing site layout and infrastructure.mxd

Figure 2-2. Map showing site layout and infrastructure

2.3 Land units

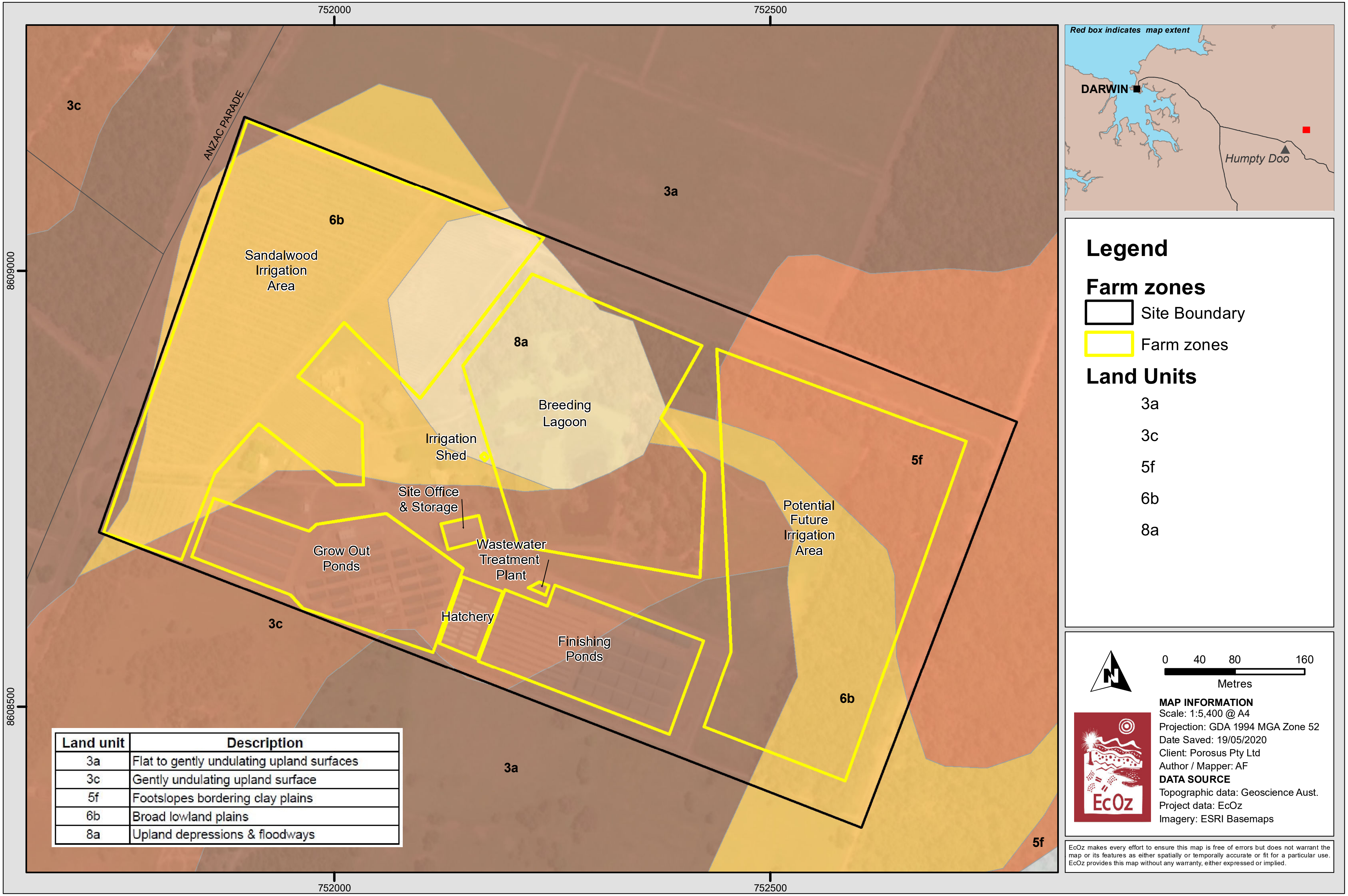
A land unit is a reasonably homogenous part of a land surface, distinct from surrounding terrain with consistent properties in landform, soil and vegetation (Jessop & King 1997). As such, each land unit has a characteristic pattern on aerial imagery. This area is within the mapped extent of the Greater Darwin Area land units which is shown in Figure 2-3.

The site contains land units that are characterised by well drained soils which is beneficial when considering the site for irrigation purposes. Whilst land unit mapping indicates the presence of hydrosols, the irrigation area is not seasonally inundated or saturated and current and historical soil data (obtained from NR maps) for the irrigation area indicate the soils are predominately well-drained, sandy loam in texture and have moderate to high permeability (discussed further in Section 2.4). The land units mapped within in the two irrigation areas are described in Table 2-2.

Table 2-2. Summary of land units relevant to irrigated areas

Land unit	Landform	Soil
3a	Flat to very gently undulating upland surface. Gradient 0-2% Very minor amounts of ferruginous gravel.	Red Kandosol. Deep red massive earths, minor yellow massive earths. Sandy loam surface over sandy clay loam grading to light clay at depth. Deep subsoil occasionally has up to 10% ferruginous gravel. Well drained.
3c	Flat to very gently undulating upland surface. Gradient 1-3% Extensive ferruginous gravels (40-80% surface cover) small areas of laterite outcrop.	Brown Kandosol. Shallow to moderately deep gravelly yellow massive earths, minor lateritic lithosols. Loamy sand to sandy loam surface grading into sandy clay loam subsoil. 20-40% ferruginous gravel in surface, 30-50% in subsoil. Well drained
6b	Broad drainage floors and creek margins. Gradient <1.5% Debil debil surface is common.	Tenosolic Oxyaquic Hydrosol. Shallow to moderately deep siliceous and earthy sands, minor sandy massive earths. Coarse textured sands to sandy loams. 0-10% gravel in surface, 5-40% gravel in subsoil. Well drained.
5f	Lower sandy colluvial wash slopes/footslopes bordering the clay plains and perennially inundated depressions. Gradient generally <1% rarely to 2%. Some minor surface gravel.	Hydrosol – variable. Variable, mottled yellow duplex soils (occasionally with organic surface or gravel layers) to earthy sands/colluvial sands (occasionally gravelly) over mottled pale clayey subsoil. 10-20% gravel throughout for earthy sands. Moderately well to imperfectly drained.

Currently the majority of the site, including the irrigation site has been previously cleared. The eastern boundary of the new proposed irrigation area is vegetated with natural vegetation that is to be used as a buffer for the neighbouring sensitive receptor Harrisons Dam.



Land unit	Description
3a	Flat to gently undulating upland surfaces
3c	Gently undulating upland surface
5f	Footslopes bordering clay plains
6b	Broad lowland plains
8a	Upland depressions & floodways

Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19095 - Janamba Croc Farm EPL\01 Project Files\Figure X-X Map of Janamba Crocodile Farm land units.mxd

Figure 2-3. Map of Janamba Crocodile Farm land units

2.4 Soil

Soil sampling was undertaken in the existing sandalwood plantation and the proposed irrigation area to determine the suitability for application of wastewater to land, on 05 July 2019. Collectively, eleven sample locations were selected over the two areas – 6 samples from the sandalwood plantation and 5 samples from the new proposed area (Figure 2-4). All sampling and handling of samples were undertaken in accordance with AS4482.1-2005 *Guide to sampling and investigation of potentially contaminated soil – Part 1: Non-volatile and semi-volatile compounds*. All samples were analysed by ALS Environmental which is a National Association of Testing Authorities (NATA) approved laboratory, with the exception of field parameters such as pH and Electrical Conductivity (EC).

As a result it was determined that the sandalwood irrigation area predominately ranges from sandy loam to clay loam, poor structure and orange to red brown in colour; and the proposed irrigation area ranges from sandy clay to silty clay, poor to moderate structure and yellow brown in colour. A summary of the soil sampling results are listed in Table 2-3 whilst the full suite of results is provided in Appendix A. With the exception of the pH results, all other results listed are an average from each sampling area.

Table 2-3. Summary of soil sampling results

Parameter	Sandalwood area	New irrigation area
Depth: 0 - 0.4 m		
pH	5.4 – 5.8	6.4 – 8.1
EC	25 µS/cm	63 µS/cm
Total P	100 mg/kg	74 mg/kg
P sorption capacity	3800 mgP/kg	1600 mgP/kg
Total Organic N	320 mg/kg	374 mg/kg
Nitrate + nitrite (NO_x)	3.5 mg/kg	3.1 mg/kg
ESP	<4 %	<2.1 %
Depth: 0.4 – 1m		
pH	5.0 – 5.8	5.9 – 8
EC	25 µS/cm	50 µS/cm
Total P	85 mg/kg	91 mg/kg
P sorption capacity	3500 mgP/kg	1624 mgP/kg
Total Organic N	180 mg/kg	378 mg/kg
Nitrate + nitrite (NO_x)	5 mg/kg	2.7 mg/kg

2.5 Groundwater

Janamba lies within the Darwin Rural Water Control District on the Howard Groundwater System. Groundwater would flow in an easterly direction towards Harrisons Dam and the Adelaide River floodplains.

Janamba holds a Water Extraction Licence (Licence no. KD17) with a maximum entitlement of 600 ML/year from three bores, with the source being the Koolpinyah Dolomite Formation Aquifer (South East Zone - Middle Point) for which the estimated sustainable yield is 4,000 ML/year.

The details of the three production bores are outlined in Table 2-4, along with an additional historical bore (RN026912) that is not utilised by Janamba. All the production bores are equipped and therefore their standing water level (SWL) is not recorded regularly. The SWL and yield in each bore was recorded at the time of construction and has been included in Table 2-4 for reference. Bore 1 was constructed in 2018 and recorded an SWL of 6 m during the middle of the dry season. The bore locations are shown in Figure 2-4. None of these bores are located within the current or proposed irrigation areas.

Table 2-4. Groundwater bore details

Site Name	Bore No.	Depth (m)	SWL (m)	Yield (L/s)	Average monthly extraction (ML)
Bore 1	RN040609	45.8	6	20	25
Bore 2	RN027100	42	6	20	0
Bore 3	RN038956	40	4	10	25
-	RN026912	40	0	9	Not used
				Total	**50**

Monitoring of the groundwater quality at the site has been undertaken since 2014. Additional groundwater sampling was also conducted for the purpose of the EPL. The results of the historical and recent sampling is summarised in Table 2-5 and compared with the ANZECC guidelines for reference. The full suite of monitoring results in included in Appendix B.

Table 2-5. Summary of average groundwater quality sampling results

Sample Site ID	pH	EC (µS/cm)	Total P (mg / L)	Total N (mg / L)	NO_3 (mg / L)	Total Cations (meq / L)	Total anions (meq / L)
ANZECC Guidelines[1]	*6.0-8.0*	*250*	*0.01*	*0.2 - 0.3*	-	-	-
Bore 1 (RN040609)	7.9	296	0.018	0.33	0.58	3	3
Bore 2 (RN027100)	7.9	-	0.018	0.48	-	-	-
Bore 3 (RN038956)	7.8	250	0.065	0.48	0.33	2.65	2.58

Note: - = No data available

Surrounding groundwater uses

The surrounding land uses are categorised by zoning plans developed under the NT Planning Scheme, in accordance with the NT *Planning Act, 1999.* The land surrounding Janamba includes privately owned lots zoned for horticulture to the north and south (including Koolpinyah Station), where a number of bores exist and groundwater is utilised. To the west of the site on the opposite side of Anzac Parade there is a school and a scientific research village.

Surrounding land users (private and commercial) all utilise equipped production bores for water supply.

Directly east of Janamba is the Harrison Dam Conservation Area while north-west is Fogg Dam Conservation Area; both of these conservation areas are supported by groundwater.

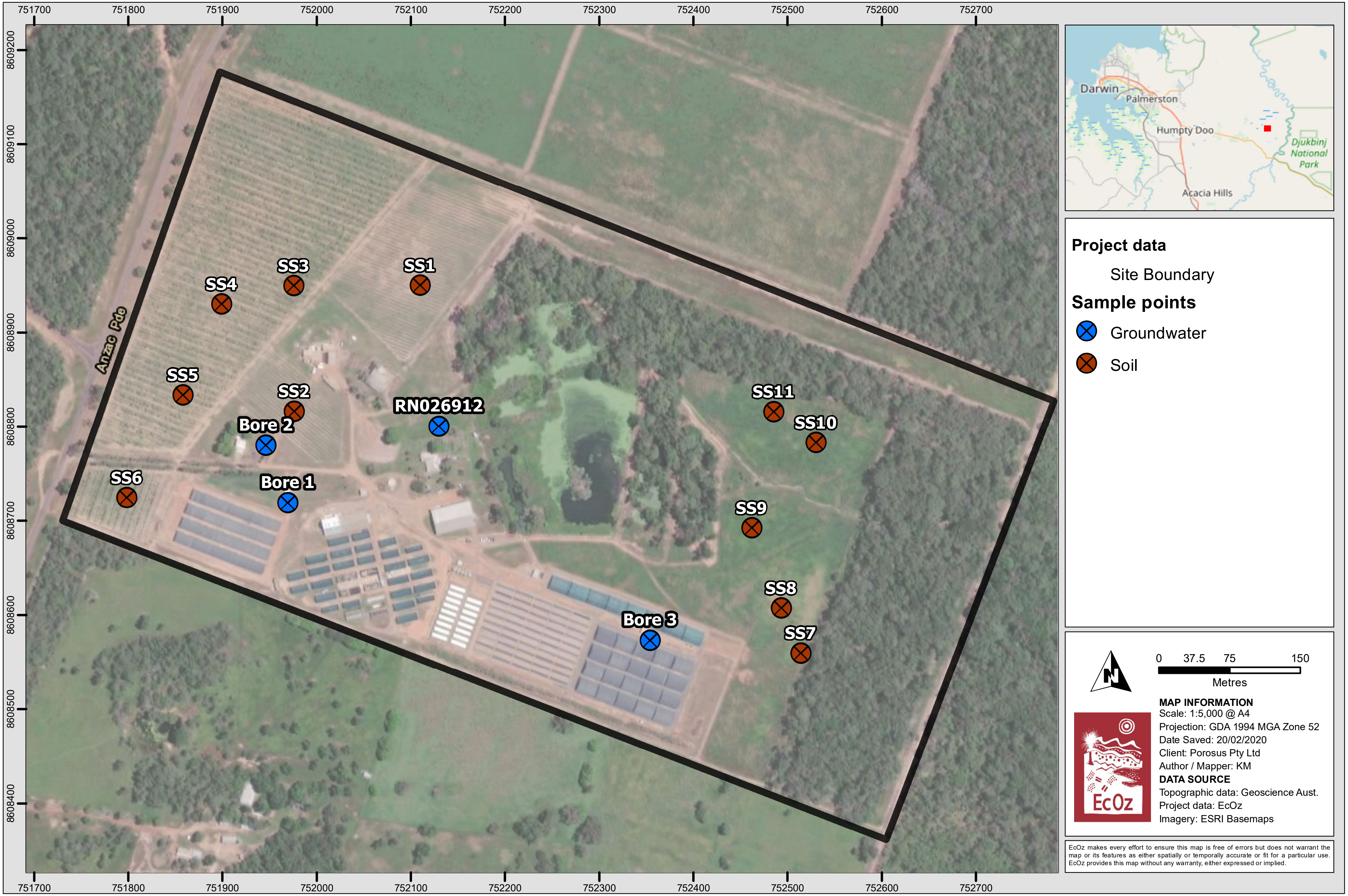
[1] ANZECC Guidelines – Aquatic ecosystems 95% species protection level

2.6 Topography and surface water drainage

Janamba lies within the Adelaide River catchment area, at the top of the sub-catchment area (water on the opposite side of Anzac Parade to Janamba, flows to the west towards Fogg Dam which is categorised as another sub-catchment area).

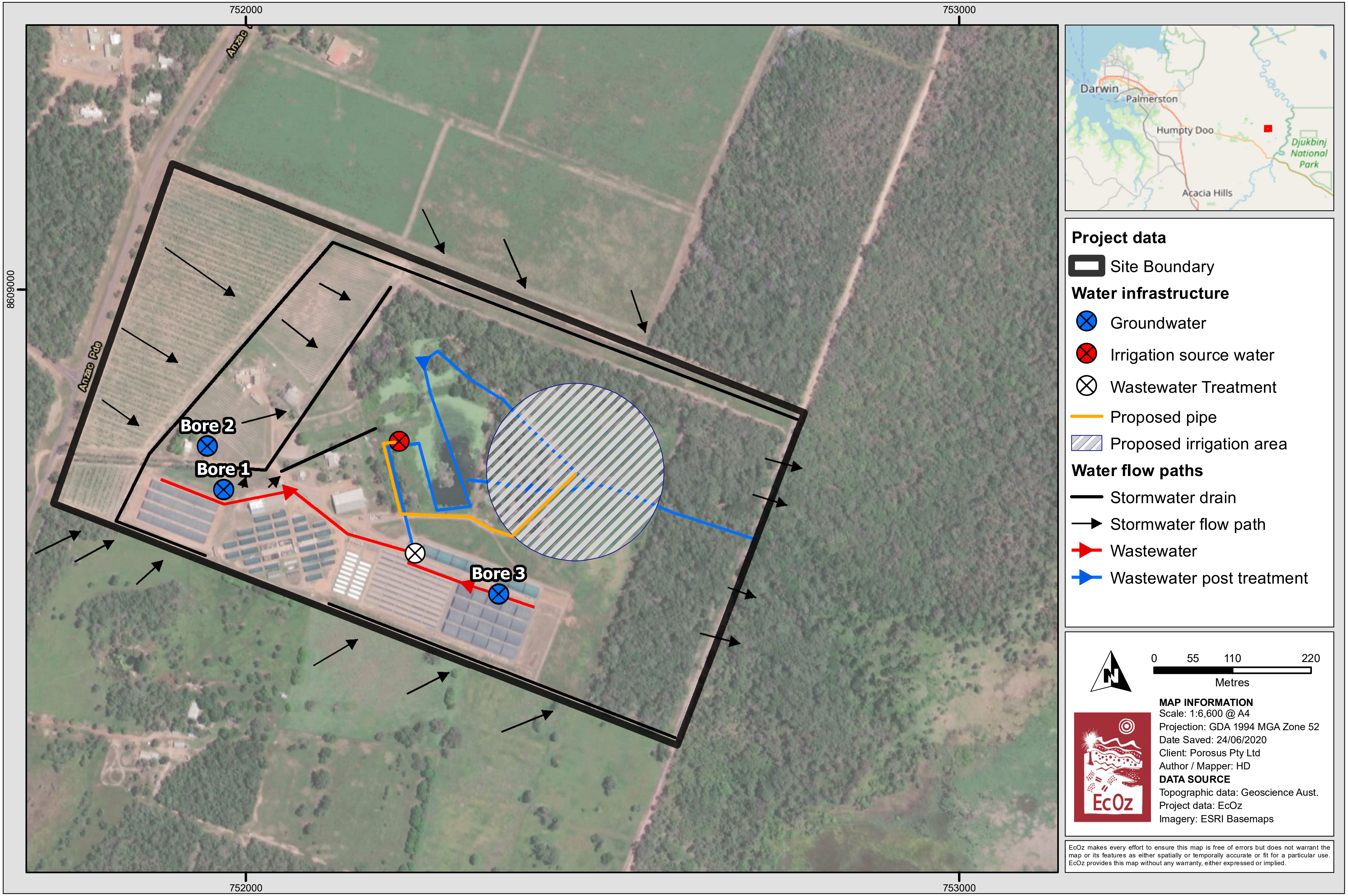
Surface water from the operational areas of Janamba flows in a south-easterly direction from Anzac Parade towards Harrison Dam. Croc Pac have constructed drainage channels on the property boundaries to divert stormwater run on from neighbouring properties around the active farm areas and discharging from the eastern boundary towards Harrison Dam (Figure 2-4). Runoff from the farm areas flows as sheet flow towards the eastern boundary and into the Harrison Dam Conservation Area. Over time, overflows from the breeding lagoon have caused a drainage channel to form from the lagoon towards the eastern boundary. Janamba have constructed a discharge outlet on the property boundary to dissipate surface water flows from site.

From the property discharge outlet, there are no defined channels or watercourses that the surface water flows into. Surface water flows as sheet flow into the Harrison Dam Conservation Area, which is a wide expanse of waterholes and wetlands.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19095 - Janamba Croc Farm EPL\01 Project Files\Figure 2-4. Map showing sampling and monitoring locations.mxd

Figure 2-4. Map showing sampling locations



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19095 - Janamba Croc Farm EPL\01 Project Files\Figure 2-4. Map showing bores, water flow paths and proposed irrigation.mxd

Figure 2-5. Map showing bores, water flow paths and proposed irrigation area

3 DESCRIPTION OF OPERATIONS

3.1 Overview

The crocodile production process is summarised as follows:

1. Eggs are collected from breeding pens and wild-collected, and are assessed and cleaned in an 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 using a dedicated trailer and then sent to an off-site location for further processing.

Janamba currently harvests 130 animals a week for off-site processing to produce raw crocodile skins, meat products and other saleable by-products. Mortality rates are highest in the hatchery at less than 10% whilst mortality in the grower and finishing pens is less than 1%.

The operations at Janamba 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. 17902), pursuant to section 56 of the *Territory Parks and Wildlife Conservation Act*.

It is also a requirement for Janamba to hold an export permit under the Convention of International Trade in Endangered Species (CITES) of Wild Fauna and Flora (Permit No. PWS2019-AU-000547 & PWS2019-AU-002045), pursuant to s303CG of the *Environment Protection and Biodiversity Conservation Act 1999*.

3.1.1 Water supply

The crocodile production process requires large high quality water inputs to provide a suitable habitat for the individuals and also for adequate skin quality production. Janamba currently holds a groundwater extraction licence (Licence no. KD17) which allows a maximum extraction entitlement of 600ML/year from the three groundwater bores located within the site boundary (see Table 2-4). The source of the water is from Koolpinyah Dolomite Formation. On average, Janamba uses approximately 50 ML of water per month predominately from Bore 1 and 3.

The primary use of water is through regular flushing of the different pens for maintenance of hygiene and health of individuals. The bores also supply water to the office and site facilities. Bore 1 supplies water to the grower pens, hatchery and office buildings, whilst Bore 3 supplies water to the finishing pens. On average the water usage at Janamba is estimated at 1,600 KL/day.

A map outlining water supply bore locations and wastewater drainage through the different farm areas is included in Figure 2-4.

3.1.2 Farming routine

The animals move through different growth stages, therefore the farming routine changes accordingly. Table 3-1 outlines the water, food and cleaning schedule requirements for the three different growth type pens and the breeding lagoons.

Table 3-1. Janamba farming routine

	Hatchery	Grower Pens	Finishing Pens	Breeders
Water input	Bore water			Pen effluent & stormwater
Chlorine	Chlorine dosing on bore inlets Granulated chlorine used for cleaning empty pens only			-
Food	5 times / week	4 times / week	2 times / week	Every 3 weeks
Cleaning	6 times / week	Weekly	Every 3 weeks	-
Sanitizer	2-3 times / week	-	-	-

The feed type is determined by the growth type for each crocodile, therefore hatchlings feed consists of kangaroo meat, juvenile crocodiles (1-2 years) feed is a combination of kangaroo meat and minced lamb, then chicken heads for mature crocodiles. Additional food additives are included in the feeds to ensure optimal growth of the individuals (Monsoon Crocodile CH Premium).

Potassium permanganate is added to the finishing pens to prevent bacteriological skin conditions that may impact on the quality of the skin as a product. Potassium permanganate is only added if there are high bacteriological counts (as identified by routine water quality monitoring) and is therefore not added routinely. Monitoring of bacterial counts in the bore water before and after chlorination is undertaken on a monthly basis.

Antibiotics are only administered in the hatchery to specified individuals if identified as necessary, as opposed to a blanket inoculation of the whole cohort. It is very rare that antibiotics are administered to individuals in the grower or finishing bens as illness is not common and the antibiotics impact the ability to process individuals for meat products.

4 WASTEWATER GENERATION AND TREATMENT

4.1 Current wastewater flows

Water obtained from the bores is pumped through the hatchery, grower and finishing pens, with the effluent from each stage discharging into a concrete lined drainage system. The drainage system is currently directed through a wastewater treatment system that consists of a filtration and screening process to remove grit and sludge (Spirac and drum filters). The treated wastewater then flows into a series of ponds which are part of a large on-site crocodile breeding lagoon. Earthen drainage lines result in excess water (predominately during the wet season) flowing towards the eastern boundary and ultimately discharging off-site. A basic schematic of the current wastewater treatment plant is outlined in Figure 4-1.

In August 2018, a sandalwood plantation was established over an area of approximately 7.8 ha where treated wastewater is currently used as irrigation water through a drip system. A further 2.2 ha area of sandalwood was planted in September/October 2019 and joined to the existing system. Water for irrigation is extracted from the breeding lagoon ponds post treatment. Depending on the season, between 5,000 KL and 30,000 KL of water is used for irrigation per month.

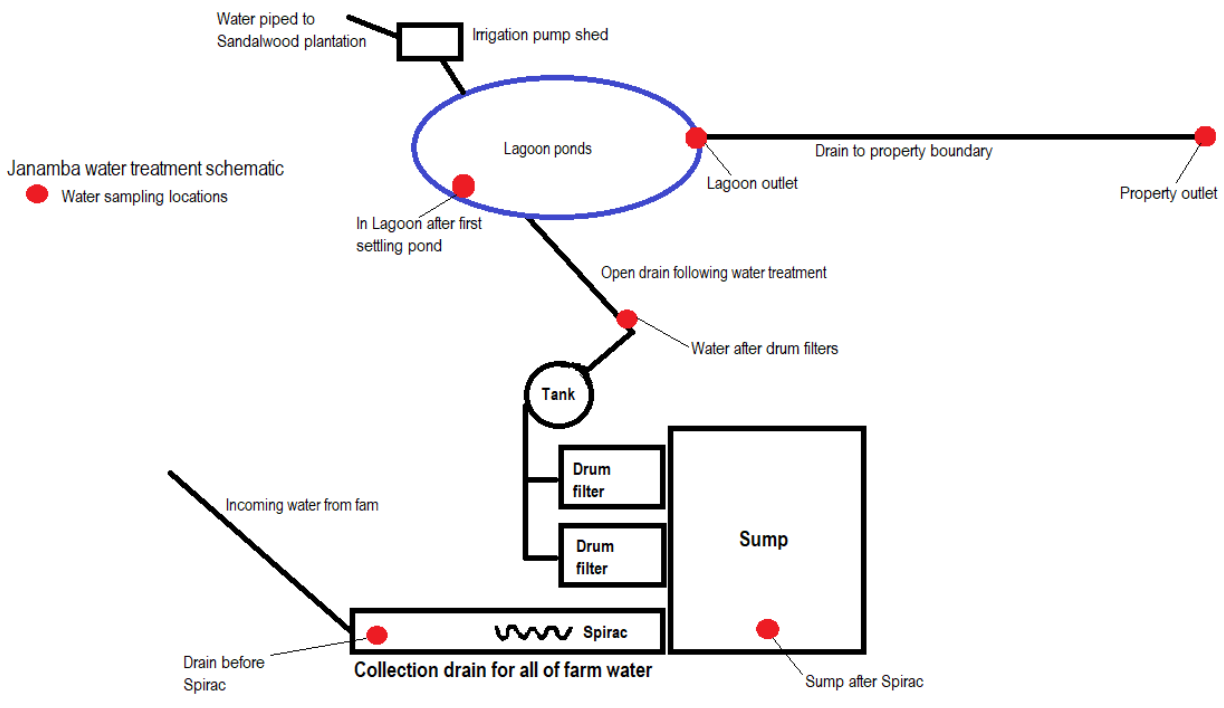


Figure 4-1. Schematic drawing of current wastewater treatment system with water sampling locations

4.2 Current wastewater quality

The quality of water to be used for irrigation is summarised in Table 4-1, based on average water quality from previous monitoring conducted in the lagoon (irrigation source water) in July 2019 and historically over three years (from 2014-2017).

Table 4-1. Quality of wastewater to be used for irrigation

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*
8.3	432.6	281.4	17	<5	4.95	6.7	1.7	1200	1200

When assessed against the *Environmental Guidelines – use of effluent by irrigation (DEC 2004)*, the current wastewater concentration is classified as "low" strength (Table 4-2).

Table 4-2. Classification of effluent based on DEC 2004 criteria

	Current irrigation water quality	Strength (average concentration mg/L)		
		Low	Medium	High
Total Nitrogen	6.7	<50	50-100	>100
Total Phosphorus	1.7	<10	40-1500	>1500
BOD	17	<40	40-1500	>1500
TDS	281.4	<600	600-1000	>1000

4.3 Irrigation suitability

This section assesses all of the factors that need to be taken into consideration under the New South Wales (NSW) *Environmental Guidelines – use of effluent by irrigation (DEC 2004)* (NSW guideline). Currently the sandalwood plantation alone is 10 ha of area where irrigation of the wastewater is to be conducted. In addition to this there is 5 ha of available space to be utilised for a new irrigation area, resulting in 15 ha of total area available for irrigation.

4.3.1 Organic content

Organic material is present in many effluent waste streams and when applied at a suitable rate, can assist in the physical and chemical health of soils. Normally, organic material concentrations are low enough to prohibit any short-term detrimental effects on soil and vegetation characteristics. However, if soil is continually overloaded with organic material this can result in the blocking of soil pores, favour anaerobic soil microbes and lead to a slimy bacterial scum crust on the soil (DEC 2004).

The average maximum daily organic material loading was calculated from the irrigation rate and the BOD (mg/L) concentration of the applied effluent. The NSW guideline suggests 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 17 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 (h)

C = concentration of BOD^5 (mg/L)

Q = average effluent flow rate (kL/month)

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

For Janamba:

A = 17 mg/L x 48,000 kL / month / (1,000 x 1,500 kg/ha/month)

A = 0.544 hectares

The above calculation indicates that a minimum area of 0.544 ha is required to manage the organic content of the Janamba wastewater, therefore, the current nominated irrigation area of 15 ha is sufficient in regards to organic content loading.

4.3.2 Suspended solids

The Total Suspended Solids (TSS) concentration is between <10 - 130 mg/L prior to the removal at the drain before spirac, and <10 - 30 mg/L in the lagoon after the first settling pond (point of irrigation water extraction). There is no water quality limit or concentration of concern for TSS in the NSW guidelines for irrigation.

Recommendation guidelines for concentrations of suspended solids to avoid clogging in localised (drip) irrigation systems are available from Ayers and Wescot (1985). The recommendations are based on the degree of restriction of use:

- <50 mg/L = no restriction
- 50-100 mg/L = slight to moderate restriction
- >100 mg/L = severe restriction

The current low levels will not present a problem in regards to the irrigation system getting clogged or the coating of leaf surfaces. In conjunction an appropriately sized nozzle will be used to prevent potential clogging.

4.3.3 pH

The NSW guideline suggests 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), the wastewater may need to be neutralised before being used for irrigation as soil pH affects the availability of nutrients and other elements to plants. Basewd on sampling undertaken to date, the pH of the irrigation water is between 7.3 – 8.5.

4.3.4 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 4-3) 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 all below the detectable limit and are therefore well below the LTV.

Table 4-3. 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)	Janamba wastewater quality
As	0.1	2.0	<0.001
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

4.3.5 Mineral salts and specific ions

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

Table 4-4. 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*
28	15	23	2	2	35	175

Note: Location is in lagoon after 1st settling pond

4.3.6 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.

4.3.7 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 off-limits to the public, therefore any pathogens in the wastewater are not expected to cause any harm to human receptors. Irrigation application is to be managed appropriately to avoid potentially harmful runoff.

5 MODELLING OF THE EFFLUENT REUSE SYSTEM

The Model for Effluent Disposal using Land Irrigation (MEDLI) is a program for designing effluent reuse schemes. The model addresses many factors impacting on effluent irrigation, such as the quality and quantity of effluent, climate, storage, irrigation frequency and amount, nitrogen, phosphorus and salt components and plant growth. The MEDLI program was used on the Janamba wastewater to assess the viability of irrigation as a method of wastewater management.

5.1 Model input data

The quantity of effluent and current quality outlined in the sections above was used in the MEDLI assessment. A 100-year climate file for the Middle Point Rangers station was obtained from the SILO database (a climate database managed by the Queensland Department of Environment and Science) to input rainfall and evaporation data. Whilst 100 years of data is available, the model was run from 1950 to 2019, to account for recent impacts of climate change that may affect the model outputs.

The MEDLI program operates on the assumption that effluent is managed through tanks or ponds prior to disposal or reuse. The wastewater from the current treatment plant is directed into the breeding lagoons through a series of interconnected ponds. The lagoons are all interconnected and inhabit breeding crocodiles and therefore they are not specifically effluent storage ponds however do provide some storage benefit. For the purpose of modelling, the estimated dimensions of the small lagoon where the irrigation water is sourced were used for the storage pond component.

The default MEDLI soil type, *red earth* was used in the model, as the default parameters are representative of the soil type identified at Janamba in both the sandalwood and proposed irrigation areas (as discussed in Sections 2.3 and 2.4). Site soil samples also contained concentrations of organic nitrogen in the organic layer, similar to the default values for *red earth* in MEDLI.

5.1.1 Sandalwood plantation

Without an understanding on the growth parameters of sandalwood, the default values for banana pastures were used to model the current sandalwood plantation.

As sandalwood is a rather unique crop, there are no existing input parameters to use as a guide, hence why the banana pasture was selected. If the model is re-run using the monthly green cover model using a forest with 70% cover scenario, the annual irrigation volume increases whilst deep drainage decreases from that of the banana pasture model. If the model is re-run using the crop model using a cotton crop scenario, the same outcome is achieved (i.e. increased irrigation and decreased deep drainage). The nutrient balance also indicated an increased nitrogen uptake with less leaching than the banana model. These output files have been included in Appendix C for reference.

Therefore whilst the banana pasture model is not necessarily representative of the sandalwood performance, it is considered a conservative alternative in terms of modelling irrigation performance. The MEDLI outcomes are used to provide a guide, however ongoing monitoring of the irrigation system will determine the irrigation performance and detect any potential environmental impacts.

The irrigation method modelled was a fixed sprinkler system over an irrigation area of 10 ha, with irrigation triggered when the soil water deficit reaches the drained upper limit (DUL). The irrigation was applied at a rate to return the soil water to 100% of the DUL each day, with an irrigation override (i.e. no irrigation) on days where rainfall exceeds 5 mm.

5.1.2 Proposed crop irrigation area

The default planting parameters for Forage Sorghum Crop were used in the model as they are representative of the crop selection for the proposed new irrigation area. The default crop also has a maximum crop coefficient of 0.8, and according to the NT *Guidelines for Land Capability Assessment for On-site Wastewater Management* (DOH, 2014), 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.

The irrigation method modelled was a centre pivot system over an irrigation area of 4.85 ha, with irrigation triggered when the soil water deficit reaches the DUL. The irrigation was applied at a rate to return the soil water to 100% of the DUL each day, with an irrigation override (i.e. no irrigation) on days where rainfall exceeds 5 mm.

A “dry-run” was also modelled for both irrigation areas, where the irrigation inputs were removed, in order to determine the natural conditions and deep drainage rates for the area without any irrigation inputs.

5.2 Modelling results

The results of the water and nutrient balances modelled by MEDLI are outlined in Table 5-1 and Table 5-2 respectively. The full MEDLI report is included in Appendix C.

Table 5-1. Water balance

	Unit	Sandalwood Irrigation	Sandalwood Dry-run	Crop Irrigation	Crop Dry-run
Rain	mm/year	1481.07	1481.07	1481.07	1481.07
Irrigation	mm/year	999.92	0	1337.53	0
Soil evaporation	mm/year	504.88	563.21	913.15	416.38
Transpiration	mm/year	913.93	103.52	972.69	362.32
Rain runoff	mm/year	27.62	97.31	56.49	63.94
Irrigation runoff	mm/year	0	0	0	0
Deep drainage	mm/year	1034.50	717.19	876.15	639.46

Table 5-2. Nutrient balance

	Unit	Sandalwood N balance	Sandalwood P balance	Crop N balance	Crop P balance
Irrigation (effluent load added)	kg/ha/year	58.28	20.43	77.50	27.33
Denitrification	kg/ha/year	0.003	-	0.01	-
Irrigation runoff	kg/ha/year	0	0	0	0
Plant uptake	kg/ha/year	85.57	17.61	110.88	23.55
Leached	kg/ha/year	2.47	0.05	1.66	0.05

5.2.1 Sandalwood plantation

Based on the modelled water capacity of the soils in the sandalwood plantation, approximately 1000 mm, or 100 ML, of wastewater can be irrigated annually. Due to the sandy nature and high permeability of the soils, this volume of irrigation does result in an increase in deep drainage of approximately 300 mm/year. This is considered to be on the upper limit of acceptable deep drainage increase, therefore volumes of wastewater irrigated need to be monitored in conjunction with rainfall.

The plant uptake of nitrogen is much higher than the nitrogen effluent load added which means the nitrogen concentration of the wastewater is acceptable. Based on the model inputs, the results show a small quantity of nitrate leaching at a concentration of less than 0.24 mg/L. Whilst these levels meet the performance criteria for assessment of MEDLI outputs, potential impacts of nitrogen leaching will need to be appropriately monitored through the sites groundwater monitoring program. Leaching of nutrients has a direct correlation with deep drainage rates.

The plant uptake of phosphorus is lower than the effluent load added, however unlike nitrogen, phosphorus can be managed through natural processes in the soil. Based on the negligible leaching of phosphorus, the modelling indicates that the p-sorption capacity of the soil is sufficient to manage the effluent load.

5.2.2 Proposed crop irrigation area

Based on the modelled water capacity of the soils in the proposed crop irrigation area, approximately 1300 mm, or 65 ML, of wastewater can be irrigated annually. The irrigation will not generate any run-off and whilst the activity increases the natural deep drainage rate of the soils, the increase is approximately 200 mm/year due to the sandy nature of the soils. The nutrient uptake by the plants is higher than the nutrient load added during irrigation, and can therefore manage the effluent quality. The leaching of nutrients is due to the high deep drainage rates, however the concentrations are considered low (0.19 mg/L of nitrate) and within the acceptable performance criteria for MEDLI assessment.

5.3 Limitations

Whilst MEDLI is recognised as a useful tool for modelling irrigation of effluent, it still has many limitations and it is difficult to model the actual scenario at Janamba. Whilst it is understood that 585 ML of wastewater is generated annually, this wastewater is pumped into a series of breeding lagoons and ponds prior to reaching the final lagoon for irrigation. During this process it is subject to evaporation outputs and rainfall inputs that are difficult to simulate in the model.

The model was set to prevent irrigation on days where rainfall exceeds 5 mm which results in prevention of irrigation approximately 25% of the year. In reality however, with high evaporation rates, irrigation may still occur on days that experience minor rainfall events provided the conditions in this IMP are adhered too.

Whilst the two nominated irrigation areas can handle the quality of the irrigated wastewater to the soil water capacity, the volume of wastewater generated annually by Janamba is higher than what the combined irrigation areas can manage. Based on the assumptions included in the model, a total 585 ML of wastewater is generated annually, whilst only 165 ML can be irrigated. Additional scenario modelling was undertaken to assess the potential storage and irrigation area combinations required to ensure appropriate wastewater management at Janamba (at least 95% of effluent irrigated). A summary of this additional modelling is detailed in Table 5-3.

Table 5-3. Scenario modelling of irrigation using MEDLI

Storage volume (ML)	Irrigation area (ha)	Effluent irrigation (%)
20	100	96
30	70	95
30	80	96
40	60	95
40	70	96
50	60	96
60	50	95

Janamba recognise that additional land is required for irrigation in order to make this a viable option for wastewater disposal. However as highlighted in their application for an Environmental Protection Licence (EPL), Janamba wish to irrigate over the current nominated area as a trial to determine the viability of the activity prior to purchasing additional land and expanding the system. The trial will also allow for additional monitoring and gathering of real-time data to better inform the model.

6 SALINITY AND SODICITY ASSESSMENT

6.1 Effect on salinity of soils

Salinity is the term for the presence of soluble salts in soils or water. Salinity is a land-use issue when the concentrations of salt adversely affect plant growth, therefore salt content can affect the ability to reuse water for irrigation.

In order to assess the suitability of a water sources and soil for irrigation the following need to be considered;

- The quality of the irrigation water.
- Characteristics of the soil being irrigated.
- Salt tolerance of the crop to be grown.

EC is a measure of the total soluble salts in water. Some general irrigation electrical conductivity (ECi) ratings for wastewater are shown in Table 6-1. The current average ECi of the Janamba wastewater to be used for irrigation is 0.4 dS/m, which is considered low for irrigation according to ANZECC (2000).

Table 6-1. 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

6.2 Effect on sodicity of soils

Sodicity is a term for the high concentrations of sodium ions relative to other cations in the exchangeable and / or soluble form in soil or water. 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 results of sampling identified that the exchange sodium percentage (ESP) was less than 4%.

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

Irrigation water with a high sodium concentration can result in the degradation of soil structure. The potential for excess sodium effecting soils is commonly assessed using sodium adsorption ratio (SAR). The SAR is used to calculate the projected potential of sodium accumulation in soil, which is the end product of continual use of sodic water.

The SAR in the Janamba wastewater for irrigation was identified to be 0.84 which is not considered an issue, as outlined in Table 6-2.

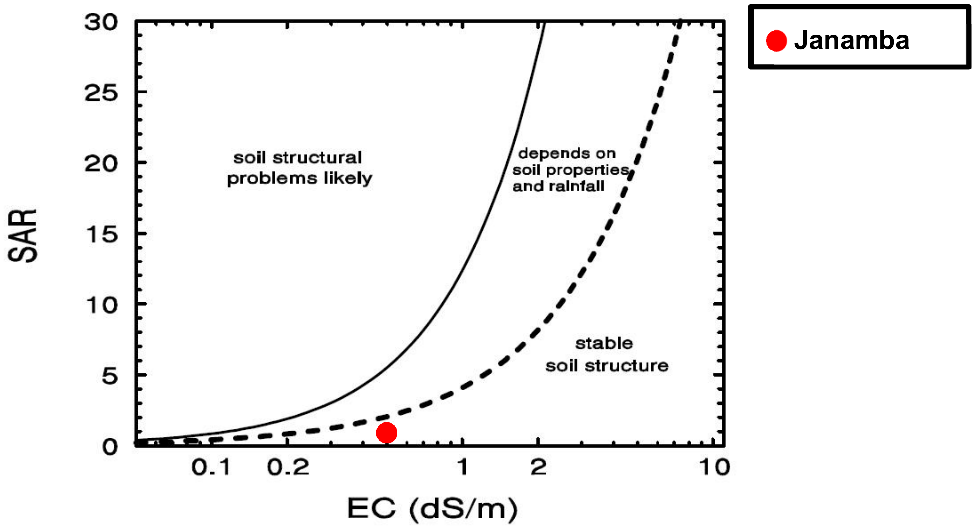
Table 6-2. Sodicity classes for irrigation water (Mills 2001)

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

6.3 Relationship between salinity and sodicity

Based on the low salinity rating of the proposed irrigation site soil and the low SAR of the irrigation water, it is not expected that the irrigation will have an impact on the soil structure. When plotted on the EC/SAR relationship graph detailed in the ANZECC 2000 guidelines, the levels fall within the "stable soil structure category (Figure 6-1).

Figure 6-1. Relationship between SAR and EC for irrigation water for prediction of soil structure stability



Based on the relationship between SAR and EC for irrigation water being within the stable soil structure region and the water quality being of very low EC, salinity is not expected to be an issue for irrigation and salinity modelling is not required in this case.

