



Supporting Information for the Lambells Lagoon Crocodile Farm EPL320-01 Amendment and Renewal PRI Farming Pty Ltd



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ACRONYMS

ADP1	Authorised Discharge Point One
ADP2	Authorised Discharge Point Two
BOD	Biological Oxygen Demand
BOM	Bureau of Meteorology
CITES	Convention of International Trade in Endangered Species
CSM	Conceptual Site Model
DENR	Department of Environment and Natural Resources (Northern Territory) – now Department of Lands, Planning and Environment
DHWQO	Darwin Harbour Region Water Quality Objectives
DP	Development Permit
DO	Dissolved Oxygen
EA	Environmental Assessment
EC	Electrical Conductivity
EMP	Environmental Management Plan
EPA	Environmental Protection Approval
EPL	Environmental Protection Licence
EPO	Environmental Protection Objective
ERP	Emergency Response Plan
ERT	Emergency Response Team
ESCP	Erosion and Sediment Control Plan
ESP	Exchangeable Sodium Percentage
GDE	Groundwater Dependent Ecosystem
GWEL	Groundwater Extraction Licence
IMP	Irrigation Management Plan
LLCF	Lambells Lagoon Crocodile Farm
LOR	Limit of Reporting
LPG	Liquefied Petroleum Gas
LTV	Long-term Trigger Value
NAFI	North Australian Fire Information
NATA	National Association of Testing Authorities
NEPM	National Environmental Protection Measure
NOI	Notice of Intent
NT	Northern Territory
NT EPA	Northern Territory Environmental Protection Authority
NTG	Northern Territory Government
PRI	PRI Farming Pty Ltd
SDS	Safety Data Sheets
SOCS	Site of Conservation Significance
SOP	Standing Operating Procedure
SSTV	Site-Specific Trigger Value

SWL	Standing Water Level
TN	Total Nitrogen
TP	Total Phosphorus
WMPC Act	Waste Management and Pollution Control Act (Northern Territory)
WoNS	Weed of National Significance
WWS	Wet Weather Storage

1 INTRODUCTION

PRI Farming Pty Ltd (PRI) propose to operate the Lambells Lagoon Crocodile Farm (LLCF), here-in referred to as the “Project”, for commercial production of saltwater crocodiles (*Crocodylus porosus*) for meat and skin products. The site is located in the Lambells Lagoon area on Section 1611 and 1688 Hundred of Guy, at the end of Alphatonia Road, 5.5 km north of the Arnhem Highway (Figure 2-1).

The Project is operated in two stages. Stage one encompasses the incubation, hatchery and auxiliary infrastructure. Stage two encompasses the grow-out pens, finishing pens, auxiliary infrastructure and water management infrastructure (Figure 2-2). Wastewater generated from operations at both stages is currently irrigated to the Stage 1 irrigation area (15 ha) and the Stage 2 irrigation area (130 ha).

This document presents information to support an amendment and renewal to Environmental Protection Licence (EPL320-01) to incorporate current and proposed changes to the onsite wastewater management system, the addition of new soil monitoring sites within the Stage 2 irrigation area, and modifications to surface water monitoring sites and applicable surface water quality criteria.

The document structure addresses the information requirements specified in the Northern Territory Environment Protection Authority (NT EPA) *Guide to Environment Protection Approvals and Licences Under the Waste Management and Pollution Control Act* (NTEPA 2013).

1.1 Purpose and scope

This supporting document has been updated to incorporate current and proposed changes to the onsite wastewater management system, the addition of new soil monitoring sites within the Stage 2 irrigation area, and modifications to surface water monitoring sites and applicable surface water quality criteria.

An updated summary of water and soil quality is also provided, based on all data collected at the monitoring sites. This data, along with water usage at each stage, was used to update the water and nutrient balance for the farm, as presented in the Irrigation Management Plan (IMP; see Appendix A).

1.2 Approvals

Environmental assessment

A Notice of Intent (NOI) was submitted to the NT EPA during February 2020 for assessment under the Northern Territory (NT) *Environmental Assessment (EA) Act 1982*. The NT EPA assessment of the NOI determined that the potential environmental impacts and risks associated with the proposal were not significant and that the proposal did not require assessment under the *EA Act*.

Development permit

Under the NT *Planning Act 1999*, a Development Permit (DP20/0217) was approved for Section 1611 and 1688 Hundred of Guy, 255 and 405 Alphatonia Road, Lambells Lagoon by the NT Development Consent Authority, on the 27 August 2020. The DP20/0217 approved land use for the purpose of intensive animal husbandry (crocodile farm) in accordance with the DP conditions and endorsed plans.

Environmental Protection Approval and Licence

Construction and operation of the Project is regulated under the *WMPC Act* because the water discharged from the crocodile pens contains crocodile effluent, faeces, residual feed and other ‘crocodile wastes’, which are classified as ‘animal effluent and residues’ and therefore are a listed waste under the Act. An Environment Protection Approval (EPA) for works associated with construction of the premises was granted on the 06

October 2020 (approval number EPA306-01). Currently, the farm operates under the Environment Protection Licence 320-01 (EPL320-01), which licences the *'storing, treating and disposing of animal effluent and residues on a commercial basis from Stage 1 (hatchery operations) and Stage 2 (growers and finishers) has been granted for the operation of stage one (hatchery) and stage two (growers and finishers).'* The licence expires in April 2026.

Land access

The land for the Project (Section 1611 and 1688), is privately owned, freehold land, purchased by PRI on the 21 September 2020. No other land access agreements are required.

Water Extraction

As a requirement under the NT *Water Act 1992*, a Groundwater Extraction Licence (GWEL) is required for the extraction and use of water. PRI Farming is the licence holder of GWEL Licence no. HGS10000 (Expiry 2050), which allows a maximum extraction entitlement total of 3,216 ML/year.

2 SITE DESCRIPTION AND EXISTING ENVIRONMENT

2.1 Location

The site of the Crocodile Farm is located in the Lambells Lagoon area on Section 1611 and 1688 Hundred of Guy, west of Alphonson Road (Figure 2-1). The closest main highway is the Arnhem Highway (approximately 5.5 km away). The nearest town to the project area is Humpty Doo, approximately 17 km south west.

2.2 Site history and land use

The Project area is zoned horticulture, has been largely previously cleared and has a history of irrigated horticulture production with fertile, well-drained soil. Land to the west of section 1688 is zoned Agriculture (A) and is part of Koolpinyah Station. The Project area is located between two Conservations Reserves, the Black Jungle to the west and Lambells Lagoon to the east (Figure 2-1).

2.3 Surrounding land and sensitive receptors

The surrounding horticultural zoned land is comprised of fruit farming businesses (Darwin Fruit Farms) approximately 1 km to the north-east, and two nurseries (Darwin Plant Wholesalers and Jungle Plant and Flower Service) to the south. In addition to the horticultural infrastructure, there are multiple buildings on neighbouring properties to the south of the irrigation and farming operations areas, where neighbours may reside. Alphonson Road is immediately to the east of section 1611 and 1688. Other surrounding land users accessing Alphonson Road past the Project includes the Koolpinyah Station.

Because the project area is cleared of native vegetation, it does not support any significant sites or features. There are significant floodplain and wetland ecosystems in the surrounding areas, which are described below.

2.3.1 Adelaide River floodplain

The project area is located within the lower Adelaide River catchment and is surrounded by the Adelaide River coastal floodplains. The floodplain is designated as a Site of Conservation Significance (SOCS) by the NT Government. It is comprised of a mix of tidal and seasonal wetland habitats, with dominating vegetation such as grass and sedge communities and is edged by open woodland with pockets of monsoon forest. The floodplain is recognised as internationally significant due to its contribution to supporting a large number of water bird species, such as Magpie Goose (*Anseranas semipalmata*) and Whistling-Ducks.

The Adelaide River SOCS boundary encompasses the project area, which has been mostly cleared, except for approximately 22 ha of remnant Eucalyptus woodland vegetation. Because of the pre-existing clearing and land use, the project area does not encompass habitats of recognised conservation value or significance within the SOCS.

2.3.2 Black Jungle and Lambells Lagoon

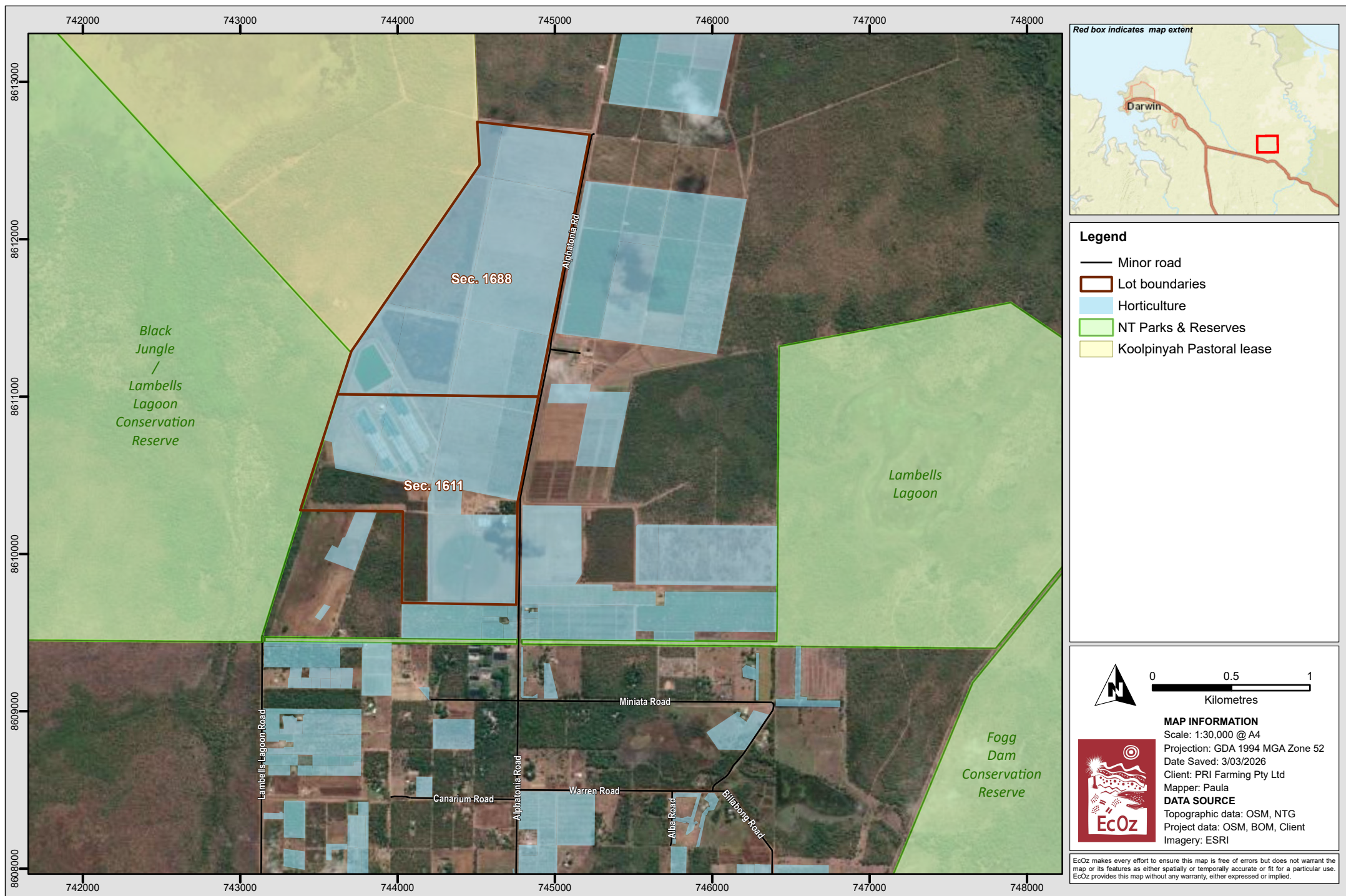
The Black Jungle Conservation Reserve borders the western boundary of the project area. Black Jungle is a surface water ecosystem that is supported by groundwater within the Howard Groundwater System during the dry season (Department of Environment and Natural Resources (DENR) 2018). This reserve protects

significant species and habitats, and access is currently restricted to scientific research, organised groups with permits, and licensed operators collecting crocodile eggs (Parks and Wildlife 2014).

Lambells Lagoon Conservation Reserve borders the eastern boundary of the project area. The reserve is designated as a recreational hunting area and is a popular bird watching area outside of the hunting season (Parks and Wildlife, 2014).

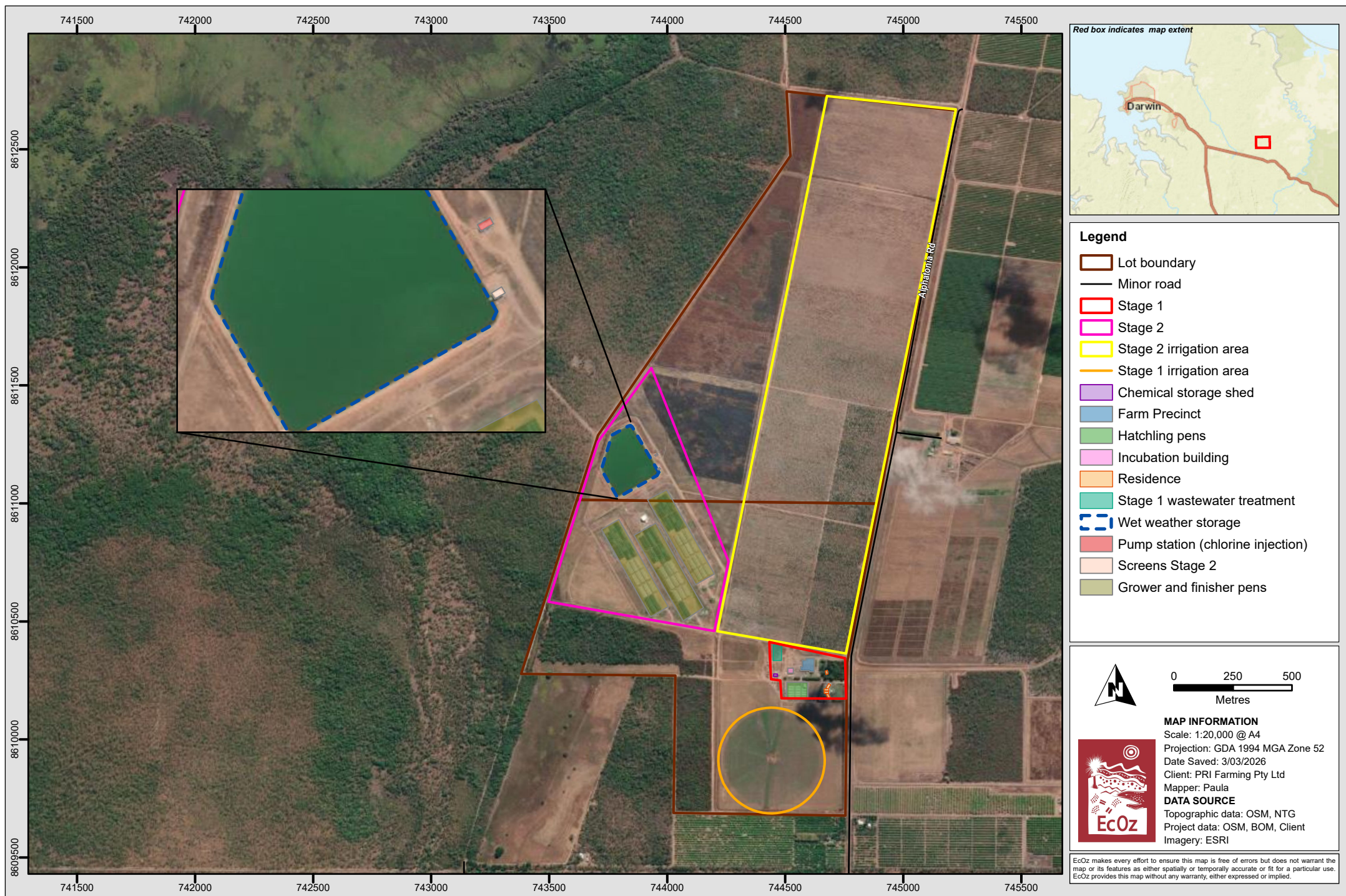
2.3.3 Fogg Dam

Approximately 1.8 km east of the project area is the Fogg Dam Conservation Reserve, which protects a manmade dam that provides important year-round habitats for water birds. The wetland wildlife and habitats at Fogg Dam are a key tourist attraction in the region.



Path: C:\Users\Paula\Documents\Maps\Marpu - EPL Amendment 2026\1. Project Files\Marpu EPL.aprx
 Layout: Figure 2-1. Map of Lambells Lagoon Crocodile Farm Project Location

Figure 2-1. Map of Lambells Lagoon Crocodile Farm Project Location



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 Layout: Figure 2-2 Map of Lambells Lagoon Crocodile Farm Layout

Figure 2-2 Map of Lambells Lagoon Crocodile Farm Layout

2.4 Land suitability

2.4.1 Climate

The region of the project area experiences a tropical climate with a distinct dry season (May to October) and wet season (November to April). Typically, for this region, humidity, maximum and minimum temperatures are highest in the wet season, and annual evaporation far exceeds annual rainfall.

Rainfall and evaporation

Rainfall data is sourced from the Bureau of Meteorology (BoM) weather monitoring station at Middle Point Rangers (station number 014090), located approximately 7 kms to the south-east of the Project area. Pan evaporation data from the Middle Point Rangers has been extracted from SILO (climate database managed by the Queensland Department of Environment and Science), for 1956 to 2025.

Average annual rainfall recorded at Middle Point Rangers station is 1449.8 mm with the highest rainfall occurring in January and the lowest in July. The average annual evaporation is 2,286.8 mm, exceeding the average annual rainfall. Evaporation is highest in October and lowest in February (Table 2-1).

Table 2-1. Average rainfall and evaporation.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall (mm)	349.5	288.0	251.3	90.0	21.9	1.3	0.7	2.1	13.5	56.1	133.0	228.4	1449.8
Pan Evaporation (mm)	168.3	147.5	164.8	175.7	188.2	178.8	191.8	211.9	224.2	236.7	207.6	191.4	2286.8

Wind

Wind direction and wind speed (km / hr) data has been retrieved from the Darwin Airport weather station (Site number: 014015). For the Darwin area, the wet season wind direction in the morning is predominantly calm (12%), with winds variable from westerly, easterly and south easterly direction. During the afternoon, the winds are predominantly north westerly, westerlies and to a lesser extent, northerlies. Dry season wind in the morning is predominantly south easterly and easterly direction, and in the afternoon, the winds are variable between north westerly, northerly and easterlies.

2.4.2 Flooding

The Project area is unlikely to flood. The area has been currently cleared and has a series of well-established network of drains. The two Conservation Reserves in the adjacent land are wetland (floodplain) areas, and the receiving waters for surface shed from the project area.

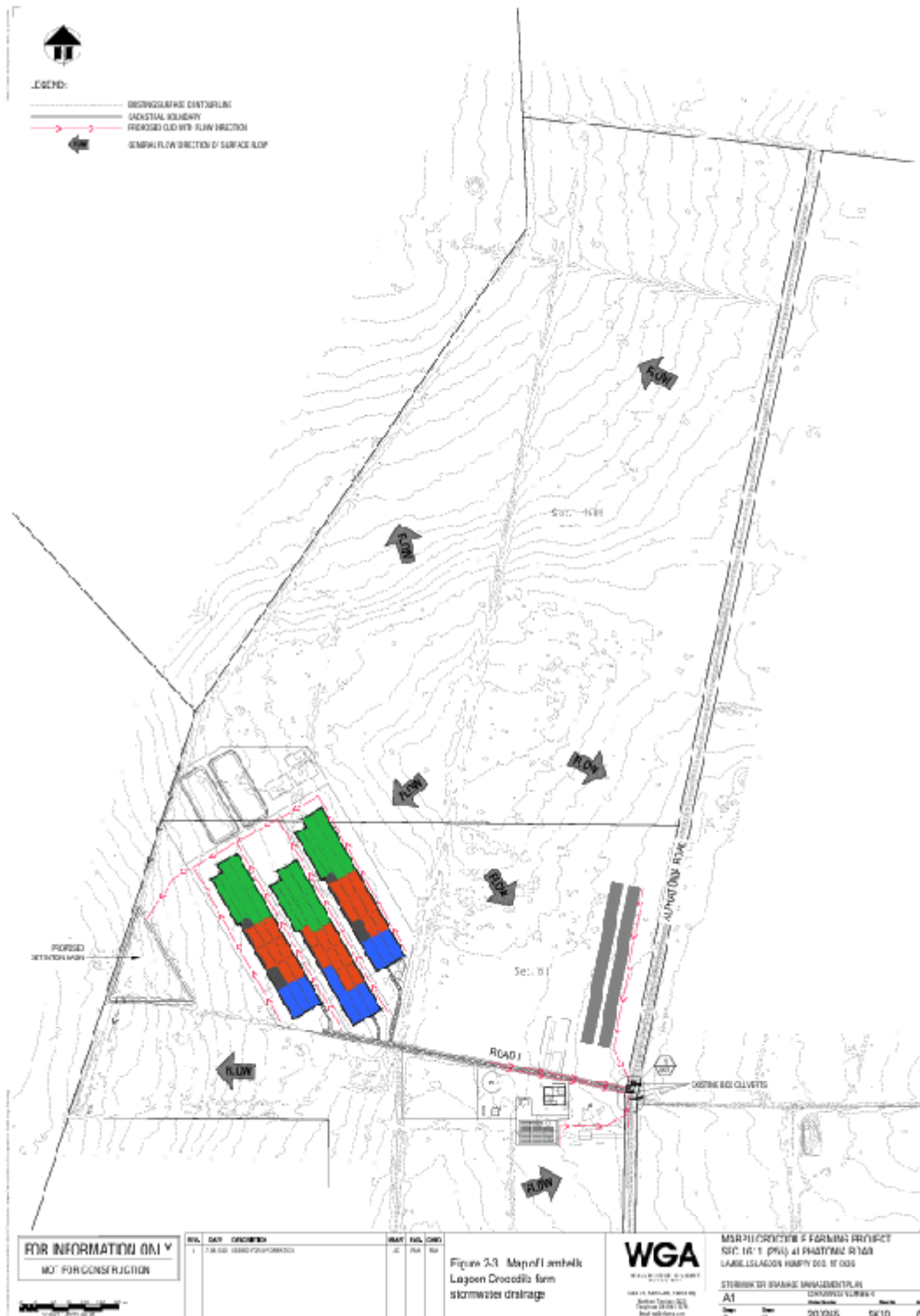
2.4.3 Topography and drainage

The majority of the Project area is relatively flat with a gradient of <2 %. The Project area is moderately well-drained allowing adequate infiltration and minimal surface water runoff. The established network of drains is designed with gentle sloping for the gradual movement of water shed off-site.

There are no water bodies or waterways in the Project area. There are existing constructed drainages that collect and direct overland flows towards the property boundaries (Figure 2-3). Surface water drainage from the Stage one area sheds to the east through existing box culverts under Alphatonia road, flowing towards Lambells Lagoon. The northern portion of the project area (section 1688) flows to the north-west into Black Jungle Swamp. The south-west section of 1688 and western portion of section 1611 (primarily Stage two) flows to the south-west into a drainage line flowing into Black Jungle Conservation Reserve. Overland flows in

the eastern parts of sections 1611 and south-east corner of section 1688 drain to the east towards Lambells Lagoon.

Figure 2-3. Map of Lambells Lagoon Crocodile Farm stormwater drainage



2.4.4 Soil and vegetation

Overall, soil testing, site visual observations and the extensive history of the land utilised for irrigated horticulture, indicates that the soil and land is suitable for irrigated crop production.

Soil sampling undertaken (Figure 2-4) during January 2020, prior to the commencement of irrigation at the site, identified the following:

- Soil colour was predominantly classed very dark grey and very dark brown and soil texture is predominantly clay loam.
- The soils are non-saline, with a low Electrical Conductivity (EC) ($<45 \mu\text{S}/\text{cm}$) and average pH of 6.66.
- The soils are classified as non-sodic (<6) with an average exchangeable sodium percentage (ESP) of 0.5 %.
- Soils are dispersion class 3 (class 1 being complete dispersion), and 12 of the 13 sample results are Emerson class number 3. Standard erosion and sediment controls will prevent soil loss through dispersion and runoff.
- Nutrient values are within the acceptable range compared to the National Environmental Protection Measure (NEPM) guidelines for soil (2013) and the preferred levels for crop/plant growth (NSW DPI 2004) with the exception of Total Phosphorus (TP) levels, outside of the preferred levels for crop/plant growth (20 – 30 mg/L) with a range of 128 mg/L to 500 mg/L. Total nitrogen (TN) levels ranged from 390 to 1310 mg/L.
- All metals are within acceptable guideline limits compared to the NEPM guidelines for soil (2013) and the preferred levels for crop/plant growth (NSW DPI 2004).

See Appendix B for all baseline soil quality results.

Approximately 90% of the project area is cleared and has in the past been planted with various horticultural crops. Predominantly, the remnant vegetation is Eucalyptus woodland and surrounding vegetation varies from open woodland, woodland and open forest.

Soil quality since irrigation started

In compliance with EPL320-01, soil sampling has been conducted annually in the 15 ha and 20 ha irrigation areas corresponding with the irrigation discharge points, Authorised Discharge Point One (ADP1) and Authorised Discharge Point Two (ADP2) respectively. A summary of the results obtained since monitoring from 2022 until 2025 are presented below:

- EC levels in the monitoring areas average 119 and 112 $\mu\text{S}/\text{cm}$, with concentrations being higher in 2025 than in previous years. In samples collected before operations started, EC was below 36 $\mu\text{S}/\text{cm}$ in Stage 1 and 30 $\mu\text{S}/\text{cm}$ in Stage 2, noting that concentration in other sampling sites, outside of Stage 1 and 2 irrigation area ranged from 12 to 45 $\mu\text{S}/\text{cm}$.
- The average pH in both areas is 6.8 and remains within the range reported in the soil baseline sampling (5.6 – 7.5).
- Average TN and TP in the two areas monitored have remained below 515 and 218 mg/L respectively. In the ADP1 irrigation area, TN levels have ranged from 160 to 860 mg/L, while at the ADP2 irrigation area, concentrations have ranged from 80 to 1,020 mg/L. TP has ranged from 79 to 542 mg/L and 91 to 483 mg/L, respectively. In baseline samples, TN and TP concentrations ranged from 390 to 1,310 mg/L, and 153 to 500 mg/L, respectively.

- Average levels of enterococci and total coliforms in ADP1 are 221 and 6,801 MPN/g dry weight, respectively, compared to 308 and 1,187 MPN/g dry weight in ADP2. *E. coli* is commonly below detection limits (11 or 12 MPN/g dry weight) at all monitoring sites, although spikes up to 47 MPN/g dry weight have occasionally been detected. These analyses were not included in the baseline soil sampling.

In the 110 ha of Stage 2 now irrigated, eight soil samples were collected in February 2025. A summary of the results obtained are presented below:

- EC ranged from 70 to 116 $\mu\text{S}/\text{cm}$, while pH was slightly acidic (5.8 – 6.8)
- Elevated levels of TN and TP were recorded, with concentrations ranging from 230 mg/L to 970 mg/L for TN, and 137 mg/L to 694 mg/L for TP.
- Bacteria levels were consistent with results from all other monitoring sites. *E. coli* was below the limit of reporting (LOR; 11 MPN/g dry weight) at all sites, while enterococci ranged from 36 MPN/g dry weight to 1,800 MPN/g dry weight.

All results obtained since monitoring started, excluding baseline samples, are presented in Appendix C.

2.4.5 Pests and weeds

Where areas have previously been cleared the land is heavily weed infested, with namely Gamba Grass (*Andropogon gayanus*) and Mission grass (*Cenchrus sp.*) and is encroaching on the remnant vegetation areas. Gamba grass and Perennial Mission grass (*Cenchrus polystachios*) are declared weeds, and Gamba grass is a Weed of National Significance (WoNS). No other declared weeds are currently reported at the Project area (Department of Lands, Planning and Environment 2003)

2.4.6 Biting insects

Floodplain environments, such as the surrounding area Adelaide River floodplain system, Lambells Lagoon and Black Jungle Conservation Reserves, are areas where biting insects (mosquitos, midges etc.) are common. Distribution and abundance vary seasonally.

Water in the crocodile pens is unlikely to provide mosquito breeding habitat as it is chlorinated and regularly replaced. The farm stormwater drainage design and operational procedures for wastewater irrigation incorporates controls to minimise pooling of water that could lead to creation of mosquito breeding habitat. Site management practices avoid the creation of shallow stagnant water where biting insects are likely to breed. This includes the routine cleaning schedule and constant water flows through the pens. Irrigation areas are designed and managed to minimise the creation of mosquito breeding habitat (i.e. avoid oversaturation and pooling of water).

2.4.7 Surface water

Beneficial uses and water quality objectives

The project area is located within the lower Adelaide River catchment and is surrounded by the Adelaide River coastal floodplains. The surface water and groundwater resources in the area are covered by the Darwin Rural Adelaide River Water Control District declared under the *Water Act*. The NT Government Gazette No. G25, 20 June 2024 (Northern Territory Government (NTG) 2024), states the following declared beneficial uses:

- Aboriginal economic development
- Agriculture
- Aquaculture

- Public water supply
- Environment
- Cultural
- Industry
- Rural stock and domestic
- Mining activity
- Petroleum activity.

The Darwin Harbour region water quality objectives for freshwater rivers and streams and lagoons are applied for the Project, given the drainage flows into Black Jungle and Lambells Lagoon Conservation Reserve.

Baseline water quality

Baseline surface water samples were collected on 22 January 2020. Locations were selected based on observed flow during the site visit at boundary drainage lines. SW01 flows to the east into Lambells Lagoon and SW02, SW03 and SW04 flows west into Black Jungle Conservation Reserve (Figure 2-4). These sites, along with SW05 are currently monitored as per the EPL320-01, although limited data is available given that the monitoring sites only flow after substantial rainfall events.

The results are compared against the Darwin Harbour Region Water Quality Objectives (DHWQO) for freshwater rivers and streams and lagoons, as well as the EPL320-01 trigger values for surface water

- The pH is slightly acidic, below the DHWQOs for freshwater rivers and streams, but within the criteria for lagoons. Concentrations at the monitoring sites ranged from 5.52 to 5.38 which is typical of rainwater in the NT.
- The water is classed as freshwater with an average EC of 18.95 $\mu\text{S}/\text{cm}$, within DHWQO for freshwater rivers and streams guideline value of 20 to 200 $\mu\text{S}/\text{cm}$ and average salinity of 0.01 ppt.
- All metals were below laboratory detection limits.
- TP and reactive Phosphorus levels exceed the DHWQO guideline value of <0.01 mg/L for freshwater rivers and streams (except for SW02), with a range of 0.06 to 0.12 mg/L. This may indicate previous use of high Phosphorus fertilisers. Nitrate + Nitrite (NO_x) also exceeded the DHWQO of 0.008 mg/L, ranging between <0.001 mg/L and 0.04 mg/L. TN ranged from 0.2 to 0.5 mg/L, with the concentration at SW03 above the DHWQO for freshwater rivers and streams, and lagoons.

Surface water quality since monitoring started

All historical results are compared against the EPL320-01 trigger values for surface water and summarised below:

- pH ranged from 4.23 to 7.2, some of these levels were slightly below the adopted criteria, but are considered typical of rainwater in the NT (Noller et al., 1990).
- EC has remained below 81 $\mu\text{S}/\text{cm}$, below the adopted criteria.
- TP has mostly been above the EPL320-01 trigger value (0.01 mg/L), with levels ranging from 0.02 to 0.11 mg/L, except on one occasion at SW01 (0.39 mg/L in Jan 2023), but concentrations decreased the following year. These results have been consistent with those reported in the baseline sampling conducted in 2020 (<0.01 – 0.12 mg/L).
- Exceedances in TN concentrations have been frequently reported at the monitoring sites, with concentrations ranging between 0.4 and 2.2 mg/L. While baseline TN levels were generally lower, the limited sampling conducted to characterise baseline conditions impacts the

representativeness of these results and any subsequent assessments against those values. Additionally, control sites SW02 and SW06 have only been sampled once since monitoring started. However, concentrations at these sites indicate background concentrations are well above the criteria.

- Bacterial loads have been variable since monitoring began, with *E. coli* concentrations ranging from 2 to 12,000 cfu/100 mL, and enterococci from 2 to 60,000 org/100 mL. Concentrations at the control sites indicate elevated background levels of *E. coli* (4,900 cfu/100 mL at SW06 and 370 cfu/100 mL at SW02) and enterococci (1,900 org/100 mL at SW06 and 320 org/100 mL at SW02).

See Appendix D for the baseline surface water quality results, and all results obtained since monitoring started, excluding baseline samples, are presented in Appendix E.

2.4.8 Groundwater

Beneficial uses and water quality objectives

The Project lies within the Darwin Rural Adelaide River Water Control District and groundwater is extracted from the Howard Groundwater System - South for the production process. The project area is underlain by the Howard Groundwater system, which includes the Koolpinyah Dolostone aquifer. The aquifer is high yielding and is an important water source for agricultural development, rural and public water supply for a large portion of Darwin's rural area. The aquifer is considered to be over-allocated and a Water Allocation Plan is under development by the NT Government pursuant to the Water Act.

The Howard Groundwater System is a fill and spill system, which relies on annual wet season rainfall to replenish the source. Hydrographs for RN030344, located within the Project area, indicate that groundwater is generally 1.5–4 m below ground level during the wet season (Northern Territory Government (NTG) 2025). During the dry season, groundwater is typically 8–12 m below ground level.

The Howard groundwater system discharges to several surface water ecosystems including Howard Springs, Howard River, Melacca Creek and Black Jungle, supporting important flora and fauna conservation values in those areas. Protection of these environmental values is a key focus of water allocation planning in the Darwin rural area and an allocation plan for the Howard Groundwater system is under development.

The Black Jungle Conservation Reserve is classified as an aquatic Groundwater Dependent Ecosystem (GDE) as it relies on discharge from the Howard Springs aquifer during the dry season. Lambells Lagoon is mapped as a moderate potential aquatic GDE.

Baseline groundwater quality

Groundwater extracted from the bores in the Project area is suitable for the proposed use in crocodile farming and as a potable water supply.

Background groundwater quality was obtained from seven bores across the Project area during three sampling occasions on the 23 January, 27 February and 9 July 2020. The bores sampled included RN030418 (Bore 9), RN024671, RN036485 (Bore 5 / GW4), RN029096 (Bore 4 / GW1), RN029097 (Bore 2 / GW3), RN030413 and RN029098 (Bore 10 / GW2); their location is shown in Figure 2-4.

The results obtained were compared with the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000) Primary Industries Long-term Trigger Values (LTV) for Irrigation, the DHWQO for groundwater, and the Australian Drinking Water Guideline (NHMRC 2011) as a conservative assessment for potable water use.

