



Construction Environmental Management Plan Lambells Lagoon Crocodile Farm



DOCUMENT CONTROL RECORD

Job	EZ19153
Document ID	190179
Author(s)	S. Barber

DOCUMENT HISTORY

Rev	Reviewed by	Approved by	Issued to	Date
1	Kylie Welch	Kylie Welch	NT EPA	21/08/2020

Recipients are responsible for eliminating all superseded documents in their possession.

EcOz Pty Ltd.
 ABN: 81 143 989 039
 Level 1, 70 Cavenagh Street
 DARWIN NT 0800
 GPO Box 381, Darwin NT 0800

Telephone: +61 8 8981 1100
 Email: ecoz@ecoz.com.au
 Internet: www.ecoz.com.au



QMS Certification Services



QMS Certification Services



QMS Certification Services

RELIANCE, USES and LIMITATIONS

This report is copyright and is to be used only for its intended purpose by the intended recipient, and is not to be copied or used in any other way. The report may be relied upon for its intended purpose within the limits of the following disclaimer.

This study, report and analyses have been based on the information available to EcOz Environmental Consultants at the time of preparation. EcOz Environmental Consultants accepts responsibility for the report and its conclusions to the extent that the information was sufficient and accurate at the time of preparation. EcOz Environmental Consultants does not take responsibility for errors and omissions due to incorrect information or information not available to EcOz Environmental Consultants at the time of preparation of the study, report or analyses.

TABLE OF CONTENTS

1	INTRODUCTION	1
1.1	Purpose and scope	1
1.2	Approvals	1
2	EXISTING ENVIRONMENT	4
2.1	Soil and land	4
2.2	Vegetation	8
2.3	Climate	8
2.4	Groundwater	10
2.4.1	Groundwater Quality	14
2.5	Surface water	15
2.5.1	Surface Water Quality	15
2.6	Surrounding land use	18
2.7	Significant sites or features	18
2.7.1	Adelaide River floodplain	18
2.7.2	Black Jungle and Lambell's Lagoon	18
2.7.3	Fogg Dam	18
3	ACTIVITY DESCRIPTION	19
3.1	Site Layout and Design	19
3.1.1	Access	21
3.1.2	Crocodile pens	21
3.1.3	Ancillary facilities	21
3.1.4	Stormwater management	21
3.1.5	Water treatment systems	22
3.1.6	Treated water storage	26
3.1.7	Irrigation areas	27
3.1.8	Composting facility	27
3.1.9	Fuel and chemical storage	28
3.1.10	Water supply	28
3.1.11	Power supply	28
3.1.12	Sewage	29
3.2	Construction	29
3.2.1	Schedule	29
3.2.2	Ground Preparation	29
3.2.3	Erosion and Sediment Control	29
3.2.4	Building	30
3.2.5	Water storages	30
3.2.6	Treatment systems	30
3.2.7	Pollutants and waste	30
3.3	Operations process	31
3.3.1	Schedule	31
3.3.2	Process overview	31

3.3.3	Water demand and supply	32
3.3.1	Wastewater irrigation	32
3.3.1	Finished product.....	32
3.3.2	Pollutants and wastes	33
4	DISCHARGE SPECIFICATIONS.....	35
4.1	Discharges to Air	35
4.2	Discharges to land.....	35
4.2.1	Effluent quality and volume	35
4.2.2	Irrigation areas	36
4.2.3	Irrigation system	37
4.2.4	Irrigation quality.....	38
4.2.5	Monitoring points.....	39
4.3	Discharges to water.....	39
4.3.1	Stormwater	39
4.3.2	Treated wastewater overflows	39
4.3.3	Hydrology and receiving waters	39
4.3.4	Monitoring points.....	39
4.4	Adaptive management	40
5	CONCEPTUAL SITE MODEL.....	41
6	ENVIRONMENTAL RISK ASSESSMENT.....	42
6.1	Project construction risks	42
7	ENVIRONMENTAL MONITORING PLAN.....	49
7.1	Construction monitoring	49
7.2	Baseline monitoring.....	51
7.2.1	Soil monitoring	51
7.2.4	Surface water	53
7.2.5	Groundwater	55
7.3	Quality assurance / quality control	56
7.4	Project operational monitoring.....	56
8	COMPLIANCE PLAN.....	58
9	CONSULTATION AND COMMUNICATION.....	59
9.1	Stakeholder engagement	59
9.2	Complaint management	59
10	EMERGENCY RESPONSE PLAN.....	60
10.2	Incident reporting	62
10.3	Training and awareness	63
11	REFERENCES.....	64

Tables

Table 2-1. Land capability assessment classes	4
Table 2-2. Project area soil and land capability assessment.....	4
Table 2-3. Average rainfall and evaporation (SILO)	8
Table 2-4. Darwin Airport wet season wind rose	9
Table 2-5. Darwin Airport dry season wind rose	9
Table 2-6. Groundwater bore details at the Project area	11
Table 3-1. Predicted effluent quality pre and post treatment	26
Table 4-1. Indicative trigger values for irrigation water	38
Table 6-1. Likelihood categories	42
Table 6-2. Consequence categories	42
Table 6-3. Risk matrix	43
Table 6-4. Project construction environmental aspect and impact register	44
Table 7-1. Project construction environmental monitoring summary	49
Table 7-2. On-site dewatering water quality criteria	50
Table 7-3. Monitoring program, frequencies and trigger levels for soil	51
Table 7-4. Monitoring program and trigger values for surface water sites	53
Table 7-5. Monitoring program and trigger values groundwater sites	55
Table 7-6. Monitoring program and trigger values for irrigation water	56
Table 9-1. Stakeholder consultation	59
Table 10-1. Emergency events and responses	60
Table 10-2. Assessing the severity of the spill.....	62
Table 10-3. Volume of spill to determine severity	62
Table 10-4. Emergency contact details	63

Figures

Figure 1-1. Map of Project location	3
Figure 2-1. Map of Project topography, slope and acid sulfate soils	7
Figure 2-2. Map of existing bore locations and monitored bores	13
Figure 2-3. Equipped and non-equipped bores	14
Figure 2-4. Surface water sampling 23 January 2020	15
Figure 2-5. Map of surface water drainage and baseline surface water monitoring locations	17
Figure 3-1. Map of proposed site plan	20
Figure 3-2. PASS process flow diagram	24
Figure 3-3. Diagram of floating treatment wetland	25
Figure 3-4. Process flow diagram	34
Figure 7-1. Map of baseline soil monitoring locations	52
Figure 7-2. Map of proposed surface water monitoring locations	54

Appendices

Appendix A	Baseline Soil Quality Results
Appendix B	Baseline Groundwater Quality Results
Appendix C	Baseline Surface Water Quality Results
Appendix D	Design Details
Appendix E	Construction Schedule
Appendix F	MEDLI Model Summary and Reports

ACRONYMS

AAPA	Aboriginal Areas Protection Authority
ABS	Australian Bureau of Statistics
BOM	Bureau of Meteorology
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
CCF	Cairns Crocodile farm
CEMP	Construction Environment Management Plan
CSM	Conceptual Site Model
DA	Development Application
DCF	Darwin Crocodile Farm
DENR	Department of Environment and Natural Resources (Northern Territory) – formerly DLRM
DIPL	Department of Infrastructure, Planning and Logistics
DLRM	Department of Land Resource Management (Northern Territory) – now DENR
DOEE	Department of the Environment and Energy (Commonwealth)
DO	Dissolved Oxygen
EC	Electrical Conductivity
EPA	Environmental Protection Approval
EPL	Environmental Protection Licence
ERT	Emergency Response Team
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act (1999)</i> (Commonwealth)
ESCP	Erosion and Sediment Control Plan
GDE	Groundwater Dependent Ecosystem
GEL	Groundwater Extraction Licence
GHG	Greenhouse Gas
GSM	Global System for Mobile Communication
HDPE	High-density Polyethylene
IMP	Irrigation Management Plan
JCF	Janamba Crocodile Farm
LCF	Lagoon Crocodile Farm
NOI	Notice of Intent
NT	Northern Territory
NT EPA	Northern Territory Environmental Protection Authority
NT PFES	NT Police, Fires and Emergency Services
PEX	Cross-linked Polyethylene
PRI	Primary Resources Investments
PVC	Polyvinyl Chloride
SDS	Safety Data Sheets
SWL	Standing Water Level
TPWC Act	<i>Territory Parks and Wildlife Conservation Act</i> (Northern Territory)
TRH	<i>Total Recoverable Hydrocarbons</i>
WMPC Act	<i>Waste Management and Pollution Control Act</i> (Northern Territory)
WoNS	Weed of National Significance

1 INTRODUCTION

The Construction Environmental Management Plan (CEMP) is for the construction of the Lambells Lagoon Crocodile Farm, here-in referred to as the “Project”. The Project is to establish a new farm for commercial production of saltwater crocodiles (*Crocodylus porosus*) predominantly for skin and meat 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 1-1).

The EMP structure addresses the information requirements specified in the NTEPA’s *Guide to Environment Protection Approvals and Licences Under the Waste Management and Pollution Control Act* (NTEPA, 2013).

1.1 Purpose and scope

This CEMP has been developed to establish a framework for identification, management, monitoring and reporting of potential environmental impacts associated with the design and construction phase of the Project. The objectives of this plan are:

- To prevent or minimise pollution or environmental harm from the construction activities.
- Ensure that the premise is constructed in a manner that provides for suitable storage, recycling and treatment of the wastewater from animal effluent and residues (a listed waste), so that the future operational activities can be licensed under the NT *Waste Management and Pollution Control (WMPC) Act 1998*.
- To adhere to conditions of applicable licence approvals and permits.

This CEMP deals specifically with the construction of the Project. The operational aspects of the Project will be addressed through an application for an Environmental Protection Licence (EPL), and its associated management and monitoring plans.

1.2 Approvals

Environmental assessment

A NOI was submitted to the NT EPA on the 19th February 2020 for assessment under the NT *Environmental Assessment (EA) Act 1982*. On the 25 June the NT EPA assessment of the NOI determined that the potential environmental impacts and risks associated with the Proposal were assessed as not significant and that the Proposal does not require assessment under the EA Act.

Development permit

A Development Application (DA) has been prepared and submitted to the NT Development Consent Authority, a division of the Department of Infrastructure, Planning and Logistics (DIPL), on the 20 June 2020, seeking approval for the proposed development under the NT *Planning Act 1999*. Construction of the farm cannot commence prior to issue of a DP.

Environmental Protection Approval and Licence

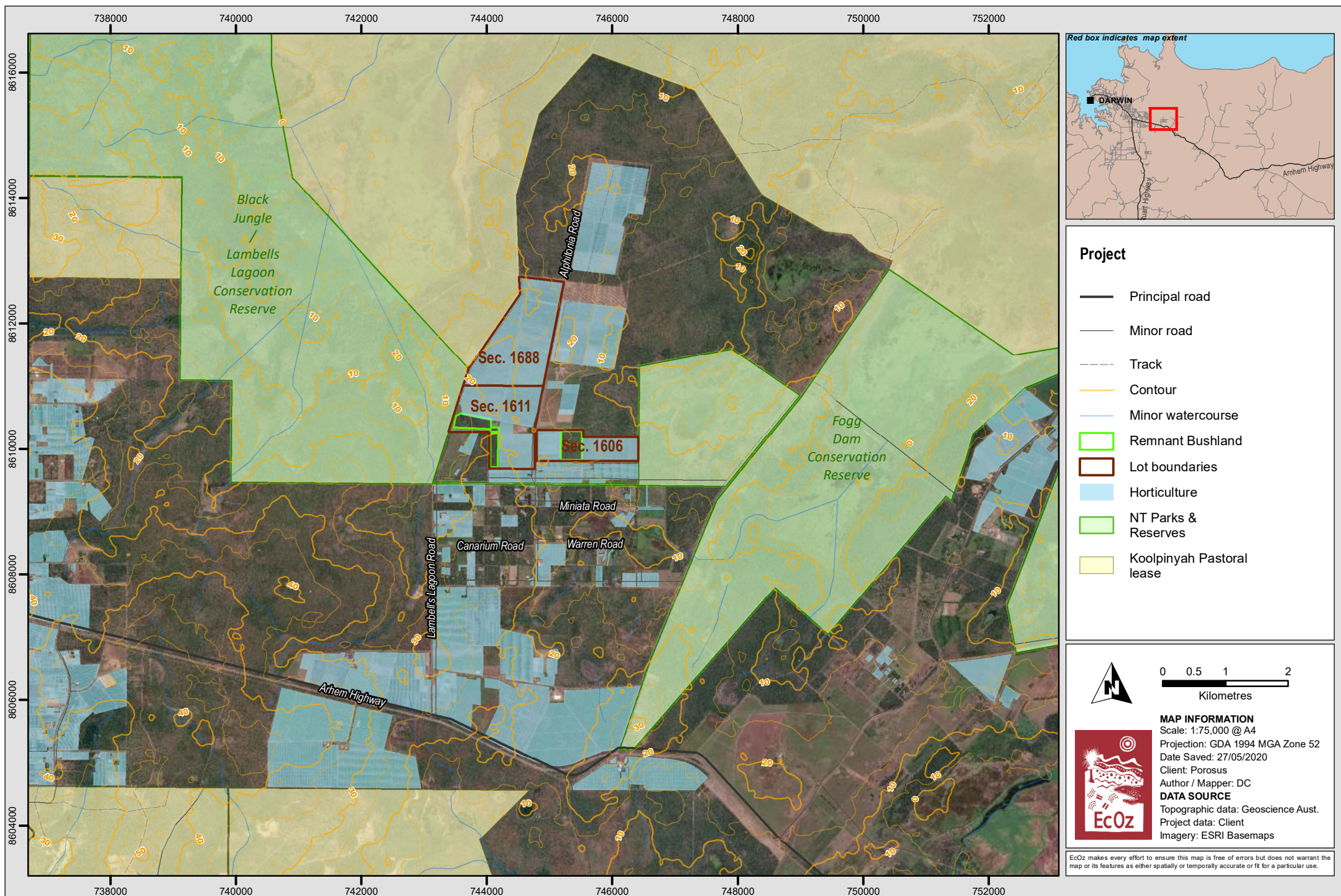
Construction and operation of the Project will be regulated under the *WMPC Act* because the water discharged from the crocodile pens will contain crocodile effluent, faeces, residual feed and other ‘crocodile wastes’, which are classified as ‘animal effluent and residues’ and therefore are a **listed waste** under the Act. An Environment Protection Approval (EPA) is required for works associated with construction of the premises and an Environment Protection Licence (EPL) is required for the Crocodile farming operations. This CEMP is supporting documentation to the EPA application, that will be acquired prior to construction. An EPL will be attained prior to operations.

Land access

The land for the proposed Project (Section 1611 and 1688), is privately owned, freehold land. Purchase of the land for the Project is subject to DA approval. No other land access agreements are required.

Water Extraction

As a requirement under the NT *Water Act 1992*, a Groundwater Extraction Licence (GEL) is required for the extraction and use of water. An existing GEL (Licence no. HGS10000, Expiry 2026) is in place, which allows a maximum extraction entitlement total of 3,216 ML/year. Once DA approval is granted and ownership of the land is transferred, the licence will be transferred.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19153 - MARPU Project Environmental Approvals\01 Project Files\Figure 1-1. Map of project location (zoomed out).mxd

Figure 1-1. Map of project location

2 EXISTING ENVIRONMENT

The Project area is zoned horticulture 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.

2.1 Soil and land

A land capability assessment has been undertaken in accordance with the Department of Environment and Natural Resources, *Northern Territory Planning Scheme, Land Clearing Guidelines* (DENR 2020). The land capability assessment evaluates soil and land aspects (Table 2-2), to determine the land capability classes as per Table 2-1.

Soil and land suitability was assessed through a desktop assessment and existing soils data within NRMaps in Parcel 1688, and has been field-verified through site observations and the collection and analysis of soil samples across the Project area. Soils sampling was undertaken to define local soil properties, and gain baseline data. Thirteen background soil samples were taken across the Project on the 23 January 2020 (Figure 7-1) (See Appendix A for soil quality results).

A moderate land capability – Class 2 was determined by the Projects most limiting factors; slope, flooding and drainage (Table 2-2). Class 2 land is capable of development, however the Project will require some controls such as development and implementation of an Erosion and Sediment Control Plan (ESCP), and an Irrigation Management Plan (IMP).

Table 2-1. Land capability assessment classes

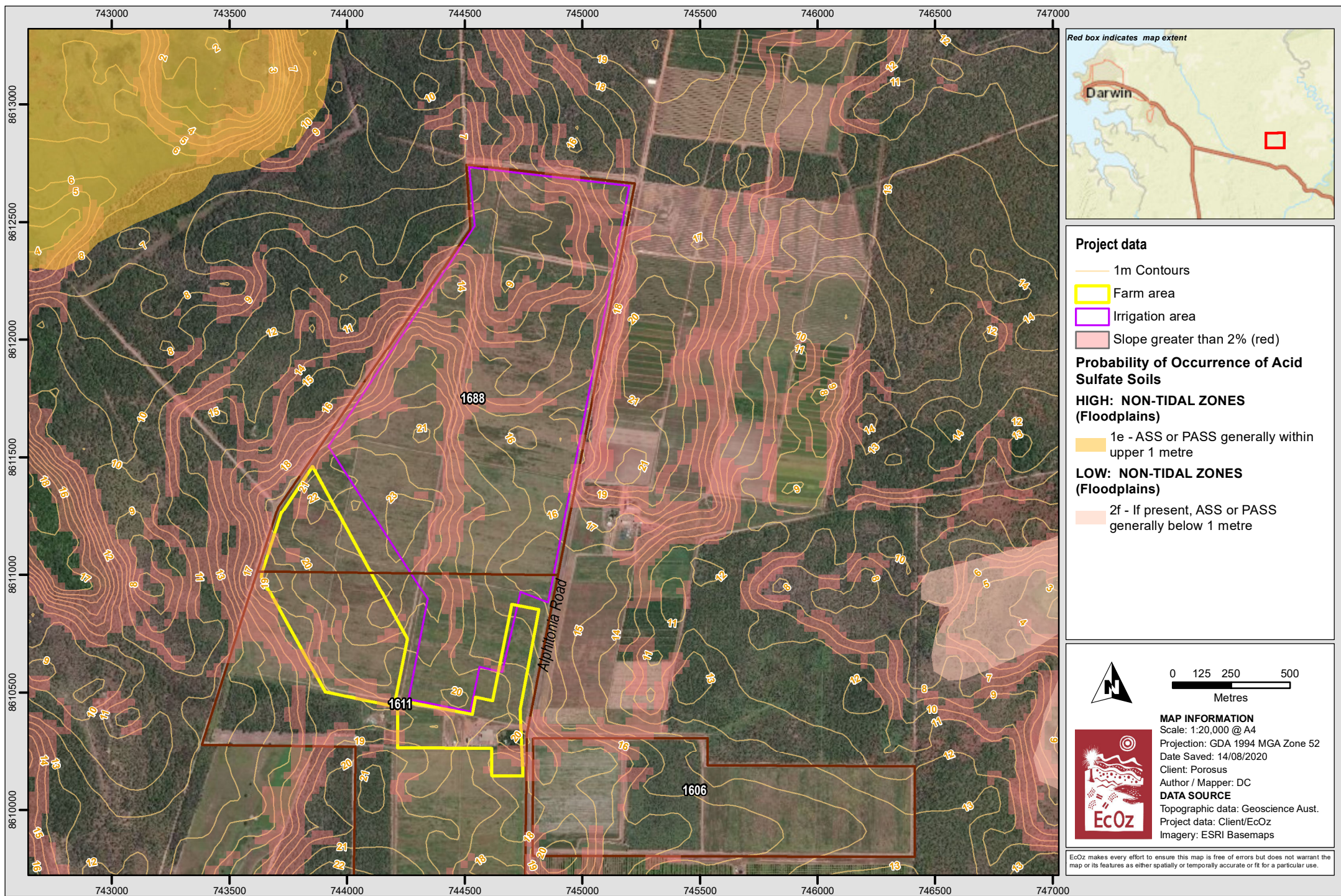
Class	Land capability	Description
1	High	Land with negligible constraints and requires only simple management practices.
2	Moderate	Land with minor to moderate constraints but requires more than the simple management practices of Class 1.
3	Marginal	Land with severe constraints and requires considerable management practices.
4	Not recommended	Land with extreme constraints too severe to develop. Can only be overcome with major management and/or engineered solutions.

Table 2-2. Project area soil and land capability assessment

Soil and land aspects	Analysis and potential implications	Land capability assessment
Topography	The Project area is relatively flat with a gradient of <2 % (Figure 2-1). Indicated areas >2% slope are predominantly existing constructed drains and swales. The small portion of remaining area >2% slope can effectively be managed through tillage across slope in the of cropped irrigation areas to slow water flow or erosion and sediment control structures. Soil investigation for Sweet Life Lambells Lagoon was conducted in 2014, within parcel 1688, indicates a 1 % slope (NRMaps, 2020).	Slope <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 Reserve in the adjacent land are wetland (floodplain) areas, and the receiving waters for surface shed.	Unlikely. Assumed to be extremely rare (<1 in 30 years)
Drainage	The Project area is classed as well drained allowing adequate	Moderately well-

Soil and land aspects	Analysis and potential implications	Land capability assessment
	infiltration and minimal surface water runoff. Soil investigation for Sweet Life Lambells Lagoon, conducted in 2014, within parcel 1688, indicates that the area is moderately well-drained and moderately permeable (NRMaps, 2020). The established network of drains is designed with gentle sloping for the gradual movement of water shed off-site.	drained
Microrelief (Gilgai)	Site visit during January, February and July showed no signs of Gilgai. The area is predominantly tilled with grass vegetation and no signs of mounds or depressions with pooling. The site drains well through existing constructed drains across the Project area.	None
Surface rock	There was no surface rock visible across the Project area. Soil investigation for Sweet Life Lambells Lagoon, conducted in 2014, within parcel 1688, indicates no surface rock in the area (NRMaps, 2020).	0% Surface rock
Soil depth / profiles	Soil Sampling was taken at the surface 100 mm depth and all samples were visually homogenous. There are two soil horizons A and B. Soil investigation for Sweet Life Lambells Lagoon, conducted in 2014, within parcel 1688, detailed the following soil profiles: • Layer 1 – A1p, depth 0-0.6m, loamy sand • Layer 2 – B21p, depth 0.06-0.3m, Sandy clay loam • Layer 3 – B22, depth 0.3-0.55m, sandy clay loam • Layer 4 – B3, depth 0.55-1.4m, light medium clay (NRMaps, 2020).	Soil depth >1m
Soil colour and texture	Soil colour was predominantly classed very dark grey and very dark brown and soil texture is predominantly clay loam (Appendix A).	N/A – additional information. Not assessed as a determining factor.
Acid sulfate soils (ASS)	Acid sulfate soils are not present within the project area as determined by NR Maps. However, the adjacent Black Jungle conservation reserve has a high probability of occurrence of ASS within the upper 1m soil layer. Lambells Lagoon has a low probability of occurrence of ASS.	Not present
Salinity	Electrical Conductivity remained low (<45 $\mu\text{S}/\text{cm}$) The average pH of the soils is 6.66 pH, also indication that the soils are non-saline (Appendix A).	< 2 dS/m (< 2,000 $\mu\text{S}/\text{cm}$).
Soil sodicity	The soils are classified as non-sodic (<6) with and an average exchangeable sodium percentage (ESP) of 0.5 % (Appendix A).	ESP <6%
Erosion potential	Twelve of the thirteen sample results are emerson class number 3, defining the soil structure to be dispersive. This may pose a potential problem with soil loss through dispersion and runoff (Appendix A).	N/A – additional information. However, noted that materials are predominantly dispersive and will need adequate controls in place. Management of the soils will require the development of an ESCP and IMP to ensure soil dispersion is

Soil and land aspects	Analysis and potential implications	Land capability assessment
		managed appropriately. Crop cover and suitable crop selection will also assist with binding and stabilising soil to prevent soil loss.
Wind erosion	The Project is predominantly cleared and open to potential wind erosion. However, wind speed and gusts experienced in the Darwin area are not likely to impact the Project. The Project will be divided into a farming infrastructure area and to the north, cropped irrigation area. Propagated crops and irrigation will minimise potential for wind erosion. The Alphatonia road frontage will also be planted with a tree buffer that will reduce any potential wind erosion impacts.	Low hazard
Total metals	Total metal results were compared to the National Environmental Protection Measure (NEPM) guidelines for soil (2013) and the preferred levels for crop/plant growth (NSW DPI, 2004). All metals were within acceptable guideline limits (Appendix A).	N/A – additional information. Not assessed as an issue.
Total Nutrients	Nutrients results were compared to the National Environmental Protection Measure (NEPM) guidelines for soil (2013) and the preferred levels for crop/plant growth (NSW DPI, 2004). Total Phosphorus (TP) levels were outside of the preferred levels for crop/plant growth (20 – 30 mg/L) with a range of 128 mg/L to 500 mg/L (Appendix A).	N/A – additional information. However, TP levels will need to be monitored and managed. Propagation of crop with an uptake demand for TP will reduce levels over time. Irrigated water quality will focus on nutrient levels.
Suitability for crop growth	Overall, the results and site visual observation determined that the soil and land is suitable for crop growth. The extensive history of the land being utilised for irrigated horticulture also supports this.	N/A – additional information. Not assessed as an issue.
Hydrocarbon contamination	There is no visual evidence of hydrocarbon contamination across the Project.	N/A – additional information. Not assessed as an issue.
Asbestos contamination	There is no evidence of asbestos contamination across the Project.	N/A – additional information. Not assessed as an issue.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\IEZ19153 - MARPU Project Environmental Approvals\01 Project Files\Crocodile farm\Slope map.mxd

Figure 2-1. Map of Project topography, slope and acid sulfate soils

2.2 Vegetation

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.