7 IRRIGATION AND CROP MANAGEMENT

7.1 Irrigation infrastructure

7.1.1 Drip irrigation lines

The sandalwood plantation covers an area of 9.42 ha and is irrigated by an in-line drip irrigation system specified in Table 7-1. The system extracts water from the Lagoon ponds through a Netafim arkal pump system comprised of three 130µn filter units and an automatic cleaning and backflush system.

Table 7-1. Sandalwood irrigation system specifications

Aspect	Units	
Rows/Beds spacing	m	3.60
Plant spacing	m	2.75
Emitter type	-	Uniram AS 23010
Minimum emitter pressure	m	10.00
Emitter discharge	L/hr	1.60
Emitter spacing	m	0.5
Laterals average spacing	m	3.60
No. of laterals per bed	No.	1
No. of laterals in total	No.	209
Flow rates	m3/hr	30 – 40
Required pressure	m	13 – 14
Application rate	mm/hr	0.89
Maximum daily application	mm/day	7.00

7.1.2 Pierce centre pivot system

The Pierce C600 centre pivot system has been selected to be used as the irrigation mechanism for wastewater disposal over the proposed crop irrigation area. The system is a self-propelled system that rotates around a fixed central point. The system is a remote irrigation management product that uses GSM technology is monitor and manage the irrigation system. The technology allows for remote access to the current end pressure, speed percentage, angle, endgun, total hours running and total hours with water. This system will be fitted with a Zenner Flanged meter attached to the water extraction pump and is for loaded water, i.e. agriculture, wastewater treatment plants or sewage works. The meter enables readings to be recorded with each extraction.

The benefits of using a centre pivot system are:

- Irrigation water is applied gently to reduce the risk of puddling or surface runoff.
- Water coverage is evenly distributed over the irrigation area selected.
- The system continuously moves over the crops.
- An alignment control valve is attached to stop irrigation if the system faults, with a sensor shutting down the water at the same time.

The pivot system has a total length of 124m and can achieve a 4.85 ha irrigation (or a 129m wetted radius) without being moved. The control panel features forward and reverse controls, variable application rates, GPS monitoring and the ability to stop in a set position as well as an SMS alert system. The sprinkler system is comprised of nylon goosenecks, flexible drops, 10spi regulators and I-Wob sprinklers. The pivot system will rest on a heavy duty concrete pivot pad.

Irrigation will commence at a rate of 5mm/day as calculated by the site water balance and as recommended by the Australian Standard for *On-site domestic wastewater management* (AS/NZS 1547:2012) for drip or spray irrigation. The irrigation rate will be monitored alongside soil moisture levels to ensure appropriate application rates to avoid runoff.

The irrigation areas and associated infrastructure are outlined on Figure 7-1.

7.2 Irrigation management

Janamba recognise the importance of finding a solution to wastewater management and preventing discharge of untreated wastewater offsite which has the potential to impact the receiving environment. Sustainable wastewater management involves the selection of suitable irrigation infrastructure to the water and nutrient requirements of the crops, while also preventing oversaturation resulting in uncontrolled run off, damaging of the soil and unsustainable crops.

A procedure regarding monitoring and the reuse of wastewater via land irrigation has been developed to ensure the activities are managed appropriately (see Appendix D).

7.2.1 Runoff control

Janamba will control and manage runoff of effluent by:

- Using a spray/drip irrigation system, that applies the irrigation water at a low rate.
- Apply the effluent water over an area large enough to absorb the capacity of water.
- Daily visual inspections of irrigation area for evidence of potential runoff (also mist/overspray and odour).
- Only apply effluent at the rate identified applicable to each season (i.e. dry season and wet season).
- Buffer zone of 50m around the irrigation area, to prevent impact on sensitive receptors and neighbouring properties.

During the wet season (November to April) rainfall in the area increases, resulting in the soils becoming saturated and the wastewater no longer can infiltrate at the same rate as the dry season, leading to runoff. Irrigation will not be undertaken during rain events and will only recommence once soil moisture conditions allow as per the procedures in Appendix D.

7.3 Crop management

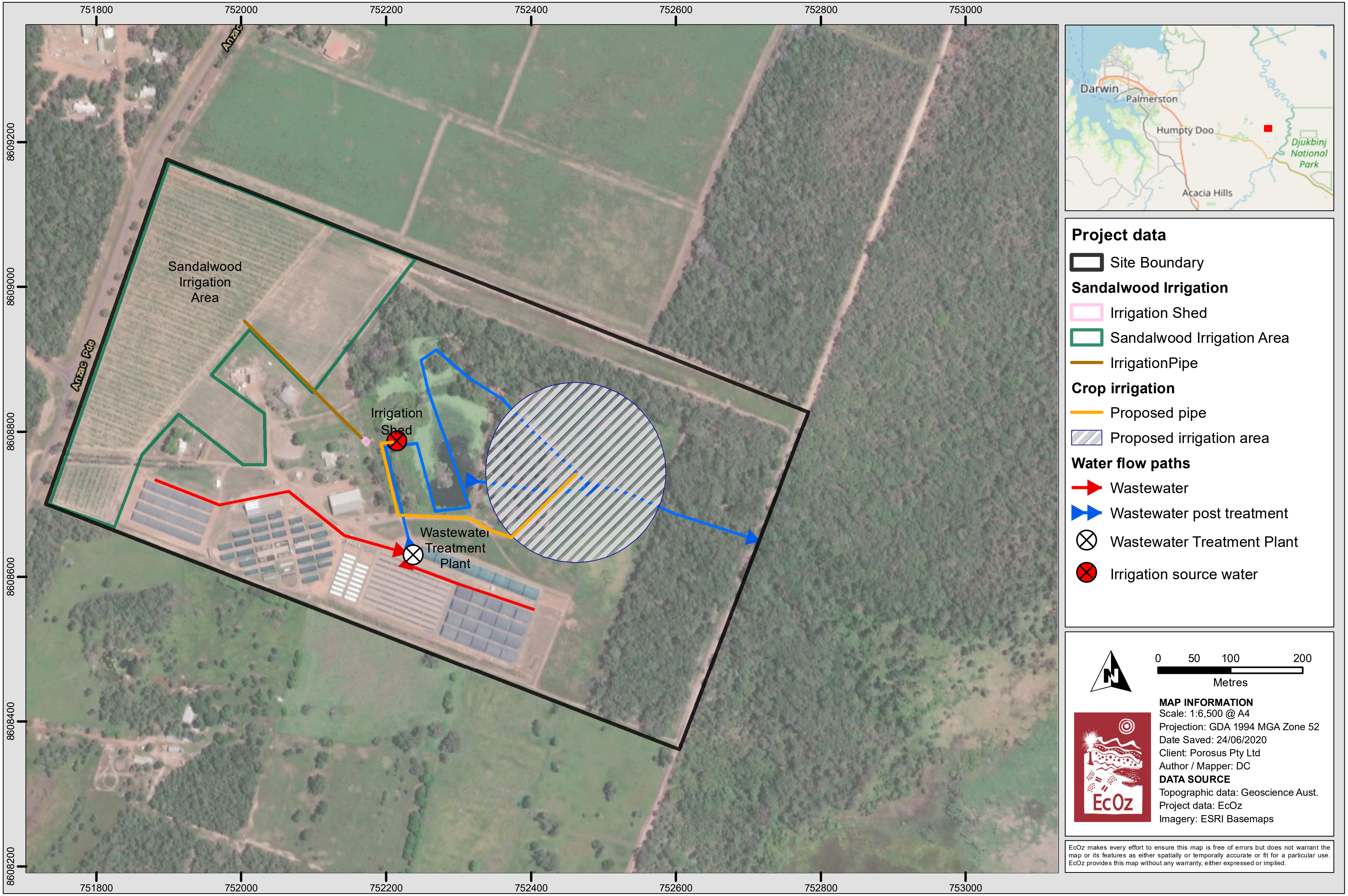
Both irrigation areas are to be managed by a third party local crop farmer, who will be responsible for the harvesting when required. The crops proposed to be trialled in the eastern irrigation area are *Urochloa humidicola* (Tully), *Chamaecrista rotundifolia* (Wynn round leaf cassia) and grain sorghum. The western irrigation area is an established sandalwood plantation. The crops will be inspected regularly to monitor their growth as well as plant health to determine any visual impacts of nutrient supply.

Tully grass is a strong creeping perennial, and is suitable for areas receiving more than 1000 mm average annual rainfall. Tully grass is tolerant of poor drainage and its vigorous and dense habit of growing makes it difficult for weeds to grow with it (Cameron, 2013).

Wynn round leaf cassia is a short-lived herbaceous perennial legume, which grows to a height of between 60 to 70 cm. Wynn has grown well in the Northern Territory (including red earth areas around Humpty Doo) and has persisted in northern areas with over 900 mm average rainfall. It is adapted to a wide range of soils, but is best suited to sandy-surfaced soils and can be susceptible to water-logging (Cameron, 2010).

Dryland grain sorghum has been consistently grown in the NT over the last few decades to supply the local stockfeed market. Dryland grain sorghum can be grown in regions where the average wet season rainfall is between 700 mm to 1,400 mm. Most sorghum production has been on red earth soils, which vary from clay loams to loamy sands (Hausler et.al., 2002).

Crops will be harvested regularly to encourage growth and nutrient uptake and will then be processed for stockfeed.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19095 - Janamba Croc Farm EPL\01 Project Files\Figure X-X. Irrigation areas and infrastructure.mxd

Figure 7-1. Irrigation areas and infrastructure

8 MONITORING AND REPORTING

8.1 Daily monitoring

Monitoring of the irrigation area will be undertaken as per the procedures included in Appendix D.

Irrigation activities will only be conducted during work hours when the system can be monitored at all times.

8.2 Compliance water and soil monitoring

The EPL application for this project has been submitted to the NT EPA, therefore monitoring and reporting for irrigation activities will be conducted in accordance with the EPL application. Water sampling includes the sampling of groundwater, surface water and wastewater to be irrigated, and soil sampling is a standardised regime aligned with the NSW Guideline *Use of Effluent by Irrigation* (DEC 2004).

8.3 Monitoring procedure

All sampling and handling of samples are 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.

8.3.1 Monitoring parameters and frequencies

Figure 8-1 outlines the locations of the where irrigation water, surface water, groundwater and soil monitoring is be conducted on-site. As there are no defined watercourses flowing onto the site (representing background/reference) or receiving water from the site, surface water monitoring on-site is for a reference only to compare quality of site water throughout the year. One monitoring point will be established at the site boundary, representing the quality of surface water leaving the site during the irrigation trial period. Two off-site monitoring points will also be established to provide reference data for runoff water quality from surrounding properties to assist in the assessment (see Figure 8-2). Once the wastewater management system is fully operational, there should not be any discharge of water off-site, and the monitoring point can cease. In the interim, all practical measure to minimise wastewater leaving the site will be undertaken.

The monitoring parameters, location, frequencies and guideline values for the irrigation water are outlined in Table 8-1. 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. The adopted guidelines values will be used to assess the suitability of the water for irrigation and whether or not loading rates need to be adjusted to appropriately manage nutrient uptake.

Table 8-1. Monitoring program and trigger values for irrigation water

Monitoring site	Parameter	Sampling frequency	Trigger value
Irrigation source water -12.57475, 131.32108	pH	Monthly when discharging and quarterly when not discharging	6 – 9
	EC		1,300 µs/cm
	Total P		12 mg/L
	Total N		125 mg/L
	Cations and anions		1,000 cfu/100mL (fodder)
	E.coli, *Enterococci*, Total coliforms		N/A

Soil

The monitoring parameters and frequencies of sampling for soil in the irrigation area are outlined in Table 8-2. Soil sampling locations are based on the initial sampling undertaken to establish baseline conditions. The guideline values will be used to assess any impacts on the soil as a result of irrigation activities.

Table 8-2. Monitoring program, frequencies and guideline values for soil

Monitoring sites	Parameter	Sampling frequency	Trigger value
SS1, SS2, SS4, SS6, SS8, SS9 and SS10	pH	Annually	6 – 8
	EC		Any increase from the previous monitoring round
	Total P		
	Total N		
	E.coli, *Enterococci*, Total coliforms		

Surface water

Surface water monitored on-site is for reference only to compare quality of site water throughout the year. Establishment of receiving environment monitoring points is difficult due to the nature of Harrison Dam (areas of sheet flow, pools, and fluctuating dam water levels and water quality, rather than a defined watercourse). Water quality naturally fluctuates significantly in the lagoons and wetlands of the Darwin region due to seasonal changes. Additionally, there is no reference point or upstream monitoring point which would provide reliable data for comparison to impacted/downstream monitoring sites. One monitoring point will be established at the site boundary, which will represent water quality leaving the site during the irritation trial period. Two off-site monitoring points will also be established to provide reference data for runoff water quality from surrounding properties to assist in the assessment

The monitoring frequencies and parameters of sampling for surface waters are outlined in Table 8-3.

Table 8-3. Monitoring program for surface water sites

Monitoring sites	Parameter	Sampling frequency	Trigger value
Property outlet, SW1* & SW2*	pH	3 times during the wet season (start, during, end)	6.0 – 7.5
	EC		200 µs/cm
	Total P		0.01 mg/L
	Total N		0.23 mg/L
	E.coli, *Enterococci*, Total coliforms		Any increase from previous monitoring round

**Trigger values not applicable for SW1 & SW2*

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. Where there are significant increases in the parameters measured, further assessment will be undertaken to determine potential sources of contamination. The monitoring program, frequencies and trigger levels of sampling for groundwater are outlined in Table 8-4.

Table 8-4. Monitoring program and trigger values groundwater sites

Monitoring sites	Parameter	Sampling frequency	Trigger value
Bore 1, Bore 2 and Bore 3	Standing water level (SWL)	Monthly	N/A
	pH	Quarterly	7.0 – 8.5
	EC		400 µs/cm
	Total P		Any increase from previous monitoring round
	Total N		
	E.coli, *Enterococci*, Total coliforms		
	Cations and anions		N/A

8.4 Assessment of performance indicators

Annual nutrient balance calculations should be undertaken and compared with the soil monitoring results to assess the sustainability of the wastewater irrigation system. If the wastewater is managed so that the nitrogen and phosphorous input and output levels remain consistent, the overall soil nutrient concentrations should remain consistent.

The key parameters of soil should be graphed and compared annually, to identify any nutrient application issues or irrigation practices that may need to be altered.

Key parameters:

- Soil nitrogen
- Available phosphorus
- Salinity
- Sodicity

8.5 Reporting

All routine wastewater and soil monitoring data along with incident/investigation monitoring data will be recorded in a water and soil quality database, and to be available upon request to the NT EPA.

8.5.1 Internal reporting

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 (all streams) and energy use across the farm.

8.5.2 External reporting

All non-compliances of the EPL will be reported by Janamba by completing a Non-Conformance Notification via the NT EPA website as soon as practicable after becoming aware of the non-conformance (and within 24 hours of the event), as per Section 14 of the *Waste Management and Pollution Control Act 1998 (NT)*.

Reporting will be undertaken in accordance with the EPL, but it is assumed that an annual report will be submitted to the NT EPA on the anniversary data of the EPL which summaries the activities and outcomes of the previous 12 months of operation. Additionally, a monitoring report will be prepared and submitted in conjunction with the Annual report, which will include a trend analysis of the water quality monitoring data and an assessment of any environmental impacts from the Janamba operations.

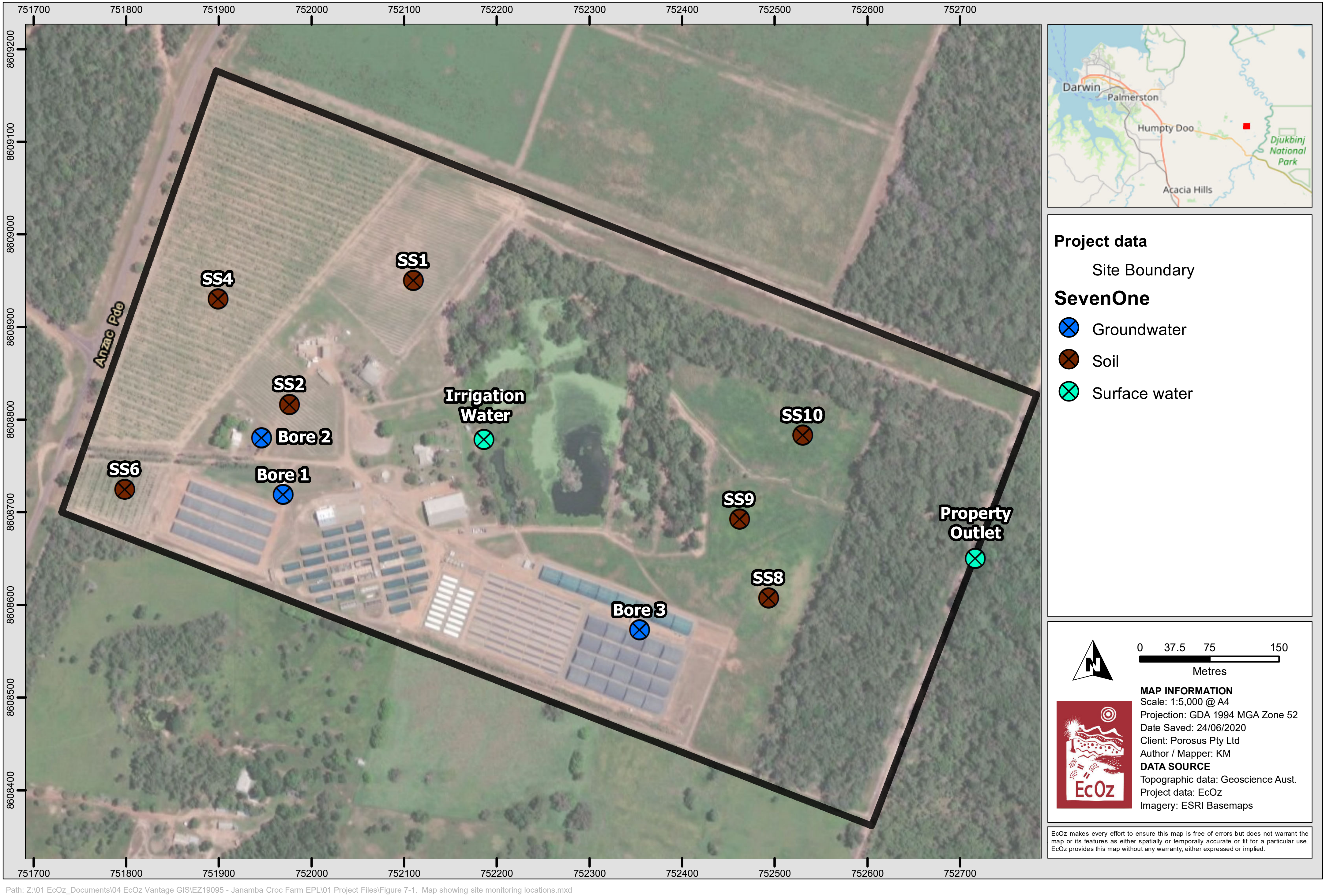
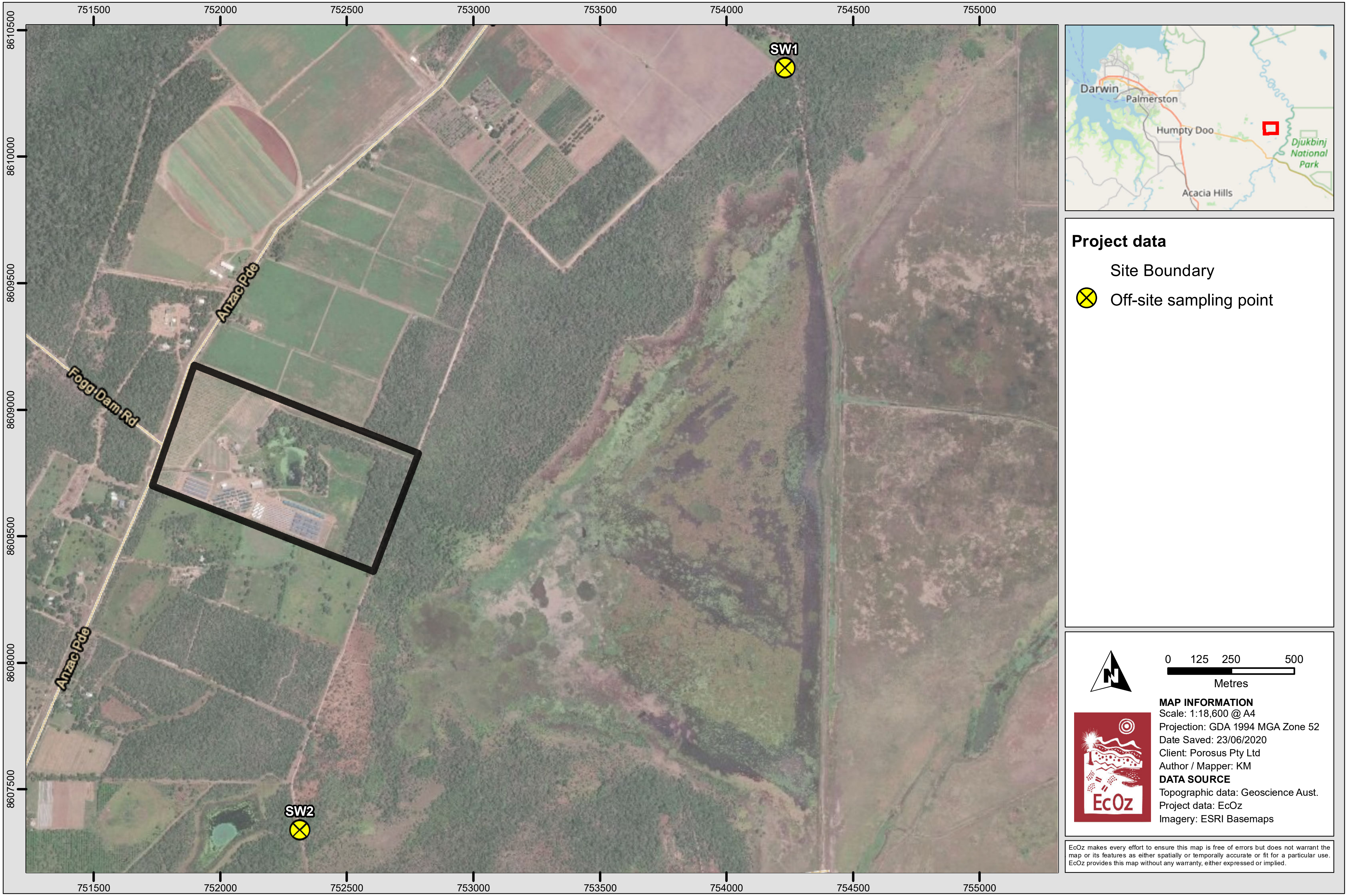


Figure 8-1. Map showing site monitoring locations



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19095 - Janamba Croc Farm EPL\01 Project Files\Figure X-X. Map showing outer sampling sites.mxd

Figure 8-2. Map showing off-site monitoring locations

9 SUMMARY AND RECOMMENDATIONS

The nutrient loading of the wastewater generated at Janamba is considered low level and suitable for irrigation over the nominated irrigation area. The main issue impacting irrigation as a wastewater management method, is the large volumes of wastewater generated annually. It is acknowledged that the current 15 ha irrigation area is insufficient for the complete management of current wastewater volumes. However, provided the scheduled irrigation trial is successful, it can be expanded into neighbouring areas.

It is recommended that the wastewater overflows from the breeding lagoon be monitored in order to calculate the estimated volumes of wastewater to be managed. This will allow for the appropriate irrigation area to be determined and modelled prior to expansion of the current system and this IMP will be updated accordingly.

10 REFERENCES

Australian and New Zealand Environment and Conservation Council (ANZECC) (2000), Australian and New Zealand Guidelines for fresh and marine water quality, Volume 3, Primary industries – rationale and background information, Agriculture and Resource Management Council of Australia and New Zealand.

Cameron A.G. (2010). *Agnote No. E21: Wynn Round Leaf Cassia.* Department of Primary Industry, Fisheries and Mines, Northern Territory Government.

Cameron A.G. (2013). *Agnote No. E31: Tully.* Department of Primary Industry, Fisheries and Mines, Northern Territory Government.

Department of Environment Conservation (DEC) (2004), *Use of Effluent by Irrigation; Environmental Guidelines*, Department of Environment and Conservation (DEC), New South Wales Government, Sydney.

Department of Land Resource Management (LRM), *Soils of the Northern Territory factsheet*, LRM, Northern Territory Government, Darwin.

Hausler P., O'Gara F. and Price T. (2002) *Agnote No. C32: Growing Grain Sorghum in the Northern Territory.* Department of Primary Industry, Fisheries and Mines, Northern Territory Government.

Jessop P.J. and King, D. (1997). *The Land Resources of New Crown Station*, NTG Technical Report No. TM96/18.

Mills, B (2001), *DPI&F Notes: Interpreting water analysis for crop and pasture* (revised 2004), The State of Queensland Department of Primary Industry and Fisheries.

APPENDIX A SOIL SAMPLING RESULTS

Site ID	Date	Field Notes													Emerson Aggregate Test			Particle Sizing						
		Horizon	Depth Range(m)	Texture	Structure	Colour	Course Fragments size and %	Moisture Condition	Surface Gravel Cover	Rock Cover	pH	Sodium Absorptio	Conductivity	Moisture Content	Colour	Texture	Class Number	+75Âµm	+150Âµm	+300Âµm	+425Âµm	+600Âµm	+1180Âµm	+2.36mm
														%			EC/TC	%	%	%	%	%	%	%
											0.1	0.01	1	0.1				1	1	1	1	1	1	1
Objectives																								
Soil Sample 1 - Suface	05-7-2019	1	0m	Loamy Sand	G and W3	Grey Orange	10% @ 2 - 10mm	Dry	< 1% @ 2 - 6mm	0%	-	0.52	-	-	-	-	-	68	54	31	16	7	<1	<1
Soil Sample 1 - 0-0.4 m	05-7-2019	2	0.5m	Loam	W4	Orange	20% @ 2 - 20mm	Slightly Moist	< 1% @ 2 - 6mm	0%	8	0.47	32	4	wn (7.5YR	Sand	8	-	-	-	-	-	-	-
Soil Sample 1 - 0.4-1 m	05-7-2019	2	1.0m	Sandy Clay Loam	W4	Orange	20% @ 5 - 20mm	Moist	< 1% @ 2 - 6mm	0%	5.8	-	15	14.2	-	-	-	-	-	-	-	-	-	-
Soil Sample 2 - Surface	05-7-2019	1	0m	Sandy Loam	W3	Grey	15% @ 5 - 35mm	Dry	15%	15%	-	0.45	-	-	-	-	-	72	57	34	19	8	2	<1
Soil Sample 2 - 0-0.4 m	05-7-2019	2	0.5m	Silty Loam	W2	Yellow Grey	25% @ 5- 50mm	Dry	15%	15%	5.6	1.5	14	6.4	Brown (10Y	ledium Cla	4	-	-	-	-	-	-	-
Soil Sample 2 - 0.4-1 m	05-7-2019	2	1.0m	Silty Loam	W5	Yellow Grey	30% @ 5 - 50mm	Dry	15%	15%	5.5	1.73	14	7.6	-	-	-	-	-	-	-	-	-	-
Soil Sample 3 - Surface	05-7-2019	1	0m	Clay Loam	W3	Brown	25% @ 5 - 35mm	Very Slightly Moist	20% @ 4 - 10mm	1% @ 40 - 150mm	-	0.7	-	-	-	-	-	69	55	33	20	11	6	4
Soil Sample 3 - 0-0.4	05-7-2019	2	0.5m	Clay Loam	W4	Red Brown	25% @ 5- 55mm	Moist	20% @ 4 - 10mm	20% @ 4 - 150mm	5.5	0.45	41	8	wn (7.5YR	y Loam Sar	4	-	-	-	-	-	-	-
Soil Sample 3 - 0.4-1	05-7-2019	2	1.0m	Clay Loam	W4	Red Brown	55% @ 5 - 10mm	Moist	20% @ 4 - 10mm	20% @ 4 - 150mm	5.4	0.75	28	9.9	-	-	-	-	-	-	-	-	-	-
Soil Sample 4 - Surface	05-7-2019	1	0m	Sandy Loam	W2	Yellow Grey	20% @ 5 - 15mm	Dry	<1%	<1%	-	0.7	-	-	-	-	-	76	59	30	15	6	<1	<1
Soil Sample 4 - 0-0.4 m	05-7-2019	2	0.5m	Sandy Loam	W5	Red Brown	30% @ 5 - 50mm	Moist	<1%	<1%	5.4	0.7	26	11.2	wn (7.5YR	y Loam Sar	4	-	-	-	-	-	-	-
Soil Sample 4 - 0.4-1m	05-7-2019	3	1.0m	Sandy Loam	W5	Orange	25% @ 5 - 30mm	Moist	<1%	<1%	5	0.34	53	12	-	-	-	-	-	-	-	-	-	-
Soi Sample 5 - Surface	05-7-2019	1	0m	Sandy Loam	W3	Red Brown	20% @ 2 - 25mm	Dry	<1%	<1%	-	0.43	-	-	-	-	-	65	50	28	16	6	1	<1
Soil Sample 5 - 0-0.4 m	05-7-2019	2	0.5m	Sandy Loam	W5	Orange	20% @ 10 - 50mm	Moist	<1%	<1%	5.8	0.32	17	10.2	wn (7.5YR	ledium Cla	4	-	-	-	-	-	-	-
Soil Sample 5 - 0.4-1 m	05-7-2019	2	1.0m	Silty Clay	W5	Orange	20% @ 10 - 45mm	Moist	<1%	<1%	5.3	0.44	24	12	-	-	-	-	-	-	-	-	-	-
Soil Sample 6 - Surface	05-7-2019	1	0m	Sand	G	Grey	5% @ 5 - 15mm	Moist	5%	1%	-	0.38	-	-	-	-	-	81	65	37	20	8	2	2
Soil Sample 6 - 0-0.4 m	05-7-2019	2	0.5m	Silty Clay	M5	Brown Yellow	35% @ 15 - 30mm	Moist	5%	1%	5.6	0.27	21	10.6	wn (10YR	ledium Cla	4	-	-	-	-	-	-	-
Soil Sample 6 - 0.4-1 m	05-7-2019	3	1.0m	Silty Clay	W3	Yellow	15% @ 5 - 20mm	Moist	5%	1%	5.6	0.26	16	10.4	-	-	-	-	-	-	-	-	-	-
Soil Sample 7 - Suface	05-7-2019	1	0m	Sandy Loam	W1	Grey	5% @ 2 - 10mm	Dry	<5%	<1%	-	0.38	-	-	-	-	-	79	63	38	26	19	15	13
Soil Sample 7 - 0-0.4 m	05-7-2019	2	0.5m	Sandy Loam	W1	Pale Grey	35% @ 2 - 20mm	Dry	15% @ 5 - 15mm	<1%	8	1.15	91	8.8	Gray (2.5Y	ledium Cla	3	-	-	-	-	-	-	-
Soil Sample 7 - 0.4-1 m	05-7-2019	3	1.0m	Sand	G	Red Grey	35% @ 5 - 15mm	Dry	10% @ 5 - 20mm	<1%	6	0.75	12	4.4	-	-	-	-	-	-	-	-	-	-
Soil Sample 8 - Surface	05-7-2019	1	0m	Silty Loam	W1	Grey	5% @ 5 - 20mm	Dry	<1%	<1%	-	0.36	-	-	-	-	-	77	62	37	22	12	4	<1
Soil Sample 8 - 0-0.4 m	05-7-2019	2	0.5m	Sandy Clay	W5	Yellow Brown	15% @ 5 - 50mm	Slightly Moist	<1%	<1%	6.4	0.55	19	7.2	h Brown (1	ledium Cla	4	-	-	-	-	-	-	-
Soil Sample 8 - 0.4-1 m	05-7-2019	2	1.0m	Silty Clay	W6	Yellow Brown	20% @ 5 - 50mm	Slightly Moist	<1%	<1%	5.9	0.74	21	10	-	-	-	-	-	-	-	-	-	-
Soil Sample 9 - Surface	05-7-2019	1	0m	Sandy Loam	W5	Dark Grey	15% @ 5 - 20mm	Dry	<1%	<1%	-	0.36	-	-	-	-	-	76	60	37	24	14	6	3
Soil Sample 9 - 0-0.4	05-7-2019	2	0.5m	Silty Clay	W4	Dark Grey Brown	20% @ 5 - 50mm	Slightly Moist	<1%	<1%	8.1	0.76	136	9.3	ay (10YR 5/	Sandy Clay	3	-	-	-	-	-	-	-
Soil Sample 9 - 0.4-1	05-7-2019	3	1.0m	Clay	M3	Dark Brown Orange Yelllow	5% @ 3 - 5mm	Moist	<1%	<1%	8	1.99	149	12	-	-	-	-	-	-	-	-	-	-
Soil Sample 10 - Surface	05-7-2019	1	0m	Sandy Loam	W5	Brown	5% @ 5 - 20mm	Dry	<1%	<1%	-	0.97	-	-	-	-	-	78	67	44	28	16	7	4
Soil Sample 10 - 0-0.4 m	05-7-2019	1	0.5m	Sandy Loam	W5	Brown	5% @ 5 - 20mm	Moist	<1%	<1%	7	0.27	35	8.1	Brown (10	Sandy Clay	3	-	-	-	-	-	-	-
Soil Sample 10 - 0.4-1m	05-7-2019	2	1.0m	Sandy Loam	M6	Yellow	0%	Moist	<1%	<1%	7.1	0.5	40	11.4	-	-	-	-	-	-	-	-	-	-
Soi Sample 11 - Surface	05-7-2019	1	0m	Sandy Loam	W3	Brown	10% @ 5- 15mm	Dry	<1%	<1%	-	1.24	-	-	-	-	-	78	64	41	25	13	4	2
Soil Sample 11 - 0-0.4 m	05-7-2019	2	0.5m	Sandy Clay	M5	Yellow Brown	10% @ 5- 15mm	Moist	<1%	<1%	7.1	0.32	35	7.4	Brown (10Y	Sandy Clay	3	-	-	-	-	-	-	-
Soil Sample 11 - 0.4-1 m	05-7-2019	2	1.0m	Clay	M7	Yellow Brown	10% @ 5- 15mm	Moist	<1%	<1%	7	0.43	26	11.9	-	-	-	-	-	-	-	-	-	-

Site ID	Date	Laboratory Results																												
							Soil Classification based on Particle Size					Exchangable Cations on Alkaline Soils						Exchangable Cations						Nitrate plus Nitrite as N(Nox) by discrete Analyser	Total Kjeldahl Nitrogen by Discrete Analyser	Total Nitrogen asN (TKN + Nox)	Total Phosphurous as P by Discrete Analyser	Phosphate Sorption Capacity		Organic Matter
		+4.75mm	+9.5mm	+19.0mm	+37.5mm	+75.0mm	Clay(<2 Âµm)	Silt (2-60 Âµm)	Sand (0.06 -	Gravel (>2mm)	Cobbles (>6cm)	Exchangable	Exchangable	Exchangable	Exchangable	Cation Exchange	Exchangable	Exchangable	Exchangable	Exchangable	Exchangable	Cation Exchange	Exchangable	Nitrate plus	Total Kjeldahl	Total Nitrogen	Total Phosphur	Phosphate	Phosphate	Organic Matter
		%	%	%	%	%	%	%	%	%	%	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	%	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	%	mg/kg	mg/kg	mg/kg	mg/kg	mg P sorbed/kg	mgkg-1/log10ugL-1	%
		1	1	1	1	1	1	1	1	1	1	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	20	20	2	250	1	0.5
Objectives																														
Soil Sample 1 - Suface	05-7-2019	<1	<1	<1	<1	<1	23	7	70	<1	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Soil Sample 1 - 0-0.4 m	05-7-2019	-	-	-	-	-	-	-	-	-	-	0.5	<0.2	<0.2	<0.2	0.5	<0.2	-	-	-	-	-	-	1.1	300	300	93	4180	17	<0.5
Soil Sample 1 - 0.4-1 m	05-7-2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.9	170	170	96	4950	107	-
Soil Sample 2 - Surface	05-7-2019	<1	<1	<1	<1	<1	17	10	72	1	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Soil Sample 2 - 0-0.4 m	05-7-2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.6	260	260	75	4660	71	<0.5
Soil Sample 2 - 0.4-1 m	05-7-2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.6	180	180	86	4540	84	-
Soil Sample 3 - Surface	05-7-2019	2	<1	<1	<1	<1	22	7	66	5	<1	-	-	-	-	-	-	2.2	1	0.1	<0.1	18.2	<0.1	-	-	-	-	-	-	-
Soil Sample 3 - 0-0.4	05-7-2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	320	330	110	4840	82	0.8
Soil Sample 3 - 0.4-1	05-7-2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.3	140	140	78	4580	35	-
Soil Sample 4 - Surface	05-7-2019	<1	<1	<1	<1	<1	16	6	78	<1	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Soil Sample 4 - 0-0.4 m	05-7-2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.6	370	370	104	4640	83	1.1
Soil Sample 4 - 0.4-1m	05-7-2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.6	180	190	78	2770	74	-
Soi Sample 5 - Surface	05-7-2019	<1	<1	<1	<1	<1	20	12	68	<1	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Soil Sample 5 - 0-0.4 m	05-7-2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.8	290	290	92	2480	78	0.9
Soil Sample 5 - 0.4-1 m	05-7-2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.7	160	170	90	2240	98	-
Soil Sample 6 - Surface	05-7-2019	<1	<1	<1	<1	<1	10	8	80	2	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Soil Sample 6 - 0-0.4 m	05-7-2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.9	380	380	102	2050	67	0.7
Soil Sample 6 - 0.4-1 m	05-7-2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.8	250	250	83	2000	97	-
Soil Sample 7 - Suface	05-7-2019	7	<1	<1	<1	<1	9	9	68	14	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Soil Sample 7 - 0-0.4 m	05-7-2019	-	-	-	-	-	-	-	-	-	-	2.7	1	<0.2	<0.2	3.9	<0.2	-	-	-	-	-	-	2.5	300	300	68	1650	27	1
Soil Sample 7 - 0.4-1 m	05-7-2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.9	190	190	62	1300	25	-
Soil Sample 8 - Surface	05-7-2019	<1	<1	<1	<1	<1	10	10	78	2	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Soil Sample 8 - 0-0.4 m	05-7-2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.9	200	200	65	2020	32	0.8
Soil Sample 8 - 0.4-1 m	05-7-2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.6	290	290	85	1960	76	-
Soil Sample 9 - Surface	05-7-2019	2	<1	<1	<1	<1	13	9	74	4	<1	3.1	0.8	0.3	<0.2	4.2	<0.2	-	-	-	-	-	-	-	-	-	-	-	-	-
Soil Sample 9 - 0-0.4	05-7-2019	-	-	-	-	-	-	-	-	-	-	3.1	1.1	<0.2	<0.2	4.4	<0.2	-	-	-	-	-	-	3.8	780	780	84	1540	21	1.6
Soil Sample 9 - 0.4-1	05-7-2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.8	920	920	115	1540	24	-
Soil Sample 10 - Surface	05-7-2019	3	<1	<1	<1	<1	10	10	75	5	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Soil Sample 10 - 0-0.4 m	05-7-2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.8	350	350	72	1460	18	0.9
Soil Sample 10 - 0.4-1m	05-7-2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.2	280	280	94	1560	33	-
Soi Sample 11 - Surface	05-7-2019	2	<1	<1	<1	<1	9	11	77	3	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Soil Sample 11 - 0-0.4 m	05-7-2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.7	240	240	81	1350	15	<0.5
Soil Sample 11 - 0.4-1 m	05-7-2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.8	210	210	100	1760	26	-