Overall, the average water quality in the wells had a neutral pH, on one occasion reading below the guidelines for Primary Industries LTV for Irrigation of 6.00 pH. The water is classed as freshwater with an average EC of

269.1 $\mu\text{S}/\text{cm}$. All bores were within the DHWQO for groundwater guideline value of 350 $\mu\text{S}/\text{cm}$, with the exception of one bore RN024671 (with a value of 380 $\mu\text{S}/\text{cm}$). All results for dissolved metals and nutrients were within the guideline limits with the exception of one parameter, TP exceeding the ANZG 2018 Primary Industries LTV for Irrigation (0.05 mg/L). *E. coli* levels were also below the adopted health criteria at all bores except RN030418.

See Appendix F for all baseline groundwater quality results.

Groundwater quality since monitoring started

A summary of the groundwater quality results obtained since monitoring started in 2021 is presented below. All groundwater quality data is presented in Appendix G.

- Water quality has an almost neutral pH (levels ranged from 6.27 to 8.19) and is classed as freshwater, with EC concentrations always below 300 $\mu\text{S}/\text{cm}$.
- The median concentrations of TN and TP at the monitoring bores were 1.7 mg/L and 0.03 mg/L, respectively. These values are within the range recorded during the baseline sampling for these parameters (1.5 – 2.6 mg/L for TN and 0.01 – 0.19 mg/L for TP). Higher concentrations of up to 4.6 mg/L (TN) and 0.48 mg/L (TP) have been recorded since 2021; however, no increasing trend has been evident.
- *E. coli* and enterococci loads in the monitoring bores have been variable, with concentrations mostly below the LOR and only occasional elevated results, except at GW2. At this bore, concentrations have generally been above those recorded in the baseline sampling and higher than those observed at other monitoring bores since 2021. However, since August 2025 to date (February 2026), bacterial levels have decreased, with results frequently reported below the LOR.

Groundwater Levels and flow

Groundwater levels at and around the farm exhibit a clear seasonal pattern, with levels typically lowest in the late dry to early wet season and increasing in response to wet-season recharge. Seasonal fluctuations of up to approximately 10 m have been observed.

Based on monthly groundwater level monitoring, groundwater flow across the site is interpreted to have a predominantly north and north-western direction, with localised variations influenced by groundwater extraction from production bores. Seasonal average groundwater contours were used to characterise regional flow patterns and minimise the influence of short-term pumping effects.

Detailed groundwater level data and contour maps are provided in Appendix H.

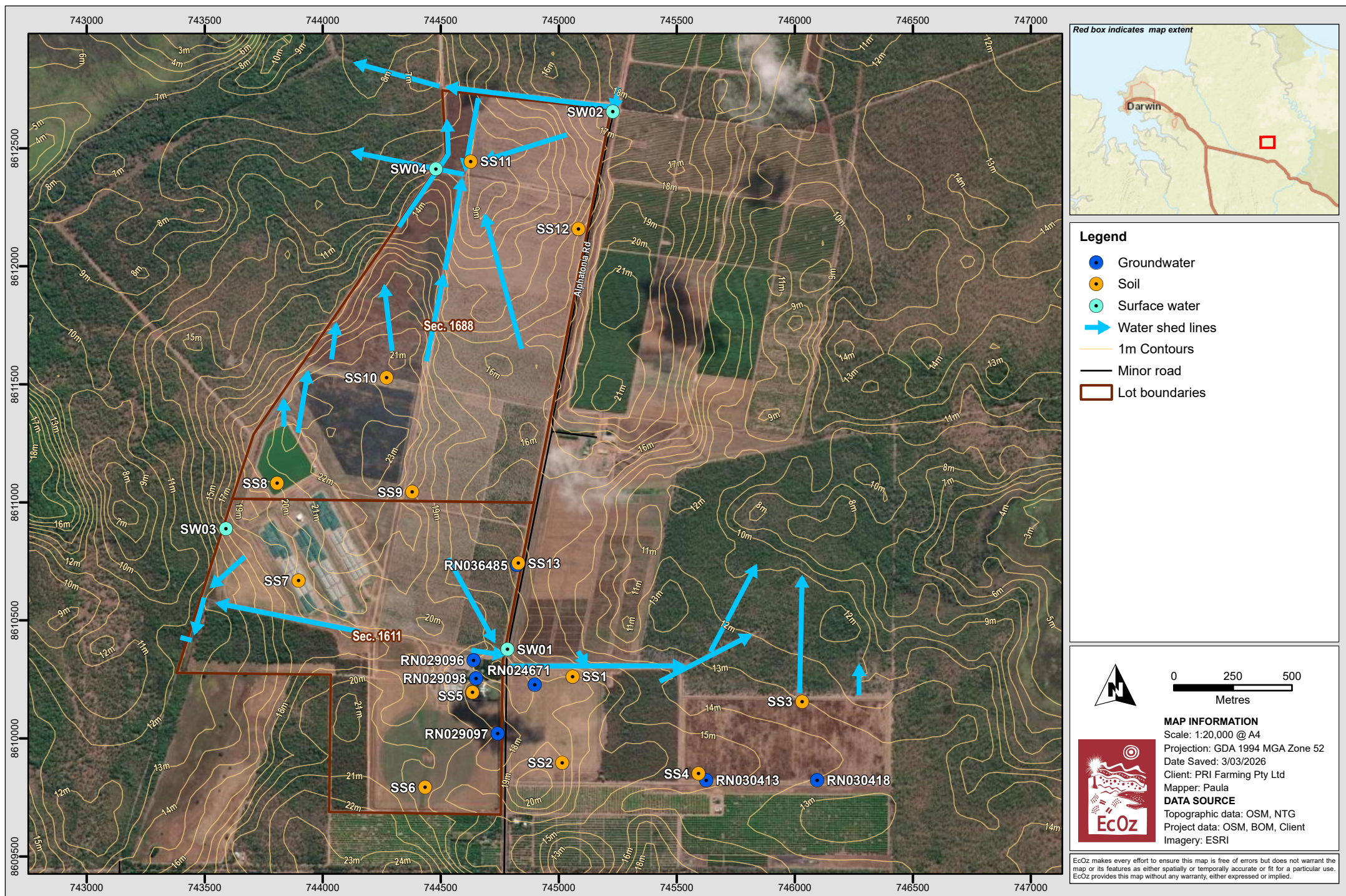
Surrounding groundwater users

GWEL (HGS10000) is in force over the Project area which allows a maximum extraction entitlement total of 3,216 ML/year. A GWEL permits water use from selected bores at specified total quantities as per licence conditions. This allowed water use is to be monitored to ensure quantities extracted remain within sustainable levels, regulated under the Water Act. There are eight bores across the Project area associated with the existing GWEL.

Based on a desktop assessment, 28 GWELs are allocated around the Project area, primarily for agricultural use (see Table 2-2).

Table 2-2. Surrounding groundwater extraction licences.

Licence	Purpose of water	Location respect to site
HGS10043	Agriculture	South
HGS10044	Agriculture	Southeast
HGS10045	Agriculture	East
HGS10060	Agriculture	Southwest
HGS10062	Agriculture	South
HGS10063	Agriculture	Southwest
HGS10066	Agriculture	South
HGS10084	Agriculture	South
HGS10088	Agriculture	South
HGS10089	Agriculture	South
HGS10090	Agriculture	Southeast
HGS10090	Agriculture	Southeast
HGS10091	Agriculture, rural stock & domestic	South – 2 km south from Project area
HGS10092	Agriculture	South
HGSC10082	Industry	South
HGSC10098	Agriculture	southwest
HGSC10108	Agriculture	South
HGSC10115	Agriculture & Industry	South
HGSC10125	Agriculture	South
HGSC10126	Agriculture	Southeast
HGSC10127	Agriculture	Southeast
HGSC10131	Agriculture	South
HGSC10309	Agriculture & Industry	South
HGSC10340	Agriculture	South
HGSE10042	Agriculture	Southeast
HGSE10370	Agriculture	Southeast
KD18	Agriculture	Southwest
KD5	Agriculture	East



Path: C:\Users\Paula\Documents\Maps\Marpu - EPL Amendment 2026\1. Project Files\Marpu EPL.aprx
 Layout: Figure 2-4. Map of Baseline monitoring locations, surface water drainage and contours

Figure 2-4. Map of Baseline monitoring locations, surface water drainage and contours

2.5 Social and economic environment

The Crocodile Farm site is located at Lambells Lagoon on the outer edge of Darwin's rural area. The property is at the end of the bituminised Alphatonia Road, which is accessed from the Arnhem Highway. The highway is also the main access route to Darwin for the towns and communities of Humpty Doo, Marrakai, Corroboree, Jabiru and Arnhem Land communities. The town of Humpty Doo is the closest service centre, approximately 20 km by road from the Project area. The nearest rural residential area where there is a higher density of residences is the properties along Wanderie Road approximately 8 km to the west of the Project area.

The conservation land to the west (around Black Jungle) is not developed for visitor use; however, the land to the east (Lambells Lagoon) receives regular visitor access for hunting and bird watching.

The neighbouring horticultural properties to the south and east of the project area have buildings where people may live or regularly spend time for work. The NT EPA Guideline: Recommended Land Use Separation Distances (2017) suggest that an activity with livestock / holding pens containing >10,000 animals per year should be separated from sensitive land uses by a 1,000 m radius.

3 PROJECT DESCRIPTION

3.1 Overview

Key operational activities include animal husbandry activities from incubation, hatchlings through to grow-out and finishers, when they are culled for skin and meat products. Wastewater is produced from the hatchlings, grower and finisher pens, increasing in volume as the crocodile's grow. Wastewater produced is managed through land irrigation crop application.

PRI have 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*, pursuant to section 56 of the *Territory Parks and Wildlife Conservation Act*, for the Lambells Lagoon Crocodile Farm.

PRI also hold an export permit under the Convention of International Trade in Endangered Species (CITES) of Wild Fauna and Flora (Permit No. PWS2020-AU-001710), pursuant to s303CG of the *Environment Protection and Biodiversity Conservation Act 1999*.

Drawings of the Stage one and two designs are presented in Appendix I. The farm layout is presented in Figure 2-2.

3.2 Site layout and design

3.2.1 Stage one

Stage one is located within parcel 1611, immediately south of the existing access road within an area of approximate 7 ha. The immediate surrounding land is used for Stage one irrigation, requiring a minimum area of 15 ha (Figure 2-2).

Office and cold store

The office and cold store area include multiple office space designed to accommodate 40 personnel, staff kitchen, lunchroom and amenities, admin, outdoor area, septic tank, parking area, fridge/freezer, meat prep room (thawing and staging area), dry and chemical stores, unloading area for deliveries and loading area for crocodile food distribution.

Incubation building

The incubation building located within the existing shed, includes a loading bay, delivery, clean and wash area, receive and prep room, incubation rooms with high humidity regulated atmosphere and a hatching room. Eggs collected from the wild and alternate crocodile farm breeding pens are placed into the incubation room for approximately three months until they hatch.

Hatchery pens

The hatchery area includes a series of hatchery pens. Hatchlings from the hatchery room within the incubation building, are transferred to the hatchery pens where they will remain for approximately six to nine months. Waste produced from the hatchery pens is flushed through to the effluent collection sump.

Effluent collection sump

The effluent collection sump collects all waste produced from the hatchery. The sump is located adjacent to the hatchery where water is pumped from the sump to the primary screen.

Screening

Primary coarse screening removes solids from the wastewater. The primary screen is comprised of a step screen system to remove solids. Following the initial screening of solids, the wastewater passes through a fine screen to remove finer solids prior to secondary treatment or direct irrigation.

Wastewater from the hatchery pens drains to a pump station, where the flow is regulated and pumped into a step screen to remove solids. From the step screen, the wastewater gravity-feeds into a second pump station and is then pumped to the 15 ha centre-pivot irrigator. Six 25 m³ emergency storage poly tanks are installed to accommodate any pumping breakdowns.

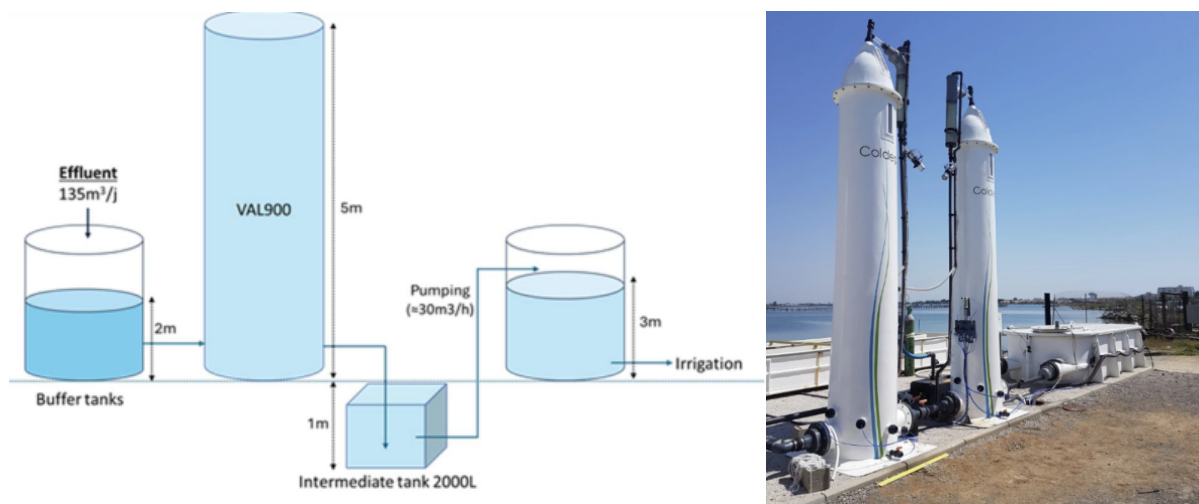


Figure 3-1. System design for the farm, and example of Coldep tower system.

Wastewater disinfection

The 25 m³ tanks are fitted with a float switch that pumps wastewater to the pivot once a set level is reached. Wastewater has been treated with peracetic acid and soda ash since December 2025, prior to irrigation, and will continue to be treated until the Coldep VAL 900 begins operations.

Peracetic acid injection into the wastewater commenced as a medium-term measure to improve bacterial removal prior to irrigation. The injected solution is a mixture of peracetic acid, hydrogen peroxide, and acetic acid, and is an effective disinfectant even in the presence of high organic matter. It requires a short contact time and does not generate harmful disinfection by-products.

The dosing system consists of a dosing pump connected to a flowmeter. This setup ensures that dosing only occurs when the irrigation pump is operating and wastewater is flowing through the flowmeter. Peracetic acid is typically dosed at a rate of 34 L per 100 m³ of wastewater, with doses of up to 53 L applied when required.

Advanced physical treatment – Coldep VAL 900 (permanent wastewater treatment system)

A Coldep VAL 900 wastewater treatment system is proposed to commence operation in June 2026 as a long-term measure to reduce bacterial loads in wastewater from Stage 1.

The system consists of a vacuum air-lift treatment unit used to process wastewater through advanced physical separation. Wastewater flows through a vertical column under partial vacuum while air is injected in the form of microbubbles. These microbubbles interact with impurities (i.e. suspended particles, organic matter and grease), causing them to rise to the surface, where they are removed via a venturi-driven separation process.

As bacteria are commonly associated with suspended particles, removal of these impurities is expected to result in a substantial reduction in bacterial loads in the treated wastewater prior to irrigation.

Ozone will also be injected directly into the column to enhance treatment performance and further support contaminant and microorganism reduction.

The system design for the farm and an example of the tower system are shown in Figure 3-1. The VAL 900 is designed for a nominal flowrate of 7 m³/h and will integrate a double ozonation system (2 x 30 g/h) and an autonomous oxygen concentrator.

Wastewater storage

After the Coldep VAL 900 system, two wastewater storage tanks of 45 m³ capacity will contain the wastewater prior to land application via irrigation.

Irrigation area

The cleared land immediately south the Stage one farm area is utilised as an irrigation area for all wastewater produced from the hatchery. A centre pivot system is used to irrigate the wastewater in the 15 ha where Jarra Grass is grown.

Security fencing

Security fencing surrounds Stage one operations.

3.2.2 Stage two

Stage two is predominantly located within the northwest section of parcel 1611. Surrounding land north of Stage one, west of Alphonson Road is used for Stage two irrigation, which currently comprises a total area of 130 ha.

Grower and finishing pens

The Stage two area is split into three teams, each team consisting of grower and finisher pens. The effluent drains into separate pump stations for each team.

Effluent collection

Wastewater drains from each of the three teams to separate team pump stations. Each team pump station can cater for a 1 in 100 year, 5 min intensity rainfall event. From the pump stations the wastewater is transferred to the primary screens.

Primary treatment - Screening

The primary screen is comprised of a step screen system to remove solids with a peak flow capacity of 150L/s, filtering all solids before draining into a Retention Basin for disposal via irrigation. The step screen is a 3.6 m wide step screen with 0.9 mm slots.

Wastewater storage

Wet weather storage (WWS) pond is a 60ML retention basin, used to store water for irrigation. Water storage facilities are constructed with low permeability foundations to prevent potential seepage to groundwater. Water storage volumes were assessed in the MEDLI modelling conducted in 2021, which concluded that 60ML of WWS capacity should be large enough to minimise the uncontrolled release of effluent, except during extreme weather events. The results indicate that overflow events may occur at a rate of 0.18 events/year, or 1.8 events

every ten years. While increasing the size of the WWS will reduce the frequency of overflow events, the cost and feasibility of managing such larger storages are a limitation (EcOz 2021).

An aerator was installed at the WWS in October 2025 to enhance the quality of wastewater from Stage 2. In addition, the inlet pipeline to the pond was relocated in December 2025, as its previous position near the outlet pipeline was reducing retention time and limiting treatment effectiveness. The inlet is now positioned closer to the aerator, improving circulation and overall treatment within the pond.

Wastewater disinfection

Prior to irrigation, wastewater is disinfected using hydrogen peroxide to reduce the bacterial load.

Irrigation area

The cleared land immediately north of the Stage one farm area (west of Alphatonia Road) is currently used for irrigation of wastewater generated from Stage two. According to the MEDLI model run in 2021 (EcOz 2021), the land required for irrigation of the grower and finisher in Stage Two is 100 ha when operations reach full capacity (50,000 animals). At the start of operations, an initial area of 20 ha, where African Mahogany are currently established, was irrigated. In 2023, an additional 110 ha of syntropic plantation was established to accommodate further wastewater irrigation from Stage two.

An additional 50 ha of African Mahogany are proposed to be planted north of the WWS by March 2027.

Security fencing

Security fencing surrounds Stage two operations.

3.3 Key operational activities

3.3.1 Schedule

Stage one includes the incubation building refurbishment, hatchery pens, administration building refurbishment, water management infrastructure (water supply tank, effluent collection sump, wastewater storage tank, wastewater screening and an interim irrigation area), and associated infrastructure.

Stage two crocodile production process involves animal husbandry activities for growing crocodiles through grow-out and finishing stages until the animals are harvested around two years of age. The production process for the farm is detailed in Table 3-1.

Table 3-1. Crocodile production process

Production process	Description
Egg collection	Eggs are collected from breeding pens (other farms) and the wild. Viable eggs transferred to the incubator room.
Incubation	Eggs are maintained in a temperature-controlled incubator until they hatch, then are immediately transferred to hatching pens.
Hatchery	The hatchlings are raised in the hatching pens
Grow-out	When animals are of suitable size, they are transferred from hatchery to grower pens
Finishing	When animals approach a size suitable for market, they are transferred to finishing pens to ensure best possible skin and meat condition.

3.3.2 Farming routine

The farming routine involves a cycle of feeding, flushing and cleaning.

3.3.3 Water supply and demand

The Project holds a GWEL no. HGS10000, which allows a maximum extraction entitlement total of 3,216 ML/year from nine existing bores. The bores are all located within the property boundary, underlain by the Howard Groundwater system, which includes the Koolpinyah Dolostone aquifer.

On average (since May 2021), water demand for the hatchery, sourced mostly from bore RN029096, is approximately 150 kL/day. Water is also sourced from another bore located in proximity to the hatchery area (Table 3-2). Bore water is pumped into the main water supply tank (approximate capacity 2,100 kL). The primary use of water on site is for regular flushing of the hatchery pens to maintain hygiene and health of the hatchlings. From the main water storage tank, the bore water is pumped into the hatchery storage tank (approximately 260 kL capacity) where it is heated and dosed with chlorine via an automated system, and then reticulated around the hatchery pens.

For Stage 2, water is sourced from bore RN042465 and an average of 1,040 kL/day is extracted, but up to 1,365 kL/day is expected to be extracted at full operation. Overall, water usage in the dry season is lower than in the wet season, due to the change in crocodile behaviours. During the drier months (i.e April to November), an average of 1,145 kL/day is used, while from December to March, an average of 960 k/day is required.

The primary use of water on site is for regular flushing of the grower pens to maintain hygiene and health of the growers.

Table 3-2 below identifies the primary bores for use in Stage one and Stage two and their average annual extraction based on data available since May 2021.

Table 3-2. Average annual extraction (ML) from licenced bores.

Bore (RN)	Bore ID (this management plan)	Bore ID (Farm)	Location	Depth (m)	Yield (L/s)	Use	Average annual extraction (ML)
029733	N/A	Bore 3	Outside of Project area – east of the site	87.5	40	Stage two	410.6
029096	GW1	Bore 4	Main area - Incubation	47	20	Stage one - main supply for hatchery, office and houses	53.8
029097	GW3	Bore 2	East of Stage 1 irrigation area	103.3	9	No extraction from this bore	0.0
029098	GW2	Bore 10	East of Hatchery	44.5	10	Stage one - amenities, firefighting, admin/residence and backup supply for hatchery.	2.7
030410	N/A	Bore 1	Eastern boundary of the Project area	76.7	10	Backup bore	17.4*

Bore (RN)	Bore ID (this management plan)	Bore ID (Farm)	Location	Depth (m)	Yield (L/s)	Use	Average annual extraction (ML)
030412	N/A	Bore 8	Outside of Project area – east of the site	109.3	5	No extraction from this bore – bore was backfilled after drilled	0.0
030418	N/A	Bore 9	Outside of Project area – east of the site	90.8	50	Backup bore	0.0
031822	GW5	Bore 6	Within Stage 2 irrigation area	96.3	30	Backup bore	0.0
031829	N/A	Bore 7	Within Stage 2 irrigation area	84.9	40	Backup bore	0.1*
036485	GW4	Bore 5	Eastern boundary of Stage 2 irrigation area	73	5	Backup bore	24.9*
042465	GW7	Bore 11	Stage 2, within the team two area to the east of the retention basin	91	20	Stage two - main water supply	379.7

*groundwater extraction from these bore has only occurred occasionally. Groundwater has not been extracted from these bores since Oct 2021 (RN031829), Jul 2022 (RN030410) and Feb 2023 (RN036485).

3.3.4 Wastewater management

Stage one

Wastewater from the hatchery is directed to the effluent collection sump prior to primary treatment through coarse screening of solids followed by fine screening. While the Coldep VAL 900 is installed, water is directed into a six 25 m³ storage tanks from where it is then treated with peracetic acid and later pumped into the Stage one irrigation area.

When the Coldep VAL 900 is fully operational, water will be directed from the storage tanks, which are equipped with overflows and level sensors to regulate flow and homogenise pollutant loads, into the Coldep VAL 900 system. The treated water will then be directed into two 45 m³ holding tanks before irrigation.

Composting does not currently occur on-site, but the feasibility of composting solid waste generated during the screening of wastewater is undergoing. Solid waste is removed from the effluent collection sump and taken off-site for disposal by a licensed waste removal company.

A water and nutrient balance for Stage one has been undertaken with current data for the site (Appendix A). The results of the water and nutrient balance indicate that the 15 ha area is sufficient to irrigate the volume of water and nutrients generated at Stage 1, without causing runoff or negatively impacting the soil.

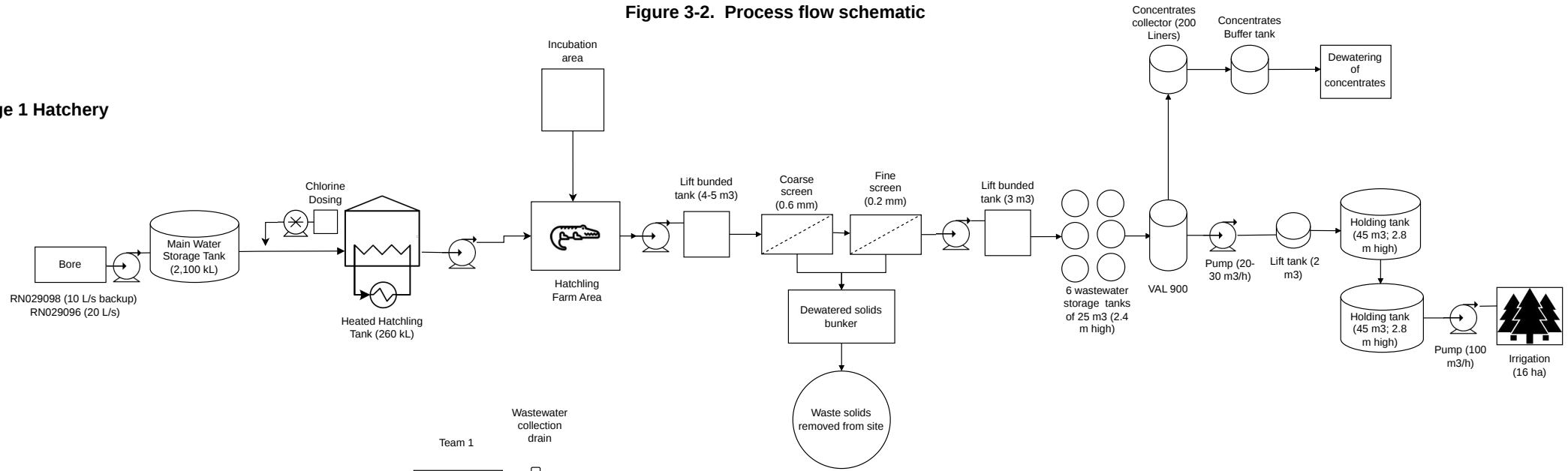
Stage two

Wastewater from the growers and finishers is directed to the Stage two effluent collection sump prior to primary treatment through coarse screening of solids followed by fine screening. The wastewater is then pumped to the WWS retention basin, where an aerator is located. From there, water is pumped and chlorinated prior to irrigation in Stage 2. As the number of crocodiles has increased since operations started, the irrigation area was expanded from 20 ha to 130 ha in 2023. Irrigation of an additional 50 ha area north of the WWS is proposed by March 2027.

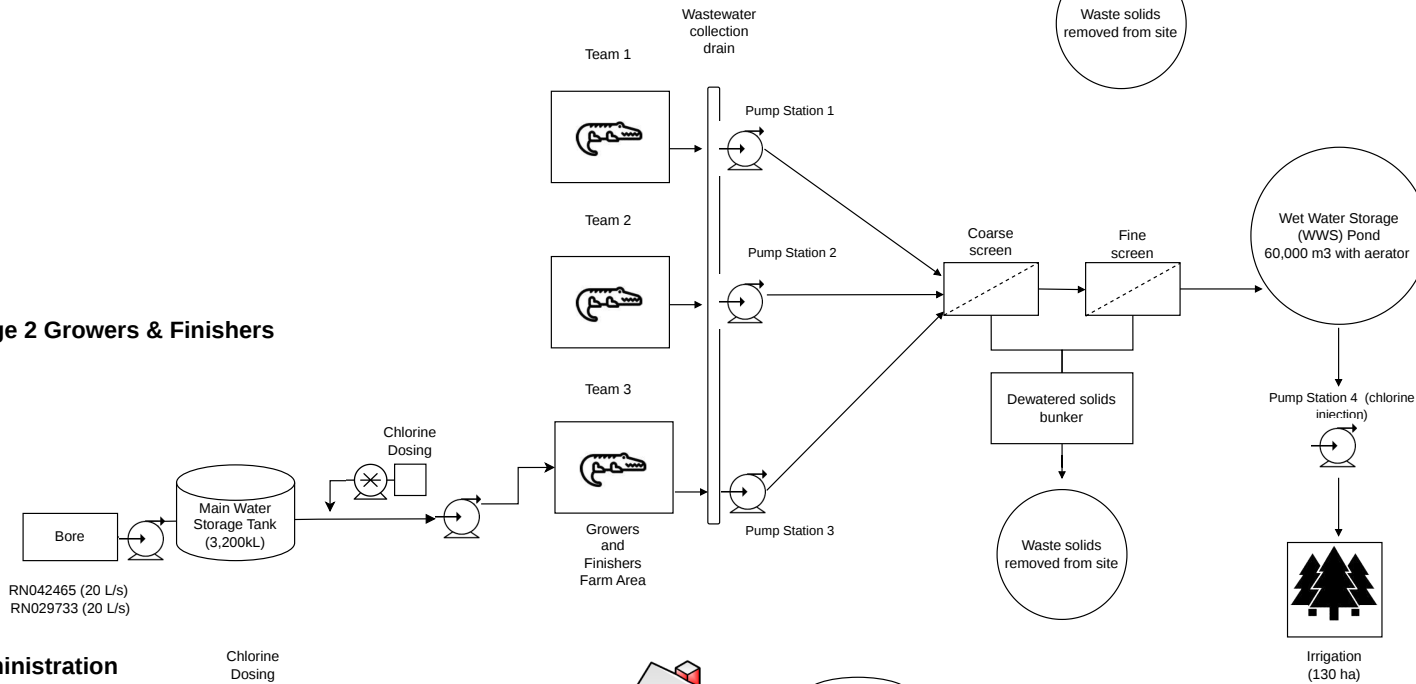
Figure 3-2 below details the process flow schematic for the overall farm.

Figure 3-2. Process flow schematic

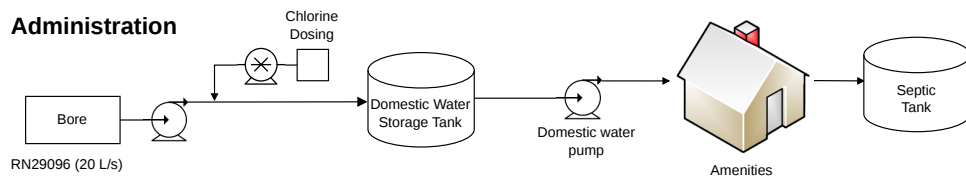
Stage 1 Hatchery



Stage 2 Growers & Finishers



Administration



3.3.5 Pollutants and wastes

Pollutants and wastes produced during operations are listed in Table 3-3, with details of treatment and disposal methods.

Table 3-3. Waste management

Pollutant/waste	Treatment / Mitigation	Disposal
Odour emissions	Appropriate separation distances to sensitive receptors. Irrigate in accordance with the approved IMP.	NA
Crocodile mortalities	NA	Stored in closed waste bin and collected by a licensed waste contractor and disposed off-site to a licensed facility
Solid animal effluent and feed waste	Primary water treatment screenings	Collected by a licensed waste contractor to an off-site compost facility until the on-site compost facility has been constructed.
Wastewater from crocodile pens	Primary and secondary treatment	Discharged to land for irrigation of crops or secondary treatment for reuse on-site.
Domestic / putrescible waste	NA	Stored in lidded waste receptacles around site and removed off-site by a waste contractor
Used chemical containers	NA	Off-site by licensed contractor
Waste oils from light maintenance activities	NA	Off-site by licensed contractor
Sewage	On-site septic tank	Pump out by licensed contractor
Stormwater discharges	Retention basin	Controlled discharge to surface waters via stormwater drains and collection sump.

An estimate of annual waste volumes generated and removed from Lambells Lagoon Crocodile farm is provided in Table 3-4 below.

Table 3-4. Estimate of annual waste volumes generated

Waste type	Annual volume
Animal waste – solids	365 tonnes
Septic (liquid)	3,000 litres
General & recycling waste	63 tonnes
Waste oil	80 litres

3.3.6 Hazardous materials storage and handling

A 5000 L diesel fuel storage tank (double skinned), used for re-fuelling of farm equipment, a back-up generator and a 3,000 L Liquefied Petroleum Gas (LPG) storage tank, is located within the Stage one operational area. LPG is used to provide heating of the water for the hatchery due to the sensitivity of hatchlings to the temperature profile.

Liquid chlorine is the primary hazardous material stored on site, used to disinfect the water in the main header tank prior to distribution to the hatchery pens. Bulk chlorine (max. 2000 L) is kept in the chemical's storage located to the west of the incubation building.

Hydrogen peroxide was introduced onsite to reduce bacterial loads in wastewater before its irrigation in the designated areas. It is also stored in the chemicals storage facility.

Other chemicals stored and used on site includes:

- Hydrogen peroxide (maximum of 4,000 L)
- Peracetic acid (maximum of 2,000 L)
- Cleaners and disinfectants (maximum of 100 L)
- F10SC Veterinary disinfectant, foaming sanitiser
- Herbicide for weed treatment (Glyphosate, maximum of 20 L)
- Oils/lubricants for farm equipment (maximum of 100 L)
- Paints and thinners (maximum 100 L)
- Epoxy sealants (maximum 1000 L for short periods).

A hazardous substance register is maintained on site, which includes storage location, summary of hazardous/dangerous goods status and links to Safety Data Sheets (SDSs). The register will be located in the site office as well as in the chemical store. Storage and handling will comply with Australian Standard 1940 – Storage and handling of flammable and combustible liquids. Copies of Safety Data Sheets (SDS's) of all chemicals will be kept in the store.

4 DISCHARGE SPECIFICATIONS

4.1 Discharges to air

Odours may be produced from Stage one, Stage two, water treatment and irrigation areas. Aerosols may also be dispersed through irrigation of wastewater.

The key measures that will minimise odour emissions are listed below:

- Primary treatment of wastewater to remove solids
- Removal of solids off-site
- Monitoring of treatment system performance to ensure wastewater entering the treated wastewater storage tank meets water quality criteria for irrigation.
- Operational procedures for irrigation of wastewater as per IMP (See Appendix A).

4.2 Discharges to land

All Stage one wastewater produced is irrigated to established crops (Jarra Grass). The wastewater pump station is the monitoring location for ADP1, to ensure wastewater meets water quality criteria for irrigation prior to discharge to land. The 15 ha irrigation area for Stage one is located south of the Stage one farm operations area.

Stage two wastewater is irrigated to an established African Mahogany plantation (20 ha) and syntropic plantation (110 ha). The irrigation area is located north of Stage one, to the west of Alphonsonia road. The wastewater pumping station from the retention basin is the monitoring location for the irrigation extraction point and ADP2 to ensure wastewater meets water quality criteria for irrigation prior to discharge to land. The plantations in this stage are intended to be used as a carbon sink and will not be harvested for approximately 20 years.

Irrigation details such as irrigation rate and water balance are included in the IMP (Appendix A). Suitability of the existing land for cropping and irrigation of wastewater is detailed in Section 2.4.

Table 4-1. Water discharge point

Discharge point ID	Latitude	Longitude	Description
ADP1	-12.565000°	131.249722°	Stage one wastewater pump station authorised discharge point.
ADP2	-12.553333°	131.245000°	Stage two wastewater retention basin pump station authorised discharge point.

4.3 Discharges to water

Surface water drainage from site is monitored as detailed in Section 8. Surface watershed pathways are shown in Figure 2-3.