Where areas have previously been cleared the vegetation is heavily weed infested, with weeds, namely Gamba Grass (*Andropogon gayanus*) and Mission grass (*Cenchrus sp.*) 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). Additional declared weeds at the Project area, as recorded on NR Maps include, Hyptis (*Hyptis suaveolens*) and Snake weed (*Stachytarpheta sp.*).

2.3 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 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 1950 to 2019 to account for recent impacts of climate change that may affect the model outputs.

Average annual rainfall recorded at Middle Point Rangers station is 1481.1 mm with the highest rainfall occurring in January and the lowest in July. The average annual evaporation is 2,190.0 mm, exceeding the average annual rainfall. Evaporation is highest in October and lowest in February.

Table 2-3. Average rainfall and evaporation (SILO)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall (mm)	339.8	300.4	262.7	103.2	20.2	1.1	1.0	2.4	12.2	61.6	134.9	241.6	1481.1
Pan Evaporation (mm)	160.7	141.7	158.5	169.3	178.7	173.3	183.9	204.6	217.4	226.9	195.9	180	2190.9

Wind

Wind direction and wind speed (km / hr) data has been retrieved from the Darwin airport weather station (Site number: 014015). Wind rose data from January 1942 to April 2019 is available (refer to Table 2-4 and Table 2-5).

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.

Table 2-4. Darwin Airport wet season wind rose

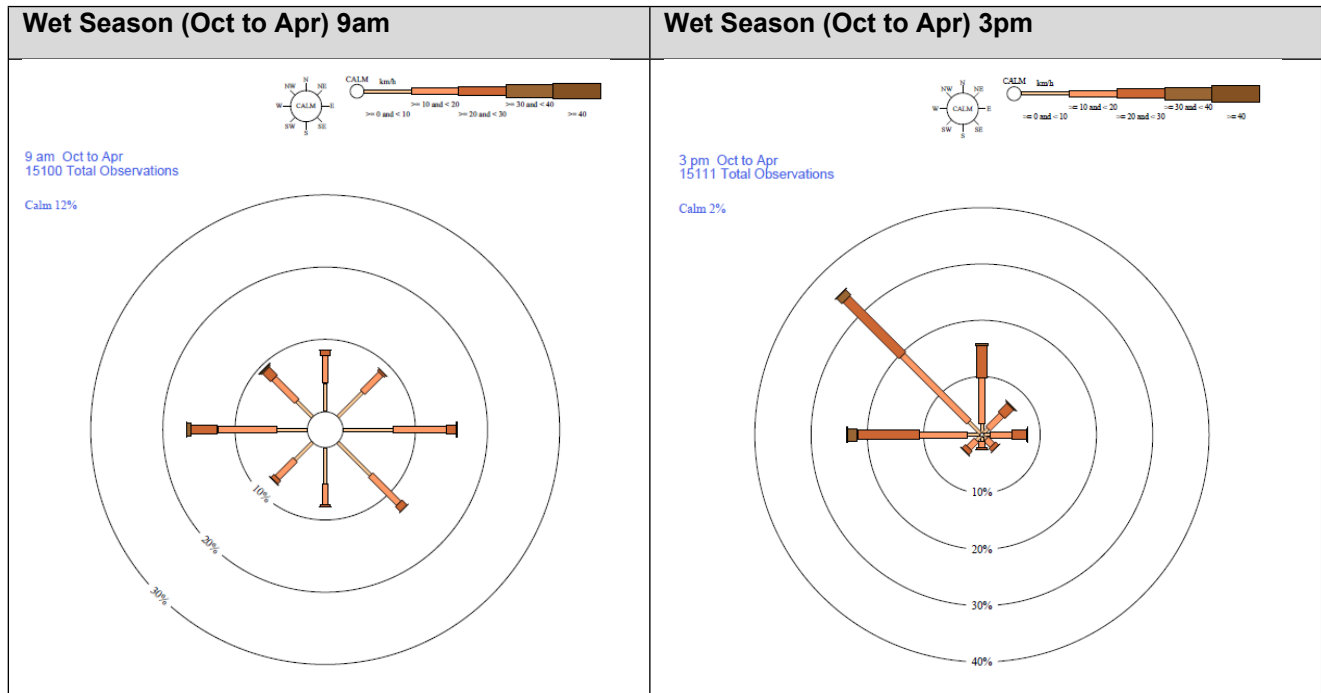
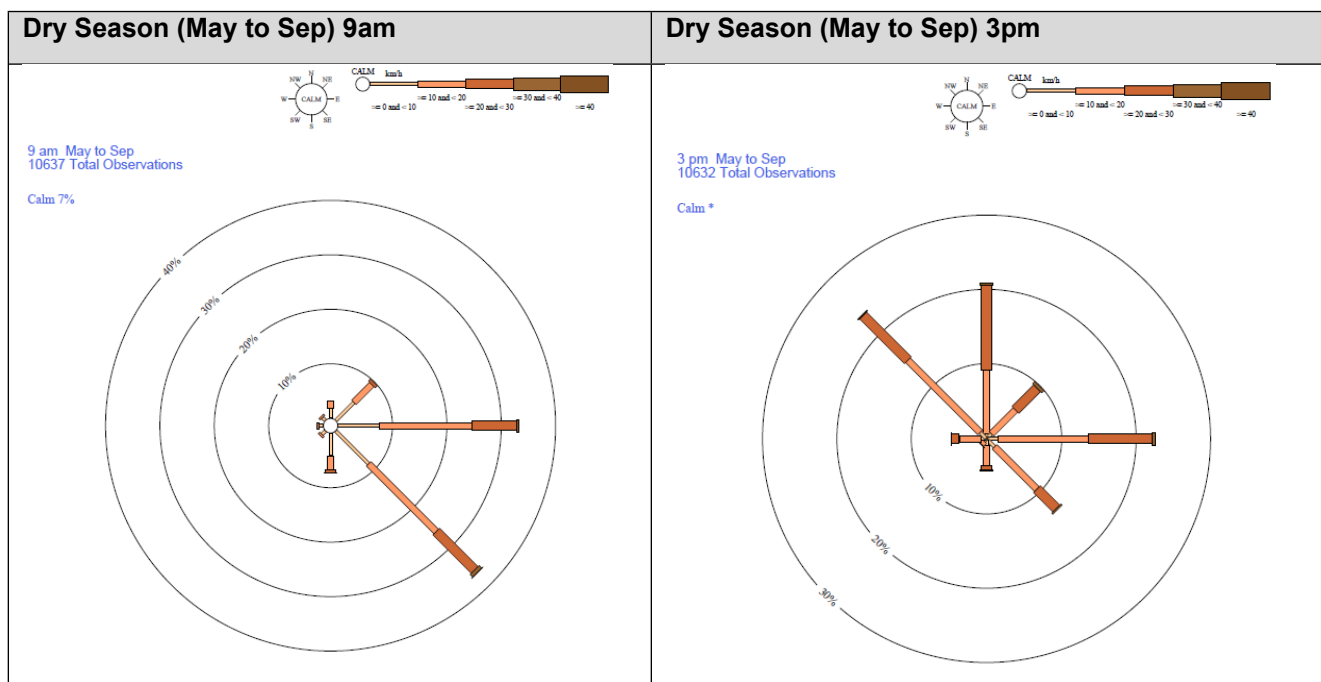


Table 2-5. Darwin Airport dry season wind rose



Source: Bureau of Meteorology, Commonwealth of Australia 2019.

2.4 Groundwater

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 monitoring bores in the Lambells Lagoon area (DENR, 2020) indicate that groundwater is generally 4-5 m below ground level during the wet season. During the dry season, groundwater is typically 13-14 m below ground level, but levels have dropped to as low as 18.8 m in 2016 after two poor wet seasons. GEL (HGS10000) is in force over the Project area. A GEL permits water use from selected bores at specified total quantities as per licence conditions. This allows water use to be monitored to ensure quantities extracted remain within sustainable levels, regulated under the *Water Act*. There are currently fourteen bores across the project area. Additional bores are located off-site to the west of the project area in the Black Jungle Conservation Reserve and within neighbouring properties. The off-site bores will be investigated to monitor off-site groundwater impacts ensuing land and bore access approval. Ten bores are associated with the existing groundwater extraction licence. Bore RN030412 is not listed in Table 2-6 as it is a historical bore; however, it is included under the existing extraction licence. A map showing the location of water supply bores and monitored bores is included in Figure 2-2.

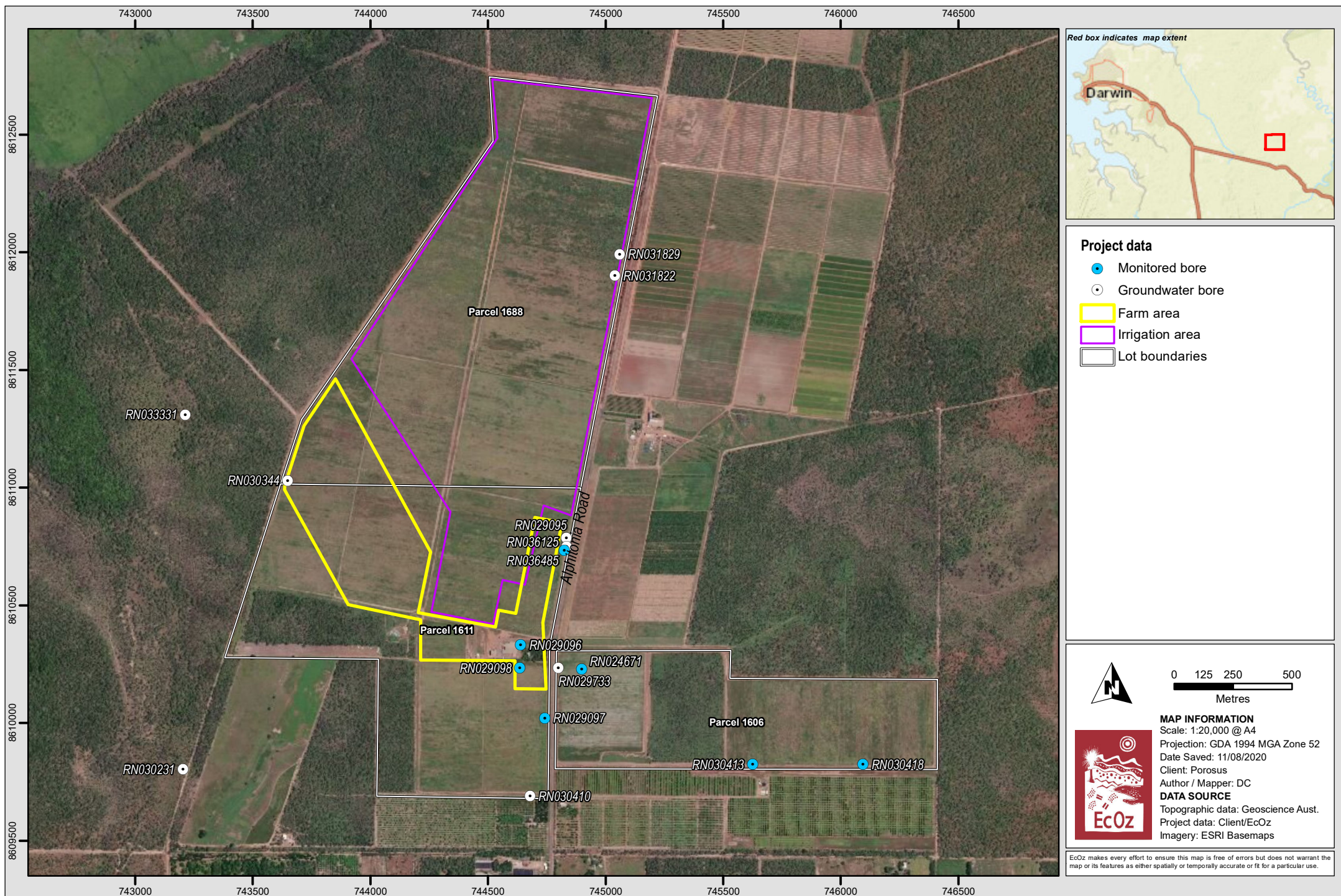
The Howard groundwater system discharges to several surface water ecosystems including Howard Springs, Howard River, Melacca Creek and Black Jungle, supporting important flora and fauna conservation values in those areas. Protection of these environmental values is a key focus of water allocation planning 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 a Moderate potential aquatic GDE.

Table 2-6. Groundwater bore details at the Project area

Purpose	Extraction Licence	Bore ID	*Easting	Northing	Bore Name	Location description	Depth completed (m)	Yield (L/s)
Monitoring - Levels	No	RN024671	744899	8610228	Lambells Lagoon – WR 86/1	East of Alphonatia Rd. Area 3. NW of Parcel 1606	60.4	5
Production	No	RN029095	744834	8610785	Top Bananas Bore No 2/95 Lambells Lagoon	West of Alphonatia Rd. Area 1. Parcel 1611	47	35
Production	Yes	RN029096	744639	8610331	Top Bananas 3-95 Lambells Lagoon	West of Alphonatia Rd. Parcel 161. NE of Shed	47	20
Production	Yes	RN029097	744742	8610020	Top Bananas 4-95 Lambells Lagoon	West of Alphonatia Rd. Area 2. Parcel 1611	103.3	25
Production	Yes	RN029098	744650	8610254	Top Bananas 5-94 Lambells Lagoon	West of Alphonatia Rd. Area 2 Sth of House. Parcel 1611	44.5	10
Production	Yes	RN029733	744800	8610228	Top Bananas 1-94 Lambells Lagoon	East of Alphonatia Rd. Area 3. Parcel 1606	87.5	40
Production	Yes	RN030410	744679	8609688	Top Bananas 7-95 Lambells Lagoon	West of Alphonatia Rd. Area 2 on southern boundary. Parcel 1611	75.6	30
Production	No	RN030413	745625	8609823	Top Bananas 3-96 Lambells Lagoon	East of Alphonatia Rd. Area 4. Parcel 1606	84	45
Production	Yes	RN030418	746095	8609823	Top Bananas 8-96 Lambells Lagoon	East of Alphonatia Rd. Area 4. Parcel 1606	90.8	40
Production	Yes	RN031822	745040	8611900	Top Bananas Bore No 4/98	West of Alphonatia Rd. Area 1. Parcel 1688	87.6	13 - 30
Production	Yes	RN031829	745060	8611990	Top Bananas Bore No	West of Alphonatia	84.9	30 - 40

Purpose	Extraction Licence	Bore ID	*Easting	Northing	Bore Name	Location description	Depth completed (m)	Yield (L/s)
					11/98	Rd. Area 1. Parcel 1688		
Production	No	RN036125	744835	8610749	Marvoe Management Pty Limited (G.D. Amaro)	West of Alphatonia Rd. Area 1. Parcel 1611	36	20
Production	Yes	RN036485	744824	8610734	Marvoe Management Pty Limited (G.D. Amaro)	West of Alphatonia Rd. Area 1. Parcel 1611	62.2	20
Monitoring – Quality	No	RN030231	743203	8609803	Lambells 95/1	Off lease, west of 1610	36.3	8.0
Monitoring - Levels	No	RN033331	743213	8611310	-	Off lease, west of 1688	31.9	20
Monitoring - Levels	No	RN030344	743649	8611029	Lambells 95/1	SW corner of 1688	36.5	15-20



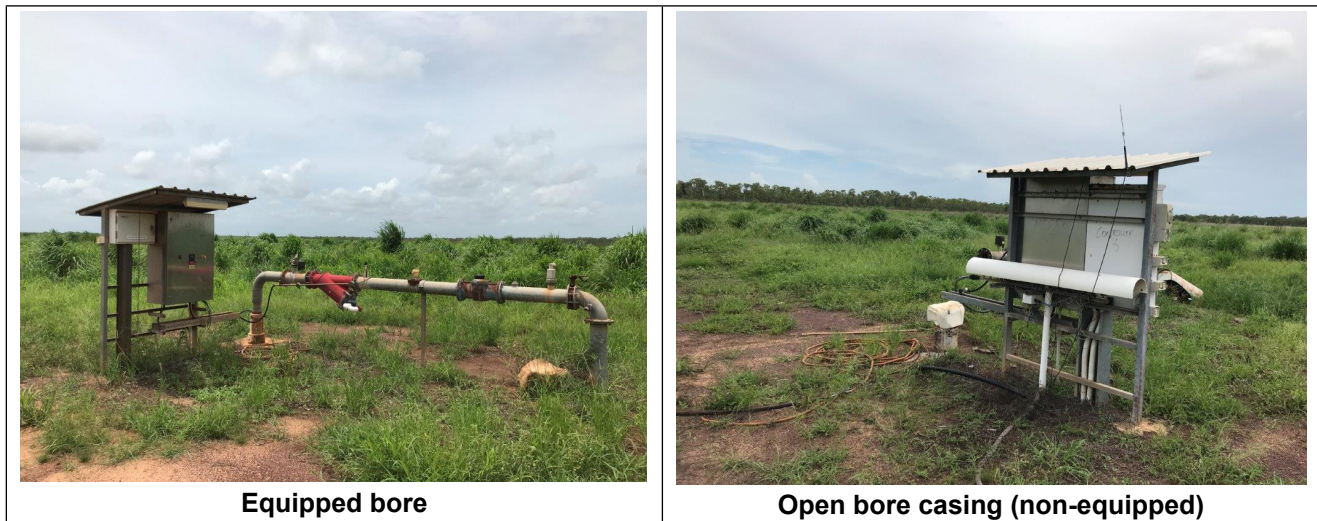
Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19153 - MARPU Project Environmental Approvals\01 Project Files\Crocodile farm\Map 3.mxd

Figure 2-2. Map of existing bore locations and monitored bores

2.4.1 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 has only been obtained from seven bores across the Project area, including RN030418, RN024671, RN036485, RN029096, RN029097, RN030413 and RN029098 (Figure 2-2), during three sampling occasions on the 23 January, 27 February and 9 July 2020. No other bores have been sampled as the bores are equipped, however no power connected to pump water.

Figure 2-3. Equipped and non-equipped bores



The results were compared against the ANZECC (2000) Primary Industries Long-term Trigger Values (LTV) for Irrigation, as well as the Australian Drinking Water Guideline (ADWG, 2011) as a conservative assessment. Overall the average water quality was neutral pH, on one occasion reading below the ANZECC (2000) guidelines for Primary Industries LTV for Irrigation of 6.00 pH. The water is classed as freshwater with an average EC of 269.1 $\mu\text{S}/\text{cm}$ and average salinity of 0.12 ppt. All results for dissolved metals and nutrients were within the guideline limits with the exception of one parameter, Total Phosphorus (TP) in three bores (RN036485, RN029096 & RN029097) exceeding the ANZECC (2000) Primary Industries LTV for Irrigation. However, TP remains well below the NSW Department of Environment and Conservation (DEC, 2004) *Use of Effluent by Irrigation* guidelines for low strength (<10 mg/L). (See Appendix B groundwater quality results).

2.5 Surface water

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 Water Control District declared under the *Water Act*. The NT Government Gazette No. G25, 11 June 2019 (DENR 2019), states the declared beneficial uses to include:

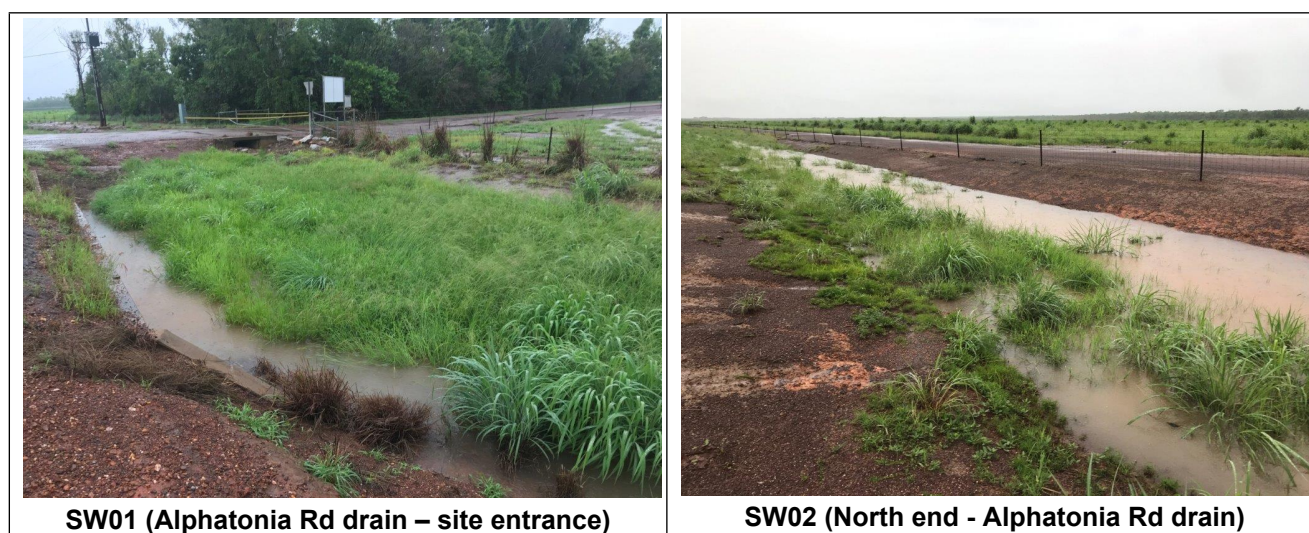
- Agriculture
- Aquaculture
- Public water supply
- Environment
- Cultural
- Industry
- Rural stock and domestic
- Mining activity
- Petroleum activity.

There are no water bodies or defined drainage lines in the Project area. There are existing constructed unlined drainages that collect and direct overland flows towards the property boundaries (Figure 2-5). Overland flows in the eastern parts of sections 1688 and 1611, drain towards Black Jungle Swamp. West of Alphatonia road, Section 1606 drains towards Lambells Lagoon. Baseline sampling of the receiving lagoons will be undertaken prior to operations to gain a representative water quality dataset to develop site specific trigger values. (SSTVs).

2.5.1 Surface Water Quality

Baseline surface water samples were collected on the 22 January 2020. Four sampling locations were selected based on observed flow during the site visit at boundary drainage lines. SW01 flows to the east into Lambells Lagoon. SW02, SW03 and SW04 flows west into Black Jungle Conservation Reserve (Figure 2-5). Middle Point (station 014041) recorded 50.2 mm on the day prior to the sampling event and 60.6 mm on the day of the sampling event. The area project area was notably rapidly draining with no evidence of water pooling the following day on the 23 January 2020.