EcOz Environmental Consultants

APPENDIX B WATER QUALITY DATA

Janamba Crocodile Farm

Site ID	Date	Analyte	Field Parameters: pH	Temp	ORP	EC	TDS	Salinity	Dissolved Oxygen	Turbidity	pH	Dissolved oxygen DO	Total Suspended Solids TSS	Biological Oxygen Demand BOD	Free Ammonia NH3_F	Nitrite NO2-N	Nitrate NO3-N	Nitrogen Oxides NOX-N	Total Nitrogen TN	Reactive Phosphorus RP	Total Phosphorus TP
		Units		°C	mV	µS/cm	mg/L	ppt	%	NTU		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
		Limit of Reporting									2	0.1	5	1	0.3	0.1	0.1	0.1	0.4	0.1	0.1
Darwin Harbour Water Quality Objectives - Lagoons			**5.0-6.0**	**-**	**-**	**25**	**-**	**-**	**35-100**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0.55**	**0.005**	**0.02**
Bore 1	Jan-14	Bore Water									7.9	7	10	1	-	-	-	-	0.37	-	0.075
Bore 1	Feb-14	Bore Water	-	-	-	-	-	-	-	-	7.9	10	10	1	-	-	-	-	0.29	-	0.01
Bore 1	Mar-14	Bore Water	-	-	-	-	-	-	-	-	7.8	9	10	1	-	-	-	-	0.32	-	0.01
Bore 1	Apr-14	Bore Water	-	-	-	-	-	-	-	-	7.9	10	10	1	-	-	-	-	0.27	-	0.01
Bore 1	May-14	Bore Water	-	-	-	-	-	-	-	-	7.9	9	10	1	-	-	-	-	0.27	-	0.005
Bore 1	Jun-14	Bore Water	-	-	-	-	-	-	-	-	7.9	9	-	1	-	-	-	-	0.3	-	0.05
Bore 1	Jul-14	Bore Water	-	-	-	-	-	-	-	-	7.9	10	10	1	-	-	-	-	0.31	-	0.02
Bore 1	Aug-14	Bore Water	-	-	-	-	-	-	-	-	7.7	10	10	1	-	-	-	-	0.3	-	0.01
Bore 1	Sep-14	Bore Water	-	-	-	-	-	-	-	-	8	10	10	1	-	-	-	-	0.31	-	0.08
Bore 1	Nov-14	Bore Water	-	-	-	-	-	-	-	-	7.8	9	10	1	-	-	-	-	0.29	-	0.01
Bore 1	Dec-14	Bore Water	-	-	-	-	-	-	-	-	8	9	10	1	-	-	-	-	0.32	-	0.005
Bore 1	Jan-15	Bore Water	-	-	-	-	-	-	-	-	8.1	7	10	-	-	-	-	-	0.27	-	0.01
Bore 1	Mar-15	Bore Water	-	-	-	-	-	-	-	-	8	11	10	1	-	-	-	-	0.31	-	0.02
Bore 1	Apr-15	Bore Water	-	-	-	-	-	-	-	-	7.9	8	10	1	-	-	-	-	0.29	-	0.015
Bore 1	May-15	Bore Water	-	-	-	-	-	-	-	-	7.9	9	<10	1.2	-	-	-	-	0.31	-	<0.005
Bore 1	Jun-15	Bore Water	-	-	-	-	-	-	-	-	7.8	9	<10	<1	-	-	-	-	0.29	-	0.015
Bore 1	Jul-15	Bore Water	-	-	-	-	-	-	-	-	8.4	7	10	<1	-	-	-	-	0.3	-	0.01
Bore 1	Jan-16	Bore Water	-	-	-	-	-	-	-	-	8.4	9	<10	<1	-	-	-	-	0.33	-	0.01
Bore 1	Feb-16	Bore Water	-	-	-	-	-	-	-	-	8.4	9	30	<1	-	-	-	-	0.33	-	0.01
Bore 1	Mar-16	Bore Water	-	-	-	-	-	-	-	-	8	9	30	<1	-	-	-	-	0.32	-	0.01
Bore 1	Apr-16	Bore Water	-	-	-	-	-	-	-	-	7.8	8	<10	<1	-	-	-	-	0.32	-	<0.005
Bore 1	May-16	Bore Water	-	-	-	-	-	-	-	-	7.7	9	<10	1.6	-	-	-	-	0.29	-	0.015
Bore 1	Jun-16	Bore Water	-	-	-	-	-	-	-	-	7.7	8	<10	<1	-	-	-	-	0.29	-	0.01
Bore 1	Jul-16	Bore Water	-	-	-	-	-	-	-	-	7.9	8	<10	<1	-	-	-	-	0.31	-	0.02
Bore 1	Aug-16	Bore Water	-	-	-	-	-	-	-	-	7.9	8	<10	<1	-	-	-	-	0.31	-	0.025
Bore 1	Sep-16	Bore Water	-	-	-	-	-	-	-	-	7.8	8	<10	1.1	-	-	-	-	0.33	-	0.005
Bore 1	Jan-17	Bore Water	-	-	-	-	-	-	-	-	7.8	10	<10	<1	-	-	-	-	0.34	-	0.005
Bore 1	Apr-17	Bore Water	-	-	-	-	-	-	-	-	7.8	7	10	<1	-	-	-	-	0.31	-	0.015
Bore 1	Sep-17	Bore Water	-	-	-	-	-	-	-	-	7.9	9	30	<1	-	-	-	-	0.33	-	0.02
Bore 1	May-19	Bore Water	-	-	-	-	-	-	-	-	7.7	7	<10	1	-	-	-	-	0.59	-	0.01
Bore 1	Oct-14	Bore Water	-	-	-	-	-	-	-	-	7.8	6	10	-	-	-	-	-	0.31	-	0.015
Bore 2	Jan-14	Bore Water	-	-	-	-	-	-	-	-	7.9	6	10	1	-	-	-	-	0.35	-	0.075
Bore 2	Feb-14	Bore Water	-	-	-	-	-	-	-	-	8	10	10	1	-	-	-	-	0.29	-	0.01
Bore 2	Mar-14	Bore Water	-	-	-	-	-	-	-	-	7.7	9	10	1	-	-	-	-	0.56	-	0.015
Bore 2	Apr-14	Bore Water	-	-	-	-	-	-	-	-	7.7	9	10	1	-	-	-	-	0.49	-	0.01
Bore 2	May-14	Bore Water	-	-	-	-	-	-	-	-	7.6	9	10	1	-	-	-	-	0.45	-	0.01
Bore 2	Jun-14	Bore Water	-	-	-	-	-	-	-	-	7.7	9	-	1	-	-	-	-	0.58	-	0.06
Bore 2	Jul-14	Bore Water	-	-	-	-	-	-	-	-	7.9	9	10	1	-	-	-	-	0.3	-	0.02
Bore 2	Aug-14	Bore Water	-	-	-	-	-	-	-	-	7.7	10	10	1	-	-	-	-	0.64	-	0.015
Bore 2	Sep-14	Bore Water	-	-	-	-	-	-	-	-	7.8	10	10	1.2	-	-	-	-	0.65	-	0.065
Bore 2	Nov-14	Bore Water	-	-	-	-	-	-	-	-	7.7	9	10	1	-	-	-	-	0.41	-	0.025
Bore 2	Dec-14	Bore Water	-	-	-	-	-	-	-	-	8	9	10	1	-	-	-	-	0.69	-	0.005
Bore 2	Jan-15	Bore Water	-	-	-	-	-	-	-	-	8	8	10	-	-	-	-	-	0.56	-	0.01
Bore 2	Mar-15	Bore Water	-	-	-	-	-	-	-	-	7.8	10	10	1	-	-	-	-	0.62	-	0.005
Bore 2	Apr-15	Bore Water	-	-	-	-	-	-	-	-	7.9	8	10	1	-	-	-	-	0.28	-	0.015
Bore 2	May-15	Bore Water	-	-	-	-	-	-	-	-	7.7	9	<10	1.1	-	-	-	-	0.64	-	<0.005
Bore 2	Jun-15	Bore Water	-	-	-	-	-	-	-	-	7.7	10	<10	<1	-	-	-	-	0.57	-	0.015
Bore 2	Jul-15	Bore Water	-	-	-	-	-	-	-	-	8.4	7	<10	<1	-	-	-	-	0.28	-	0.015
Bore 2	Jan-16	Bore Water	-	-	-	-	-	-	-	-	8.4	9	<10	<1	-	-	-	-	0.32	-	0.01.
Bore 2	Feb-16	Bore Water	-	-	-	-	-	-	-	-	8.3	9	40	<1	-	-	-	-	0.32	-	0.015
Bore 2	Mar-16	Bore Water	-	-	-	-	-	-	-	-	7.8	9	30	<1	-	-	-	-	0.39	-	<.005
Bore 2	Apr-16	Bore Water	-	-	-	-	-	-	-	-	7.8	7	10	<1	-	-	-	-	0.31	-	0.01
Bore 2	May-16	Bore Water	-	-	-	-	-	-	-	-	7.7	8	<10	4	-	-	-	-	0.28	-	0.015
Bore 2	Jun-16	Bore Water	-	-	-	-	-	-	-	-	8	7	<10	<1	-	-	-	-	0.3	-	0.005
Bore 2	Jul-16	Bore Water	-	-	-	-	-	-	-	-	7.9	7	<10	<1	-	-	-	-	0.31	-	0.015
Bore 2	Aug-16	Bore Water	-	-	-	-	-	-	-	-	7.8	7	<10	<1	-	-	-	-	0.3	-	0.015
Bore 2	Sep-16	Bore Water	-	-	-	-	-	-	-	-	7.8	10	<10	1.6	-	-	-	-	1.66	-	0.01
Bore 2	Jan-17	Bore Water	-	-	-	-	-	-	-	-	7.9	9	<10	<1	-	-	-	-	0.37	-	0.005
Bore 2	Apr-17	Bore Water	-	-	-	-	-	-	-	-	7.7	11	10	<1	-	-	-	-	0.38	-	0.01

Site ID	Date	Analyte	Field Parameters																		
		Analyte	pH	Temp	ORP	EC	TDS	Salinity	Dissolved Oxygen	Turbidity	pH	Dissolved oxygen	Total Suspended Solids	Biological Oxygen Demand	Free Ammonia	Nitrite	Nitrate	Nitrogen Oxides	Total Nitrogen	Reactive Phosphorus	Total Phosphorus
												DO	TSS	BOD	NH3_F	NO2-N	NO3-N	NOX-N	TN	RP	TP
		Units		°C	mV	µS/cm	mg/L	ppt	%	NTU		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
		Limit of Reporting									2	0.1	5	1	0.3	0.1	0.1	0.1	0.4	0.1	0.1
Darwin Harbour Water Quality Objectives - Lagoons			**5.0-6.0**	**-**	**-**	**25**	**-**	**-**	**35-100**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0.55**	**0.005**	**0.02**
Bore 2	Sep-17	Bore Water	-	-	-	-	-	-	-	-	7.9	8	10	<1	-	-	-	-	0.35	-	0.01
Bore 2	Oct-14	Bore Water	-	-	-	-	-	-	-	-	7.7	5	10	-	-	-	-	-	0.66	-	0.01
Bore 3	May-16	Bore Water	-	-	-	-	-	-	-	-	7.8	9	<10	4.4	-	-	-	-	0.27	-	0.02
Bore 3	Jun-16	Bore Water	-	-	-	-	-	-	-	-	8	7	<10	1.6	-	-	-	-	1.71	-	0.405
Bore 3	Jul-16	Bore Water	-	-	-	-	-	-	-	-	8	9	<10	<1	-	-	-	-	0.33	-	0.035
Bore 3	Aug-16	Bore Water	-	-	-	-	-	-	-	-	8	9	<10	<1	-	-	-	-	0.28	-	0.04
Bore 3	Sep-16	Bore Water	-	-	-	-	-	-	-	-	7.8	10	10	1.5	-	-	-	-	0.27	-	0.015
Bore 3	Jan-17	Bore Water	-	-	-	-	-	-	-	-	7.7	13	<10	<1	-	-	-	-	0.3	-	0.015
Bore 3	Apr-17	Bore Water	-	-	-	-	-	-	-	-	8	6	30	<1	-	-	-	-	0.26	-	0.025
Bore 3	Sep-17	Bore Water	-	-	-	-	-	-	-	-	8	9	40	<1	-	-	-	-	0.31	-	0.02
Bore 3	May-19	Bore Water	-	-	-	-	-	-	-	-	7.6	6	<10	17	-	-	-	-	0.75	-	0.01
Drain before spirac	Jan-16	Wastewater	-	-	-	-	-	-	-	-	7.7	<1	70	79	-	-	-	-	25.6	-	4..88
Drain before spirac	Feb-16	Wastewater	-	-	-	-	-	-	-	-	8.3	8	40	<1	-	-	-	-	4.45	-	1.04
Drain before spirac	Mar-16	Wastewater	-	-	-	-	-	-	-	-	7.6	5	30	9.1	-	-	-	-	11.1	-	4.72
Drain before spirac	Apr-16	Wastewater	-	-	-	-	-	-	-	-	7.9	4	130	7.3	-	-	-	-	21.6	-	10.9
Drain before spirac	May-16	Wastewater	-	-	-	-	-	-	-	-	7.8	4	30	89	-	-	-	-	4.71	-	0.955
Drain before spirac	Jun-16	Wastewater	-	-	-	-	-	-	-	-	8.1	6	40	12	-	-	-	-	5.6	-	1.56
Drain before spirac	Jul-16	Wastewater	-	-	-	-	-	-	-	-	7.9	6	10	7.2	-	-	-	-	4.71	-	1.08
Drain before spirac	Aug-16	Wastewater	-	-	-	-	-	-	-	-	8	3	140	34	-	-	-	-	22.4	-	8.42
Drain before spirac	Sep-16	Wastewater	-	-	-	-	-	-	-	-	7.7	9	10	6.3	-	-	-	-	3.18	-	0.77
Drain before spirac	Nov-17	Wastewater	-	-	-	-	-	-	-	-	7.7	6	60	18	-	-	-	-	6.51	-	1.13
Drain before Spirac	May-19	Wastewater	-	-	-	-	-	-	-	-	7.8	7	<10	12	-	-	-	-	7.75	-	1.96
In lagoon after 1st settling pond	Feb-14	Wastewater	-	-	-	-	-	-	-	-	7.3	6	20	7.7	-	-	-	-	12.6	-	1.59
In lagoon after 1st settling pond	Mar-14	Wastewater	-	-	-	-	-	-	-	-	7.3	6	10	6.2	-	-	-	-	8.97	-	1.15
In lagoon after 1st settling pond	Apr-14	Wastewater	-	-	-	-	-	-	-	-	7.6	6	20	13	-	-	-	-	9.95	-	1.38
In lagoon after 1st settling pond	May-14	Wastewater	-	-	-	-	-	-	-	-	8	6	30	12	-	-	-	-	15.1	-	1.73
In lagoon after 1st settling pond	Jun-14	Wastewater	-	-	-	-	-	-	-	-	7.6	7	-	21	-	-	-	-	13.8	-	1.3
In lagoon after 1st settling pond	Jul-14	Wastewater	-	-	-	-	-	-	-	-	8	7	10	6.4	-	-	-	-	11	-	1.15
In lagoon after 1st settling pond	Aug-14	Wastewater	-	-	-	-	-	-	-	-	8.1	9	30	14	-	-	-	-	11.2	-	0.93
In lagoon after 1st settling pond	Sep-14	Wastewater	-	-	-	-	-	-	-	-	8.2	10	20	9.6	-	-	-	-	8.94	-	1.3
In lagoon after 1st settling pond	Oct-14	Wastewater	-	-	-	-	-	-	-	-	8.2	8	10	-	-	-	-	-	10.1	-	1.32
In lagoon after 1st settling pond	Nov-14	Wastewater	-	-	-	-	-	-	-	-	8.5	10	10	8.6	-	-	-	-	8.57	-	1.16
In lagoon after 1st settling pond	Dec-14	Wastewater	-	-	-	-	-	-	-	-	8.1	7	10	11	-	-	-	-	12.2	-	1.98
In lagoon after 1st settling pond	Jan-15	Wastewater	-	-	-	-	-	-	-	-	7.8	3	20	-	-	-	-	-	11.5	-	2.16
In lagoon after 1st settling pond	Mar-15	Wastewater	-	-	-	-	-	-	-	-	7.8	10	10	9.4	-	-	-	-	16.1	-	2.04
In lagoon after 1st settling pond	Apr-15	Wastewater	-	-	-	-	-	-	-	-	7.8	5	10	10	-	-	-	-	18.7	-	2.66
In lagoon after 1st settling pond	May-15	Wastewater	-	-	-	-	-	-	-	-	7.7	8	<10	2.7	-	-	-	-	7.46	-	2.13
In lagoon after1st settling pond	Jan-14	Wastewater	-	-	-	-	-	-	-	-	7.4	2	10	5.4	-	-	-	-	7.19	-	1.18
In lagoon after1st settling pond	Nov-17	Wastewater	-	-	-	-	-	-	-	-	7.8	7	10	4.4	-	-	-	-	5.11	-	1.2
In lagoon after1st settling pond	May-19	Wastewater	-	-	-	-	-	-	-	-	7.6	5	<10	24	-	-	-	-	12.9	-	1.68
Lagoon Outlet	Jan-14	Wastewater	-	-	-	-	-	-	-	-	7.5	6	10	1.4	-	-	-	-	4.9	-	1.09
Lagoon Outlet	Feb-14	Wastewater	-	-	-	-	-	-	-	-	7.4	9	10	1.6	-	-	-	-	4.9	-	0.585
Lagoon Outlet	Mar-14	Wastewater	-	-	-	-	-	-	-	-	7.4	7	10	1.8	-	-	-	-	7.17	-	0.93
Lagoon Outlet	Apr-14	Wastewater	-	-	-	-	-	-	-	-	7.4	9	10	1.6	-	-	-	-	8.56	-	1.29
Lagoon Outlet	May-14	Wastewater	-	-	-	-	-	-	-	-	7.1	7	30	10	-	-	-	-	14.1	-	1.91
Lagoon Outlet	Jul-14	Wastewater	-	-	-	-	-	-	-	-	8.2	5	20	-	-	-	-	-	5.19	-	1.27
Lagoon Outlet	Aug-14	Wastewater	-	-	-	-	-	-	-	-	8.9	9	30	15	-	-	-	-	6.75	-	1.27
Lagoon Outlet	Sep-14	Wastewater	-	-	-	-	-	-	-	-	8.7	8	50	20	-	-	-	-	6.9	-	2.02
Lagoon Outlet	Oct-14	Wastewater	-	-	-	-	-	-	-	-	9.5	14	30	-	-	-	-	-	5.86	-	1.56
Lagoon Outlet	Nov-14	Wastewater	-	-	-	-	-	-	-	-	9.6	8	40	29	-	-	-	-	7.87	-	1.33
Lagoon Outlet	Dec-14	Wastewater	-	-	-	-	-	-	-	-	8.3	9	20	4.6	-	-	-	-	4.8	-	1.09
Lagoon Outlet	Jan-15	Wastewater	-	-	-	-	-	-	-	-	7.7	6	10	-	-	-	-	-	8.14	-	1.75
Lagoon Outlet	Mar-15	Wastewater	-	-	-	-	-	-	-	-	8.3	9	20	6.8	-	-	-	-	5.99	-	1.68
Lagoon Outlet	Apr-15	Wastewater	-	-	-	-	-	-	-	-	9.4	4	20	8.2	-	-	-	-	8.02	-	2.19
Lagoon Outlet	May-15	Wastewater	-	-	-	-	-	-	-	-	8.9	8	30	9.7	-	-	-	-	8.41	-	2.7
Lagoon Outlet	Jun-15	Wastewater	-	-	-	-	-	-	-	-	9.3	<1	110	100	-	-	-	-	16.2	-	4.48
Lagoon Outlet	Jul-15	Wastewater	-	-	-	-	-	-	-	-	8.8	12	110	16	-	-	-	-	9.3	-	2.66
Lagoon Outlet	Aug-15	Wastewater	-	-	-	-	-	-	-	-	8.60	10.00	20	7.6	-	-	-	-	4.37	-	1.96
Lagoon Outlet	Sep-15	Wastewater	-	-	-	-	-	-	-	-	9.1	10	30	7.7	-	-	-	-	4.48	-	1.69
Lagoon Outlet	Oct-15	Wastewater	-	-	-	-	-	-	-	-	10	10	90	39	-	-	-	-	1.41	-	1.9
Lagoon Outlet	Nov-15	Wastewater	-	-	-	-	-	-	-	-	9.3	6	20	11	-	-	-	-	6.21	-	1.39
Lagoon Outlet	Jan-16	Wastewater	-	-	-	-	-	-	-	-	8.3	8	<10	1.5	-	-	-	-	4.09	-	1.35
Lagoon Outlet	Feb-16	Wastewater	-	-	-	-	-	-	-	-	8.3	8	60	19	-	-	-	-	7.74	-	2.24
Lagoon Outlet	Mar-16	Wastewater	-	-	-	-	-	-	-	-	7.4	8	30	8.6	-	-	-	-	8.65	-	1.53
Lagoon Outlet	Apr-16	Wastewater	-	-	-	-	-	-	-	-	7.2	5	30	56	-	-	-	-	9.7	-	2.35
Lagoon Outlet	May-16	Wastewater	-	-	-	-	-	-	-	-	7.7	7	10	55	-	-	-	-	5.36	-	1.17
Lagoon Outlet	Jun-16	Wastewater	-	-	-	-	-	-	-	-	8	7	20	3.6	-	-	-	-	4.36	-	1.48
Lagoon Outlet	Jul-16	Wastewater	-	-	-	-	-	-	-	-	8	8	20	4.2	-	-	-	-	3.75	-	1.6
Lagoon Outlet	Aug-16	Wastewater	-	-	-	-	-	-	-	-	7.4	7	20	<1	-	-	-	-	3.74	-	1.31
Lagoon Outlet	Sep-16	Wastewater	-	-	-	-	-	-	-	-	7.2	8	10	9.5	-	-	-	-	5.44	-	1.8

Site ID	Date	Analyte	Field Parameters																		
		Analyte	pH	Temp	ORP	EC	TDS	Salinity	Dissolved Oxygen	Turbidity	pH	Dissolved oxygen	Total Suspended Solids	Biological Oxygen Demand	Free Ammonia	Nitrite	Nitrate	Nitrogen Oxides	Total Nitrogen	Reactive Phosphorus	Total Phosphorus
												DO	TSS	BOD	NH3_F	NO2-N	NO3-N	NOX-N	TN	RP	TP
		Units		°C	mV	µS/cm	mg/L	ppt	%	NTU		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
		Limit of Reporting									2	0.1	5	1	0.3	0.1	0.1	0.1	0.4	0.1	0.1
Darwin Harbour Water Quality Objectives - Lagoons			**5.0-6.0**	**-**	**-**	**25**	**-**	**-**	**35-100**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0.55**	**0.005**	**0.02**
Property outlet	Jan-14	Wastewater	-	-	-	-	-	-	-	-	7.3	6	70	2.2	-	-	-	-	4.02	-	1.06
Property outlet	Feb-14	Wastewater	-	-	-	-	-	-	-	-	7.3	9	10	1.7	-	-	-	-	3.98	-	0.53
Property outlet	Mar-14	Wastewater	-	-	-	-	-	-	-	-	7.7	8	10	1.4	-	-	-	-	6.65	-	0.875
Property outlet	Apr-14	Wastewater	-	-	-	-	-	-	-	-	7.6	8	20	2.2	-	-	-	-	8.03	-	1.22
Property outlet	Jul-14	Wastewater	-	-	-	-	-	-	-	-	7.9	5	30	-	-	-	-	-	5.55	-	0.97
Property outlet	Aug-14	Wastewater	-	-	-	-	-	-	-	-	9.4	9	40	16	-	-	-	-	6.08	-	1.19
Property outlet	Sep-14	Wastewater	-	-	-	-	-	-	-	-	8	9	460	-	-	-	-	-	9.07	-	1.98
Property outlet	Nov-14	Wastewater	-	-	-	-	-	-	-	-	7.5	8	120	16	-	-	-	-	8.94	-	0.93
Property outlet	Dec-14	Wastewater	-	-	-	-	-	-	-	-	8.2	8	70	4.6	-	-	-	-	4.84	-	0.875
Property outlet	Jan-15	Wastewater	-	-	-	-	-	-	-	-	7.8	5	10	-	-	-	-	-	7.98	-	1.48
Property outlet	Mar-15	Wastewater	-	-	-	-	-	-	-	-	7.9	10	20	4.1	-	-	-	-	5.56	-	1.5
Property outlet	Apr-15	Wastewater	-	-	-	-	-	-	-	-	7.9	5	10	6.9	-	-	-	-	7.88	-	1.85
Property outlet	May-15	Wastewater	-	-	-	-	-	-	-	-	8	8	30	4.8	-	-	-	-	8.08	-	2
Property outlet	Jun-15	Wastewater	-	-	-	-	-	-	-	-	8.9	4	40	23	-	-	-	-	7.93	-	2.2
Property outlet	Jul-15	Wastewater	-	-	-	-	-	-	-	-	8.4	11	100	13	-	-	-	-	7.87	-	2.47
Property outlet	Aug-15	Wastewater	-	-	-	-	-	-	-	-	8.00	8.00	30	8.3	-	-	-	-	6.00	-	1.67
Property outlet	Sep-15	Wastewater	-	-	-	-	-	-	-	-	7.9	8	50	8.4	-	-	-	-	5.08	-	1.46
Property outlet	Oct-15	Wastewater	-	-	-	-	-	-	-	-	6	6	90	39	-	-	-	-	0.62	-	1.41
Property outlet	Nov-15	Wastewater	-	-	-	-	-	-	-	-	7.9	4	30	9.3	-	-	-	-	6.44	-	1.24
Property outlet	Jan-16	Wastewater	-	-	-	-	-	-	-	-	8.3	<1	10	3.3	-	-	-	-	4.36	-	1.19
Property outlet	Feb-16	Wastewater	-	-	-	-	-	-	-	-	8.3	8	20	11	-	-	-	-	6.79	-	1.96
Property outlet	Mar-16	Wastewater	-	-	-	-	-	-	-	-	7.6	9	30	1.7	-	-	-	-	8.59	-	1.23
Property outlet	Jun-16	Wastewater	-	-	-	-	-	-	-	-	8	7	10	3.8	-	-	-	-	4.29	-	1.46
Property outlet	Aug-16	Wastewater	-	-	-	-	-	-	-	-	7.4	6	<10	2.2	-	-	-	-	4.15	-	1.48
Property outlet	Sep-16	Wastewater	-	-	-	-	-	-	-	-	7.4	11	10	6.8	-	-	-	-	5.64	-	1.78
Sump After Spirac	Jun-15	Wastewater	-	-	-	-	-	-	-	-	7.6	2	10	27	-	-	-	-	13.2	-	1.9
Sump After Spirac	Jul-15	Wastewater	-	-	-	-	-	-	-	-	8.2	3	40	7.5	-	-	-	-	9.47	-	1.77
Sump After Spirac	Aug-15	Wastewater	-	-	-	-	-	-	-	-	7.80	7.00	<10	5.6	-	-	-	-	5.03	-	1.44
Sump After Spirac	Sep-15	Wastewater	-	-	-	-	-	-	-	-	7.9	8	280	8.5	-	-	-	-	5.94	-	8.07
Sump After Spirac	Oct-15	Wastewater	-	-	-	-	-	-	-	-	7	7	10	6	-	-	-	-	0.725	-	0.725
Sump After Spirac	Nov-15	Wastewater	-	-	-	-	-	-	-	-	8	5	40	17	-	-	-	-	9.2	-	1.77
Sump After Spirac	Jan-16	Wastewater	-	-	-	-	-	-	-	-	7.7	9	50	93	-	-	-	-	25.8	-	4.65
Sump After Spirac	Feb-16	Wastewater	-	-	-	-	-	-	-	-	8.3	9	30	5.8	-	-	-	-	6.31	-	1.17
Sump After Spirac	Mar-16	Wastewater	-	-	-	-	-	-	-	-	7.6	5	50	8.1	-	-	-	-	10.7	-	4.5
Sump After Spirac	Apr-16	Wastewater	-	-	-	-	-	-	-	-	7.9	4	130	17	-	-	-	-	22.2	-	11.3
Sump After Spirac	May-16	Wastewater	-	-	-	-	-	-	-	-	7.8	6	20	56	-	-	-	-	4.5	-	0.78
Sump After Spirac	Jun-16	Wastewater	-	-	-	-	-	-	-	-	8.1	6	50	10	-	-	-	-	6.44	-	1.59
Sump After Spirac	Jul-16	Wastewater	-	-	-	-	-	-	-	-	7.9	6	10	8	-	-	-	-	4.58	-	1.03
Sump After Spirac	Aug-16	Wastewater	-	-	-	-	-	-	-	-	8	2	150	33	-	-	-	-	24.4	-	8.62
Sump After Spirac	Sep-16	Wastewater	-	-	-	-	-	-	-	-	7.7	9	30	9.7	-	-	-	-	3.38	-	0.87
Sump After Spirac	Jan-17	Wastewater	-	-	-	-	-	-	-	-	7.7	8	180	38	-	-	-	-	30.9	-	13.6
Sump After Spirac	Apr-17	Wastewater	-	-	-	-	-	-	-	-	7.7	19	100	9	-	-	-	-	7.54	-	5.83
Sump After Spirac	Sep-17	Wastewater	-	-	-	-	-	-	-	-	7.2	<1	350	330	-	-	-	-	96.5	-	6.54
Sump After Spirac	Nov-17	Wastewater	-	-	-	-	-	-	-	-	7.8	7	60	20	-	-	-	-	7.48	-	1.33
Sump After Spirac	May-19	Wastewater	-	-	-	-	-	-	-	-	7.6	2	130	77	-	-	-	-	25.2	-	2.61
Water after drum filters	Sep-17	Wastewater	-	-	-	-	-	-	-	-	7.4	<1	290	170	-	-	-	-	55.2	-	4.4
Water after drum filters	Nov-17	Wastewater	-	-	-	-	-	-	-	-	8.1	7	40	4.9	-	-	-	-	0.46	-	0.155
Pit Before Spirac	4/07/2019	Wastewater	7.76	26.3	379.8	572	370.5	0.28	60.3	27.8	-	-	-	<2	-	<0.01	0.41	0.41	6.3	0.69	1.39
In Lagoon after 1st settling pond	4/07/2019	Wastewater	6.92	25.1	379.8	456.7	297.05	0.22	15.7	16.3	-	-	-	21	-	<0.01	0.04	0.04	12.8	1.55	1.92
Bore 1	4/07/2019	Bore Water	7.03	29.3	185.5	296	192.4	0.14	49.3	1.91	-	-	-	<2	-	<0.01	0.58	0.58	0.6	<0.01	<0.01
Bore 3	4/07/2019	Bore 3	7.07	28.9	174.7	250.6	163.15	0.12	35.4	9.92	-	-	-	<2	-	<0.01	0.33	0.33	0.3	0.01	<0.01
Lagoon Outlet	4/07/2019	Wastewater	6.94	21.9	188.1	432.6	281.4	0.21	24.7	4.45	-	-	-	<2	-	0.01	0.06	0.06	5.5	1.76	1.92
Property outlet	4/07/2019	Wastewater	7.32	24.6	177.9	409.6	266.5	0.2	57.2	2.89	-	-	-	<2	-	0.57	2.5	2.5	4.4	1.51	1.49
Fin 1	8/07/2019	Pen Water	7.78	24	193.8	342.3	222.3	0.16	49	6.39	-	-	-	<2	-	0.19	0.35	0.54	4	1.09	1.11
Hatch 1	8/07/2019	Pen Water	7.73	32.5	165.4	521	338	0.25	6.6	29.9	-	-	-	93	-	<0.01	0.33	0.33	37.9	2.94	3.13
Grow 1	8/07/2019	Pen Water	7.28	27.3	157	409.5	265.8	0.19	87.5	11.6	-	-	-	7	-	0.04	0.49	0.53	4.6	2.16	2.44
Grow 2	8/07/2019	Pen Water	7.79	24.7	157.3	591	383.5	0.29	41.8	30.5	-	-	-	10	-	<0.01	<0.01	<0.01	22.5	8.09	8.86

Site ID	Date	Laboratory Results																	
		Total dissolved Solids	Hydroxide Alkalinity	Carbonate Alkalinity	Bicarbonate Alkalinity	Total Alkalinity	Sulfate	Chloride	Calcium	Magnesium	Sodium	Potassium	Sodium Absorption Ratio	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel
		@180Â°C	CaCO3	CaCO3	CaCO3	CaCO3	SO4												
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L							
		10	1	1	1	1	1	1	1	1	1	1	0.01	0.001	0.0001	0.001	0.001	0.001	0.001
Darwin Harbour Water Quality Objectives - Lagoons																			
Property outlet	Jan-14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Feb-14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Mar-14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Apr-14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Jul-14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Aug-14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Sep-14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Nov-14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Dec-14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Jan-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Mar-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Apr-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	May-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Jun-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Jul-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Aug-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Sep-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Oct-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Nov-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Jan-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Feb-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Mar-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Jun-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Aug-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Sep-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Jun-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Jul-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Aug-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Sep-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Oct-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Nov-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Jan-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Feb-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Mar-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Apr-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	May-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Jun-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Jul-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Aug-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Sep-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Jan-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Apr-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Sep-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Nov-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	May-19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water after drum filters	Sep-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water after drum filters	Nov-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pit Before Spirac	4/07/2019	345	<1	<1	134	134	2	70	43	15	30	2	1	<0.001	<0.0001	<0.001	0.006	<0.001	<0.001
In Lagoon after 1st settling pond	4/07/2019	196	<1	<1	175	175	2	35	28	15	23	2	0.87	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
Bore 1	4/07/2019	159	<1	<1	123	123	2	19	27	16	9	<1	0.34	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
Bore 3	4/07/2019	140	<1	<1	115	115	<1	10	24	15	5	<1	0.2	<0.001	<0.0001	<0.001	0.002	<0.001	<0.001
Lagoon Outlet	4/07/2019	208	<1	<1	164	164	<1	37	33	17	24	2	0.84	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
Property outlet	4/07/2019	220	<1	<1	143	143	<1	36	31	17	23	2	0.82	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
Fin 1	8/07/2019	187	<1	<1	124	124	2	30	25	16	19	2	0.73	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
Hatch 1	8/07/2019	283	<1	<1	221	221	7	25	32	19	14	9	0.48	<0.001	<0.0001	<0.001	0.067	<0.001	<0.001
Grow 1	8/07/2019	229	<1	<1	127	127	8	45	30	17	27	1	0.98	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
Grow 2	8/07/2019	290	<1	<1	201	201	8	53	36	18	32	2	1.09	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001

Site ID	Date	Zinc	Mercury	Ammonia	Nitrite	Nitrate	Nitrite plus Nitrate	Total Kjeldahl Nitrogen	Total Nitrogen	Total Phosphorus	Reactive Phosphorus	Total Anions	Total Cations	Ionic Balance	Chlorophyll a	Oil & Grease	Biochemical Oxygen Demand	Faecal Coliforms	Escherichia coli	Enterococci
				N	N	N	N	N	N	P	P									
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L	%	mg/mÂ³	mg/L	mg/L	CFU/100mL	CFU/100mL	CFU/100mL
		0.005	**0.0001**	**0.01**	**0.01**	**0.01**	**0.01**	**0.1**	**0.1**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**1**	**5**	**2**	**1**	**1**	**1**
Darwin Harbour Water Quality Objectives - Lagoons																				
Property outlet	Jan-14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Feb-14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Mar-14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Apr-14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Jul-14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Aug-14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Sep-14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Nov-14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Dec-14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Jan-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Mar-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Apr-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	May-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Jun-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Jul-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Aug-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Sep-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Oct-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Nov-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Jan-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Feb-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Mar-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Jun-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Aug-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property outlet	Sep-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Jun-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Jul-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Aug-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Sep-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Oct-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Nov-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Jan-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Feb-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Mar-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Apr-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	May-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Jun-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Jul-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Aug-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Sep-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Jan-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Apr-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Sep-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	Nov-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sump After Spirac	May-19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water after drum filters	Sep-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water after drum filters	Nov-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pit Before Spirac	4/07/2019	0.014	<0.0001	0.1	<0.01	0.41	0.41	5.9	6.3	1.39	0.69	4.69	4.74	0.45	<1	<5	<2	~3200	~3200	~10
In Lagoon after 1st settling pond	4/07/2019	<0.005	<0.0001	9.99	<0.01	0.04	0.04	12.8	12.8	1.92	1.55	4.52	4.4	1.48	69	<5	21	42000	42000	15000
Bore 1	4/07/2019	0.007	<0.0001	<0.01	<0.01	0.58	0.58	<0.1	0.6	<0.01	<0.01	3.04	3.06	0.34	<1	<5	<2	<1	<1	<1
Bore 3	4/07/2019	<0.005	<0.0001	<0.01	<0.01	0.33	0.33	<0.1	0.3	<0.01	0.01	2.58	2.65	----	<1	<5	<2	<1	<1	<1
Lagoon Outlet	4/07/2019	<0.005	<0.0001	4.95	0.01	0.05	0.06	5.4	5.5	1.92	1.76	4.32	4.14	2.12	3	<5	<2	1200	1200	490
Property outlet	4/07/2019	<0.005	<0.0001	1.27	0.57	1.93	2.5	1.9	4.4	1.49	1.51	3.87	4	1.59	2	<5	<2	3400	3400	~200
Fin 1	8/07/2019	<0.005	<0.0001	2.01	0.19	0.35	0.54	3.5	4	1.11	1.09	3.36	3.44	1.12	<1	<5	<2	6	<2	<2
Hatch 1	8/07/2019	0.04	<0.0001	12.4	<0.01	0.33	0.33	37.6	37.9	3.13	2.94	5.27	4.89	3.8	<2	<5	93	52000	52000	60000
Grow 1	8/07/2019	<0.005	<0.0001	1.31	0.04	0.49	0.53	4.1	4.6	2.44	2.16	3.97	4.1	1.52	1	<5	7	30000	30000	1900
Grow 2	8/07/2019	<0.005	<0.0001	15.3	<0.01	<0.01	<0.01	22.5	22.5	8.86	8.09	5.68	5.81	1.15	105	<5	10	-	-	-

APPENDIX C MEDLI OUTPUT FILES

MEDLI REPORT - FULL RUN

Enterprise: **Janamba Crocodile Farm**

Description:
No subject entered

Client: **Croc Pac Pty Ltd**

MEDLI User: Emma Lewis

Scenario Details:

DESCRIPTION

Climate Data: Middle Point Rangers, -12.58°, 131.31°

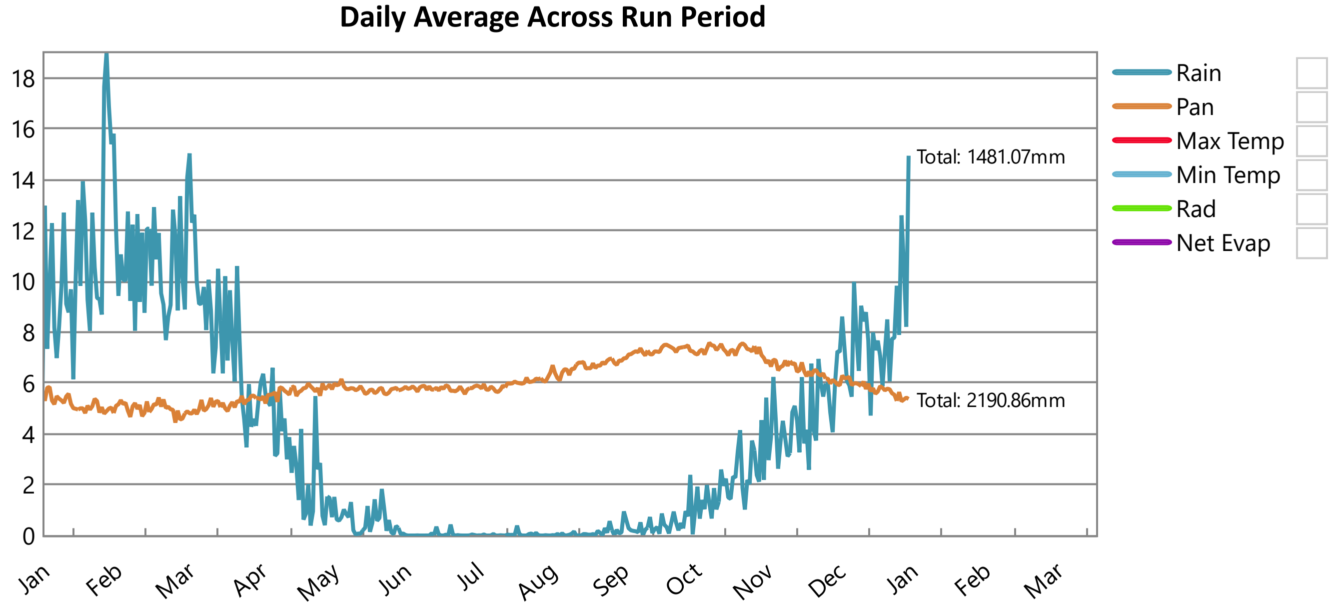
Run Period: 01/01/1950 to 31/12/2019 70 years, 0 days

Climate Statistics:

Climate Data:

Chart Table

Monthly Daily



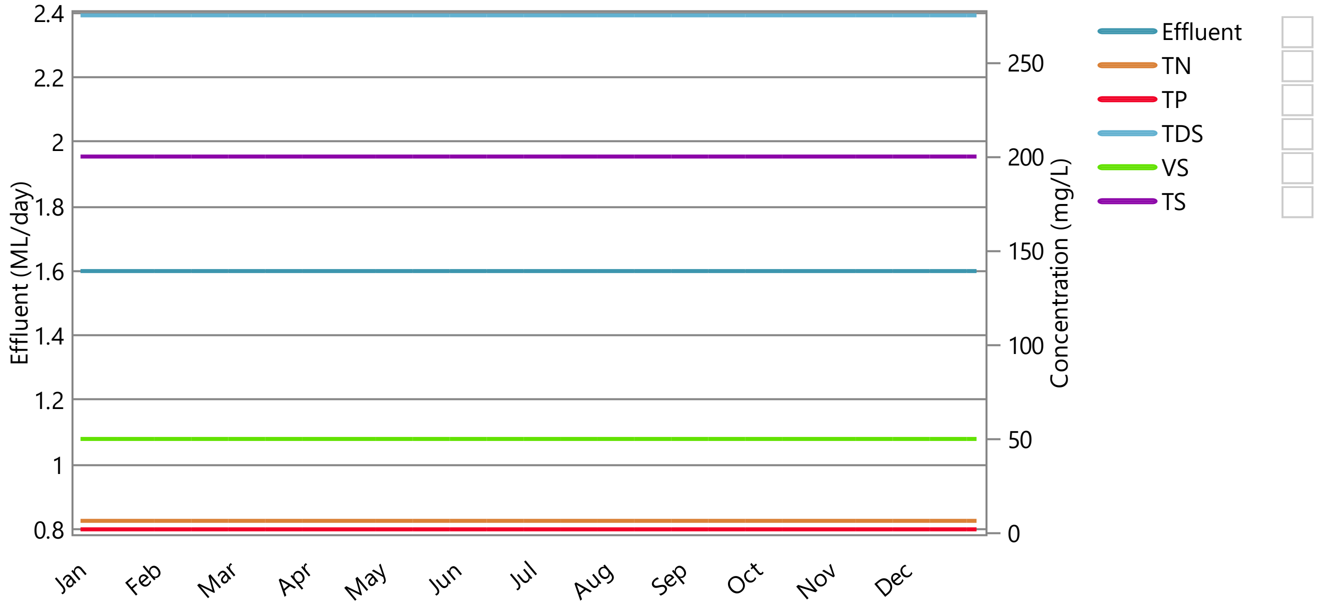
DESCRIPTION

Effluent type: Janamba Croc Farm

Wastestream before any recycling or pretreatment

Average daily quantity and flow-weighted average quality:

■ Chart ☐ Table



Wastestream after any recycling and pretreatment if applicable

Effluent quantity: 584.39 ML/year or 1.60 ML/day (Min-Max: 1.60 - 1.60)

Flow-weighted average (minimum - maximum) daily effluent quality entering pond system:

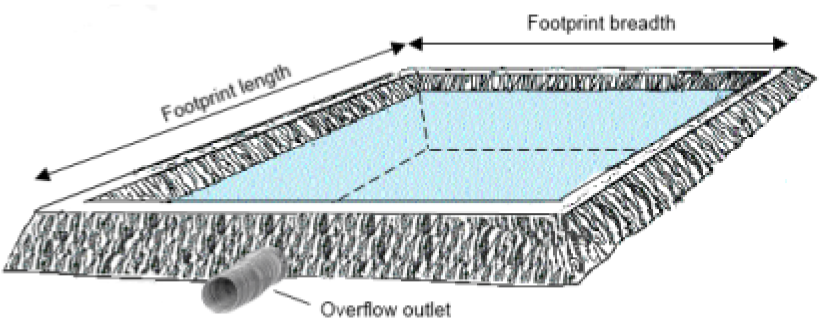
	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	6.50 (6.50 - 6.50)	3798.53 (3796.00 - 3806.40)
Total Phosphorus	2.00 (2.00 - 2.00)	1168.78 (1168.00 - 1171.20)
Total Dissolved Salts	275.00 (275.00 - 275.00)	160706.86 (160600.00 - 161040.00)
Volatile Solids	50.00 (50.00 - 50.00)	29219.43 (29200.00 - 29280.00)
Total Solids	200.00 (200.00 - 200.00)	116877.71 (116800.00 - 117120.00)

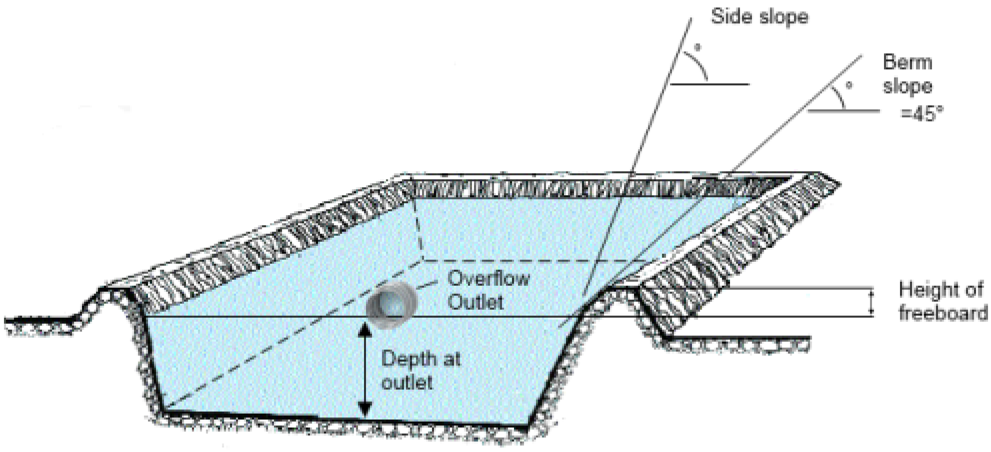
DESCRIPTION

Pond system: 1 facultative, aerobic or storage pond

Pond system details:

	Pond 1
Maximum pond volume (ML)	30.00
Minimum allowable pond volume (ML)	1.20
Pond depth at overflow outlet (m)	2.40
Maximum water surface area (m2)	13074.10
Pond footprint length (m)	163.70
Pond footprint width (m)	82.85
Pond catchment area (m2)	13563.21
Average active volume (ML)	29.82





Irrigation pump limits:

Minimum pump rate per area limit (ML/day/ha)	0.00
Maximum pump rate per area limit (ML/day/ha)	1.00

Shandying water:

Annual allocation of fresh water available for shandying (ML/year)	0.00
Maximum rate of application of fresh water (ML/day)	0.00
Nitrogen concentration (mg/L)	0.00
Salinity (dS/m)	0.00
Minimum shandy water is used	False

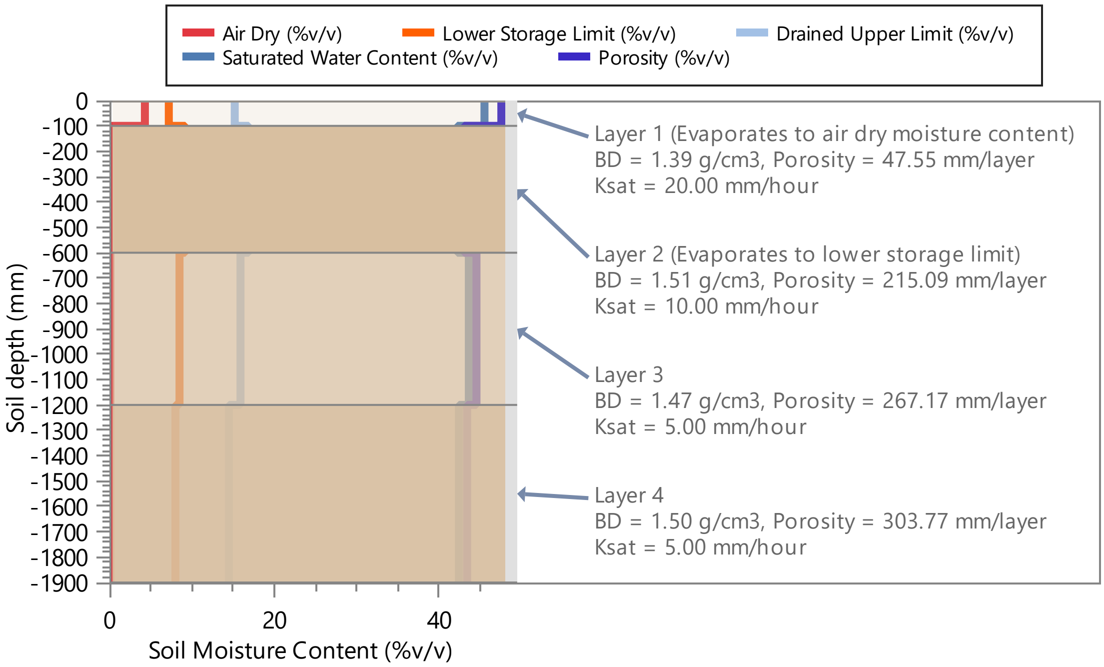
DESCRIPTION

Land: New Irrigation Paddock

Area (ha): 4.85

Soil Type: Red Earth, 1900.00 mm defined profile depth

Profile Porosity (mm)	833.58
Profile saturation water content (mm)	814.90
Profile drained upper limit (or field capacity) (mm)	296.60
Profile lower storage limit (or permanent wilting point) (mm)	160.20
Profile available water capacity (mm)	136.40
Profile limiting saturated hydraulic conductivity (mm/hour)	5.00
Surface saturated hydraulic conductivity (mm/hour)	20.00
Runoff curve number II (coefficient)	83.00
Soil evaporation U (mm)	10.00
Soil evaporation Cona (mm/sqrt day)	4.00



Plant Data: Continuous Forage Sorghum Crop

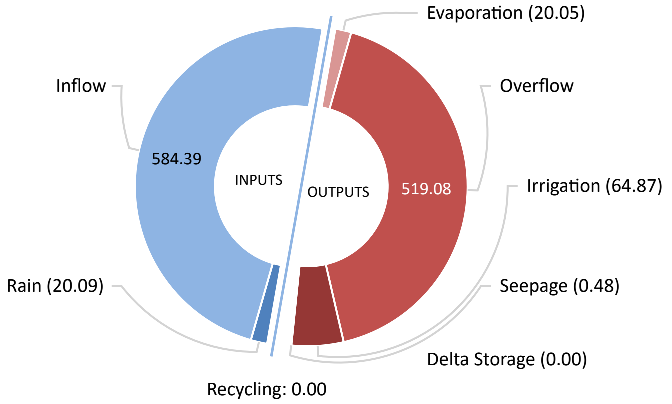
Average monthly cover (fraction) (minimum - maximum)	0.56 (0.53 - 0.60)
Maximum crop factor at 100% cover (mm/mm) (Maximum crop coefficient 0.8 x Pan coefficient 1)	0.80
Total plant cover (both green and dead) left after harvest (fraction)	0.00
Maximum potential root depth in defined soil profile (mm)	1900.00
Salt tolerance	Tolerant
Salinity threshold EC sat. ext. (dS/m)	8.30
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.11

PERFORMANCE

Pond System Water Performance - Overflow: 1 facultative, aerobic or storage pond

Capacity of wet weather storage pond: **30 ML**

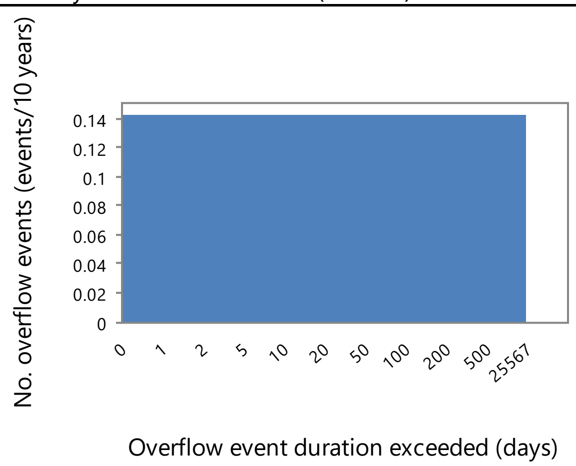
Pond System Water Balance (ML/year)

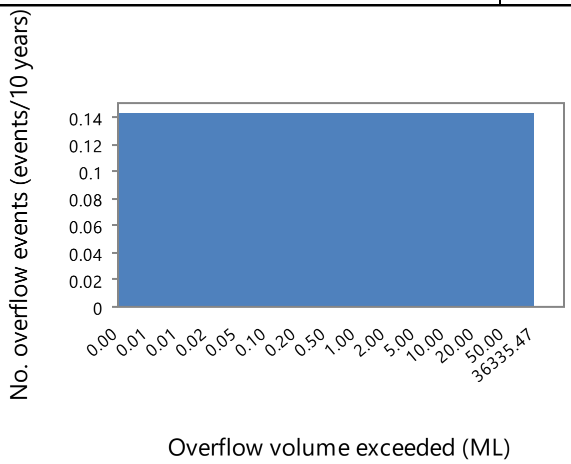


Name	Value
Rain	20.09
Inflow	584.39
Recycling	0.00
Evaporation	20.05
Overflow	519.08
Irrigation	64.87
Seepage	0.48
Delta Storage	0.00

Overflow Diagnostics

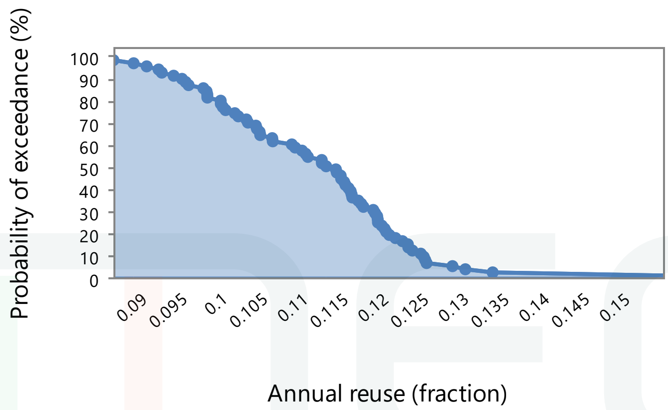
Volume of overflow (ML/year)	519.08
No. days pond overflows (days/year)	365.24
Average duration of overflow (days)	25567.00
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	0.11
Probability of at least 90% reuse (fraction)	0.00





Export plot

Export plot



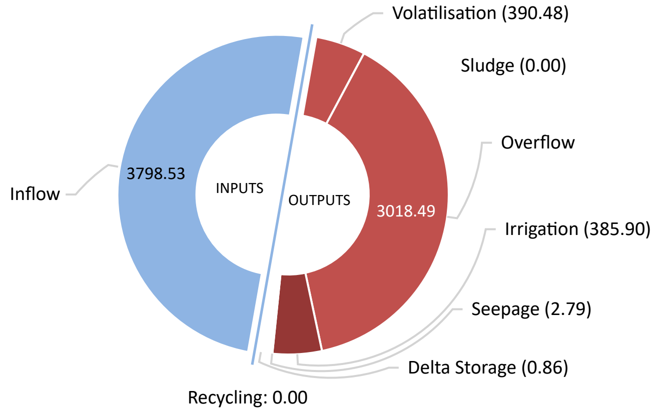
Export plot

PERFORMANCE

Pond System Performance - Nutrient: 1 facultative, aerobic or storage pond

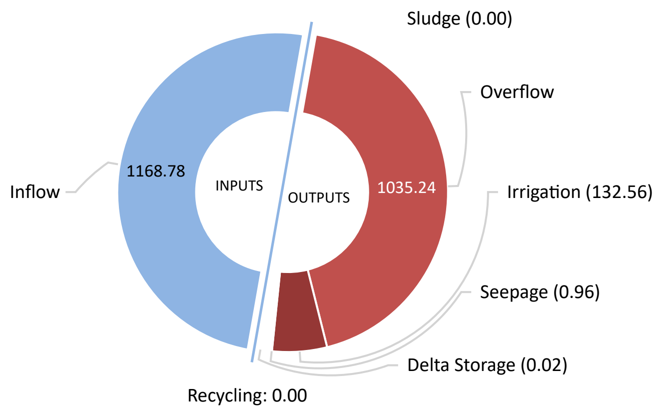
Pond System Nutrients and Salt Balance:

Nitrogen Balance (kg/year)



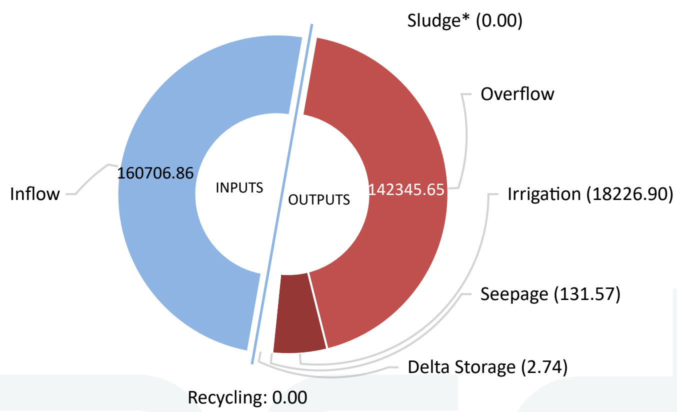
Name	Value
Inflow	
Recycling	
Volatilisation	
Sludge	
Overflow	
Irrigation	
Seepage	
Delta Storage	

Phosphorus Balance (kg/year)



Name	Value
Inflow	
Recycling	
Sludge	
Overflow	
Irrigation	
Seepage	
Delta Storage	

Salt Balance (kg/year)



Name	Value
Inflow	
Recycling	
Sludge*	
Overflow	
Irrigation	
Seepage	
Delta Storage	

* Salt removal in sludge is not calculated from the pond salt balance. However if salt could be assumed to be present in the sludge at the same concentration as in the pond supernatant (up to a maximum of salt added in inflow) - then salt accumulation in the sludge could be 0.00 kg/year

Pond System Sludge Accumulation: 0.00 kg dwt/year

PERFORMANCE

Pond System Performance - Nutrient: 1 facultative, aerobic or storage pond

Pond Nutrient Concentrations and Salinity:

Average across simulation period	Pond 1
Average nitrogen concentration of pond liquid (mg/L)	5.80
Average phosphorus concentration of pond liquid (mg/L)	2.00
Average salinity of pond liquid (dS/m)	0.43

Value on final day of simulation period	Pond 1
Final nitrogen concentration of pond liquid (mg/L)	5.92
Final phosphorus concentration of pond liquid (mg/L)	2.05
Final salinity of pond liquid (dS/m)	0.44

PERFORMANCE

Irrigation Performance:

Water Use: (assumes 100% Irrigation Efficiency)

Pond water irrigated (ML/year)	64.87
Average Shandy water irrigation (ML/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Total water irrigated (ML/year)	64.87
Proportion of irrigation events requiring shandying (fraction of events)	0.00
Proportion of years shandying water allocation of 0 ML/year is exceeded (fraction of years)	0.00
Average exceedance as a proportion of annual shandy water allocation (fraction of allocation) (minimum - maximum)	0.00 (0.00 - 0.00)

Irrigation Quality:

Average nitrogen concentration of irrigation water - before ammonia loss during irrigation (mg/L)	5.95
Average nitrogen concentration of irrigation water - after ammonia loss during irrigation (mg/L)	5.79
Average phosphorus concentration of irrigation water (mg/L)	2.04
Average salinity of irrigation water (dS/m)	0.44

Irrigation Diagnostics:

Proportion of Days rain prevents irrigation (fraction)	0.17
Proportion of Days water demand too small to trigger irrigation (fraction)	0.08
Proportion of Days irrigation occurs (fraction)	0.75

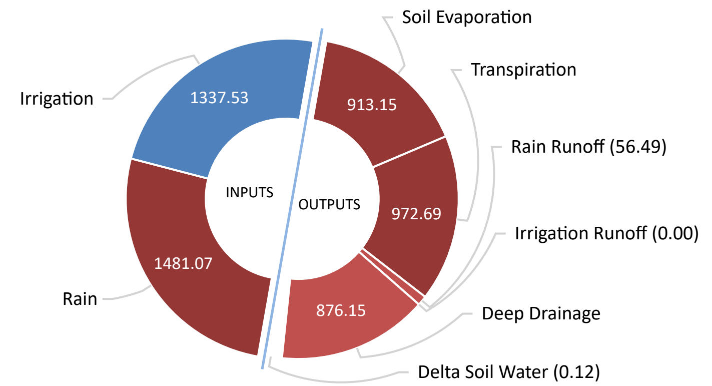
PERFORMANCE

Land Performance - Soil Water

Paddock: New Irrigation Paddock, 4.85 ha
Soil Type: Red Earth, 136.40 mm PAWC at maximum root depth

Land Water Balance (mm/year):

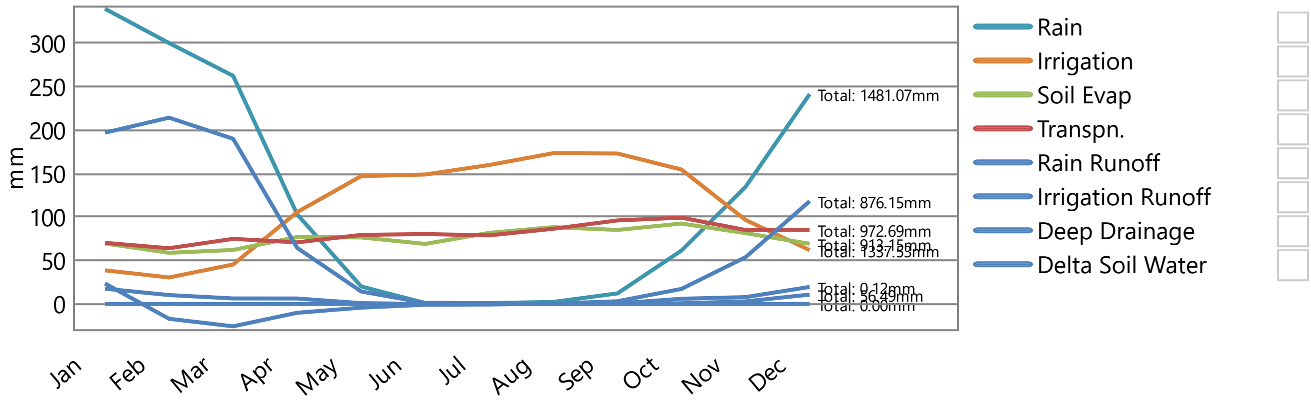
■ mm/year ☐ % Total inputs



Name	Value
Rain	
Irrigation	
Soil Evaporation	
Transpiration	
Rain Runoff	
Irrigation Runoff	
Deep Drainage	
Delta Soil Water	

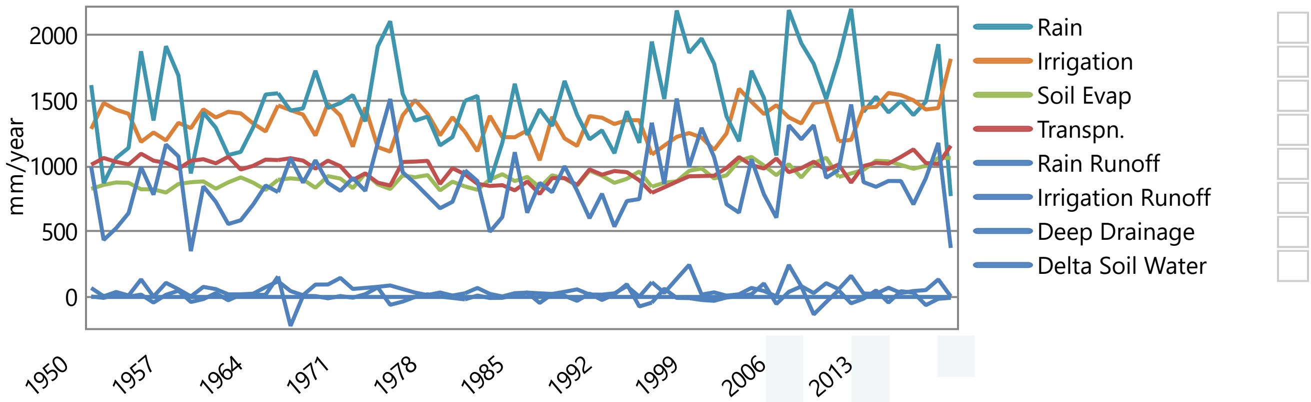
Average Monthly Totals (mm):

■ Chart ☐ Table



Average Annual Totals (mm/year):

■ Chart ☐ Table



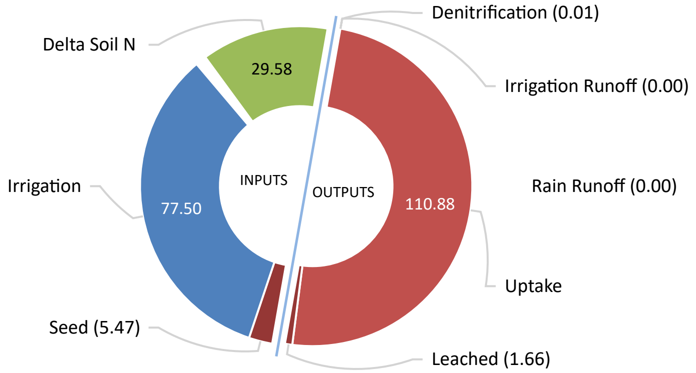
PERFORMANCE

Land Performance - Soil Nutrient

Paddock: New Irrigation Paddock, 4.85 ha **Soil Type**: Red Earth

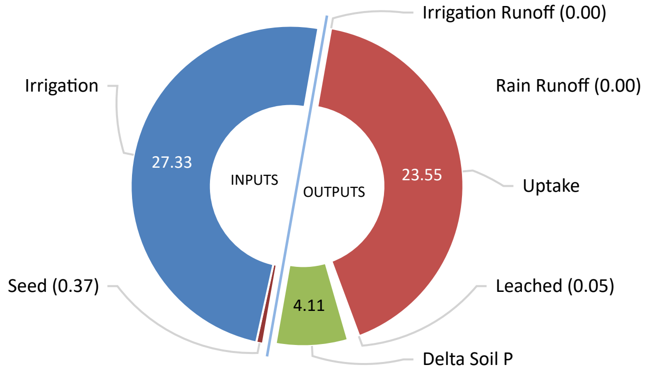
Irrigation ammonium volatilisation losses (kg/ha/year): 2.07
Proportion of total nitrogen in irrigated effluent as ammonium (fraction): 0.10

Land Nitrogen Balance (kg/ha/year)



Name	Value
Seed	5.47
Irrigation	77.50
Denitrification	0.01
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	110.88
Leached	1.66
Delta Soil N	-29.58

Land Phosphorus Balance (kg/ha/year)



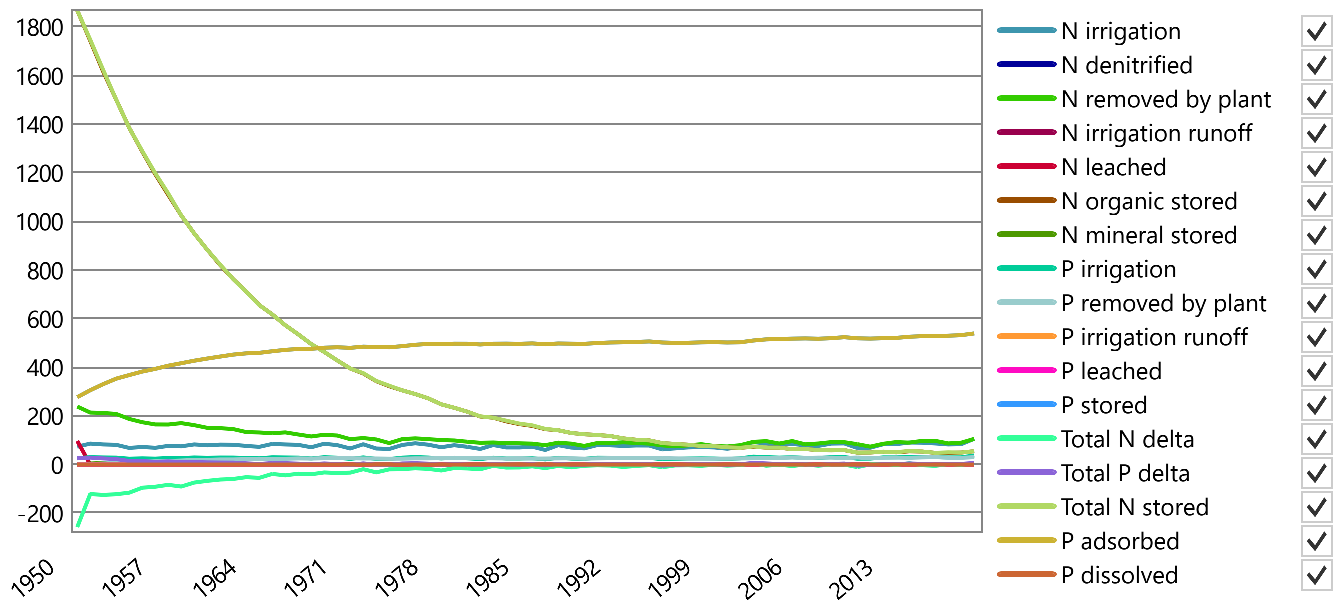
Name	Value
Seed	0.37
Irrigation	27.33
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	23.55
Leached	0.05
Delta Soil P	4.11

PERFORMANCE

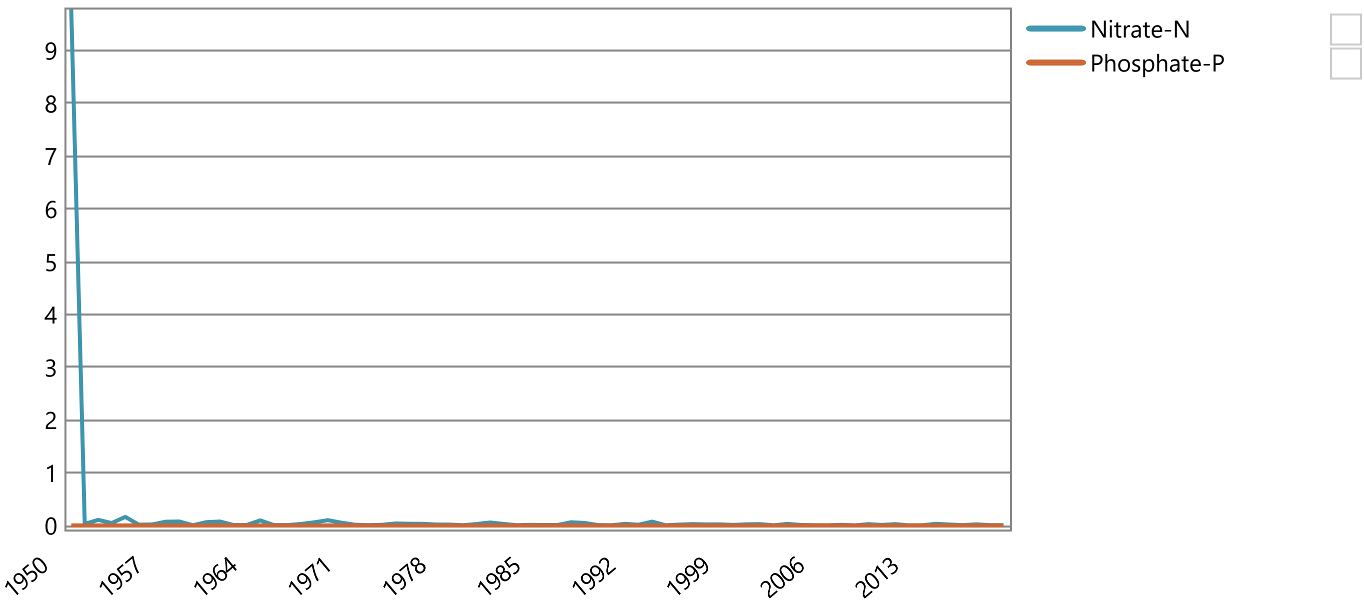
Land Performance - Soil Nutrient

Paddock: New Irrigation Paddock, 4.85 ha **Soil Type**: Red Earth

Annual Nutrient Totals (kg/ha):



Annual Nutrient Leaching Concentration (mg/L):



PERFORMANCE

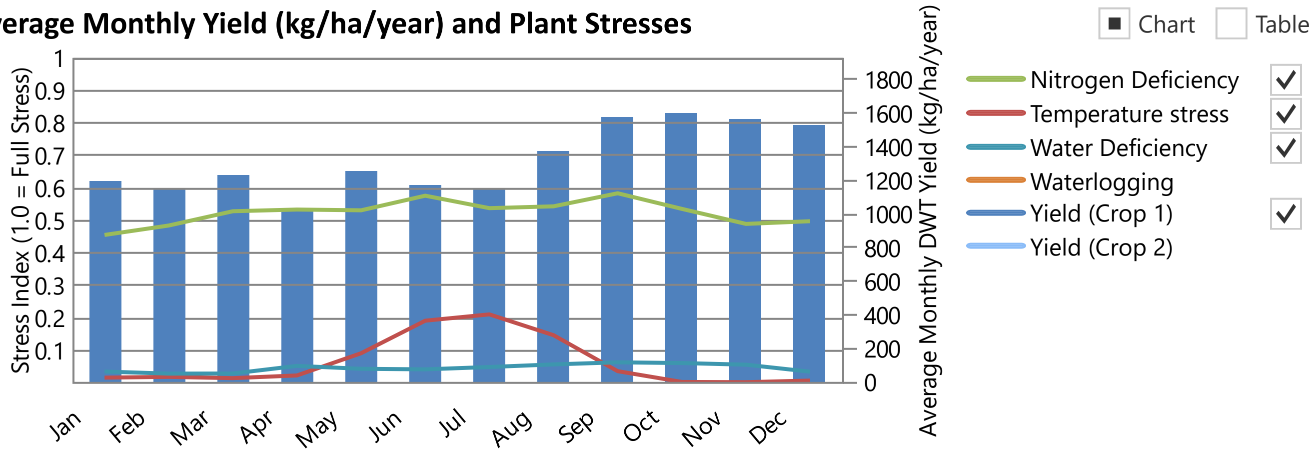
Plant Performance and Nutrients

Paddock: New Irrigation Paddock, 4.85 ha **Soil Type**: Red Earth

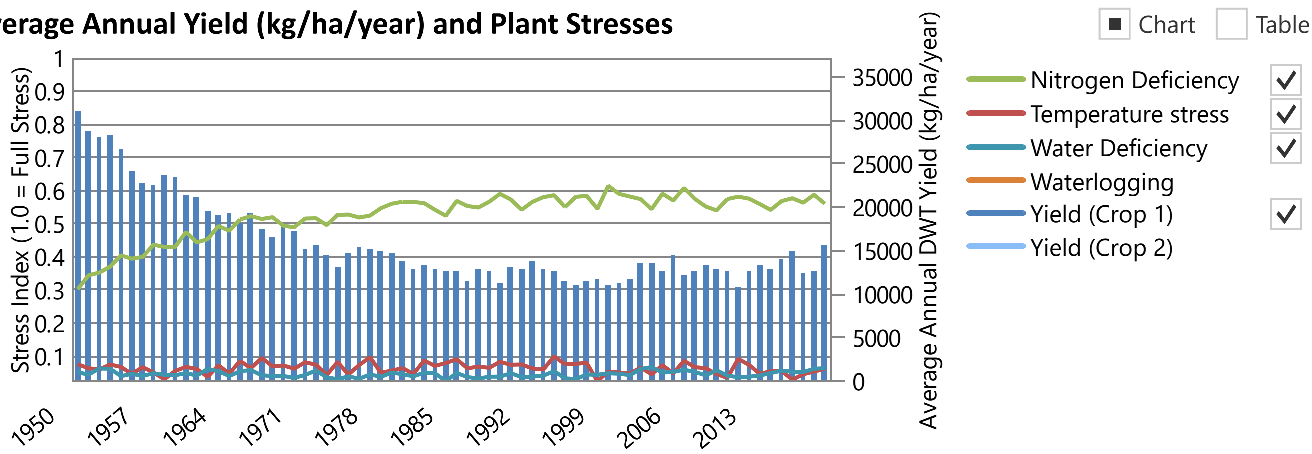
Plant: Continuous Forage Sorghum Crop

Nutrient Uptake (minimum - maximum):

Average Monthly Yield (kg/ha/year) and Plant Stresses



Average Annual Yield (kg/ha/year) and Plant Stresses



No. of harvests/year: 4.11 (normal), 0.01 (forced by crop death due to nitrogen stress (0.01))
No. days without crop/year (days/year): 0.00

PERFORMANCE

Land Performance

Paddock: New Irrigation Paddock, 4.85 ha **Soil Type**: Red Earth

Plant: Continuous Forage Sorghum Crop

	8.30
	0.11
	10.00

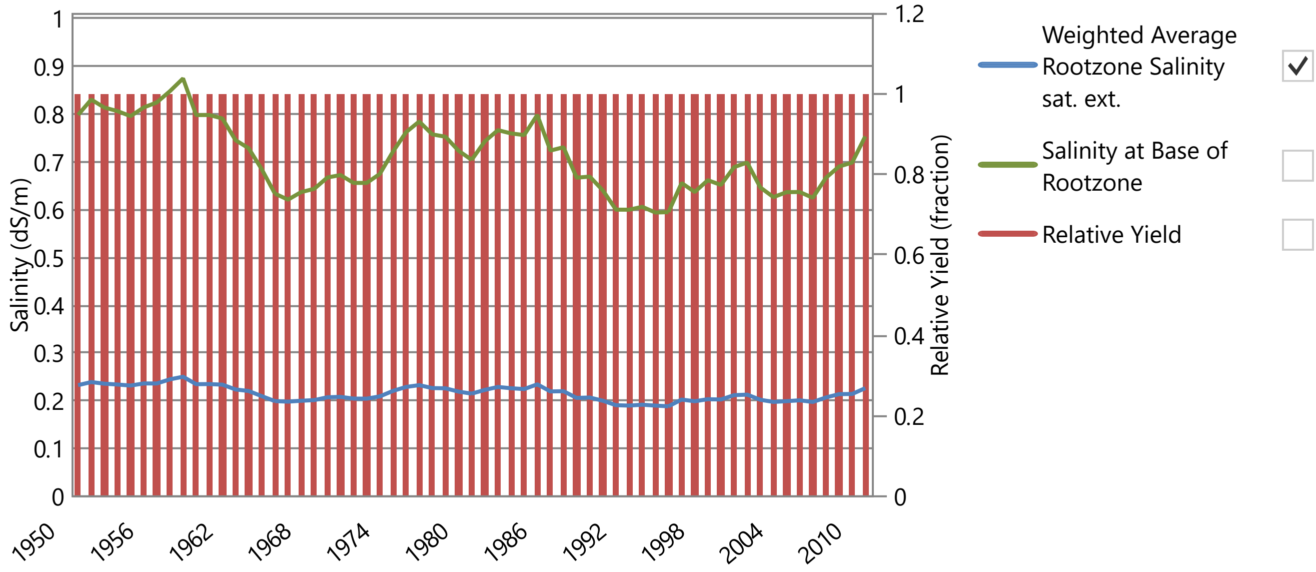
Soil Salinity:

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.23
	273.52
	4031.64
	0.48
	0.22
	0.71
	1.00
	0.00

Average Annual Rootzone Salinity and Relative Yield:

■ Chart ☐ Table

All values based on 10 year running averages



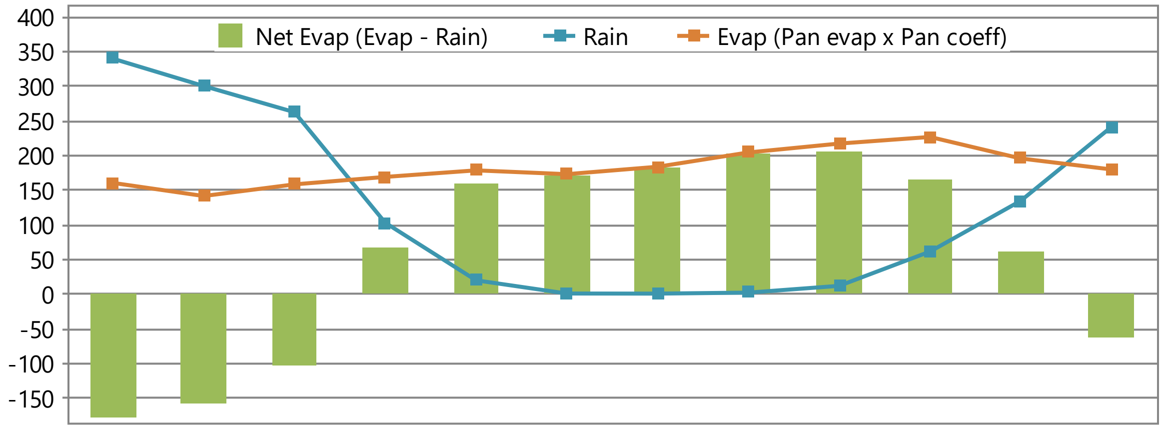
DIAGNOSTICS

Sustainability Diagnostics: Janamba Crocodile Farm

Averaged Historical Climate Data Used in Simulation (mm)

Location: Middle Point Rangers, -12.58°, 131.31°

Run Period: 01/01/1950 to 31/12/2019   70 years, 0 days



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	339.8	300.4	262.7	103.2	20.2	1.1	1.0	2.4	12.2	61.6	134.9	241.6	1481.1
Evap	160.7	141.7	158.5	169.3	178.7	173.3	183.9	204.6	217.4	226.9	195.9	180.0	2190.9
Net Evap	-179.2	-158.6	-104.1	66.1	158.6	172.1	182.9	202.1	205.2	165.3	61.0	-61.6	709.8
Net Evap/day	-5.8	-5.6	-3.4	2.2	5.1	5.7	5.9	6.5	6.8	5.3	2.0	-2.0	1.9

DIAGNOSTICS

Sustainability Diagnostics: Janamba Crocodile Farm

Pond System: 1 facultative, aerobic or storage pond

Janamba Croc Farm - 584.39 ML/year or 1.60 ML/day generated on average

Effluent entering pond system after any pretreatment and recycling

Average (Minimum-Maximum) influent quality calculated for 365.24 non-zero flow days, after any pretreatment and recycling.

Constituent	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	6.50 (6.50 - 6.50)	3798.53 (3796.00 - 3806.40)
Total Phosphorus	2.00 (2.00 - 2.00)	1168.78 (1168.00 - 1171.20)
Total Dissolved Salts	275.00 (275.00 - 275.00)	160706.86 (160600.00 - 161040.00)
Volatile Solids	50.00 (50.00 - 50.00)	29219.43 (29200.00 - 29280.00)
Total Solids	200.00 (200.00 - 200.00)	116877.71 (116800.00 - 117120.00)

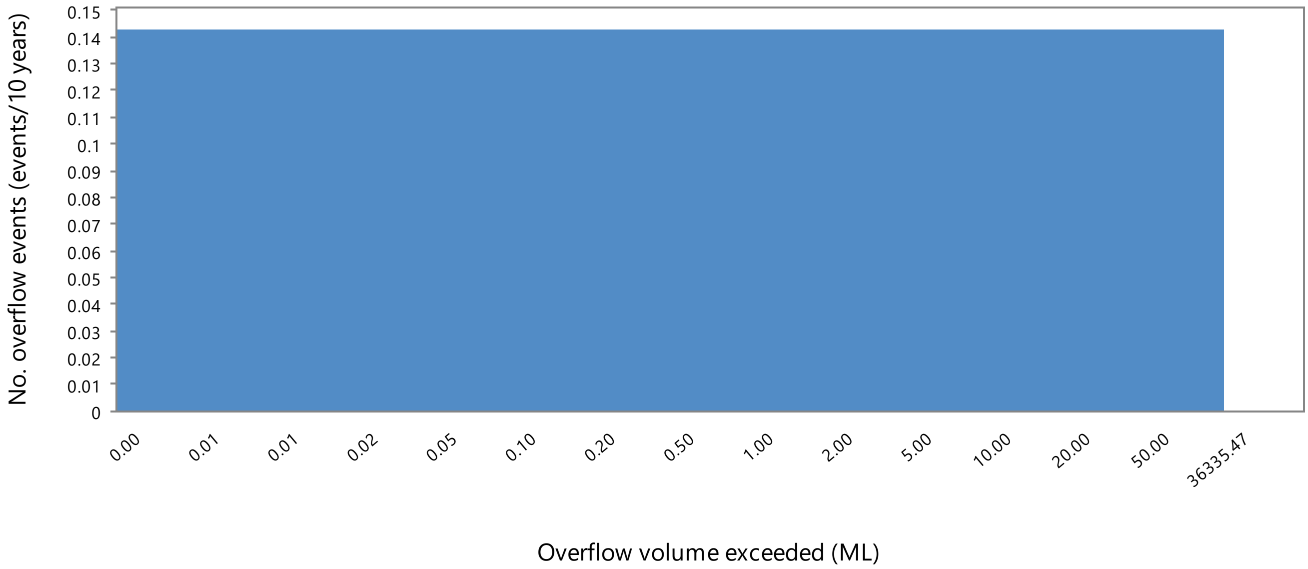
Last pond (Wet weather store): 30.00 ML

Theoretical hydraulic retention time (days)	18.75
Average volume of overflow (ML/year)	519.08
No. overflow events per year exceeding threshold* of 0.01 ML (no./year)	0.01
Average duration of overflow (days)	25567.00
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	0.11
Probability of at least 90% effluent reuse (fraction)	0.00
Average salinity of last pond (dS/m)	0.43
Salinity of last pond on final day of simulation (dS/m)	0.44
Ammonia loss from pond system water area (kg/m2/year)	2.09

* The threshold is the volume equivalent to the top 1 mm depth of water of a full pond

Overflow exceedance:

■ Chart ☐ Table



Export plot

DIAGNOSTICS

Sustainability Diagnostics: Janamba Crocodile Farm

Irrigation Information

Irrigation: 4.85 ha total area (assumed 100% irrigation efficiency)

	Quantity/year	Quantity/ha/year
Total irrigation applied (ML)	64.87	13.38
Total nitrogen applied (kg)	375.87	77.50
Total phosphorus applied (kg)	132.56	27.33
Total salts applied (kg)	18226.90	3758.12

Shandying

Annual allocation of fresh water for shandying (ML/year)	0.00
Average Shandy water irrigation (ML/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Average exceedance as a proportion of annual shandy water allocation (% of allocation) (minimum - maximum)	0.00 (0.00 - 0.00)
Proportion of irrigation events requiring shandying (fraction of events)	0.00
Minimum shandy water is used	False

Irrigation Issues

Proportion of Days irrigation is prevented when triggered (fraction)	0.17
Proportion of Days water demand is too small to trigger irrigation (fraction)	0.08
Proportion of Days irrigation occurs (fraction)	0.75

DIAGNOSTICS

Sustainability Diagnostics: Janamba Crocodile Farm

Paddock Land: New Irrigation Paddock: 4.85 ha

Irrigation: Centre Pivot with 0.26% ammonium loss during irrigation

Irrigation triggered when soil water deficit reaches 0.00 mm and rainfall is less than or equal to 5.00 mm
Irrigate up to a soil water content of 1.00 fraction of profile drained upper limit
Irrigation window from 1/1 to 31/12 including the days specified
A minimum of 0 days must be skipped between irrigation events

Soil Water Balance (mm): Red Earth, 136.40 mm PAWC at maximum root depth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	339.8	300.4	262.7	103.2	20.2	1.1	1.0	2.4	12.2	61.6	134.9	241.6	1481.1
Irrigation	38.8	30.6	45.5	105.8	147.3	149.1	160.0	173.7	173.2	154.7	96.8	62.0	1337.5
Soil Evap	69.7	59.0	62.2	77.2	76.6	69.2	82.0	88.5	85.3	92.6	81.6	69.3	913.2
Transpn.	70.4	64.2	75.0	71.0	79.6	80.5	79.0	86.7	96.2	99.4	85.2	85.4	972.7
Rain Runoff	17.6	10.3	6.4	6.3	1.0	0.0	0.0	0.0	0.1	0.8	3.0	10.9	56.5
Irr. Runoff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Drainage	197.3	214.5	190.2	64.6	14.4	1.3	0.6	0.5	3.2	17.4	53.9	118.3	876.2
Delta	23.6	-17.0	-25.7	-10.1	-4.2	-0.8	-0.6	0.5	0.7	6.1	7.9	19.7	0.1

Soil Nitrogen Balance

Average annual effluent nitrogen added (kg/ha/year)	77.50
Average annual soil nitrogen removed by plant uptake (kg/ha/year)	110.88
Average annual soil nitrogen removed by denitrification (kg/ha/year)	0.01
Average annual soil nitrogen leached (kg/ha/year)	1.66
Average annual nitrate-N loading to groundwater (kg/ha/year)	1.66
Soil organic-N kg/ha (Initial - Final)	1984.50 - 54.94
	141.30 - 0.03
Average nitrate-N concentration of deep drainage (mg/L)	0.19
Max. annual nitrate-N concentration of deep drainage (mg/L)	9.80