5 CONCEPTUAL SITE MODEL

A diagrammatic conceptual site model (CSM) has been developed (Figure 5-1) for the project operations to identify:

Potential contaminants

- Chemicals - the use of cleaning products in the pens include multipurpose cleaners and disinfectant sanitisers which contain chlorine and ammonium-based compounds.
- Hydrocarbons – bulk storage for on-site fuel use
- Bacterial and nutrients - Nitrates, phosphates, ammonia, bacteria and pathogens (i.e. *E.coli*, *enterococci* or faecal coliforms) from the farming of animals.
- The generation of airborne contaminants and nuisance odour.

The release of these contaminants could result in an increased biochemical oxygen demand, reduced dissolved oxygen (DO), changes in pH, increased electrical conductivity, turbidity or total suspended solids, an increase in chlorophyll-a and/or an increase in hydrocarbons. Amenity impacts may also occur due to irrigation, such as an increase in odour or spray drift.

Inferred sources

- Feed inputs
- Faecal matter (crocodile pens, effluent collection sump and wastewater treatment)
- Cleaning products used in pens
- The storage of bulk hazardous chemicals and hydrocarbons
- Airborne molecules from irrigation activities.

Pathways and mechanisms for transport

- Wind dispersing odour
- Irrigation of wastewater – aerosol droplets transferred through wind dispersion
- Surface water runoff
- Groundwater seepage

Potential sensitive receptors

- People – employees and neighbours
- Surrounding land and crops
- Black Jungle and Lambells Lagoon Conservation Reserve - the receiving terrestrial and aquatic organisms with potential impacts to water quality of drawdown.
- Recreational users
- Howard groundwater system - the receiving terrestrial and aquatic organisms, GDEs and surrounding groundwater users with potential impacts to water quality of drawdown.

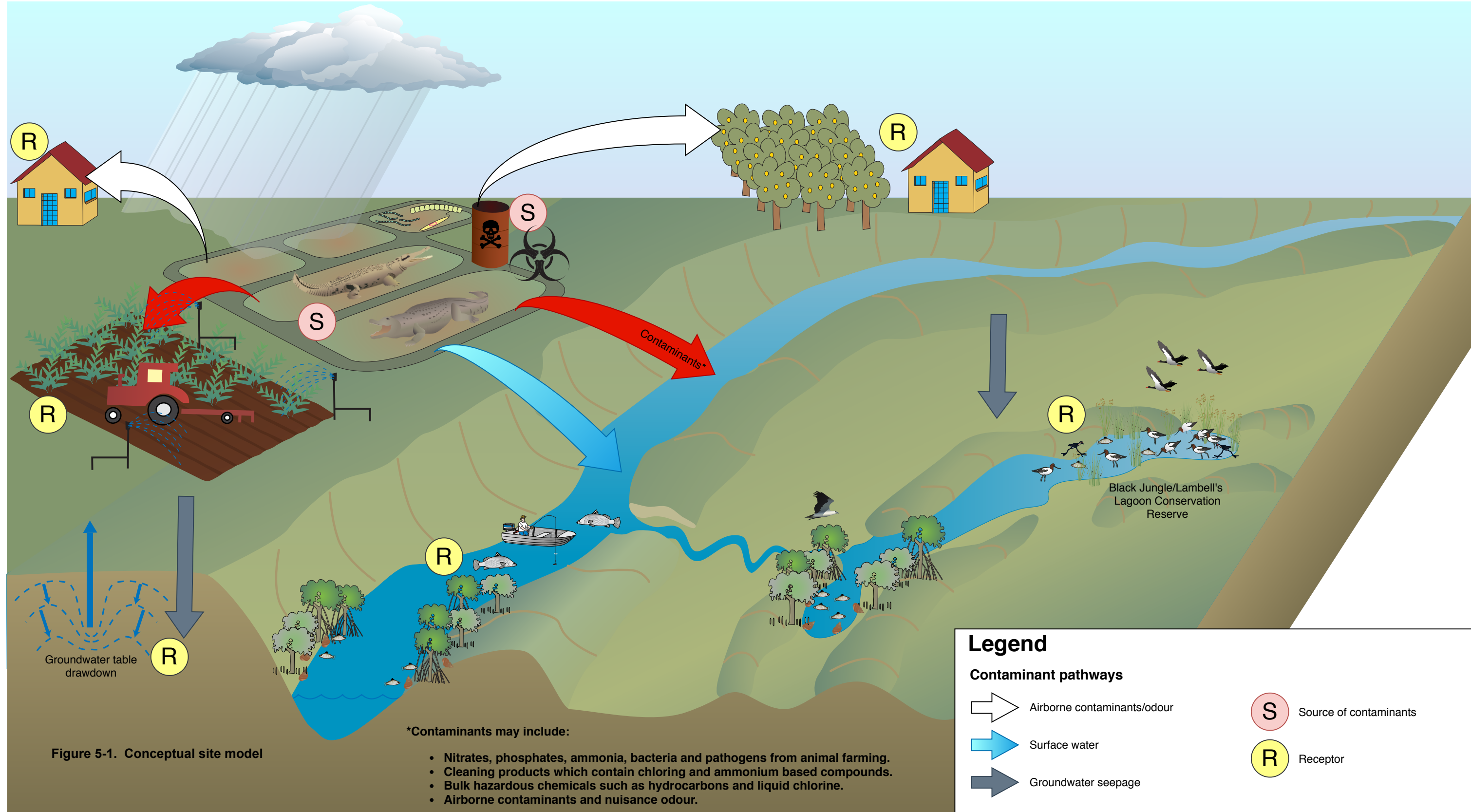


Figure 5-1. Conceptual site model

6 ENVIRONMENTAL RISK ASSESSMENT

The CSM outlined in Section 5 above has been used to inform environmental risk assessment of the overall farm operations and derive corresponding mitigation measures for identified risks. An Operational Aspects and Impact Register is presented in Table 6-4.

6.1 Operational risks

The potential environmental risks associated with operation of the Project, have been considered and addressed in an environmental aspect and impact register. The likelihood and consequence categories adopted are provided in Table 6-1 and Table 6-2, and were combined to derive an overall risk rating using the matrix in Table 6-3 below. The environmental aspects and impacts register is provided in Table 6-4.

Table 6-1. Likelihood categories

Level	Descriptor	Likelihood Description
1	Rare	The impact is very unlikely to occur. The impact has not occurred on similar projects and/or in similar environments.
2	Unlikely	The impact is not expected to occur. The impact occurs very infrequently on similar projects and/or in similar environments.
3	Possible	The impact could occur in some circumstances. The impact has occurred infrequently on similar projects and/or in similar environments.
4	Likely	The impact will probably occur in most circumstance but there is some uncertainty about the likelihood. The impact has association with similar projects and/or in similar environments.
5	Almost Certain	The event/impact will occur or is expected to occur. The impact occurs regularly in association with similar projects and/or in similar environments.

Table 6-2. Consequence categories

Level	Descriptor	Description
1	Insignificant	No noticeable or measurable impact.
2	Minor	Low intensity short-term impact that is very limited in extent i.e. confined to the direct disturbance footprint.
3	Moderate	Localised impact that alters environmental quality without compromising ecological integrity. Impact occurs periodically or is experienced over short periods of time i.e. months.
4	Major	Impact/damage that occurs at a regional scale. Impact compromises the integrity of environmental values and is felt for many years (i.e. is long-term)
5	Severe	Widespread and permanent/irreversible damage to receiving environment will occur - unlikely to ever be fixed (e.g. extinctions).

Table 6-3. Risk matrix

			CONSEQUENCE				
			1	2	3	4	5
			Insignificant	Minor	Moderate	Major	Severe
LIKELIHOOD	5	Almost Certain	Medium	Medium	High	Very High	Very High
	4	Likely	Medium	Medium	High	Very High	Very High
	3	Possible	Low	Medium	Medium	High	Very High
	2	Unlikely	Low	Low	Medium	Medium	High
	1	Rare	Low	Low	Low	Medium	High

Table 6-4. Operational environmental risk assessment

Activity	Aspect	Impact	Background information and assumptions	INITIAL RISK			Controls	Relevant Documents	RESIDUAL RISK		
				Likelihood	Consequence	Risk Score			Likelihood	Consequence	Risk Score
Filling and replenishing ponds	Extraction of groundwater	Drawdown on the Howard Springs aquifer, resulting in reduction of environmental flows in the Black Jungle or Lambell's Lagoon, which are aquatic GDEs	LLCF operate under existing GWEL HGS10000 which allows for 3,216 ML to be extracted annually. Total sustainable extraction volumes are estimated at 3,000 ML/yr. The five existing licences in place for the aquifer allocate 3,696 ML/yr, which exceeds the 20% limit set in the NT Water Allocation Planning Framework. The Howard Groundwater System is as fill and spill system, which relies on annual wet season rainfall to replenish the source. Hydrographs for RN030344, located within the Project area, indicates that groundwater is generally 1.5-4 m below ground level during the wet season (Northern Territory Government 2025). During the dry season, groundwater is typically 8-12 m below ground level. Since monitoring started in 2020, groundwater levels have remained consistent, with no decreasing trend that could indicate a potential drawdown.	3	2	Moderate (8)	Groundwater extraction to be conducted in accordance with GWEL HGS10000 and 'announced annual allocations'. Meter and monitor water extraction rates to ensure volumes are within licence conditions. Standing water level monitoring to occur.	GWEL HGS10000 Marpu Project Notice of Intent and Response to NT EPA additional Information.	2	2	Low (4)
Discharging wastewater (effluent)	Surface water quality	Reduction in water quality downstream of discharge point (addition of nutrients), and subsequent impacts on aquatic ecosystem health downstream of discharge point.	The main potential contaminants are nutrients (ammonia and nitrate) from metabolic waste products and food products and bacteriological (<i>E.coli</i>). Discharges are most likely in the wet season when the property discharge area is unable to absorb the combined inputs of effluent and catchment runoff. The Project area does not contain any water bodies, creek lines, wetlands or riparian vegetation that would support aquatic ecosystems. There are existing constructed unlined drainages that collect and direct overland flows towards the property boundaries. Overland flows in the western parts (sections 1688 and 1611) drain towards Black Jungle Swamp and in the south-eastern part towards Lambells Lagoon. The Black Jungle and Lambells Lagoon Conservation Reserves provide important year-round habitat for aquatic fauna.	4	2	Moderate (8)	Provide adequate wastewater storage for wet season runoff events. Establish irrigation area (vegetated and actively managed) for discharge of wastewater. Irrigation design to incorporate appropriate irrigation rates to prevent surface water ponding and generation of runoff. Treat wastewater prior to discharge. Only discharge from authorised discharge points. Establish a monitoring program, which incorporates monitoring quality of wastewater prior to, during and following discharge. Record all water quality results in a database and compare to guideline values. Monitor and record discharge volumes. Record and respond to any complaints received in regards to discharges.	Environment Protection Licence Irrigation Management Plan Water Quality Database Water Quality Monitoring Plan	3	2	Low (6)

Activity	Aspect	Impact	Background information and assumptions	INITIAL RISK			Controls	Relevant Documents	RESIDUAL RISK		
				Likelihood	Consequence	Risk Score			Likelihood	Consequence	Risk Score
Discharging wastewater (effluent)	Groundwater quality	Contamination of groundwater by wastewater percolation through soil profile to aquifer.	The main potential contaminants are nutrients (ammonia and nitrate) from metabolic waste products and food products, as well as bacteria (<i>E.coli</i>, enterococci and total coliforms). The National GDE Atlas (Bureau of Meteorology 2017) does not identify any subterranean or aquatic GDE's within the project footprint. Black Jungle is a known aquatic GDE and Lambell's Lagoon as a Moderate potential aquatic GDE. The ecological integrity of these areas is reliant on surface expression of groundwater from the Howard Springs groundwater system. Elevated levels of <i>E.coli</i> and enterococci have been detected at some monitoring bores, particularly at GW2; however, results from other bores appear to indicate that the elevated concentration is localised.	4	2	Moderate (8)	Provide adequate wastewater storage for wet season runoff events. Establish irrigation area (vegetated and actively managed) for discharge of wastewater. Irrigation design to incorporate appropriate irrigation rates to prevent groundwater infiltration. Treat wastewater prior to discharge. Only discharge from authorised discharge points. Establish a monitoring program, which incorporates monitoring quality of wastewater prior to, during and following discharge. Record all water quality results in a database and compare to guideline values. Monitor and record discharge volumes. Record and respond to any complaints received in regard to discharges.	Environment Protection Licence Irrigation Management Plan Water Quality Database Water Quality Monitoring Plan	3	2	Low (6)
Irrigation of wastewater	Odours Overspray/mist generation	Impacts on comfort of neighbouring properties. Windborne particles spreading potential contaminants	The nearest stakeholders to the LLCF is the Darwin Fruit Farm and Darwin Plant Wholesalers, who will be included in ongoing consultation and communications. The nearest rural residential area where there is a higher density of residences is the properties along Wanderie Road approximately 8 km to the west of the project area.	4	2	Moderate (8)	Irrigation design to include provision for large droplet size to prevent mist generation. Irrigation activities confined to approved irrigation areas and appropriate buffers maintained.	Environment Protection Licence - Irrigation Management Plan	3	2	Low (6)
Storage and use of chemicals, hydrocarbons and hazardous substances	Spills of chemicals, hydrocarbons or hazardous substances	Spills of chemicals, hydrocarbons or hazardous substances	All refuelling of vehicles occurs within a designated area. No hazardous chemicals are added to the ponds from which discharge occurs. Fuel storage on site - diesel tank All other chemicals stored in small quantities in designated bunded area	4	2	Moderate (8)	Training and site inductions provided to all employees. Appropriate hazardous substance storage and handling procedures. All products are stored in accordance with AS:1940(2004) and NOHSC:1015 (2001), including bunding or self-bunded containers. All fuels are stored in double lined and bunded fuel tanks. Spill kits are onsite, adequately sized and stocked to respond to a spill if required. Safety Data Sheets are kept onsite and in storage areas for all products. Chemical register is kept up to date for all chemicals, their volumes and storage locations. Following the 3 C's (contain, communicate, clean-up). Toolbox talks. Routine site inspections on all chemicals and hazardous goods containers. Robust incident reporting	Chemical register and SDSs Spill response Incident reporting Water Quality Monitoring Plan	3	2	Low (6)

Activity	Aspect	Impact	Background information and assumptions	INITIAL RISK			Controls	Relevant Documents	RESIDUAL RISK		
				Likelihood	Consequence	Risk Score			Likelihood	Consequence	Risk Score
							system/culture. Conduct water sampling as per the Water Quality Monitoring Plan.				
Waste generation	Waste	Pollution caused from poor waste management such as wind-blown waste and illegal dumping / incorrect disposal of waste. Waste attracting fauna and pests.	Waste to be disposed of at the nearest licensed waste management facility / transfer station accepting commercial waste, such as Humpty Doo or Shoal Bay Waste Management Facility.	4	1	Low (4)	Waste to be disposed of as required at an approved licenced waste management facility and in accordance with the NT WMPC Act. All waste streams to be segregated where possible. Listed waste (i.e. asbestos, tyres, hydrocarbon mixtures/emulsions, septic tank sludge), is to be transported and disposed of by an approved listed waste handler. All waste bins to be secure and fitted with a lid to prevent wind-blown waste, contaminated water and occurrences of pests and vermin. Waste management to prevent the introduction and spread of pest and vermin. Putrescible waste to be kept in a lidded bin and removed from site regularly. Prevent water from pooling in sumps, pits, depressions for extended periods of time. A waste management register is used to document the type and volumes of waste.	Environmental Management Plan Waste management register Incident reporting Audit reports	3	1	Low (3)
General farm operations - movement of vehicle and operating farm equipment	Dust and GHG emissions	Degradation of air quality, including dust and emissions	Particulate matter including dust, plant and equipment emissions will be produced from plant and equipment operation. All works will be confined to the boundaries of LLCF. The nearest stakeholders to the LLCF is the Darwin Fruit Farm, Darwin Plant Wholesalers and Jungle Plant and Flower Service, who will be included in ongoing consultation and communications. The nearest rural residential area where there is a higher density of residences is the properties along Wanderie Road approximately 8 km to the west of the project area.	4	1	Low (4)	All machinery will be regularly maintained to ensure that it is in good working order and in accordance with manufacturer's specifications. Work hours will be confined daylight hours. Avoid activities generating excessive dust and if required, implement dust mitigation measures. Burning of material/waste will not be permitted on-site, preventing smoke and potential odour issues.	Environmental Management Plan - Consultation and Communication Plan Incident reporting	3	1	Low (3)
General farm operations -pen maintenance	Excessive odours	Excessive odour - disturbance to neighbouring properties.	The nearest stakeholders to the LLCF is the Darwin Fruit Farm and Darwin Plant Wholesalers, who will be included in ongoing consultation and communications. The nearest rural residential area where there is a higher density of residences is the properties along Wanderie Road approximately 8 km to the west of the project area.	4	1	Low (4)	Adherence to pen cleaning schedule. All putrescible waste to be stored appropriately prior to removal from site by a licensed waste contractor.	Environmental Management Plan	3	1	Low (3)

Activity	Aspect	Impact	Background information and assumptions	INITIAL RISK			Controls	Relevant Documents	RESIDUAL RISK		
				Likelihood	Consequence	Risk Score			Likelihood	Consequence	Risk Score
General farm operations - movement of vehicles	Spread of weeds	Spread of weeds –degradation of environment quality / native flora.	The small portion of remnant vegetation on site is impacted from encroaching weeds from the cleared areas. The cleared areas are largely degraded with weeds resulting from years of agricultural use (i.e. irrigated horticulture) and unmaintained prior to acquisition of the land.	5	2	Moderate (10)	Weed management in accordance with the NT <i>Weed Management Act</i> . Implementation of good weed hygiene practices, such as; - cleaning of plant & equipment, all machinery and equipment to be certified weed free prior to mobilisation on site - prevent driving through weed infested areas - clearing of areas avoided during seeding to prevent spread - no offsite movement of soil or vegetation materials contaminated with weeds. - herbicide spraying program undertaken annually to control weed species within construction areas. - regular slashing prior to seeding - regular inspections	Environmental Management Plan	3	2	Low (6)
General farm operations - flushing of pens with water, water ponds and drains	Biting insects	Increased presence of and/or increased breeding sites for biting insects causing discomfort of employees/neighbours and increased mosquito borne disease risk.	The location of the LLCF, surrounded by wetlands, means the area will be exposed to high mosquito numbers and standard precautions will be required to protect employees from mosquito borne diseases.	3	2	Low (6)	Surface water drainage assessed during site audits ensuring water is not pooling or stagnant for extended periods of time. Effluent collection sump water levels kept to a minimum and banded to prevent surface water ingress. All bunds and other potential water holding receptacles to be covered during the wet season. Appropriate PPE will be issued to employees for mitigation of existing biting insects due to proximity of project location to floodplains. Additional measures to be adopted during the wet season. Adherence to pen cleaning schedule.	Environmental Management Plan Audit reports	2	2	Low (4)
General farm operations - movement in and out of farm	Social and economic	Increased traffic to and from the LLCF impacting surrounding users of Lambells Lagoon.	Access via existing access road off Alphatonia Rd. Limited other road users to access past LLCF (Koolpinyah Stn and the Darwin Fruit Farm), road ends at Koolpinyah Station gates.	3	2	Low (6)	Continued consultation and communications with surrounding stakeholders and interested parties. Complaints register; - Date and time of complaint - Method complaint was made - Contact details of complainant - Details of complaint - Follow-up actions taken - Monitoring to ensure complaint has been resolved	Environmental Management Plan - Consultation and Communication Plan	3	1	Low (3)

Activity	Aspect	Impact	Background information and assumptions	INITIAL RISK			Controls	Relevant Documents	RESIDUAL RISK		
				Likelihood	Consequence	Risk Score			Likelihood	Consequence	Risk Score
General farm operations - operation of equipment / pumps	Noise and vibration	Increased noise and vibrations generated from operation of the LLCF - impact on surrounding land users within Lambells Lagoon and reduced habitat quality.	Operational activities will only occur during the day. There are three neighbouring horticultural properties with operations areas/infrastructure that fall within a 1 km buffer. The nearest rural residential area where there is a higher density of residences is the properties along Wanderie Road approximately 8 km to the west of the project area.	3	2	Low (6)	Noise will be managed in accordance with the NT EPA (2018) Noise Management Framework Guidelines. Operational activities will only occur during daylight hours. Farm equipment will be used as per manufacturers guidelines and modified (i.e. mufflers) as required to meet appropriate noise emission levels. All vehicles and equipment will be regularly serviced and maintained. Vehicles and equipment will not be left running when not in use. All complaints will be recorded in the complaints register and immediately assessed to prevent future noise complaints. If a noise complaint is received, the site / equipment will be assessed to ensure noise levels are within acceptable guidelines.	Environmental Management Plan - Consultation and Communication Plan	3	1	Low (3)
Farming of live animals	Mortality Odour	Quarantine issues or spread of diseases. Odour issues impacting neighbouring properties	Strict quarantine practices as required by the NT Government. Antibiotics administered in hatchery as necessary. Pens cleaned as per farming regime and any animal waste processed according to listed waste requirements	3	2	Low (6)	Established quarantine practices within LLCF. Established monitoring and surveillance program to identify any potential disease outbreak. Established cleaning regime and listed waste handling procedures	Biosecurity plan	3	1	Low (3)
Land disturbance	Erosion and sediment control	Discharge of sediment laden water to the Black Jungle and/or Lambells Lagoon, post construction earthworks during the wet season.	Erosion and sedimentation risks are unlikely to be significant in extent as the land is relatively flat (slope <2 %).	4	2	Moderate (8)	A site-specific Erosion and Sediment Control Plan (ESCP) developed to align with the Best Practice Erosion and Sediment Control Guidelines (IECA 2008), prepared by a suitably qualified person remaining active post construction to ensure erosion and sediment loss is as low as reasonably practicable during the wet season. Only land required for Stage one construction was cleared to minimise land disturbance.	Environmental Management Plan ESCP developed for construction of stages still applied as required until appropriate levels of cover are achieved.	3	2	Low (6)

7 ENVIRONMENTAL MANAGEMENT AND COMPLIANCE

The risk assessment process detailed in Section 6 identified controls that will be implemented to minimise the risks to the environment during operational activities. This Environmental Management Plan (EMP) provides a consolidated plan for environmental management to mitigate the environmental risks. Section 7.1 identifies the potential impacts of operations on the environment and includes environmental objectives, management and mitigation measures, performance criteria and target indicators, corrective actions and contingencies, monitoring and reporting and record-keeping mechanisms for each aspect.

7.1 Environmental provisions

Table 7-1. Environmental management plan

ACTIVITY	POTENTIAL IMPACT	OBJECTIVE / OUTCOME	MANAGEMENT ACTION	TARGET / PERFORMANCE INDICATOR	MONITORING	CORRECTIVE ACTIONS AND CONTINGENCIES	REPORTING AND RECORD-KEEPING
Filling and replenishing pens	Reduction in groundwater availability	No reduction in groundwater availability due to extraction.	Extract water within permitted volumes.	No exceedance of licenced groundwater extraction volumes	Meter and monitor water extraction rates to ensure volumes are within licence.	- Revise meter monitoring procedure and introduce a more frequent meter reading schedule. - Review potentials for water reuse. - Assess extraction limits.	- Water usage is recorded in a database - Groundwater usage detailed in Annual Report.
Discharging wastewater (effluent)	Reduction in water quality downstream of discharge point (addition of nutrients and bacteria), and subsequent impacts on aquatic ecosystem health downstream of discharge point.	No reduction of water quality in receiving environments.	- Established irrigation area (vegetated and actively managed) for discharge of wastewater - Irrigation design to incorporate appropriate irrigation rates to prevent surface water ponding and generation of runoff - Provide adequate wastewater storage for wet season runoff events - Irrigation of stored water during dry periods to maximise storage capacity through wet periods. - Treatment of wastewater to be irrigated to improve quality.	- No exceedance of approved trigger levels - No recorded incidents of wastewater runoff from irrigation area	- Established monitoring program, which incorporates monitoring quality of wastewater prior to and following irrigation. - Monitor and record irrigation volumes.	- Review irrigation system capabilities and opportunities for improvement. - Review potentials for water reuse - Review alternative treatment methods - Review monitoring program to allow for further detection of potential contaminants	- Record all water quality results in a database and compare to guideline values and historic/ baseline data. - Record and respond to any complaints received in regard to discharges. - Reporting undertaken through Monitoring Report and Annual Return
Discharging wastewater (effluent)	Reduction in water quality of underlying aquifers.	- No long-term reduction of groundwater quality of underlying aquifer. - No long-term off-site migration of any contamination detected.	- Established irrigation area (vegetated and actively managed) for discharge of wastewater - Irrigation design to incorporate appropriate irrigation rates to prevent groundwater infiltration - Provide adequate wastewater storage for wet season runoff events - Irrigation of stored water during dry periods to maximise storage capacity through wet periods. - Treat wastewater prior to irrigation to improve water quality.	No change in quality of inlet water from bores in comparison to historical data	- Established monitoring program, which incorporates monitoring quality of wastewater prior to, during and following discharge. - Monitor and record discharge volumes.	- Review irrigation system capabilities and opportunities for improvement. - Review potentials for water reuse - Review alternative treatment methods - Review monitoring program to allow for further detection of potential contaminants	- Record all water quality results in a database and compare to guideline values and historic data. - Record and respond to any complaints received in regard to discharges. - Reporting undertaken through Monitoring Report and Annual Return
Irrigation of wastewater	Overspray/mist generation	No impacts on neighbouring properties from irrigation	- Irrigation design to include provision for large droplet size to prevent mist generation. - Irrigation activities confined to approved irrigation areas and appropriate buffers maintained (>50m from neighbouring properties). - Irrigation restrictions pending weather conditions (rain and/or wind)	No complaints received in regard to mist generation	Established monitoring plan which incorporates visual inspections of irrigation areas	Review Irrigation Management Plan, including irrigation rates, areas, and timing	- Record and respond to any complaints received - Reporting undertaken through Monitoring Report and Annual Return

ACTIVITY	POTENTIAL IMPACT	OBJECTIVE / OUTCOME	MANAGEMENT ACTION	TARGET / PERFORMANCE INDICATOR	MONITORING	CORRECTIVE ACTIONS AND CONTINGENCIES	REPORTING AND RECORD-KEEPING
Irrigation of wastewater	Odour generation	No impacts on neighbouring properties from odour during irrigation	- Irrigation design to include provision for large droplet size to prevent odour generation. - Irrigation activities confined to approved irrigation areas and appropriate buffers maintained (>50m from neighbouring properties). - Irrigation restrictions pending weather conditions (wind) - Treat wastewater prior to irrigation to improve water quality.	No complaints received in relation to odour	- Established monitoring plan which incorporates odour monitoring by site staff - Establish a monitoring program, which incorporates monitoring quality of wastewater prior to and following irrigation	- Review Irrigation Management Plan, including irrigation rates, areas and timing - Review water quality and implement additional treatment if required (e.g. to reduce odour from Biological Oxygen Demand (BOD), oil and grease, bacteria)	- Record and respond to any complaints received - Reporting undertaken through Monitoring Report and Annual Return
Storage and use of chemicals, hydrocarbons and hazardous substances	- Uncontrolled discharge of dangerous goods or hazardous substances. - Contamination of ponds, and discharge of contaminated water into receiving environment. - Reduction in water quality downstream of discharge or spill point, and subsequent impacts on aquatic ecosystem health downstream of discharge point. - Reduction in water quality of underlying aquifers.	No contamination to farm water, sediments or surface water as a result of chemical, hydrocarbon or hazardous substance spill.	- All refuelling of vehicles occurs within a designated area. - No hazardous chemicals are added to the ponds from which discharge occurs. - Fuel storage within self-bunded container - All other chemicals stored in designated bunded area - Training and site induction provided to all employees - Appropriate spill kits kept on-site and stocked in chemical storage and refuelling areas	- No indication of spills of chemicals or hazardous substances. - Any spill of stored product is contained and remediated through the spill response procedure. - No leaks from equipment.	- Regular inspections of chemical and hazardous substance storage areas through operational activities. - Water quality performance will be monitored through the monitoring program.	- Review storage and handling practices for chemicals and hazardous substances. - Increase the amount of bunding and containment for chemical and hazardous substance storage areas. - Increase the number, capacity or type of spill kit materials.	- Incident reporting records - Water quality database - Reporting undertaken through the Monitoring Report and Annual Return - Chemical and SDS register maintained - Hazardous material tracking undertaken through invoicing process
Waste generation	- Poorly managed site attracting native fauna and pests - Contamination to land/soils	- No introduction of pest species or increase in native fauna as a result of poor waste management practices - No contamination as a result of poor waste management practices	- Ensure waste is stored/disposed of in appropriate containers for waste type prior to disposal. - Removal of waste products by licensed waste contractors.	- No recorded incidents of pests or native fauna accessing waste - No indication of land/soil contamination	Monitoring of waste disposal areas.	Review waste handling and disposal practices	- Inspection records - Incident reporting records
General farm operations - movement of vehicle and operating farm equipment	Degradation of air quality, including dust and emissions from operating farm equipment	Minimise air emissions	- Maintenance of equipment to minimise air emissions as far as possible. - Avoid activities generating excessive dust and if required, implement dust mitigation measures.	No complaints in relation to air quality	- Maintenance regime for all plant and equipment. - Visual monitoring during periods of dry weather and high winds.	- Review maintenance regime - Review dust control measures and implementation	Record and respond to any complaints received
General farm operations -pen maintenance	Disturbance to neighbouring properties associated with excessive odours	Minimise odour	- Adherence to pen cleaning schedule. - General housekeeping around farm to reduce odour sources. - All putrescible waste to be stored appropriately prior to removal from site by a licensed waste contractor.	No complaints in relation to odour	- Daily pen inspections. - Inspections of waste management areas.	- Review of cleaning schedule - Review of waste management practices	Record and respond to any complaints received
General farm operations - movement of vehicles	Spread of weeds	- To prevent spread of established weeds within and off the property - To prevent introduction of new weed species to the property	- Regular control of weeds by herbicide spraying. - Regular slashing. - Equipment brought on to site certified as weed free.	- No increase in the distribution of existing weed species. - No introduction of new weed species.	Undertake regular weed outbreak inspections.	Review weed control activities and frequency	- Inspection records - Incident reporting records

ACTIVITY	POTENTIAL IMPACT	OBJECTIVE / OUTCOME	MANAGEMENT ACTION	TARGET / PERFORMANCE INDICATOR	MONITORING	CORRECTIVE ACTIONS AND CONTINGENCIES	REPORTING AND RECORD-KEEPING
General farm operations - flushing of pens with water, water ponds and drains	Creation of mosquito breeding habitat impacting on comfort of employees/neighbours and increased disease risk	- To prevent mosquito breeding opportunities - To reduce the potential for contact between mosquitoes and people	- Minimise any stagnant water by ensuring containers are kept out of rain. - Adherence to pen cleaning schedule.	- No prolonged areas of ponding water on-site - No incidence of mosquito borne disease	Regular inspections of site to identify areas of ponding water and subsequent rectification.	- Review stormwater controls and site flow paths. - Review inspection regime.	- Inspection records - Record and respond to any complaints received
General farm operations - movement in and out of farm	Increased traffic to and from the LLCF impacting surrounding users of Lambells Lagoon.	No nuisance impacts on neighbouring properties from increased traffic	- Continued consultation and communications with surrounding stakeholders and interested parties. - Operational traffic management plan if required	No complaints in relation to increased vehicle movements	Sign in/out register to monitor movement of personnel to and from site	Review traffic management plan	- Record and respond to any complaints received - Visitor register
General farm operations - operation of equipment / pumps	Increased noise and vibrations generated from operations of the LLCF - impact on surrounding land users within Lambells Lagoon and reduced habitat quality.	No impacts on neighbouring properties from noise or vibration.	- Operational activities will only occur during daylight hours - Equipment maintained and serviced regularly	No complaints in relation to noise or vibration	Maintenance regime for all plant and equipment	- Review maintenance regime - Review noise control measures and implementation	Record and respond to any complaints received
Farming of live animals	Quarantine issues or spread of diseases.	No introduction or spread of disease across the farm or into the receiving environment.	Established quarantine practices within Lambells Lagoon Crocodile Farm.	No recorded incidents of disease spread/outbreak	Established monitoring and surveillance program to identify any potential disease outbreak.	- Review quarantine practices - Review monitoring program	- Inspection records - Incident reporting records
Land disturbance	Discharge of sediment laden water to the Black Jungle and/or Lambell's Lagoon, post construction earthworks during the wet season.	To minimise erosion and sedimentation of receiving waterways	Erosion and sediment control structures maintained for the duration of the first wet season following land disturbance activities during construction	- Minimal loss of topsoil - Minimal erosion observed - Minimal sedimentation impacts downstream	- Surface water monitoring program monitor turbidity, TDS and erosion and sedimentation observations. - Regular inspections of site to identify areas of erosion and sedimentation issues. Monitor efficacy of erosion and sediment control structures.	- Review stormwater controls and site flow paths. - Maintenance of erosion and sediment control structures. De-silt as required.	- Inspection records - Incident reporting records - Surface water quality data

7.2 Training and awareness

All new site personnel, contractors, and unaccompanied visitors will complete a site induction prior to commencing work on-site. The induction will include details of the emergency procedures, site familiarisation, environmental awareness, incident reporting, spill response, and familiarisation of the EMP. Induction and training activities will be reviewed regularly to ensure they contain the most up-to-date information and procedures.

A training and induction register will be maintained. All personnel required to operate machinery and complete their required duties will be appropriately trained, licenced and suitably qualified. Relevant staff will have training provided so that they are able to undertake the environmental management and monitoring activities specified in this plan including first aid and spill response. In-house training will be provided by relevant contractors (consultants) in specific environmental monitoring tasks.

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

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

7.3 Roles and responsibilities

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

7.4 Non-conformance and corrective actions

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

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

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

In the event results of environmental monitoring show levels exceeding the developed trigger values, an investigation will determine the cause and further sampling may be required to determine extent of impact and corrective actions and adapt management methods will be implemented.

Auditing of the site operational efficacy will be based of the monitoring requirements meeting the Site-Specific Trigger Value (SSTV) and conditions as per approved environmental monitoring plans.

8 ENVIRONMENTAL MONITORING PLAN

8.1 Objectives

The following environmental protection objectives (EPOs) under the *WMPC Act* and *Water Act* are applied to the Project:

- environmental quality is to be maintained, enhanced, managed or protected
- pollution, or environmental harm resulting from pollution, is to be assessed, prevented, reduced, controlled, rectified or cleaned up
- effective waste management is to be implemented or evaluated
- protect the beneficial use of the Darwin Rural Water Control District as declared under the *Water Act*.

The monitoring program will provide early-warning of surface and groundwater quality and soil quality issues and inform adaptive management of the operational water management including the wastewater treatment system, to achieve water quality criteria; and monitor off-site impacts to receiving surface waters and groundwater.

8.2 Operational monitoring program

During farm operations, environmental sampling will be conducted on surface water, irrigation water, groundwater bores and soil. Program details are outlined below.

The site sampling locations for surface water and groundwater are shown on Figure 8-1.

8.2.1 Surface water

There are no well-defined watercourses flowing onto the site (representing background/reference). An adjacent creek to the west of the Project area has been identified as a suitable upstream control site and a location further downstream within Black Jungle conservation reserve, monitoring potential impacts, receiving discharge water from the western boundary. The monitoring sites at the property boundary is indicative of the quality of water leaving the site.