Figure 2-4. Surface water sampling 23 January 2020





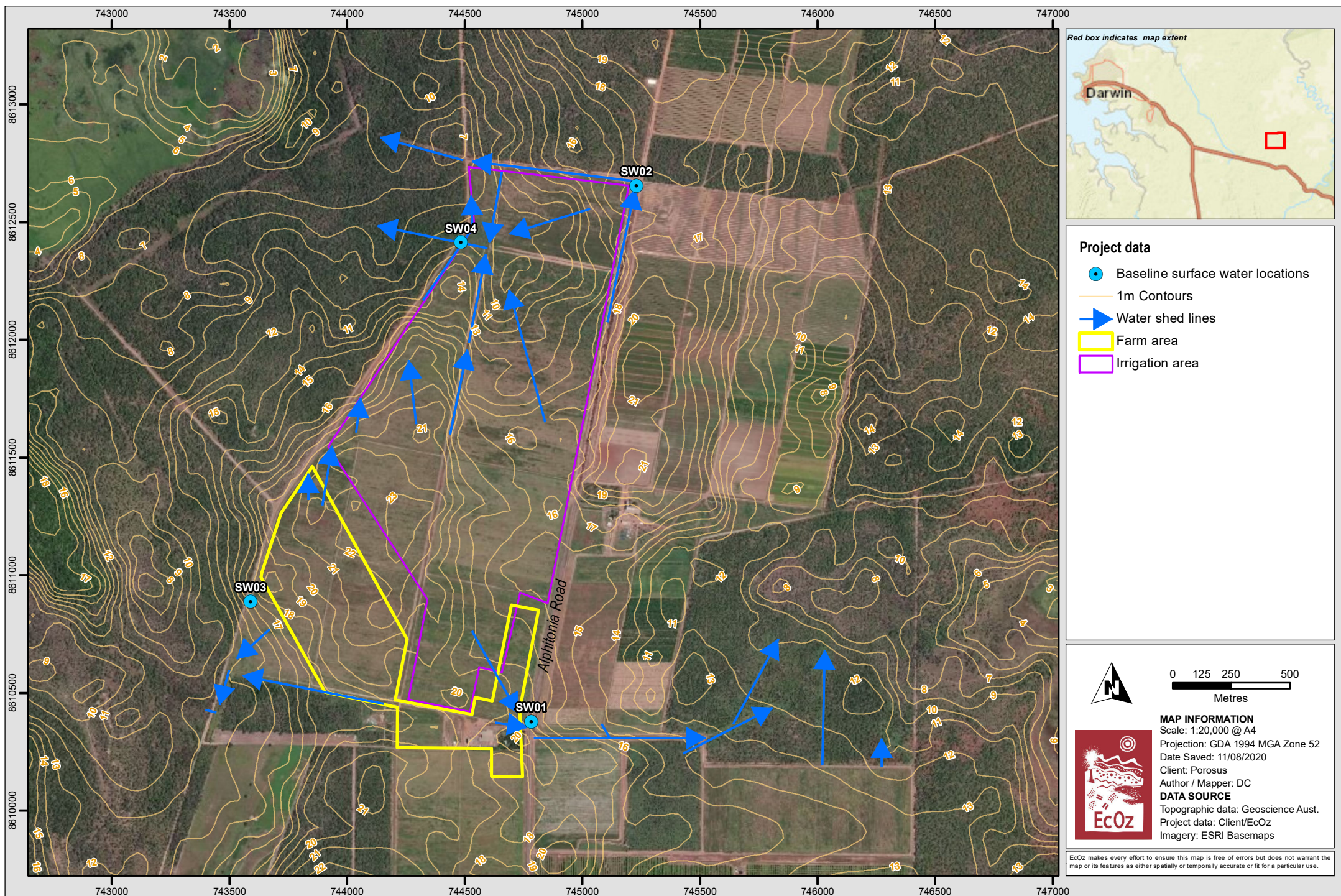
SW03 (SW Boundary)



SW04 Discharge culvert (NW Boundary)

The results have been compared with the ANZECC (2000) Aquatic ecosystem - freshwater protection value of 95% and the ANZECC (2000) Aquatic ecosystem- tropical freshwater lakes and reservoirs given the drainage flows into Black Jungle and Lambells Lagoon Conservation Reserve.

The pH is slightly acidic, ranging from 5.52 to 5.38 which is typical of rainwater in the NT due to the dissolution of carbon dioxide in the air into the water, creating carbonic acid; typical in tropical climates. The water is classed as freshwater with an average EC of 18.95 $\mu\text{S}/\text{cm}$ and average salinity of 0.01 ppt. All metals are below laboratory detection limits and also well below the ANZECC 2000 trigger values for 95% species protection. TP and reactive Phosphorus levels exceed the ANZECC (2000) Aquatic ecosystem-tropical freshwater lakes and reservoirs guideline of 0.01 mg/L (except for SW02), with a range of 0.06 to 0.12 mg/L. This may indicate previous use of high Phosphorus fertilisers. (See Appendix C for surface water quality results).



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\IEZ19153 - MARPU Project Environmental Approvals\01 Project Files\Crocodile farm\Map 1.mxd

Figure 2-5 Map of surface water drainage and baseline surface water monitoring locations

2.6 Surrounding land use

The existing land (section 1611 and 1688), has been largely previously cleared and used for production from irrigated agriculture and plantations. The surrounding horticultural zoned land is comprised of fruit farming businesses (Darwin Fruit Farms) to the east, and a nursery (Darwin Plant Wholesalers) located to the south. A volunteer fire brigade station is also located to the south of the project area. In addition to the horticultural infrastructure, there are multiple buildings on neighbouring properties to the south and east of the irrigation and farming operations areas, where neighbours may reside. Alphatonia Road is immediately to the east of section 1611 and 1688, and to the west of 1606. Other surrounding land users accessing Alphatonia Road via the Project include, The Darwin Fruit Farm (approximately 1 km from construction activities) and Koolpinyah Station.

Land directly to the west of section 1611 and east / northeast of section 1606 is zoned Conservation (CN) and is part of the Black Jungle/ Lambells Lagoon Conservation Area. Land to the west of section 1688 is zoned Agriculture (A) and is part of Koolpinyah Station (Figure 1-1).

2.7 Significant sites or features

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.

2.7.1 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 waterbird species, such as Magpie Goose (*Anseranas semipalmata*) and Whistling-Ducks.

The Adelaide River SOCS boundary encompasses the eastern part of the project area, which has been mostly cleared, excepting the approximately 23 ha of remnant Eucalyptus woodland vegetation. Because of the pre-existing clearing and landuse, the project area does not encompass habitats of recognised conservation value or significance within the SOCS.

2.7.2 Black Jungle and Lambell's 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 (DENR 2018b). 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).

Lambell's 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).

2.7.3 Fogg Dam

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

3 ACTIVITY DESCRIPTION

This section provides a detailed description of the construction activities covered by this CEMP and an overview of the activities associated with future farm operations.

3.1 Site Layout and Design

The development footprint for the farm infrastructure is approximately 50 ha, with an additional 160 ha to be used for irrigation of wastewater to grow crops. The site layout is shown in Figure 3-1. The key components are:

- Main and internal access roads
- Fencing – security and internal separation fencing
- Ancillary facilities
 - Managers residence (232 m²)
 - Supervisors residence (refurbishment of existing house)
 - Office and amenities
 - Feed processing and storage (fridge / freezer)
 - Incubation building
- Crocodile enclosures
 - Hatchery pens
 - Grower pens
 - Finishing pens
- Water management infrastructure and treatment plant (screening, water recycling, tanks, floating wetland, storage dam, irrigation system)
- Future construction
 - Compost shed (total 1,250 m²)
 - Solar farm
 - Demonstration farm.

The location and positioning of the proposed farm infrastructure has been designed with consideration of local topography for stormwater management and proximity to neighbouring properties to manage potential noise, air (dust and odour) emissions. Positioning and design of the pens is also critical for the animal's health, preventing stress and disease. The design of the pens (sloping pools, drains and ball valves) allows for ease of regular cleaning, flushing and changing water of the pens, a key management tool for prevention of odour issues and maintaining animal health, hygiene and safety of employees. Materials to be used for construction have been considered for thermal control. The wastewater treatment and composting systems are located to the far west of the property, for greater separation distances to neighbouring properties, minimising potential noise and dust issues during construction and odour issues during operations.

Design details for each component are provided in the sections below and building plans are provided at Appendix D.



- LEGEND**
- MANAGERS RESIDENCE**
NEW 4 BEDROOM HOUSE WITH SCREENING VEGETATION AND SEPARATE ACCESS ROAD. HEIGHT LESS THAN 8.5M.
 - 2IC RESIDENCE**
REFURBISH EXISTING HOUSE. REMOVE SOME EXISTING VEGETATION TO EAST AND NORTH.
 - OFFICE & AMENITIES**
 - FRIDGE FREEZER**
 - INCUBATION BUILDING**
 - FUTURE DEMONSTRATION FARM**
 - PENS**
 - FLOATING WETLAND**
 - SCREENING**
 - WATER RECYCLING**
 - FUTURE COMPOST SHED 50x25M**
 - FUTURE SOLAR ARRAY FARM**
SOLAR INSTALLATION MAX HEIGHT 3M.

- KEY:**
- SECURITY FENCE
 - INTERNAL FENCE SEPARATION
 - ENCLOSED FIREBREAK
 - MAIN ACCESS ROAD
 - INTERNAL ACCESS ROAD
 - SITE DRAINAGE
 - BORE LOCATIONS
 - IRRIGATION AREAS
 - PENS
 - PENS TYPE A
 - PENS TYPE B
 - PENS BUILDING TYPE A
 - PENS BUILDING TYPE B
 - FUTURE PROVISION

Figure 3-1. MAP OF PROPOSED SITE PLAN

3.1.1 Access

The site will only be accessible via Alphonson Road. The site entrance will be secured with a lockable gate and security perimeter fence surrounding the main farm operational area. Internal fencing will be constructed surrounding the enclosure compounds and sub-compounds.

3.1.2 Crocodile pens

All crocodile pens will be built with concrete and covered with low permeability shade cloth and solid roof structures, including;

- Main pen compound, separated into three sub-compounds for biosecurity control. Roof constructed with steel support framing system with shade cloth membrane and 1500 mm high walls lined with 18 mm celuka panel (PVC foam board with solid topcoat and acellular core). The main pen compound includes 18 grower pens in groups of 4 (building footprint 20 x 80 m) or rows of 3 (10 x 120 m), and 34 standard pen buildings. Standard pens designed with internal pools with floor sloping inward (16.6% fall) to centre drain / overflow pipe, floors coated with Tufflon P90 (polyurea) protective coating to manufacturers specification. The pools will be surrounded by dry resting banks.
- 150 x 10 m² hatchery pens, located separate to the main pens for stricter biosecurity controls. Centre of enclosure contains a pool surrounded by a dry resting bank. A drain will be located at the centre of the pool with a ball valve to refill and clean pools. External walls are 200 mm reinforced concrete blockwork, solid roofing with hinged door system.
- Demonstration farm will consist of pens from all stages of farming operations (hatchery, grower and finishing) for educational purposes.

Effluent from each pen will gravity feed into an effluent collection sump (minimum 100 m³) via a network of pipes and channels.

3.1.3 Ancillary facilities

Existing infrastructure located on the site, including a manager's residence, machinery and packing shed and other ancillary buildings associated with horticultural use, will be utilised for the Project. New and modified vehicle access tracks, fencing and firebreaks will be constructed or refurbished. The ancillary area will include office and staff amenities, refrigeration, freezer and feed preparation and storage, egg incubation building, plant, machinery and equipment storage. The existing dwelling will be refurbished dwelling for the 2IC (second in-charge) residence with access from the main farm driveway. A new dwelling will be constructed for the manager's residence with a separate driveway from Alphonson Road.

3.1.4 Stormwater management

Stormwater management controls required during construction will be detailed in an Erosion and Sediment Control Plan (ESCP) prepared by a Certified Practitioner in Erosion and Sediment Control (CPESC). The land disturbance that will occur during construction has potential to increase sediment loads in stormwater runoff from the area. The potential for erosion and off-site movement of sediments is limited because the land is relatively flat (<2%), however, erosion and sediment control (ESC) structures will be applied for the construction area, along access tracks and in stormwater drains to minimise sediment losses and downstream turbidity.

Stormwater runoff from the building roofs and other hard-stand areas during operations will be collected and diverted separately from the effluent collection network. A first-flush stormwater management bunding system will be installed down-gradient to the south-west of the farm operations area to capture and manage the potentially contaminated first flush water. First flush water will be tested and if it is not suitable for release (in accordance to the ANZECC, 2000 aquatic ecosystem- tropical freshwater lakes and reservoirs),

the water may be reused following settlement time to remove sediments or be pumped into the treatment lagoon for settlement and treatment. Clean stormwater (water that has not come into contact with effluent wastewater), following the first flush will be released off-site.

A stormwater drainage assessment will be completed by Sitzler to inform design of the stormwater management infrastructure that is required to manage stormwater flows and discharges from the site so that potential for downstream flooding, scouring, erosion and sedimentation is minimised.

Surface water sampling has been undertaken prior to construction activities (Section 2.5.1) and will continue to be undertaken during construction and operations as per Section 7, to monitor the performance of the ESC structures and water quality conditions of the receiving environment.

3.1.5 Water treatment systems

Wastewater streams from the hatchery, grower and finishing ponds will be combined and all streams will be subject to primary and secondary treatment. The objective of the wastewater treatment systems is to achieve water quality that is suitable for reuse in the farm operations (to offset groundwater use) and/or irrigation of crops, pastures or woodlots.

All effluent from the crocodile pens will be directed to an effluent collection sump. A submersible macerator pump located in the effluent collection sump will deliver the effluent to the inlet of the primary screening plant.

Primary treatment – screening

Primary treatment will involve coarse screening to separate the solids from the wastewater with construction of a mechanical screening plant. Solids separated from the screening plant will be deposited into a dewatered solids bunked where a loader will take the solids to the on-site composting facility. Following removal of the coarse solids, fine screening and dewatering of finer solids (rotating screen filter with dewatering screw press) will occur.

Secondary treatment

Secondary treatment will reduce nutrients, biological oxygen demand (BOD) and pathogens to further improve water quality for irrigation and/or reuse in farming operations. The treatment system will involve a Particulate Air Separation System (PASS) and/or a floating treatment wetland (FTW). It is possible that both systems could be used on site, with the PASS system installed to treat water from the hatchery operations and the FTW constructed as the farm expands over the first five years of operations. The treatment system design, construction and commissioning will be finalised in Quarter 4 2020.

Particulate Air Separation System (PASS)

The PASS utilises ozone, flocculants and other chemicals (such as pH control) in combination with particulate removal and foam fractionation to improve the quality of a wastewater stream prior to further filtration, reuse or discharge. The process uses diffused air and ozone, resulting in rising gas bubbles that produce a foam that continuously discharges unwanted waste from the water system. Ozone is often used in wastewater treatment as it is effective in decreasing BOD, removing bacteria and some metals. PASS can also effectively remove some dissolved compounds, such as nitrogen, large light particles and colloidal material, without specific targeting required. See PASS Process flow diagram in Figure 3-2 below.

Other benefits of using PASS are that it:

- Uses no media, screens, barriers or membranes so requires no re-charging, replacement, replenishing or cleaning of media.
- Removes the unwanted material from the stream as a matter of process and on a continuous basis.

- Typically has a smaller footprint than most water treatment process as it functions at much higher velocities.
- Is wide ranging in its ability to remove matter, is compact and continuously removes the unwanted material from the stream.

The PASS system is currently being trialled at Lagoon Crocodile Farm (LCF), capable of treating up to 50 m³ of water per day. There is potential for the PASS to be able to treat the water to a suitable quality for reuse back through the crocodile farming process. If the treated water requires further treatment to meet the requirements for reuse or off-site discharge, LCF are also investigating a polishing system comprised of specific algal filters to be added to the system post PASS treatment.

The PASS system will require construction of the following major components:

- Flocculating column(s) – where a flocc enhancing agent can be dosed to start a flocculation process. The proposed flocculant for the Lagoon Crocodile PASS is Phlocc Medio, with the dose rate to be determined during commissioning but with a target of 1:1 with P levels.
- Ozone contact column(s) – to provide mixing and contact/retention time for Ozone.
- Ultra Violet Steriliser – UV is incorporated at the end of the PASS process as final disease barrier step, but also to help maintain dissolved ozone levels below the maximum limit as specified by the particular application. This level will vary depending on whether the treated water is for re-use or to be discharged.
- Hydrocyclones – used at two points in the system, first to remove major particulates from the waste-water prior to entering the PASS system, then after the contact chambers and before the foam fractionator to remove the floc generated in the mixing column. The waste stream from each hydrocyclone is estimated at 300 L per purge with one purge per day (particulates and flocculant).
- In addition to the above, pH control may be needed, in which case the material Spa Alkalinity Up will be used as required.

Process Flow Diagram

Particulate air separation system (PASS) + algal polishing filters

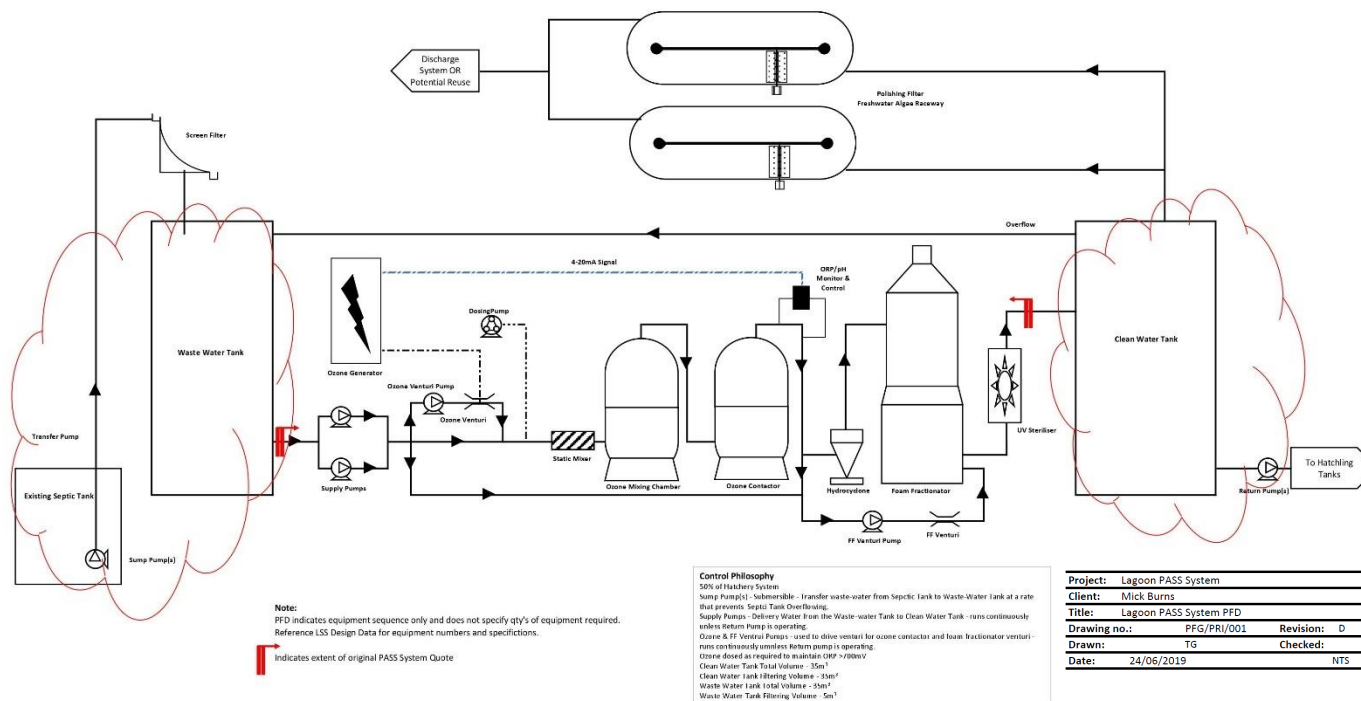
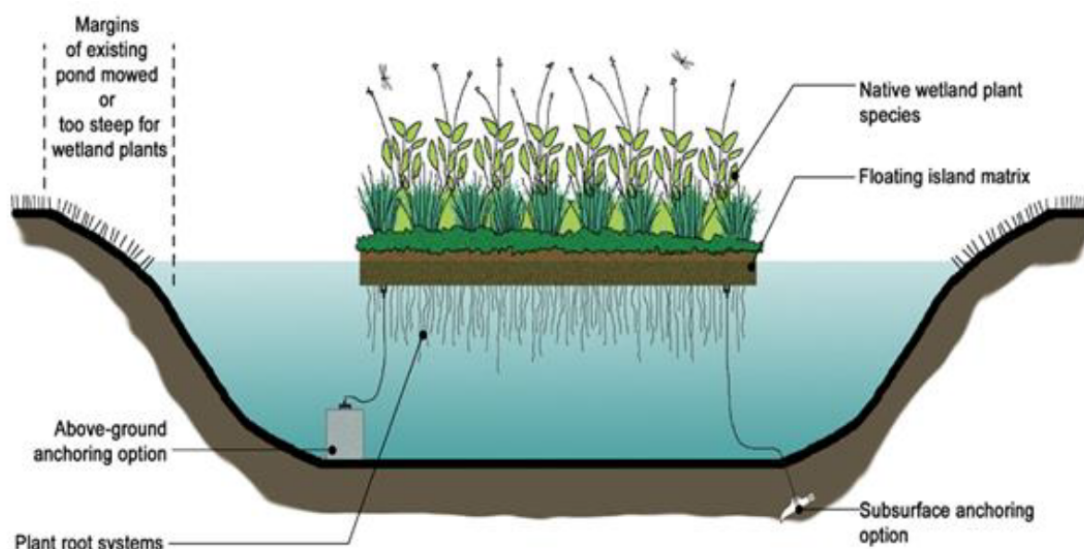


Figure 3-2. PASS process flow diagram

Floating treatment wetlands

The FTW are a constructed wetland with a series of anchored floating platforms populated with plants. The roots of the plants remain submerged in the water and create an anaerobic environment. The floating platforms allow water levels in the wetland to rise and fall without affecting the plants. Wetlands have proven to be proficient in the removal of TSS, dissolved organics and nutrients. According to the *Process Design Brief: Waste Water Treatment and Reuse – Marpu Crocodile Farm Design Concept*, GPA Engineering April 2020, “Microbes are responsible for breaking down nutrients and other water-borne pollutants. Suspended solids slough off into the benthic zone below the island. Organic solids stick to the biofilms and become the base of the freshwater food web... Nutrients circulating in the water will come into contact with biofilms and be consumed, while a smaller fraction is taken up by plant roots. Independent laboratory tests have shown removal rates of 20 times more nitrate, 10 times more phosphate and 11 times more ammonia when compared with unplanted islands. They are also very effective at reducing total suspended solids and dissolved organic carbon” (GPA, 2020).

The FTW will be designed with a series of anchored floating platforms constructed of durable non-toxic recycled plastics which are planted out with native plants. The roots of the plants remain submerged in the water and create an anaerobic environment. The floating platforms allow water levels in the wetland to rise and fall without affecting the plants.



Source: GPA, 2020

Figure 3-3. Diagram of floating treatment wetland

According to the *Process Design Brief: Waste Water Treatment and Reuse – Marpu Crocodile Farm Design Concept*, GPA Engineering April 2020, the design considerations for the FTW include the following:

- The water must be directed through the suspended root mass
- The establishment of an extensive root mass is very important for the performance of the system
- Root length is typically 0.4 to 0.8 m
- A minimum water depth of 1.0 to 1.5 m should be maintained (but no deeper)
- Anchoring should allow the floating mat to rise and fall with changing water levels to avoid the macrophyte vegetation being submerged, or roots attaching to benthic substrate
- Feed is required to be as continuous as possible to maintain water flow around the vegetation
- Plant selection should incorporate locally endemic species.

It is recommended that the wetlands be designed on the following basis:

- Hydraulic flow = 3,383 m³/day
- Water depth = 1 m
- Water residence time = 3 days
- Wetland surface area = 10,150 m²
- Floating platform area = 50% (to be confirmed in detailed design).

The dimensions of the constructed wetlands will be adjusted to suit land contours. Generally, it is better to have a longer flow path relative to width (typical length to width ratio of 3:1) in order to minimise possible short circuiting. Baffles can also be used if necessary (GPA, 2020).

The predicted effluent quality pre and post treatment is provided in Table 3-1. The prediction of combined effluent quality and level of contaminant removal achieved by primary treatment is based on actual monitoring data collected at the Janamba Crocodile Farm (JCF). The effluent quality predicted from the FTW is indicative based on system performance achieved elsewhere and requires further design review.