Soil Phosphorus Balance

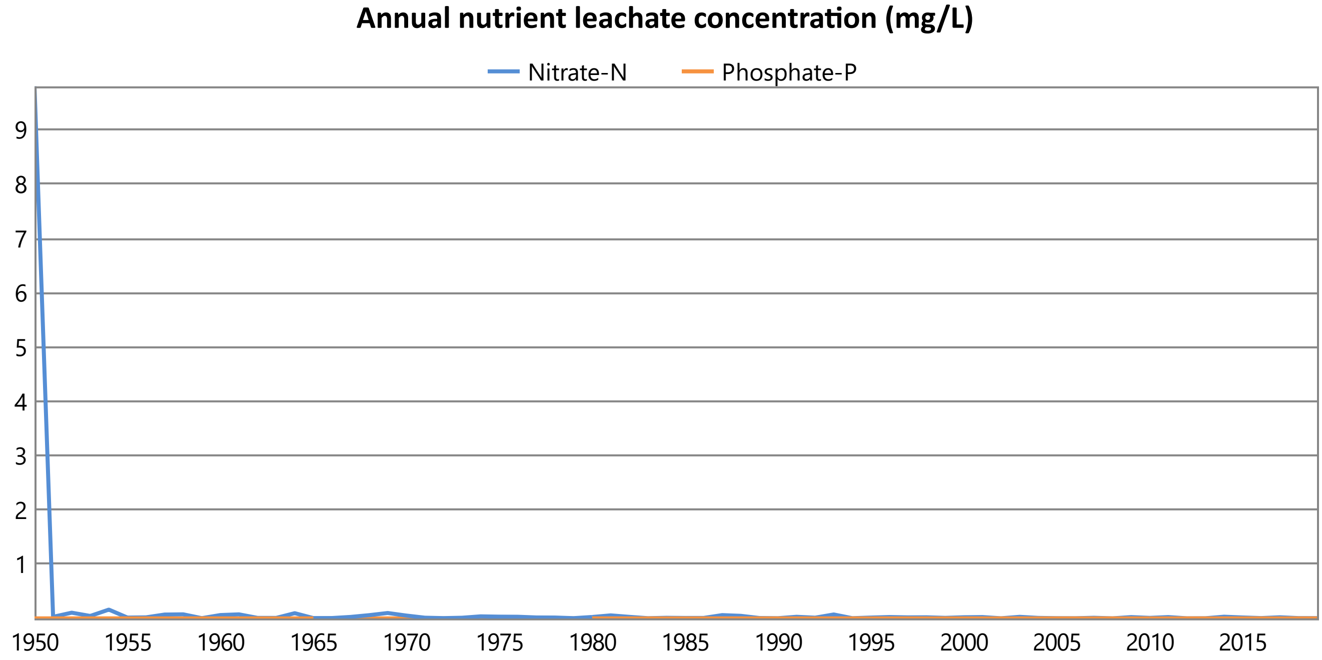
Average annual effluent phosphorus added (kg/ha/year)	27.33
Average annual soil phosphorus removed by plant uptake (kg/ha/year)	23.55
Average annual soil phosphorus leached (kg/ha/year)	0.05
Dissolved phosphorus (kg/ha) (Initial - Final)	0.01 - 0.02
Adsorbed phosphorus (kg/ha) (Initial - Final)	251.51 - 539.44
Average phosphate-P concentration in rootzone (mg/L)	0.02
Average phosphate-P concentration of deep drainage (mg/L)	0.01
Max. annual phosphate-P concentration of deep drainage (mg/L)	0.01
Design soil profile storage life based on average infiltrated water phosphorus concn. of 0.99 mg/L (years)	165.62

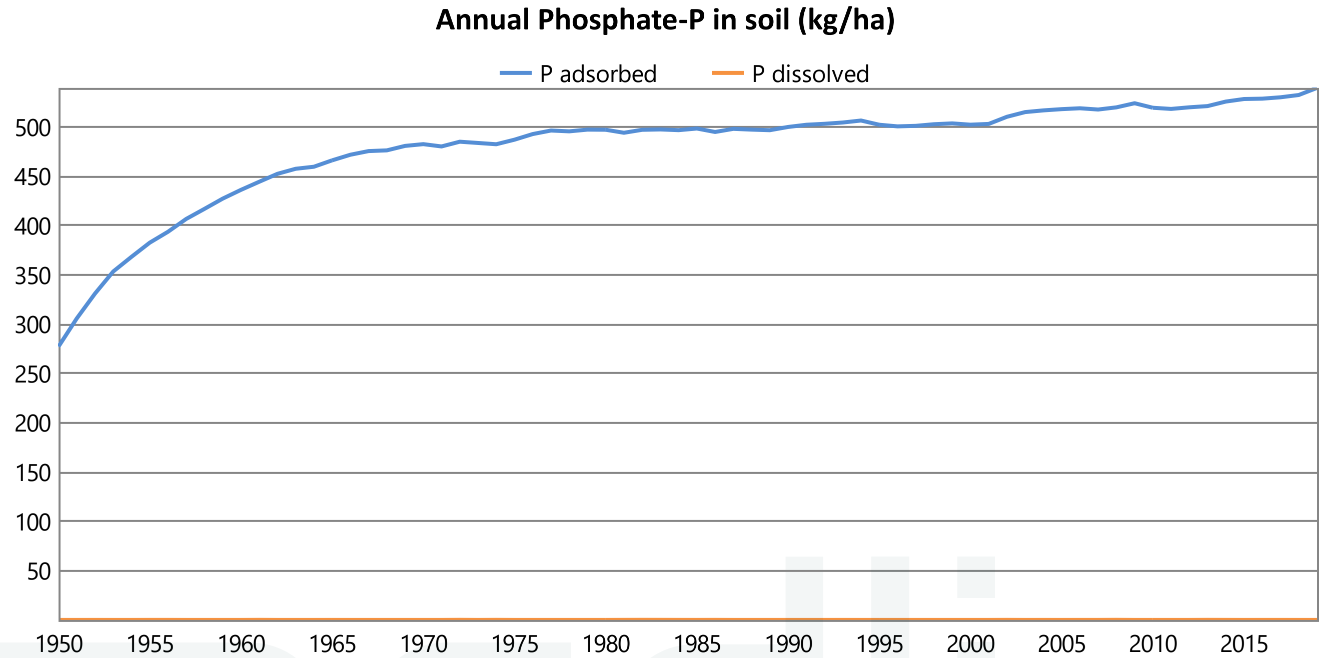
DIAGNOSTICS

Sustainability Diagnostics: Janamba Crocodile Farm

Paddock Land: New Irrigation Paddock: 4.85 ha

Irrigation: Centre Pivot with 0.26% ammonium loss during irrigation





DIAGNOSTICS

Sustainability Diagnostics: Janamba Crocodile Farm

Paddock Plant Performance: New Irrigation Paddock: 4.85 ha

Average Plant Performance (Minimum - Maximum): Continuous Forage Sorghum Crop

Average annual shoot dry matter yield (kg/ha/year)	15975.11 (10936.14 - 31086.04)
Average monthly plant (green) cover (fraction)	0.56 (0.53 - 0.60)
Average monthly crop factor (fraction)	0.45 (0.42 - 0.48)
Total plant cover (both green and dead) left after harvest (fraction)	0.00
Average monthly root depth (mm)	1335.75 (1268.96 - 1399.55)
Average number of normal harvests per year (no./year)	4.11 (3.00 - 5.00)
Average number of normal harvests for last five years only (no./year)	4.20
Average number of crop deaths per year (no./year)	0.01 (0.00 - 1.00)
Average number of crop deaths for last five years only (no./year)	0.00
Average annual nitrogen deficiency index (0 = no stress, 1 = full stress) (coefficient)	0.52 (0.30 - 0.61)
Average January temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.02 (0.00 - 0.05)
Average July temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.21 (0.07 - 0.36)
Average monthly water stress index (0 = no stress, 1 = full stress) (coefficient)	0.05 (0.03 - 0.06)
Average monthly waterlogging index (0 = no stress, 1 = full stress) (coefficient)	0.00 (0.00 - 0.00)
No. days without crop/year (days)	0.00

Soil Salinity - Plant salinity tolerance: Tolerant

Assumes 1.0 dS/m Electrical Conductivity = 640 mg/L Total Dissolved Salts

All values based on 10 year running averages

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.23
Salt added by rainfall (kg/ha/year)	273.52
Average annual effluent salt added & leached at steady state (kg/ha/year)	4031.64
Average leaching fraction based on 10 year running averages (fraction)	0.48
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.22
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	0.71
Relative crop yield expected due to salinity (fraction)	1.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (fraction)	0.00

DIAGNOSTICS

Run Messages

Messages generated when the scenario was run:

Full run chosen

MEDLI REPORT - FULL RUN

Enterprise: **Janamba Crocodile Farm**

Description:
No subject entered

Client: **Croc Pac Pty Ltd**

MEDLI User: Emma Lewis

Scenario Details:

DESCRIPTION

Climate Data: **Middle Point Rangers, -12.58°, 131.31°**

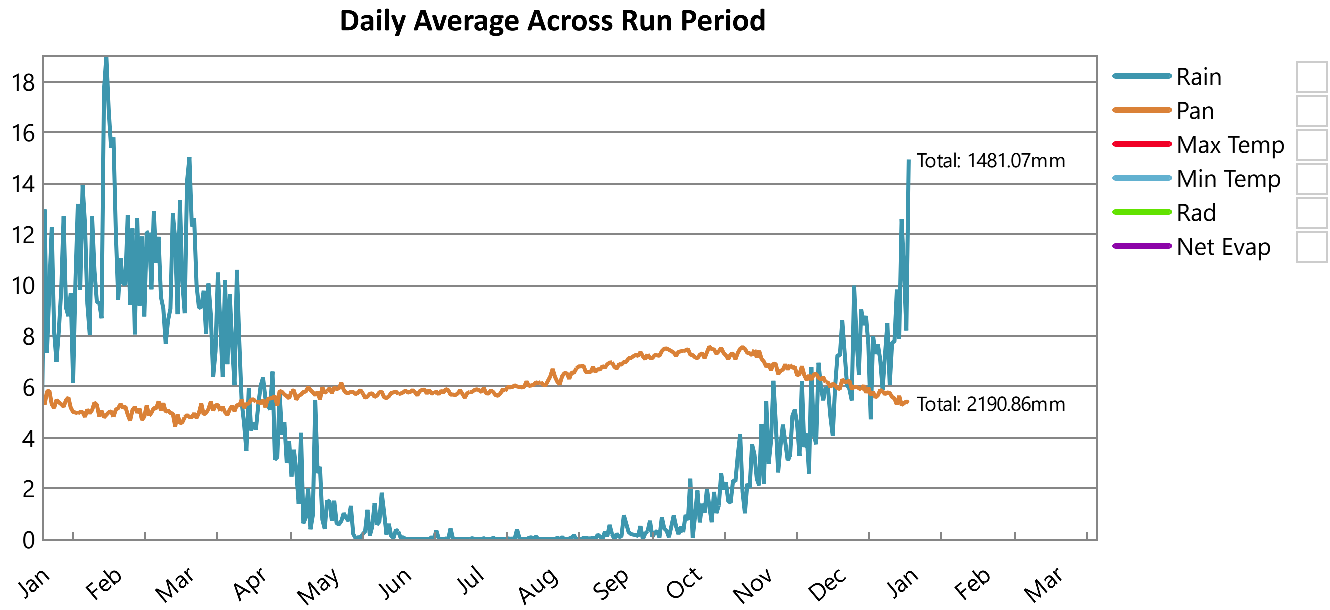
Run Period: **01/01/1950 to 31/12/2019** 70 years, 0 days

Climate Statistics:

Climate Data:

■ Chart ☐ Table

☐ Monthly ■ Daily

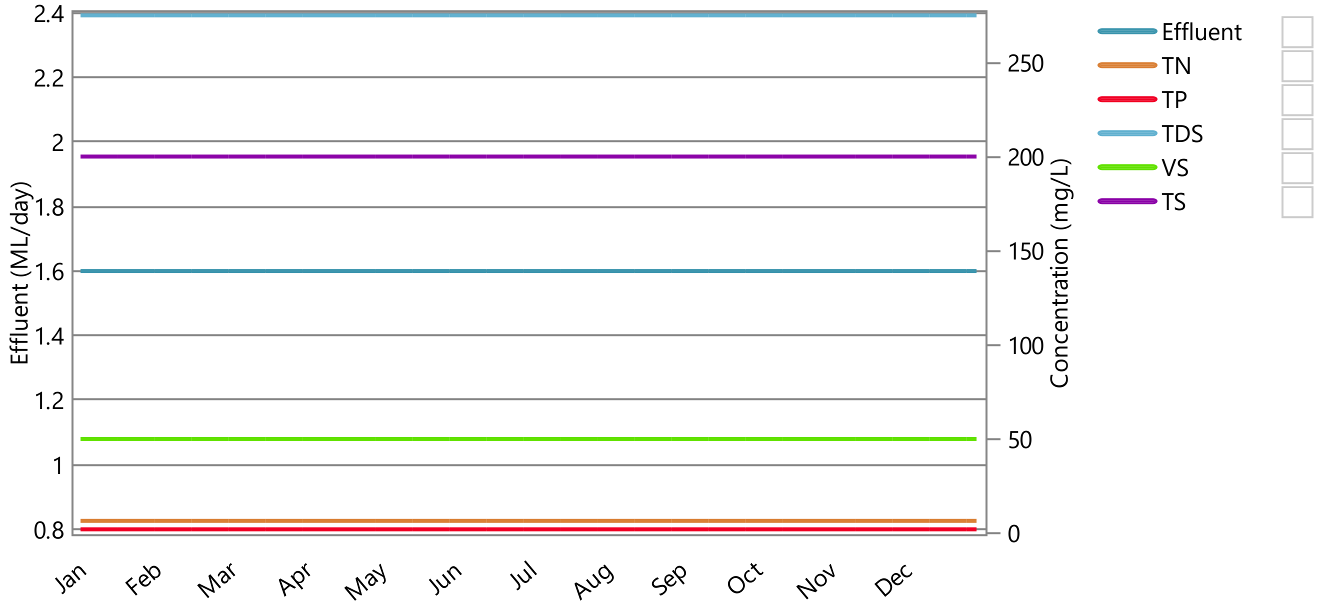


DESCRIPTION

Effluent type: Janamba Croc Farm

Wastestream before any recycling or pretreatment

Average daily quantity and flow-weighted average quality:



Wastestream after any recycling and pretreatment if applicable

Effluent quantity: 584.39 ML/year or 1.60 ML/day (Min-Max: 1.60 - 1.60)

Flow-weighted average (minimum - maximum) daily effluent quality entering pond system:

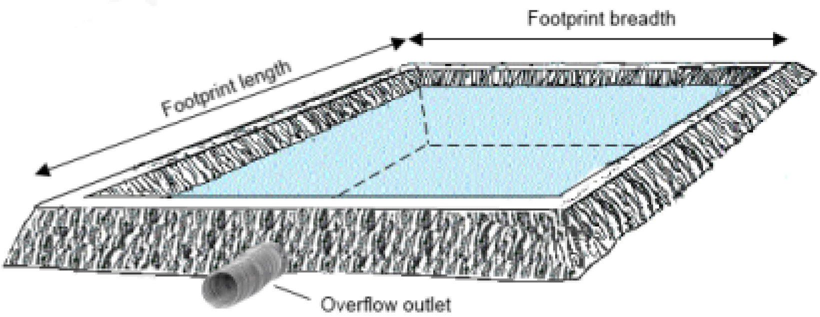
	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	6.50 (6.50 - 6.50)	3798.53 (3796.00 - 3806.40)
Total Phosphorus	2.00 (2.00 - 2.00)	1168.78 (1168.00 - 1171.20)
Total Dissolved Salts	275.00 (275.00 - 275.00)	160706.86 (160600.00 - 161040.00)
Volatile Solids	50.00 (50.00 - 50.00)	29219.43 (29200.00 - 29280.00)
Total Solids	200.00 (200.00 - 200.00)	116877.71 (116800.00 - 117120.00)

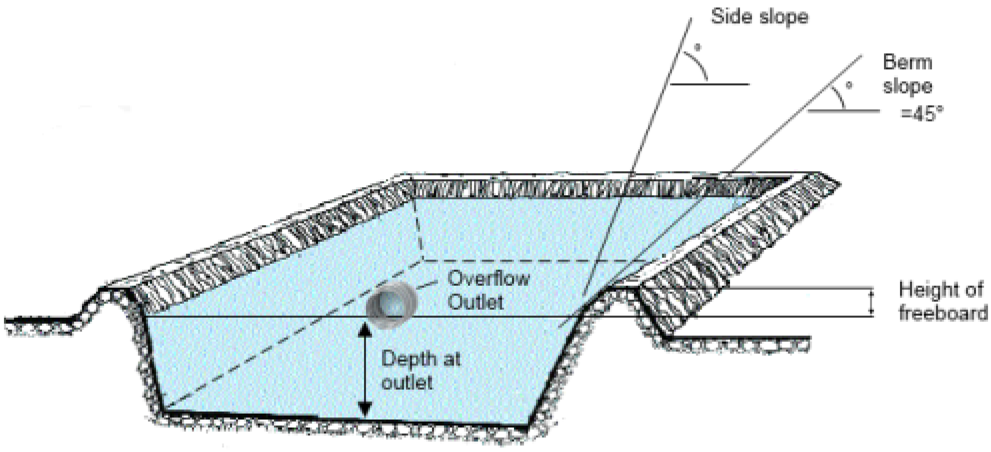
DESCRIPTION

Pond system: 1 facultative, aerobic or storage pond

Pond system details:

	Pond 1
Maximum pond volume (ML)	30.00
Minimum allowable pond volume (ML)	1.20
Pond depth at overflow outlet (m)	2.40
Maximum water surface area (m2)	13074.10
Pond footprint length (m)	163.70
Pond footprint width (m)	82.85
Pond catchment area (m2)	13563.21
Average active volume (ML)	29.73





Irrigation pump limits:

Minimum pump rate per area limit (ML/day/ha)	0.00
Maximum pump rate per area limit (ML/day/ha)	10.00

Shandying water:

Annual allocation of fresh water available for shandying (ML/year)	0.00
Maximum rate of application of fresh water (ML/day)	0.00
Nitrogen concentration (mg/L)	0.00
Salinity (dS/m)	0.00
Minimum shandy water is used	False

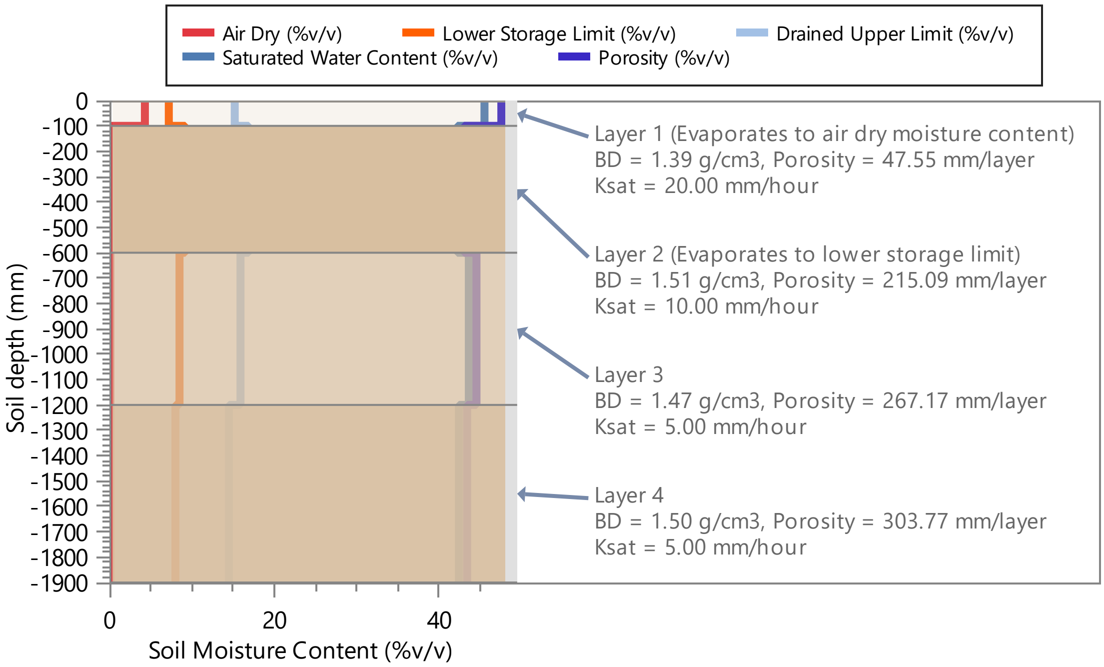
DESCRIPTION

Land: Sandalwood Paddock

Area (ha): 10.00

Soil Type: Red Earth, 1900.00 mm defined profile depth

Profile Porosity (mm)	833.58
Profile saturation water content (mm)	814.90
Profile drained upper limit (or field capacity) (mm)	296.60
Profile lower storage limit (or permanent wilting point) (mm)	160.20
Profile available water capacity (mm)	136.40
Profile limiting saturated hydraulic conductivity (mm/hour)	5.00
Surface saturated hydraulic conductivity (mm/hour)	20.00
Runoff curve number II (coefficient)	83.00
Soil evaporation U (mm)	10.00
Soil evaporation Cona (mm/sqrt day)	4.00



Plant Data: Continuous Banana Pasture

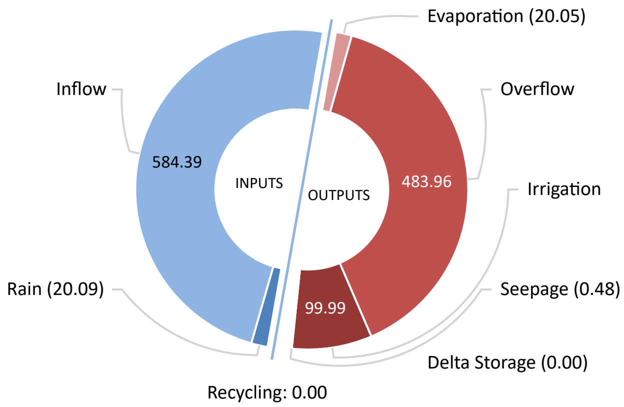
Average monthly cover (fraction) (minimum - maximum)	0.60 (0.56 - 0.64)
Maximum crop factor at 100% cover (mm/mm) (Maximum crop coefficient 0.7 x Pan coefficient 1)	0.70
Total plant cover (both green and dead) left after harvest (fraction)	0.70
Maximum potential root depth in defined soil profile (mm)	600.00
Salt tolerance	Tolerant
Salinity threshold EC sat. ext. (dS/m)	10.00
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.01

PERFORMANCE

Pond System Water Performance - Overflow: 1 facultative, aerobic or storage pond

Capacity of wet weather storage pond: **30 ML**

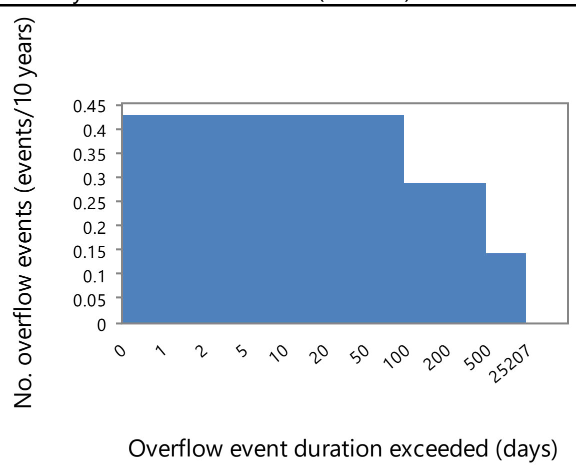
Pond System Water Balance (ML/year)

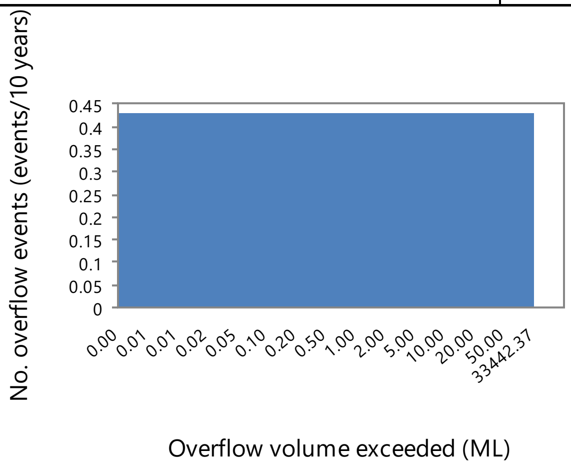


Name	Value
Rain	20.09
Inflow	584.39
Recycling	0.00
Evaporation	20.05
Overflow	483.96
Irrigation	99.99
Seepage	0.48
Delta Storage	0.00

Overflow Diagnostics

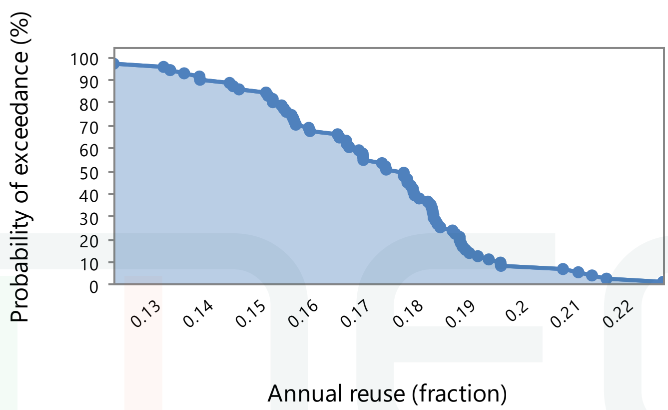
Volume of overflow (ML/year)	483.96
No. days pond overflows (days/year)	365.21
Average duration of overflow (days)	8521.67
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	0.17
Probability of at least 90% reuse (fraction)	0.00





Export plot

Export plot



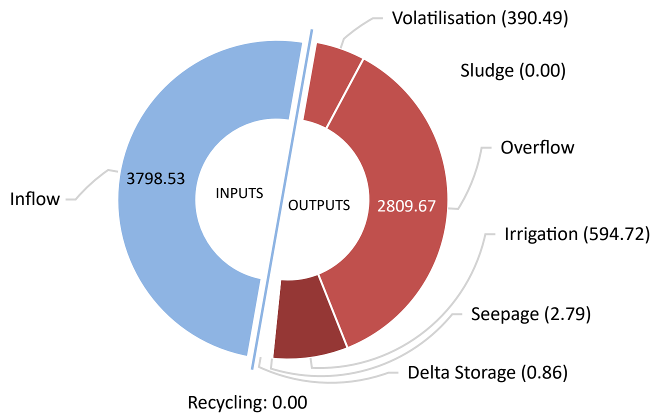
Export plot

PERFORMANCE

Pond System Performance - Nutrient: 1 facultative, aerobic or storage pond

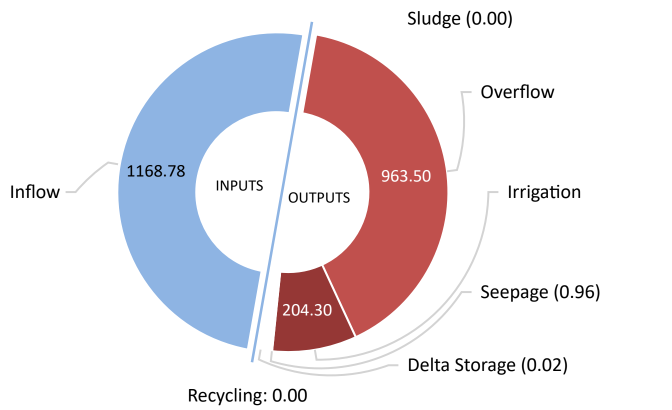
Pond System Nutrients and Salt Balance:

Nitrogen Balance (kg/year)



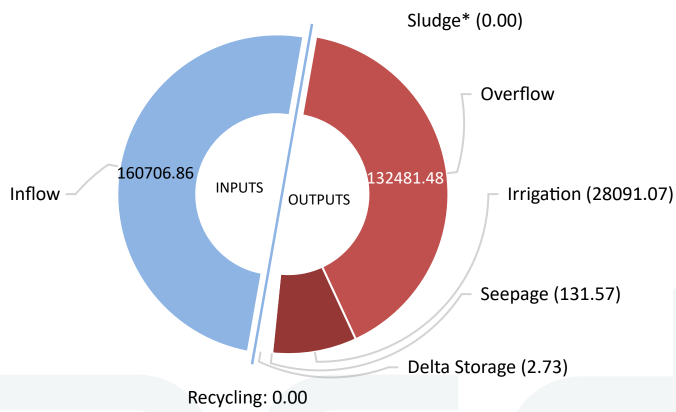
Name	Value
Inflow	
Recycling	
Volatilisation	
Sludge	
Overflow	
Irrigation	
Seepage	
Delta Storage	

Phosphorus Balance (kg/year)



Name	Value
Inflow	
Recycling	
Sludge	
Overflow	
Irrigation	
Seepage	
Delta Storage	

Salt Balance (kg/year)



Name	Value
Inflow	
Recycling	
Sludge*	
Overflow	
Irrigation	
Seepage	
Delta Storage	

* Salt removal in sludge is not calculated from the pond salt balance. However if salt could be assumed to be present in the sludge at the same concentration as in the pond supernatant (up to a maximum of salt added in inflow) - then salt accumulation in the sludge could be 0.00 kg/year

Pond System Sludge Accumulation: 0.00 kg dwt/year

PERFORMANCE

Pond System Performance - Nutrient: 1 facultative, aerobic or storage pond

Pond Nutrient Concentrations and Salinity:

Average across simulation period	Pond 1
Average nitrogen concentration of pond liquid (mg/L)	5.80
Average phosphorus concentration of pond liquid (mg/L)	2.00
Average salinity of pond liquid (dS/m)	0.43

Value on final day of simulation period	Pond 1
Final nitrogen concentration of pond liquid (mg/L)	5.92
Final phosphorus concentration of pond liquid (mg/L)	2.05
Final salinity of pond liquid (dS/m)	0.44

PERFORMANCE

Irrigation Performance:

Water Use: (assumes 100% Irrigation Efficiency)

Pond water irrigated (ML/year)	99.99
Average Shandy water irrigation (ML/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Total water irrigated (ML/year)	99.99
Proportion of irrigation events requiring shandying (fraction of events)	0.00
Proportion of years shandying water allocation of 0 ML/year is exceeded (fraction of years)	0.00
Average exceedance as a proportion of annual shandy water allocation (fraction of allocation) (minimum - maximum)	0.00 (0.00 - 0.00)

Irrigation Quality:

Average nitrogen concentration of irrigation water - before ammonia loss during irrigation (mg/L)	5.95
Average nitrogen concentration of irrigation water - after ammonia loss during irrigation (mg/L)	5.83
Average phosphorus concentration of irrigation water (mg/L)	2.04
Average salinity of irrigation water (dS/m)	0.44

Irrigation Diagnostics:

Proportion of Days rain prevents irrigation (fraction)	0.17
Proportion of Days water demand too small to trigger irrigation (fraction)	0.11
Proportion of Days irrigation occurs (fraction)	0.72

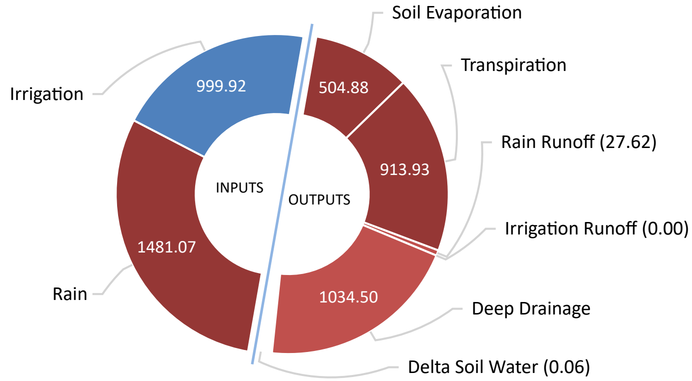
PERFORMANCE

Land Performance - Soil Water

Paddock: **Sandalwood Paddock, 10 ha**
Soil Type: **Red Earth**, **46.50 mm PAWC at maximum root depth**

Land Water Balance (mm/year):

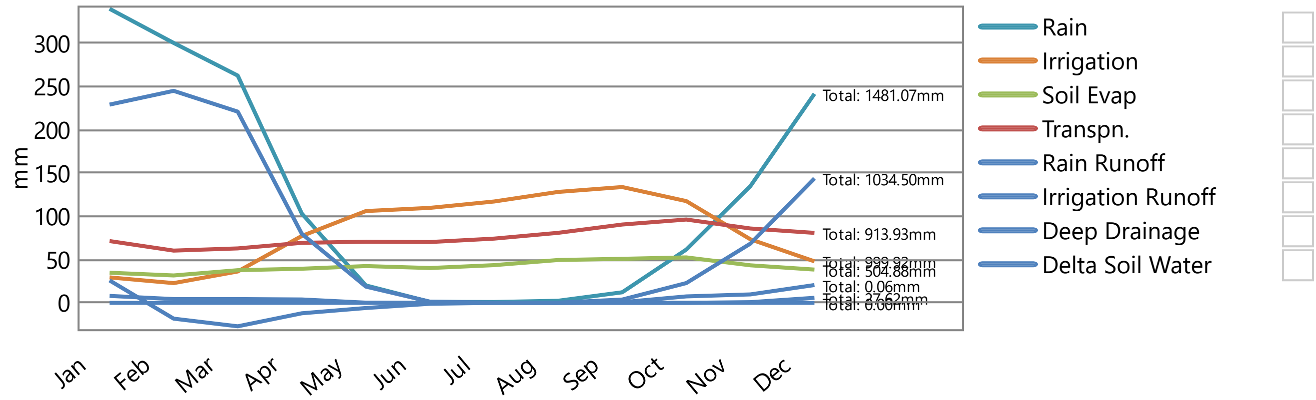
■ mm/year ☐ % Total inputs



Name	Value
Rain	
Irrigation	
Soil Evaporation	
Transpiration	
Rain Runoff	
Irrigation Runoff	
Deep Drainage	
Delta Soil Water	

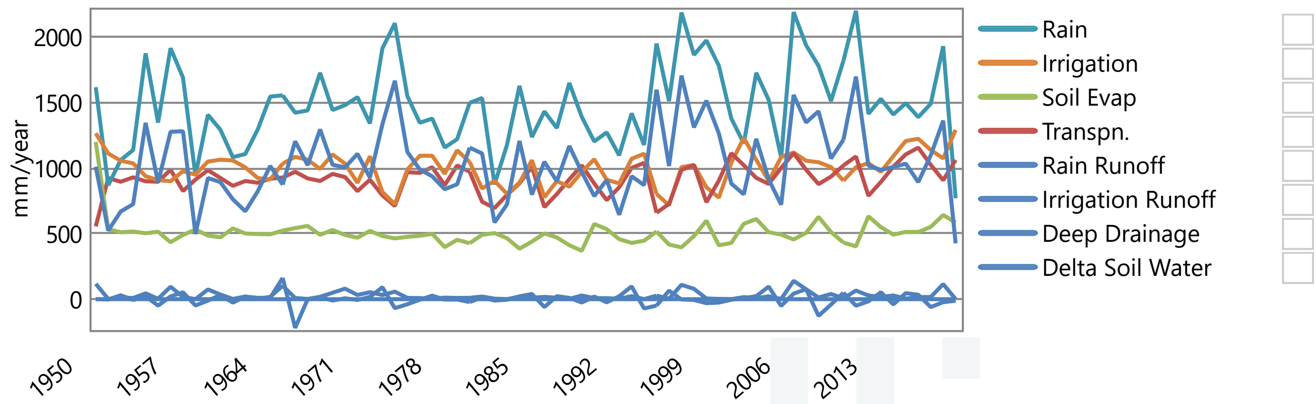
Average Monthly Totals (mm):

■ Chart ☐ Table



Average Annual Totals (mm/year):

■ Chart ☐ Table



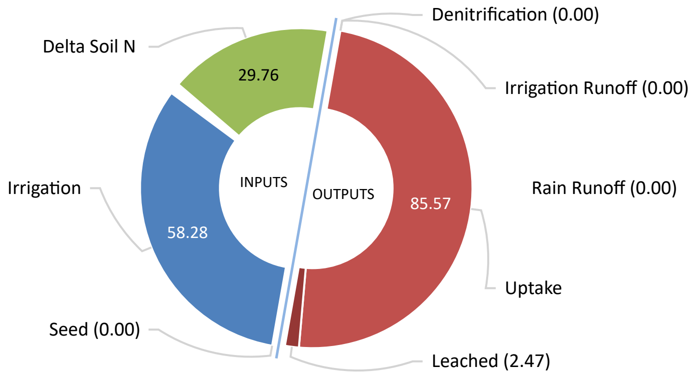
PERFORMANCE

Land Performance - Soil Nutrient

Paddock: Sandalwood Paddock, 10 ha **Soil Type: Red Earth**

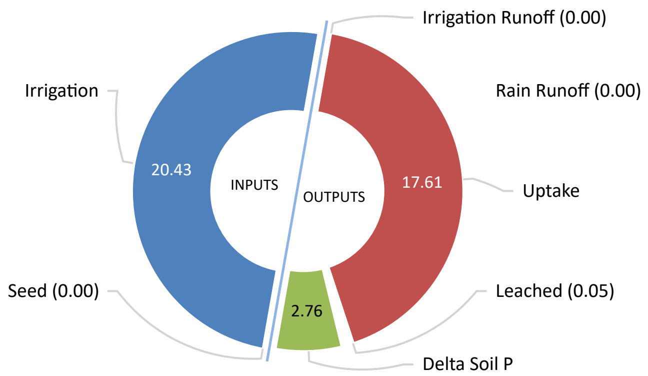
Irrigation ammonium volatilisation losses (kg/ha/year): 1.19
Proportion of total nitrogen in irrigated effluent as ammonium (fraction): 0.10

Land Nitrogen Balance (kg/ha/year)



Name	Value
Seed	2.14E-03
Irrigation	58.28
Denitrification	3.43E-03
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	85.57
Leached	2.47
Delta Soil N	-29.76

Land Phosphorus Balance (kg/ha/year)



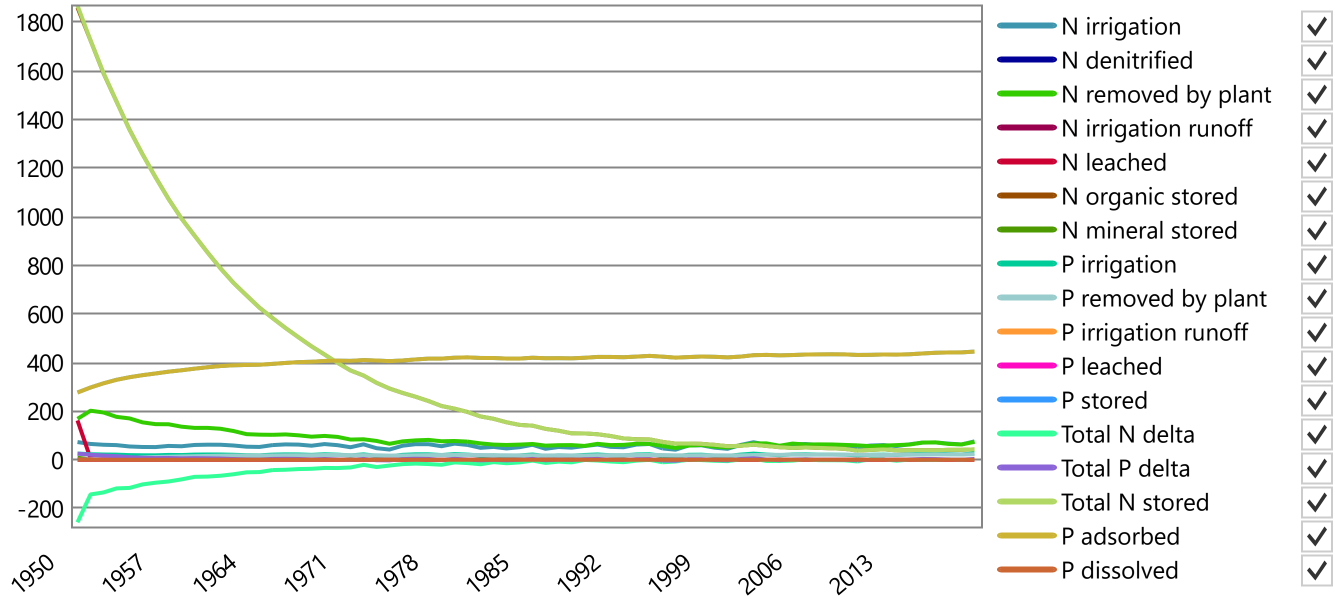
Name	Value
Seed	1.29E-03
Irrigation	20.43
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	17.61
Leached	0.05
Delta Soil P	2.76

PERFORMANCE

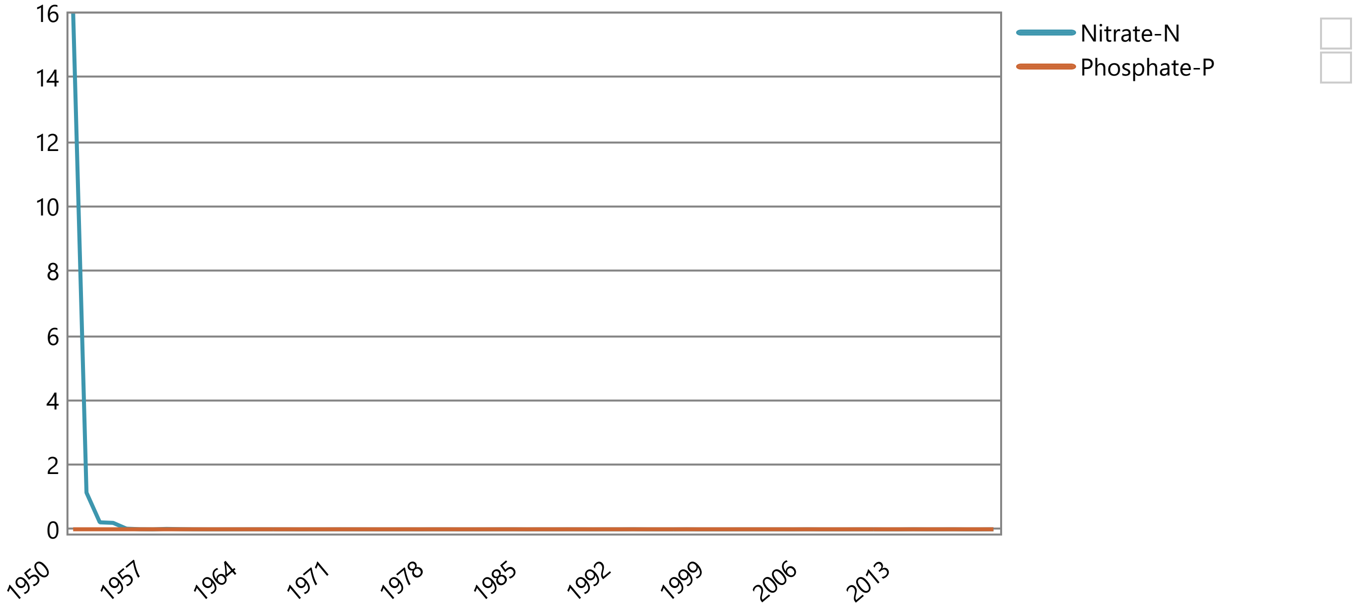
Land Performance - Soil Nutrient

Paddock: Sandalwood Paddock, 10 ha **Soil Type**: Red Earth

Annual Nutrient Totals (kg/ha):



Annual Nutrient Leaching Concentration (mg/L):