Surface water sampling is to be undertaken through the wet season when site runoff is generated. Sampling shall be undertaken at upstream and downstream locations each sampling event when the sites are flowing (not stagnant).

Table 8-1. Surface water monitoring program

Monitoring sites	Easting*	Northing*	Control / Impact	Description	Parameters	Frequency
SW01	744770	8610323	Impact	Drainage line west of Alphatonia Rd. at Property entrance, receiving water runoff from Stage one – parcel 1611, flowing east to Lambells Lagoon.	<i>Field measurements</i> • pH • EC	3 times during the wet season (start, during, end)
SW02	745229	8612655	Control	Drainage line west of Alphatonia Rd. at the north-east corner of parcel 1688. Receiving surface water runoff from Alphatonia Rd	<i>Laboratory analysis:</i> • Total nitrogen • Total phosphorous	

Monitoring sites	Easting*	Northing*	Control / Impact	Description	Parameters	Frequency
				flowing west along the northern boundary into Black Jungle CN.	• <i>E.coli</i> • <i>Enterococci</i> • Thermotolerant coliforms	
SW03	743417	8610332	Impact	Drainage line on south-west boundary corner of parcel 1611 flowing west to Black Jungle CN. Downstream stormwater drainage from Stage two.		
SW04	744480	8612413	Impact	Drainage line north-west of parcel 1688 flowing west to Black Jungle CN. Surface water runoff from irrigation area proposed for Stage two.		
SW06	742978	8609442	Control	Upstream creek on western side of Project, flowing into Black Jungle CN. Upstream of SW03 discharge point.		

*GDA94 Zone 52L

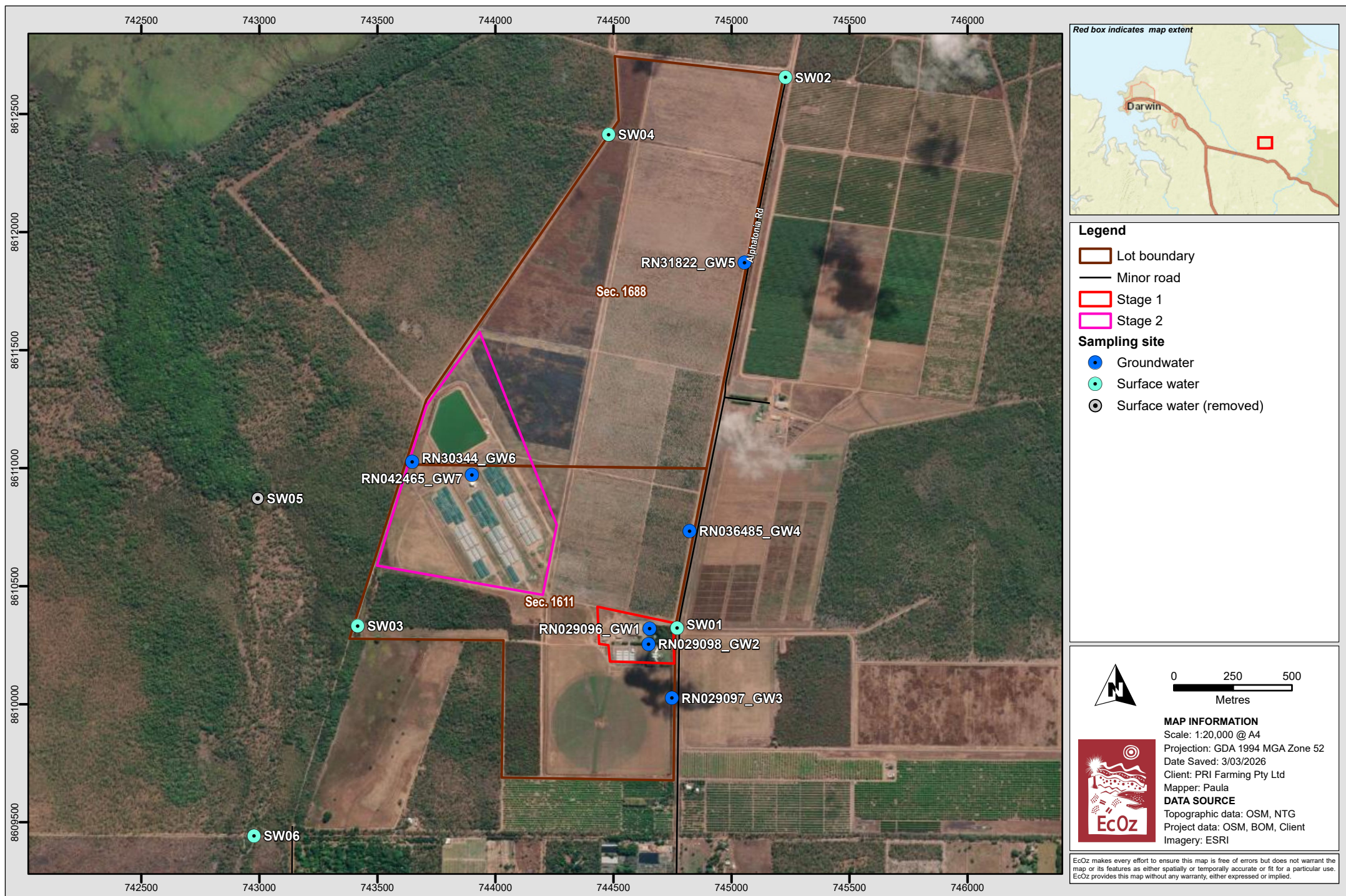
8.2.2 Groundwater

Groundwater sampling is proposed from six bores and standing water level (SWL) from an additional bore (Table 8-2), to detect any potential migration of contaminants from the irrigation areas and farm operations and monitor SWL. Where these bores do not provide for adequate monitoring of seepage from the irrigation areas, there may be a requirement to install additional bores downstream of the irrigation areas. An NTG Water Resources investigation bore (RN30344), located on the western boundary, collects and records SWL data from 1996 to current. Whilst the SWL data is available publicly for download on the NT Water Data Portal, water quality monitoring is unable to be undertaken.

Table 8-2. Monitoring program for groundwater sites

Monitoring sites	RN	Easting	Northing	Completion depth (m below ground level)	Location and description	Parameters	Frequency
GW1	RN029096	744654	8610320	47	Bore located adjacent to the existing office facilities and east of incubation building. Water supply bore.	<i>Field measurements</i> • pH • EC • SWL <i>Laboratory analysis:</i> • Total nitrogen • Total phosphorous • <i>E.coli</i> • <i>Enterococci</i> • Thermotolerant coliforms • Cations and anions (calcium, magnesium,	Quarterly
GW2	RN029098	744649	8610254	44.5	Bore located adjacent to the proposed hatchery. Water supply bore.		
GW3	RN029097	744748	8610026	103.3	Bore located west of Alphatonia rd.		

Monitoring sites	RN	Easting	Northing	Completion depth (m below ground level)	Location and description	Parameters	Frequency
					within south-east section of parcel 1611.	sodium, potassium, sulfate, chloride and alkalinity as CaCO ₃).	
GW4	RN036485	744823	8610734	62.2	Bore located west of Alphatonia rd. within north-east section of parcel 1611.		
GW5	RN31822	745056	8611871	87.6	Bore located west of Alphatonia rd. within parcel 1688.		
GW6	RN30344	743648	8611027	36.5	Water Resources Bore equipped with water level logger. Located on the western side of Project on boundary, SW corner of parcel 1688 downstream Stage 2.	SWL (data accessed online)	As determined by NT Water Resources –logger – 4 logged intervals per year.
GW7	RN042465	743905	8610978	41	New bore located in Stage two area near retention basin. Water supply bore for Stage two operations.	<i>Laboratory analysis:</i> • Total nitrogen • Total phosphorous • <i>E.coli</i> • <i>Enterococci</i> • Thermotolerant coliforms • Cations and anions (calcium, magnesium, sodium, potassium, sulfate, chloride and alkalinity as CaCO₃).	Quarterly



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 Layout: Figure 8-1 Map of proposed surface and groundwater operational monitoring bores

Figure 8-1 Map of proposed surface and groundwater operational monitoring bores

8.2.3 Irrigation water

Treated effluent quality and volumes will be monitored at the irrigation extraction points / authorised discharge points at Stage one and Stage two prior to irrigation (Figure 8-1).

The monitoring parameters and frequencies of sampling for the irrigation water are outlined in Table 8-3

Table 8-3. Monitoring parameters and frequencies for irrigation water

Monitoring sites	Parameter	Sampling frequency
Irrigation extraction points / authorised discharge points (ADP1 and ADP2)	pH	Monthly when discharging and quarterly when not discharging
	EC	
	Total P	
	Total N	
	Cations & anions (calcium, magnesium, sodium, potassium, sulfate, chloride and alkalinity as CaCO ₃)	
	<i>E.coli</i> , <i>Enterococci</i> thermotolerant coliforms	
	Herbicides (Glyphosate)	Annually
	Nitrate, Ammonia and organic N	Quarterly (required to calculate nutrient loading)

8.2.4 Soil

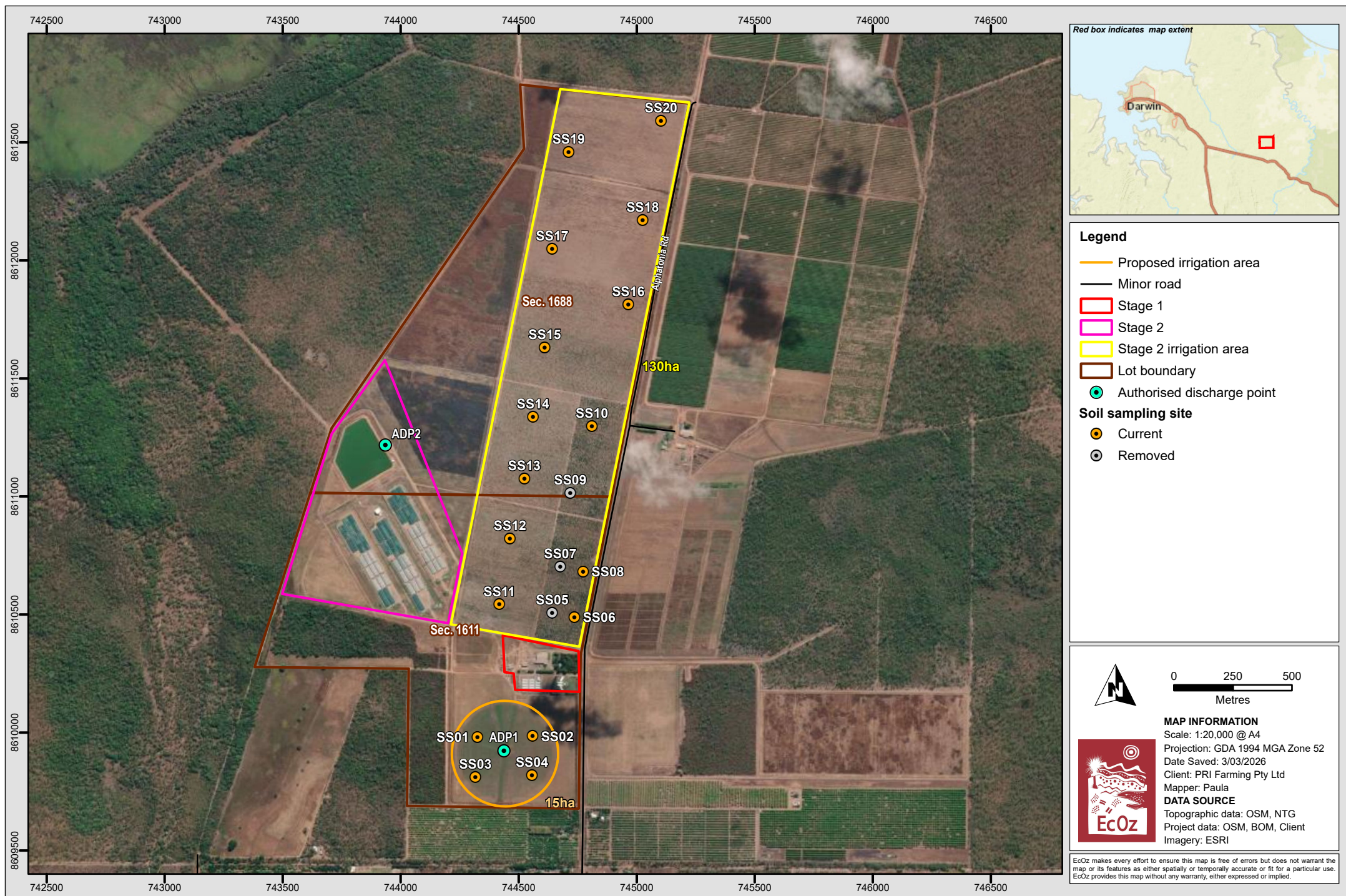
Soil samples will be taken from the Stage one and Stage two irrigation areas (Figure 8-2 and Table 8-4). The number of soil sampling sites was increased to include the 110 ha where irrigation commenced for Stage two. Soil sites SS05, SS07 and SS09 have been removed as sites SS11, SS12 and SS13 provide enough coverage for the area where these sites were located.

Notably, a higher frequency of soil sampling sites was used than that recommended by the *Victorian Guideline for Irrigation with Recycled Water* (2022), which suggests one composite sample per 20 ha, in order to better characterise the site.

Table 8-4. Soil monitoring program

Monitoring sites	Easting (52L)	Northing (52L)	Status	Description	Parameters	Frequency		
SS01	744326	8609983	Current	Stage one irrigation area (15 ha)	• pH • EC • Total nitrogen & phosphorous • Nitrogen oxides • <i>E. coli</i> • Enterococci • Thermotolerant coliforms • P-sorption	Annual		
SS02	744560	8609986	Current					
SS03	744317	8609812	Current					
SS04	744557	8609821	Current					
SS05	744683	8610449	Removed	Stage two irrigation area (20 ha)				
SS06	744679	8610651	Current					
SS07	744772	8610801	Removed					
SS08	744725	8610971	Current					
SS09	744811	8611124	Removed					
SS10	744811	8611299	Current					
SS11	744419	8610544	Current	Stage two irrigation area (110 ha)				
SS12	744464	8610823	Current					

Monitoring sites	Easting (52L)	Northing (52L)	Status	Description	Parameters	Frequency
SS13	744525	8611077	Current			
SS14	744562	8611338	Current			
SS15	744611	8611633	Current			
SS16	744965	8611814	Current			
SS17	744643	8612050	Current			
SS18	745026	8612172	Current			
SS19	744712	8612461	Current			
SS20	745104	8612593	Current			



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Layout: Figure 8-2 Map of proposed authorised discharge points and soil monitoring locations

Figure 8-2 Map of proposed authorised discharge points and soil monitoring locations

8.3 Assessment criteria

8.3.1 Surface water

Water quality from monitoring locations (SW1, SW3, SW4) is compared against the Darwin Harbour Water Quality Objectives for freshwater rivers and streams (see Table 8-5). Results are also compared against the baseline data (see Appendix D), and results from the control sites SW2 and SW6.

As the Darwin Harbour Water Quality Objectives do not include bacterial guidelines, the assessment of bacterial indicators is based on historical monitoring results at each site and on results from SW2 and SW6.

Table 8-5. Darwin Harbour water quality objectives for freshwater rivers and streams and lagoons

Parameter	Trigger value – freshwater rivers and streams ¹²
pH	6.0-7.5
EC	<200 µS/cm
TP	<0.01 mg/L
TN	<0.23 mg/L
<i>E. coli</i> , enterococci, thermotolerant coliforms	Concentrations exceeding those recorded at control sites

¹Trigger values only applicable to SW1, SW3 and SW4.

²If the concentration at SW2 or SW6 is greater than the trigger value, then the concentration at these sites becomes the trigger value for that monitoring round.

8.3.2 Groundwater

Groundwater quality is compared against site-specific trigger values (SSTVs) calculated using data collected from bores GW3 and GW4 since 2020 (up to February 2026). These bores were selected based on the inferred groundwater flow in the area and are considered likely indicative of background conditions, as they frequently exhibit higher hydraulic heads compared to other bores (see Section 2.4.8).

SSTV calculation

Data from GW3 since June 2020 and from GW4 since 2021 was used to estimate the SSTVs. A review of the data collected indicated that enough data from bores was available to account for seasonal patterns. The data used to calculate the SSTVs is presented in Appendix J.

The 80th percentile of the two reference sites was used as the SSTV. SSTVs for pH and EC were not calculated, as these parameters have not been measured in-situ. Similarly, SSTVs for thermotolerant coliforms are not presented, as this parameter is yet to be monitored.

Table 8-6. SSTVs for groundwater

Item	TN	TP	<i>E. coli</i>	Enterococci
Units	mg/L	mg/L	cfu/100 mL	org/100 mL
Number of data points used	34	30	32	32
Minimum concentration	1.2	<0.01*	<1*	<1*
Maximum concentration	3.2	0.48	28	58
SSTV	2.4	0.05	3	1

*A concentration equal to half the laboratory limit of reporting was adopted for the 80th percentile calculation

Trigger values

The trigger values shown in Table 8-7 have been adopted from the DHWQO for groundwater (field parameters) and the SSTVs outlined above. Where there are significant increases in the parameters measured, further assessment will be undertaken to determine potential sources of contamination.

Results from the monitoring bores will be assessed against the trigger values listed below, as well as against results from bores GW3 and GW4, unless groundwater flow in the area differs from that observed to date.

The adopted pH range incorporates a lower bound of 5.5 to account for the potential influence of aquifer recharge on groundwater quality, particularly at GW2, where baseline data indicate lower pH and EC relative to other sites.

Table 8-7. Trigger values for groundwater

Parameter	Trigger value
pH	5.5 – 8.5
EC	<400 μ S/cm
TP	0.06 mg/L
TN	2.4 mg/L
<i>E.coli</i>	3 cfu/100mL
Enterococci	1 org/100mL
Thermotolerant coliforms	Increasing trend observed over three consecutive monitoring events
Cations and anions	N/A ¹

¹N/A – Not applicable

8.3.3 Irrigation water

Ongoing monitoring is undertaken to ensure that the quality remains within the acceptable limits for irrigation in the nominated area.

Trigger values were derived from the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Volume 3 – Chapter 9 – Primary Industries* (ARMCANZ 2000) guidelines. Where there are significant increases in the parameters measured, further assessment will be undertaken to determine the impact on irrigation. Given that only the crops established in the Stage 2 irrigation area are not used for animal consumption and public access to the area is restricted, a higher load of pathogens is adopted.

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

Monitoring sites	Parameter	Indicative Trigger values
Authorised Discharge points (ADP 1 and ADP2)	pH	6-9 ¹
	EC	1,300 μ S/cm ¹
	TP	12 mg/L ¹
	TN	125 mg/L ¹
	Cations & anions (Ca, Mg, Na, K, SO ₄ , Cl, CaCO ₃)	N/A ²
	<i>E.coli</i> , enterococci, thermotolerant coliforms	1,000 cfu/100mL (fodder) ¹³ 10,000 cfu/100mL ⁴

Note: ¹ Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Volume 3 – Chapter 9 – Primary Industries (ANZG, 2000) irrigation water quality Short Term Trigger Values.

² N/A – Not applicable.

³Trigger value applicable to ADP1 only.

⁴Trigger value applicable to ADP2 only.

8.3.4 Soil

Soil quality is compared against results from previous monitoring round at each site, and against baseline data. Where there are significant increases in the parameters measured, further assessment will be undertaken to determine the impact on irrigation practices and the receiving environment.

Table 8-9. Trigger values for soils in the irrigated areas

Parameter	Trigger value*
pH	6 – 8
EC	Increasing trend observed over three consecutive monitoring events
TP	
TN	
<i>E. coli</i> , enterococci and thermotolerant coliforms	

*B Horizon results.

Annual nutrient balance calculations are undertaken and compared with the soil monitoring results to assess the sustainability of the effluent 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, including TN, TP, EC and P-sorption, should be graphed and compared annually, to identify any nutrient application issues or irrigation practices that may need to be altered.

8.4 Quality assurance and quality control

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

- Australian Standard on Water Quality Sampling - Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples (AS/NZS 5667.1:1998);
- Australian Standard on Water Quality Sampling – Part 6: Guidance on sampling of rivers and streams (AS/NZS 5667.6:1998);
- Australian Standard on Water Quality Sampling – Part 10: Guidance on sampling of wastewaters (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)
- ANZG & 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.
- ANZG & 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.

- Standard Operating Procedure (SOP) for Groundwater and Wastewater Monitoring (2024). Document prepared by EcOz Environmental Consultants for PRI Farming Pty Ltd.

Monitoring equipment will be calibrated prior to use and calibration checks performed to be within an acceptable range. Sampling will be collected, preserved, stored and transported in accordance with above standards and sampled by a suitably qualified sampler. All samples will be tracked with a chain of custody and sample receipt/record of delivery. Adequate sampling frequency, duplicates, triplicates and inter-laboratory checks will be undertaken as per sampling methodology.

All samples will be analysed in accordance with National standards, and an accredited National Association of Testing Authority (NATA).

8.5 Audits and inspections

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

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

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

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

Response to environmental incidents and complaints is details in Section 9.2 and Section 10.2 respectively.

8.6 Reporting and records

8.6.1 Internal

Reporting requirements are in accordance with the EMP. The EMP will be reviewed annually to reflect any changes in operations.

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 and will be available upon request to the NT EPA.

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

8.6.2 External

Non-compliances with the EPL will be reported by completing a Non-Compliance Notification via the NT EPA website within 24 hours of the event. The non-compliance notification will include:

- Date and time on non-compliance
- When the non-compliance was detected and by whom
- Nature of non-compliance

- The actual and potential causes and contributing factors to the non-compliance
- The risk of environmental harm as a result of the non-compliance
- Actions taken to mitigate environmental harm as a result of the non-compliance
- Corrective actions to prevent re-occurrence
- If no action was taken, explanation why; and
- Date when investigation report will be submitted to the NT EPA.

An Annual return will be submitted to the NT EPA on the anniversary date of the EPL to summarise the activities and outcomes of the previous 12 months. Additionally, a Monitoring Report will be prepared and submitted with the Annual Return that includes all monitoring data tabulated, trend analysis of the water and soil quality monitoring data, calculations of maximum total annual loads of nitrogen and phosphorus, all exceedances and their respective investigations and an assessment of any environmental impacts from LLCF operations. Investigations for groundwater and surface water will be triggered only where one or more of the following conditions are met. This approach is intended to account for seasonal variability in water quality, including changes associated with recharge conditions:

- A concentration greater than three times the adopted trigger value is reported;
- Exceedances are recorded during three consecutive monitoring rounds; or
- An increasing concentration trend is observed across the last three consecutive monitoring rounds.

9 EMERGENCY RESPONSE PLAN

Emergency response planning includes responses to environmental emergencies, and operational actions that cause an environmental incident. The Emergency Response Plan (ERP) provides detailed information regarding the types of environmental emergencies that could be experienced at the Project as well as specific procedures for flood events, cyclone and sever weather. The ERP also outlines the roles and responsibilities of the Emergency Response Team in responding to environmental emergencies.

Table 9-1 lists the potential emergency events and relevant responses, applicable to the operation of the Project.

Table 9-1. Emergency events and responses

Emergency event	Relevant response
Medical	<u>Preparation</u> - Site-based staff trained in first aid - First aid equipment maintained on site <u>In the event of a medical emergency:</u> - First aid to be administered by trained first aid personnel. - If required call emergency services (000) for assistance.
Bushfire	<u>Preparation</u> - Ensure firebreaks surrounding perimeter of the facility is adequately cleared all year round in accordance with the Bushfires Management Act 2016. - If hazard reduction burns are identified as necessary on site, a burn permit is to be applied for through the local Lambells Lagoon Volunteer Bushfire Brigade (M: 0414 576 363 Email: llvbf11@gmail.com). - Ensure no remnant materials, that could cause a fire hazard, are built up on the site. - If smoke is visible in the vicinity of the Project, utilise the North Australian Fire Information (NAFI) website as a first response capacity to track the bushfire. <u>In the event of a fire</u> - If required call external Lambells Lagoon Volunteer Bushfire Brigade (M: 0414 576 363) or emergency services (000) for assistance. - Arrange for safe removal of personnel and contractors from any dangerous situation. - If able to be conducted safely, apply appropriate firefighting equipment to fire source (Ensure that water or water-based suppression is not applied to Class E (electrical) fires until de-energised). - Secure the area and do not allow any disturbance to the Project area - Ensure all hazards identified and managed / isolated prior to entry. - Allow only designated personnel into the Project area.
Fire / explosion on site	<u>In the event of a fire</u> - If required call external Lambells Lagoon Volunteer Bushfire Brigade (M: 0414 576 363) or emergency services (000) for assistance. - Arrange for safe removal of personnel and contractors from any dangerous situation. - If able to be conducted safely, apply appropriate firefighting equipment to fire source (Ensure that water or water-based suppression is not applied to Class E (electrical) fires until de-energised). - Secure the area and do not allow any disturbance to the Project area - Ensure all hazards identified and managed / isolated prior to entry. - Allow only designated personnel into the Project area.
Cyclone	<u>Preparation</u> - All rubbish and other materials that could be projectiles in the event of tropical cyclone conditions to be removed, stored or tied down as appropriate. <u>Cyclone watch</u> - Secure or remove all unfixed items - Check to ensure all fuel tanks are full (for vehicles, equipment and generators) (if applicable). - Check to ensure equipment/ machinery stored in the open are secured. <u>Cyclone warning</u> - Ensure all portable equipment/ machinery and related items are tied down, and when advised, vacate the Project area and move off site as advised by the Site Manager or Northern Territory Emergency Services.

Emergency event	Relevant response
Flood event	<u>Preparation</u> - Secure / store any loose materials or equipment that has the potential to cause harm or damage in a safe location. - Park any vehicles/ equipment to be left at the facilities, under solid shelter. - Secure all external doors and windows (if applicable). - Disconnect all electrical items, external radio aerials and computer equipment (if applicable). - Listen to announcements on ABC Local Radio 105.7FM for weather updates. <u>Unexpected / during</u> - Personnel on site to move to any fastened structure or vehicle on site. - Move all people away from windows and shut windows. - Shut doors and shelter in the strongest part of the structure. - Stay inside. - Monitor all directions from staff/ emergency services.
Severe weather	<u>After</u> - Listen to your portable radio for Warning updates. - Check for damaged windows, walls, or roof. Temporarily cover with plastic sheeting and nailed on wooden strips (if applicable). - For emergency assistance, contact your local emergency services call 000. - If you don't need help, check, and if necessary, help your neighbours. Don't go sightseeing.
Fuel or chemical spill	In the event of a spill of a contaminating material, the spill response procedure is to be implemented as per the subsequent section below.
Unauthorised discharge	In the event of an unauthorised discharge in accordance with the EPL, the NT EPA will be notified with a Section 14 pollution incident report. All reasonable attempts will be made to control, contain, clean-up and dispose of the material. An incident investigation will occur to prevent future reoccurrence and conduct environmental monitoring to mitigate prolonged potential risk to the environment.
Disease outbreak	In the event of a disease outbreak resulting in crocodile mortalities and large-scale quantities of biological wastes, the disease is to be immediately diagnosed through the Berrimah Veterinary Laboratory and measures taken according to the farm biosecurity plan.

General emergency response preparedness is undertaken through the following actions:

- Ensure that all personnel including management have received a site induction that specifically covers emergency response procedures
- The Farm Manager and Emergency Response Team (ERT) regularly liaise with staff to ensure that they are competent in responding to emergencies
- Conduct regular inspections on all emergency response equipment and ensure that all equipment is in good working order
- Undertake emergency drills to ensure all employees and contractors can be accounted for, assess response to the drill and provide learnings and continual improvements.
- Following an emergency event, undertake an incident debrief and provide all staff with training into improved emergency response procedures or actions.

9.1 Spill response procedure

All spills will be addressed under the following procedure:

- **Assess** the spill by determining:
 - The type of spill
 - Location of the spill
 - Source of the spill, and whether it can be isolated

- The requirements to address the spill – i.e. personal protective equipment, volume of spill control materials, etc.
- **Severity** of the spill as per **Table 9-2** and **Table 9-3**.

Table 9-2. Assessing the severity of the spill

Type	Potential Consequence
Minor	Reversible and localised impact on the environment. OR Environmental impact requires a programmed commitment of time and/or money to remediate, OR would take less than 2 years to recover naturally.
Moderate	Significant but reversible, OR irreversible and localised, impact on the environment. OR Environmental impact requires a programmed commitment of moderate time and/or money to remediate, OR would take 2-10 years to recover naturally.
Major / severe	Significant AND irreversible impact on the environment. OR Environmental impact requires emergency commitment of significant time and/or money to remediate, OR would take more than 10 years to recover naturally.

In terms of volume, the following can be used as a guideline for determining severity.

Table 9-3. Volume of spill to determine severity

Minor	<100 L to inland waters/land
Moderate	100 – 1,500 L to inland waters/land
Major / severe	>1,500 L to inland waters/land

- **Secure** the spill – if safe to do so, the spill should be immediately secured, by eliminating the source, barricading the area to prevent personnel from accessing the area unnecessarily.
- **Control** the spill – by constructing an earthen bund, or by deploying suitable absorbent spill kit materials (i.e. absorbent booms, absorbent pads, granular absorbents, disposable bags and ties).
- **Dispose** of the contaminated material – which will be determined by the nature and extent of the spill. Advice will be sought from Litchfield Council and the relevant authorities (i.e. the NT EPA) to determine the appropriate disposal method for the contaminated material. Used absorbent material including granular absorbents, boom and pads shall be put into disposable bags, tied and placed in regular waste bins. Bags will be clearly labelled and transported to a licenced waste disposal facility as soon as possible.
- **Report** the spill – Any spill within the Project construction area is to be reported to the Project Manager as soon as possible (and within 24 hours). Lambells Lagoon Crocodile Farm Project Manager will be responsible for reporting the spill to the NT EPA that are of a moderate or major severity level.

9.2 Incident reporting

The Farm Manager is the contact person for all emergencies and environmental incidents. All incidents which cause or have the potential to cause environmental pollution will be reported to the NT EPA as soon as possible after the event, and in any case within 24 hours, as required under Section 14 of the NT *WMPC Act*.

The details of the designated contact persons for emergencies and environmental incidents are included in Table 9-4. This includes contacts for reporting pollution incidents (including non-urgent problems such as dust/noise) and contacts for provision of advice.

Table 9-4. Emergency contact details

Entity	Contact Details
NT EPA Pollution Hotline / Pollution reporting	Level 1 Arnhemica House, 16 Parap Road, Parap NT 0820 Pollution Hotline: 1800 064 567 pollution@nt.gov.au
NT Police / Fire	131 444 / 000
PRI Group Industrial Director	Ben Chesneau PO Box 3942, Darwin NT 0801 P: 08 8988 1491 M: 045 911 8445 E: benjamin.chesneau@priaust.com
Farm Manager	Ash Underhill
Department of Lands, Planning and Environment - Works on waterway, fauna sightings, vegetation clearing	Energy House 18-20 Cavenagh Street, Darwin, NT, 0801 08 8924 4218 (general services) 08 8999 4455 (water resources general enquiries)
EcOz Environmental Consultants	70 Cavenagh Street, Darwin NT, 0801 08 8981 1100 ecoz@ecoz.com.au

10 CONSULTATION AND COMMUNICATION PLAN

10.1 Stakeholder and community engagement

Consultation with stakeholders is undertaken directly through written (letters, emails) or verbal communication (meetings, phone calls) as required. Relevant stakeholders for the Project are outlined in Table 10-1.

Table 10-1. Relevant stakeholders

Stakeholder	Relationship
NT Government	
NT EPA Department of Lands, Planning and Environment – Environmental regulation	Issuer and regulator of the EPL and its compliance
Department of Lands, Planning and Environment	Water Resources - Groundwater extraction regulation. Parks and Wildlife - Issuer and regulator of wildlife permits and permit access into Black Jungle CN for monitoring a downstream surface water location.
Industry	
Crocodile Farmers Association NT	Crocodile Farmers Industry body for NT
Lambells Lagoon Operations	
Employees	Workforce
Contractors	
Surrounding land users	
Darwin Fruit Farms	Neighbouring stakeholders
Darwin Plant Wholesalers	
Jungle Plant and Flower Service	
Koolpinyah Station (PPL1147)	

10.2 Complaint management

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

- Date and time the complaint was reported
- Method by which complaint was made (i.e. telephone, letter, meeting, etc.)
- Person to whom the complaint was made
- Name, address, contact telephone number of complainant/s
- Details of complaint, including; nature of complaint, date and time of event giving rise to the complaint, prevailing weather conditions at the time if relevant to the complaint,
- Action taken in response to the complaint, including follow up contract with the complainant
- Any monitoring to confirm the complaint has been satisfactorily resolved
- If no action was taken, the reason for no action being taken.

11 REFERENCES

- Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 3: Primary Industries. Canberra: Australian and New Zealand Environment and Conservation Council. Available at: <https://www.waterquality.gov.au/anz-guidelines/resources/anzecc-armcanz-2000-volume-3> [Accessed 10 May 2025].
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APPENDIX A IRRIGATION MANAGEMENT PLAN



Irrigation Management Plan

Lambells Lagoon Crocodile Farm

PRI Farming Pty Ltd



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Acronyms

ANZECC	Australian and New Zealand Environment and Conservation Council
BOD	Biological Oxygen Demand
BoM	Bureau of Meteorology
Ca	Calcium
DEC	Department of Environment and Conservation (NSW)
EC	Electrical Conductivity
ECi	Electrical Conductivity (irrigation)
EPA	Environment Protection Authority
EPL	Environment Protection Licence
ESP	Exchange Sodium Percentage
GSM	Global System for Mobile Communications
IMP	Irrigation Management Plan
LLCF	Lambells Lagoon Crocodile Farm
LTV	Long-term trigger values
Mg	Magnesium
Na	Sodium
NSW	New South Wales
NT	Northern Territory
SAR	Sodium Adsorption Ratio
STV	Short-term trigger values
TN	Total nitrogen
TP	Total phosphorus
TSS	Total Suspended Solids
WWS	Wet Weather Storage

1 INTRODUCTION

1.1 Background

PRI Farming Pty Ltd (PRI) operates the Lambells Lagoon Crocodile Farm (LLCF) for commercial production of saltwater crocodiles (*Crocodylus porosus*) for meat and skin products. The site is located in the Lambells Lagoon area on Section 1611 and 1688 Hundred of Guy, at the end of Alphatonia Road, 5.5 km north of the Arnhem Highway.

LLCF is constituted by Stage one, which encompasses the incubation, hatchery and auxiliary infrastructure, and Stage two, which encompasses the grow-out pens, finishing pens and auxiliary infrastructure.

1.2 Purpose and scope

PRI 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, PRI utilises irrigation practices to dispose of the wastewater from Stage one and two onto suitable crops.

This Irrigation Management Plan (IMP) has been updated to illustrate the current management of wastewater by PRI at LLCF through irrigation application during both Stage one and two operations. This updated plan provides a revised water balance based on current water quality data from the irrigation points and discharge volumes. Data collected up to September 2025 were used for this update.

This plan is a requirement as part of the Environmental Protection Licence (EPL) application (amendment to EPL320-01).