Table 3-1. Predicted effluent quality pre and post treatment

Constituent	Combined effluent	Ex primary treatment	Ex Floating Wetland	Low strength effluent criteria ¹
EC (μS/cm)	412	412	412	-
BOD (mg/L)	7	6-7	3-5	<40
Total N (mg/L as N)	18	18	9-12	<50
Total P (mg/L as P)	4	3.2-3.6	1.5-2.5	<10
Ammonia (as N) (mg/L as N)	5	5	2-3	-
Faecal coliforms (cfu/100 ml)	13708	13708	<1000	-
E coli (cfu/100 ml)	13704	13704	<1000	-
pH	7.7	7.7	8	-

1 – From Department of Environment and Conservation (NSW) *Environmental Guidelines – Use of Effluent by Irrigation* – Table 3-1

The treatment systems will be designed to achieve concentrations of bacteriological contaminants (*E.coli*, Enterococci, Total coliforms) that comply with the ANZECC trigger value for water use on fodder crops (> 1,000 cfu/100 mL) and nutrient concentrations classified as low strength under the *NSW Irrigation Guidelines*. Water that meets the above criteria can be sustainably irrigated to crops as long as application rates and areas are managed to minimise runoff or seepage, and irrigation areas are rested and rotated to minimised degradation of soils. A further disinfection treatment for final pathogen reduction will be undertaken if required to achieve reuse criteria.

Any discharges to the environment would be monitored to ensure compliance with ANZECC (2000) Aquatic ecosystem- tropical freshwater lakes and reservoirs guidelines given the farm operational area drainage flows into Black Jungle Conservation Reserve and the ancillary infrastructure area flows into Lambells Lagoon Reserve.

3.1.6 Treated water storage

The treated water will overflow into the wastewater buffering ponds (i.e. wet weather storage) from where it will be pumped to crops for irrigation or water tanks for reuse in the farming operations. Water storage facilities will be constructed with low permeability foundations to prevent potential seepage to groundwater.

Water storage volumes have been assessed in the Model for Effluent Disposal using Land Irrigation (MEDLI) modelling conducted to date (See Appendix F). Water storage volumes and irrigation area is dependent on percentage of reuse;

- No reuse, water storage volume requirements is 100 to 120 ML which will require 100 to 130 Ha of irrigation area.

- 25% reuse, require 70 to 90 ML water storage and 100 to 130 Ha of irrigation area.
- 50% reuse, water storage volumes will need to be 50 to 60 ML and 100 to 120 Ha for irrigation area.

There is sufficient space to construct a water storage dams and irrigation capacity (160 ha) for all scenarios. Wet weather storage ponds will be built over the five year staging of farm operations.

Placement of the water storage areas (on the western boundary) minimise potential downstream impacts. There are no dwellings, roads or infrastructure downstream of the proposed water storage area that would be at risk as a result of a dam wall failure.

Construction of the storage ponds are discussed in Section 3.2.5.

3.1.7 Irrigation areas

There will be approximately 160 ha of previously cleared land directly to the north of the farm infrastructure (west of Alphatonia Road) to be utilised for cropping and irrigation of wastewater (Figure 3-1). There is sufficient land to manage all wastewater disposal requirements through irrigation and incorporating paddock rotation as discussed in Appendix F. The wastewater is a valuable resource for crop application with the existing nutrient loads available for plant uptake.

Irrigation system

The types of irrigation infrastructure proposed to be used includes the Pierce C600 centre pivot system and/or lateral irrigator. The deciding factor will be determined by the size and dimensions of irrigation areas to maximise efficiency.

The centre pivot system is a self-propelled system that rotates around a fixed central point, which creates a circular footprint for the application of irrigation.

The lateral irrigation system works on the same technology, however spans in a linear formation, allowing for rectangle size areas to be irrigated whilst maximising the irrigation coverage.

Benefits of both the centre pivot and lateral move irrigator systems include:

- 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.

Due to the large amount of land available for the application of wastewater via irrigation, the irrigation area will be rotated.

3.1.8 Composting facility

Solid wastes (screenings) from the water treatment system, will be treated in a composting facility. An enclosed, undercover and concrete foundation composting system has been designed to minimise potential odour issues, surface water runoff and groundwater seepage. The shed is proposed to be constructed in the future and will be approximately 50 m x 25 m (1,250 m²).

Three composting options have been considered through the preliminary design review phase as follows:

- In-vessel composting
- Aerated static pile (ASP) composting
- Windrow composting.

The preferred option has not been selected; however, none will pose a significant risk to groundwater. Composting requires addition of only small amounts of water to maintain moisture without saturation and so leachate production is expected to be minimal. The compost pad will be bunded with a sump to capture any leachate, which would be directed to the wastewater treatment system. Once the final design has been selected, further design details will be lodged with the NT EPA for discussion prior to future construction.

An initial composting trial was undertaken during 2017 at the DCF near Noonamah. The business, Organic Australian Grown ('Organic Ag') assisted given their expertise and previous extensive experience in composting. The initial trial was considered successful. A follow-up trial has been proposed at the Organic Ag farm, located on Anzac Parade, Middle Point, to validate the results. The compost site trial will receive solid waste from JCF, DCF and from the processing facility at Noonamah. The results of this trial will determine the design details of the on-site composting facility at Crocodile Farm.

Until final design and construction has been undertaken, solid wastes will be taken to the Organic AG off-site composting facility.

3.1.9 Fuel and chemical storage

A 5,000 L double skinned diesel storage tank will be located within the Project area nearby the existing infrastructure. Diesel will be used for re-fuelling farm equipment such as tractors and the back-up generators. A hydrocarbon spill kit will be fully stocked and located next to the diesel storage tank.

A 3,000 L LPG tank will be established on-site to store gas used to heat the water for the hatchery with support of the cross-linked polyethylene (PEX) pipe under the pens. Gas will be used for the hatchery due to the sensitivity of hatchlings to temperature profile.

Liquid chlorine is the primary hazardous material stored on site and is used to disinfect the water in the main header tank farm prior to distribution to the animal pens. Bulk chlorine is kept in the chemicals storage shed (shipping container) on portable intermediate bulk container (IBC) spill bunds and the maximum volume stored on site at any given time will be 2,000 L.

Other chemicals stored and used on site during construction such as paints and thinners, epoxy sealants, Tufflon-P90, will be kept in a lockable store with a minimum bund capacity of 110% of the contents of the largest container in the store. A chemical spill kit will be fully stocked and located next to 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.

3.1.10 Water supply

The bores under the existing groundwater extraction licence (Licence no. HGS10000, Expiry 2026) will be used as a water source for all construction related activities that warrant water usage such as dust suppression and concrete mixing. Potable water tanks will be established within the office administration and housing/accommodation areas. The most suitable bore water supply may be used to supply the potable water. Wastewater and stormwater will be reused when water quality is permissible for dust suppression, earthworks and other construction activities.

3.1.11 Power supply

The site is connected to existing Power and Water Corporation (PWC) infrastructure. A solar farm has been identified for future construction. Back-up diesel generators will be required to ensure the health and well-being of the animals is not at risk during power outages.

3.1.12 Sewage

The existing building contains ablutions and septic tank that will be used for the construction personnel during the construction process. The septic tank will be pumped out as required by an authorised and licenced waste management contractor. If required, additional portable toilets will be temporarily established on-site.

3.2 Construction

The Crocodile farm will be constructed by Darwin-based construction company Sitzler. Construction design details are included in Appendix D.

3.2.1 Schedule

The Project is scheduled to commence construction during late September 2020 subject to DA and EPA approvals. The construction phase is expected to be on-going for a period of 65 weeks until completion. Construction activities will be staged to minimised areas of disturbance prior to the wet season as per the construction schedule in Appendix E.

Stage 1 construction activities and schedule include;

- Site mobilisation (September 2020)
- Stormwater detention area and drainage to ensure appropriate stormwater management controls are in place prior to construction of infrastructure (Commencing October 2020)
- Excavation of the water treatment pond to provide earth material to construct the elevated foundation pad for the hatchery area (Commencing October 2020)
- Construction of the incubation (October 2020 to January 2021)
- Construction of the hatchery (November 2020 to April 2021).

The incubation and hatchery area is critical as a primary construction stage to enable the wild harvest of the eggs and time in the incubators of approximately 90 days to hatching. The hatchling pens need to be ready to accept these hatchlings. The hatchlings will spend 6 – 9 Months in the hatchery area prior to shifting out to the grower pens.

Stage 2 construction activities and schedule include;

- The grower and finishing pens (January to June 2021)
- Ancillary infrastructure (April to September 2021)
- Water treatment area (March to June 2021)
- Irrigation system (June to September 2021)

3.2.2 Ground Preparation

No remnant vegetation is required to be cleared. The proposed construction area will be stripped of existing grass vegetation, topsoil, silt and graded. The area will then be compacted and conditioned as required for the infrastructure foundation.

3.2.3 Erosion and Sediment Control

Construction is proposed to occur over a period of approximately 16 months, thus will span over one wet season. Prior to construction, Sitzler will develop an erosion and sediment control plan (ESCP), prepared by a suitably qualified person aligning with the *Best Practice Erosion and Sediment Control Guidelines (IECA, 2008)* and implemented prior to the onset of the wet season.

ESC structures will be maintained for the duration of the construction activities to ensure erosion is minimised and prevent sediment movement off site. Monitoring will be undertaken to ensure the ESC structures are functioning as intended and water quality pollution is prevented (see Section 7 for monitoring).

3.2.4 Building

All building and construction will be undertaken by Sitzler in accordance with relevant Australian Standards, specifications and building codes. Building materials will largely involve a combination of on-site concrete slab construction and pre-fabricated slabs, block work, steel and timber framing, brick work, plasterboard, excavated rock/soil material; roof and wall cladding, shade cloth and plastic materials, drainage pipes and irrigation networks. Details of the ancillary building infrastructure and crocodile pens are detailed in Section 3.1 above.

3.2.5 Water storages

Installation of water storage tanks and the construction of earth-fill dams and ponds will be in accordance with relevant Australian Standards and specifications for dams and water tanks to ensure the facility is fit for purpose and safe.

All water storage ponds will be constructed by excavating in-situ material to form the pond walls i.e. turkeys nest type design. The ponds will be lined with low permeability compacted material to minimise seepage.

Additional water storage ponds will be constructed as required with the up-scaling of farm production over a five-year period.

3.2.6 Treatment systems

Wastewater treatment systems will be installed in the second half of the 16-month construction phase.

The PASS treatment system is a package type system that will be installed on site. Details of the PASS has been detailed in Section 3.1.5.

The FTW will be excavated and the pond margins constructed using the excavated materials. The foundations will be compacted to prevent seepage. The process for establishment and commissioning of the FTW will be determined through the detailed design phase.

3.2.7 Pollutants and waste

Pollutants and wastes produced during construction are listed below, with details of treatment / mitigation and disposal methods.

Pollutant/waste	Treatment / Mitigation	Disposal
Dust emissions	Dust suppression	NA
Stormwater discharges (sediments)	ESCP Stormwater infrastructure (drains, pipes, swales)	Controlled discharge via stormwater infrastructure.
Wash-down water (concrete)	Retention ponds	Reuse
Green waste	Segregation, stockpiling and reuse	Wood chipping / mulch for use on-site or disposal off-site to authorised waste disposal facility
Building waste	Segregation and recycling	Disposal off-site to authorised waste disposal facility
Building waste (timber, concrete,	Segregation and recycling	Off-site by licenced contractor

Pollutant/waste	Treatment / Mitigation	Disposal
bricks/mortar, plasterboard, metal/steel, excavated rock/soil material; shade cloth, plastic, High-density Polyethylene (HDPE), Polyvinyl Chloride (PVC), Cross-linked Polyethylene (PEX).		
Hydrocarbon waste (oils, lubricants, fuel) for running and servicing of vehicles, plant and equipment and any hydrocarbon contaminated material	Segregation	Off-site by licenced contractor
Other hazardous substances / chemical waste, such as paint, solvents, Tufflon-P90	Segregation	Off-site by licenced contractor
Domestic waste	Segregation and recycling	Off-site by licenced contractor
Sewage	On-site septic	Pump out by licenced contractor

Management of waste has been included in the risk register in Section 6.

3.3 Operations process

3.3.1 Schedule

The operations will commence on a small scale for the first 12 months, with approximately 4,000 grower crocodiles. The second year of operations will see the commencement of production with the addition of hatchlings. Production will gradually increase until the fifth year of operation when the farm is expected to have reached full-scale production at approximately 45,000 crocodiles.

3.3.2 Process overview

The key stages of production that will take place at the farm are summarised below:

1. Egg incubation: Collected eggs are assessed and cleaned in egg laboratory, with viable eggs transferred to the incubator room.
1. Hatchery: Animals hatch in incubator, predominantly between March – May, then are immediately transferred to hatchling pens.
2. Grow-out: When animals are about one-year-old, they are transferred to grower pens.
3. Finishing: When animals approach a size suitable for market, they are transferred to finishing pens for six to eight months to ensure best possible skin and meat condition.
4. Harvest and processing: Animals are harvested from the finishing pens; cleaned and prepared for transport and then sent to a separate processing facility at the Noonamah site (DCF).

As outlined in the process flow diagram (Figure 3-4), water is sourced from the licenced water extraction groundwater bores and pumped via a pipework with in-line chlorine dosing prior to entering a series of water supply storage tanks. A separate water supply storage tank will be installed for grower and finishing water, hatchling water (heated tank) and domestic water. Water is supplied as required to each area of farming operations.

All stages of production produce animal effluent and wastes including faeces and excess feed wastes. The crocodile pens are routinely cleaned and flushed and the animal wastes from the grower, finishing and hatchlings are combined into a wastewater/effluent sump. The effluent is pumped through a macerating pump followed by coarse and fine screening to separate the solid wastes, which are dewatered in a solids bunker and taken to the compost facility for treatment. The remaining effluent wastewater is pumped into the

secondary treatment system prior to overflow into the irrigation lagoon where it will either be reused or irrigated to crops.

3.3.3 Water demand and supply

Water demand will increase over the five years of farm upscaling until full-production is reached. Farm water will be supplied from the licenced extraction bores. Water produced during farm operations will be treated for reuse and irrigation, reducing the reliance on the groundwater.

3.3.1 Wastewater irrigation

Treated wastewater that is not reused will be used to irrigate crops planted in the irrigation areas. There is 160 ha of land available for irrigation. To ensure that the wastewater does not impact offsite environmental values or neighbouring land uses, the irrigation regime will be designed and operated to minimise runoff and seepage to groundwater. The nutrient loading in the wastewater will be managed by rotational application of irrigation water across different areas.

Details of the irrigation systems, crop types, irrigation regimes and monitoring requirements will be developed and included in an IMP to be submitted with the future application for an EPL. To demonstrate the capacity of the proposed system to manage nutrients onsite, a MEDLI assessment has been prepared on the combined wastewater streams (Appendix F). The model addresses factors impacting on effluent irrigation, such as the quality and quantity of effluent, climate, soil type, storage, irrigation frequency and amount, nitrogen, phosphorus and salt components and plant type and growth. The model is set to prevent irrigation when soils become saturated (i.e. during or following rain events).

Irrigation of wastewater has potential to cause erosion where there is slope and/or the application rates are too high and result in runoff. The irrigation rate will be 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. There is potential to increase/decrease the irrigation rate based on actual project area conditions, soil types and crop selection, which will be determined through soil sampling and modelling.

Crop types proposed for irrigation areas includes Sorghum, Wynn Cassia, Sandalwood, Guinea Grass and potential use for Bananas in the future.

Irrigation management controls

Irrigation will be controlled by monitoring saturation levels to ensure there is no runoff of the irrigated water. The irrigation system uses Global System for Mobile Communication (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. This enables readings to be recorded with each extraction. This meter is for loaded water, i.e. agriculture, wastewater treatment plants or sewage works. If the system faults, an automated alignment control valve and sensor shuts down the irrigation.

The pressure of the sprayer will be kept low to mitigate any off-spray impact to surrounding users. However, the quality of the irrigated water will be regularly sampled to ensure the quality is at an accepted level.

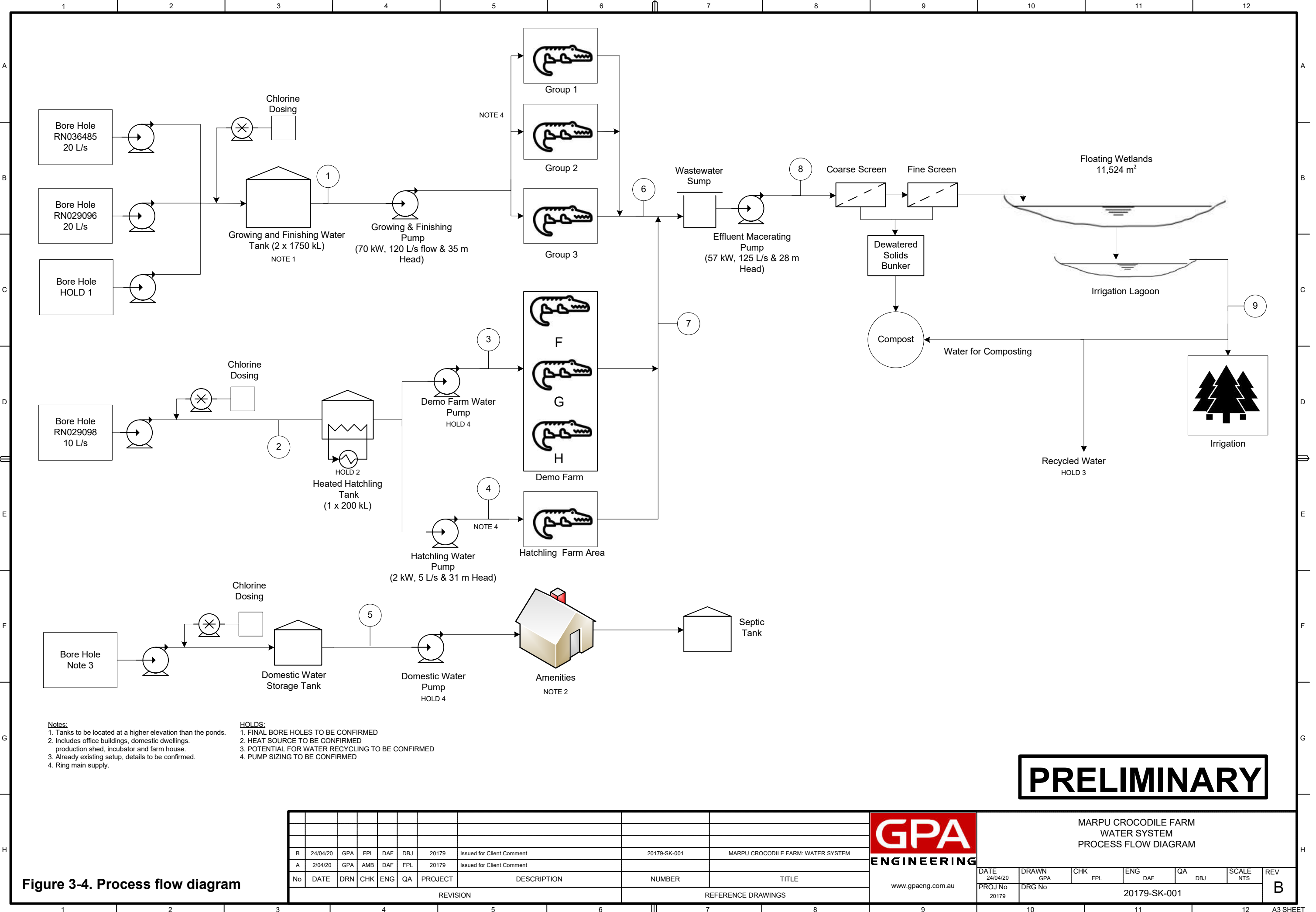
3.3.1 Finished product

The Crocodile farm at Lambells Lagoon is for the commercial production of saltwater crocodiles predominantly for skin and meat products. 45,000 crocodile will be reached at full production in year five.

3.3.2 Pollutants and wastes

Pollutants and wastes produced during operations are listed below, with details of treatment and disposal methods.

Pollutant/waste	Treatment / Mitigation	Disposal
Odour emissions	Appropriate separation distances to sensitive receptors. Compost facility will be a covered shed structure that prevents ingress of rainfall.	NA
Crocodile mortalities	NA	Off-site by licenced contractor
Primary water treatment screenings - solid waste (animal effluent and feed waste)	Composting	Conversion to compost at an off-site compost facility until the on-site compost facility has been constructed.
Wastewater from crocodile pens	Primary and secondary treatment on site	Reuse in production system with excess discharged to land for irrigation of crops
Domestic waste	NA	Off-site by licenced contractor
Used chemical containers	NA	Off-site by licenced contractor
Waste oils from light maintenance activities	NA	Off-site by licenced contractor
Sewage	On-site septic	Pump out by licenced contractor
Stormwater discharges	Detention basins	Controlled discharge to surface waters via stormwater drains and collection sump.



- Notes:**

 - 1. Tanks to be located at a higher elevation than the ponds.
 - 2. Includes office buildings, domestic dwellings, production shed, incubator and farm house.
 - 3. Already existing setup, details to be confirmed.
 - 4. Ring main supply.
- HOLDS:**

 - 1. FINAL BORE HOLES TO BE CONFIRMED
 - 2. HEAT SOURCE TO BE CONFIRMED
 - 3. POTENTIAL FOR WATER RECYCLING TO BE CONFIRMED
 - 4. PUMP SIZING TO BE CONFIRMED

PRELIMINARY

Figure 3-4. Process flow diagram

										GPA ENGINEERING www.gpaeng.com.au	MARPU CROCODILE FARM WATER SYSTEM PROCESS FLOW DIAGRAM						
B	24/04/20	GPA	FPL	DAF	DBJ	20179	Issued for Client Comment	20179-SK-001	MARPU CROCODILE FARM: WATER SYSTEM		DATE 24/04/20	DRAWN GPA	CHK FPL	ENG DAF	QA DBJ	SCALE NTS	REV B
A	2/04/20	GPA	AMB	DAF	FPL	20179	Issued for Client Comment				PROJ No 20179	DRG No	20179-SK-001				
No	DATE	DRN	CHK	ENG	QA	PROJECT	DESCRIPTION	NUMBER	TITLE								
REVISION								REFERENCE DRAWINGS									

4 DISCHARGE SPECIFICATIONS

The sections below provide details of the quality, treatment and disposal methods for the pollutants and waste products generated by the farm operations.

4.1 Discharges to Air

Odour emissions

Odour emissions will occur from the wastewater treatment lagoon and compost facility. The treated wastewater storage ponds and irrigation areas could become a source of odour, if the wastewater treatment system is not operating effectively. The farm operations areas have been located in the western half of the property to maximise the separation distance from operations areas/infrastructure on neighbouring horticultural properties. The wastewater treatment lagoon and compost facility are located a minimum of 1.2 km away from these areas, which is consistent with the NT EPA Guidelines *Recommended Land Use Separation Distances* (2017), which state that an activity with livestock/holding pens containing >10,000 animals per year should be separated from sensitive land uses by 1,000 m radius.

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

- Primary treatment of wastewater to remove solids prior to entering the wastewater treatment lagoon.
- Monitoring of treatment system performance to ensure wastewater entering the treated wastewater storage ponds meets water quality criteria.
- Solid screenings will be treated in an onsite compost facility, which will be in a covered shed structure to minimise the moisture content of the compost.
- Operational procedures for handling and storage of wastes will avoid putrefaction prior to composting or removal from site.

Fugitive dust emissions

Dust emissions will occur during site clearing and preparation. During operations, crop harvesting activities will produce dust emissions. Dust could impact site personnel, but is not expected to affect neighbouring land uses because:

- The separation distance between the activities and the operations areas/infrastructure on neighbouring horticultural properties will allow for most dust to settle within the property boundaries.
- Dust emissions will occur only for discrete periods of time and so any dust that does cross the property boundaries would at worst cause a short-term/temporary nuisance impact.

Dust emissions will be managed to ensure the health and safety of personnel working on site.

4.2 Discharges to land

Treated wastewater that is excess to the farm reuse requirements, will be discharged by land irrigation.

4.2.1 Effluent quality and volume

Effluent quality pre and post treatment has been detailed in Section 3.1.5.

The volume of water that will be discharged to irrigation areas will depend on the level of recycling and reuse that can be achieved within the system and the amount of rainfall entering the system.

The most conservative wet weather storage requirements (i.e. calculated by the MEDLI model with 0% reuse) were used to run the remainder of the scenario. Whilst the Project will be aiming for a high level of water efficiency and reuse, which will reduce storage requirements, the worst-case scenario is modelled for the purpose of demonstrating the feasibility of a sustainable effluent reuse scheme at the site. For comparison sake, the 50% reuse scenario was also modelled and summarised below. Full MEDLI summary and report scenarios are detailed in Appendix F.