PERFORMANCE

Plant Performance and Nutrients

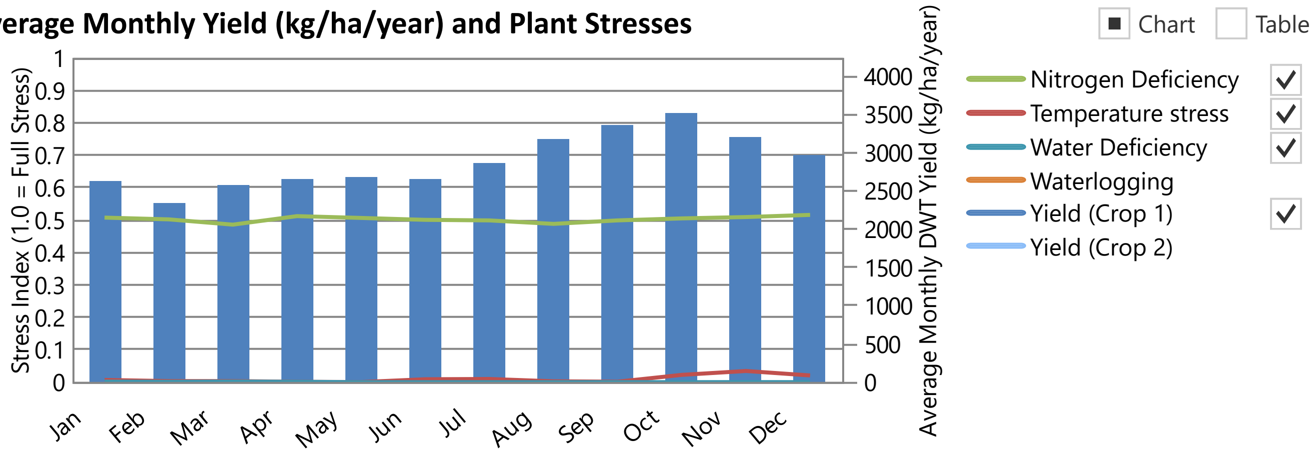
Paddock: Sandalwood Paddock, 10 ha

Soil Type: Red Earth

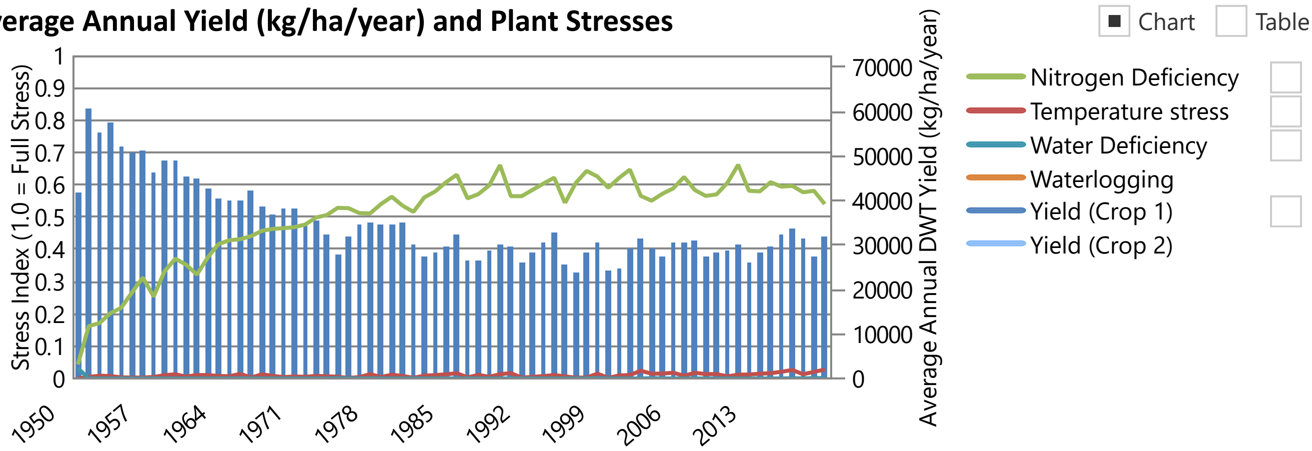
Plant: Continuous Banana Pasture

Nutrient Uptake (minimum - maximum):

Average Monthly Yield (kg/ha/year) and Plant Stresses



Average Annual Yield (kg/ha/year) and Plant Stresses



No. of harvests/year: 0.93 (normal)
No. days without crop/year (days/year): 0.00

PERFORMANCE

Land Performance

Paddock: Sandalwood Paddock, 10 ha **Soil Type: Red Earth**

Plant: Continuous Banana Pasture

	10.00
	0.01
	10.00

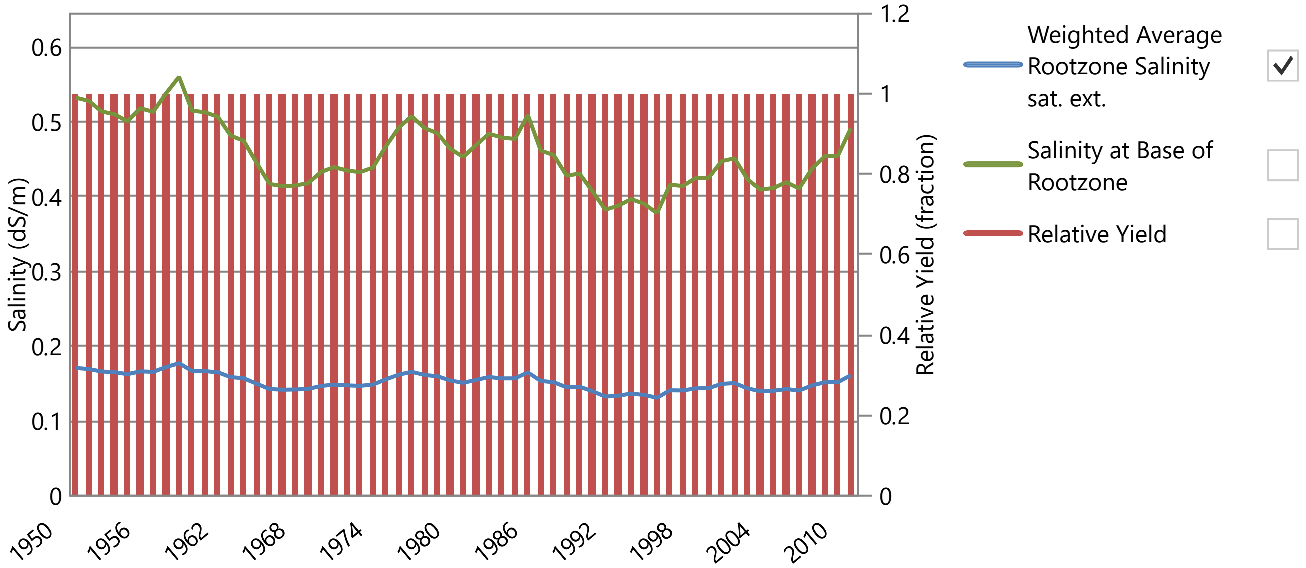
Soil Salinity:

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.19
	279.06
	3088.17
	0.58
	0.15
	0.46
	1.00
	0.00

Average Annual Rootzone Salinity and Relative Yield:

■ Chart ☐ Table

All values based on 10 year running averages



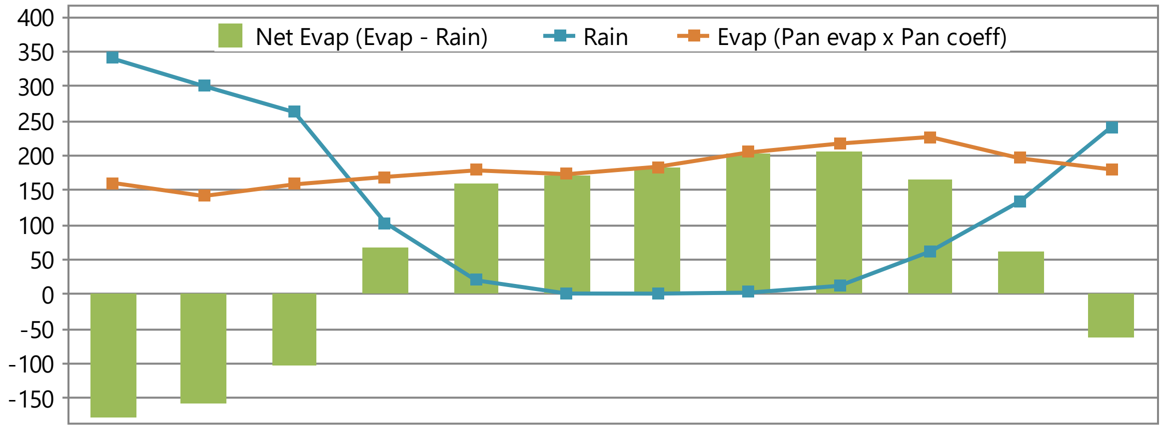
DIAGNOSTICS

Sustainability Diagnostics: Janamba Crocodile Farm

Averaged Historical Climate Data Used in Simulation (mm)

Location: Middle Point Rangers, -12.58°, 131.31°

Run Period: 01/01/1950 to 31/12/2019 70 years, 0 days



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	339.8	300.4	262.7	103.2	20.2	1.1	1.0	2.4	12.2	61.6	134.9	241.6	1481.1
Evap	160.7	141.7	158.5	169.3	178.7	173.3	183.9	204.6	217.4	226.9	195.9	180.0	2190.9
Net Evap	-179.2	-158.6	-104.1	66.1	158.6	172.1	182.9	202.1	205.2	165.3	61.0	-61.6	709.8
Net Evap/day	-5.8	-5.6	-3.4	2.2	5.1	5.7	5.9	6.5	6.8	5.3	2.0	-2.0	1.9

DIAGNOSTICS

Sustainability Diagnostics: Janamba Crocodile Farm

Pond System: 1 facultative, aerobic or storage pond

Janamba Croc Farm - 584.39 ML/year or 1.60 ML/day generated on average

Effluent entering pond system after any pretreatment and recycling

Average (Minimum-Maximum) influent quality calculated for 365.24 non-zero flow days, after any pretreatment and recycling.

Constituent	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	6.50 (6.50 - 6.50)	3798.53 (3796.00 - 3806.40)
Total Phosphorus	2.00 (2.00 - 2.00)	1168.78 (1168.00 - 1171.20)
Total Dissolved Salts	275.00 (275.00 - 275.00)	160706.86 (160600.00 - 161040.00)
Volatile Solids	50.00 (50.00 - 50.00)	29219.43 (29200.00 - 29280.00)
Total Solids	200.00 (200.00 - 200.00)	116877.71 (116800.00 - 117120.00)

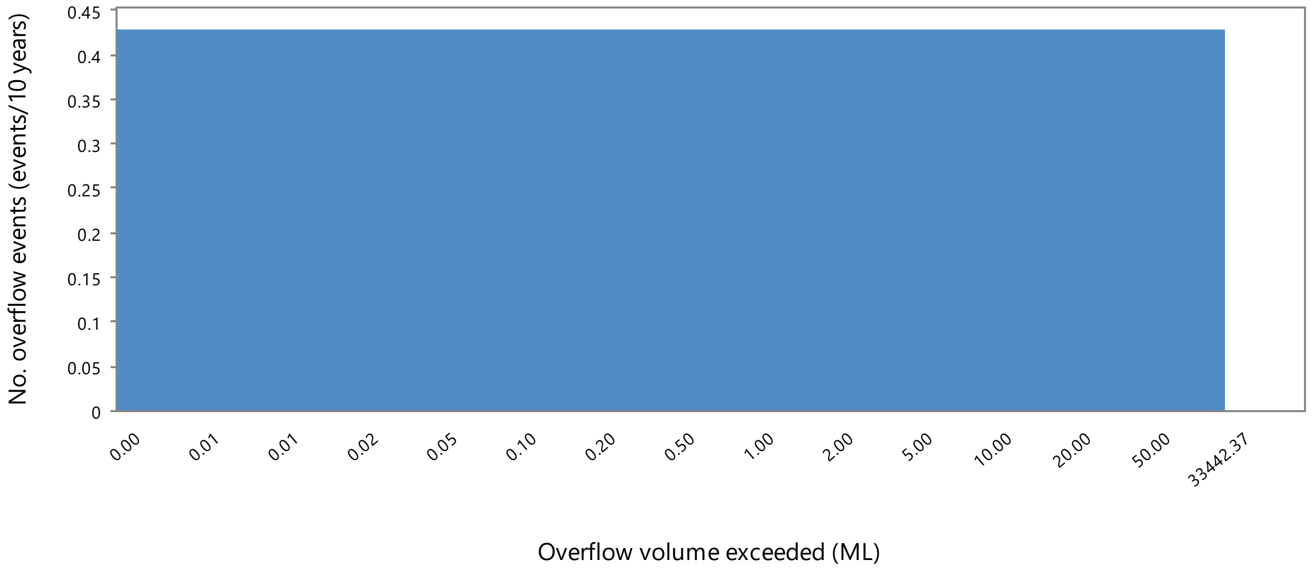
Last pond (Wet weather store): 30.00 ML

Theoretical hydraulic retention time (days)	18.75
Average volume of overflow (ML/year)	483.96
No. overflow events per year exceeding threshold* of 0.01 ML (no./year)	0.04
Average duration of overflow (days)	8521.67
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	0.17
Probability of at least 90% effluent reuse (fraction)	0.00
Average salinity of last pond (dS/m)	0.43
Salinity of last pond on final day of simulation (dS/m)	0.44
Ammonia loss from pond system water area (kg/m2/year)	2.09

* The threshold is the volume equivalent to the top 1 mm depth of water of a full pond

Overflow exceedance:

Chart Table



Export plot

DIAGNOSTICS

Sustainability Diagnostics: Janamba Crocodile Farm

Irrigation Information

Irrigation: 10 ha total area (assumed 100% irrigation efficiency)

	Quantity/year	Quantity/ha/year
Total irrigation applied (ML)	99.99	10.00
Total nitrogen applied (kg)	582.82	58.28
Total phosphorus applied (kg)	204.30	20.43
Total salts applied (kg)	28091.07	2809.11

Shandying

Annual allocation of fresh water for shandying (ML/year)	0.00
Average Shandy water irrigation (ML/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Average exceedance as a proportion of annual shandy water allocation (% of allocation) (minimum - maximum)	0.00 (0.00 - 0.00)
Proportion of irrigation events requiring shandying (fraction of events)	0.00
Minimum shandy water is used	False

Irrigation Issues

Proportion of Days irrigation is prevented when triggered (fraction)	0.17
Proportion of Days water demand is too small to trigger irrigation (fraction)	0.11
Proportion of Days irrigation occurs (fraction)	0.72

DIAGNOSTICS

Sustainability Diagnostics: Janamba Crocodile Farm

Paddock Land: Sandalwood Paddock: 10 ha

Irrigation: Fixed Sprinkler with 0.2% ammonium loss during irrigation

Irrigation triggered when soil water deficit reaches 0.00 mm and rainfall is less than or equal to 5.00 mm
Irrigate up to a soil water content of drained upper limit plus 0.00 mm
Irrigation window from 1/1 to 31/12 including the days specified
A minimum of 0 days must be skipped between irrigation events

Soil Water Balance (mm): Red Earth, 46.50 mm PAWC at maximum root depth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	339.8	300.4	262.7	103.2	20.2	1.1	1.0	2.4	12.2	61.6	134.9	241.6	1481.1
Irrigation	29.4	22.8	36.3	77.3	106.1	109.8	117.1	128.2	133.8	117.6	73.5	48.0	999.9
Soil Evap	34.8	31.7	37.7	39.5	42.5	40.3	43.6	49.5	50.9	52.5	43.4	38.5	504.9
Transpn.	71.4	60.4	62.9	69.4	70.7	70.3	74.3	80.9	90.5	96.3	85.9	80.9	913.9
Rain Runoff	8.0	4.4	4.4	3.9	0.2	0.0	0.0	0.0	0.0	0.0	0.8	5.9	27.6
Irr. Runoff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Drainage	229.1	245.0	221.0	79.8	18.8	1.4	0.3	0.3	3.8	22.9	68.5	143.8	1034.5
Delta	25.9	-18.2	-27.1	-12.1	-5.9	-1.1	0.0	-0.1	0.8	7.5	9.8	20.6	0.1

Soil Nitrogen Balance

Average annual effluent nitrogen added (kg/ha/year)	58.28
Average annual soil nitrogen removed by plant uptake (kg/ha/year)	85.57
Average annual soil nitrogen removed by denitrification (kg/ha/year)	3.43E-03
Average annual soil nitrogen leached (kg/ha/year)	2.47
Average annual nitrate-N loading to groundwater (kg/ha/year)	2.47
Soil organic-N kg/ha (Initial - Final)	1984.50 - 42.76
	141.30 - 0.02
Average nitrate-N concentration of deep drainage (mg/L)	0.24
Max. annual nitrate-N concentration of deep drainage (mg/L)	16.01

Soil Phosphorus Balance

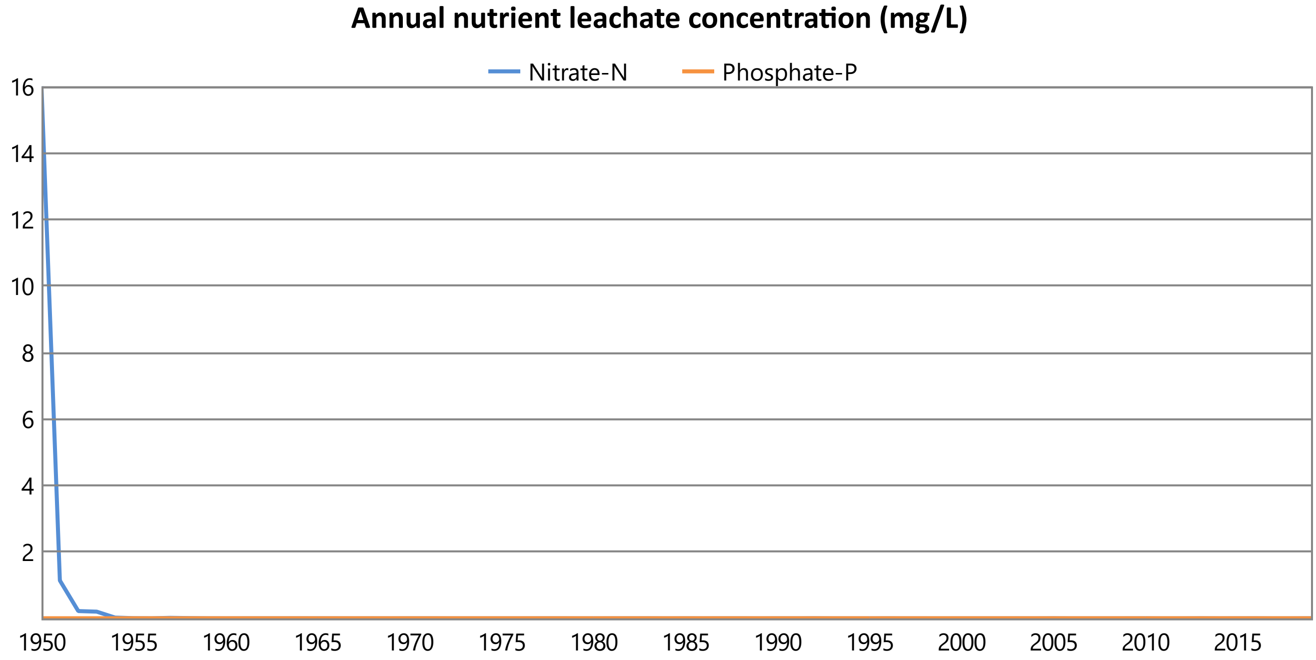
Average annual effluent phosphorus added (kg/ha/year)	20.43
Average annual soil phosphorus removed by plant uptake (kg/ha/year)	17.61
Average annual soil phosphorus leached (kg/ha/year)	0.05
Dissolved phosphorus (kg/ha) (Initial - Final)	0.01 - 0.02
Adsorbed phosphorus (kg/ha) (Initial - Final)	251.51 - 445.01
Average phosphate-P concentration in rootzone (mg/L)	0.01
Average phosphate-P concentration of deep drainage (mg/L)	0.01
Max. annual phosphate-P concentration of deep drainage (mg/L)	0.01
Design soil profile storage life based on average infiltrated water phosphorus concn. of 0.83 mg/L (years)	204.65

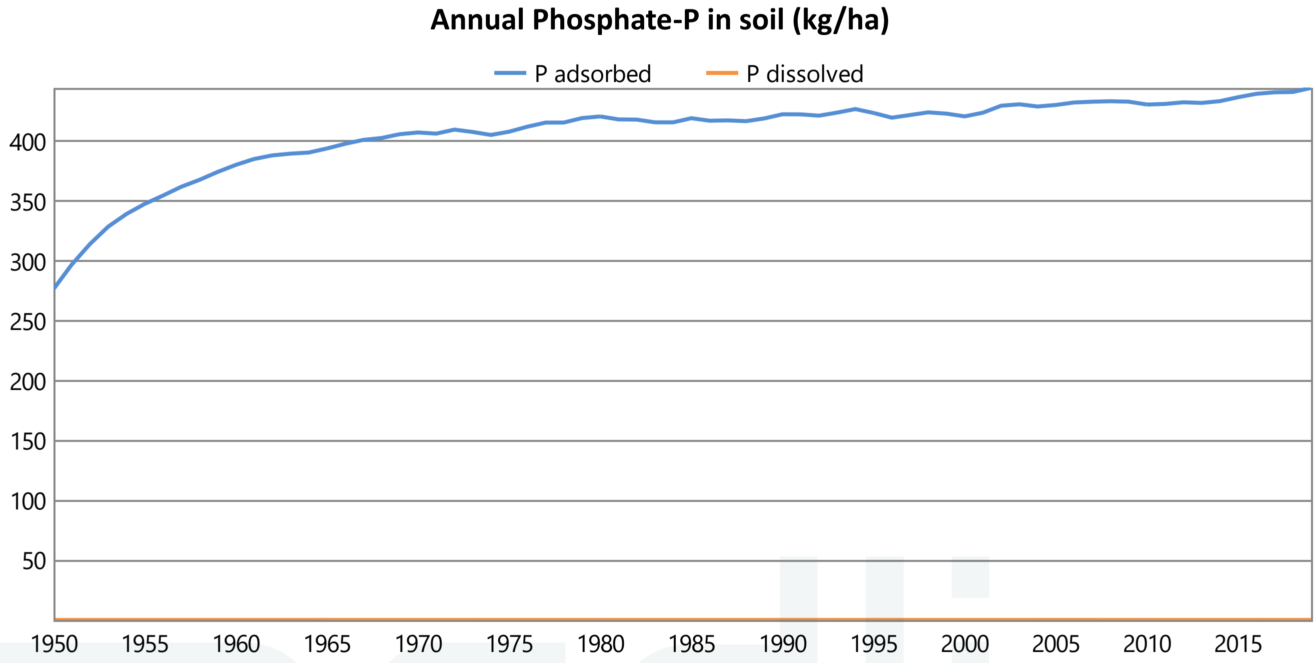
DIAGNOSTICS

Sustainability Diagnostics: Janamba Crocodile Farm

Paddock Land: Sandalwood Paddock: 10 ha

Irrigation: Fixed Sprinkler with 0.2% ammonium loss during irrigation





DIAGNOSTICS

Sustainability Diagnostics: Janamba Crocodile Farm

Paddock Plant Performance: Sandalwood Paddock: 10 ha

Average Plant Performance (Minimum - Maximum): Continuous Banana Pasture

Average annual shoot dry matter yield (kg/ha/year)	34691.66 (23936.81 - 60545.63)
Average monthly plant (green) cover (fraction)	0.60 (0.56 - 0.64)
Average monthly crop factor (fraction)	0.42 (0.39 - 0.45)
Total plant cover (both green and dead) left after harvest (fraction)	0.70
Average monthly root depth (mm)	595.76 (592.00 - 598.98)
Average number of normal harvests per year (no./year)	0.93 (0.00 - 2.00)
Average number of normal harvests for last five years only (no./year)	0.80
Average number of crop deaths per year (no./year)	0.00 (0.00 - 0.00)
Average number of crop deaths for last five years only (no./year)	0.00
Average annual nitrogen deficiency index (0 = no stress, 1 = full stress) (coefficient)	0.50 (0.04 - 0.66)
Average January temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.01 (0.00 - 0.06)
Average July temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.01 (0.00 - 0.10)
Average monthly water stress index (0 = no stress, 1 = full stress) (coefficient)	0.00 (0.00 - 0.00)
Average monthly waterlogging index (0 = no stress, 1 = full stress) (coefficient)	0.00 (0.00 - 0.00)
No. days without crop/year (days)	0.00

Soil Salinity - Plant salinity tolerance: Tolerant

Assumes 1.0 dS/m Electrical Conductivity = 640 mg/L Total Dissolved Salts
All values based on 10 year running averages

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.19
Salt added by rainfall (kg/ha/year)	279.06
Average annual effluent salt added & leached at steady state (kg/ha/year)	3088.17
Average leaching fraction based on 10 year running averages (fraction)	0.58
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.15
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	0.46
Relative crop yield expected due to salinity (fraction)	1.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (fraction)	0.00

DIAGNOSTICS

Run Messages

Messages generated when the scenario was run:

Full run chosen

MEDLI REPORT - FULL RUN

Enterprise: **Janamba Crocodile Farm**

Description:
No subject entered

Client: **Croc Pac Pty Ltd**

MEDLI User: Emma Lewis

Scenario Details:

DESCRIPTION

Climate Data: Middle Point Rangers, -12.58°, 131.31°

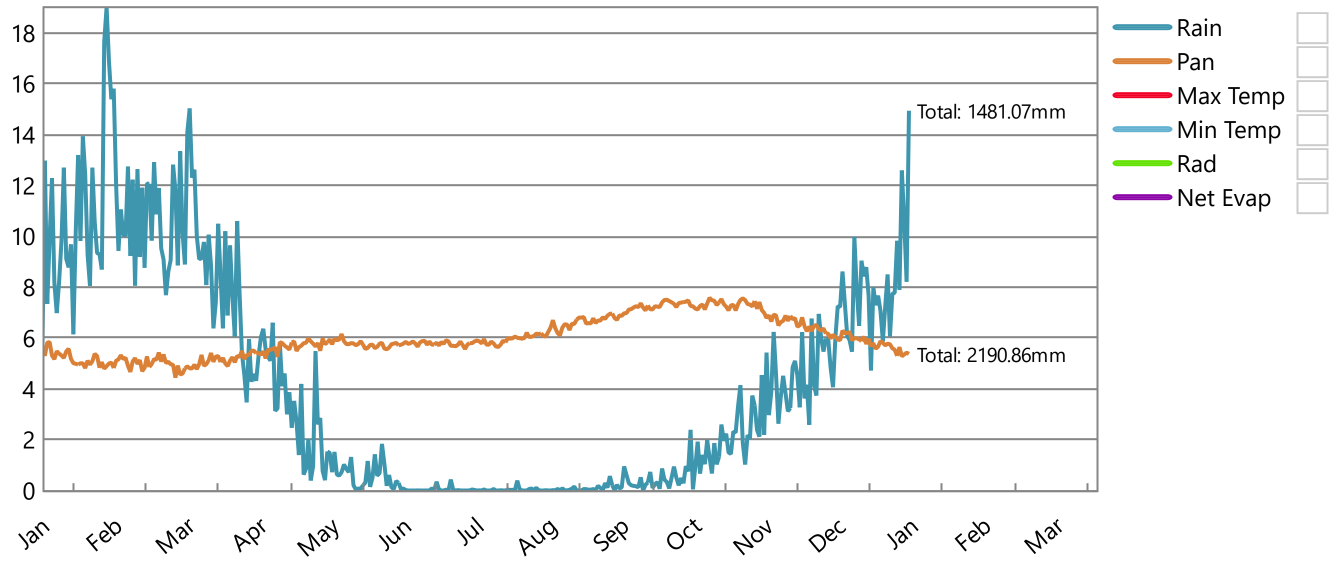
Run Period: 01/01/1950 to 31/12/2019 70 years, 0 days

Climate Statistics:

Climate Data:

Chart Table
Monthly Daily

Daily Average Across Run Period



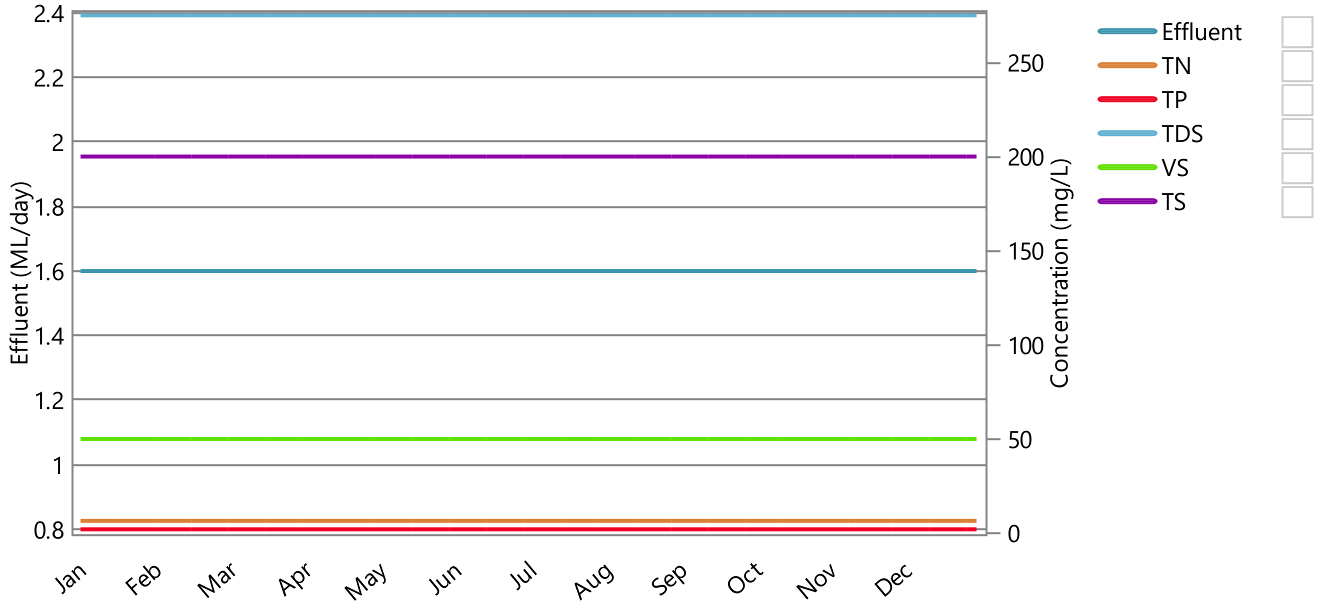
DESCRIPTION

Effluent type: Janamba Croc Farm

Wastestream before any recycling or pretreatment

Average daily quantity and flow-weighted average quality:

Chart Table



Wastestream after any recycling and pretreatment if applicable

Effluent quantity: 584.39 ML/year or 1.60 ML/day (Min-Max: 1.60 - 1.60)

Flow-weighted average (minimum - maximum) daily effluent quality entering pond system:

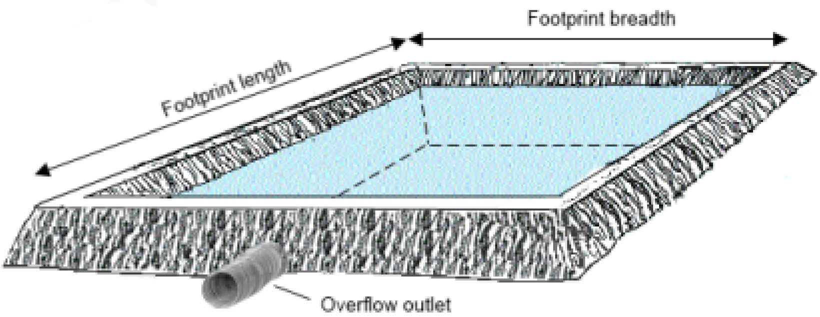
	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	6.50 (6.50 - 6.50)	3798.53 (3796.00 - 3806.40)
Total Phosphorus	2.00 (2.00 - 2.00)	1168.78 (1168.00 - 1171.20)
Total Dissolved Salts	275.00 (275.00 - 275.00)	160706.86 (160600.00 - 161040.00)
Volatile Solids	50.00 (50.00 - 50.00)	29219.43 (29200.00 - 29280.00)
Total Solids	200.00 (200.00 - 200.00)	116877.71 (116800.00 - 117120.00)

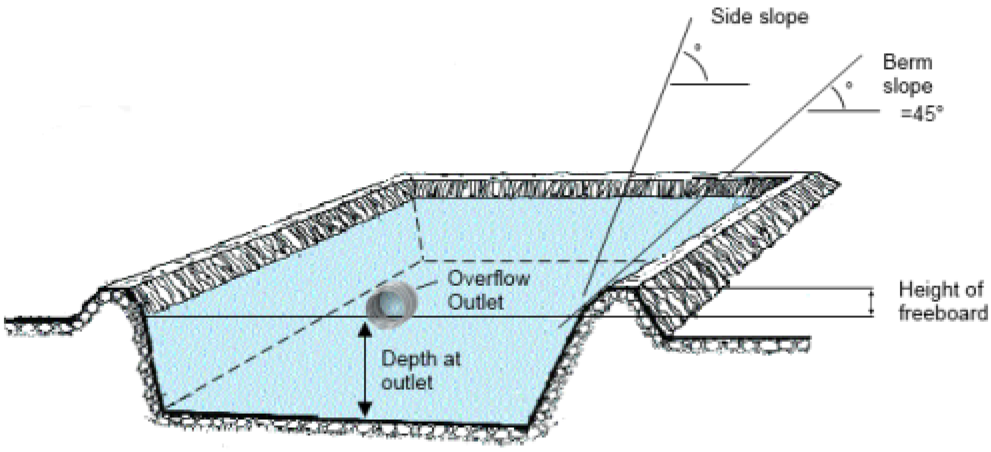
DESCRIPTION

Pond system: 1 facultative, aerobic or storage pond

Pond system details:

	Pond 1
Maximum pond volume (ML)	30.00
Minimum allowable pond volume (ML)	1.20
Pond depth at overflow outlet (m)	2.40
Maximum water surface area (m2)	13074.10
Pond footprint length (m)	163.70
Pond footprint width (m)	82.85
Pond catchment area (m2)	13563.21
Average active volume (ML)	29.64





Irrigation pump limits:

Minimum pump rate per area limit (ML/day/ha)	0.00
Maximum pump rate per area limit (ML/day/ha)	10.00

Shandying water:

Annual allocation of fresh water available for shandying (ML/year)	0.00
Maximum rate of application of fresh water (ML/day)	0.00
Nitrogen concentration (mg/L)	0.00
Salinity (dS/m)	0.00
Minimum shandy water is used	False

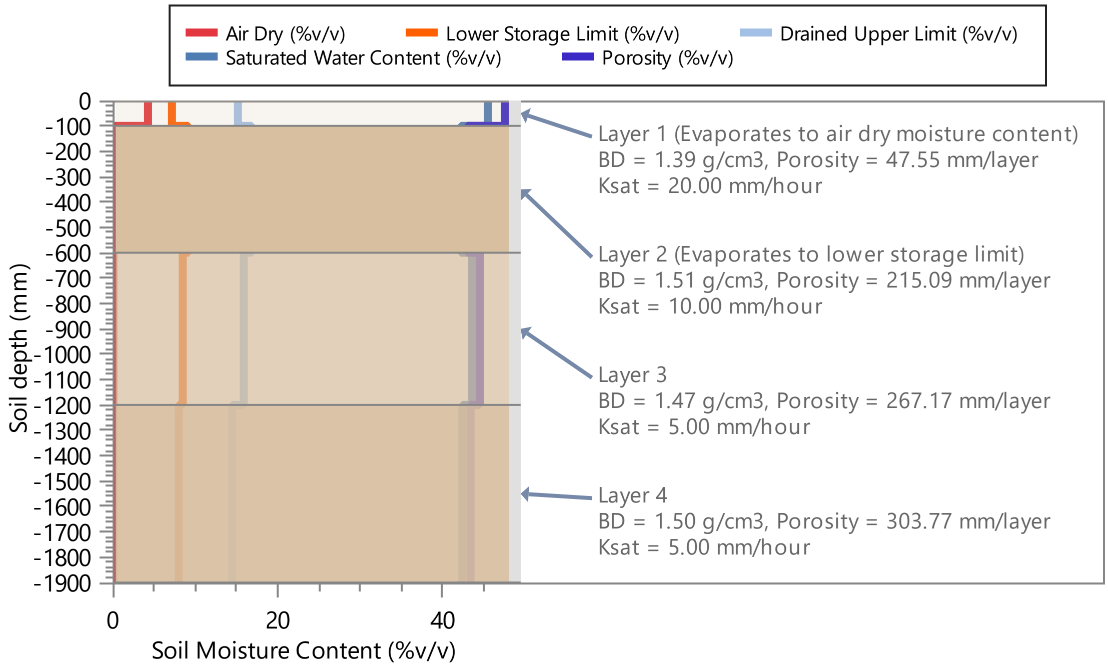
DESCRIPTION

Land: Sandalwood Paddock

Area (ha): 10.00

Soil Type: Red Earth, 1900.00 mm defined profile depth

Profile Porosity (mm)	833.58
Profile saturation water content (mm)	814.90
Profile drained upper limit (or field capacity) (mm)	296.60
Profile lower storage limit (or permanent wilting point) (mm)	160.20
Profile available water capacity (mm)	136.40
Profile limiting saturated hydraulic conductivity (mm/hour)	5.00
Surface saturated hydraulic conductivity (mm/hour)	20.00
Runoff curve number II (coefficient)	83.00
Soil evaporation U (mm)	10.00
Soil evaporation Cona (mm/sqrt day)	4.00



Plant Data: Monthly Covers - Forest with 70 Percent Cover

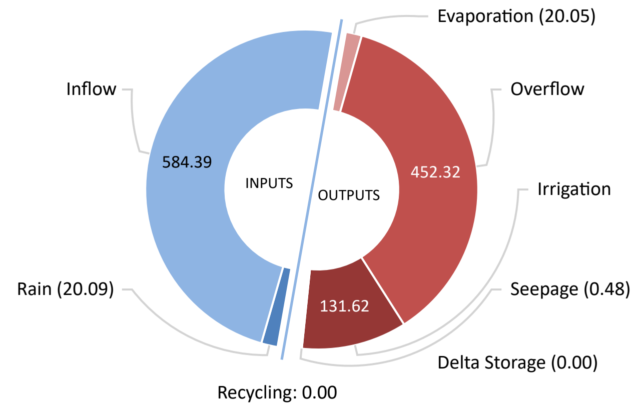
Average monthly cover (fraction) (minimum - maximum)	0.70 (0.70 - 0.70)
Maximum crop factor at 100% cover (mm/mm) (Maximum crop coefficient 0.8 x Pan coefficient 1)	0.80
Total plant cover (both green and dead) left after harvest (fraction)	0.20
Maximum potential root depth in defined soil profile (mm)	1900.00
Salt tolerance	Tolerant
Salinity threshold EC sat. ext. (dS/m)	20.00
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.20

PERFORMANCE

Pond System Water Performance - Overflow: 1 facultative, aerobic or storage pond

Capacity of wet weather storage pond: **30 ML**

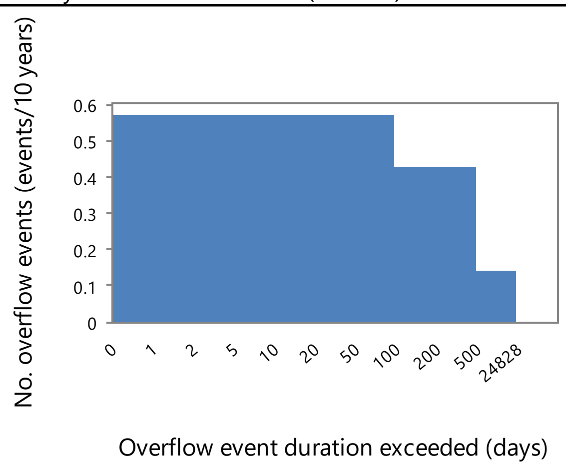
Pond System Water Balance (ML/year)

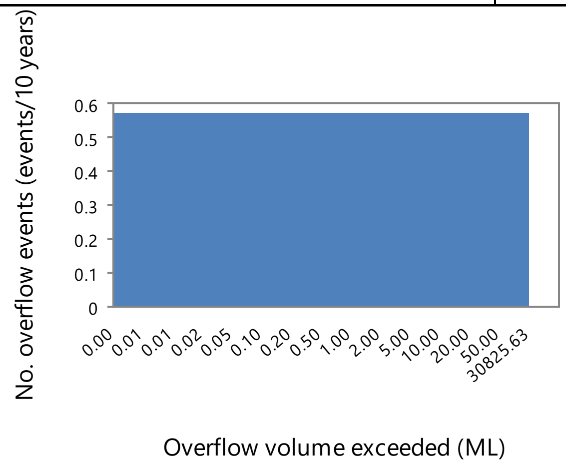


Name	Value
Rain	20.09
Inflow	584.39
Recycling	0.00
Evaporation	20.05
Overflow	452.32
Irrigation	131.62
Seepage	0.48
Delta Storage	0.00

Overflow Diagnostics

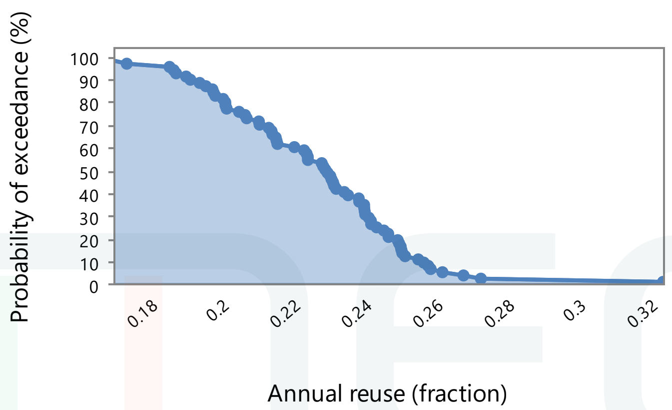
Volume of overflow (ML/year)	452.32
No. days pond overflows (days/year)	365.19
Average duration of overflow (days)	6390.75
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	0.23
Probability of at least 90% reuse (fraction)	0.00





Export plot

Export plot



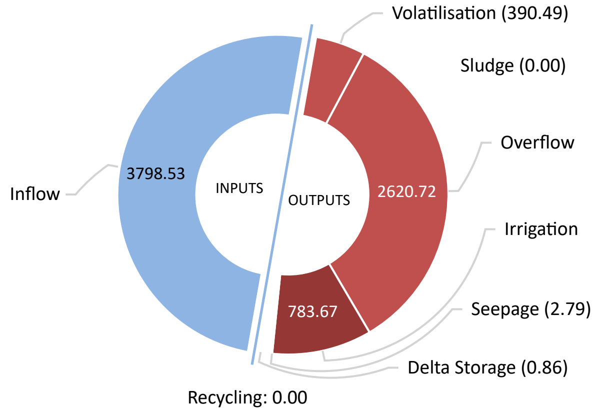
Export plot

PERFORMANCE

Pond System Performance - Nutrient: 1 facultative, aerobic or storage pond

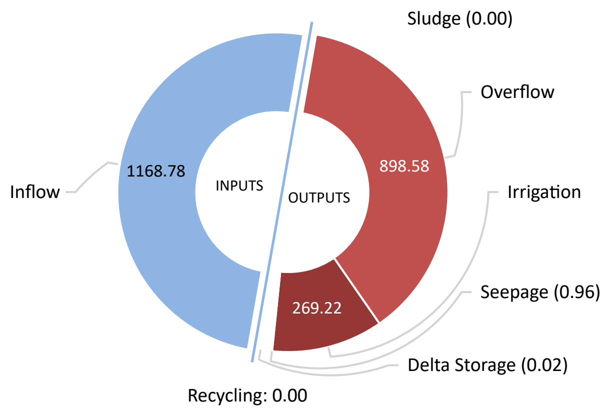
Pond System Nutrients and Salt Balance:

Nitrogen Balance (kg/year)



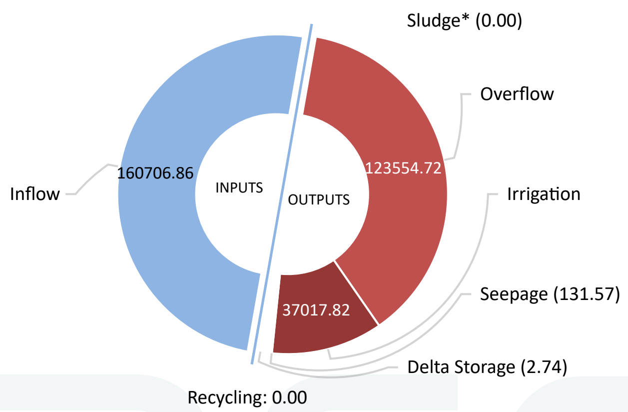
Name	Value
Inflow	3798.53
Recycling	0.00
Volatilisation	390.49
Sludge	0.00
Overflow	2620.72
Irrigation	783.67
Seepage	2.79
Delta Storage	0.86