2 WASTEWATER QUALITY

Monitoring at the authorised discharge points ADP1 (Stage one) and ADP2 (Stage two) has been undertaken by PRI Farming in compliance with EPL320-01 since 2021 and 2022, respectively. The average concentrations of monitoring parameters for each of the irrigation points have been calculated and presented in Table 2-1 to assess the water quality from the site. Water quality collected until September 2025 was used to estimate the average values presented.

The current monitoring program does not include the collection of samples for the analysis of Biological Oxygen Demand (BOD), metals and grease and oil. For the purpose of assessing irrigation requirements, effluent quality (i.e. BOD, Metals and Grease and oil concentration) has been derived from sampling undertaken directly from the hatchery at three other existing crocodile farms and limited sampling undertaken from hatchery effluent post solids screening at Lagoon Crocodile Farm (as part of a wastewater treatment trial). Effluent from the growers and finishers was taken from Janamba Crocodile farm and used to provide an estimate of predicted effluent quality for LLCF.

As shown in Table 2-1, the wastewater concentration for Stage one and two is classed as of “low” strength, when assessed against the Environmental Guidelines – use of effluent by irrigation (Department of Environment and Conservation New South Wales (DEC) 2004).

Table 2-1. Classification of effluent based on DEC 2004 criteria

Analyte	Unit	Irrigation water quality – Stage 1	Irrigation water quality – Stage 2	Strength (average concentration mg/L)		
				Low	Medium	High
Total Nitrogen	mg/L	34.0	9.4	<50	50-100	>100
Total Phosphorus	mg/L	3.1	2.0	<10	10-20	>20
Biological oxygen demand (BOD)	mg/L	<2	ND	<40	40-1500	>1500
Total dissolved solids (TDS)	mg/L	261	190	<600	600-1000	>1000
Metals	mg/L	see Section 3.4		Concentrations > 5 times the long-term trigger value (see Section 3.4) must be considered high strength		
Grease and oil	mg/L	<5		Concentrations > 1500mg/L must be considered high strength		
Effluent strength		Low strength	Low strength			

3 IRRIGATION SUITABILITY ASSESSMENT

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).

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.

As a conservative approach, the maximum monthly discharge volume recorded at each Stage since monitoring started in 2021, was adopted for the calculations below. Therefore, a flow rate of 21,300 kL/month was adopted for Stage one (recorded in August 2022), and 92,600 kL/month (recorded in September 2024) for Stage two.

The median BOD content of the wastewater for irrigation is estimated at 100 mg/L. This value was used as a conservative approach until site specific data can be determined. The minimum irrigation area required based on organic loading can be estimated as follows:

$$A = CQ / (1,000 \times Lc)$$

Where:

A = irrigation area (ha)

C = concentration of BOD⁵ (mg/L)

Q = average effluent flow rate (kL/month)

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

For LLCF Stage 1:

$$A = 100 \text{ mg/L} \times 21,300 \text{ kL / month} / (1,000 \times 1,500 \text{ kg/ha/month})$$

$$A = 1.42 \text{ hectares}$$

The above calculation indicates that a minimum area of 1.42 ha is required to manage the organic content of LLCF wastewater in Stage 1.

For LLCF Stage 2:

$$A = 100 \text{ mg/L} \times 92,600 \text{ kL / month} / (1,000 \times 1,500 \text{ kg/ha/month})$$

$$A = 6.17 \text{ hectares}$$

The above calculation indicates that a minimum area of 2.53 ha is required to manage the organic content of LLCF wastewater in Stage 2.

3.2 Suspended solids

The Total Suspended Solids (TSS) concentration is expected to be < 100 mg/L post solids screening. There is no water quality limit or concentration of concern for TSS in the NSW guidelines for irrigation.

Recommendations 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 anticipated low levels of suspended solids are not expected to present a problem in regard to the irrigation system getting clogged or the coating of leaf surfaces. In conjunction with solids treatment, an appropriately sized nozzle will be used to prevent potential clogging.

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.

Based on monitoring data available, pH levels at ADP1 range from 7.27 to 9.41, with an average of 7.70, while at ADP2 the levels are from 6.99 to 9.45, with an average of 8.30. Although pH levels above 8.5 have been recorded since monitoring started at both sampling sites, results have mostly remained within the recommended range. It is worth noting that pH is measured at the laboratory, and not in-situ, which likely impacts on the accuracy of the results here presented.

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 adopted concentration of metals in the wastewater is shown below (Table 3-1) along with the long-term trigger value (LTV) and short-term trigger value (STV) guidelines adapted from the Guidelines. The majority of metal levels in the groundwater and similar wastewaters are all below the detectable limit and are therefore well below the LTV.

Table 3-1. 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)	Project 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	0.03
Pb	2	5	<0.001
Hg	0.002	0.002	<0.0001
Ni	0.2	2	<0.001
Zn	2	5	0.05

*Adopted based on water quality results from other farms, as mentioned in Section 2.

3.5 Mineral salts and specific ions

The concentration of salts and specific ions (sodium, chloride, alkalinity etc) in the wastewater (see Table 3-2) is lower than that presented in first version of this IMP. The aim of maintaining low concentrations is to protect soil structure and downstream surface and groundwater, and to not exceed the salt tolerance of pasture grasses.

Table 3-2. Average salt and ion concentrations in irrigation water (2021-2025).

Site	Ca	Mg	Na	K	SO4	Chloride	Alkalinity
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ADP1	33	19	16	6.3	10	22	259
ADP2	26	14	12	3.5	4.4	22	137

3.6 Oil and grease

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

3.7 Pathogens

The concentration of *E.coli*, enterococci and total coliforms in the wastewater irrigated has been commonly high; however, improvements have been observed since peracetic acid started to be injected in wastewater from Stage 1 in December 2025, and hydrogen peroxide in wastewater from Stage 2 in May 2024, with additional chlorine dosing introduced in January 2026, as shown in Table 3-3.

Table 3-3. Average pathogens concentration in irrigation water.

Site	Aug 2021 – Dec 2025			Jan 2026		
	<i>E. coli</i>	Total coliforms	Enterococci	<i>E. coli</i>	Total coliforms	Enterococci
	cfu/100 ml	cfu/100 ml	org/100ml	cfu/100 ml	cfu/100 ml	org/100ml
ADP1	59,557,614	133,822,561	1,813,280	<1	<1	<1
ADP2	17,672	2,673,247	16,583	3	<1	<1

Bacterial movement through soils is limited, as supported by the limited exceedances in most monitoring bores, except GW2 (EcOz 2025), and the harsh sunlight and climatic conditions typical of the area rapidly diminish viable populations of bacteria. In addition, the irrigation area is off-limits to the public; therefore, the bacterial load in irrigated wastewater is not expected to cause any harm to human receptors.

Irrigation application is managed appropriately to avoid potentially harmful runoff. Treatment of the wastewater with hydrogen peroxide was introduced in 2024 to support bacteria load reduction.

3.8 Salinity & sodicity

3.8.1 Salinity

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.

Some general irrigation electrical conductivity (ECi) ratings for wastewater are shown in Table 3-4. The average ECi of wastewater irrigated at Stage 1 is 0.6 dS/m, while that of Stage 2 is 0.3 dS/m. Based on these values, the wastewater used for irrigation is considered to have low salinity.

Table 3-4. 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

3.8.2 Sodicity

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 irrigation areas in 2020 (prior to the commencement of activities) and the results of sampling identified that the exchange sodium percentage (ESP) was less than 1%. 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 estimate the potential of sodium accumulation in soil, which is the end product of continual use of sodic water.

The SAR in LLCF wastewater for irrigation was calculated using average concentrations as follows:

$$SAR = \frac{[Na]}{([Ca] + [Mg])/2)^{1/2}}$$

Where:

Na = sodium ion concentration (meq/L) = (mg/L in effluent)/22.99

Ca = calcium ion concentration (meq/L) = (mg/L in effluent)/(40.08 x 0.5)

Mg = magnesium ion concentration (meq/L) = (mg/L in effluent)/ (24.32 x 0.5)

Therefore, for LLCF Stage 1:

$$SAR = \frac{\frac{16 \text{ mg/L}}{22.99}}{\left(\left(\frac{33 \text{ mg/L}}{40.08 \times 0.5} + \frac{19 \text{ mg/L}}{24.32 \times 0.5} \right) / 2 \right)^{1/2}} = 0.55$$

For LLCF Stage 2:

$$SAR = \frac{\frac{12 \text{ mg/L}}{22.99}}{\left(\left(\frac{26 \text{ mg/L}}{40.08 \times 0.5} + \frac{14 \text{ mg/L}}{24.32 \times 0.5} \right) / 2 \right)^{1/2}} = 0.47$$

The results above indicate that the wastewater used for irrigation has low sodicity and does not pose a risk to soil structure and stability.

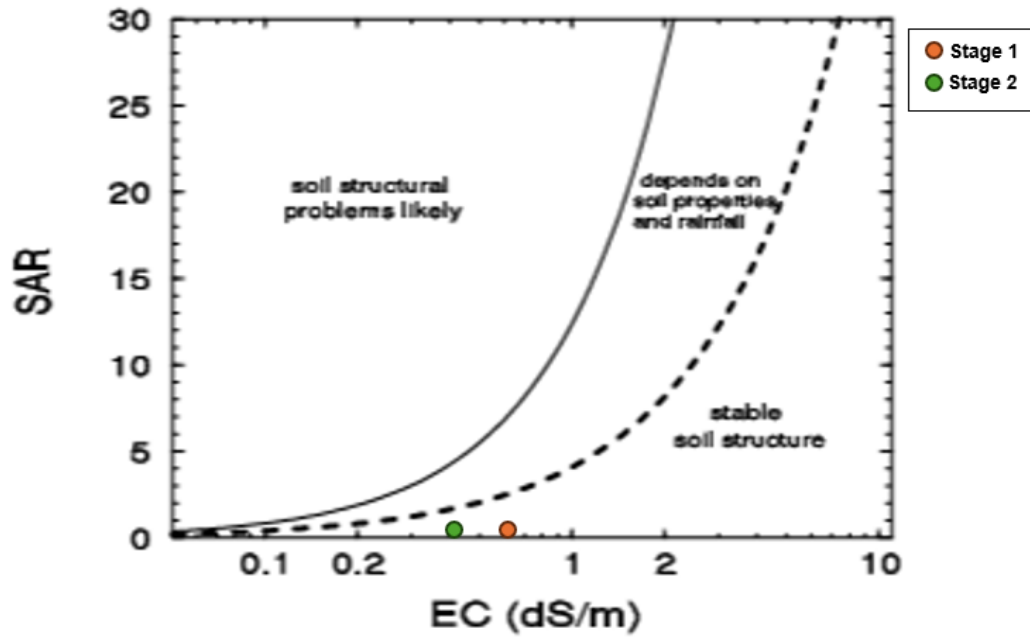
Table 3-5. Sodicity classes for irrigation water (Mills 2001)

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

3.8.3 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 3-1).

Figure 3-1. Relationship between SAR and EC for irrigation water



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.

4 WATER AND NUTRIENT BALANCE

A water and nutrient balance was used to assess the suitability of irrigation as a management method for wastewater generated from Stage one and Stage two. The balance incorporated climate data, site-specific nutrient concentrations, and updated discharge and groundwater usage rates. All results are presented in Appendix B.

It is worth noting that multiple assumptions were required due to the lack of crop- or site-specific data. However, conservative estimates were adopted in these cases to reduce the risk of underestimation.

4.1 Stage 1

A water and nutrient balance was undertaken to inform the design requirements for the effluent land irrigation scheme for Stage 1 of the LLCF based on current water usage and nutrient loads. In this instance, Stage 1 refers to the development and operation of the hatchery components of the farming operations.

4.1.1 Input data

Climate

Rainfall and evaporation data is sourced from the Bureau of Meteorology (BoM) weather monitoring station at Middle Point Rangers (station number 014090), located approximately 7 kms to the south-east of the Project area. Climate data from the Middle Point Rangers has been extracted from SILO, (a climate database managed by the Queensland Department of Environment and Science). Data used is from 1956 to 2024.

Inflow

Data available since March 2021 until April 2025 was used to estimate the average water usage at Stage 1 (see Appendix C). Monthly averages in m³ are presented in Table 4-1. For the design wastewater flow, 139 kL/day were adopted based on the irrigation data at ADP1 since May 2022. Notably, the daily volume adopted is above that implemented in 2021 (100 m³/day) when MEDLI modelling was run for the site (EcOz 2021).

Table 4-1. Average monthly water usage – Stage 1

Month	Average usage (m ³)
January	1,820
February	1,920
March	2,930
April	3,520
May	2,960
June	5,660
July	5,220
August	9,190
September	6,890
October	6,580

Month	Average usage (m ³)
November	3,640
December	2,810
Total	53,140

Design Irrigation Rate

The design irrigation rate was set at 5 mm per day as recommended by the Australian Standard for *On-site domestic wastewater management* (AS/NZS 1547:2012) for drip or spray irrigation.

Nominated Land Application Area & Crop Factor

All wastewater generated from Stage 1 is irrigated in an area of 15 ha, where Jarra Grass is grown. A crop factor of 0.8 (Bithell & Smith 2011) was adopted for the wet season months (Oct – Dec) and 0.7 for the dry season (Apr – Sep) to account for the impact of temperature and lower humidity.

Retained Rainfall

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

Pens and Wet Weather Storage Retention Basin

The hatchery area (2,200 m²) is fully covered and therefore, rainfall infiltration was not considered for such area; however, the effect of evaporation (10% assumed) and seepage from the pens (1% assumed) were considered.

Nitrogen and Phosphorus Concentration

The average concentrations of total nitrogen (TN) and total phosphorus (TP) from the monitoring site for irrigated wastewater from Stage 1 (ADP1) were adopted. Therefore, concentrations of 34 mg/L for TN and 3.1 mg/L of TP were used.

Phosphorus sorption rate

Soil samples were collected from LLCF area on 10 July 2020 and sent a laboratory for analysis (see results in Appendix A). Phosphorus sorption rate results from samples SS5 and SS6, located in the Stage 1 irrigation area, were averaged (956 mg/kg) and used in the nutrient balance.

Other assumptions

Other assumptions made in the nutrient balance for Stage 1 include:

- A standard nitrogen loss rate to soil of 0.2 was adopted (Geary & Gardener 1996)
- A design life of 50 years was assumed for the system.
- Annual nitrogen and phosphorus uptake rates of 270 kg/ha/yr and 45 kg/ha/yr, respectively, were adopted for forage sorghum (DEC 2004), as no data for Jarra Grass is available.
- A conservative bulk density value of 1.3 g/cm³ was adopted based on LCA guidelines; site-specific results are yet to be determined.
- A soil depth of 0.4 m was adopted based on the soil sampling conducted in 2020.

- A phosphorus retention multiplier of 33% was adopted to account for the proportion of applied phosphorus expected to remain sorbed in the soil (DEC 2004). This reflects the gradual decline in sorption efficiency as the soil's phosphorus capacity fills and leaching risk increases.

4.1.2 Results

The results of the water and nutrient balances are outlined in Table 4-2 to Table 4-4. Based on the water and nutrient balance, the 15 ha used for irrigation of wastewater generated in Stage 1 is still sufficient.

The concentration of nutrients in the wastewater is to be monitored to ensure that if concentrations increase significantly above the predicted values, the irrigation area is adjusted accordingly, or alternative treatment methods are assessed.

Table 4-2. Water balance results – Stage 1

Parameter	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Days in Month	days	31	28	31	30	31	30	31	31	30	31	30	31
Outputs													
Total Outputs (irrigation + pen and WWS losses + evapotranspiration + percolation)	m ³ /day	1453	1428	1428	1410	1451	1448	1460	1516	1565	1695	1618	1528
Inputs													
Total Inputs (retained rainfall – irrigation area and WWS + water usage)	m ³ /day	886	832	697	342	149	192	170	302	263	350	440	646
Storage Calculation													
Storage requirement	m ³ /day	-567	-596	-730	-1068	-1301	-1256	-1290	-1214	-1302	-1345	-1178	-882
Cumulative Storage	m ³ /month	-17582	-34266	-56906	-88954	-129292	-166965	-206963	-244602	-283670	-325368	-360706	-388041
% waste water irrigated	%	164%	172%	205%	412%	971%	754%	859%	502%	595%	484%	368%	236%
Remaining volume	m ³ /day	0	0	0	0	0	0	0	0	0	0	0	0

Table 4-3. Nitrogen Balance – Stage 1.

N Area Required	Unit	Result
Daily N load	mg/day	4,740,280
Annual N load	mg/L	1,730,202,200
N lost to soil	mg/yr	346,040,440
Annual N load (ANL)	kg/yr	1,384
Plant uptake	kgN/ha/yr	270
Area	m²	51,265
	ha	5.1

Table 4-4. Phosphorus Balance – Stage 1.

P Area Required	Unit	Result
P adsorbed (Pad)	kg/ha	1,640.5
	kg/m ²	0.1640
P uptake (Pup)	kg/m ²	0.055
P generated (Pgen)	kg	7888
Area	m²	36,050
	ha	3.6

4.2 Stage 2

A water and nutrient balance was undertaken to inform the design requirements for the effluent land irrigation scheme for Stage 2 of the LLCF. In this instance, Stage 2 refers to the development and operation of the grower and finisher components of the farming operations.

4.2.1 Input data- general

The inputs below were used for the Stage 2 water and nutrient balance. The same climate, design irrigation rate, retained factor, nitrogen loss rate, design life, bulk density, soil depth and phosphorus retention multiplier adopted for Stage 1 were used for Stage 2.

Inflow

Data from May 2024 until April 2025 from bores RN029096 and RN042465, presented in Table 4-5, was used for the balance, considering that operations in the stage were limited prior to this period and, consequently, lower volumes of water were used (see Appendix B). The daily wastewater flow in Stage 2 was assumed to be 2,185 kL, based on the discharge rates recorded at ADP2. Notably, the daily volume adopted is above that implemented in 2021 (1,265,000 L/day) when MEDLI modelling was run for the site (EcOz 2021).

Table 4-5. Average monthly water usage – Stage 1

Month	Average usage (m ³)
January	71,070
February	69,500
March	72,840
April	73,120
May	99,790
June	119,720
July	124,570
August	132,120
September	139,980
October	95,370
November	112,350
December	81,950
Total	1,192,380

Nominated Land Application Area & Crop Factor

All wastewater generated from Stage 2 is irrigated in an area of 130 ha, which includes 20 hectares of African Mahogany and 110 hectares of Syntropic Plantation. Due to the lack of crop factors available for the crops in Stage 2, a value of 0.7 was adopted for the wet season months (Oct – Dec), considering that crop factors for trees can range from 0.5 to 1.0 (Diczbalis 1999). A factor of 0.6 was adopted for the dry season months (Apr – Sep) to account for the impact of temperature and lower humidity.

Pens and Wet Weather Storage Retention Basin

The grower and finisher pens cover a total area of 61,410 m². The pens are fully covered and therefore, rainfall infiltration was not considered for such area; however, the effect of evaporation (10% assumed) and seepage from the pens (1% assumed) was included in the balance.

The area covered by the hatchery and Wet Weather Storage (WWS) retention basing was considered for the inputs and outputs of the water balance. For the WWS (41,420 m²), which is fully uncovered, losses for evaporation were calculated based on the monthly evaporation adopted for the site and the area covered by the WWS. A 1% loss due to seepage was assumed monthly. Rainfall inputs in the WWS were estimated based on the area covered by the basin and monthly rainfall.

Nitrogen and Phosphorus Concentration

The average concentrations of TN and TP from the monitoring site for irrigated wastewater from Stage two (ADP2) were adopted. Therefore, concentrations of 8.5 mg/L for TN and 1.8 mg/L of TP were used.

Phosphorus sorption rate

Soil samples were collected from LLCF area on 10 July 2020 and sent a laboratory for analysis (see results in Appendix A). Phosphorus sorption rate results from samples SS9, SS11, SS12 and SS13, located in the Stage 2 irrigation area, were averaged (1,160 mg/kg) and used in the nutrient balance.

Other assumptions

Other assumptions made in the nutrient balance for Stage 2 include:

- Annual nitrogen and phosphorus uptake rates of 90 kg/ha/yr and 15 kg/ha/yr, respectively, were adopted for the Stage two crops. These nutrient uptake rates are based on those of eucalyptus (Victoria EPA 2024), as data is not available for the specific crops in the Project area.

4.2.2 Results

The results of the water and nutrient balances are outlined in Table 4-6 to Table 4-8. Based on the water balance, the 130 ha used for irrigation of wastewater generated in Stage two is still sufficient. The nutrient balance for the irrigation area also supports the water balance assessment.

The concentration of nutrients in the wastewater is to be monitored to ensure that if concentrations increase significantly above the predicted values, the irrigation area is adjusted accordingly, or alternative treatment methods are assessed.

Table 4-6. Water balance results – Stage 2

Parameter	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Days in Month	days	31	28	31	30	31	30	31	31	30	31	30	31
Outputs													
Total Outputs (irrigation + pen losses + evapotranspiration + percolation)	m ³ /day	12210	12053	12028	11824	12198	12178	12289	12683	13130	14158	13625	12851
Inputs													
Total Inputs (retained rainfall – irrigation area + water usage)	m ³ /day	9918	9522	7908	4509	3716	4021	4034	4311	4972	4346	6686	7765
Storage Calculation													
Storage requirement	m ³ /day	-2292	-2530	-4120	-7314	-8482	-8157	-8255	-8372	-8158	-9812	-6939	-5087
Cumulative Storage	m ³ /month	-71046	-141898	-269633	-489059	-751997	-996715	-1252631	-1512163	-1756891	-2061074	-2269244	-2426928
% waste water irrigated	%	120%	127%	152%	262%	328%	303%	305%	294%	264%	326%	204%	166%
Remaining volume	m ³ /day	0	0	0	0	0	0	0	0	0	0	0	0

Table 4-7. Nitrogen Balance – Stage 2.

N Area Required	Unit	Result
Daily N load	mg/day	18,572,500
Annual N load	mg/L	6,778,962,500
N lost to soil	mg/yr	1,355,792,500
Annual N load (ANL)	kg/yr	5,423
Plant uptake	kgN/ha/yr	90
Area	m²	602,574
	ha	60

Table 4-8. Phosphorus Balance – Stage 2.

P Area Required	Unit	Result
P adsorbed (Pad)	kg/ha	1,991
	kg/m ²	0.1991
P uptake (Pup)	kg/m ²	0.055
P generated (Pgen)	kg	71,777
Area	m²	282,804
	ha	28

5 IRRIGATION AND CROP MANAGEMENT

5.1 Irrigation infrastructure

Stage 1

The Pierce C600 centre pivot system has been selected 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 the Global System for Mobile Communications (GSM) technology to 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.

To achieve a minimum 15 ha area, one pivot system has been installed half reach to each achieve an 8 ha span. 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 is conducted 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 is monitored alongside soil moisture levels to ensure appropriate application rates to avoid runoff.

The irrigation areas for Stage one area outlined on Figure 5-1.

Stage 2

An in-line drip system, installed at approximately 500 mm depth, is used as the irrigation mechanism for wastewater disposal over the proposed 130 ha crop irrigation area.

Similar to the centre pivot system above, irrigation is undertaken 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 areas for Stage two are outlined on Figure 5-1.

5.2 Irrigation management

PRI 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).

5.2.1 Runoff control

LLCF controls and manages 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 50 m around the irrigation area, to prevent impact on sensitive receptors and neighbouring properties.

5.2.2 Storage contingencies

Stage 1

The outcomes of the MEDLI water balance run in 2021 indicated that a 100 m³ of storage was required to prevent overflows and irrigation runoff. As such, six 25 m³ storage tanks were installed to contain wastewater generated in Stage 1 prior to its application. The tanks support the storage of wastewater when significant rainfall events impede the irrigation of water.

Where this storage requirement cannot be achieved in one tank (i.e. the concrete tank modelled), additional storage tanks will be kept on site with emergency overflow valves fitted to direct water as required. Notably, two additional 45 m³ will be located onsite upon operations of the Coldep VAL 900 starts in July 2026.

In the event of infrastructure maintenance or breakdown, water ingress into the hatchery will cease until repairs can be undertaken. As the generation of wastewater will be interrupted, this will reduce reliance on storages to accommodate additional wastewater flows during the maintenance process. Likewise, in the event of large monsoonal events that may hinder irrigation activities, water inputs can be managed to try and reduce the volume of wastewater generated during this period.

Stage 2

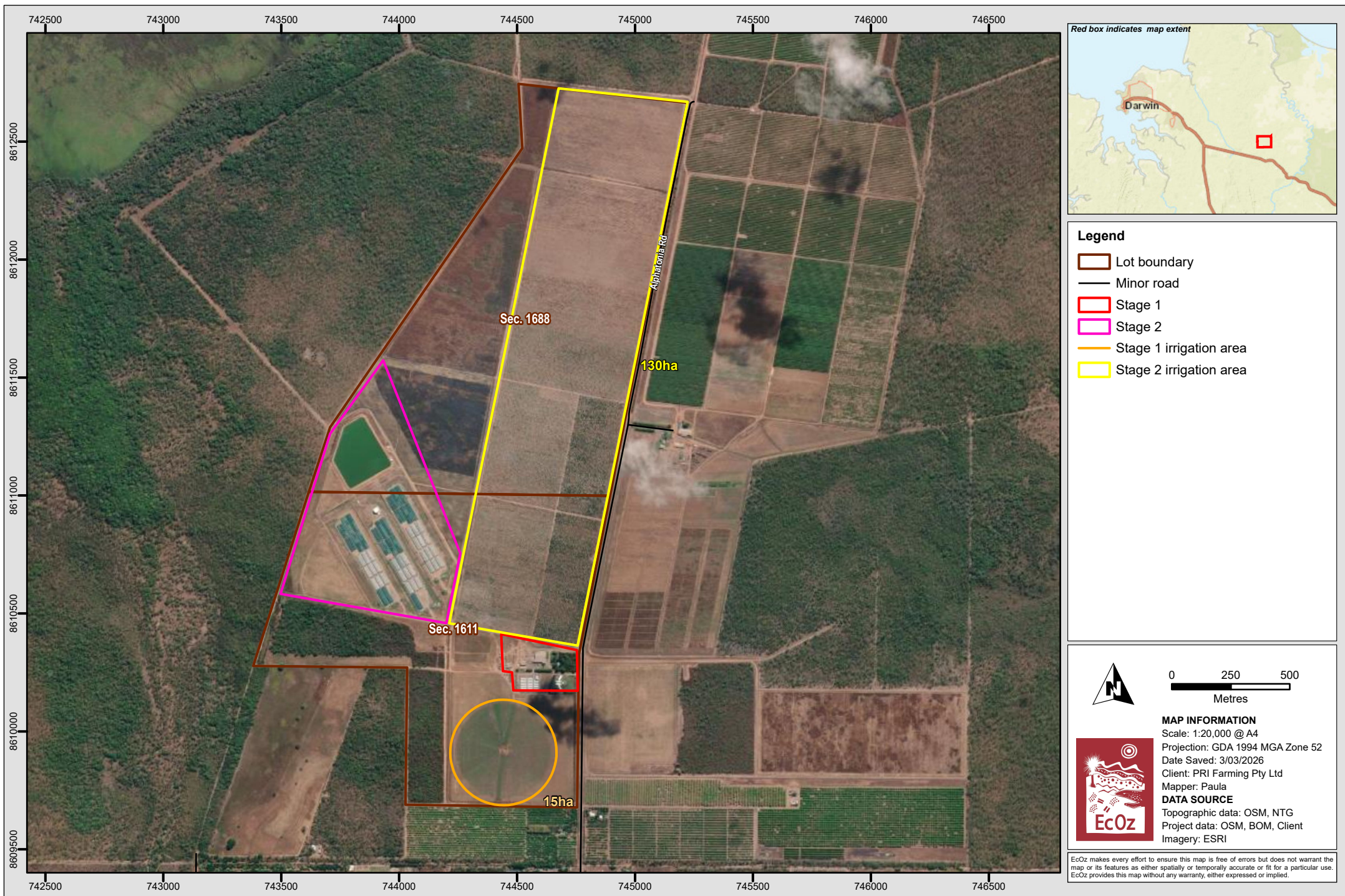
The 60ML WWS design incorporates a sump, to cater for the times when there is only a small volume of water available for irrigation purposes. Based on the current Stage 2 wastewater irrigation rate (2,185 kL/day, May 2024–April 2025), the WWS has sufficient capacity to contain wastewater during high rainfall events when irrigation cannot occur.

Additional WWS can be assessed in the future if the need arises.

5.3 Crop management

The irrigation area is managed by a specialist agricultural technician, who is responsible for the harvesting when required. The crop used in Stage 1 irrigation area is Jarra Grass, and in Stage 2 irrigation area is African Mahogany (20 ha) and Syntropic Plantation (110 ha). The crops are inspected regularly to monitor their growth as well as plant health to determine any visual impacts of nutrient supply.

Jarra Grass is harvested annually to encourage growth and nutrient uptake and are then processed for stockfeed. The crops are Stage two will not be harvested for approximately 20 years.



Path: C:\Users\Paula\Documents\Maps\Marpu - EPL Amendment 2026\1. Project Files\Marpu EPL.aprx
 Layout: Figure 5-1 Irrigation areas

Figure 5-1 Irrigation areas

6 MONITORING AND REPORTING

6.1 Daily monitoring

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

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

6.2 Compliance water and soil monitoring

Monitoring and reporting for irrigation activities are conducted in accordance with the EPL320-01 and LLCF Environmental Management Plan. Water sampling includes the sampling of groundwater, surface water wastewater irrigated, and soil sampling is a standardised regime aligned with the NSW Guideline *Use of Effluent by Irrigation* (DEC 2004). Soil sampling in Stage 2 also aligns with the frequency stipulated in the *Victorian Guideline for Irrigation with Recycled Water* (Environment Protection Authority Victoria 2022)

6.3 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 (total nitrogen, total phosphorus, EC and P-sorption) should be graphed and compared annually, to identify any nutrient application issues or irrigation practices that may need to be altered.

6.4 Reporting

All routine wastewater and soil monitoring data along with incident/investigation monitoring data are recorded in a water and soil quality database, and available upon request to the Northern Territory Environment Protection Authority (NT EPA).

6.4.1 Internal reporting

Details of environmental incidents, non-conformances or other relevant information are included in daily reports which are issued to the Farm Manager. 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.

6.4.2 External reporting

All non-compliances of the EPL are reported by PRI 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 is undertaken in accordance with the latest version of EPL320. An annual return is submitted to the NT EPA within 10 business days after each anniversary data of the EPL, which summaries the activities and outcomes of the previous 12 months of operation. Additionally, a monitoring report is prepared and submitted by 31 May each year. The report includes all monitoring data tabulated, trend analysis of the water and soil quality monitoring data, calculations of maximum total annual loads of nitrogen and phosphorus, all exceedances and their respective investigations and an assessment of any environmental impacts from LLCF operations.