The forecast water usage is 1,365 kl/day and the average daily forecast effluent quantity is 1,450 kl/day (530 ML/year).

No reuse

With a wet weather storage capacity of 120 ML and an irrigation area of 100 ha, there would be pond overflows 0.53 times a year, or 5.3 events every 10 years, and the effluent reuse (through irrigation) is at 99%. The effluent reuse is defined as the proportion of effluent inflow + net rain gain that is irrigated from the pond. The probability of at least 90% reuse is also 94% which is a desired outcome for MEDLI. The irrigation application rate has been calculated to be 511 mm/yr (511 ML/yr).

50% reuse

With a wet weather storage capacity of 50 ML and an irrigation area of 120 ha, there would be pond overflows 0.57 times a year, or 5.7 events every 10 years, and the effluent reuse (through irrigation) is at 99%. The probability of at least 90% reuse is also 97%. The irrigation application rate has been calculated to be 225 mm/yr (270 ML/yr).

4.2.2 Irrigation areas

The irrigation area sizing and storage requirements will depend to a large extent on water efficiency measures and the level of recycling that can be achieved within the system as discussed above in Section 4.2.1.

Soil and land characteristics

The soil and land is determined suitable for use, through historical land use (irrigated horticultural activities) and the soil and land capability assessment detailed in Section 2.1.

Topography

The topography is relatively flat allowing water to saturate the soil with limited runoff (Figure 2-1).

Climate

The dry season months allow for adequate irrigation to consistently occur. The MEDLI model was set to prevent irrigation when soils become saturated (i.e. during or following rain events). Based on the assumptions used in relation to rainfall, evaporation, soil and crop types, this prevents irrigation for approximately 13% of the year at the Crocodile Farm site (or 47 days) (See Appendix F).

In reality with high evaporation rates, it is possible that irrigation may still occur on days that experience minor rainfall events provided conditions in a site-specific IMP are adhered too.

Groundwater

Impacts to groundwater will be minimised by:

- Primary and secondary treatment of the wastewater to reduce contaminant loads
- Selection of suitable irrigation infrastructure to match the water and nutrient requirements of the crops

- Controlling irrigation rates and areas under irrigation to prevent oversaturation that results in seepage
- Monitoring of effluent quality and irrigation volumes to ensure nutrient loading is within acceptable limits
- Installation and monitoring of groundwater bores downstream of the irrigation areas for early detection of contamination.

Surface water

Impacts to surface water will be minimised by:

- Primary and secondary treatment of the wastewater to reduce contaminant loads
- Selection of suitable irrigation infrastructure to match the water and nutrient requirements of the crops
- Controlling irrigation rates and areas under irrigation to prevent oversaturation that results in runoff
- Monitoring of effluent quality and irrigation volumes to ensure nutrient loading is within acceptable limits
- Monitoring of surface water quality at locations where surface water flows cross the property boundary and drain towards the conservation reserves.

Proximity to dwellings

Impacts to sensitive receptors and surrounding land users will be minimised by:

- A 30-metre-wide buffer will be maintained from all structures to the Alphatonia Road frontage;
- Positioning of pens and wastewater treatment and compost facility within the western portion of the Project area to maximise land separation distances (>1 km) from potentially sensitive surrounding land uses.
- Design of infrastructure taken into account such as slope of pen floors/pools to allow regular flushing and enclosed composting facility to prevent odour related issues.
- Primary and secondary treatment of the wastewater prior to irrigation to minimise odour
- Controlled irrigation in accordance with weather conditions (prevailing wind direction, rainfall), irrigation droplet size to prevent spray drift, prevention of oversaturation and potential runoff or seepage and rotation of irrigation area.
- Reuse and irrigation of treated wastewater minimises reliance on the groundwater supply, critical for other groundwater users in the area
- Maintain frequent stakeholder engagement and ensure complaints are managed promptly
- Managing dust, noise and vibration as detailed in the risk assessment (see Section 6).

4.2.3 Irrigation system

To ensure that the wastewater does not impact offsite values, the irrigation regime will be designed and operated to minimise runoff and seepage.

The irrigation rate will be 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. There is potential to increase/decrease the irrigation rate based on actual project area conditions, which will be further determined through soil sampling and modelling.

Remote access GSM technology will monitor and manage the irrigation system, including 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. To measure and record readings.

The nutrient loading in the wastewater will be managed by rotational application of irrigation water across different areas. Wet weather storage ponds will provide buffering capacity that will allow for containment of effluent during prolonged periods of rainfall during the wet season, such that on average discharges occur at a low frequency (i.e. 50% of years) and only when there is a high level of dilution both within the storages and within the receiving environment.

A detailed IMP will be provided in the EPL application supporting documentation. The below outlines the proposed irrigation management system including construction and proposed irrigation areas. Details of the proposed irrigation system has been included in Section 3.1.7 above.

4.2.4 Irrigation quality

Trigger levels will be used to determine if the wastewater can be irrigated. Table 4-1 lists indicative trigger values derived from current baseline conditions from the Darwin Crocodile Farm (DCF) used for the irrigation assessment, the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Volume 3 – Chapter 9 – Primary Industries* (ANZECC, 2000) guidelines and the *Environmental Guidelines – Use of Effluent by Irrigation* (DEC, 2004). Specific trigger levels for Crocodile Farm will be refined through further assessment and the development of an IMP and EPL.

Table 4-1. Indicative trigger values for irrigation water

Parameter		Trigger value	Source
pH		6 – 9	ANZECC, 2000
EC		400 – 500 μ S/cm	Baseline levels
TDS		200 – 300 mg/L	Baseline levels
Total P		To be developed	Site specific modelling
Total N		To be developed	Site specific modelling
NH ₃		1 mg/L	Baseline levels
BOD		40 mg/L	DEC, 2004
Cations & anions (Ca, Mg, Na, K, SO ₄ , Cl, CaCO ₃)		30 mg/L (CaCO ₃ - 220 mg/L)	Baseline levels
<i>E.coli</i> , <i>Enterococci</i> , Total coliforms		> 1,000 cfu/100mL (fodder)	ANZECC, 2000
Oil & Grease		> 5 mg/L (presence/absence)	Laboratory limit of reporting (LOR)
Total Metals	As	2.0 mg/L	ANZECC, 2000 Short-term trigger values
	Cd	0.05 mg/L	
	Cr	1 mg/L	
	Cu	5 mg/L	
	Hg	0.002 mg/L	
	Ni	2 mg/L	
	Pb	5 mg/L	
	Zn	5 mg/L	
Herbicides (Glyphosate)		1 mg/L	ADWG, 2019*

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

4.2.5 Monitoring points

Monitoring discharges to land will be undertaken prior to and during operations. Water quality monitoring will occur on-site during operations at each phase of the water process including; source, effluent and wastewater treatment to determine treatment efficacy and monitor for potential impacts, including;

- Supply bores
- Wastewater pre-treatment from combined effluent collection sump
- Wastewater quality following primary treatment (course and fine screening)
- Wastewater quality following secondary treatment (FTW or PASS)
- Treated wastewater storage prior to irrigation and/or reuse.

Soil monitoring will also be undertaken prior to and during operations. Soil sampling will occur within the irrigation areas. See details of the monitoring program in Section 7.

4.3 Discharges to water

The following discharges to surface water will occur during the wet season:

- Stormwater detention basin overflows following rainfall events (with the exception of the first-flush event)
- Overflows from the treated wastewater storage during peak wet season rainfall events.

4.3.1 Stormwater

Development of the farming operations area may further increase run-off as previously vegetated or bare earth surfaces are replaced by impervious surfaces such as compacted access roads/tracks, concrete and building roofs. Construction and management of stormwater is detailed in Section 3.1.4.

4.3.2 Treated wastewater overflows

Wet weather storage ponds will provide buffering capacity that will allow for containment of treated water during prolonged periods of rainfall during the wet season, such that on average discharges occur at a low frequency (i.e. 50% of years) and only when there is a high level of dilution both within the storages and within the receiving environment.

4.3.3 Hydrology and receiving waters

Surface water runoff from the Project will shed into the receiving Black Jungle and Lambells Lagoon Conservation reserves. Overflows from the treated water storage will flow into the Black Jungle Conservation reserve. Potential impacts include excessing nutrients and elevated turbidity levels. Mitigation measures include:

- Construction and maintenance of ESC structures
- Land stabilisation with plantation of crops for irrigation
- Rigorous monitoring of water quality treatment processes, water shed and off-site monitoring of the receiving Black Jungle and Lambells Lagoon Conservation reserves
- Development and implementation of an IMP for the EPL.

4.3.4 Monitoring points

Addition to the monitoring specified in Section 4.2.5, monitoring of discharges water quality will occur;

- Upstream of an unnamed creek feeding the Black Jungle conservation reserve

- Downstream of the farm operations at the project boundary discharge locations
- Receiving waters off –site (Black Jungle and Lambells Lagoon Conservation reserves) and
- Stormwater collection drain.

Monitoring locations are further discussed in Section 7 and Figure 7-2. A detailed water monitoring plan for operations will be provided with the EPL.

4.4 Adaptive management

As project construction and establishment will be staged over 5 years, there will be an opportunity to monitor and verify the whole of system performance as new stages are added. At each stage, the MEDLI modelling will be refined using field verified data, and the farm design and management procedures can be adapted to ensure that nutrients are being contained onsite (i.e. seepage, runoff and storage overflows are within acceptable limits). Adaptive management measures could include additional treatment to increase recycling, altering irrigation regimes and progressively adding water storage as required to sustainably manage water volumes and nutrient loads within the land area available. The project staging provides an opportunity for adaptive management without posing a significant risk to offsite environmental values or other water users.

5 CONCEPTUAL SITE MODEL

A conceptual site model (CSM) has been developed for the project construction phase to identify:

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

A CSM for the operations phase will be provided in the updated EMP submitted with the EPL application.

Contaminants/impacts/sources	Pathways and transport	Receptors
Soils/sediments disturbed by land clearing and earthworks.	Mobilised by rainfall and transported by surface water flows into the surrounding receiving environment. This could occur if construction is on-going during the wet season.	Black Jungle and Lambells Lagoon Conservation Reserve and the Howard groundwater system, including impacts to the receiving terrestrial and aquatic organisms.
Minor spills of hydrocarbons or chemicals from equipment failures or during refuelling. Volumes used and stored on site will be small due to scale of activity and because the site is close to fuel supplies and workshops.	Mobilised by rainfall and transported by surface water flows into the surrounding receiving environment. This would only occur if a large spill occurred during a large rainfall event, which is unlikely. Migration through the soil profile into groundwater.	Black Jungle and Lambells Lagoon Conservation Reserve and the Howard groundwater system, including impacts to the receiving terrestrial and aquatic organisms.
Bacterial and nutrient contaminants associated with domestic wastewater from staff ablutions.	Wastewater system overflows transported by surface water flows into the surrounding receiving environment. Migration through the soil profile into groundwater.	Black Jungle and Lambells Lagoon Conservation Reserve and the Howard groundwater system, including impacts to the receiving terrestrial and aquatic organisms.
Weed infestations introduced and spread on construction plant and equipment, and fill material.	Introduction to site on machinery and equipment that has not been properly cleaned, or in contaminated fill. Spread from one area of the site to others by equipment movement.	Surrounding vegetation communities could become infested with, which increases fire risk. Surrounding land users in horticulture zones may be impacted by weed spread.
Dust emissions from land clearing and earthworks.	Sediments may be mobilised as dust, which in windy conditions may be transported across the site and deposit into surrounding areas.	Personnel working within the property could be impacted by dust. Off-site impacts to surrounding land users with dust deposition on crops. Black Jungle and Lambells Lagoon Conservation Reserve, including impacts to the receiving terrestrial and aquatic organisms from dust covering vegetation and water bodies.
Noise emissions from machinery and equipment.	Noise may travel to surrounding land users.	Personnel working within the property could be impacted by noise. Off-site impacts to immediate neighbours.

6 ENVIRONMENTAL RISK ASSESSMENT

The CSM outlined in Section 5 above has been used to inform environmental risk assessment of construction and derive corresponding mitigation measures for identified risks. A Construction Aspects and Impact Register is presented in Table 6-4. Following assessment of the EPA application, a comprehensive risk assessment of the operational details of the Project will be addressed in the Lambells Lagoon Crocodile Farm application for an EPL.

6.1 Project construction risks

The potential environmental risks associated with construction of the Project, have been considered through an environmental aspects and impacts 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 as 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. Project construction environmental aspect and impact register

Aspect	Impact	Background information and assumptions	INITIAL RISK			Controls	RESIDUAL RISK		
			Likelihood	Consequence	Risk Score		Likelihood	Consequence	Risk Score
Erosion and sediment control	Runoff or discharge of sediment laden stormwater to the Black Jungle and/or Lambells Lagoon	Erosion and sedimentation risks are unlikely to be significant in extent as the land is relatively flat (slope <2 %). Stormwater detention basin will be constructed as part of early works and will be used as part of the construction ESCP. Construction will occur over a wet season (approximately 36 weeks). Conservation reserves are sensitive receiving environments that require a high level of protection.	5	3	High	Prior to the commencement of works, a site-specific Erosion Sediment Control Plan (ESCP) will be submitted to DENR for endorsement. Erosion and sediment controls will be in place, inspected and maintained from 1 Oct to 31 April. The effectiveness of controls will be monitored visually by inspecting site boundaries and discharge points during and following rainfall events for evidence of sediments (i.e. re/brown colouring).	2	3	Med
Spills of fuels or chemicals	Contamination soils, surface water or groundwater	Volumes used and stored on site will be small due to scale of activity and because the site is close to fuel supplies and workshops. Major maintenance will be undertaken off-site at local workshops. Site drainage discharges to sensitive receiving environments in Black Jungle and/or Lambells Lagoon. Shallow surface water during wet season.	3	2	Med	All fuels and chemicals will be stored in accordance with AS:1940 (2004) and NOHSC:1015 (2001), including bunding or self-bunded containers. Chemical register will be kept up to date for all chemicals, their volumes and storage locations. Safety Data Sheets (SDS) will be kept onsite and in storage areas for all products. Emergency Response Plan. Training and site inductions. Spill kits will be onsite, adequately sized and stocked. Storage areas and spill kits inspected weekly.	3	1	Low
Dewatering of works area Wastewater	Contamination of surface water	Wastewater could be produced from dewatering of the works areas during the wet season. Water will be free from chemical contaminants but will contain high sediment loads	4	3	High	Dewatering will be discharged via a sediment sock to remove sediment loads. Treated water will be discharge via the site stormwater management system. Water quality monitoring at site stormwater	3	2	Med

Aspect	Impact	Background information and assumptions	INITIAL RISK			Controls	RESIDUAL RISK		
			Likelihood	Consequence	Risk Score		Likelihood	Consequence	Risk Score
						discharge points. On-site concrete mixing will occur in a contained area to manage excess water and prevent wastewater from entering drainage areas.			
Water Use	Over-extraction of groundwater	Construction water will be sourced from existing on site groundwater bores. Water use is expected to be minimal, used predominantly for dust suppression during the dry season during construction. Groundwater extraction to be conducted in accordance with Groundwater Extraction Licence HGS10000 and 'announced annual allocations'.	2	2	Low	Meter and monitor water extraction rates to ensure volumes are within licence conditions. Standing water level monitoring in groundwater bores to commence during construction to provide baseline for monitoring of drawdown during operations.	2	2	Low
Onsite domestic wastewater disposal	Bacterial and nutrient contamination of surface water or groundwater	Small construction workforce will utilise existing amenities and/or porta-loos System design, siting and sizing will comply with the Code of Practice for Onsite Wastewater Management (July 2014)	3	1	Low	Wastewater system maintained (pumped out) as required by licenced contractor to maintain capacity and efficacy of treatment.	2	1	Low
Construction waste Management	Pest and vermin Contamination of surface and groundwater Increased waste to landfill	Construction wastes will be inert. Small volumes of contaminated wastes from minor machinery equipment maintenance. Small volumes of domestic waste from construction workforce amenities.	4	1	Med	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.	3	1	Low

Aspect	Impact	Background information and assumptions	INITIAL RISK			Controls	RESIDUAL RISK		
			Likelihood	Consequence	Risk Score		Likelihood	Consequence	Risk Score
						All waste bins to be secure and fitted with a lid to prevent wind-blown waste, contaminated water and occurrences of pests and vermin. A waste management register will be used to document the type and volumes of waste. On-site concrete mixing will occur in a contained area to manage excess water and prevent wastewater from entering drainage areas.			
Weeds	Introduction and spread of weeds and increased bushfire risks	The cleared areas are largely degraded with weeds resulting from years of agricultural use (i.e. irrigated horticulture). The small portion of remnant vegetation on site is impacted from encroaching weeds and increased fire risk.	5	2	Med	Machinery and equipment will be clean prior to entering the site. Only clean fill will be used. Machinery will operate in approved development footprint only. Vegetation and soil stockpiles from site clearing will be inspected for weeds and control implemented if required. Soils will be reused in the development footprint and will not be spread around the property. Follow up weed control during operations in accordance with legal obligations on land owners under the <i>Weed Management Act</i> .	3	2	Low

Aspect	Impact	Background information and assumptions	INITIAL RISK			Controls	RESIDUAL RISK		
			Likelihood	Consequence	Risk Score		Likelihood	Consequence	Risk Score
Traffic	Traffic impacts on other road users and neighbours	Construction access via existing access road off Alphatonia Rd. Minor increase in traffic associated with initial delivery of machinery, equipment and materials to site. Machinery based on site for duration of construction works. Limited other road users to access past Project (Koolpinyah Station and the Darwin Fruit Farm), road ends at Koolpinyah Station gates.	3	2	Low	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	3	1	Low
Noise emissions	Noise nuisance impact to neighbours	Site is remote from noise sensitive receptors. Day time construction.	2	1	Low	• In accordance with WHS Regulations • Respond to complaints	1	1	Low
Dust emissions	Dust emissions affect people or the environment	Particulate matter including; dust, plant and equipment emissions will be produced construction activities. Personnel working within the property could be impacted by dust. Off-site impacts are unlikely due to distance and vegetation buffers between the works and surrounding areas. The nearest stakeholders to the Project 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	Implement ESCP measures for minimising wind erosion i.e. staging clearing and earth works, stockpile management Dust suppression methods will be utilised if required (i.e. use of sprinkler systems, water carts, etc.). Aerosols not used in windy conditions (such as spraying of paint). Activities will be reduced where possible when wind speed and direction is problematic. Traffic management measures implemented such as reducing speed limits and restricted access areas. Loads carrying earth material will be covered to minimise dust. Stockpiling of material will be kept to a minimum (<2m height).	3	1	Low

Aspect	Impact	Background information and assumptions	INITIAL RISK			Controls	RESIDUAL RISK		
			Likelihood	Consequence	Risk Score		Likelihood	Consequence	Risk Score
Biting insects	Increased presence of and/or increased breeding sites for biting insects	The location of the project area, 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. Construction works will extent for approximately 36 weeks, thus will be on-going throughout a wet season.	2	1	Low	Visual monitoring of construction areas for pooling water, and/or presence of biting insect habitats (i.e. stagnant water). Modify construction area to eliminated areas of pooling water. Sumps/trenches dewatered during the wet season or covered to prevent 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.	1	1	Low

7 ENVIRONMENTAL MONITORING PLAN

The risk assessment process detailed in Section 6 identified controls that will be implemented to minimise the risks to the environment during construction activities. This section outlines how compliance with these requirements will be monitored during construction. Preliminary details are also provided in relation to baseline monitoring and operational monitoring programs, that will be further developed and finalised as part of the future EPL application.

7.1 Construction monitoring

The environmental aspects identified through the risk assessment process will be monitored throughout construction of the Project. Table 7-1 provides a summary of the monitoring to be undertaken, the frequency of monitoring efforts and the proposed corrective actions to be implemented in the event that management and mitigation controls are shown to be ineffective.

Table 7-1. Project construction environmental monitoring summary

Aspect	Monitoring	Frequency	Corrective Actions and Contingencies
Erosion and sediment control	Visual monitoring of construction activities and effectiveness of the erosion and sediment control structures. Visual monitoring of turbidity in surface water flows / drainage. Surface water monitoring at site discharge points (pH, Electrical Conductivity (EC), Dissolved Oxygen (DO), Total Suspended Solids (TSS), Turbidity	Daily visual inspections wet season and monthly during the dry season. Surface water monitoring every 2 months during wet season	Revision of Erosion and Sediment Control Plan (ESCP) Implement additional efforts to stabilise disturbed soils and surfaces Undertake regular maintenance on erosion controls during the wet season.
Spills of chemicals, hydrocarbons or hazardous substances	Visual monitoring for signs of inappropriate chemical storage or handling. Visual monitoring for signs of spills / contaminated soils. Surface water monitoring at site discharge points - Total recoverable Hydrocarbons (TRH), Benzene, Toluene, Ethylbenzene and Xylene (BTEX)	Daily during construction. Ongoing throughout construction. Surface water monitoring every 2 months during wet season	Clean-up spills and remove contaminated soils in accordance with the Spill Response Procedure. Conduct additional maintenance on machinery and equipment. Conduct additional training with employees regarding the storage and handling of chemicals and hazardous substances.
Dewatering	Visual monitoring of water for evidence of contaminants i.e. oily sheen, prior to dewatering During construction any on-site dewatering must meet the water quality release criteria as specified in the <i>NT EPA Guidelines to prevent pollution from building sites</i> (NT EPA 2015) Table 7-2 below. Water quality testing will occur prior to release.	When dewatering required	Improve sediment removal systems. Remove hydrocarbons using booms/mats. Utilise flocculants to remove suspended sediments.
Groundwater extraction	Water use meter	Quarterly	Review groundwater usage Spread extraction over separate bores
Pests and weeds	Machinery and equipment inspections on arrival to the Project area for any	Daily upon arrival to site.	Undertake machinery and equipment wash-down prior to

Aspect	Monitoring	Frequency	Corrective Actions and Contingencies
	organic material or seeds. Visual monitoring of the construction / disturbed site for signs of weed presence/ establishment.	Weekly during construction.	entry to site. Undertake further target weed spraying activities in accordance with routine operational procedures.
Traffic	Monitoring of correspondence and/or complaints received from stakeholders or interested parties.	Ongoing throughout construction.	Conduct additional stakeholder engagement and consultation efforts.
Dust emissions	Visual monitoring for excess generation of dust and direction of dust dispersion. Regular engagement with neighbours. Recording and management of complaints.	Daily during construction. As required in consultation with stakeholders.	Increase dust suppression efforts. Alteration of activities, in consultation with complainants, where possible to minimise cross-boundary impacts.
Noise and vibration	Noise level checks and maintenance records for all plant and equipment. Regular engagement with neighbours. Recording and management of complaints.	Prior to mobilisation of plant and equipment to site and as required thereafter. Daily during construction. As required in consultation with stakeholders.	Audit of plant and equipment fleet (maintenance inspections, equipment to manufactures specifications) Alteration of activities, in consultation with complainants, where possible to minimise cross-boundary impacts.
Biting insects	Visual monitoring of construction area for evidence of pooling water	Weekly during construction.	Modify construction area to eliminated areas of pooling water with drainage augmentation works.
Waste	Visual monitoring of waste management system Waste register completed and up-to-date.	Weekly during construction. Ongoing throughout construction.	Clean-up debris and segregate waste as appropriate. Conduct additional training with employees regarding waste management Review waste management procedures.

Table 7-2. On-site dewatering water quality criteria

Indicators	Criteria
Turbidity (NTU)	<20
Total Suspended Solids (TSS)	<50mg/L
pH	6.5 – 8.5
Dissolved Oxygen (DO)	90 th %ile >80% saturation or 6 mg/L
Litter	No visible litter washed from site
Oil and grease	No visible litter oil or grease

7.2 Baseline monitoring

Baseline monitoring has commenced during 2020 and will continue with the objective of providing site specific trigger values (SSTV's). The SSTV's will provide a benchmark for the water quality criteria during operations. Details of the proposed baseline monitoring is provided below.