Phosphorus Balance (kg/year)



Name	Value
Inflow	1168.78
Recycling	0.00
Sludge	0.00
Overflow	898.58
Irrigation	269.22
Seepage	0.96
Delta Storage	0.02

Salt Balance (kg/year)



Name	Value
Inflow	160706.86
Recycling	0.00
Sludge*	0.00
Overflow	123554.72
Irrigation	37017.82
Seepage	131.57
Delta Storage	2.74

* Salt removal in sludge is not calculated from the pond salt balance. However if salt could be assumed to be present in the sludge at the same concentration as in the pond supernatant (up to a maximum of salt added in inflow) - then salt accumulation in the sludge could be 0.00 kg/year

Pond System Sludge Accumulation: 0.00 kg dwt/year

PERFORMANCE

Pond System Performance - Nutrient: 1 facultative, aerobic or storage pond

Pond Nutrient Concentrations and Salinity:

Average across simulation period	Pond 1
Average nitrogen concentration of pond liquid (mg/L)	5.80
Average phosphorus concentration of pond liquid (mg/L)	2.00
Average salinity of pond liquid (dS/m)	0.43

Value on final day of simulation period	Pond 1
Final nitrogen concentration of pond liquid (mg/L)	5.92
Final phosphorus concentration of pond liquid (mg/L)	2.05
Final salinity of pond liquid (dS/m)	0.44

PERFORMANCE

Irrigation Performance:

Water Use: (assumes 100% Irrigation Efficiency)

Pond water irrigated (ML/year)	131.62
Average Shandy water irrigation (ML/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Total water irrigated (ML/year)	131.62
Proportion of irrigation events requiring shandying (fraction of events)	0.00
Proportion of years shandying water allocation of 0 ML/year is exceeded (fraction of years)	0.00
Average exceedance as a proportion of annual shandy water allocation (fraction of allocation) (minimum - maximum)	0.00 (0.00 - 0.00)

Irrigation Quality:

Average nitrogen concentration of irrigation water - before ammonia loss during irrigation (mg/L)	5.95
Average nitrogen concentration of irrigation water - after ammonia loss during irrigation (mg/L)	5.83
Average phosphorus concentration of irrigation water (mg/L)	2.05
Average salinity of irrigation water (dS/m)	0.44

Irrigation Diagnostics:

Proportion of Days rain prevents irrigation (fraction)	0.17
Proportion of Days water demand too small to trigger irrigation (fraction)	0.08
Proportion of Days irrigation occurs (fraction)	0.75

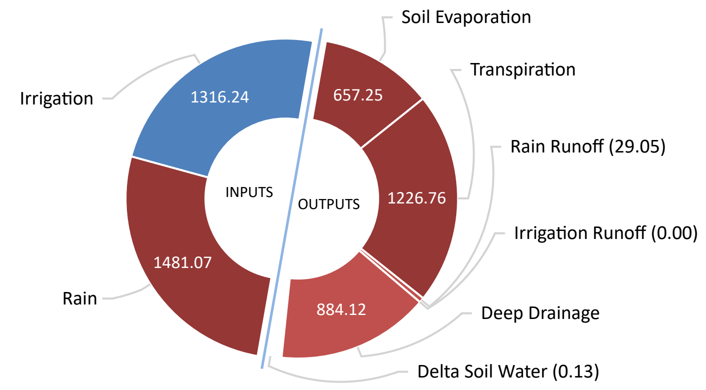
PERFORMANCE

Land Performance - Soil Water

Paddock: Sandalwood Paddock, 10 ha
Soil Type: Red Earth, 136.40 mm PAWC at maximum root depth

Land Water Balance (mm/year):

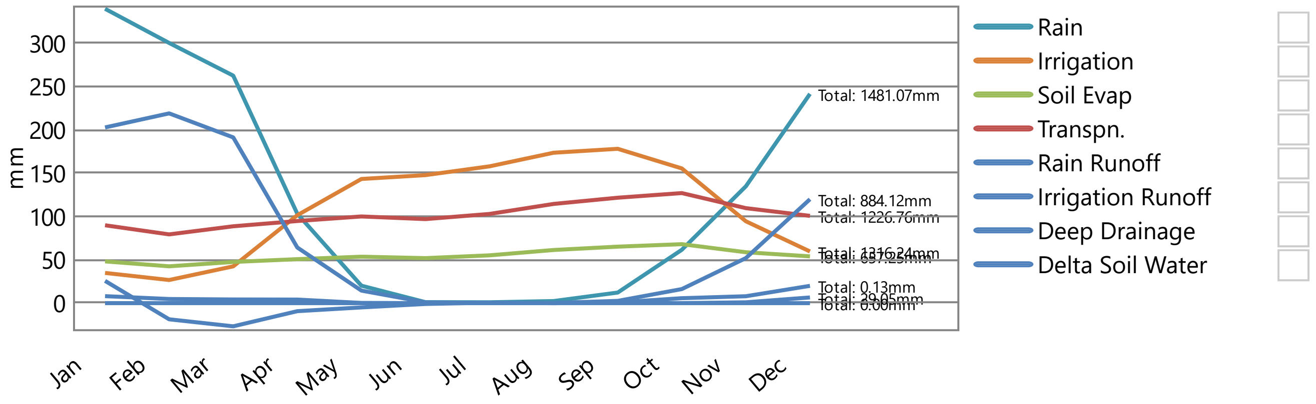
■ mm/year ☐ % Total inputs



Name	Value
Rain	
Irrigation	
Soil Evaporation	
Transpiration	
Rain Runoff	
Irrigation Runoff	
Deep Drainage	
Delta Soil Water	

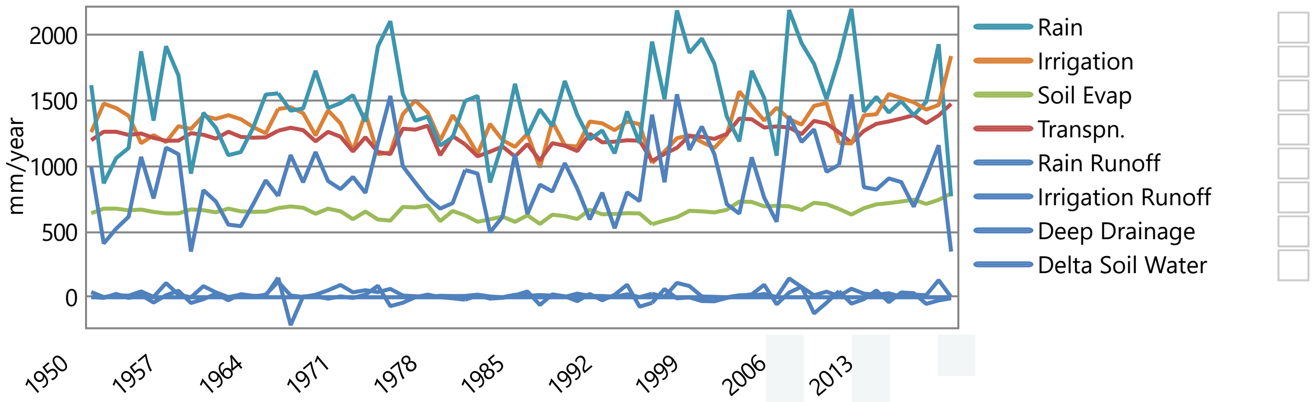
Average Monthly Totals (mm):

■ Chart ☐ Table



Average Annual Totals (mm/year):

■ Chart ☐ Table



PERFORMANCE

Land Performance

Paddock: Sandalwood Paddock, 10 ha **Soil Type: Red Earth**

Irrigation ammonium volatilisation losses (kg/ha/year): 1.57
Proportion of total nitrogen in irrigated effluent as ammonium (fraction): 0.10
Nitrogen added by irrigation (kg/ha/year): 76.80
Phosphorus added by irrigation (kg/ha/year): 26.92

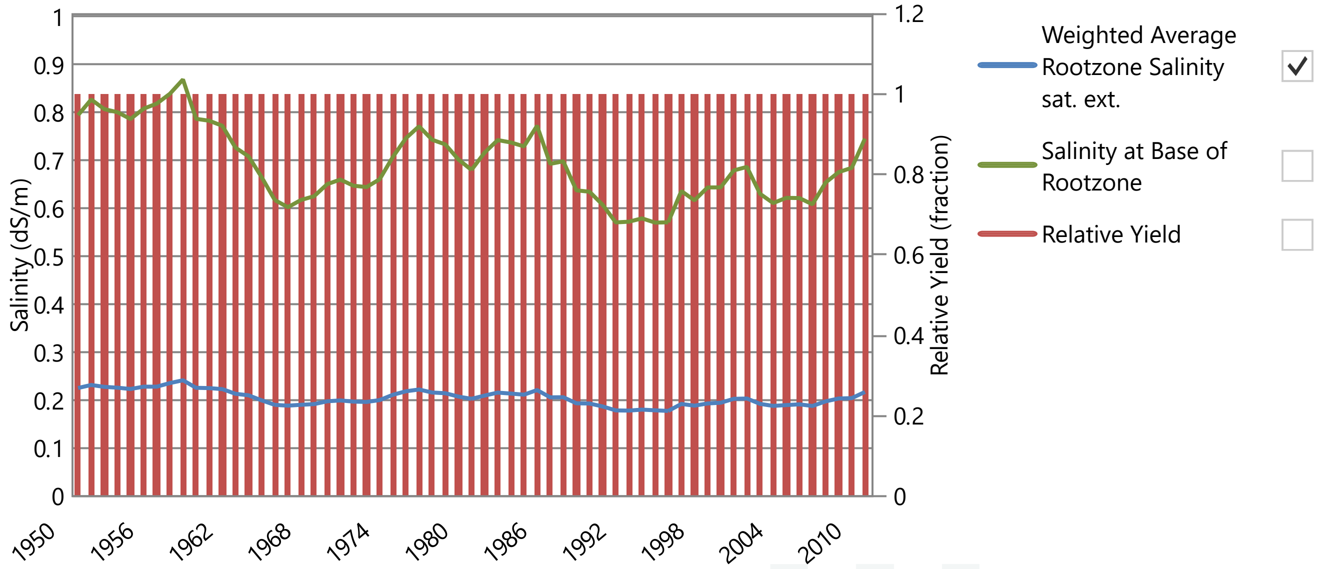
Plant: Monthly Covers - Forest with 70 Percent Cover

	20.00
	0.20
	10.00

Soil Salinity:

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.22
	278.79
	3980.57
	0.49
	0.21
	0.69
	1.00
	0.00

Average Annual Rootzone Salinity and Relative Yield:
Chart Table
All values based on 10 year running averages



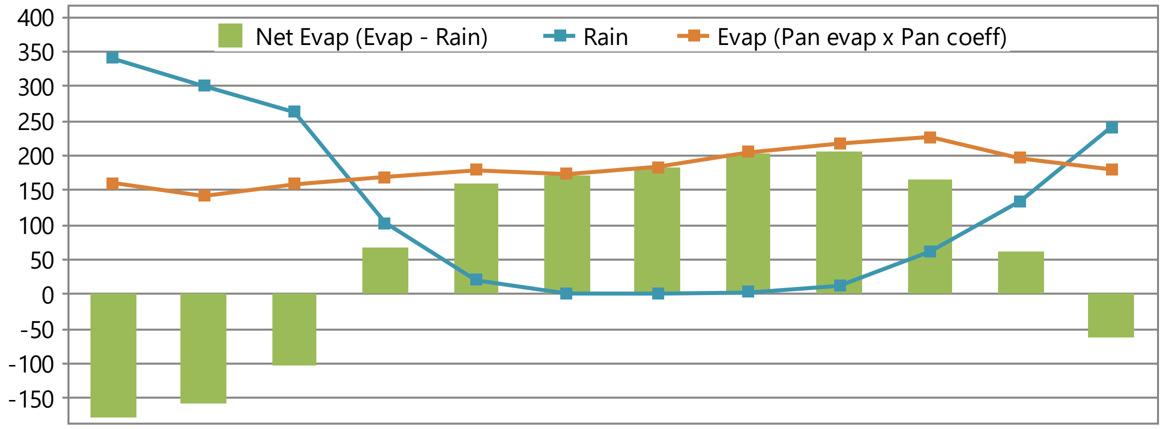
DIAGNOSTICS

Sustainability Diagnostics: Janamba Crocodile Farm

Averaged Historical Climate Data Used in Simulation (mm)

Location: Middle Point Rangers, -12.58°, 131.31°

Run Period: 01/01/1950 to 31/12/2019 70 years, 0 days



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	339.8	300.4	262.7	103.2	20.2	1.1	1.0	2.4	12.2	61.6	134.9	241.6	1481.1
Evap	160.7	141.7	158.5	169.3	178.7	173.3	183.9	204.6	217.4	226.9	195.9	180.0	2190.9
Net Evap	-179.2	-158.6	-104.1	66.1	158.6	172.1	182.9	202.1	205.2	165.3	61.0	-61.6	709.8
Net Evap/day	-5.8	-5.6	-3.4	2.2	5.1	5.7	5.9	6.5	6.8	5.3	2.0	-2.0	1.9

DIAGNOSTICS

Sustainability Diagnostics: Janamba Crocodile Farm

Pond System: 1 facultative, aerobic or storage pond

Janamba Croc Farm - 584.39 ML/year or 1.60 ML/day generated on average

Effluent entering pond system after any pretreatment and recycling

Average (Minimum-Maximum) influent quality calculated for 365.24 non-zero flow days, after any pretreatment and recycling.

Constituent	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	6.50 (6.50 - 6.50)	3798.53 (3796.00 - 3806.40)
Total Phosphorus	2.00 (2.00 - 2.00)	1168.78 (1168.00 - 1171.20)
Total Dissolved Salts	275.00 (275.00 - 275.00)	160706.86 (160600.00 - 161040.00)
Volatile Solids	50.00 (50.00 - 50.00)	29219.43 (29200.00 - 29280.00)
Total Solids	200.00 (200.00 - 200.00)	116877.71 (116800.00 - 117120.00)

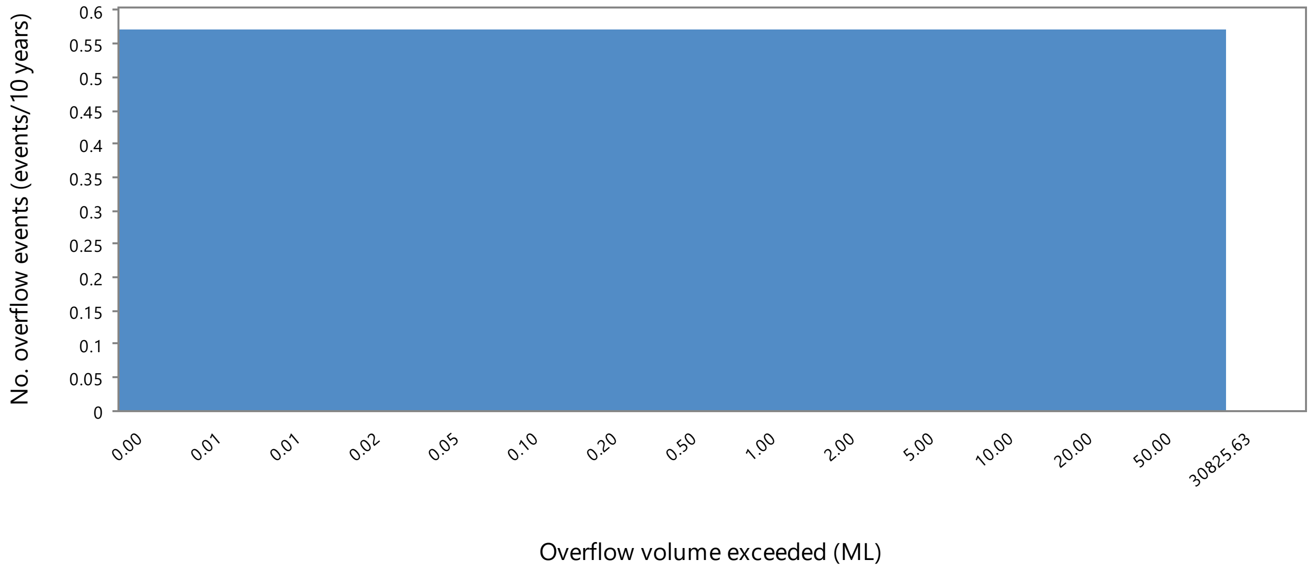
Last pond (Wet weather store): 30.00 ML

Theoretical hydraulic retention time (days)	18.75
Average volume of overflow (ML/year)	452.32
No. overflow events per year exceeding threshold* of 0.01 ML (no./year)	0.06
Average duration of overflow (days)	6390.75
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	0.23
Probability of at least 90% effluent reuse (fraction)	0.00
Average salinity of last pond (dS/m)	0.43
Salinity of last pond on final day of simulation (dS/m)	0.44
Ammonia loss from pond system water area (kg/m2/year)	2.09

* The threshold is the volume equivalent to the top 1 mm depth of water of a full pond

Overflow exceedance:

■ Chart ☐ Table



Export plot

DIAGNOSTICS

Sustainability Diagnostics: Janamba Crocodile Farm

Irrigation Information

Irrigation: 10 ha total area (assumed 100% irrigation efficiency)

	Quantity/year	Quantity/ha/year
Total irrigation applied (ML)	131.62	13.16
Total nitrogen applied (kg)	767.99	76.80
Total phosphorus applied (kg)	269.22	26.92
Total salts applied (kg)	37017.82	3701.78

Shandying

Annual allocation of fresh water for shandying (ML/year)	0.00
Average Shandy water irrigation (ML/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Average exceedance as a proportion of annual shandy water allocation (% of allocation) (minimum - maximum)	0.00 (0.00 - 0.00)
Proportion of irrigation events requiring shandying (fraction of events)	0.00
Minimum shandy water is used	False

Irrigation Issues

Proportion of Days irrigation is prevented when triggered (fraction)	0.17
Proportion of Days water demand is too small to trigger irrigation (fraction)	0.08
Proportion of Days irrigation occurs (fraction)	0.75

DIAGNOSTICS

Sustainability Diagnostics: Janamba Crocodile Farm

Paddock Land: Sandalwood Paddock: 10 ha

Irrigation: Fixed Sprinkler with 0.2% ammonium loss during irrigation

Irrigation triggered when soil water deficit reaches 0.00 mm and rainfall is less than or equal to 5.00 mm
Irrigate up to a soil water content of drained upper limit plus 0.00 mm
Irrigation window from 1/1 to 31/12 including the days specified
A minimum of 0 days must be skipped between irrigation events

Soil Water (mm): Red Earth, 136.40 mm PAWC at maximum root depth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	339.8	300.4	262.7	103.2	20.2	1.1	1.0	2.4	12.2	61.6	134.9	241.6	1481.1
Irrigation	34.9	26.7	42.5	101.5	143.3	147.8	158.0	173.7	178.2	155.5	94.5	59.7	1316.2
Soil Evap	48.2	42.5	47.6	50.8	53.6	52.0	55.2	61.4	65.2	68.1	58.8	54.0	657.2
Transpiration	89.9	79.4	88.7	94.8	100.1	97.0	103.0	114.6	121.7	127.1	109.7	100.8	1226.8
Rain Runoff	8.1	4.8	4.2	4.1	0.2	0.0	0.0	0.0	0.0	0.1	1.0	6.6	29.1
Irrigation Runoff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Drainage	202.8	219.1	191.4	64.2	14.5	0.9	0.2	0.2	2.6	16.2	52.0	120.0	884.1
Delta	25.7	-18.7	-26.8	-9.3	-4.9	-1.0	0.6	-0.1	0.8	5.7	8.0	20.0	0.1

Plant: Monthly Covers - Forest with 70 Percent Cover

Average monthly cover (fraction) (minimum - maximum)	0.70 (0.70 - 0.70)
Average monthly crop factor (fraction) (minimum - maximum)	0.56 (0.56 - 0.56)
Total plant cover (both green and dead) left after harvest (fraction)	0.20
Maximum potential root depth in defined soil profile (mm)	1900.00

Soil Salinity - Plant salinity tolerance: Tolerant

Assumes 1.0 dS/m Electrical Conductivity = 640 mg/L Total Dissolved Salts
All values based on 10 year running averages

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.22
Salt added by rainfall (kg/ha/year)	278.79
Average annual effluent salt added & leached at steady state (kg/ha/year)	3980.57
Average leaching fraction based on 10 year running averages (fraction)	0.49
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.21
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	0.69
Relative crop yield expected due to salinity (fraction)	1.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (fraction)	0.00

DIAGNOSTICS

Run Messages

Messages generated when the scenario was run:

Monthly Covers plant option does not model soil nitrogen and soil phosphorus.
Note: Groundwater nitrate module can not be run when Monthly Covers plant option is chosen
Full run chosen

MEDLI REPORT - FULL RUN

Enterprise: **Janamba Crocodile Farm**

Description:
No subject entered

Client: **Croc Pac Pty Ltd**

MEDLI User: Emma Lewis

Scenario Details:

DESCRIPTION

Climate Data: Middle Point Rangers, -12.58°, 131.31°

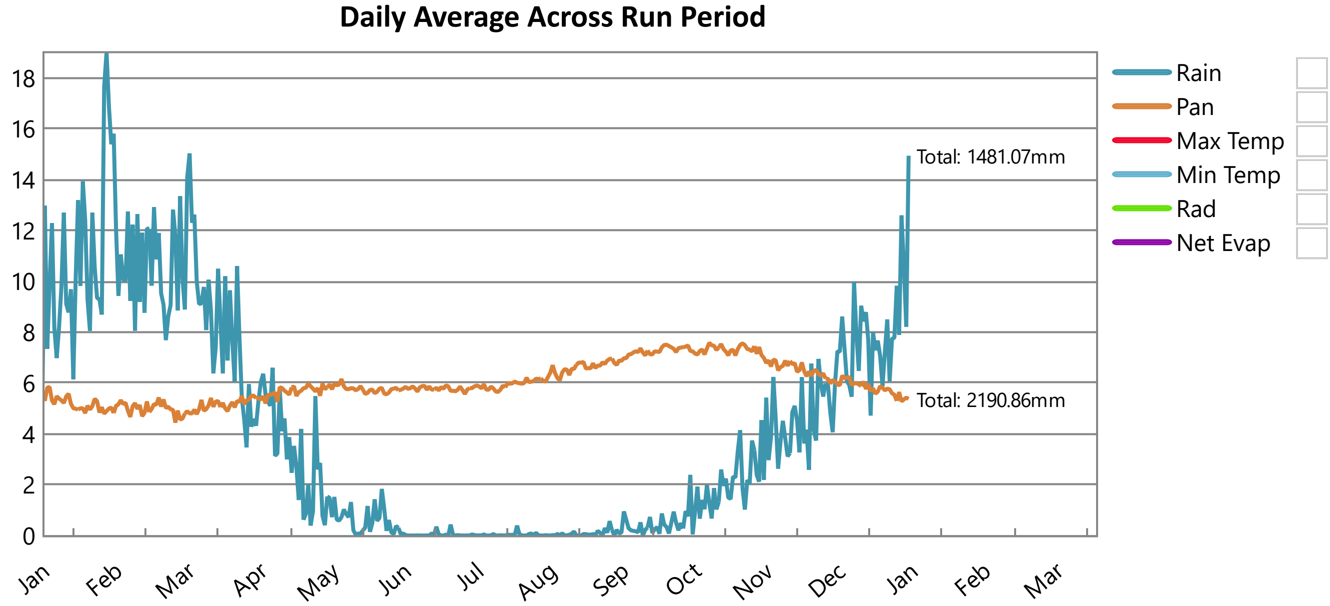
Run Period: 01/01/1950 to 31/12/2019 70 years, 0 days

Climate Statistics:

Climate Data:

Chart Table

Monthly Daily



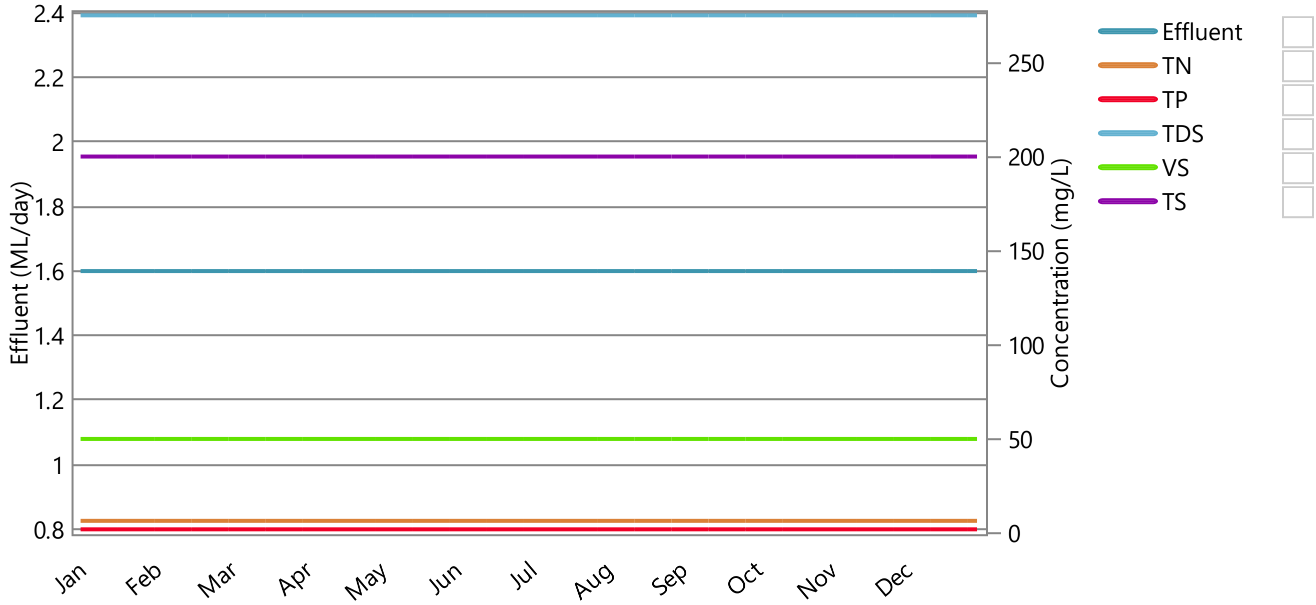
DESCRIPTION

Effluent type: Janamba Croc Farm

Wastestream before any recycling or pretreatment

Average daily quantity and flow-weighted average quality:

Chart Table



Wastestream after any recycling and pretreatment if applicable

Effluent quantity: 584.39 ML/year or 1.60 ML/day (Min-Max: 1.60 - 1.60)

Flow-weighted average (minimum - maximum) daily effluent quality entering pond system:

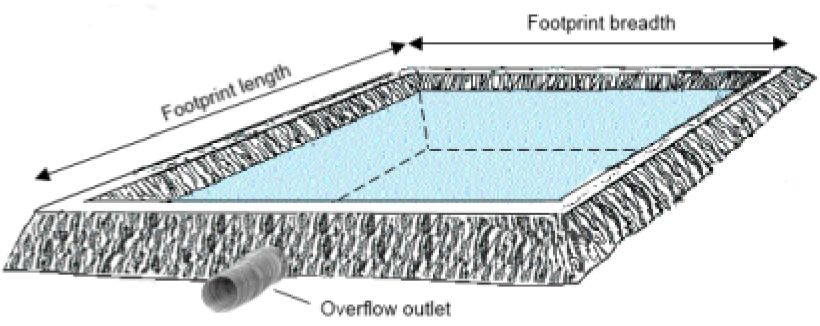
	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	6.50 (6.50 - 6.50)	3798.53 (3796.00 - 3806.40)
Total Phosphorus	2.00 (2.00 - 2.00)	1168.78 (1168.00 - 1171.20)
Total Dissolved Salts	275.00 (275.00 - 275.00)	160706.86 (160600.00 - 161040.00)
Volatile Solids	50.00 (50.00 - 50.00)	29219.43 (29200.00 - 29280.00)
Total Solids	200.00 (200.00 - 200.00)	116877.71 (116800.00 - 117120.00)

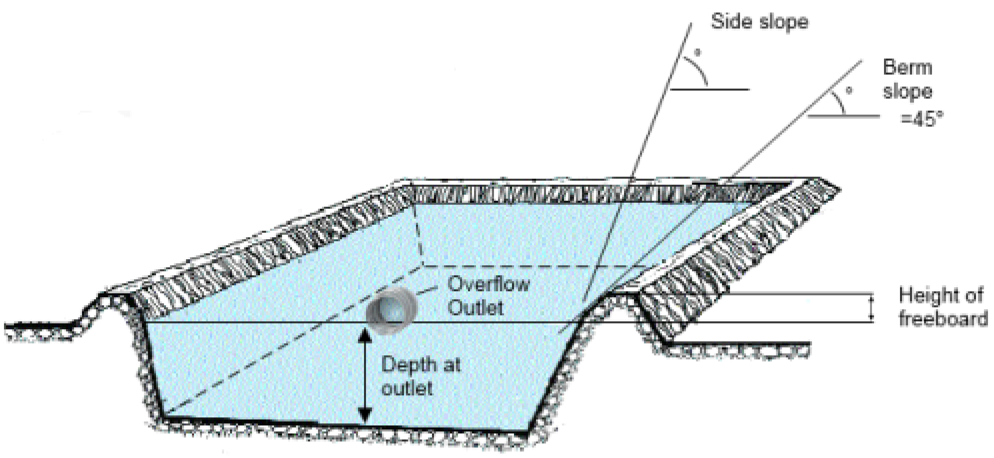
DESCRIPTION

Pond system: 1 facultative, aerobic or storage pond

Pond system details:

	Pond 1
Maximum pond volume (ML)	30.00
Minimum allowable pond volume (ML)	1.20
Pond depth at overflow outlet (m)	2.40
Maximum water surface area (m2)	13074.10
Pond footprint length (m)	163.70
Pond footprint width (m)	82.85
Pond catchment area (m2)	13563.21
Average active volume (ML)	29.59





Irrigation pump limits:

Minimum pump rate per area limit (ML/day/ha)	0.00
Maximum pump rate per area limit (ML/day/ha)	10.00

Shandying water:

Annual allocation of fresh water available for shandying (ML/year)	0.00
Maximum rate of application of fresh water (ML/day)	0.00
Nitrogen concentration (mg/L)	0.00
Salinity (dS/m)	0.00
Minimum shandy water is used	False

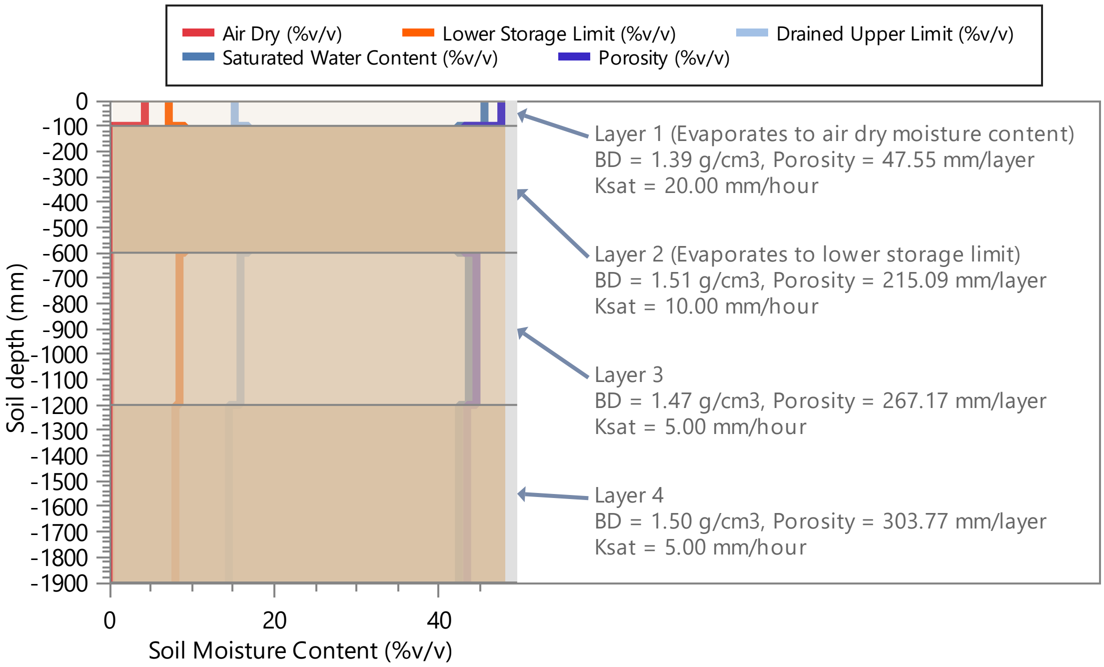
DESCRIPTION

Land: Sandalwood Paddock

Area (ha): 10.00

Soil Type: Red Earth, 1900.00 mm defined profile depth

Profile Porosity (mm)	833.58
Profile saturation water content (mm)	814.90
Profile drained upper limit (or field capacity) (mm)	296.60
Profile lower storage limit (or permanent wilting point) (mm)	160.20
Profile available water capacity (mm)	136.40
Profile limiting saturated hydraulic conductivity (mm/hour)	5.00
Surface saturated hydraulic conductivity (mm/hour)	20.00
Runoff curve number II (coefficient)	83.00
Soil evaporation U (mm)	10.00
Soil evaporation Cona (mm/sqrt day)	4.00



Plant Data: Continuous Cotton Crop

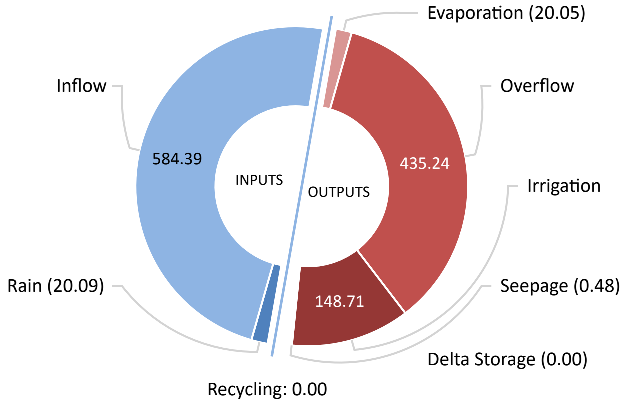
Average monthly cover (fraction) (minimum - maximum)	0.47 (0.44 - 0.49)
Maximum crop factor at 100% cover (mm/mm) (Maximum crop coefficient 0.9 x Pan coefficient 1)	0.90
Total plant cover (both green and dead) left after harvest (fraction)	0.00
Maximum potential root depth in defined soil profile (mm)	1200.00
Salt tolerance	Tolerant
Salinity threshold EC sat. ext. (dS/m)	7.70
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.05

PERFORMANCE

Pond System Water Performance - Overflow: 1 facultative, aerobic or storage pond

Capacity of wet weather storage pond: **30 ML**

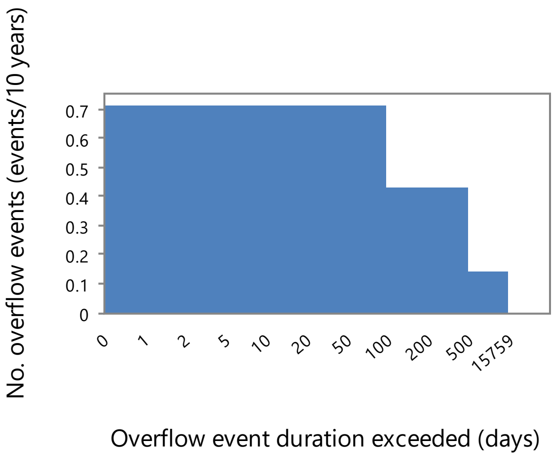
Pond System Water Balance (ML/year)

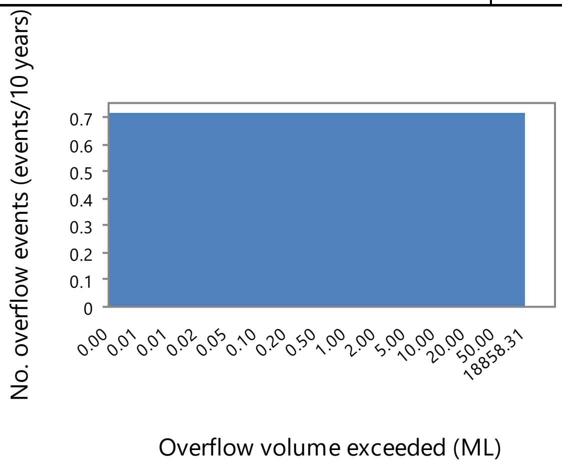


Name	Value
Rain	20.09
Inflow	584.39
Recycling	0.00
Evaporation	20.05
Overflow	435.24
Irrigation	148.71
Seepage	0.48
Delta Storage	0.00

Overflow Diagnostics

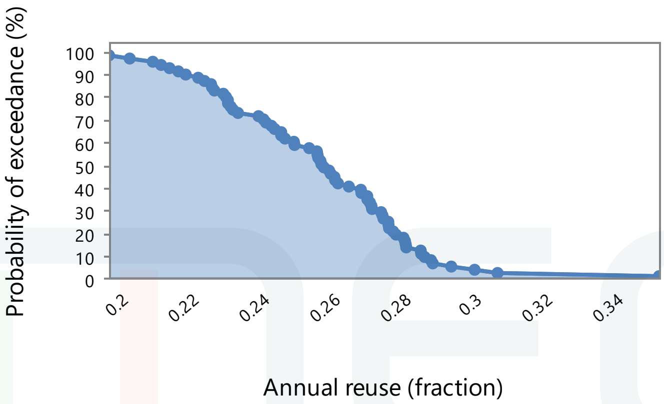
Volume of overflow (ML/year)	435.24
No. days pond overflows (days/year)	365.19
Average duration of overflow (days)	5112.60
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	0.25
Probability of at least 90% reuse (fraction)	0.00





Export plot

Export plot



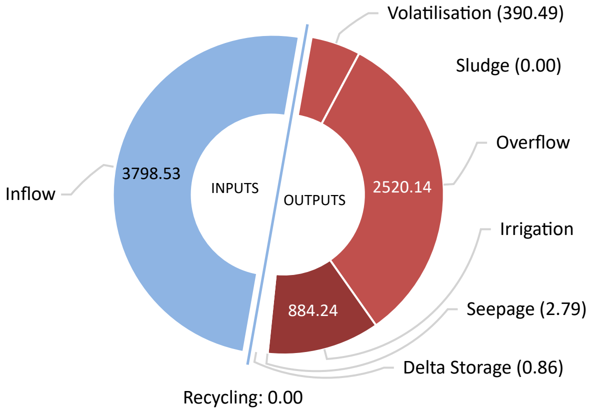
Export plot

PERFORMANCE

Pond System Performance - Nutrient: 1 facultative, aerobic or storage pond

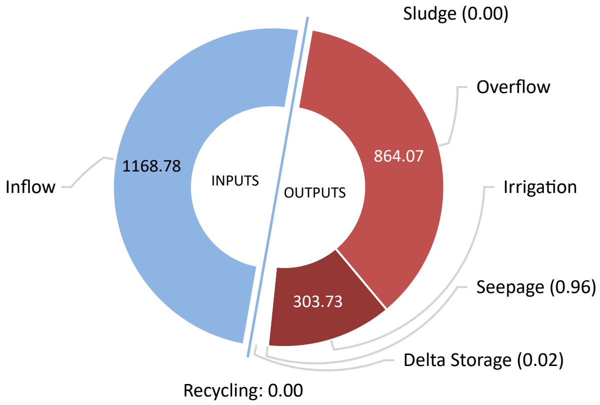
Pond System Nutrients and Salt Balance:

Nitrogen Balance (kg/year)



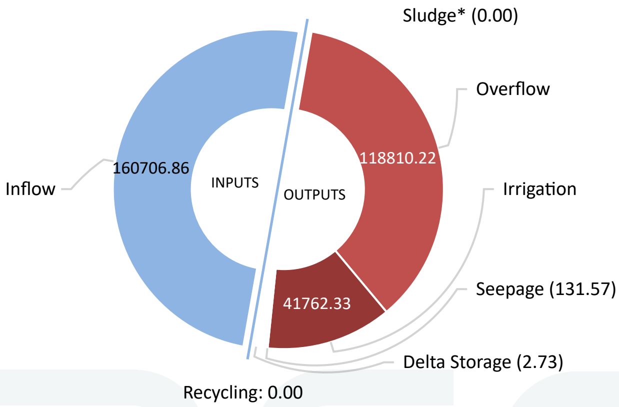
Name	Value
Inflow	3798.53
Recycling	0.00
Volatilisation	390.49
Sludge	0.00
Overflow	2520.14
Irrigation	884.24
Seepage	2.79
Delta Storage	0.86

Phosphorus Balance (kg/year)



Name	Value
Inflow	1168.78
Recycling	0.00
Sludge	0.00
Overflow	864.07
Irrigation	303.73
Seepage	0.96
Delta Storage	0.02

Salt Balance (kg/year)



Name	Value
Inflow	160706.86
Recycling	0.00
Sludge*	0.00
Overflow	118810.22
Irrigation	41762.33
Seepage	131.57
Delta Storage	2.73

* Salt removal in sludge is not calculated from the pond salt balance. However if salt could be assumed to be present in the sludge at the same concentration as in the pond supernatant (up to a maximum of salt added in inflow) - then salt accumulation in the sludge could be 0.00 kg/year

Pond System Sludge Accumulation: 0.00 kg dwt/year

PERFORMANCE

Pond System Performance - Nutrient: 1 facultative, aerobic or storage pond

Pond Nutrient Concentrations and Salinity:

Average across simulation period	Pond 1
Average nitrogen concentration of pond liquid (mg/L)	5.80
Average phosphorus concentration of pond liquid (mg/L)	2.00
Average salinity of pond liquid (dS/m)	0.43

Value on final day of simulation period	Pond 1
Final nitrogen concentration of pond liquid (mg/L)	5.92
Final phosphorus concentration of pond liquid (mg/L)	2.05
Final salinity of pond liquid (dS/m)	0.44

PERFORMANCE

Irrigation Performance:

Water Use: (assumes 100% Irrigation Efficiency)

Pond water irrigated (ML/year)	148.71
Average Shandy water irrigation (ML/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Total water irrigated (ML/year)	148.71
Proportion of irrigation events requiring shandying (fraction of events)	0.00
Proportion of years shandying water allocation of 0 ML/year is exceeded (fraction of years)	0.00
Average exceedance as a proportion of annual shandy water allocation (fraction of allocation) (minimum - maximum)	0.00 (0.00 - 0.00)

Irrigation Quality:

Average nitrogen concentration of irrigation water - before ammonia loss during irrigation (mg/L)	5.95
Average nitrogen concentration of irrigation water - after ammonia loss during irrigation (mg/L)	5.83
Average phosphorus concentration of irrigation water (mg/L)	2.04
Average salinity of irrigation water (dS/m)	0.44

Irrigation Diagnostics:

Proportion of Days rain prevents irrigation (fraction)	0.17
Proportion of Days water demand too small to trigger irrigation (fraction)	0.08
Proportion of Days irrigation occurs (fraction)	0.75