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APPENDIX A SOIL SAMPLING RESULTS

ES2002110	Date Sampled	23/01/2020	Preferred Levels* for crop/plant growth (NSW DPI, 2004)	NEPM TABLE 1-A 2013 (SOIL) - HIL A (Residential) Guideline Limit	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	SS10	SS11	SS12	SS13
Physio-chemistry	Units	LOR			ES2002110001	ES2002110002	ES2002110003	ES2002110004	ES2002110005	ES2002110006	ES2002110007	ES2002110008	ES2002110009	ES2002110010	ES2002110011	ES2002110012	ES2002110013
pH Value	pH Unit	0.1	-	-	7	7.5	6.5	6.9	7.1	6.7	6.5	6.1	6.7	5.6	6.4	6.9	6.7
Sodium Adsorption Ratio	-	0.01	-	-	0.21	0.2	0.12	0.1	0.12	0.17	0.24	0.2	0.06	0.16	0.16	0.15	0.18
Electrical Conductivity @ 25°C	µS/cm	1	-	-	29	45	22	31	36	18	25	15	24	12	22	30	30
Moisture Content	%	1	-	-	17.2	14	13.6	14.4	16.2	12	16.8	10.2	11.2	10.7	14.5	15.6	15.4
Color (Munsell)	-		-	-	Black (10YR 2/1)	Black (10YR 2/1)	Very Dark Gray (10YR 3/1)	Black (10YR 2/1)	Very Dark Gray (7.5YR 3/1)	Dark Brown (10YR 3/3)	Very Dark Brown (7.5YR 2.5/2)	Very Dark Gray (10YR 3/1)	Very Dark Grayish Brown (10YR 3/2)	Very Dark Gray (10YR 3/1)	Very Dark Brown (7.5YR 2.5/3)	Very Dark Brown (7.5YR 2.5/3)	Very Dark Brown (7.5YR 2.5/3)
Emerson Class Number	-		-	-	3	3	3	3	3	3	7	3	3	3	3	3	3
Texture	-		-	-	Clay Loam	Loam	Clay Loam	Loam	Sandy Clay Loam	Sandy Loam	Clay Loam	Clayey Sand	Clayey Sand	Loamy Sand	Clay Loam	Clay Loam	Clay Loam
Exchangeable Cations on Alkaline Soils																	
Cation Exchange Capacity	meq/100g	0.2	-	-	-	2.7	-	-	-	-	-	-	-	-	-	-	-
Exchangeable Calcium	meq/100g	0.2	-	-	-	1.2	-	-	-	-	-	-	-	-	-	-	-
Exchangeable Magnesium	meq/100g	0.2	-	-	-	0.4	-	-	-	-	-	-	-	-	-	-	-
Exchangeable Potassium	meq/100g	0.2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Exchangeable Sodium	meq/100g	0.2	-	-	-	<0.2	-	-	-	-	-	-	-	-	-	-	-
Exchangeable Sodium Percent	%	0.2	-	-	-	<0.2	-	-	-	-	-	-	-	-	-	-	-
Exchangeable Cations																	
Cation Exchange Capacity	meq/100g	0.1	-	-	7.1	-	4.4	6.6	7.4	2.2	4.2	1.3	3.7	0.5	3	6.5	5.1
Exchangeable Calcium	meq/100g	0.1	-	-	4.5	-	3	4.2	5.5	1.6	2.5	0.9	2.7	0.2	2	4.1	3.2
Exchangeable Magnesium	meq/100g	0.1	-	-	1.8	-	0.8	1.7	1.4	0.4	1.1	0.2	0.7	0.2	0.7	1.7	1.3
Exchangeable Potassium	meq/100g	0.1	-	-	0.8	-	0.5	0.7	0.5	0.2	0.6	0.1	0.2	<0.1	0.3	0.6	0.6
Exchangeable Sodium	meq/100g	0.1	-	-	0	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Exchangeable Sodium Percent	%	0.1	-	-	0.3	-	0.3	0.2	0.2	0.7	0.5	0.8	0.3	2.5	0.5	0.3	0.3
Total Metals																	
Arsenic	mg/kg	5	<20	100	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Cadmium	mg/kg	1		20	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

ES2002110	Date Sampled	23/01/2020	Preferred Levels* for crop/plant growth (NSW DPI, 2004)	NEPM TABLE 1-A 2013 (SOIL) - HIL A (Residential) Guideline Limit	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	SS10	SS11	SS12	SS13
Physio-chemistry	Units	LOR			ES2002110001	ES2002110002	ES2002110003	ES2002110004	ES2002110005	ES2002110006	ES2002110007	ES2002110008	ES2002110009	ES2002110010	ES2002110011	ES2002110012	ES2002110013
Chromium	mg/kg	2		-	11	49	18	36	42	25	11	54	25	27	14	16	14
Copper	mg/kg	5	2 - 50	6000	5	<5	<5	<5	<5	<5	7	<5	<5	<5	5	9	6
Lead	mg/kg	5	<35	300	7	7	5	6	7	5	9	5	5	<5	7	7	6
Nickel	mg/kg	2	1 - 20	400	2	<2	<2	<2	<2	<2	2	<2	<2	<2	<2	<2	<2
Zinc	mg/kg	5		7400	29	24	15	21	20	8	<5	<5	6	<5	<5	17	12
Mercury	mg/kg	0.1		40	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nutrients																	
Nitrite + Nitrate as N (Sol.)	mg/kg	0.1		-	1.2	1.4	1.9	1.7	1.7	0.8	1.5	0.6	0.8	0.6	1.9	1.1	2.5
Total Kjeldahl Nitrogen as N	mg/kg	20		-	980	880	790	860	920	390	1310	850	520	580	800	930	760
Total Nitrogen as N	mg/kg	20	>10	-	980	880	790	860	920	390	1310	850	520	580	800	930	760
Total Phosphorus as P	mg/kg	2	20 - 30	-	301	334	325	411	314	153	345	181	210	128	238	500	303
Phosphate Sorption Capacity	mg P sorbed/kg	250		-	1610	1150	1030	1020	1350	562	1710	476	1010	862	1130	1280	1220
Phosphate Sorption Index	mgkg-1/log10ugL-1	1		-	51	27	43	35	50	26	67	45	40	58	66	41	46

APPENDIX B WATER AND NUTRIENT BALANCE INPUTS AND OUTPUTS

Stage 1 – Water Balance

Input Data	Unit	Result	Assumption/comment
Design Wastewater Flow	L/day	139240	based on ADP1 average discharge rate since 2021
Design Irrigation Rate	mm/day	5	See Table M1 in AS/NZS 1547:2012 - Max DIR for both drip & spray
Nominated Land Application Area	m sq	150000	Nominate- manipulate based on wet weather storage outcomes
Crop Factor	unitless	0.8	Assumes sorghum in NT (see IMP for reference)
Retained Rainfall	Unitless (most conservative)	0.5	Based on runoff coefficient provided in the NT Trenches Standard Design Report
Pen area (covered)	m sq	2200	

Parameter	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Days in Month	days	31	28	31	30	31	30	31	31	30	31	30	31
Rainfall (Middle Point)	mm/month	341.9	285.1	249.2	89.9	22.3	1.3	0.7	2.2	13.3	56.9	127.6	229.6
Evaporation (Middle Point)	mm/month	180.4	157	173.3	186.3	204.7	195.7	206.3	220.4	228.5	240.4	214.8	199.2
Crop Factor	N/A	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8

Outputs	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Evapotranspiration	mm/month	144.3	125.6	138.6	130.4	143.3	137.0	144.4	154.3	160.0	192.3	171.8	159.4
Percolation (at 5mm day)	mm/month	155.0	140.0	155.0	150.0	155.0	150.0	155.0	155.0	150.0	155.0	150.0	155.0
Irrigation area losses (assume 5% seepage, transmission)	mm/month	0.6	0.6	1.0	1.2	1.0	1.9	1.7	3.1	2.3	2.2	1.2	0.9
Total Irrigation volume	mm/month	299.9	266.2	294.6	281.6	299.3	288.9	301.1	312.3	312.2	349.5	323.1	315.3
Total Irrigation Volume	m ³ /day	1451.3	1426.3	1425.6	1407.9	1448.1	1444.4	1457.2	1511.3	1561.2	1691.2	1615.3	1525.6
Evaporation from pens	m ³ /day	1.3	1.2	1.2	1.4	1.5	1.4	1.5	1.6	1.7	1.7	1.6	1.4
Pen losses (assume 1% seepage, transmission)	m ³ /day	0.6	0.7	0.9	1.2	1.0	1.9	1.7	3.0	2.3	2.1	1.2	0.9
Total volume loss through pens	m ³ /day	1.9	1.9	2.2	2.5	2.4	3.3	3.1	4.5	4.0	3.8	2.8	2.3

Outputs	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Outputs (irrigation + pen losses)	m ³ /day	1453	1428	1428	1410	1451	1448	1460	1516	1565	1695	1618	1528
Inputs													
Retained Rainfall (irrigation area)	m ³ /day	827.2	763.7	602.9	224.8	54.0	3.3	1.7	5.3	33.3	137.7	319.0	555.5
Monthly Water usage (m ³)	m ³ /month	1823	1923	2929	3523	2956	5660	5220	9188	6890	6580	3634	2811
Monthly Water usage	m ³ /day	58.8	68.7	94.5	117.4	95.4	188.7	168.4	296.4	229.7	212.3	121.1	90.7
Total Inputs	m ³ /day	886	832	697	342	149	192	170	302	263	350	440	646
Storage Calculation													
Storage requirement	m ³ /day	-567	-596	-730	-1068	-1301	-1256	-1290	-1214	-1302	-1345	-1178	-882
Cumulative Storage	m ³ /month	-17582	-34266	-56906	-88954	-129292	-166965	-206963	-244602	-283670	-325368	-360706	-388041
Maximum Storage for Area	m ³	-17582	-17582	-17582	-88954	-129292	-166965	-206963	-244602	-283670	-325368	-360706	-388041
% waste water irrigated	%	164%	172%	205%	412%	971%	754%	859%	502%	595%	484%	368%	236%
Remaining volume	m ³ /day	0	0	0	0	0	0	0	0	0	0	0	0

Stage 1 – Nutrient Balance

Wastewater Loading		Unit	Result	Comment/assumption
Hydraulic Load	Q	L/day	139420	based on ADP1 average discharge rate since 2021
Effluent N Conc.	N	mg/L	34	Based on recent sampling - ADP1
N lost to soil	NL	decimal	0.2	Standard multiplier- from LCA Guidelines
Total N lost to soil	TNL	mg/day	948056	$(Q*N)*NL$
Remaining N after soil loss		mg/day	3792224	$(Q*N)-TNL$
Effluent P Conc	P	mg/L	3.1	Based on recent sampling - EFF outlet
Design Life of System	DL	Years	50	Standard design life

Nutrient Crop Uptake		Unit	Result	Comment/assumption
Crop N uptake	CN	kg/ha/yr	270	From NSW Use of effluent by irrigation
Crop P uptake	CP	kg/ha/yr	45	From NSW irrigation guidelines
P-sorption rate	PSR	mg/kg	956	Based on average B horizon for baseline samples SS5 and SS6 (located around irrigation area)
Bulk Density	BD	g/cm ³	1.3	Conservative from LCA Guidelines - should be based on average laboratory results
Depth of Soil	D	m	0.4	*of absorbing layer (B horizon)
% of P sorbed		%P	0.33	Standard multiplier to account for difference between lab results and actual field p-sorption rate (LCA guidelines)

N Area Required	Formula	Unit	Result
Daily N load	$Q*N$	mg/day	4740280
Annual N load	$(Q*N)*365$	mg/L	1730202200
N lost to soil	$D23 * NL$	mg/yr	346040440.0
Annual N load (ANL)	$D23-D24$	kg/yr	1384.2
Plant uptake	CN	kgN/ha/yr	270.0
Annual N load after application	ANL/CN	ha	5.1
Convert to m2		m ²	51265.3

P Area Required	Formula	Unit	Result	Comment/assumption
P adsorbed (Pad)	$(PSR \cdot BD \cdot D \cdot .75) \cdot 10$	kg/ha	1640.496	*10 to convert from mg/m ² to kg/ha
	D34/10000	kg/m ²	0.1640496	
P uptake (Pup)	$3 \cdot 365 \cdot DL$	kg/m ²	0.055	Nominal critical loading rate (DLG guidelines)- converted to kg/m ²
P generated (Pgen)	$P \cdot Q \cdot 365 \cdot DL$	mg	7887686500	
	Convert to kg	kg	7887.69	
Area	$Pgen / (Pad + Pup)$	m ²	36049.82	See DLG Guidelines for further information

Stage 2 – Water Balance

Input Data		Unit	Result	Assumption/comment
Design Wastewater Flow	Q	L/day	2185000	
Design Irrigation Rate	DIR	mm/day	5	See Table M1 in AS/NZS 1547:2012 - Max DIR for both drip & spray
Nominated Land Application Area	L	m sq	1300000	Nominate- manipulate based on wet weather storage outcomes
Crop Factor	C	unitless	0.7	Assumes 0.5-1.0 for trees. 0.7 adopted as conservative approach
Retained Rainfall	RR	unitless (most conservative)	0.5	Based on runoff coefficient provided in the NT Trenches Standard Design Report
Pen area (shade cloth cover)		m sq	61410	
WWS area (no cover)		m sq	41420	

Parameter	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Days in Month	days	31	28	31	30	31	30	31	31	30	31	30	31
Rainfall (Middle Point)	mm/month	341.9	285.1	249.2	89.9	22.3	1.3	0.7	2.2	13.3	56.9	127.6	229.6
Evaporation (Middle Point)	mm/month	180.4	157	173.3	186.3	204.7	195.7	206.3	220.4	228.5	240.4	214.8	199.2
Crop Factor	N/A	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7

Outputs	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Evapotranspiration	mm/mont h	126.2 8	109.9	121.31	111.78	122.82	117.42	123.78	132.24	137.1	168.28	150.36	139.44
Percolation (at 5mm day)	mm/mont h	155.0	140.0	155.0	150.0	155.0	150.0	155.0	155.0	150.0	155.0	150.0	155.0
Irrigation area losses (assume 5% seepage, transmission)	mm/mont h	2.7	2.7	2.8	2.8	3.8	4.6	4.8	5.1	5.4	3.7	4.3	3.2
Total Irrigation volume	mm/mont h	284	253	279	265	282	272	284	292	292	327	305	298
Total Irrigation Volume	m ³ /day	11910	11727	11705	11466	11811	11788	11892	12259	12674	13711	13203	12480
Evaporation from pens	m ³ /day	35.7	68.9	68.7	76.3	81.1	80.1	81.7	87.3	93.5	95.2	87.9	78.9
Evaporation from WWS	mm/mont h	241.0	232.2	231.6	257.2	273.5	270.2	275.6	294.5	315.5	321.2	296.6	266.2
Pen + WWS losses (assume 1% seepage, transmission)	m ³ /day	22.9	24.8	23.5	24.4	32.2	39.9	40.2	42.6	46.7	30.8	37.4	26.4
Total volume loss through pens + WWS	m ³ /day	299.7	325.9	323.7	357.9	386.8	390.2	397.6	424.4	455.7	447.2	422.0	371.5
Total Outputs (irrigation + pen losses)	m ³ /day	12210	12053	12028	11824	12198	12178	12289	12683	13130	14158	13625	12851
Inputs													

Outputs	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Retained Rainfall (irrigation area)	m ³ /day	7168.9	6618.4	5225.2	1947.8	467.6	28.2	14.7	46.1	288.2	1193.1	2764.7	4814.2
Retained Rainfall (WWS)	m ³ /day	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monthly Water usage (m3)	m ³ /month	456.8	421.7	333.0	124.1	29.8	1.8	0.9	2.9	18.4	76.0	176.2	306.8
Monthly Water usage	m ³ /day	71065	69496	72843	73121	99790	119722	124566	132122	139976	95371	112349	81953
Total Inputs	m ³ /day	2292.4	2482.0	2349.8	2437.4	3219.0	3990.7	4018.3	4262.0	4665.9	3076.5	3745.0	2643.6
Storage Calculation													
Storage requirement	m ³ /day	-2292	-2530	-4120	-7314	-8482	-8157	-8255	-8372	-8158	-9812	-6939	-5087
Cumulative Storage	m ³ /month	-71046	-141898	-269633	-489059	-751997	-996715	-1252631	-1512163	-1756891	-2061074	-2269244	-2426928
Maximum Storage for Area	m ³	71046	141898	269633	489059	751997	996715	1252631	1512163	1756891	2061074	2269244	2426928
% waste water irrigated	%	120%	127%	152%	262%	328%	303%	305%	294%	264%	326%	204%	166%
Remaining volume	m ³ /day	0	0	0	0	0	0	0	0	0	0	0	0

Stage 2 – Nutrient Balance

Wastewater Loading		Unit	Result	Comment/assumption
Hydraulic Load	Q	L/day	2185000	From monthly water balance
Effluent N Conc.	N	mg/L	8.5	Based on recent sampling - EFF outlet
N lost to soil	NL	decimal	0.2	Refer to report for reference
Total N lost to soil	TNL	mg/day	3714500	$(Q*N)*NL$
Remaining N after soil loss		mg/day	14858000	$(Q*N)-TNL$
Effluent P Conc	P	mg/L	1.8	Based on recent sampling - EFF outlet
Design Life of System	DL	Years	50	Standard design life

Nutrient Crop Uptake		Unit	Result	Comment/assumption
Crop N uptake	CN	kg/ha/yr	90	From VIC EPA (2024) data for Eucalyptus
Crop P uptake	CP	kg/ha/yr	15	From VIC EPA (2024) data for Eucalyptus
P-sorption rate	PSR	mg/kg	1160	Based on results from soil sampling
Bulk Density	BD	g/cm ³	1.3	Conservative from LCA Guidelines - should be based on average laboratory results
Depth of Soil	D	m	0.4	*of absorbing layer (B horizon)
% of P sorbed		%P	0.33	Standard multiplier to account for difference between lab results and actual field p-sorption rate (LCA guidelines)

N Area Required	Formula	Unit	Result
Daily N load	$Q*N$	mg/day	18572500
Annual N load	$(Q*N)*365$	mg/L	6778962500
N lost to soil	$D23 * NL$	mg/yr	1355792500
Annual N load (ANL)	$D23-D24$	kg/yr	5423.17
Plant uptake	CN	kgN/ha/yr	90
Annual N load after application	ANL/CN	ha	60.25744444
Convert to m2		m2	602574.4444

P Area Required	Formula	Unit	Result	Comment/assumption
P adsorbed (Pad)	$\frac{(PSR*BD*D*.75)*1}{0}$	kg/ha	1990.56	*10 to convert from mg/kg to kg/ha
	$D34/10000$	kg/m ²	0.199056	
P uptake (Pup)	$3*365*DL$	kg/m ²	0.055	Nominal critical loading rate (DLG guidelines)- converted to kg/m ²
P generated (Pgen)	$P*Q*365*DL$	Mg	71777250000	
	Convert to kg	Kg	71777.25	
Area	$Pgen/(Pad+Pup)$	m ²	282803.598	See DLG Guidelines for further information

APPENDIX C STAGE 1 AND 2 WATER USAGE

Date	Usage (m ³)	
	Stage 1 (bore 4)	Stage 2 (Bore 3 + 11)
May-22	3383	14732
Jun-22	10850	21797
Jul-22	7706	30071
Aug-22	21337	53631
Sep-22	12091	51239
Oct-22	8009	48678
Nov-22	4938	50795
Dec-22	4454	65076
Jan-23	1947	26608
Feb-23	1754	22917
Mar-23	1454	30772
Apr-23	2386	36673
May-23	2824	61091
Jun-23	3261	77182
Jul-23	4402	107099
Aug-23	6038	84328
Sep-23	5092	71473
Oct-23	4637	93117
Nov-23	2866	81732
Dec-23	1956	77572
Jan-24	1113	63614
Feb-24	946	81453
Mar-24	1975	66562
Apr-24	4106	103703
May-24	4343	99790
Jun-24	5792	119722
Jul-24	6272	124566
Aug-24	6233	132122
Sep-24	7154	139976
Oct-24	4135	95371
Nov-24	1542	112349
Dec-24	621	81953
Jan-25	610	71065
Feb-25	1091	69496
Mar-25	4793	72843
Apr-25	7532	73121

APPENDIX D IRRIGATION PROCEDURES



Irrigation Procedures

Lambells Lagoon Crocodile Farm

PRI Farming Pty Ltd



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Appendices

APPENDIX A VISUAL INSPECTION CHECKLIST

1 INTRODUCTION

This document lists procedures to be followed by PRI Farming management, staff and contractors to ensure that the reuse of wastewater via terrestrial irrigation is managed appropriately at the Lambells Lagoon Crocodile Farm (LLCF). 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.

LLCF 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

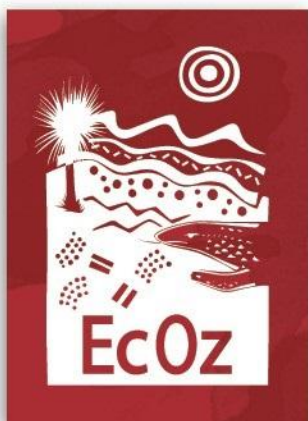
The aim of this procedure is to ensure that the application of the wastewater through irrigation activities is a controlled task, and does not cause any run-off or impacts to surrounding neighbours and sensitive receptors in the environment. The Farm Manager is the responsible person for this procedure. 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 (control via internal software).
- 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.

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 ponding? (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).								



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APPENDIX B BASELINE SOIL QUALITY RESULTS

ES2002110	Date Sampled	23/01/2020	Preferred Levels for crop/plant growth (NSW DPI, 2004)	NEPM TABLE 1-A 2013 (SOIL) - HIL A (Residential) Guideline Limit	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	SS10	SS11	SS12	SS13
Physio-chemistry	Units	LOR			ES2002110001	ES2002110002	ES2002110003	ES2002110004	ES2002110005	ES2002110006	ES2002110007	ES2002110008	ES2002110009	ES2002110010	ES2002110011	ES2002110012	ES2002110013
pH Value	pH Unit	0.1	-	-	7	7.5	6.5	6.9	7.1	6.7	6.5	6.1	6.7	5.6	6.4	6.9	6.7
Sodium Adsorption Ratio	-	0.01	-	-	0.21	0.2	0.12	0.1	0.12	0.17	0.24	0.2	0.06	0.16	0.16	0.15	0.18
Electrical Conductivity @ 25°C	µS/cm	1	-	-	29	45	22	31	36	18	25	15	24	12	22	30	30
Moisture Content	%	1	-	-	17.2	14	13.6	14.4	16.2	12	16.8	10.2	11.2	10.7	14.5	15.6	15.4
Color (Munsell)	-		-	-	Black (10YR 2/1)	Black (10YR 2/1)	Very Dark Gray (10YR 3/1)	Black (10YR 2/1)	Very Dark Gray (7.5YR 3/1)	Dark Brown (10YR 3/3)	Very Dark Brown (7.5YR 2.5/2)	Very Dark Gray (10YR 3/1)	Very Dark Grayish Brown (10YR 3/2)	Very Dark Gray (10YR 3/1)	Very Dark Brown (7.5YR 2.5/3)	Very Dark Brown (7.5YR 2.5/3)	Very Dark Brown (7.5YR 2.5/3)
Emerson Class Number	-		-	-	3	3	3	3	3	3	7	3	3	3	3	3	3
Texture	-		-	-	Clay Loam	Loam	Clay Loam	Loam	Sandy Clay Loam	Sandy Loam	Clay Loam	Clayey Sand	Clayey Sand	Loamy Sand	Clay Loam	Clay Loam	Clay Loam
Exchangeable Cations on Alkaline Soils																	
Cation Exchange Capacity	meq/100g	0.2	-	-	-	2.7	-	-	-	-	-	-	-	-	-	-	-
Exchangeable Calcium	meq/100g	0.2	-	-	-	1.2	-	-	-	-	-	-	-	-	-	-	-
Exchangeable Magnesium	meq/100g	0.2	-	-	-	0.4	-	-	-	-	-	-	-	-	-	-	-
Exchangeable Potassium	meq/100g	0.2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Exchangeable Sodium	meq/100g	0.2	-	-	-	<0.2	-	-	-	-	-	-	-	-	-	-	-
Exchangeable Sodium Percent	%	0.2	-	-	-	<0.2	-	-	-	-	-	-	-	-	-	-	-
Exchangeable Cations																	
Cation Exchange Capacity	meq/100g	0.1	-	-	7.1	-	4.4	6.6	7.4	2.2	4.2	1.3	3.7	0.5	3	6.5	5.1
Exchangeable Calcium	meq/100g	0.1	-	-	4.5	-	3	4.2	5.5	1.6	2.5	0.9	2.7	0.2	2	4.1	3.2
Exchangeable Magnesium	meq/100g	0.1	-	-	1.8	-	0.8	1.7	1.4	0.4	1.1	0.2	0.7	0.2	0.7	1.7	1.3
Exchangeable Potassium	meq/100g	0.1	-	-	0.8	-	0.5	0.7	0.5	0.2	0.6	0.1	0.2	<0.1	0.3	0.6	0.6
Exchangeable Sodium	meq/100g	0.1	-	-	0	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Exchangeable Sodium Percent	%	0.1	-	-	0.3	-	0.3	0.2	0.2	0.7	0.5	0.8	0.3	2.5	0.5	0.3	0.3

ES2002110	Date Sampled	23/01/2020	Preferred Levels for crop/plant growth (NSW DPI, 2004)	NEPM TABLE 1-A 2013 (SOIL) - HIL A (Residential) Guideline Limit	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	SS10	SS11	SS12	SS13
Physio-chemistry	Units	LOR			ES2002110001	ES2002110002	ES2002110003	ES2002110004	ES2002110005	ES2002110006	ES2002110007	ES2002110008	ES2002110009	ES2002110010	ES2002110011	ES2002110012	ES2002110013
Total Metals																	
Arsenic	mg/kg	5	<20	100	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Cadmium	mg/kg	1		20	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chromium	mg/kg	2		-	11	49	18	36	42	25	11	54	25	27	14	16	14
Copper	mg/kg	5	2 - 50	6000	5	<5	<5	<5	<5	<5	7	<5	<5	<5	5	9	6
Lead	mg/kg	5	<35	300	7	7	5	6	7	5	9	5	5	<5	7	7	6
Nickel	mg/kg	2	1 - 20	400	2	<2	<2	<2	<2	<2	2	<2	<2	<2	<2	<2	<2
Zinc	mg/kg	5		7400	29	24	15	21	20	8	<5	<5	6	<5	<5	17	12
Mercury	mg/kg	0.1		40	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nutrients																	
Nitrite + Nitrate as N (Sol.)	mg/kg	0.1		-	1.2	1.4	1.9	1.7	1.7	0.8	1.5	0.6	0.8	0.6	1.9	1.1	2.5
Total Kjeldahl Nitrogen as N	mg/kg	20		-	980	880	790	860	920	390	1310	850	520	580	800	930	760
Total Nitrogen as N	mg/kg	20	>10	-	980	880	790	860	920	390	1310	850	520	580	800	930	760
Total Phosphorus as P	mg/kg	2	20 - 30	-	301	334	325	411	314	153	345	181	210	128	238	500	303
Phosphate Sorption Capacity	mg P sorbed/kg	250		-	1610	1150	1030	1020	1350	562	1710	476	1010	862	1130	1280	1220
Phosphate Sorption Index	mgkg ⁻¹ /log10ugL ⁻¹	1		-	51	27	43	35	50	26	67	45	40	58	66	41	46

APPENDIX C SOIL QUALITY DATA

Analyte	Unit	LOR	EPL320-01; SSTV for soil	SS01	SS01	SS01	SS01	SS02	SS02	SS02	SS02	SS03	SS03	SS03	SS03	SS04	SS04	SS04	SS04
				24/01/2022	30/01/2023	31/01/2024	03/02/2025	24/01/2022	30/01/2023	31/01/2024	03/02/2025	24/01/2022	30/01/2023	31/01/2024	03/02/2025	24/01/2022	30/01/2023	31/01/2024	03/02/2025
Enterococci	MPN/g	11	Any increase from previous monitoring round	1,900	63	420	430	13	<11	48	450	48	<11	62	460	140	47	370	290
E. Coli (MPN)	MPN/g	11		-	12	11	<11	-	<11	<12	<12	-	<11	<12	<11	-	<11	<12	<11
E. Coli	orgs/g	11		<11	-	-	-	<12	-	-	-	37	-	-	-	<11	-	-	-
Total Coliforms	MPN/g	11		600	1,100	3,500	12,000	<12	72	3,800	770	220	72	4,100	1,100	190	97	28,000	1,100
Electrical Conductivity (Saturated Paste)	µS/cm	1	Any increase from previous monitoring round	7	43	182	162	10	32	103	216	10	47	101	146	12	65	82	146
Moisture Content	%	1	-	-	8.4	1.3	80	-	12.5	6.1	13.9	-	12.4	5.4	10.8	-	11.8	5.0	10.8
pH (Saturated Paste)	-	0.1	6.0 – 8.00	6.7	6.1	6.8	7.4	5.9	5.5	6.7	8.1	7.2	5.9	6.8	7.2	7.0	5.9	6.8	7.2
Total Phosphorus as P (Organic Phosphate as P)	mg/kg	2	Any increase from previous monitoring round	340	94	191	339	120	93	302	542	120	79	158	533	120	103	167	533
Kjeldahl Nitrogen Total	mg/kg	20	-	500	190	420	550	330	160	740	800	300	180	450	860	500	400	600	860
Nitrogen (Total Oxidised)	mg/kg	0.1	-	0.8	3.2	1.9	1.2	3.3	2.7	3.1	3.2	0.7	4.1	2.2	2.0	2.0	4.3	2.7	2.0
Nitrogen (Total)	mg/kg	20	Any increase from previous monitoring round	500	190	420	550	330	160	740	800	300	180	450	860	500	400	600	860

Analyte	Unit	LOR	EPL320-01; SSTV for soil	SS05	SS05	SS05	SS05	SS06	SS06	SS06	SS06	SS07	SS07	SS07	SS07	SS08	SS08	SS08	SS08
				24/01/2022	30/01/2023	31/01/2024	03/02/2025	24/01/2022	30/01/2023	31/01/2024	03/02/2025	24/01/2022	30/01/2023	31/01/2024	03/02/2025	24/01/2022	30/01/2023	31/01/2024	03/02/2025
Enterococci MPN Enterolert	MPN/g	11	Any increase from previous monitoring round	520	47	74	210	38	23	98	310	72	110	510	2,200	260	11	160	400
E. Coli (MPN)	MPN/g	11		-	<11	<12	<12	-	<12	<11	<12	-	47	<12	<12	-	<11	<12	<12
E. Coli	orgs/g	11		13	-	-	-	<12	-	-	-	<11	-	-	-	<11	-	-	-
Total Coliforms	MPN/g	11		50	750	2,000	1,600	4,900	3,400	990	4,600	47	330	300	2,300	660	23	470	120
Electrical Conductivity (Saturated Paste)	µS/cm	1	Any increase from previous monitoring round	24	68	144	172	10	40	182	216	11	46	114	166	10	19	154	144
Moisture Content	%	1	-	-	12.1	5.4	12.9	-	22.9	4.5	12.6	-	12.6	4.5	14.2	-	11.3	6.2	14.8
pH (Saturated Paste)	-	0.1	6.0 – 8.00	6.7	6.6	7.2	7.2	6.7	6.7	7.6	7.6	6.2	6.0	6.9	7.6	6.9	5.2	6.8	7.3
Total Phosphorus as P (Organic Phosphate as P)	mg/kg	2	Any increase from previous monitoring round	290	105	304	267	130	134	151	467	120	91	118	483	110	91	323	324
Kjeldahl Nitrogen Total	mg/kg	20	-	790	300	470	740	390	380	350	1,020	230	550	320	1,020	370	300	460	780
Nitrogen (Total Oxidised)	mg/kg	0.1	-	1.8	5.0	2.2	2.8	8.8	1.1	2.5	2.0	3.6	0.5	2.2	2.6	7.5	0.6	2.6	3.7
Nitrogen (Total)	mg/kg	20	Any increase from previous monitoring round	790	300	470	740	400	380	350	1,020	240	550	320	1,020	380	300	460	780

Analyte	Unit	LOR	EPL320-01; SSTV for soil	SS09	SS09	SS09	SS09	SS10	SS10	SS10	SS10
				24/01/2022	30/01/2023	31/01/2024	03/02/2025	24/01/2022	30/01/2023	31/01/2024	03/02/2025
Enterococci MPN Enterolert	MPN/g	11	Any increase from previous monitoring round	<11	<11	60	660	97	120	23	420
E. Coli (MPN)	MPN/g	11		-	<11	<12	<11	-	<12	<12	<11
E. Coli	orgs/g	11		<11	-	-	-	<11	-	-	-
Total Coliforms	MPN/g	11		<11	58	360	3,000	480	360	12	1,100
Electrical Conductivity (Saturated Paste)	µS/cm	1	Any increase from previous monitoring round	14	71	118	140	11	87	48	150
Moisture Content	%	1	-	-	12.6	3.1	19.8	-	28.2	4.0	17.1
pH (Saturated Paste)	-	0.1	6.0 – 8.00	5.9	5.6	7.2	7.0	7.4	5.9	7.1	7.4
Total Phosphorus as P (Organic Phosphate as P)	mg/kg	2	Any increase from previous monitoring round	120	95	111	304	180	104	145	178
Kjeldahl Nitrogen Total	mg/kg	20	-	230	80	320	850	330	350	490	740
Nitrogen (Total Oxidised)	mg/kg	0.1	-	7.9	0.4	2.1	1.5	7.2	1.8	2.2	2.6
Nitrogen (Total)	mg/kg	20	Any increase from previous monitoring round	240	80	320	850	340	350	490	740

Additional sites in Stage 2 Irrigation area

Analyte	Unit	LOR	SS11	SS12	SS13	SS14	SS15	SS16	SS17	SS18
			12 Feb 2025	12 Feb 2025	12 Feb 2025	12 Feb 2025	12 Feb 2025	12 Feb 2025	12 Feb 2025	12 Feb 2025
Enterococci MPN Enterolert	MPN/g	11	230	270	71	36	380	170	220	320
E. Coli (MPN)	MPN/g	11	<11	<12	<11	<12	<11	<11	<12	<12
E. Coli	orgs/g	11								
Total Coliforms	MPN/g	11	350	180	650	350	1,000	290	37	130
Electrical Conductivity (Saturated Paste)	µS/cm	1	82	116	88	70	77	82	82	95
Moisture Content	%	1	11.6	12.5	9.6	11.7	10.6	10.9	14.7	15.5
pH (Saturated Paste)	-	0.1	6.5	6.8	6.7	5.8	6.3	6.6	6.4	6.2
Total Phosphorus as P (Organic Phosphate as P)	mg/kg	2	358	344	424	137	271	404	225	694
Kjeldahl Nitrogen Total	mg/kg	20	380	600	700	340	570	420	540	970
Nitrogen (Total Oxidised)	mg/kg	0.1	1.0	2.1	1.2	1.3	2.0	1.0	3.6	3.4
Nitrogen (Total)	mg/kg	20	380	600	700	340	570	420	540	970

APPENDIX D BASELINE SURFACE WATER QUALITY RESULTS

Analyte	Units	LOR	DHWQO - Freshwater rivers & streams	DHWQO - Lagoons	EPL320-01; trigger values for surface water	SW01	SW02	SW03	SW04
Field Parameters									
pH	pH	-	6.0 -7.5	5.0 – 6.0	6.0 -7.5	5.64	5.52	5.83	5.62
Temperature	oC	-	-	-		27.2	27	27.3	26.9
Electrical Conductivity (EC)	µS/cm	-	200	25	200	17.4	15.2	19.1	24.1
Total Dissolved Solids (TDS)	mg/L	-	-	-	-	12.7	11	14	18
Salinity	ppt	-	-	-	-	0.01	0.01	0.01	0.01
Dissolved Oxygen (DO)	%sat	-	-	90 - 120	-	84	94	83	87
Turbidity	NTU	-	20	3	-	29	47	24	14.3
Dissolved Metals									
Arsenic	mg/L	0.001	-	-	-	<0.001	<0.001	<0.001	<0.001
Cadmium	mg/L	0.0001	0.0002	-	-	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	-	-	-	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.001	0.0014	-	-	<0.001	<0.001	<0.001	<0.001
Lead	mg/L	0.001	0.0034	-	-	<0.001	<0.001	<0.001	<0.001
Nickel	mg/L	0.001	0.011	-	-	<0.001	<0.001	<0.001	<0.001
Zinc	mg/L	0.005	0.008	-	-	<0.005	<0.005	<0.005	<0.005
Mercury	mg/L	0.0001	0.0006	-	-	<0.0001	<0.0001	<0.0001	<0.0001
Nutrients									
Ammonia as N	mg/L	0.01			-	<0.01	<0.01	0.02	<0.01
Nitrite as N	mg/L	0.01			-	<0.01	<0.01	<0.01	<0.01
Nitrate as N	mg/L	0.01			-	0.04	0.02	<0.01	0.02
Nitrite + Nitrate as N	mg/L	0.01	0.008	0.008	-	0.04	0.02	<0.01	0.02
Total Kjeldahl Nitrogen as N	mg/L	0.1			-	0.2	0.2	0.5	0.2
Total Nitrogen as N	mg/L	0.1	0.23	0.55	0.23	0.2	0.2	0.5	0.2
Total Phosphorus as P	mg/L	0.01	0.01	0.02	0.01	0.09	<0.01	0.06	0.12
Reactive Phosphorus as P	mg/L	0.01	0.005	0.005	-	0.05	<0.01	0.04	0.08
Major Anions									
Bicarbonate Alkalinity as CaCO3	mg/L	1	-	-	-	4	2	5	8
Carbonate Alkalinity as CaCO3	mg/L	1	-	-	-	<1	<1	<1	<1
Hydroxide Alkalinity as CaCO3	mg/L	1	-	-	-	<1	<1	<1	<1
Total Alkalinity as CaCO3	mg/L	1	-	-	-	4	2	5	8
Sulfate as SO4	mg/L	1	-	-	-	<1	<1	<1	<1
Chloride	mg/L	1	-	-	-	<1	<1	<1	<1
Dissolved Major Cations									
Calcium	mg/L	1	-	-	-	<1	<1	<1	1
Magnesium	mg/L	1	-	-	-	<1	<1	<1	<1
Potassium	mg/L	1	-	-	-	1	<1	2	2

Analyte	Units	LOR	DHWQO - Freshwater rivers & streams	DHWQO - Lagoons	EPL320-01; trigger values for surface water	SW01	SW02	SW03	SW04
Sodium	mg/L	1	-	-	-	<1	<1	<1	<1
Bacteriological									
Escherichia coli	CFU/100mL	1	-	-	-	~3000	~3000	~1100	9000
Faecal Coliforms	CFU/100mL	1	-	-	-	~3000	~3000	~1100	9000
Enterococci	CFU/100mL	1	-	-	-	23000	3200	7800	2100
Other Parameters									
Oil & Grease	mg/L	5	-	-	-	5	8	<5	<5
Biochemical Oxygen Demand	mg/L	2	-	-	-	<2	<2	3	<2