7.2.1 Soil monitoring

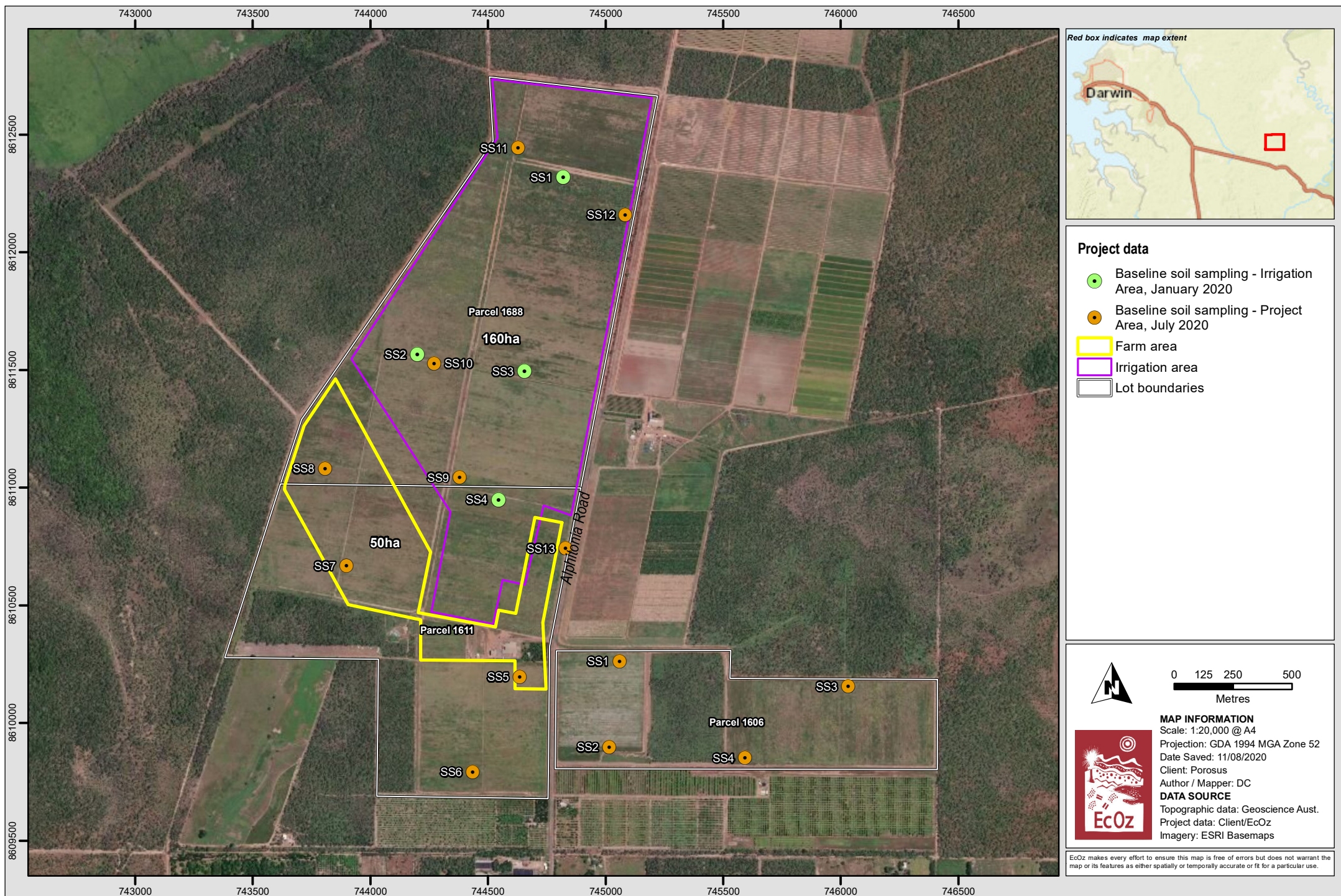
Baseline soil sampling is undertaken to establish soil conditions across the irrigation areas prior to use. These baseline sampling locations will then be included in an ongoing monitoring program that assesses changes in soil conditions over time in response to application of effluent to irrigated crops.

Baseline soil sampling locations to date are provided in Figure 7-1 and results in Appendix A.

A further four soil samples were taken from the proposed irrigation area during July 2020 to further refine the MEDLI modelling for operational activities. The analysis is undertaken by the Queensland Department of Environmental and Science and results are pending. Results of the MEDLI soil analysis will be supplied along with a revised MEDLI model with the EPL application.

Table 7-3. Monitoring program, frequencies and trigger levels for soil

Monitoring sites	Parameter	Sampling frequency
Selected within the irrigation area (SS1, SS2, SS3, SS4)	pH	Annually
	EC	Annually
	Total P	Annually
	P sorption capacity	After 3 years
	Total N	After 3 years
	Nitrate + nitrite (NO _x)	Annually
	ESP	Annually
	Total Metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn)	After 10 years



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19153 - MARPU Project Environmental Approvals\01 Project Files\Crocodile farm\Map 2.mxd

Figure 7-1. Map of baseline soil sampling locations

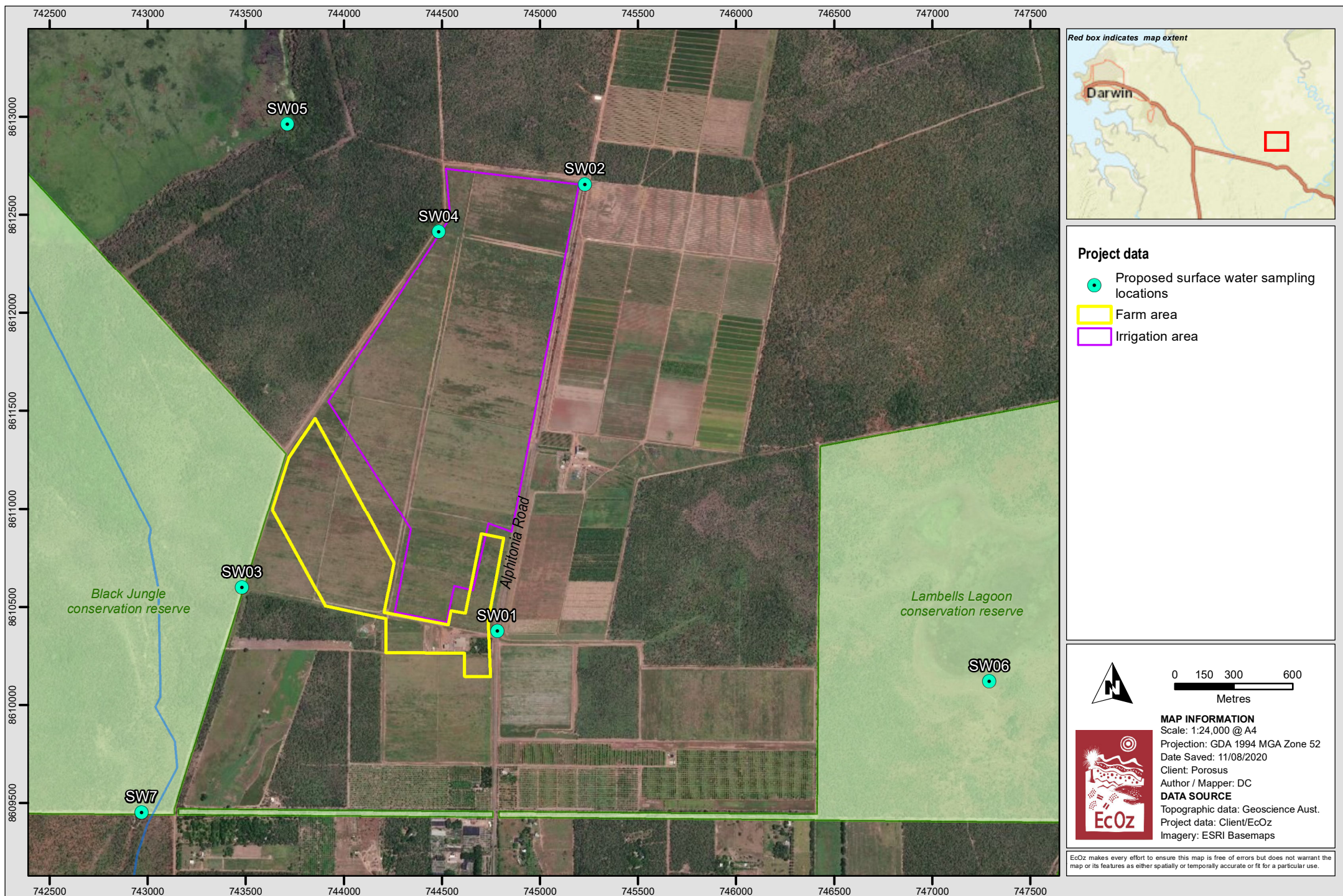
7.2.4 Surface water

Surface water monitoring sites will further be established at locations where flows cross the property boundary and off-site within the receiving waters of Black Jungle and Lambells Lagoon Conservation Reserve. Indicative locations have been provided in Figure 7-2. Suitability of the proposed sampling locations will be assessed during the coming wet season. Monitoring sites will be located to the west capturing surface water flows towards Black Jungle Conservation Reserve and sites located to the east capturing surface water flows towards Lambells Lagoon. 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 7-4. Monitoring program and trigger values for surface water sites

Monitoring sites	Parameter	Sampling frequency
Selected upstream and downstream of operations area and each irrigation area (SW01, SW02, SW03, SW04, SW05, SW06, SW07)	pH	3 times during the wet season (start, during, end)
	Temperature	
	EC	
	DO	
	Total Suspended Solids (TSS)	
	Total P	
	Total N	
	NO _x	
	NH ₃	
	BOD	
	E.coli, Enterococci, Total coliforms	If increases are evident in irrigation waters

See Appendix C for baseline surface water sampling results.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19153 - MARPU Project Environmental Approvals\01 Project Files\Crocodile farm\Map 4.mxd

Figure 7-2 Map of proposed surface water sampling locations

7.2.5 Groundwater

There are 14 groundwater bores on the Project area and three bores in the Black Jungle Conservation Reserve close to the property boundary that may be suitable for inclusion in a monitoring program. Where these bores do not provide for adequate monitoring of seepage from the irrigation areas then there may be a requirement to install additional bores downstream of the irrigation areas.

Groundwater quality will be compared against baseline conditions (historical and current data). The Hazen percentile calculator will be used to calculate 80th percentile parameters across the bores from the current data available, in order to develop trigger values for comparison.

Table 7-5. Monitoring program and trigger values groundwater sites

Monitoring sites	Parameter	Sampling frequency
Selected upstream and downstream of operations area and each irrigation area (GW1, GW2, GW3, GW4, GW5, GW6 and GW7)	pH	Quarterly
	EC	Quarterly
	Total P	Annually
	Total N	Annually
	Nitrate	Annually
	Cations & anions (Ca, Mg, Na, K, SO ₄ , Cl, CaCO ₃)	Annually

Baseline groundwater sampling locations to date are provided in Figure 2-2 and results in Appendix B. Access and permissions to monitor the groundwater bores within Black Jungle conservation reserve and surrounding land will be sought to monitor potential off-site impacts. A groundwater monitoring program will be developed with the EPL to determine the bores required to provide a spatial representation of the groundwater quality of the project area and data upstream and downstream of the site to determine potential impacts. To date, groundwater bores that have been sampled has been based on accessibility of the bore.

7.3 Quality assurance / quality control

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 specified standard sampling methods. All samples will be tracked with a chain of custody and sample receipt/record of delivery. Adequate sampling frequency, duplicates, triplicates, blanks 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).

7.4 Project operational monitoring

The EPL application will include an operational water quality-monitoring plan, which will detail the monitoring locations, parameters and frequency of monitoring. The monitoring program will also include further background sampling to establish a water quality baseline prior to commencement of full operations. Water quality trigger values will also be developed as part of the water management plan and applied to treated water to ensure it is suitable for reuse. The water quality monitoring program will provide early-warning of water quality issues and inform adaptive management of the wastewater treatment system to achieve water quality criteria; and monitor off-site impacts to receiving surface waters and groundwater.

The below Table 7-6 briefly outlines the proposed monitoring plan for effluent water quality, additional to the baseline monitoring for soil quality, surface water and groundwater detailed in Section 7.2.

Treated water monitoring

Treated effluent quality and volumes will be monitored at the irrigation extraction point/s. Monitoring locations will be selected once the system design is finalised.

Table 7-6. Monitoring program and trigger values for irrigation water

Monitoring sites	Parameter		Sampling frequency	Indicative Trigger values based on Darwin Croc Farm (DCF)
Irrigation Extraction Point	pH		Quarterly	6-9 ¹
	EC		Quarterly	400 – 500 $\mu\text{S}/\text{cm}^2$
	TDS		Quarterly	200 – 300 mg/L^2
	Total P		Quarterly	0.9 mg/L^3
	Total N		Quarterly	6 mg/L^3
	NH_3		Quarterly	1 mg/L^1
	BOD		Quarterly	40 mg/L^4
	Cations & anions (Ca, Mg, Na, K, SO_4 , Cl, CaCO_3)		Quarterly	30 mg/L (CaCO_3 - 220 mg/L) ²
	E.coli, Enterococci, Total coliforms		Quarterly	> 1,000 cfu/100mL (fodder) ¹
	Oil and grease		Biannually	> 5 mg/L (presence/absence) ⁵
	Total Metals	Arsenic	Quarterly	2.0 mg/L^6
		Cadmium	Quarterly	0.05 mg/L^6
		Chromium (VI)	Quarterly	1 mg/L^6
		Copper	Quarterly	5 mg/L^6

Monitoring sites	Parameter		Sampling frequency	Indicative Trigger values based on Darwin Croc Farm (DCF)
		Mercury	Quarterly	0.002 mg/L ⁶
		Nickel	Quarterly	2 mg/L ⁶
		Lead	Quarterly	5 mg/L ⁶
		Zinc	Quarterly	5 mg/L ⁶
	Herbicides (Glyphosate)		Annually	1 mg/L ⁷

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

²Baseline levels

³ Interim site-specific short-term trigger value

⁴ Environmental Guidelines – Use of Effluent by Irrigation (DEC, 2004)

⁵ Laboratory limit of reporting (LOR)

⁶ ANZECC, 2000 Short-term trigger values

⁷ Australian Drinking Water Guidelines 6, 2011 Version 3.5 (Updated August 2018)

Assessment of performance indicators

Annual nutrient balance calculations should be 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 should be graphed and compared annually, to identify any nutrient application issues or irrigation practices that may need to be altered.

Key parameters:

- Soil nitrogen
- available phosphorus
- salinity
- sodicity.

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

8 COMPLIANCE PLAN

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 Project 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 Project 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.

Construction activities will comply with final construction designs and relevant Australian Standards. Monitoring during construction will comply with the monitoring program as specified in Section 7.1.

Auditing of the site operational efficacy will be based of the monitoring requirements meeting the SSTV's and conditions as per approved environmental monitoring plans.

9 CONSULTATION AND COMMUNICATION

9.1 Stakeholder 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 9-1.

Table 9-1. Stakeholder consultation

Stakeholder	Relationship
NT Government	
NT EPA	Environmental assessment, EPA and EPL regulation
DENR	Groundwater extraction regulation
DIPL	NT Development Consent Authority - DA
Industry	
Crocodile Farmers Association NT	Crocodile Farmers Industry body for NT
Lagoon Crocodile Farm, Cairns Crocodile Farm, Janamba Crocodile Farm and Darwin Crocodile Farm	Knowledge sharing to improve water treatment and farming processes
Project construction workforce	
Sitzler	Construction of the Crocodile farm
Employees	Project construction workforce
Surrounding land users	
Darwin Fruit Farms	Neighbour – stakeholder engagement
Darwin Plant Wholesalers	
Koolpinyah Station (PPL1147)	
Volunteer Fire Brigade Station	

9.2 Complaint management

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

- Date and time of complaint
- Method by which complaint was made (i.e. telephone, letter, meeting, etc.)
- Name, address, contact telephone number of complainant
- Details of complaint
- Action taken in response to the complaint, including follow up contact 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.

10 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 severe weather. The ERP also outlines the roles and responsibilities of the Emergency Response Team in responding to environmental emergencies.

Table 10-1 lists the potential emergency events and relevant responses, applicable to the construction of the Project. Construction works are scheduled to occur during over the duration of a wet season, therefore the likelihood of a flood, cyclone or severe weather event during the works is possible.

Table 10-1. 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.
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.

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 Operations Manager and 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.

10.1 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 10-2 and Table 10-3.

Table 10-2. 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 10-3. 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.

10.2 Incident reporting

The Project 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 Environmental Protection Authority (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 10-4. This includes contacts for reporting pollution incidents (including non-urgent problems such as dust/noise), heritage and Aboriginal cultural heritage incidents, and contacts for provision of advice.

In the event of an unauthorised discharge, 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.

Table 10-4. 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
Managing Director / Lambells Lagoon Crocodile Farm Project Manager	Michael Burns PO Box 3942, Darwin NT 0801 P: 08 8988 1491 M: 0407 638 300 E: mick@biznt.com
Sitzler Construction Manager	Andrew McDonald P: 08 8330 0701 M: 0407 976 715 E: andrew.mcdonald@sitzler.com.au
DENR - Works on waterway, fauna sightings, vegetation clearing	Level 1, Goyder Centre, 25 Chung Wah Terrace, Palmerston NT 0830 08 8924 4218 (general services) 08 8999 4455 (water resources general enquiries)

10.3 Training and awareness

All construction personnel 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 CEMP. 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. All personnel will have a valid construction industry white card and undergo training in first aid and spill response.

11 REFERENCES

- Bureau of Meteorology (2018), Groundwater Dependent Ecosystems Atlas [online]. Available at: <http://www.bom.gov.au/water/groundwater/gde/>. Accessed 25 May 2020.
- Controller of Water Resources (2018) Groundwater Extraction Licence HGS10000 [online]. Available at: www.ntlis.gov.au/walaps-portal/report/current/gwel. Accessed 25 May 2020.
- Department of Environment and Natural Resources (DENR) (2018b), *Howard Groundwater System*, Water Resources Division, Northern Territory Government, Darwin.
- Department of Environment and Natural Resources (DENR) (2020), Water level information (hydrographs) [online]. Available at: <https://denr.nt.gov.au/water/water-management/darwin-rural-groundwater-watch> [Accessed 4 February 2020].
- Department of Environment and Natural resources, Northern Territory Planning Scheme, Land Clearing Guidelines, (DENR 2020) [online]. Available at: https://nt.gov.au/_data/assets/pdf_file/0007/236815/land-clearing-guidelines.pdf [Accessed 14 August 2020].
- Department of Environment and Natural Resources (DENR) (2019). Beneficial Water Use [online]. Available at: <https://denr.nt.gov.au/water/water-management/beneficial-use/beneficial-use-declarations> [Accessed 25 May 2020].
- EcOz Environmental Consultants (EcOz) (2020a). Project Notice of Intent. [unpublished].
- EcOz Environmental Consultants (EcOz) (2020b). Project: Response to NT EPA additional Information. [unpublished].
- Fogarty, P.J, Lynch, B. and Wood, B. (1984). The land resources of the Elizabeth, Darwin and Blackmore Rivers. Land Conservation Unit, Conservation Commission of the Northern Territory.
- GPA Engineering (GPA) (2020). *Process Design Brief: Waste Water Treatment and Reuse – Marpu Crocodile Farm Design Concept*, GPA Engineering April 2020.
- Northern Territory Environmental Protection Authority (NT EPA) (2015). *Guidelines to prevent pollution from building sites*.
- Parks and Wildlife Commission of the Northern Territory. (2014). *Adelaide River Conservation Reserves Joint Management Plan* [online] Available at: https://dtsc.nt.gov.au/_data/assets/pdf_file/0006/249036/Adelaide-River-Conservation-Reserves-JM-Plan-August-2014_final.pdf [Accessed 23 January 2020].

APPENDIX A 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
Total Metals																	

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
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 B BASELINE GROUNDWATER QUALITY RESULTS

Analyte	Units	LOR	ANZECC Primary Industries (2000) (WATER) - Long-term trigger values (LTV) - Irrigation and General Use	ADWG (2011) (WATER) - Health & Aesthetic	DEC (2004) Effluent by irrigation, NSW: LOW STRENGTH (mg/L)	RN030418	RN024671	RN036485	RN029096	RN029097	RN030413	RN029097	RN029098	RN029096	RN036485
Field Parameters	Date					23-01-20	23-01-20	27/02/2020	27/02/2020	27/02/2020	09-07-20	09-07-20	09-07-20		
Ph	Ph		6 - 8.5			7.36	6.98	7.4	7.53	7.55	7.25	7.49	5.63	7.5	7.75
Electrical Conductivity (EC)	µS/cm					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	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	-	600	<600	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	-	250		<1	<1	<1	<1	1	<1	<1	<1	<1	<1
Chloride	mg/L	1	25	250		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	180		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	1		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	3		<0.005	0.009	<0.005	<0.005	<0.005	<0.005	0.005	0.01	<0.005	<0.005
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	-	0.41		0.14	0.04	<0.01	<0.01	0.03	0.05	0.07	0.09	0.17	0.01

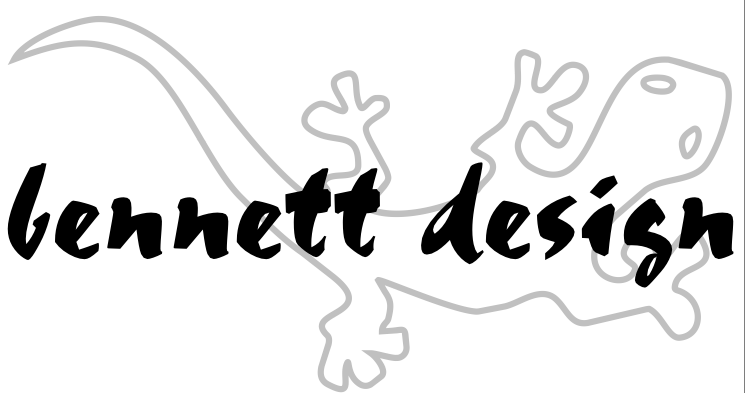
Analyte	Units	LOR	ANZECC Primary Industries (2000) (WATER) - Long-term trigger values (LTV) - Irrigation and General Use	ADWG (2011) (WATER) - Health & Aesthetic	DEC (2004) Effluent by irrigation, NSW: LOW STRENGTH (mg/L)	RN030418	RN024671	RN036485	RN029096	RN029097	RN030413	RN029097	RN029098	RN029096	RN036485
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	-	<50	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	-	<10	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	-	-	<40	<2	<2	<2	2	<2	<2	<2	<2	<2	<2
Bacteriological															
Escherichia coli	CFU/100mL	1	-	-		~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

APPENDIX C BASELINE SURFACE WATER QUALITY RESULTS

Analyte	Units	LOR	ANZECC 2000 Prot. Aquatic Ecosystems - Freshwater 95% protection	ANZECC 2000 Prot. Aquatic Ecosystems Tropical - Freshwater Lakes & Reservoirs	SW01	SW02	SW03	SW04
Field Parameters								
pH	pH		-	6.0 - 8.0	5.64	5.52	5.83	5.62
Temperature	oC		-	-	27.2	27	27.3	26.9
Electrical Conductivity (EC)	µS/cm		-	-	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		-	-	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	0.9	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	0.7	-	0.04	0.02	<0.01	0.02
Nitrite + Nitrate as N	mg/L	0.01	-	0.01	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	-	0.35	0.2	0.2	0.5	0.2
Total Phosphorus as P	mg/L	0.01	-	0.01	0.09	<0.01	0.06	0.12
Reactive Phosphorus as P	mg/L	0.01	-	0.005	0.05	<0.01	0.04	0.08
Major Anions								
Bicarbonate Alkalinity as CaCO ₃	mg/L	1	-	-	4	2	5	8
Carbonate Alkalinity as CaCO ₃	mg/L	1	-	-	<1	<1	<1	<1
Hydroxide Alkalinity as CaCO ₃	mg/L	1	-	-	<1	<1	<1	<1
Total Alkalinity as CaCO ₃	mg/L	1	-	-	4	2	5	8
Sulfate as SO ₄	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
Sodium	mg/L	1	-	-	<1	<1	<1	<1

Analyte	Units	LOR	ANZECC 2000 Prot. Aquatic Ecosystems - Freshwater 95% protection	ANZECC 2000 Prot. Aquatic Ecosystems Tropical - Freshwater Lakes & Reservoirs	SW01	SW02	SW03	SW04
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 D DESIGN DETAILS



A R C H I T E C T

P 08 8948 4607 | F 08 8918 8113 | ABN 51 083050024
www.bennettdesign.com.au | contact@bennettdesign.com.au

CLIENT:



PROJECT:

CROCODILE FARMING PROJECT

SEC 1611 (255) ALPHATONIA ROAD LAMBELLS LAGOON, HUMPTY DOO NT 0836

COMPOST SHED

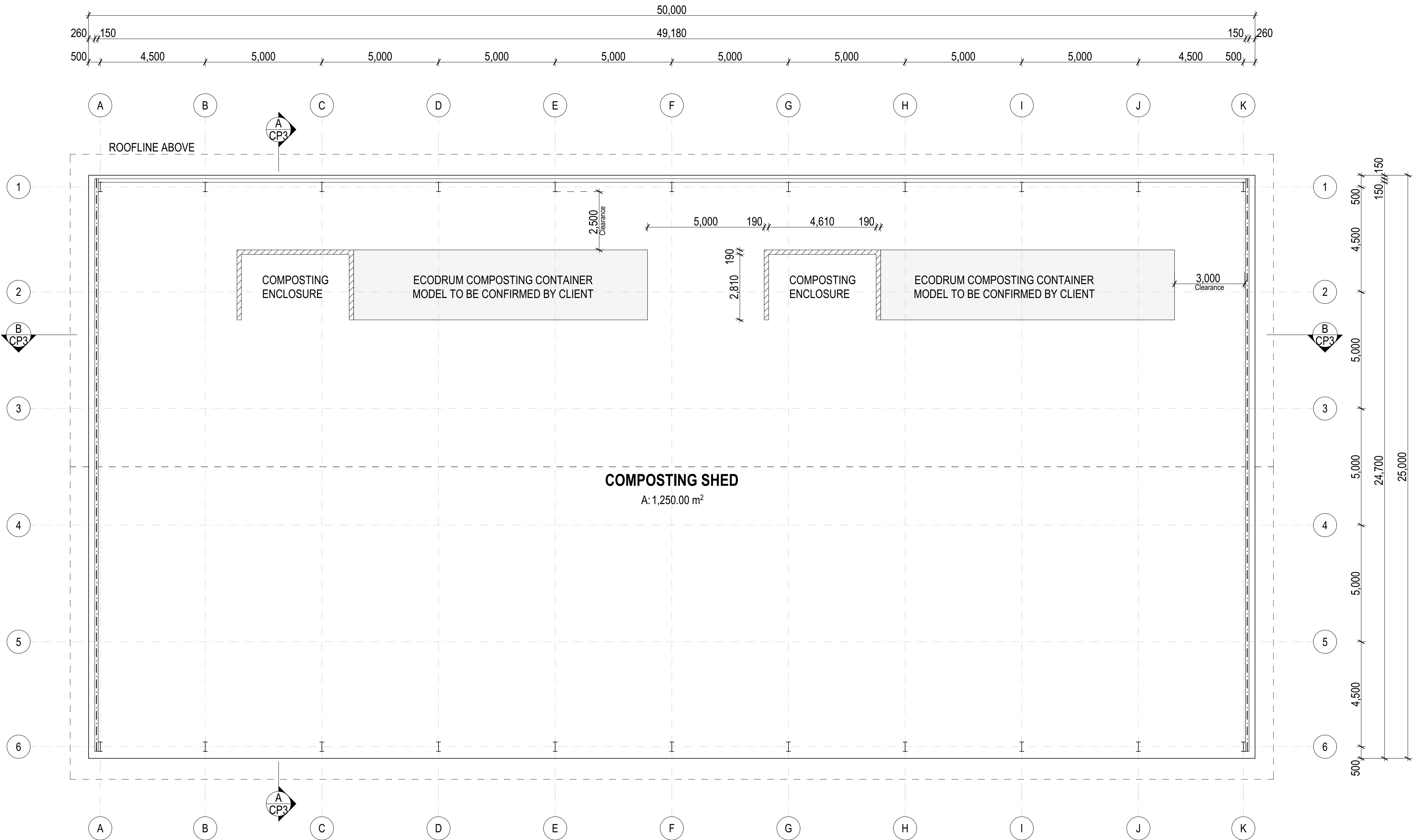
PROPOSED FLOOR PLAN

PRELIMINARY: DB2634

DATE: 04/2020	DRAWN: NL/DV	CHECKED: DB
SCALE: AS SHOWN SHEET SIZE: A1	CP1	REVISION: B

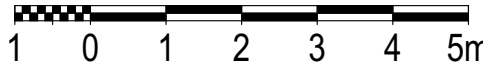
© Copyright & Liability Notice
These designs and drawings and the Copyright thereof are the property of Bennett Design P/L and are not to be used, retained or copied by either physical or electronic means without written or expressed permission. Bennett Design P/L accepts no responsibility for the completeness, accuracy or compatibility of electronically transferred documents. If necessary, recipients should request a hardcopy version for verification.

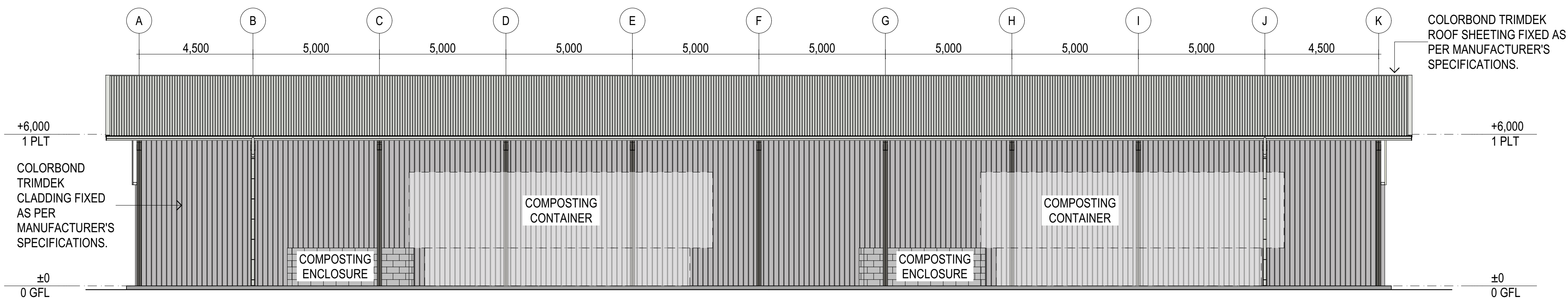
DO NOT SCALE OFF THESE DRAWINGS



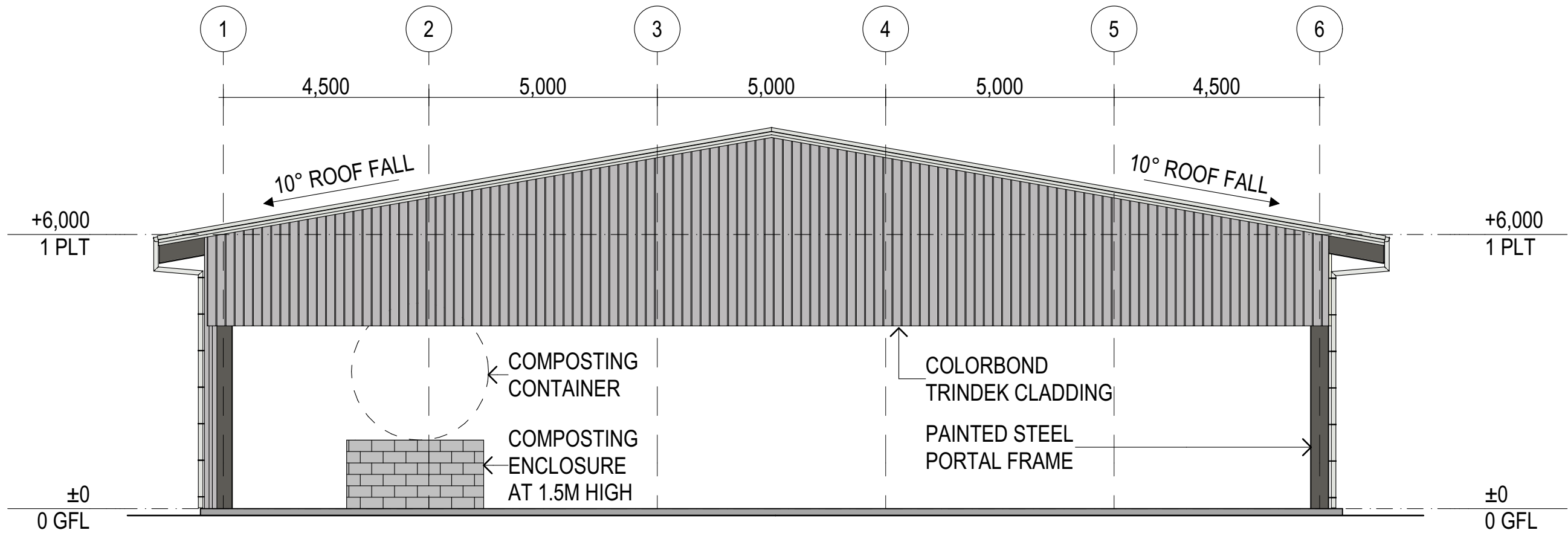
PROPOSED PLAN

SCALE 1:100

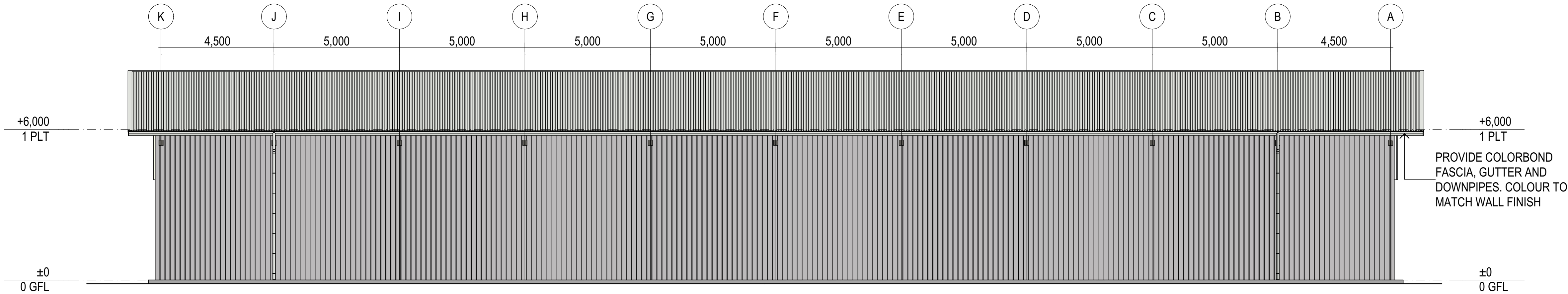




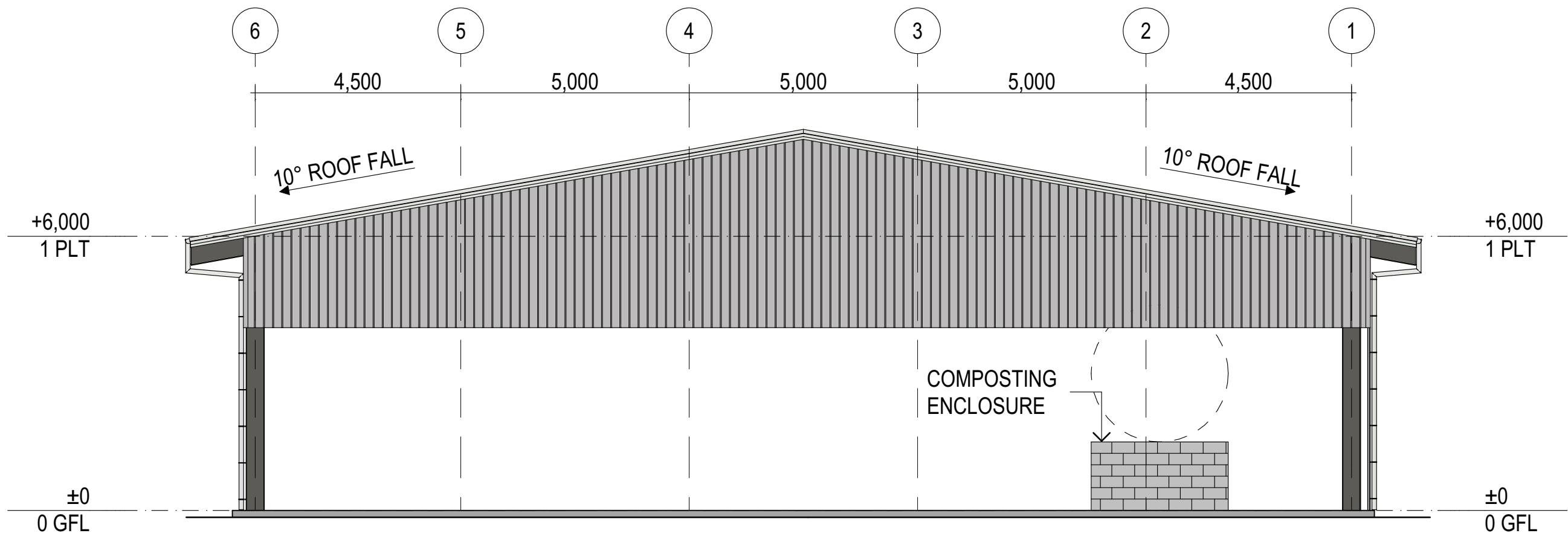
ELEVATION 1
SCALE 1:100



ELEVATION 2
SCALE 1:100



ELEVATION 3
SCALE 1:100



ELEVATION 4
SCALE 1:100

CLIENT:



PROJECT:

CROCODILE FARMING PROJECT

SEC 1611 (255) ALPHATONIA ROAD LAMBELLS LAGOON, HUMPTY DOO NT 0836

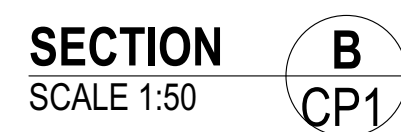
COMPOST SHED ELEVATIONS

PRELIMINARY: DB2634

DATE: 04/2020	DRAWN: NL/DV	CHECKED: DB
SCALE: AS SHOWN SHEET SIZE: A1	CP2	REVISION: B

© Copyright & Liability Notice
These designs and drawings and the Copyright thereof are the property of Bennett Design P/L and are not to be used, retained or copied by either physical or electronic means without written or expressed permission. Bennett Design P/L accepts no responsibility for the completeness, accuracy or compatibility of electronically transferred documents. If necessary, recipients should request a hardcopy version for verification.

DO NOT SCALE OFF THESE DRAWINGS



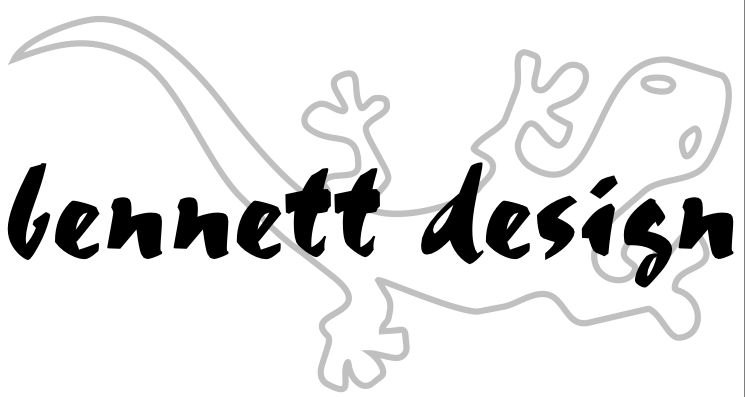
PROJECT: CROCODILE FARMING PROJECT

SEC 1611 (255) ALPHATONIA
ROAD LAMBELLS LAGOON,
HUMPTY DOO NT 0836

PRELIMINARY: DB2634		
DATE: 04/2020	DRAWN: NL/DV	CHECKED: DB
SCALE: AS SHOWN SHEET SIZE: A1	CP3	REVISION: B

© Copyright & Liability Notice
These designs and drawings and the Copyright thereof are the property of Bennett Design P/L and are not to be used, retained or copied by either physical or electronic means without written or expressed permission. Bennett Design P/L accepts no responsibility for the completeness, accuracy or compatibility of electronically transferred documents. If necessary, recipients should request a hardcopy version for verification.

DO NOT SCALE OFF THESE DRAWINGS



P 08 8948 4607 | F 08 8918 8113 | ABN 51 083050024
www.bennettdesign.com.au | contact@bennettdesign.com.au

CLIENT:



PROJECT:

CROCODILE FARMING PROJECT

SEC 1611 (255) ALPHATONIA ROAD LAMBELLS LAGOON, HUMPTY DOO NT 0836

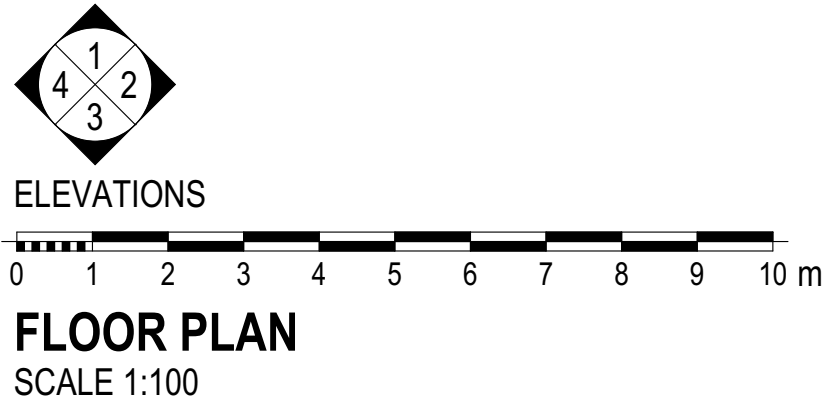
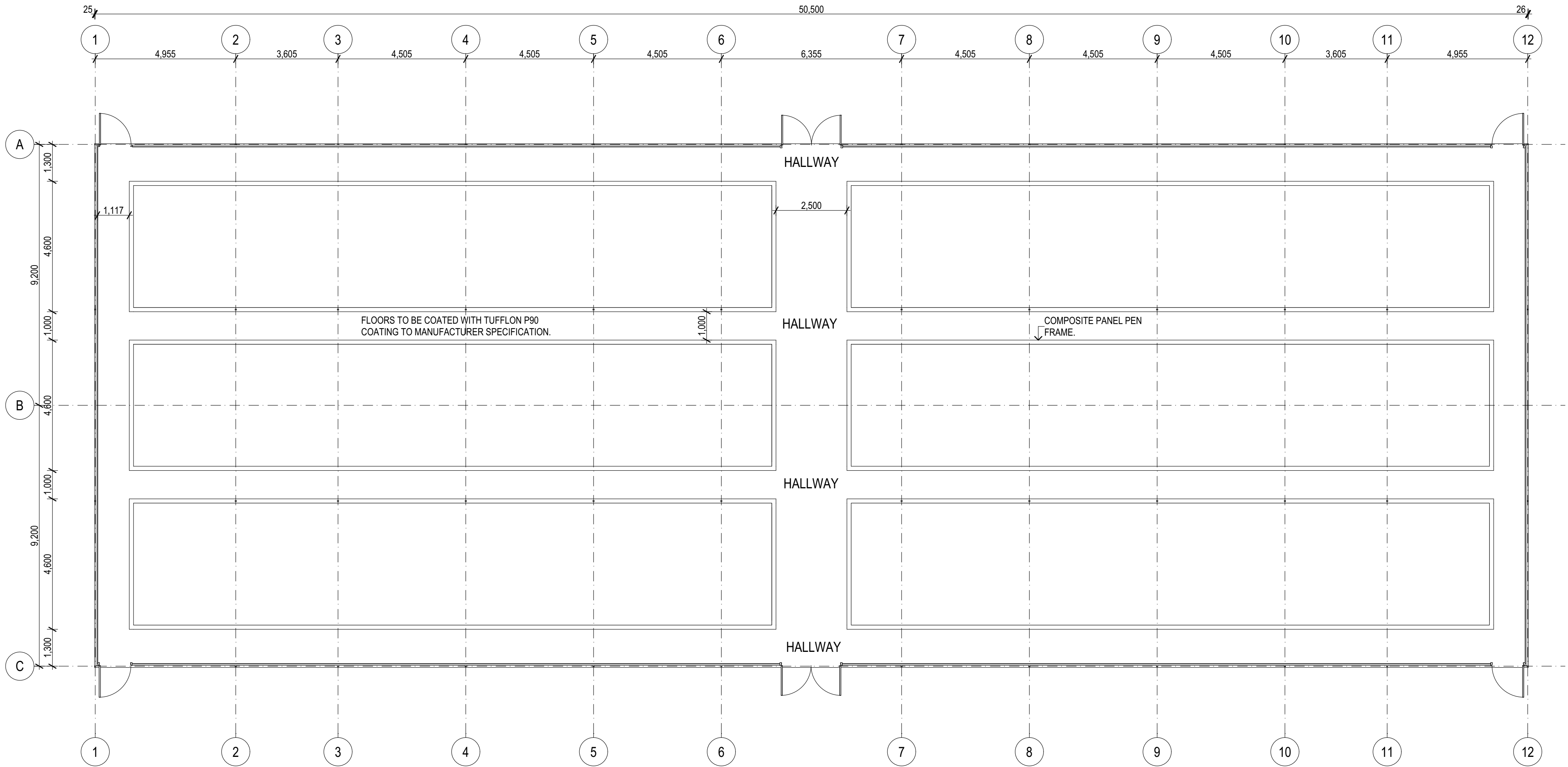
TYPE A PEN FLOOR PLAN

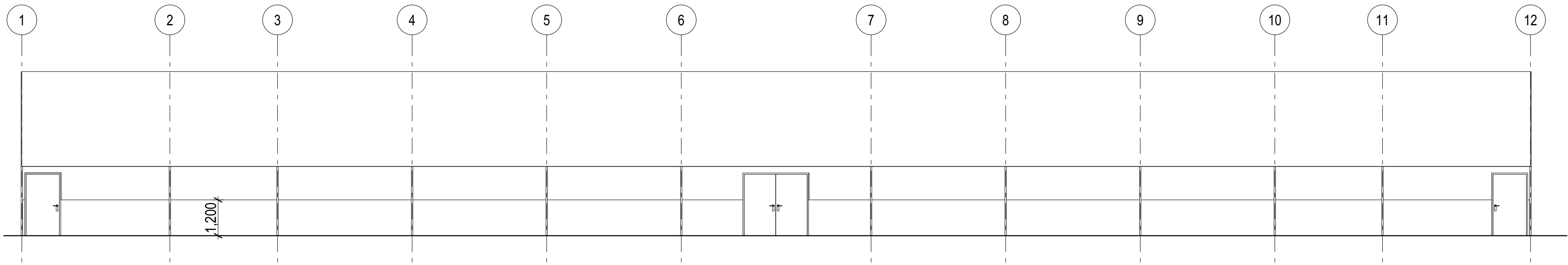
PRELIMINARY: DB2634

DATE: 04/2020	DRAWN: NL/MS	CHECKED: DB
SCALE: AS SHOWN SHEET SIZE: A1	FP01	REVISION: G

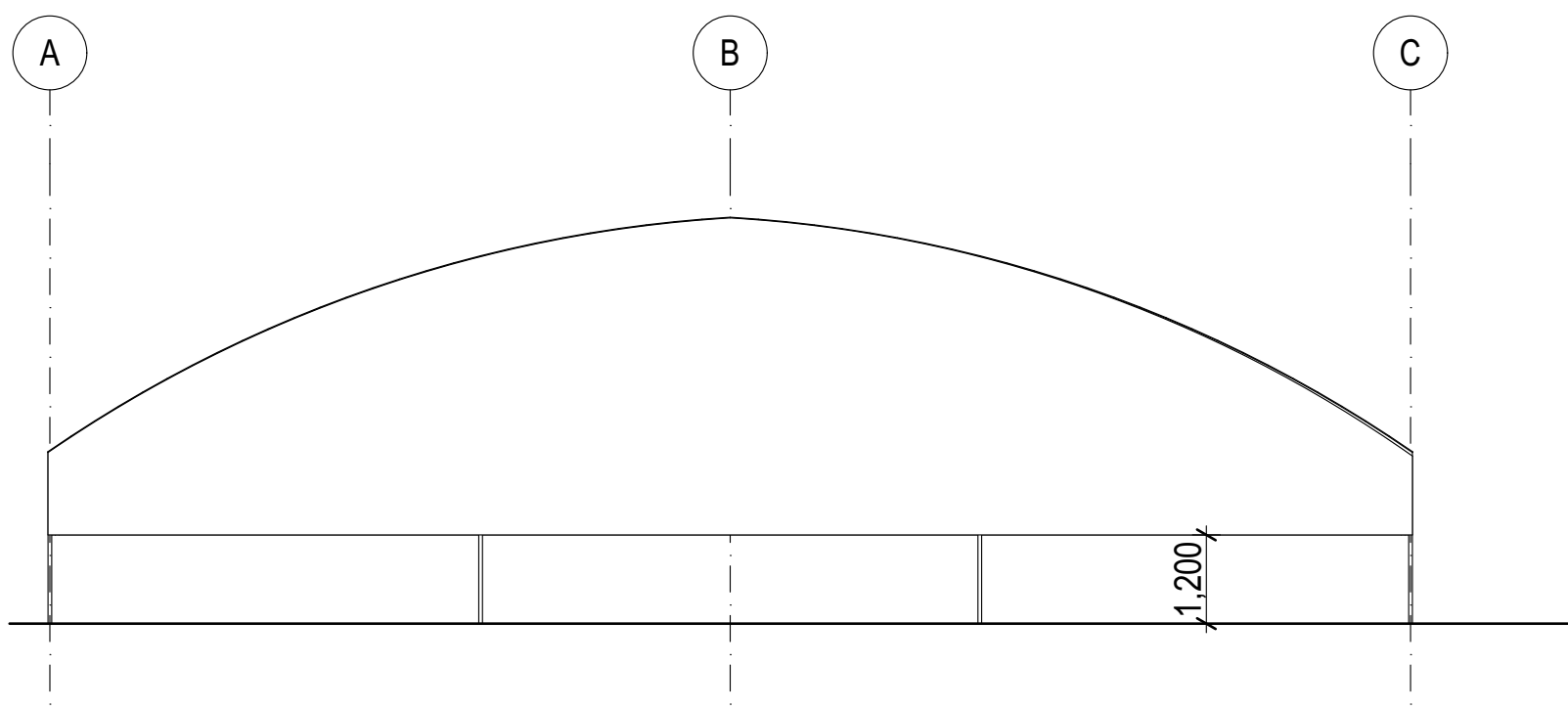
© Copyright & Liability Notice
These designs and drawings and the Copyright thereof are the property of Bennett Design P/L and are not to be used, retained or copied by either physical or electronic means without written or expressed permission. Bennett Design P/L accepts no responsibility for the completeness, accuracy or compatibility of electronically transferred documents. If necessary, recipients should request a hardcopy version for verification.