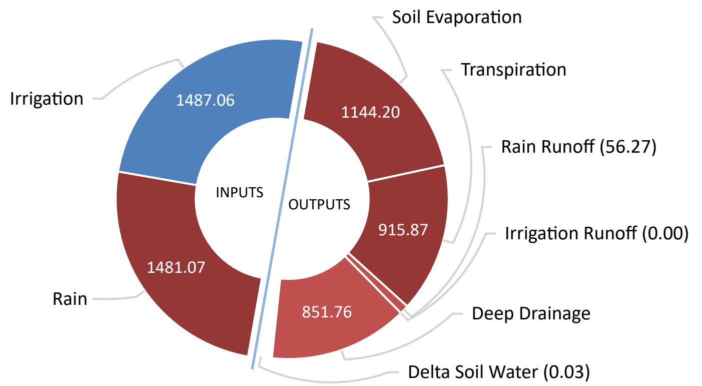
PERFORMANCE

Land Performance - Soil Water

Paddock: Sandalwood Paddock, 10 ha
Soil Type: Red Earth, 90.90 mm PAWC at maximum root depth

Land Water Balance (mm/year):

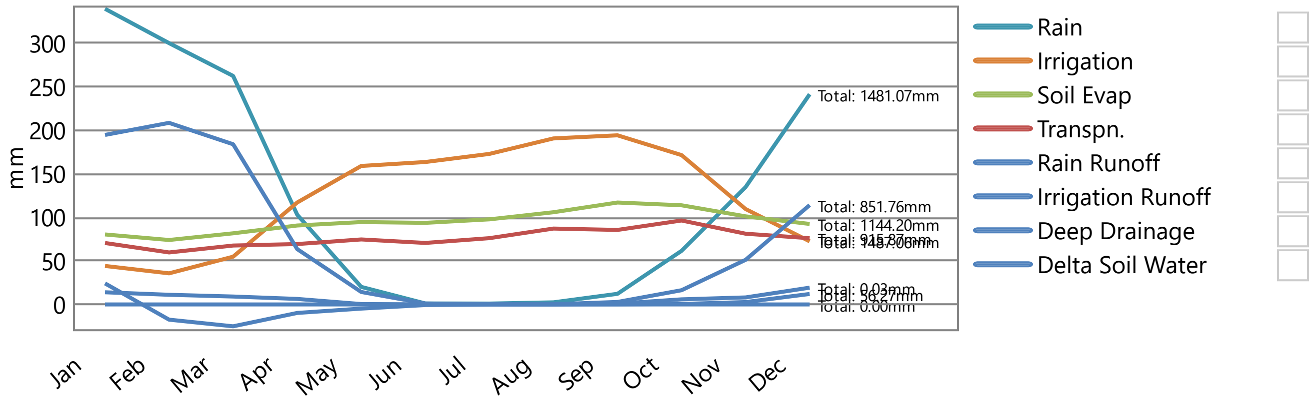
■ mm/year ☐ % Total inputs



Name	Value
Rain	
Irrigation	
Soil Evaporation	
Transpiration	
Rain Runoff	
Irrigation Runoff	
Deep Drainage	
Delta Soil Water	

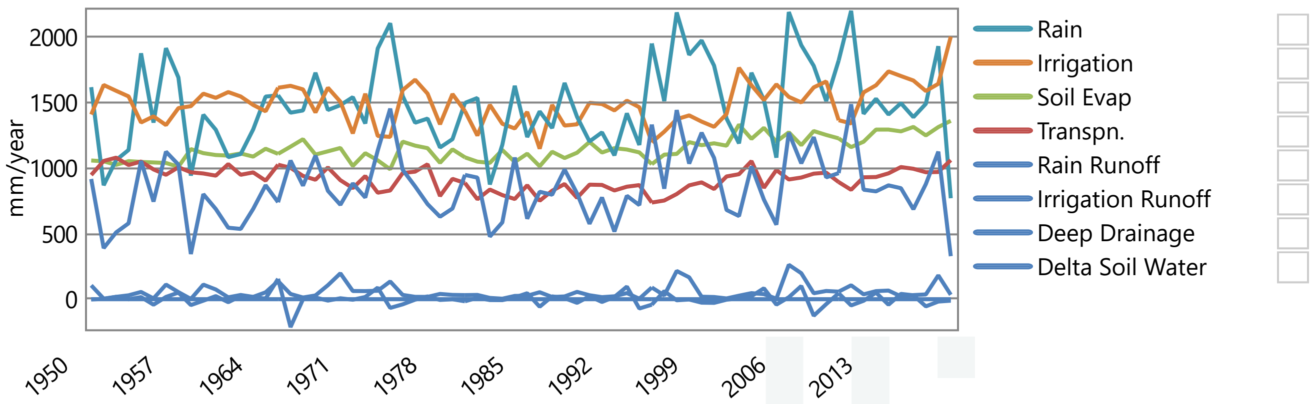
Average Monthly Totals (mm):

■ Chart ☐ Table



Average Annual Totals (mm/year):

■ Chart ☐ Table



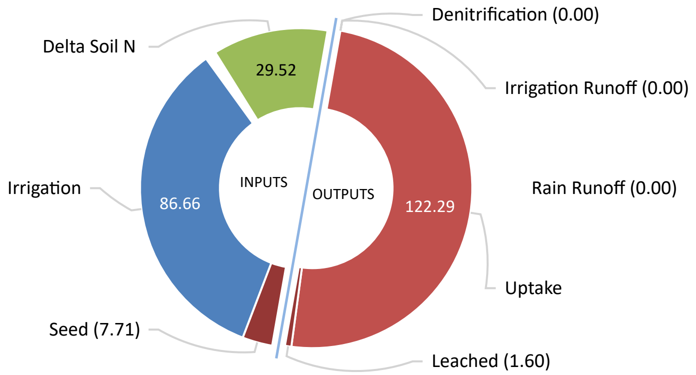
PERFORMANCE

Land Performance - Soil Nutrient

Paddock: Sandalwood Paddock, 10 ha **Soil Type**: Red Earth

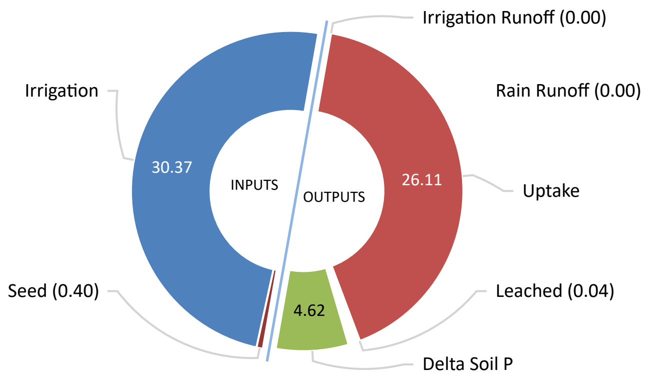
Irrigation ammonium volatilisation losses (kg/ha/year): 1.77
Proportion of total nitrogen in irrigated effluent as ammonium (fraction): 0.10

Land Nitrogen Balance (kg/ha/year)



Name	Value
Seed	7.71
Irrigation	86.66
Denitrification	2.29E-03
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	122.29
Leached	1.60
Delta Soil N	-29.52

Land Phosphorus Balance (kg/ha/year)



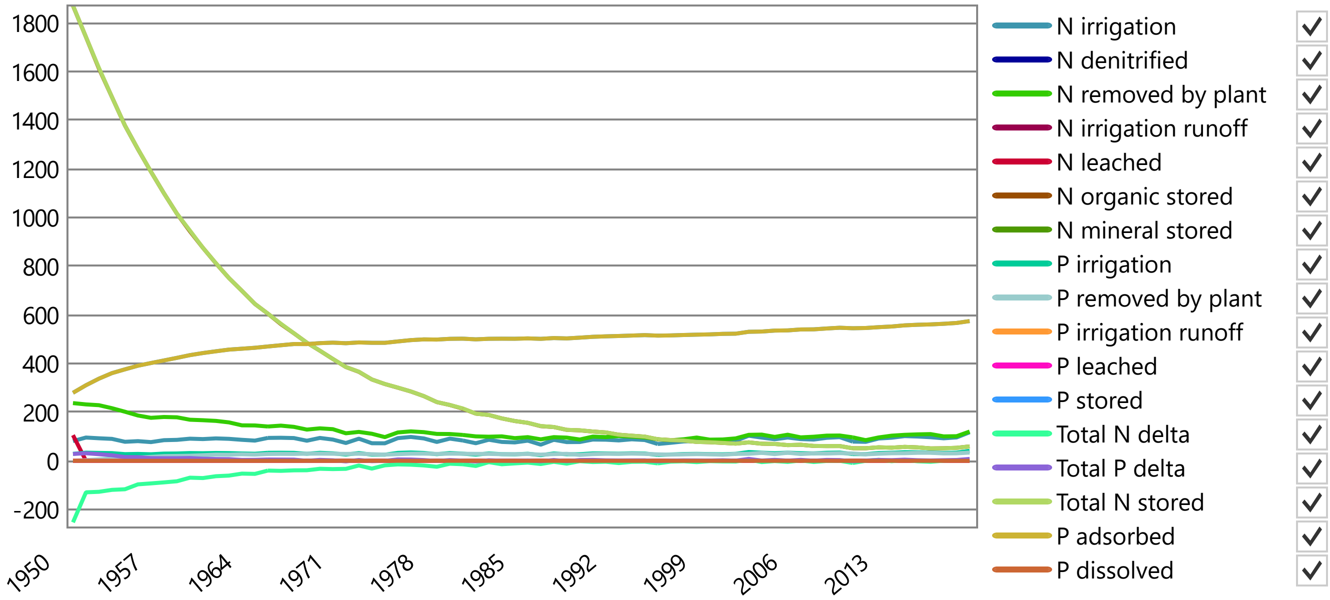
Name	Value
Seed	0.40
Irrigation	30.37
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	26.11
Leached	0.04
Delta Soil P	4.62

PERFORMANCE

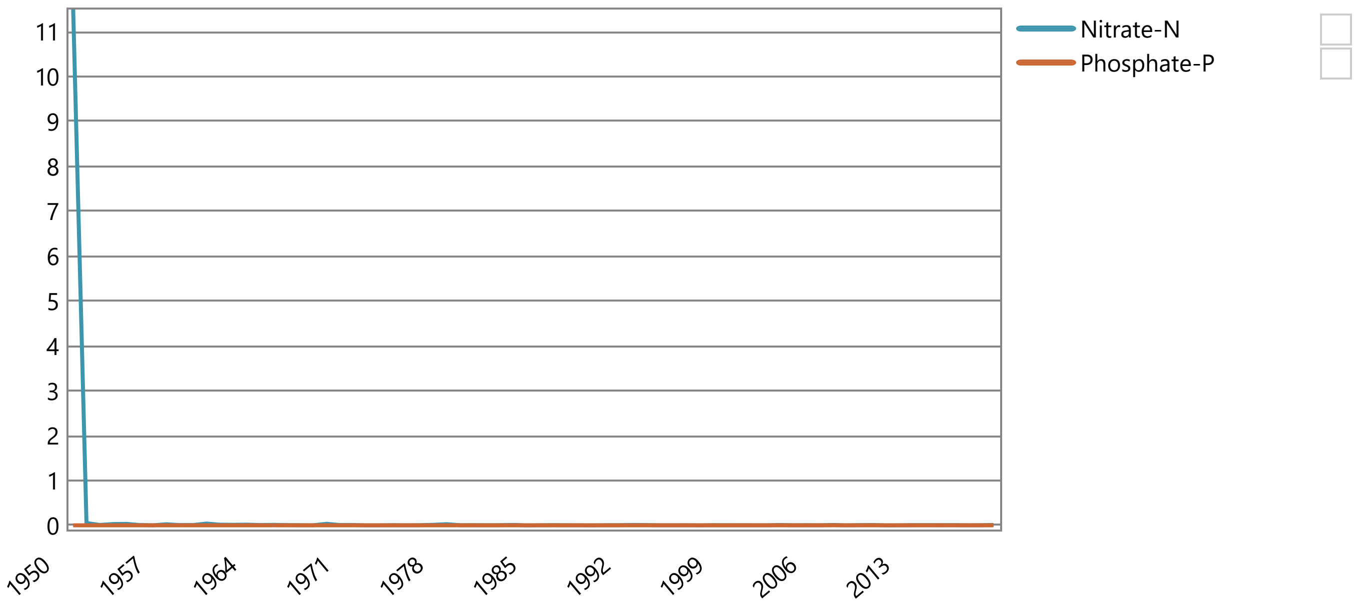
Land Performance - Soil Nutrient

Paddock: Sandalwood Paddock, 10 ha **Soil Type**: Red Earth

Annual Nutrient Totals (kg/ha):



Annual Nutrient Leaching Concentration (mg/L):



PERFORMANCE

Plant Performance and Nutrients

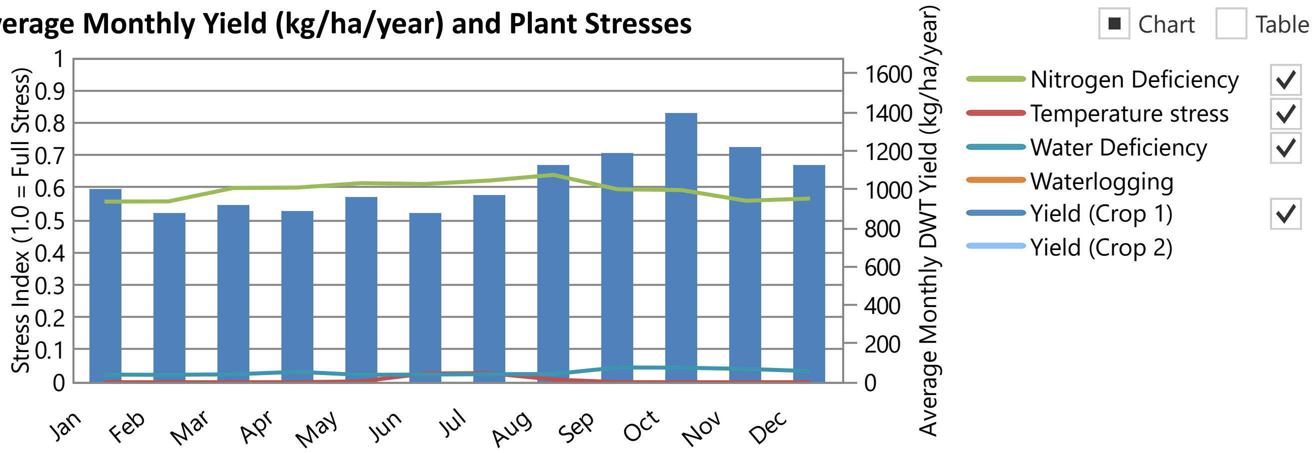
Paddock: Sandalwood Paddock, 10 ha **Soil Type**: Red Earth

Plant: Continuous Cotton Crop

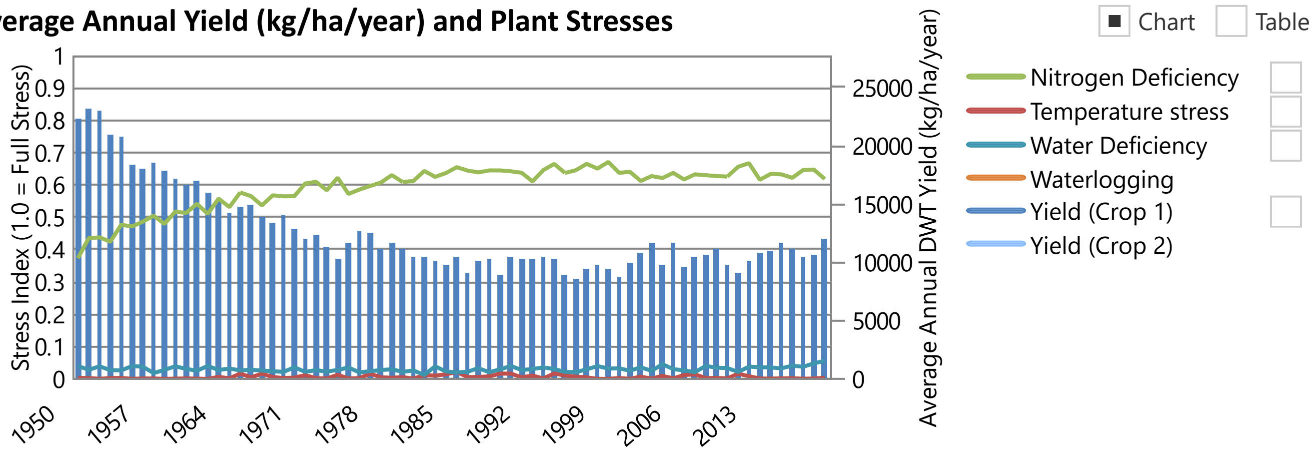
	0.47 (0.44 - 0.49)
	943.72 (910.79 - 971.28)

Nutrient Uptake (minimum - maximum):

Average Monthly Yield (kg/ha/year) and Plant Stresses



Average Annual Yield (kg/ha/year) and Plant Stresses



No. of harvests/year: 4.41 (normal)
No. days without crop/year (days/year): 0.00

PERFORMANCE

Land Performance

Paddock: Sandalwood Paddock, 10 ha **Soil Type**: Red Earth

Plant: Continuous Cotton Crop

	7.70
	0.05
	10.00

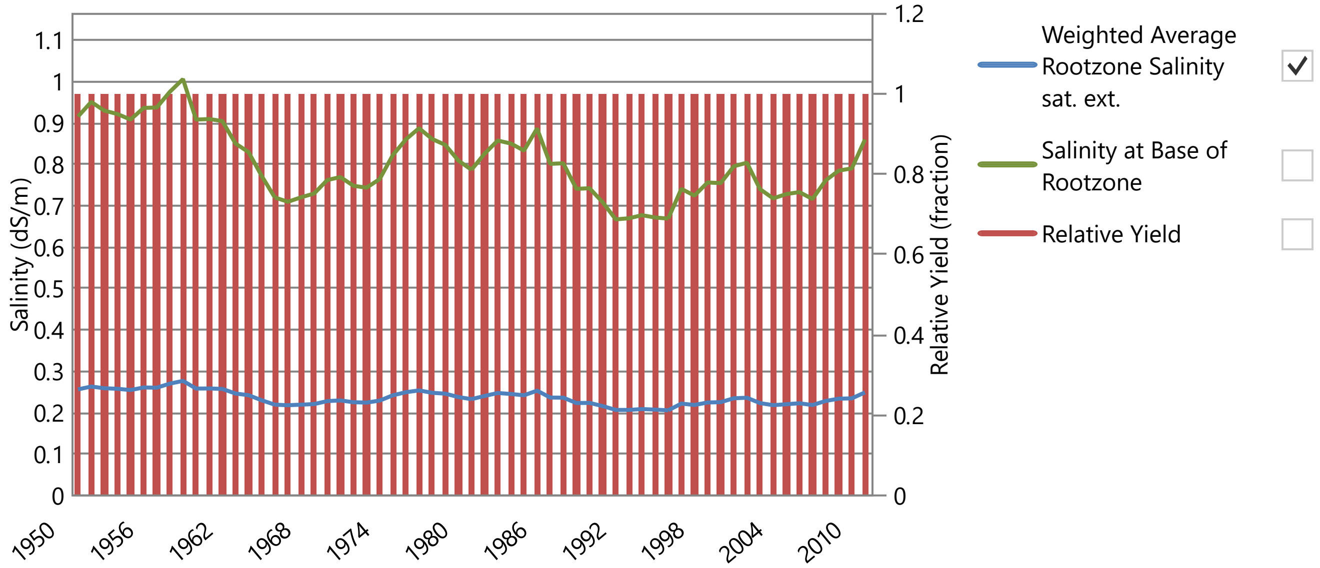
Soil Salinity:

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.24
	273.56
	4449.79
	0.46
	0.24
	0.80
	1.00
	0.00

Average Annual Rootzone Salinity and Relative Yield:

■ Chart ☐ Table

All values based on 10 year running averages



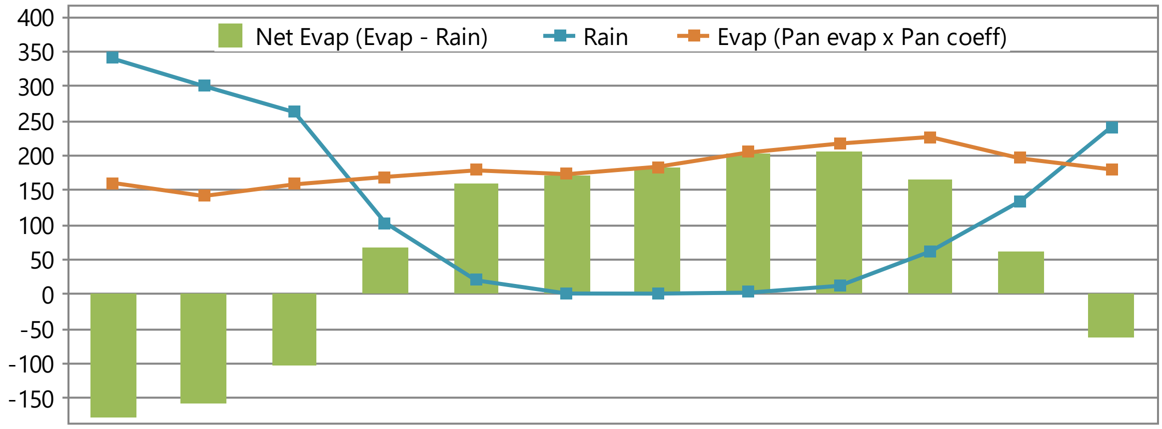
DIAGNOSTICS

Sustainability Diagnostics: Janamba Crocodile Farm

Averaged Historical Climate Data Used in Simulation (mm)

Location: Middle Point Rangers, -12.58°, 131.31°

Run Period: 01/01/1950 to 31/12/2019 70 years, 0 days



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	339.8	300.4	262.7	103.2	20.2	1.1	1.0	2.4	12.2	61.6	134.9	241.6	1481.1
Evap	160.7	141.7	158.5	169.3	178.7	173.3	183.9	204.6	217.4	226.9	195.9	180.0	2190.9
Net Evap	-179.2	-158.6	-104.1	66.1	158.6	172.1	182.9	202.1	205.2	165.3	61.0	-61.6	709.8
Net Evap/day	-5.8	-5.6	-3.4	2.2	5.1	5.7	5.9	6.5	6.8	5.3	2.0	-2.0	1.9

DIAGNOSTICS

Sustainability Diagnostics: Janamba Crocodile Farm

Pond System: 1 facultative, aerobic or storage pond

Janamba Croc Farm - 584.39 ML/year or 1.60 ML/day generated on average

Effluent entering pond system after any pretreatment and recycling

Average (Minimum-Maximum) influent quality calculated for 365.24 non-zero flow days, after any pretreatment and recycling.

Constituent	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	6.50 (6.50 - 6.50)	3798.53 (3796.00 - 3806.40)
Total Phosphorus	2.00 (2.00 - 2.00)	1168.78 (1168.00 - 1171.20)
Total Dissolved Salts	275.00 (275.00 - 275.00)	160706.86 (160600.00 - 161040.00)
Volatile Solids	50.00 (50.00 - 50.00)	29219.43 (29200.00 - 29280.00)
Total Solids	200.00 (200.00 - 200.00)	116877.71 (116800.00 - 117120.00)

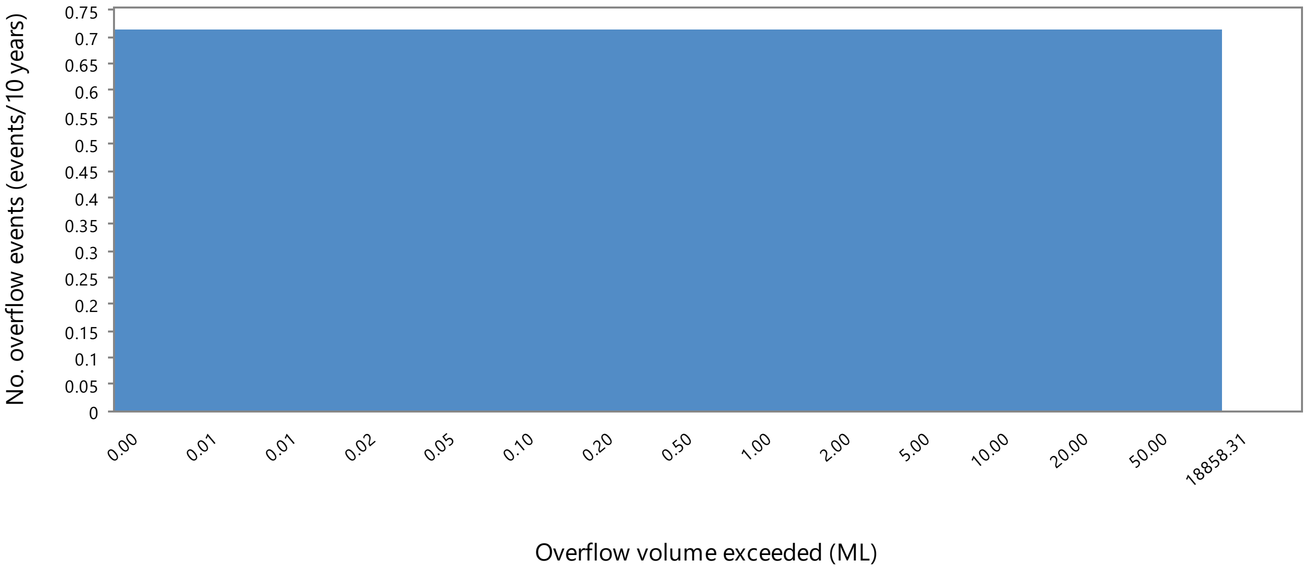
Last pond (Wet weather store): 30.00 ML

Theoretical hydraulic retention time (days)	18.75
Average volume of overflow (ML/year)	435.24
No. overflow events per year exceeding threshold* of 0.01 ML (no./year)	0.07
Average duration of overflow (days)	5112.60
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	0.25
Probability of at least 90% effluent reuse (fraction)	0.00
Average salinity of last pond (dS/m)	0.43
Salinity of last pond on final day of simulation (dS/m)	0.44
Ammonia loss from pond system water area (kg/m2/year)	2.09

* The threshold is the volume equivalent to the top 1 mm depth of water of a full pond

Overflow exceedance:

■ Chart ☐ Table



Export plot

DIAGNOSTICS

Sustainability Diagnostics: Janamba Crocodile Farm

Irrigation Information

Irrigation: 10 ha total area (assumed 100% irrigation efficiency)

	Quantity/year	Quantity/ha/year
Total irrigation applied (ML)	148.71	14.87
Total nitrogen applied (kg)	866.55	86.66
Total phosphorus applied (kg)	303.73	30.37
Total salts applied (kg)	41762.33	4176.23

Shandying

Annual allocation of fresh water for shandying (ML/year)	0.00
Average Shandy water irrigation (ML/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Average exceedance as a proportion of annual shandy water allocation (% of allocation) (minimum - maximum)	0.00 (0.00 - 0.00)
Proportion of irrigation events requiring shandying (fraction of events)	0.00
Minimum shandy water is used	False

Irrigation Issues

Proportion of Days irrigation is prevented when triggered (fraction)	0.17
Proportion of Days water demand is too small to trigger irrigation (fraction)	0.08
Proportion of Days irrigation occurs (fraction)	0.75

DIAGNOSTICS

Sustainability Diagnostics: Janamba Crocodile Farm

Paddock Land: Sandalwood Paddock: 10 ha

Irrigation: Fixed Sprinkler with 0.2% ammonium loss during irrigation

Irrigation triggered when soil water deficit reaches 0.00 mm and rainfall is less than or equal to 5.00 mm
Irrigate up to a soil water content of drained upper limit plus 0.00 mm
Irrigation window from 1/1 to 31/12 including the days specified
A minimum of 0 days must be skipped between irrigation events

Soil Water Balance (mm): Red Earth, 90.90 mm PAWC at maximum root depth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	339.8	300.4	262.7	103.2	20.2	1.1	1.0	2.4	12.2	61.6	134.9	241.6	1481.1
Irrigation	44.2	35.7	54.9	117.2	159.2	163.7	173.0	190.8	194.4	171.6	109.7	72.6	1487.1
Soil Evap	80.5	74.1	81.8	90.7	94.7	93.8	97.8	106.0	117.1	114.0	101.3	92.5	1144.2
Transpn.	70.6	59.8	67.7	69.4	74.7	70.7	76.2	87.2	85.6	96.5	81.3	76.1	915.9
Rain Runoff	14.0	11.1	9.1	6.3	0.4	0.0	0.0	0.0	0.1	0.6	2.7	12.0	56.3
Irr. Runoff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Drainage	194.8	208.7	184.1	63.6	14.3	1.1	0.2	0.2	2.8	16.3	51.3	114.2	851.8
Delta	24.2	-17.5	-25.1	-9.8	-4.8	-0.7	-0.2	-0.1	0.9	5.9	8.1	19.3	0.0

Soil Nitrogen Balance

Average annual effluent nitrogen added (kg/ha/year)	86.66
Average annual soil nitrogen removed by plant uptake (kg/ha/year)	122.29
Average annual soil nitrogen removed by denitrification (kg/ha/year)	2.29E-03
Average annual soil nitrogen leached (kg/ha/year)	1.60
Average annual nitrate-N loading to groundwater (kg/ha/year)	1.60
Soil organic-N kg/ha (Initial - Final)	1984.50 - 59.16
	141.30 - 0.03
Average nitrate-N concentration of deep drainage (mg/L)	0.19
Max. annual nitrate-N concentration of deep drainage (mg/L)	11.51

Soil Phosphorus Balance

Average annual effluent phosphorus added (kg/ha/year)	30.37
Average annual soil phosphorus removed by plant uptake (kg/ha/year)	26.11
Average annual soil phosphorus leached (kg/ha/year)	0.04
Dissolved phosphorus (kg/ha) (Initial - Final)	0.01 - 0.02
Adsorbed phosphorus (kg/ha) (Initial - Final)	251.51 - 574.72
Average phosphate-P concentration in rootzone (mg/L)	0.02
Average phosphate-P concentration of deep drainage (mg/L)	0.01
Max. annual phosphate-P concentration of deep drainage (mg/L)	0.01
Design soil profile storage life based on average infiltrated water phosphorus concn. of 1.04 mg/L (years)	153.60

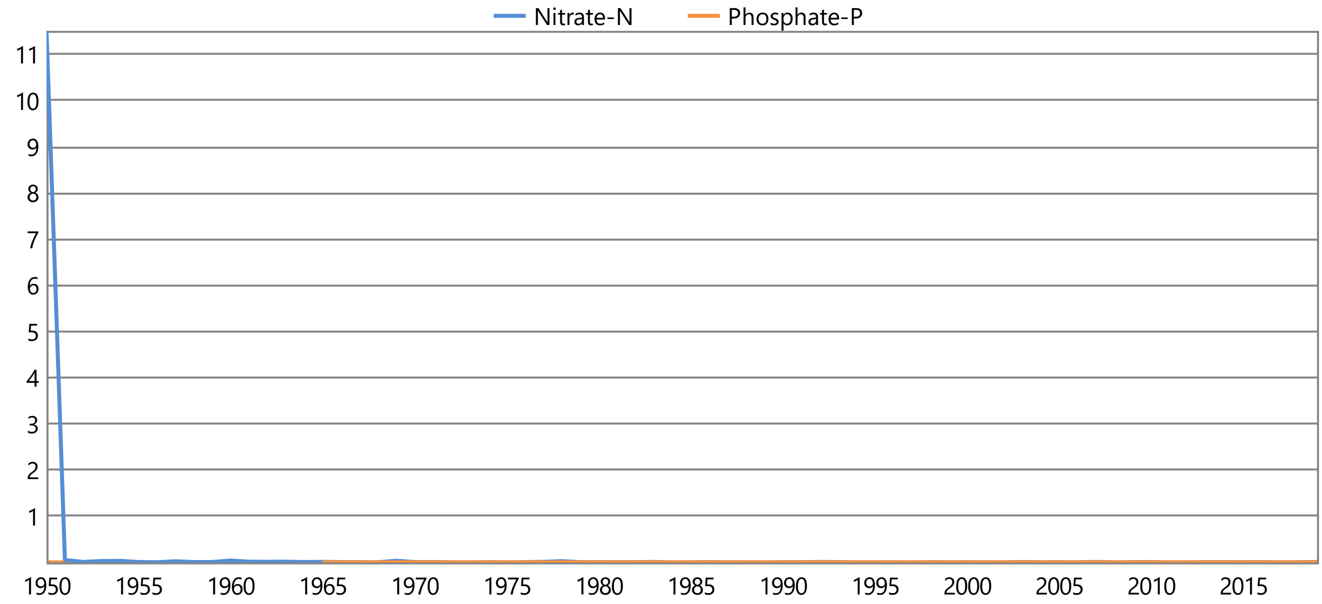
DIAGNOSTICS

Sustainability Diagnostics: Janamba Crocodile Farm

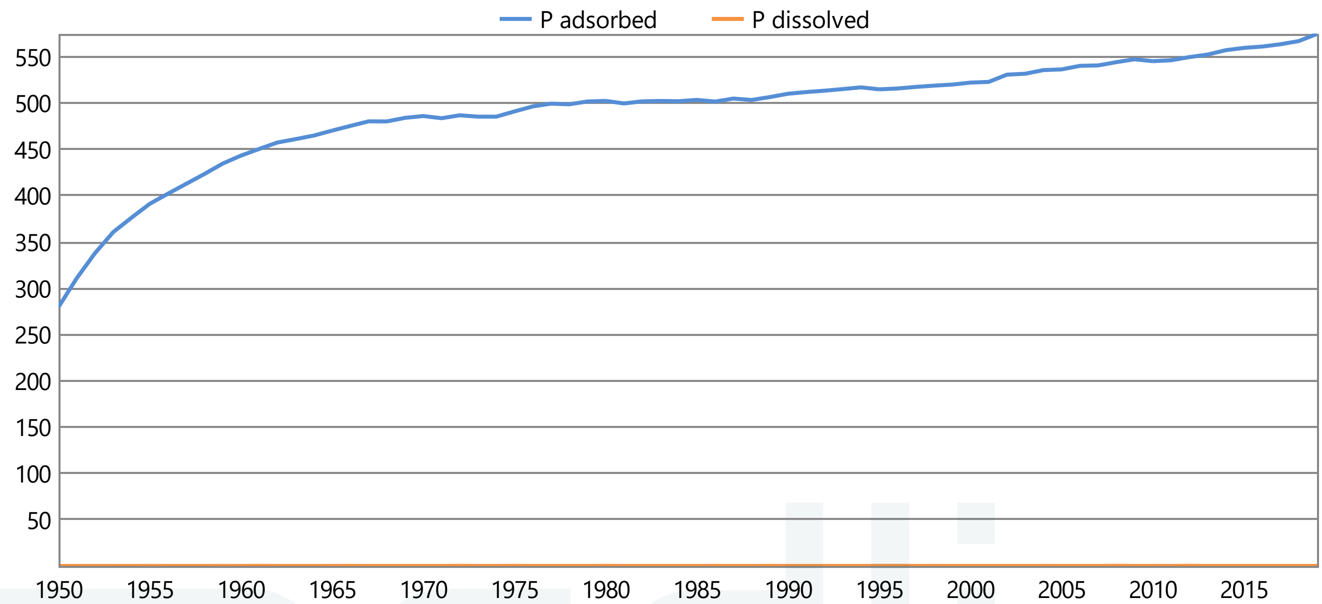
Paddock Land: Sandalwood Paddock: 10 ha

Irrigation: Fixed Sprinkler with 0.2% ammonium loss during irrigation

Annual nutrient leachate concentration (mg/L)



Annual Phosphate-P in soil (kg/ha)



DIAGNOSTICS

Sustainability Diagnostics: Janamba Crocodile Farm

Paddock Plant Performance: Sandalwood Paddock: 10 ha

Average Plant Performance (Minimum - Maximum): Continuous Cotton Crop

Average annual shoot dry matter yield (kg/ha/year)	12695.33 (8794.92 - 23237.99)
Average monthly plant (green) cover (fraction)	0.47 (0.44 - 0.49)
Average monthly crop factor (fraction)	0.42 (0.39 - 0.44)
Total plant cover (both green and dead) left after harvest (fraction)	0.00
Average monthly root depth (mm)	943.72 (910.79 - 971.28)
Average number of normal harvests per year (no./year)	4.41 (4.00 - 5.00)
Average number of normal harvests for last five years only (no./year)	4.60
Average number of crop deaths per year (no./year)	0.00 (0.00 - 0.00)
Average number of crop deaths for last five years only (no./year)	0.00
Average annual nitrogen deficiency index (0 = no stress, 1 = full stress) (coefficient)	0.59 (0.37 - 0.67)
Average January temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.00 (0.00 - 0.00)
Average July temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.03 (0.00 - 0.15)
Average monthly water stress index (0 = no stress, 1 = full stress) (coefficient)	0.03 (0.02 - 0.05)
Average monthly waterlogging index (0 = no stress, 1 = full stress) (coefficient)	0.00 (0.00 - 0.00)
No. days without crop/year (days)	0.00

Soil Salinity - Plant salinity tolerance: Tolerant

Assumes 1.0 dS/m Electrical Conductivity = 640 mg/L Total Dissolved Salts
All values based on 10 year running averages

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.24
Salt added by rainfall (kg/ha/year)	273.56
Average annual effluent salt added & leached at steady state (kg/ha/year)	4449.79
Average leaching fraction based on 10 year running averages (fraction)	0.46
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.24
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	0.80
Relative crop yield expected due to salinity (fraction)	1.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (fraction)	0.00

DIAGNOSTICS

Run Messages

Messages generated when the scenario was run:

Full run chosen

APPENDIX D IRRIGATION PROCEDURES

Irrigation Procedures
Janamba Crocodile Farm
Croc Pac Pty Ltd

DOCUMENT CONTROL RECORD

Job	EZ19095
Document ID	187362-12
Author(s)	Britanny Crescentino

DOCUMENT HISTORY

Rev	Reviewed by	Approved by	Issued to	Date
1	Emma Lewis	Emma Lewis	Croc Pac Pty Ltd	05/05/2020

Recipients are responsible for eliminating all superseded documents in their possession.

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APPROVED COMPANY AS/NZS 4801 Occupational Health & Safety Management Systems — QMS Certification Services
APPROVED COMPANY ISO 9001 Quality Management Systems — QMS Certification Services
APPROVED COMPANY ISO 14001 Environmental Management Systems — QMS Certification Services

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Appendices

1 INTRODUCTION

This document lists procedures to be followed by Croc Pac Pty Ltd (Croc Pac) management, staff and contractors to ensure that the reuse of wastewater via terrestrial irrigation is managed appropriately at the Janamba Crocodile Farm (Janamba). This document has been developed in association with the Environmental Protection Licence (EPL) application and the Irrigation Management Plan (IMP). The EPL application for this project has been submitted to the Northern Territory Environmental Protection Authority (NT EPA), therefore the monitoring and trigger values for the irrigation activities will be conducted in accordance with the EPL application. These procedures will be updated once the EPL is issued, to the EPL conditions.

Janamba recognise the importance of finding a solution to wastewater management and preventing uncontrolled discharge of untreated wastewater offsite with the potential to impact the receiving environment. Sustainable wastewater management involves the selection of suitable irrigation infrastructure to the water and nutrient requirements of the crops, while also ensuring oversaturation does not occur, resulting in uncontrolled run off, damaging of the soil and unsustainable crops.

The list of procedures includes:

- Area of irrigation
- Timing of irrigation
- Application of irrigation
- Irrigation recording sheet

2 SELECTION OF AREA TO BE IRRIGATED PROCEDURE

2.1 Aim

The aim of this procedure is to ensure that suitable irrigation areas are selected for wastewater release, considering the factors important in minimising impact on surrounding neighbours and sensitive receptors in the environment. This is to be conducted daily and the Farm Manager is the responsible person. The important factors to consider are:

- Wind speed and direction
- Recent rainfall
- Soil saturation

2.2 Procedure

1) Check the daily weather forecast for wind speed and direction and potential rainfall in months December to March (when rain is more prevalent). Avoid irrigation activities being conducted when prevailing wind direction will carry any odours or off-spray towards surrounding neighbours and sensitive receptors.
2) Ensure daily visual inspections of potential irrigation areas are conducted as per daily visual inspection checklist (refer to Appendix A). Ensure area can adequately absorb the volume being applied as per irrigation rate. This can be achieved through digging a small hole and checking the soil moisture content or through soil moisture monitoring equipment such as a tensiometer.
3) Select appropriate location for irrigation activities.

3 TIMING OF IRRIGATION PROCEDURE

3.1 Aim

The aim of this procedure is to ensure irrigation activities occur at an appropriate time and does not directly result in run-off and impacting on surrounding neighbours and sensitive receptors in the environment. The Farm Manager is the responsible person for this procedure.

3.2 Procedure

This procedure is to be implemented in conjunction with the selection of area to be irrigated procedure.

1) Check the daily weather forecast for potential rainfall. Irrigation activities are not to be conducted two hours prior to when heavy rainfall (>50mm) is forecasted, or at the time of rain events or high winds. Used as a preventative measure for surface water run-off.
2) When heavy rain (>50mm) has been received within the previous 24 hours, a daily visual inspection and moisture test (tensiometer) is to be conducted to ensure the irrigation area is not saturated prior to the commencement of irrigation activities. If saturated, delay irrigation until sufficiently dried out, or apply the minimum irrigation flow rate of 1mm/day.
3) If after rainfall, a daily visual inspection is conducted, and determines the irrigation area is unsaturated (without conducting a moisture test) the irrigation activities can commence as normal as per the application of irrigation procedure.

4 APPLICATION OF IRRIGATION

4.1 Aim

The aim of this procedure is to ensure that the application of the wastewater through irrigation activities is a controlled task, and does not cause any run-off or impacts to surrounding neighbours and sensitive receptors in the environment. The Farm Manager is the responsible person for this procedure. This procedure is to be applied after the use of the Selection of Area to be Irrigated Procedure and Timing of Irrigation Procedure.

4.2 Procedure

1) Conduct visual inspection and complete checklist (refer to Appendix A).
2) Record each irrigation event into irrigation recording sheet (refer to Appendix B).
3) Monitor the irrigation area during the irrigation application (every 1-2 hours), to ensure that surface ponding and runoff of wastewater does not occur.
4) If excess surface water ponding or run-off is identified, irrigation application is to cease immediately.
5) Control the surface ponding and run-off if there is potential for an uncontrolled release offsite, by installing diversion bunds where required and allowing the excess moisture to infiltrate or evaporate on-site.
6) Determine the likely cause of the surface water ponding or run-off (i.e. soil is too saturated or the correct irrigation application rate has not been set).
7) Review the irrigation application rate settings to determine if the correct irrigation rate was set. If the incorrect irrigation rate was set, adjust accordingly.
8) Using the Selection of Area to be Irrigated Procedure and Timing of Irrigation Procedure to identify if soil saturation is the likely cause.
9) Recommence irrigation application – and complete an irrigation recording sheet record (refer to Appendix B).

APPENDIX A VISUAL INSPECTION CHECKLIST

	Day: Date:	Mon	Tues	Wed	Thurs	Fri	Sat	Sun	Comments
#	**Visual inspection Items**	**Y/ N**	**Y/ N**	**Y/ N**	**Y/ N**	**Y/ N**	**Y/ N**	**Y/ N**	
1.	Are there any areas too saturated for irrigation application?								
2.	Is there any water pondng? (if yes, cease application until soil moisture conditions are suitable)								
3.	Is there any odour present during irrigation application? (If yes, cease application and conduct wastewater sampling).								
4.	Is there any overspray/mist? (if yes, cease application and review weather forecast)								
5.	Is there any surface water run-off present? (if yes, cease application and review soil moisture content).								

APPENDIX B IRRIGATION RECORDING SHEET

Date	Approx. Area Irrigated (m^2)	Pumping time (mins)	Volume pumped (kL)	Application rate (mm)	Check for saturation, run-off or surface ponding	Weather observations (i.e. rainfall, wind direction/speed, sunny, cloudy etc).	Checked by:

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