APPENDIX E SURFACE WATER QUALITY DATA

Analyte	Units	LOR	EPL320-01; SSTV for surface water	SW01	SW01	SW03	SW03	SW05	SW05	SW05	SW05	SW05	SW05
				24/01/2023	13/02/2024	30/03/2022	26/04/2022	24/01/2023	15/02/2023	18/01/2024	2/05/2024	15/05/2024	27/03/2025
pH (Lab)	-	0.01	6.0 – 7.5	5.88	6.86	6.56	5.52	5.85	5.99	6.11	6.76	6.29	6.21
Electrical Conductivity (Lab)	µS/cm	1	200	33	24	49	31	32	28	40	55	34	34
Total Dissolved Solids (Lab)	mg/L	10	-	98	40	25	25	60	26	74	46	26	52
Nutrients													
Total Phosphorus as P (Organic Phosphate as P)	mg/L	0.01	0.01	0.39	0.11	<0.01	0.02	0.06	0.03	0.08	0.02	0.05	0.09
Nitrite + Nitrate as N	mg/L	0.01	-	0.85	0.1	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Kjeldahl Nitrogen Total	mg/L	0.1	-	<1.0	0.9	0.4	0.6	0.6	0.5	0.5	0.4	0.4	0.4
Nitrogen (Total)	mg/L	0.1	0.23	<1.0	1	0.4	0.6	0.6	0.5	0.5	0.4	0.4	0.4
Major Anions													
Sulfate as SO4 - Turbidimetric (filtered)	mg/L	1	-	<1	1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (Bicarbonate as CaCO3)	mg/L	1	-	6	10	18	16	11	9	10	22	14	12
Alkalinity (Carbonate as CaCO3)	mg/L	1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (Hydroxide) as CaCO3	mg/L	1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (total) as CaCO3	mg/L	1	-	6	10	18	16	11	9	10	22	14	12
Anions Total	meq/L	0.01	-	0.18	0.22	0.44	0.4	0.3	0.26	0.31	0.58	0.36	0.32
Cations Total	meq/L	0.01	-	0.13	0.05	0.44	0.14	0.27	0.19	0.32	0.49	0.18	0.29
Chloride	mg/L	1	-	2	<1	3	3	3	3	4	5	3	3
Ionic Balance	%	0.01	-	-	-	-	-	-	-	-	-	33.4	-
Dissolved Major Cations													
Sodium (filtered)	mg/L	1	-	<1	<1	3	1	2	2	2	3	<1	2
Calcium (filtered)	mg/L	1	-	<1	1	3	2	2	2	2	4	2	2
Magnesium (filtered)	mg/L	1	-	<1	<1	2	<1	1	<1	1	2	1	1
Potassium (filtered)	mg/L	1	-	5	<1	<1	<1	<1	<1	2	<1	<1	1
Bacteriological													
E. Coli	cfu/100 ml	1	Any increase from previous monitoring round	12,000	2,000	49	310	560	-	70	20	2	380
Coliform	cfu/100 ml	1	Any increase from previous monitoring round	2,200,000	61,000	2,500	10,000	38,000	-	56,000	28,000	31,000	18,000
Enterococci	org/100ml	1	Any increase from previous monitoring round	12,000	7,500	44	80	560	-	100	6	4	2

Analyte	Units	LOR	EPL320-01; SSTV for surface water	SW05	SW01	SW05	SW06	SW02	SW03	SW04	SW03	SW04	SW05
				23/04/2025	17/11/2025	17/11/2025	17/11/2025	25/11/2025	25/11/2025	25/11/2025	29/01/2026	29/01/2026	29/01/2026
pH (Lab)	-	0.01	6.0 – 7.5	6.42	6.66	7.2	6.83	5.95	6.07	6.98	6.27	4.23	6.51
Electrical Conductivity (Lab)	µS/cm	1	200	38	24	81	40	29	26	79	19	65	27
Total Dissolved Solids (Lab)	mg/L	10	-	29	61	129	176	26	29	48	53	64	42
Nutrients													
Total Phosphorus as P (Organic Phosphate as P)	mg/L	0.01	0.01	0.06	0.1	0.09	0.23	0.11	0.07	0.06	0.05	0.04	0.03
Nitrite + Nitrate as N	mg/L	0.01	-	0.01	0.94	<0.01	0.05	0.04	0.38	0.88	<0.01	1.18	0.01
Kjeldahl Nitrogen Total	mg/L	0.1	-	0.4	1.3	2	2.2	1.4	0.8	0.5	0.5	0.6	0.7
Nitrogen (Total)	mg/L	0.1	0.23	0.4	2.2	2.0	2.2	1.4	1.2	1.4	0.5	1.8	0.7
Major Anions													
Sulfate as SO4 - Turbidimetric (filtered)	mg/L	1	-	<1	<1	<1	<1	<10	<1	5	<1	<1	<1
Alkalinity (Bicarbonate as CaCO3)	mg/L	1	-	12	12	39	17	9	6	25	5	<1	5
Alkalinity (Carbonate as CaCO3)	mg/L	1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (Hydroxide) as CaCO3	mg/L	1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (total) as CaCO3	mg/L	1	-	12	12	39	17	9	6	25	5	<1	5
Anions Total	meq/L	0.01	-	0.38	0.24	0.92	0.4	0.24	0.2	0.89	0.21	0.11	0.18
Cations Total	meq/L	0.01	-	0.27	0.13	0.74	0.46	0.36	0.24	0.8	0.05	0.44	0.22
Chloride	mg/L	1	-	5	<1	5	2	2	3	10	4	4	3
Ionic Balance	%	0.01	-	-	-	-	-	-	-	-	-	-	-
Dissolved Major Cations													
Sodium (filtered)	mg/L	1	-	2	<1	3	2	1	2	5	<1	3	2
Calcium (filtered)	mg/L	1	-	2	2	4	2	2	1	5	1	3	1
Magnesium (filtered)	mg/L	1	-	1	<1	4	3	2	1	4	<1	2	1
Potassium (filtered)	mg/L	1	-	1	1	3	1	2	1	<1	<1	<1	<1
Bacteriological													
E. Coli	cfu/100 ml	1	Any increase from previous monitoring round	140	1,700	6,100	4,900	370	760	410	320	150	140
Coliform	cfu/100 ml	1	Any increase from previous monitoring round	29,000	880,000	290,000	43,000	4,100,000	170,000	140,000	5,000	4,100	9,100
Enterococci	org/100ml	1	Any increase from previous monitoring round	21	60,000	9,700	1,900	320	220	1,800	140	180	290

APPENDIX F BASELINE GROUNDWATER QUALITY RESULTS

Analyte	Units	LOR	ANZG Primary Industries (2000) (WATER) - Long-term trigger values (LTV) - Irrigation and General Use	ADWG (2011) - Health	DHWQO (2010); water quality indicator for groundwater	RN030418	RN024671	RN036485	RN029096 (GW1)	RN029097 (GW3)	RN030413	RN029097 (GW3)	RN029098 (GW2)	RN029096 (GW1)	RN036485 (GW4)
Field Parameters	Date	-	-	-	-	23/01/2020	23/01/2020	27/02/2020	27/02/2020	27/02/2020	09/07/2020	09/07/2020	09/07/2020	09/07/2020	09/07/2020
pH	pH	-	6 - 8.5	-	7 – 8.5	7.36	6.98	7.40	7.53	7.55	7.25	7.49	5.63	7.50	7.75
Electrical Conductivity (EC)	µS/cm	-	-	-	400	337	380	249	291	302	266	275	76.2	317	198
Salinity (SAL)	ppt	-	-	-	-	0.16	0.18	0.12	0.14	0.14	0.12	0.13	0.03	0.15	0.09
Turbidity	NTU	-	-	-	-	0.39	21.5	1.1	1.4	4.5	0.29	4.5	5.7	0	0.4
Dissolved Oxygen (DO)	%sat	-	-	-	-	32.1	42.0	74.6	56.8	50.6	18	81.3	90.4	96.2	96.3
Temperature	oC	-	-	-	-	31.1	31.2	29.8	29.7	30.3	31	30.4	29.4	30.6	29.6
Total Dissolved Solids dried at 180 ± 5 °C															
Total Dissolved Solids @180°C	mg/L	10	-	-	-	188	217	114	167	174	145	150	65	170	122
Major Anions															
Bicarbonate Alkalinity as CaCO ₃	mg/L	1	-	-	-	163	174	119	136	130	124	119	15	137	86
Carbonate Alkalinity as CaCO ₃	mg/L	1	-	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Hydroxide Alkalinity as CaCO ₃	mg/L	1	-	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total Alkalinity as CaCO ₃	mg/L	1	-	-	-	163	174	119	136	130	124	119	15	137	86
Sulfate as SO ₄ - Turbidimetric	mg/L	1	-	-	-	<1	<1	<1	<1	1	<1	<1	<1	<1	<1
Chloride	mg/L	1	25	-	-	3	5	2	8	13	1	11	7	12	3
Dissolved Major Cations															
Calcium	mg/L	1	-	-	-	32	36	23	26	23	22	20	2	24	15
Magnesium	mg/L	1	-	-	-	22	25	15	17	16	14	15	4	18	11
Potassium	mg/L	1	-	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sodium	mg/L	1	115	-	-	3	3	3	5	8	3	7	3	7	3
SAR and Hardness Calculations															
Sodium Adsorption Ratio	-	0.01	-	-	-	0.1	0.09	0.12	0.19	0.31	0.12	0.29	0.28	0.26	0.14
Dissolved Metals															
Arsenic	mg/L	0.001	0.1	0.01	-	0.002	0.002	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001
Cadmium	mg/L	0.0001	0.01	0.002	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	0.1	0.05	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.001	0.2	2	-	0.001	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	0.008	<0.001	<0.001
Lead	mg/L	0.001	2	0.01	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	mg/L	0.001	0.2	0.02	-	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	<0.001	<0.001
Zinc	mg/L	0.005	2	-	-	<0.005	0.009	<0.005	<0.005	<0.005	<0.005	0.005	0.01	<0.005	<0.005

Analyte	Units	LOR	ANZG Primary Industries (2000) (WATER) - Long-term trigger values (LTV) - Irrigation and General Use	ADWG (2011) - Health	DHWQO (2010); water quality indicator for groundwater	RN030418	RN024671	RN036485	RN029096 (GW1)	RN029097 (GW3)	RN030413	RN029097 (GW3)	RN029098 (GW2)	RN029096 (GW1)	RN036485 (GW4)
Mercury	mg/L	0.0001	0.002	0.001	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nutrients					-										
Ammonia as N	mg/L	0.01	-	-	-	0.14	0.04	<0.01	<0.01	0.03	0.05	0.07	0.09	0.17	0.01
Nitrite as N	mg/L	0.01	-	3	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate as N	mg/L	0.01	-	50	-	0.82	0.17	2.05	1.49	1.67	2.74	1.88	3.55	1.3	2.6
Nitrite + Nitrate as N	mg/L	0.01	-	-	-	0.82	0.17	2.05	1.49	1.67	2.74	1.88	3.55	1.3	2.6
Total Kjeldahl Nitrogen as N	mg/L	0.1	-	-	-	0.2	<0.1	0.3	0.2	0.2	0.5	0.3	0.5	0.2	0.6
Total Nitrogen as N	mg/L	0.1	5	-	-	1	0.2	2.4	1.7	1.9	3.2	2.2	4	1.5	3.2
Total Phosphorus as P	mg/L	0.01	0.05	-	-	0.01	0.03	0.11	0.11	0.19	0.03	0.04	<0.01	0.04	0.04
Reactive Phosphorus as P	mg/L	0.01	-	-	-	0.02	0.02	0.02	0.02	0.02	0.02	0.01	<0.01	0.01	0.02
Oil and Grease (O&G)															
Oil & Grease	mg/L	5	-	-	-	<5	10	<5	<5	<5					
Biochemical Oxygen Demand (BOD)															
Biochemical Oxygen Demand	mg/L	2	-	-	-	<2	<2	<2	2	<2	<2	<2	<2	<2	<2
Bacteriological															
Escherichia coli	CFU/100mL	1	-	No detection	-	~3	<1	~<1	~<1	~<1	~<1	<1	<1	<1	<1
Faecal Coliforms	CFU/100mL	1	-	-	-	~3	<1	~<1	~<1	~<1	~<1	<1	<1	<1	<1
Enterococci	CFU/100mL	1	-	-	-	120	<1	~5	~2	~1	<1	<1	~2	<1	<1

*aesthetic guideline

APPENDIX G GROUNDWATER QUALITY DATA

Analyte	Unit	LO R	EPL320-01; SSTV for groundwater	GW1	GW1	GW1	GW1	GW1	GW1	GW1	GW1	GW1	GW1	GW1	GW1	GW1
				12/08/2021	16/09/2021	30/11/2021	22/02/2022	14/06/2022	26/09/2022	22/12/2022	15/03/2023	13/06/2023	12/09/2023	18/01/2024	2/05/2024	15/05/2024
pH (Lab)	-	0.01	7-8.5	7.08	7.07	7.37	7.72	7.62	7.68	8.02	7.76	7.42	7.33	7.79	7.81	7.68
Electrical Conductivity (Lab)	µS/cm	1	400	272	287	270	270	230	293	278	292	288	225	279	285	275
Total Dissolved Solids dried at 180 ± 5 °C																
Total Dissolved Solids (Lab)	mg/L	10	-	158	138	181	145	131	159	149	132	150	148	168	168	140
Nutrients																
Total Phosphorus as P (Organic Phosphate as P)	mg/L	0.01	Any increase from previous monitoring round	0.01	0.02	0.02	0.02	0.04	0.02	0.05	0.02	0.02	0.04	0.02	0.01	0.04
Kjeldahl Nitrogen Total	mg/L	0.1		<0.1	0.1	<0.1	<0.1	0.1	0.3	0.2	0.4	0.8	0.4	0.3	0.2	0.2
Nitrogen (Total)	mg/L	0.1	Any increase from previous monitoring round	1.4	1.5	1.3	1.3	1.4	1.8	1.6	1.8	2.3	2.3	1.7	1.7	1.7
Nitrite + Nitrate as N	mg/L	0.01		1.44	1.36	1.29	1.26	1.34	1.49	1.4	1.45	1.54	1.9	1.4	1.47	1.48
Major Anions																
Sulfate as SO ₄ - Turbidity (filtered)	mg/L	1		1	1	1	<1	<1	1	<1	1	<1	<1	1	1	1
Alkalinity (Bicarbonate as CaCO ₃)	mg/L	1		138	135	137	135	134	133	144	136	133	96	133	134	136
Alkalinity (Carbonate as CaCO ₃)	mg/L	1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (Hydroxide as CaCO ₃)	mg/L	1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (total) as CaCO ₃	mg/L	1		138	135	137	135	134	133	144	136	133	96	133	134	136
Anions Total	meq/L	0.01		3.12	3.06	3.1	3.01	3.02	3.02	3.27	3.08	3.02	2.26	2.96	3.01	3.08
Cations Total	meq/L	0.01		2.89	2.95	3.08	3.03	3.12	3.12	2.98	3.07	2.86	2.37	2.91	2.99	3.07
Ionic Balance	%	0.01		3.69	1.76	0.21	0.43		1.69	4.61	0.13	2.74			0.23	0.07
Chloride	mg/L	1		12	12	12	11	12	12	14	12	13	12	10	11	12
Dissolved Major Cations																
Sodium (filtered)	mg/L	1		8	7	7	7	6	9	7	11	8	7	6	8	6
Calcium (filtered)	mg/L	1		23	25	26	25	26	25	24	25	24	20	25	25	25
Magnesium (filtered)	mg/L	1		17	17	18	18	19	18	18	16	16	13	17	17	19
Potassium (filtered)	mg/L	1		<1	<1	<1	<1	<1	<1	<1	1	<1	<1	<1	<1	<1
Bacteriological																
<i>E. Coli</i>	cfu/100 ml	1	Any increase from previous monitoring round	<1	1	1	2	<1	<1	<1	<1	1	37	<1	<1	<1
Coliform	cfu/100 ml	1	Any increase from previous monitoring round	1	650	4	1	<1	460	<1	<1	39	740	1	1	2
Enterococci	org/100 ml	1	Any increase from previous monitoring round	<1	<1	<1	3	<1	21	<1	<1	2	<1	1	<1	<1

Analyte	Unit	LO R	EPL320-01; SSTV for groundwater	GW1	GW1	GW1	GW1	GW1	GW1	GW1	GW1	GW1	GW1
				12/06/2024	11/07/2024	15/08/2024	11/09/2024	17/10/2024	13/11/2024	16/12/2024	29/01/2025	19/02/2025	23/04/2025
pH (Lab)	-	0.01	7-8.5	8.15	7.04	7.06	7.89	7.85	7.32	7.56	7.91	7.93	7.83
Electrical Conductivity (Lab)	µS/cm	1	400	282	275	270	274	269	262	268	279	264	263
Total Dissolved Solids dried at 180 ± 5 °C													
Total Dissolved Solids (Lab)	mg/L	10	-	170	172	150	143	140	138	151	158	156	143
Nutrients													
Total Phosphorus as P (Organic Phosphate as P)	mg/L	0.01	Any increase from previous monitoring round	0.02	0.02	0.01	0.04	0.03	0.04	<0.01	0.01	0.04	0.02
Kjeldahl Nitrogen Total	mg/L	0.1		0.3	0.4	0.3	<0.1	0.1	<0.1	0.2	0.2	0.2	0.3
Nitrogen (Total)	mg/L	0.1	Any increase from previous monitoring round	1.8	2	1.8	1.5	1.3	1.4	1.6	2.7	1.4	1.7
Nitrite + Nitrate as N	mg/L	0.01		1.5	1.56	1.51	1.47	1.24	1.45	1.38	2.48	1.22	1.37
Major Anions													
Sulfate as SO4 - Turbidimetric (filtered)	mg/L	1		<1	1	<1	2	<1	1	<1	<1	2	<1
Alkalinity (Bicarbonate as CaCO3)	mg/L	1		118	122	122	140	127	120	130	124	132	133
Alkalinity (Carbonate as CaCO3)	mg/L	1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (Hydroxide) as CaCO3	mg/L	1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (total) as CaCO3	mg/L	1		118	122	122	140	127	120	130	124	132	133
Anions Total	meq/L	0.01		2.67	2.77	2.72	3.15	2.82	2.84	2.82	2.70	2.90	2.91
Cations Total	meq/L	0.01		2.86	2.72	2.9	2.98	2.76	2.65	2.96	2.61	2.54	2.88
Ionic Balance	%	0.01					2.7			2.33			
Chloride	mg/L	1		11	11	10	11	10	15	8	8	8	9
Dissolved Major Cations													
Sodium (filtered)	mg/L	1		6	6	7	7	8	5	6	6	4	6
Calcium (filtered)	mg/L	1		24	23	24	24	22	24	26	19	21	26
Magnesium (filtered)	mg/L	1		17	16	17	18	16	15	17	17	16	16
Potassium (filtered)	mg/L	1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bacteriological													
E. Coli	cfu/100 ml	1	Any increase from previous monitoring round	<1	1	1	1	1	<1	<1	-	-	<1
Coliform	cfu/100 ml	1	Any increase from previous monitoring round	1	1	1	1	1	12	43	-	770	14
Enterococci	org/100 ml	1	Any increase from previous monitoring round	<1	<1	<1	<1	<1	<1	<1	0	<1	<1

Analyte	Unit	LO R	SSTV - Marpu Groundwater	GW2	GW2	GW2	GW2	GW2	GW2	GW2	GW2	GW2	GW2	GW2	GW2	GW2
				12/08/2021	16/09/2021	30/11/2021	22/02/2022	14/01/2022	26/09/2022	22/12/2022	15/03/2023	13/06/2023	12/09/2023	18/01/2024	2/05/2024	15/05/2024
pH (Lab)	-	0.01	7-8.5	6.85	6.88	7.77	7.6	6.96	7.59	7.93	7.37	7.15	7.88	7.03	7.49	7.08
Electrical Conductivity (Lab)	µS/cm	1	400	188	239	270	247	125	260	224	133	235	269	191	243	218
Total Dissolved Solids dried at 180 ± 5 °C																
Total Dissolved Solids (Lab)	mg/L	10		114	134	179	127	86	150	126	56	118	170	90	156	128
Nutrients																
Total Phosphorus as P (Organic Phosphate as P)	mg/L	0.01	Any increase from previous monitoring round	<0.01	0.01	0.04	0.07	0.02	0.02	0.04	0.1	0.02	0.04	0.02	<0.01	0.02
Kjeldahl Nitrogen Total	mg/L	0.1		0.4	0.4	0.2	0.2	0.3	0.4	0.6	1	0.4	0.3	0.2	0.5	0.6
Nitrogen (Total)	mg/L	0.1	Any increase from previous monitoring round	2.7	2.2	1.7	1	1.9	2.1	0.6	1	1.9	1.9	2.2	2.3	2.7
Nitrite + Nitrate as N	mg/L	0.01		2.31	1.81	1.54	0.81	1.6	1.72	<0.01	<0.01	1.49	1.58	1.96	1.83	2.1
Major Anions																
Sulfate as SO4 - Turbidimetric (filtered)	mg/L	1		<1	1	1	<1	<1	1	<1	<1	<1	1	<1	1	<1
Alkalinity (Bicarbonate as CaCO3)	mg/L	1		96	115	140	118	101	104	107	57	103	127	89	108	102
Alkalinity (Carbonate as CaCO3)	mg/L	1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (Hydroxide) as CaCO3	mg/L	1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (total) as CaCO3	mg/L	1		96	115	140	118	101	104	107	57	103	127	89	108	102
Anions Total	meq/L	0.01		2.23	2.71	3.18	2.7	2.38	2.46	2.53	1.42	2.42	2.9	2.06	2.54	2.38
Cations Total	meq/L	0.01		2.1	2.58	3.18	2.4	2.4	2.81	2.4	1.37	2.37	2.95	2.05	2.45	2.44
Chloride	mg/L	1		11	14	13	12	13	13	14	10	13	12	10	13	12
Ionic Balance	%	0.01				0.12										1.39
Dissolved Major Cations																
Sodium (filtered)	mg/L	1		6	8	8	7	5	9	7	7	8	7	6	7	6
Calcium (filtered)	mg/L	1		17	20	27	19	19	22	19	11	19	25	16	20	19
Magnesium (filtered)	mg/L	1		12	15	18	14	15	16	14	6	13	17	12	14	15
Potassium (filtered)	mg/L	1		<1	<1	<1	<1	<1	<1	<1	1	<1	<1	<1	<1	<1
Bacteriological																
E. Coli	cfu/100 ml	1	Any increase from previous monitoring round	1	<1	3	1	60	14	330	20	2	<1	110	51	7,500
Coliform	cfu/100 ml	1	Any increase from previous monitoring round	300	14	1	1	12,000	19,000	13,000	13,000	550	16	130,000	7,000	65,000
Enterococci	org/100 ml	1	Any increase from previous monitoring round	<1	<1	3	6	2,300	<1	53	560	<1	<1	68	120	270,000

Analyte	Unit	LO R	SSTV - Marpu Groundwater	GW2	GW2	GW2	GW2	GW2	GW2	GW2	GW2	GW2	GW2
				12/06/2024	11/07/2024	15/08/2024	11/09/2024	17/10/2024	13/11/2024	16/12/2024	29/01/2025	19/02/2025	23/04/2025
pH (Lab)	-	0.01	7-8.5	7.91	6.68	6.86	7.65	7.69	7.16	7.58	7.05	7.21	6.30
Electrical Conductivity (Lab)	µS/cm	1	400	240	240	250	245	245	214	216	130	135	88
Total Dissolved Solids dried at 180 ± 5 °C													
Total Dissolved Solids (Lab)	mg/L	10		144	165	131	140	134	108	81	66	83	63
Nutrients													
Total Phosphorus as P (Organic Phosphate as P)	mg/L	0.01	Any increase from previous monitoring round	<0.01	0.05	0.01	0.05	0.04	0.04	<0.01	0.05	0.05	0.04
Kjeldahl Nitrogen Total	mg/L	0.1		0.3	0.2	0.3	0.2	0.2	0.4	0.3	0.4	0.3	0.7
Nitrogen (Total)	mg/L	0.1	Any increase from previous monitoring round	1.7	2.0	1.9	1.7	1	0.7	0.7	0.6	1.8	3.2
Nitrite + Nitrate as N	mg/L	0.01		1.44	1.79	1.62	1.54	0.77	0.28	0.37	0.16	1.48	2.55
Major Anions													
Sulfate as SO4 - Turbidimetric (filtered)	mg/L	1		<1	<1	<1	<1	<1	<1	<1	<1	2	<1
Alkalinity (Bicarbonate as CaCO3)	mg/L	1		109	98	106	124	113	98	105	45	55	26
Alkalinity (Carbonate as CaCO3)	mg/L	1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (Hydroxide) as CaCO3	mg/L	1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (total) as CaCO3	mg/L	1		109	98	106	124	113	98	105	45	55	26
Anions Total	meq/L	0.01		2.46	2.3	2.4	2.76	2.54	2.32	2.38	1.15	1.39	0.74
Cations Total	meq/L	0.01		2.36	2.36	2.54	2.67	2.48	2.32	2.40	1.01	1.48	0.80
Chloride	mg/L	1		10	12	10	10	10	13	10	9	9	8
Ionic Balance	%	0.01		-	-	-	-	-	-	-	-	-	-
Dissolved Major Cations													
Sodium (filtered)	mg/L	1		6	6	6	7	8	5	7	5	4	4
Calcium (filtered)	mg/L	1		19	19	21	21	18	19	19	6	13	6
Magnesium (filtered)	mg/L	1		14	14	15	16	15	14	14	6	8	4
Potassium (filtered)	mg/L	1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bacteriological													
E. Coli	cfu/100 ml	1	Any increase from previous monitoring round	24,000	42	19,000	100	150	700	3,600	-	-	99
Coliform	cfu/100 ml	1	Any increase from previous monitoring round	96,000	2,000	61,000	9,000	29,000	26,000	84,000	-	12,000	200,000
Enterococci	org/100 ml	1	Any increase from previous monitoring round	17,000	47	500	280	480	240	4,100	240	24	570

Analyte	Unit	LO R	SSTV - Marpu Groundwater	GW3	GW3	GW3	GW3	GW3	GW3	GW3	GW3	GW3	GW3	GW3	GW3	GW3	GW3	GW3
				14/06/ 2022	26/09/ 2022	22/12/ 2022	15/03/ 2023	13/06/ 2023	12/09/ 2023	18/01/ 2024	2/05/2 024	15/05/ 2024	12/06/ 2024	11/07/ 2024	15/08/ 2024	11/09/ 2024	17/10/ 2024	13/11/ 2024
pH (Lab)	-	0.0 1	7-8.5	7.26	7.74	8.12	7.8	7.37	7.11	7.73	7.9	7.73	8.1	7.05	7.14	7.89	7.85	7.41
Electrica l Conducti vity (Lab)	µS/cm	1	400	280	295	281	288	287	203	277	282	275	274	268	266	261	257	261
Total Dissolve d Solids dried at 180 ± 5 °C																		
Total Dissolve d Solids (Lab)	mg/L	10		161	152	147	146	146	131	182	171	160	164	175	142	150	142	139
Nutrient s																		
Total Phospho rus as P (Organic Phospha te as P)	mg/L	0.0 1	Any increase from previous monitoring round	0.02	0.02	0.04	0.01	0.03	0.03	0.03	<0.01	0.03	<0.01	0.01	0.01	0.07	0.05	0.04
Nitrite + Nitrate as N	mg/L	0.0 1		1.52	1.58	1.63	1.44	1.74	2.58	1.37	1.59	1.62	1.6	1.58	1.46	1.39	1.18	1.22
Kjeldahl Nitrogen Total	mg/L	0.1		0.2	0.3	0.3	0.5	0.9	0.6	0.4	0.5	0.2	0.3	0.2	0.3	0.2	<0.1	0.1
Nitrogen (Total)	mg/L	0.1	Any increase from previous monitoring round	1.7	1.9	1.9	1.9	2.6	3.2	1.8	2.1	1.8	1.9	1.8	1.8	1.6	1.2	1.3
Major Anions																		
Sulfate as SO4 - Turbidim etric (filtered)	mg/L	1		<1	1	1	1	1	<1	<1	1	1	<1	<1	<1	<1	<1	1
Alkalinity (Bicarbo nate as CaCO3)	mg/L	1		125	125	128	134	127	83	130	130	133	127	117	118	134	122	117
Alkalinity (Carbon ate as CaCO3)	mg/L	1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (Hydroxi de) as CaCO3	mg/L	1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (total) as CaCO3	mg/L	1		125	125	128	134	127	83	130	130	133	127	117	118	134	122	117
Anions Total	meq/L	0.0 1		2.92	2.94	3.06	3.04	2.98	1.97	2.96	2.98	3.04	2.85	2.65	2.64	2.99	2.75	2.67
Cations Total	meq/L	0.0 1		3.16	3.16	2.94	2.85	2.96	2.1	2.95	2.91	3.16	2.9	2.72	2.78	2.9	2.76	2.52
Chloride	mg/L	1		15	15	17	12	15	11	13	13	13	11	11	10	11	11	11
Ionic Balance	%	0.0 1		4.03		1.99	3.25				1.23	1.94						
Dissolve d Major Cations																		
Sodium (filtered)	mg/L	1		7	10	9	8	9	6	7	8	7	7	6	6	7	8	5
Calcium (filtered)	mg/L	1		26	25	23	21	25	17	25	25	26	24	23	24	24	22	23
Magnesi um (filtered)	mg/L	1		19	18	17	16	16	12	17	16	19	17	16	16	17	16	14
Potassiu m (filtered)	mg/L	1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bacteriol ogical																		
E. Coli	cfu/10 0 ml	1	Any increase from previous monitoring round	<1	1	1	<1	1	28	6	2	1	1	1	1	<1	3	<1
Coliform	cfu/10 0 ml	1	Any increase from previous monitoring round	3	1	14	<1	26	240	100	40	53	10	30	11,00 0	22	10	6
Enteroc occi	org/10 0ml	1	Any increase from previous monitoring round	<1	<1	1	1	<1	<1	26	<1	<1	<1	<1	<1	<1	<1	<1

Analyte	Unit	LOR	SSTV - Marpu Groundwater	GW3	GW3	GW3	GW3
				16/12/2024	29/01/2025	19/02/2025	23/04/2025
pH (Lab)	-	0.01	7-8.5	7.74	7.96	7.99	7.86
Electrical Conductivity (Lab)	µS/cm	1	400	272	279	264	263
Total Dissolved Solids dried at 180 ± 5 °C							
Total Dissolved Solids (Lab)	mg/L	10		137	173	167	148
Nutrients							
Total Phosphorus as P (Organic Phosphate as P)	mg/L	0.01	Any increase from previous monitoring round	<0.01	<0.01	0.48	0.02
Nitrite + Nitrate as N	mg/L	0.01		1.16	1.23	1.12	1.38
Kjeldahl Nitrogen Total	mg/L	0.1		0.1	0.2	0.2	<0.1
Nitrogen (Total)	mg/L	0.1	Any increase from previous monitoring round	1.3	1.4	1.3	1.4
Major Anions							
Sulfate as SO4 - Turbidimetric (filtered)	mg/L	1		<1	<1	<1	<1
Alkalinity (Bicarbonate as CaCO3)	mg/L	1		130	123	129	132
Alkalinity (Carbonate as CaCO3)	mg/L	1		<1	<1	<1	<1
Alkalinity (Hydroxide) as CaCO3	mg/L	1		<1	<1	<1	<1
Alkalinity (total) as CaCO3	mg/L	1		130	123	129	132
Anions Total	meq/L	0.01		2.91	2.82	2.92	2.95
Cations Total	meq/L	0.01		3	2.7	2.68	2.82
Chloride	mg/L	1		11	13	12	11
Ionic Balance	%	0.01		-	-	-	-
Dissolved Major Cations							
Sodium (filtered)	mg/L	1		7	8	6	6
Calcium (filtered)	mg/L	1		26	19	22	25
Magnesium (filtered)	mg/L	1		17	17	16	16
Potassium (filtered)	mg/L	1		<1	<1	<1	<1
Bacteriological							
E. Coli	cfu/100 ml or orgs/100ml	1	Any increase from previous monitoring round	10	10	<1	<1
Coliform	cfu/100 ml or orgs/100ml	1	Any increase from previous monitoring round	22	18	130	2
Enterococci	org/100ml	1	Any increase from previous monitoring round	1	3	<1	<1

Analyte	Unit	LOR	EPL320-01 - Marpu Groundwater	GW4	GW4	GW4	GW4	GW4	GW4	GW4	GW4	GW5	GW5	GW5	GW5	GW6	GW6
				12/08/2021	16/09/2021	30/11/2021	22/02/2022	14/06/2022	26/09/2022	22/12/2022	15/03/2023	14/06/2022	26/09/2022	15/03/2023	13/06/2023	14/06/2022	18/01/2024
pH (Lab)	-	0.01	7 - 8.5	7.04	6.86	7.65	7.54	6.75	7.62	7.94	7.82	7.25	7.79	7.83	7.41	7.30	7.53
Electrical Conductivity (Lab)	µS/cm	1	400	187	200	215	147	126	161	151	288	276	290	288	291	215	278
Total Dissolved Solids dried at 180 ± 5 °C																	
Total Dissolved Solids (Lab)	mg/L	10		117	128	133	82	82	101	84	144	167	158	130	147	150	184
Nutrients																	
Total Phosphorus as P (Organic Phosphate as P)	mg/L	0.01	Any increase from previous monitoring round	0.02	0.02	0.01	0.05	0.06	0.15	0.09	0.02	0.03	0.03	0.02	0.02	0.03	0.05
Nitrite + Nitrate as N	mg/L	0.01		2.02	1.30	1.99	2.54	2.64	0.58	1.31	1.39	1.52	1.58	1.44	1.75	1.39	1.40
Kjeldahl Nitrogen Total	mg/L	0.1		0.2	0.1	0.1	0.3	0.5	0.9	0.4	1.2	0.3	0.3	0.5	1.0	0.2	0.3
Nitrogen (Total)	mg/L	0.1	Any increase from previous monitoring round	2.2	1.4	2.1	2.8	3.1	1.5	1.7	2.6	1.8	1.9	1.9	2.8	1.6	1.7
Major Anions																	
Sulfate as SO4 - Turbidimetric (filtered)	mg/L	1		<1	<1	<1	<1	<1	<1	<1	1	<1	1	1	1	<1	<1
Alkalinity (Bicarbonate as CaCO3)	mg/L	1		107	114	122	68	58	74	75	134	124	117	133	128	127	146
Alkalinity (Carbonate as CaCO3)	mg/L	1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (Hydroxide) as CaCO3	mg/L	1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (total) as CaCO3	mg/L	1		107	114	122	68	58	74	75	134	124	117	133	128	127	146
Anions Total	meq/L	0.01		2.22	2.39	2.55	1.44	1.27	1.59	1.61	3.04	2.90	2.75	3.04	3.00	2.62	3.00
Cations Total	meq/L	0.01		1.78	2.20	2.51	1.52	1.38	1.83	1.34	2.77	3.12	3.16	2.82	2.86	2.83	2.96
Chloride	mg/L	1		3	4	4	3	4	4	4	12	15	14	13	15	3	3
Ionic Balance	%	0.01									4.71	3.68		3.84	2.37		0.60
Dissolved Major Cations																	
Sodium (filtered)	mg/L	1		3	3	3	3	1	4	3	8	6	10	7	8	<1	2
Calcium (filtered)	mg/L	1		15	20	23	13	12	15	11	22	26	25	23	24	27	28
Magnesium (filtered)	mg/L	1		11	13	15	9	9	11	8	15	19	18	15	16	18	18
Potassium (filtered)	mg/L	1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bacteriological																	
E. Coli	cfu/100 ml	1	Any increase from previous monitoring round	<1	<1	18	5	2	<1	<1	<1	<1	<1	<1	<1	<1	1,000
Coliform	cfu/100 ml	1	Any increase from previous monitoring round	1	1	1	9	14	43	1	1	5	6	<1	7	18	2,800
Enterococci	org/100ml	1	Any increase from previous monitoring round	<1	<1	1	<1	58	3	<1	<1	<1	<1	<1	<1	4	17

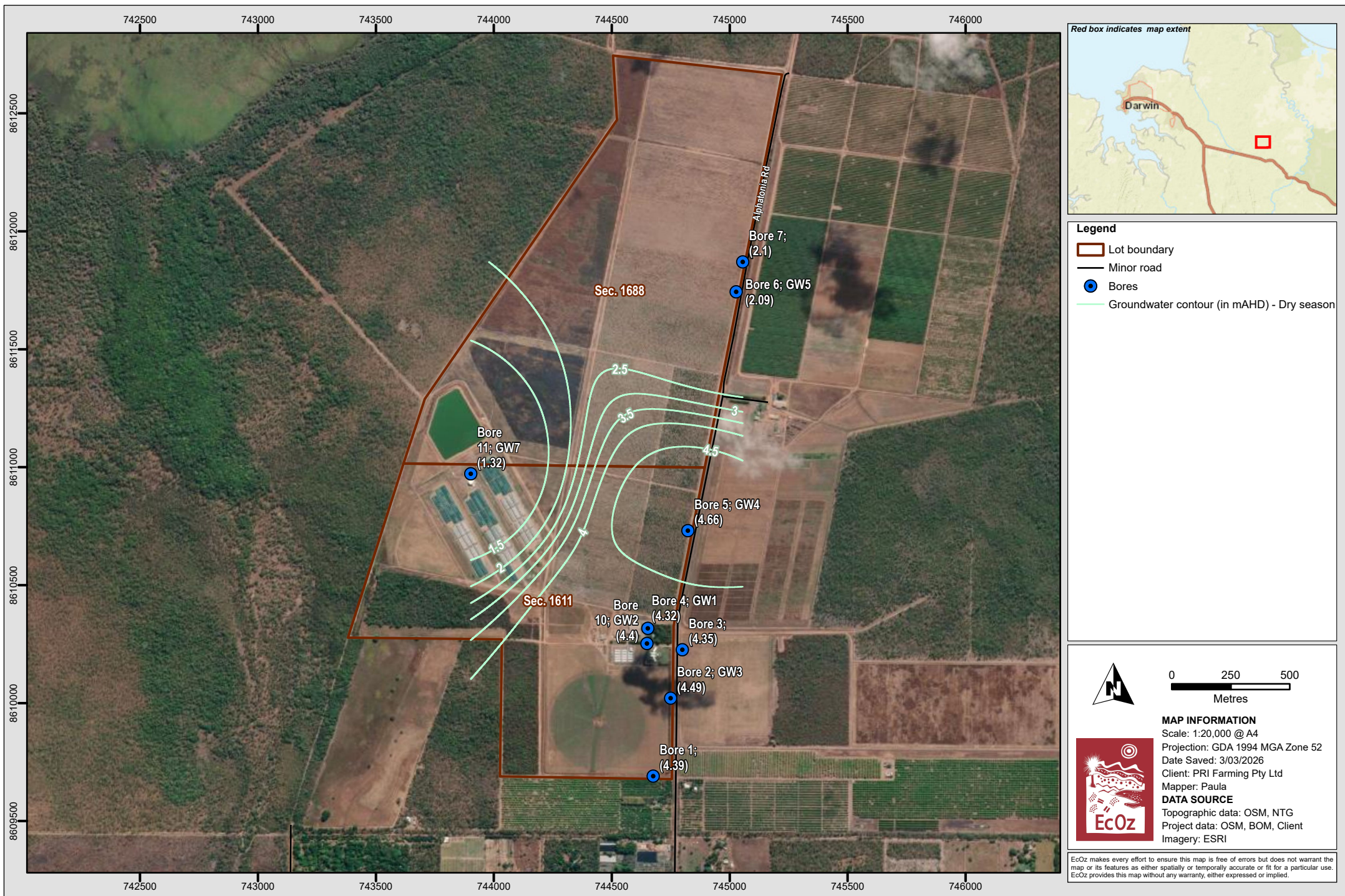
APPENDIX H GROUNDWATER LEVELS AND CONTOURS

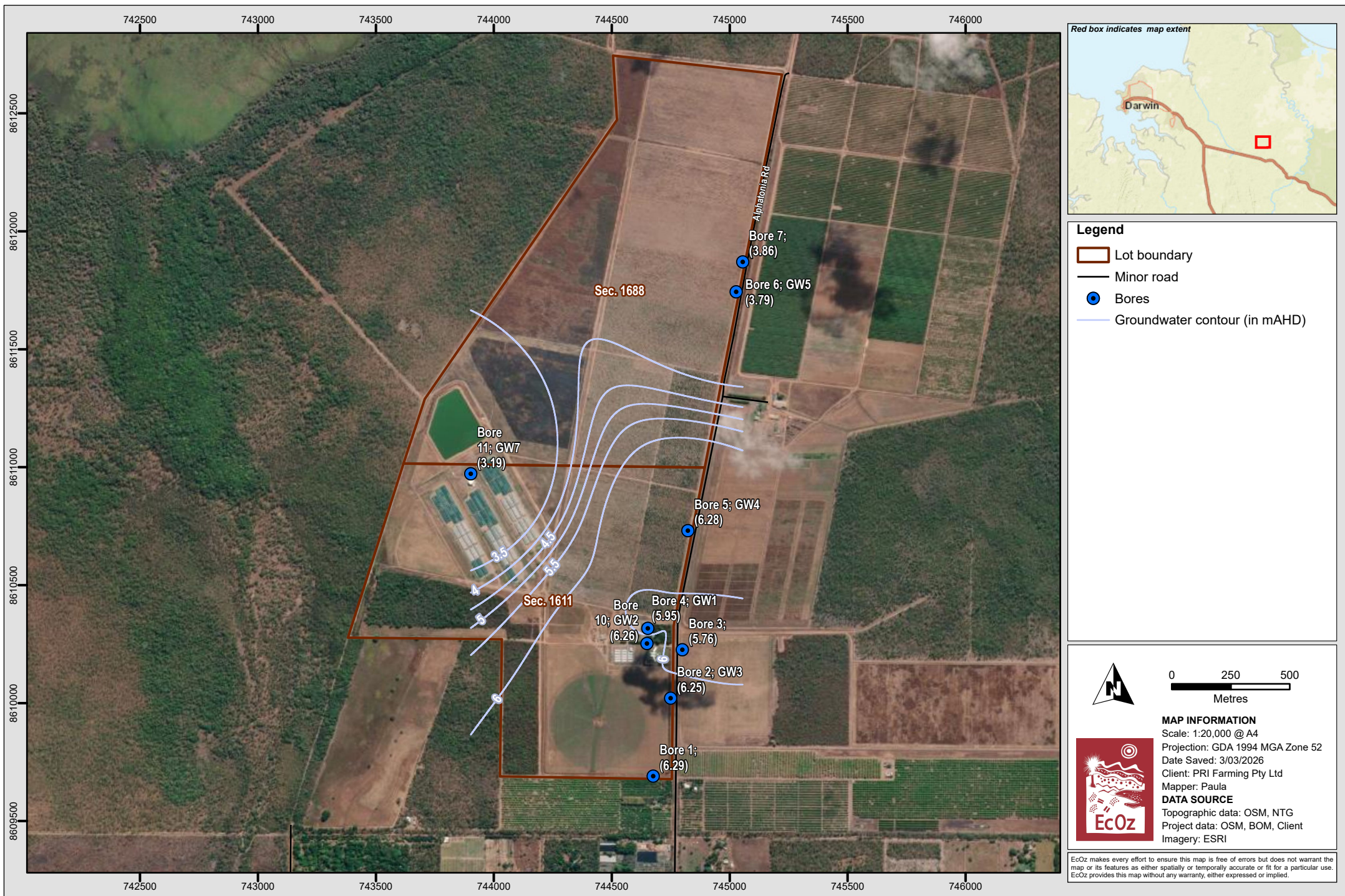
Date of measurement	Bore 1 (RN030410)		Bore 2 (GW3, RN029097)		Bore 3 (RN029733)		Bore 4 (GW1, RN029096)		Bore 5 (GW4, RN036485)		Bore 6 (GW5, RN031822)		Bore 7 (RN031829)		Bore 10 (GW2, RN029098)		Bore 11 (GW7, RN042465)		GW6 (RN030344)	
	mbTOC	mAHD	mbTOC	mAHD	mbTOC	mAHD	mbTOC	mAHD	mbTOC	mAHD	mbTOC	mAHD	mbTOC	mAHD	mbTOC	mAHD	mbTOC	mAHD	mbTOC	mAHD
1/02/2022	12.2	5.48	10.7	5.513	12.6	3.106	10.2	5.693	9.5	6.068	13.8	2.714	13.4	2.924	10.8	5.797		14.867	-	-
1/03/2022	8.7	8.98	7.1	9.113	8.7	7.006	7	8.893	6.2	9.368	10.3	6.214	9.5	6.824	7.2	9.397	11.4	3.467	-	16.67
1/04/2022	7	10.68	5.7	10.513	5	10.706	5.3	10.593	5.0	10.568	9.5	7.014	8.6	7.724	5.8	10.797	4.4	10.467	-	
1/04/2023	8.1	9.58	6.9	9.313	6.4	9.306	6.3	9.593	6.4	9.168	11.1	5.414	10.4	5.924	7.4	9.197	11.3	3.567	-	16.66
1/05/2023	9.2	8.48	7.4	8.813	7	8.706	7.2	8.693	7.1	8.468	12	4.514	11.4	4.924	7.6	8.997	6.1	8.767	-	-
1/06/2023	10	7.68	9	7.213	8	7.706	8.2	7.693	8.3	7.268	12.9	3.614	12.6	3.724	9	7.597	12.6	2.267	-	-
1/07/2023	12.2	5.48	10.5	5.713	11.9	3.806	10.2	5.693	9.5	6.068	13.5	3.014	13.4	2.924	11	5.597	8.3	6.567	-	-
1/08/2023	13.2	4.48	11.6	4.613	13.2	2.506	11.4	4.493	10.6	4.968	14.7	1.814	14.5	1.824	12.1	4.497	9.9	4.967	-	-
1/09/2023	13.9	3.78	12.5	3.713	12.1	3.606	12.2	3.693	12.1	3.468	15.4	1.114	15.3	1.024	13	3.597	10.8	4.067	-	-
1/10/2023	16.1	1.58	14.4	1.813	15.9	-0.194	14.1	1.793	13.0	2.568	16	0.514	15.8	0.524	14.7	1.897	17.3	-2.433	-	-
1/11/2023**	17.5	0.18	16	0.213	17.3	-1.594	15.6	0.293	14.7	0.868	16.8	-0.286	16.5	0.176	22	-5.403	18.4	-3.533	-	8.81
1/12/2023	16.5	1.18	15.1	1.113	14.9	0.806	14.2	1.693	14.4	1.168	16.2	0.314	16.1	0.224	15.5	1.097	13.5	1.367	-	-
3/01/2024	15.6	2.08	13.8	2.413	15.3	0.406	13.8	2.093	13.2	2.368	15.7	0.814	15.6	0.724	14.3	2.297	17	-2.133	-	-
1/02/2024	8.1	9.58	6.8	9.413	8.3	7.406	7.8	8.093	6.7	8.868	11.4	5.114	10.1	6.224	7.2	9.397	11.7	3.167	-	-
1/03/2024	7.7	9.98	6.4	9.813	7.7	8.006	6.1	9.793	6.1	9.468	10.5	6.014	9.4	6.924	7.1	9.497	11.3	3.567	-	-
1/04/2024	7.5	10.18	6.3	9.913	5.3	10.406	7.7	8.193	6.1	9.468	9.8	6.714	10.7	5.624	6.4	10.197	11.6	3.267	-	16.04
1/05/2024	10.1	7.58	8.7	7.513			10	5.893	7.6	7.968	11.8	4.714	11	5.324	8.8	7.797	13	1.867	-	-
1/06/2024	10.6	7.08	9	7.213	8.2	7.506	8.8	7.093	8.1	7.468	12.7	3.814	12.6	3.724	9.6	6.997	13.7	1.167	-	-
1/07/2024	12	5.68	10.7	5.513	9.6	6.106	10.4	5.493	9.4	6.168	14	2.514	13.9	2.424	10.7	5.897	14.5	0.367	-	-
1/08/2024	13.5	4.18	12	4.213	11	4.706	11.7	4.193	10.7	4.868	14.6	1.914	14.4	1.924	12.5	4.097	15.6	-0.733	-	-
1/09/2024	13.9	3.78	12.5	3.713	12.1	3.606	13.6	2.293	11.9	3.668	15.4	1.114	15.3	1.024	14	2.597	17.6	-2.733	-	-
1/10/2024	16.4	1.28	15	1.213	13.9	1.806	14.7	1.193	13.6	1.968	15.7	0.814	15.4	0.924	15.4	1.197	18.4	-3.533	-	8.3
1/11/2024	17.5	0.18	16	0.213	14.8	0.906	15.4	0.493	14.4	1.168	16.3	0.214	15.9	0.424	16.4	0.197	19.1	-4.233	-	-
1/12/2024	17.4	0.28	15.9	0.313	15.4	0.306	15.6	0.293	14.6	0.968	158.8*		15.5	0.824	15.9	0.697	18.8	-3.933	-	-
1/01/2025	16.1	1.58	14.8	1.413	13.6	2.106	14.4	1.493	13.3	2.268	15.4	1.114	15	1.324	14.9	1.697	32*	-	-	-
1/02/2025	14.1	3.58	12.8	3.413	11.7	4.006	12	3.893	11.3	4.268	14.5	2.014	13.9	2.424	12.7	3.897	10.4	4.467	-	-
1/03/2025	10.8	6.88	9	7.213	8.8	6.906	9.3	6.593	8.6	6.968	13.2	3.314	12.9	3.424	9.4	7.197	14	0.867	-	-
1/04/2025	9.8	7.88	8.8	7.413	7.2	8.506	9.4	6.493	7.6	7.968	11.8	4.714	12.8	3.524	8.7	7.897	13.5	1.367	-	-
1/05/2025	9.3	8.38	7.6	8.613	6.7	9.006	7.1	8.793	7.2	8.368	12	4.514	10.9	5.424	8.4	8.197	6.6	8.267	-	15.32
1/06/2025	11.3	6.38	9.4	6.813	8.5	7.206	9.5	6.393	9.4	6.168	12.5	4.014	12.2	4.124	10.1	6.497	14.1	0.767	-	-
1/07/2025	13.1	4.58	11.3	4.913	10.4	5.306	11.3	4.593	10.3	5.268	14	2.514	13.8	2.524	11.6	4.997	15.5	-0.633	-	-
1/08/2025	13.4	4.28	11.9	4.313	10.9	4.806	11.7	4.193	11.4	4.168	14.8	1.714	14.6	1.724	12.3	4.297	10.6	4.267	-	-
1/09/2025	15.1	2.58	13.3	2.913	13.1	2.606	13.2	2.693	13	2.568	15.4	1.114	15.3	1.024	13.4	3.197	18.1	-3.233	-	-
1/10/2025	16.8	0.88	15.2	1.013	14.2	1.506	15	0.893	14	1.568	16	0.514	15.9	0.424	15.3	1.297	18.6	-3.733	-	-
1/12/2025	8.7	8.98	7.2	9.013	6.1	9.606	6.8	9.093	6.8	8.768	11.4	5.114	11.2	5.124	7.7	8.897	6	8.867	-	7.98
Dry season average	-	4.39	-	4.49	-	4.35	-	4.32	-	4.66	-	2.09	-	2.10	-	4.40	-	1.32	-	-
Wet season average	-	6.29	-	6.25	-	5.76	-	5.95	-	6.28	-	3.79	-	3.86	-	6.26	-	3.19	-	-

*outlier – result excluded from average calculation.

**multiple outliers – data from sampling round excluded from average calculation.

The groundwater contours presented in the figures below were derived using dry and wet season averages. The average hydraulic head for each bore is shown in parentheses below the bore label. Groundwater contours were derived by interpolating point data using the Inverse Distance Weighted (IDW) method in QGIS, followed by contour extraction from the interpolated raster.



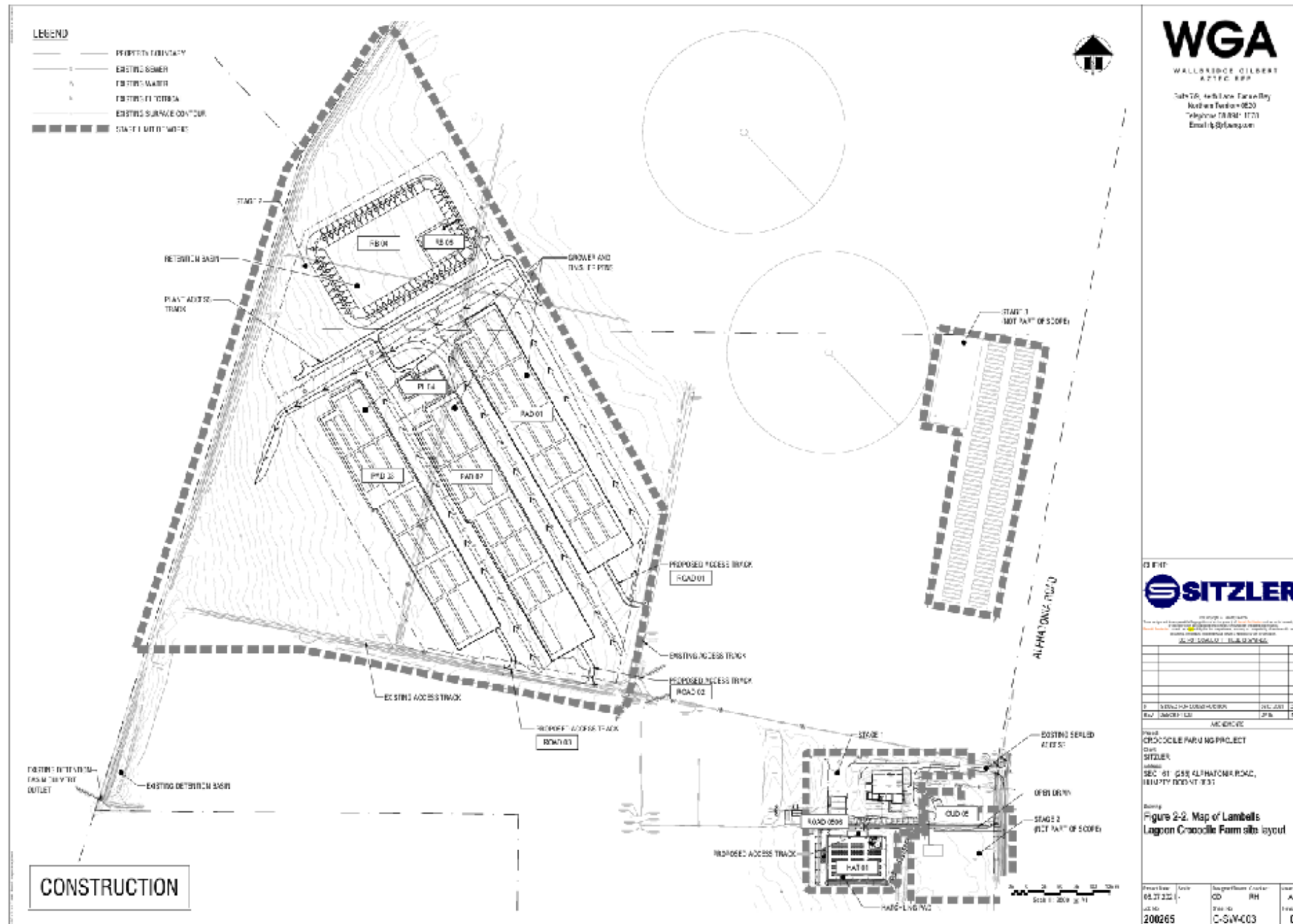


Path: C:\Users\Paula\Documents\Maps\Marpu - EPL Amendment 2026\1. Project Files\Marpu EPL.aprx
Layout: Appendix H - Wet season groundwater contours

Appendix H - Wet season groundwater contours

APPENDIX I STAGE ONE AND TWO DESIGN DRAWINGS

Farm Layout



Stage One Layout

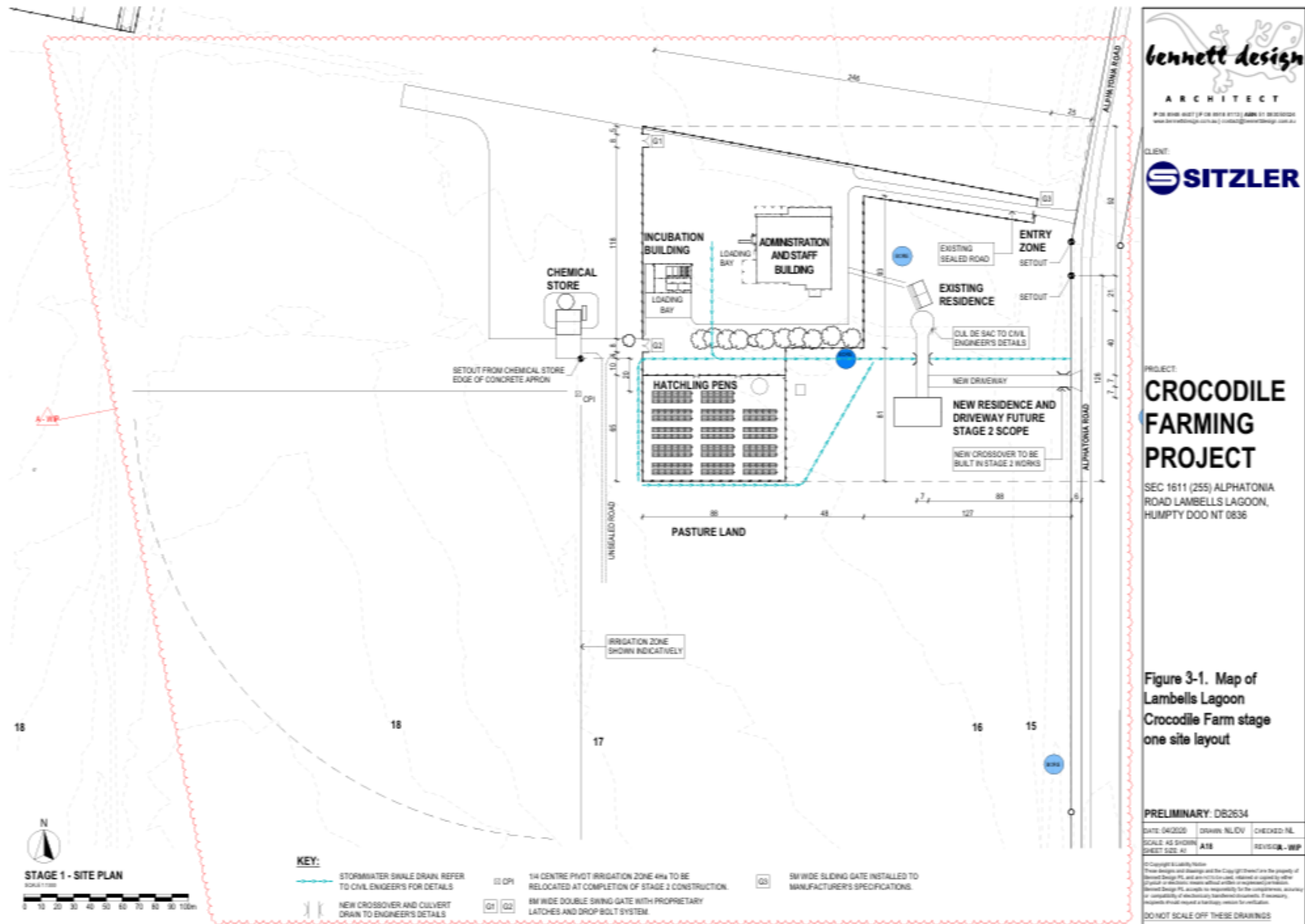
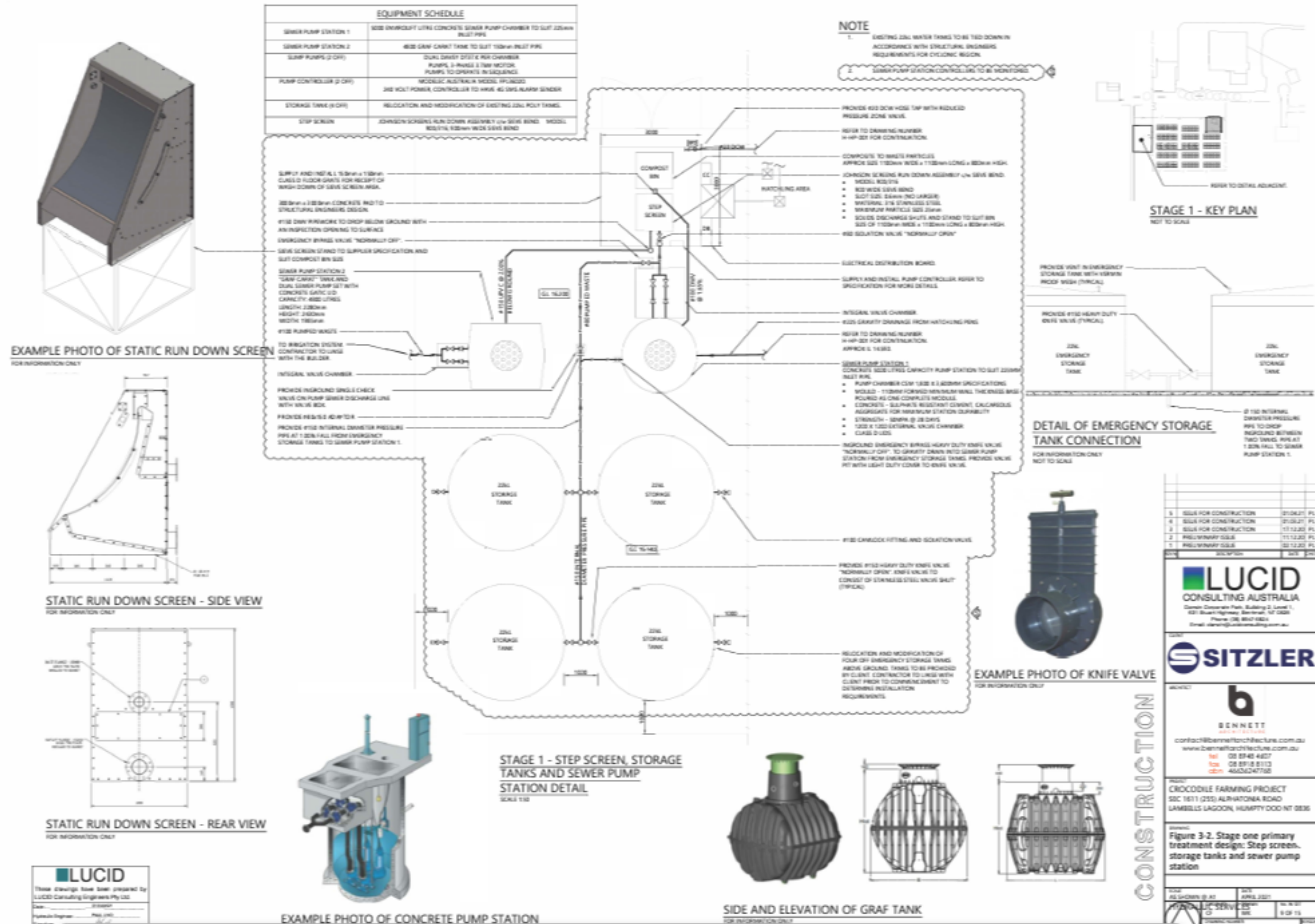
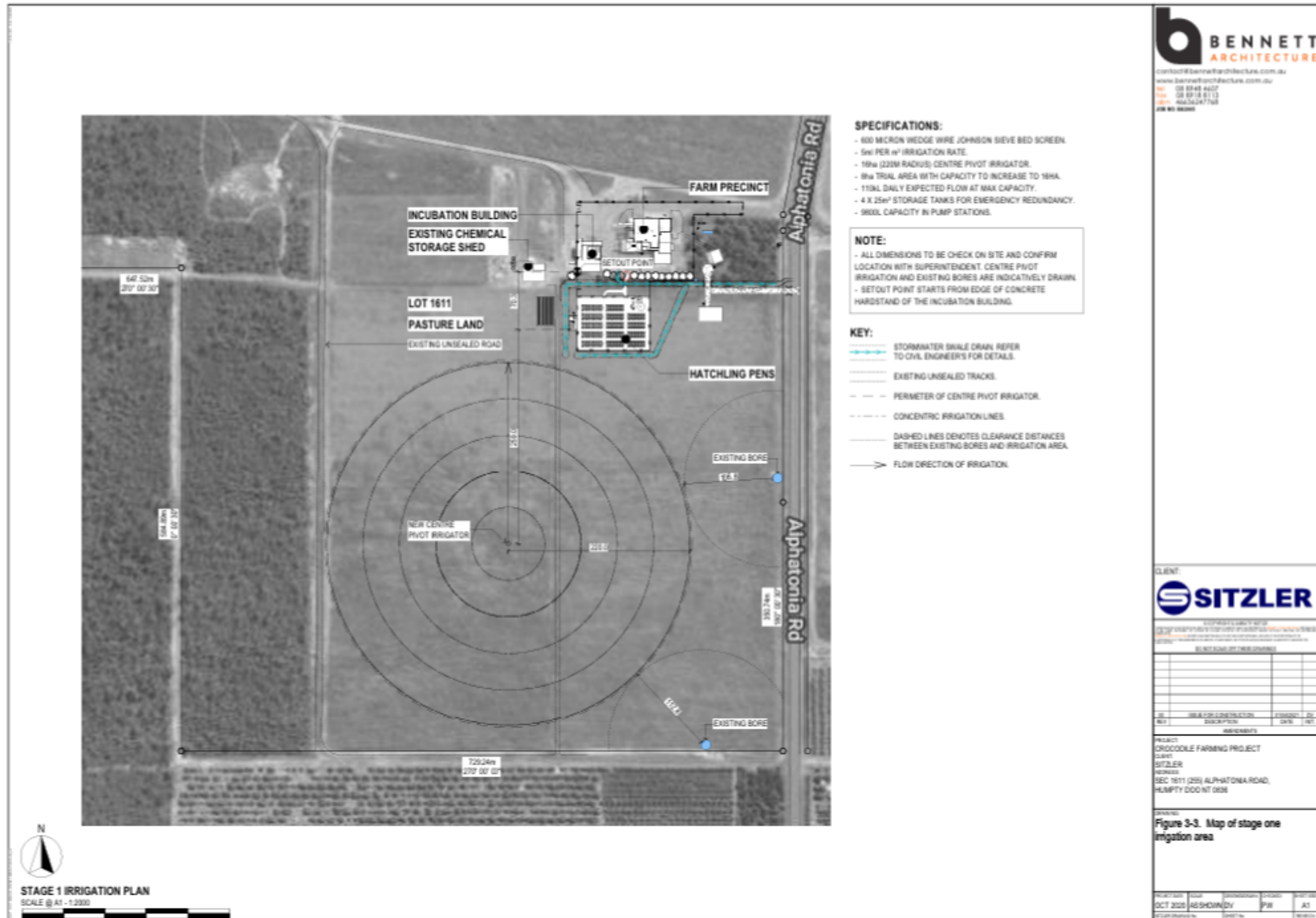


Figure 3-1. Map of Lambells Lagoon Crocodile Farm stage one site layout

Stage One Screening Treatment Design



Stage One Irrigation Area



1	WEAIVED ISSUE FOR CONSTRUCTION	15.05.21
4	WEAIVED ISSUE FOR CONSTRUCTION	23.06.21
5	WEAIVED ISSUE FOR CONSTRUCTION	26.07.21
6	ISSUE FOR CONSTRUCTION	25.03.21
7	NOI PROHIBITORY ISSUE	15.12.20
2	PROPOSED ISSUE	15.12.20
3	PROHIBITORY ISSUE	27.12.20

Date: 20/07/2021
 Page: 2/2


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Project
CROCODILE FARMING PROJECT
 SIC 1611 (235) ALPHATONIA ROAD
 LAMBILLS LAGOON, HUMPTY DOO NT 0821

L27/0046

Appendix
 Figure 3.4. Map of stage two site layout

APPENDIX J DATASET USED FOR SSTVS CALCULATION

Location	Sampling date	Total nitrogen (mg/L)	Total Phosphorus (mg/L)	E. coli (cfu/100 mL)	Enterococci (org/100 mL)
GW3	27 Feb 2020	1.9	-	1	1
GW3	03 Nov 2020	1.7	-	-	-
GW3	14 Jun 2022	1.7	0.02	<1	<1
GW3	26 Sep 2022	1.9	0.02	1	<1
GW3	22 Dec 2022	1.9	0.04	1	1
GW3	15 Mar 2023	1.9	0.01	<1	1
GW3	13 Jun 2023	2.6	0.03	1	<1
GW3	12 Sep 2023	3.2	0.03	28	<1
GW3	18 Jan 2024	1.8	0.03	6	26
GW3	02 May 2024	2.1	<0.01	2	<1
GW3	15 May 2024	1.8	0.03	1	<1
GW3	12 Jun 2024	1.9	<0.01	1	<1
GW3	11 Jul 2024	1.8	0.01	1	<1
GW3	15 Aug 2024	1.8	0.01	1	<1
GW3	11 Sep 2024	1.6	0.07	<1	<1
GW3	17 Oct 2024	1.2	0.05	3	<1
GW3	16 Dec 2024	1.3	<0.01	10	1
GW3	29 Jan 2025	1.4	<0.01	10	3
GW3	19 Feb 2025	1.3	0.48	<1	<1
GW3	27 Mar 2025	1.6	0.05	<1	<1
GW3	23 Apr 2025	1.4	0.02	<1	<1
GW3	22 May 2025	1.7	0.02	<1	<1
GW3	20 Nov 2025	2.7	0.03	<1	1
GW4	27 Feb 2020	2.4	-	1	5
GW4	03 Nov 2020	2.5	-	-	-
GW4	12 Aug 2021	2.2	0.02	<1	<1
GW4	16 Sep 2021	1.4	0.02	<1	<1
GW4	30 Nov 2021	2.1	0.01	18	1
GW4	22 Feb 2022	2.8	0.05	5	<1
GW4	14 Jun 2022	3.1	0.06	2	58
GW4	26 Sep 2022	1.5	0.15	<1	3
GW4	22 Dec 2022	1.7	0.09	<1	<1
GW4	15 Mar 2023	2.6	0.02	<1	<1
GW4	20 Nov 2025	1.5	0.1	<1	<1



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QMS Certification Services



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