DO NOT SCALE OFF THESE DRAWINGS

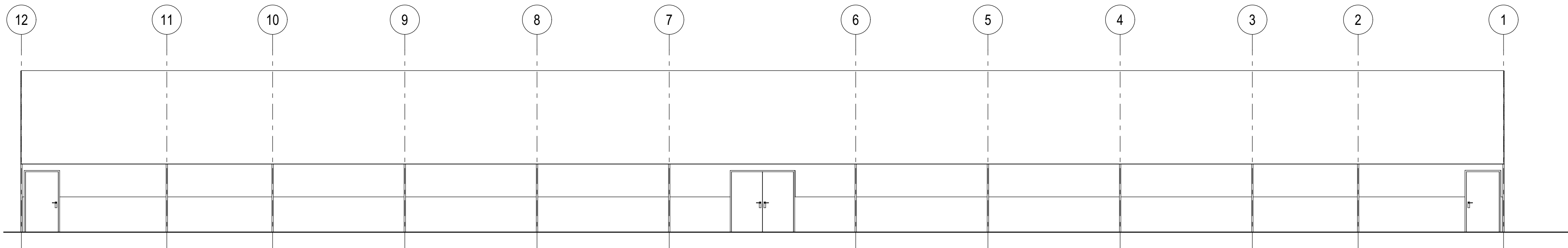




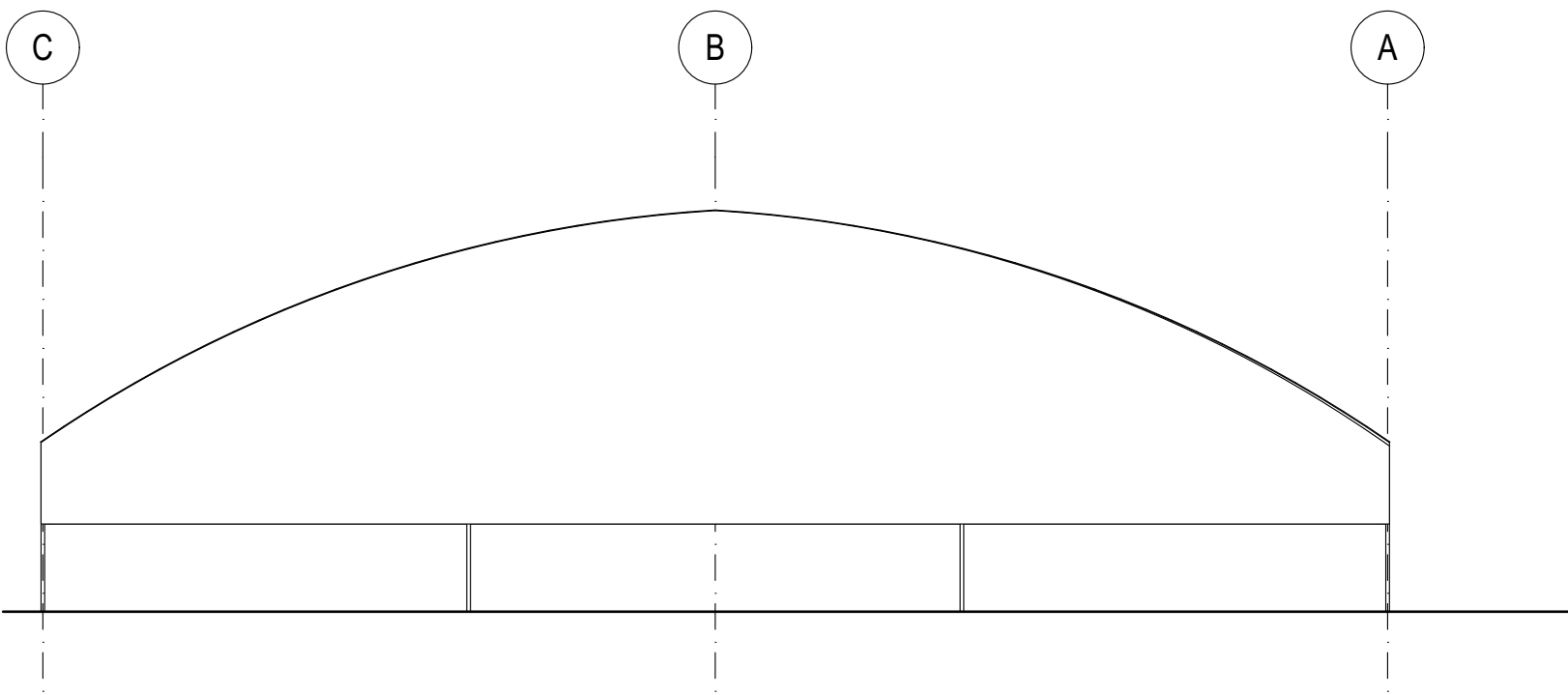
ELEVATION 1
SCALE 1:100



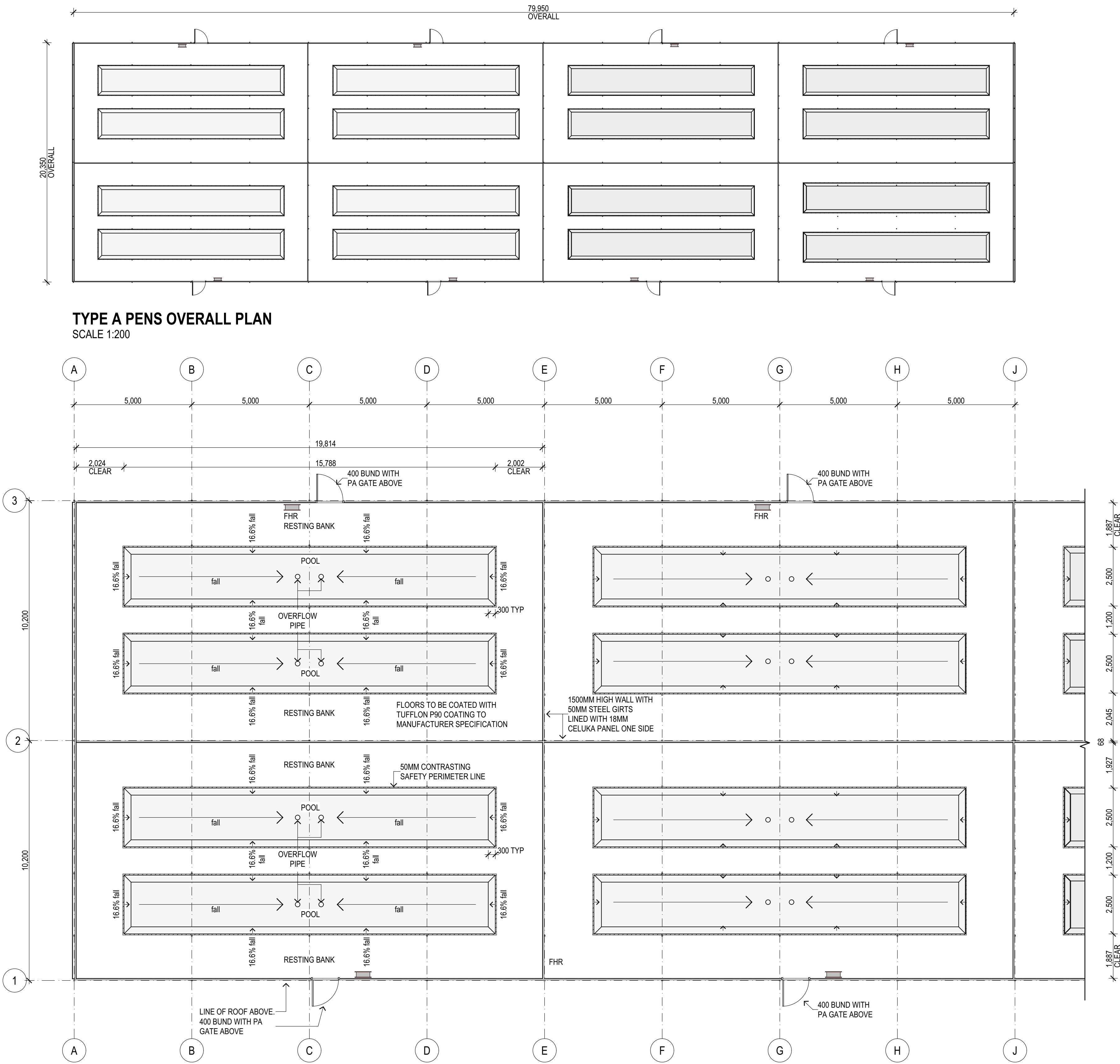
ELEVATION 2
SCALE 1:100



ELEVATION 3
SCALE 1:100

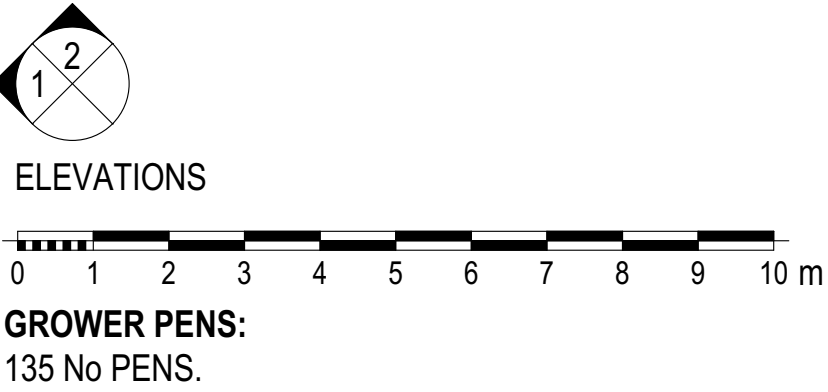


ELEVATION 4
SCALE 1:100

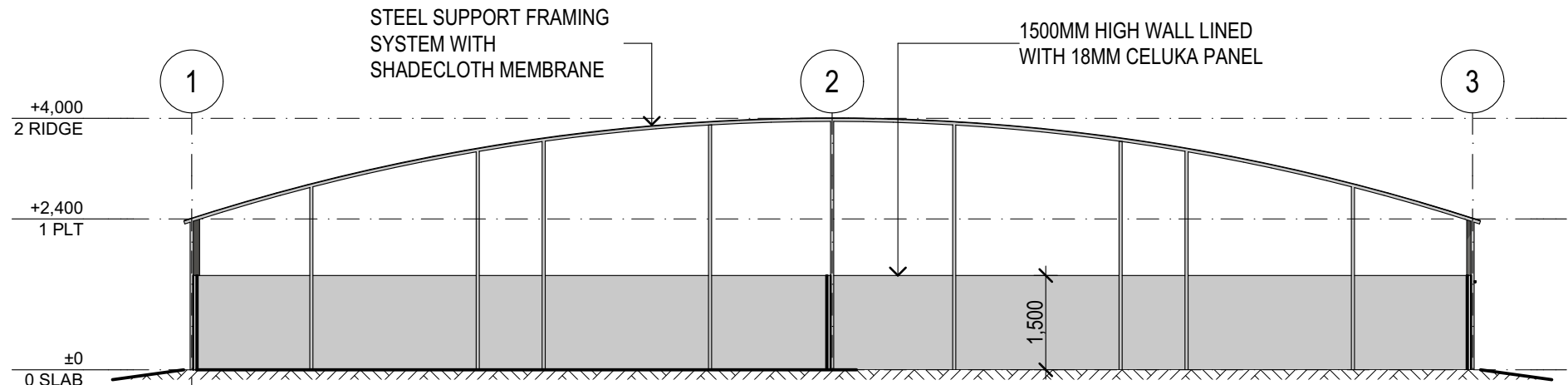


TYPE A PENS OVERALL PLAN
SCALE 1:200

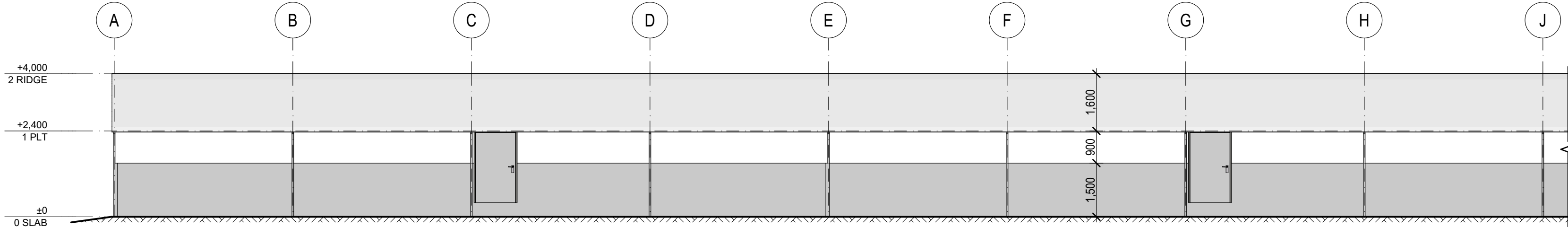
TYPE A PEN DETAILED PLAN
SCALE 1:100



GROWER PENS:
135 No PENS.



ELEVATION 1
SCALE 1:100



ELEVATION 2
SCALE 1:100

CLIENT:



PROJECT:

CROCODILE FARMING PROJECT

SEC 1611 (255) ALPHATONIA ROAD LAMBELLS LAGOON, HUMPTY DOO NT 0836

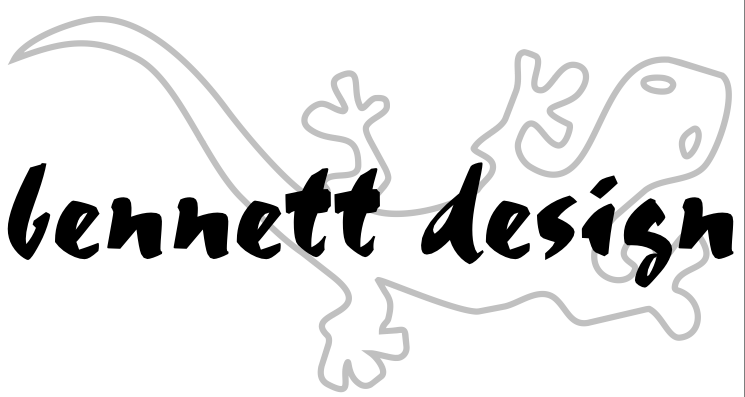
TYPE A PEN ELEVATIONS

PRELIMINARY: DB2634

DATE: 04/2020	DRAWN: NL/MS	CHECKED: DB
SCALE: AS SHOWN SHEET SIZE: A1	GP02	REVISION: G

© Copyright & Liability Notice
These designs and drawings and the Copyright thereof are the property of Bennett Design P/L and are not to be used, retained or copied by either physical or electronic means without written or expressed permission. Bennett Design P/L accepts no responsibility for the completeness, accuracy or compatibility of electronically transferred documents. If necessary, recipients should request a hardcopy version for verification.

DO NOT SCALE OFF THESE DRAWINGS



A R C H I T E C T

P 08 8948 4607 | F 08 8918 8113 | ABN 51 083050024
www.bennettdesign.com.au | contact@bennettdesign.com.au

CLIENT:



PROJECT:

CROCODILE FARMING PROJECT

SEC 1611 (255) ALPHATONIA ROAD LAMBELLS LAGOON, HUMPTY DOO NT 0836

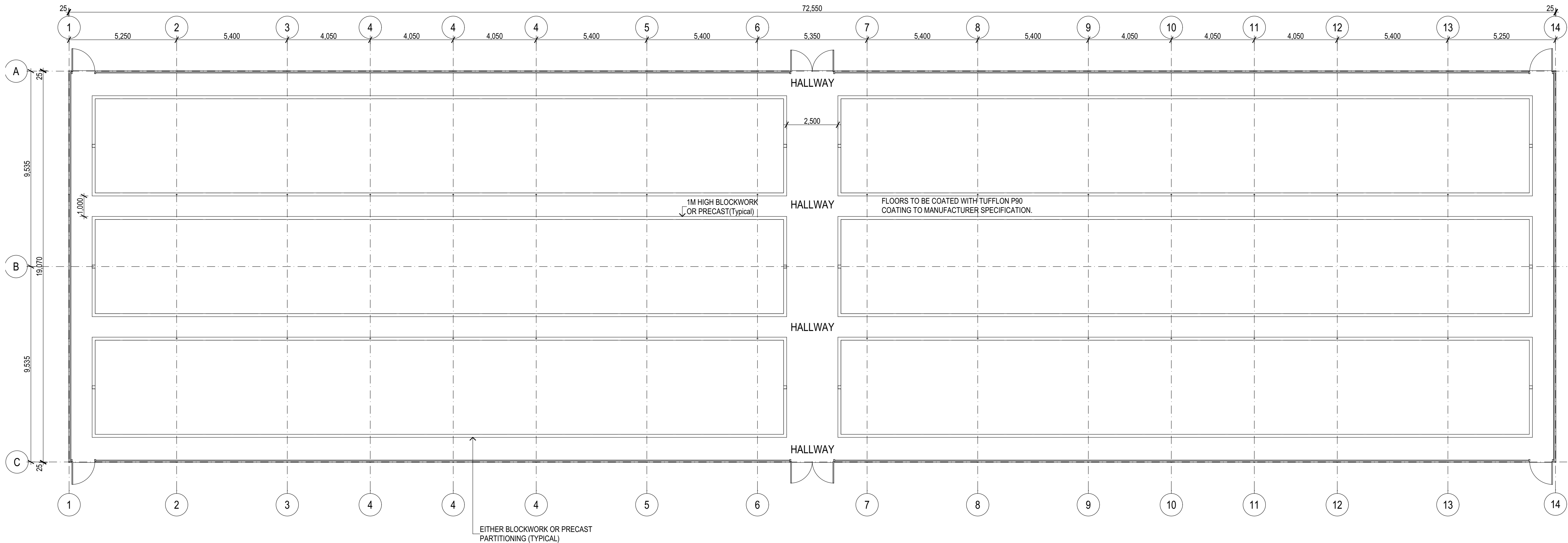
TYPE B FLOOR PLAN

PRELIMINARY: DB2634

DATE: 04/2020	DRAWN: NL/MS	CHECKED: DB
SCALE: AS SHOWN SHEET SIZE: A1	FP04	REVISION: G

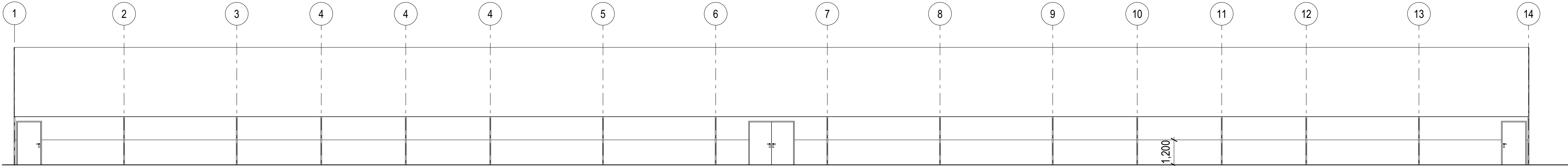
© Copyright & Liability Notice
These designs and drawings and the Copyright thereof are the property of Bennett Design P/L and are not to be used, retained or copied by either physical or electronic means without written or expressed permission. Bennett Design P/L accepts no responsibility for the completeness, accuracy or compatibility of electronically transferred documents. If necessary, recipients should request a hardcopy version for verification.

DO NOT SCALE OFF THESE DRAWINGS

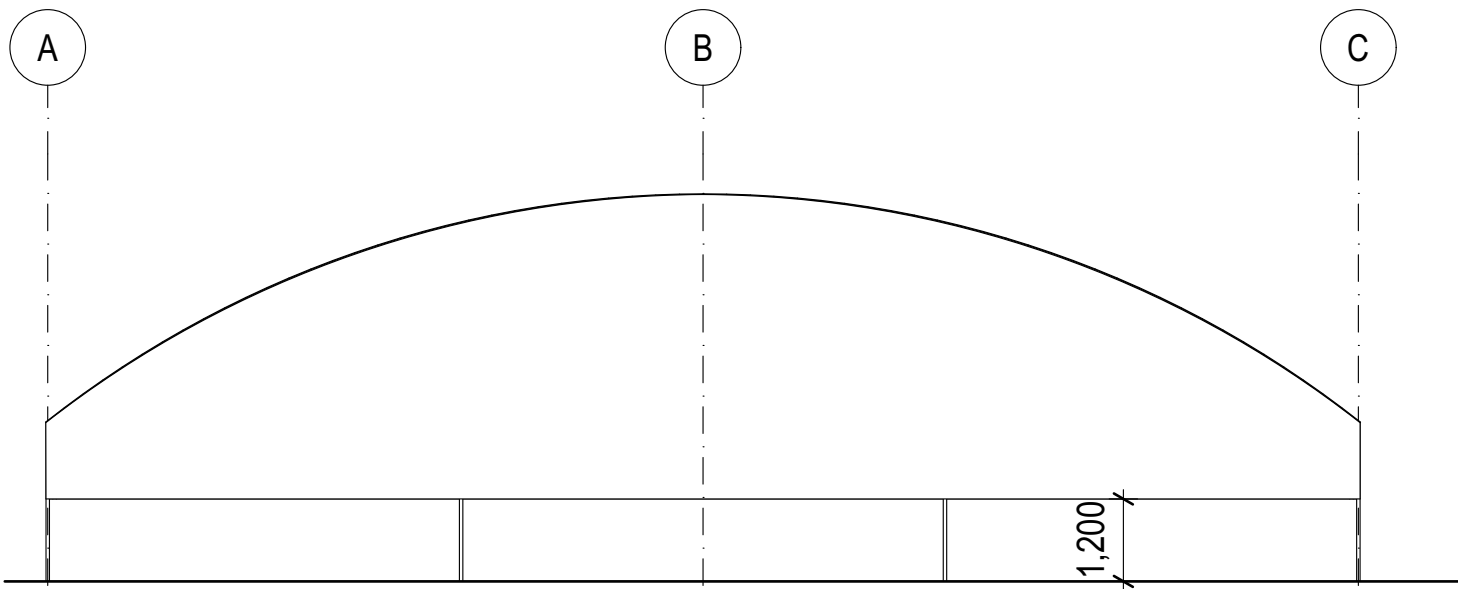


ELEVATIONS
0 1 2 3 4 5 6 7 8 9 10 m

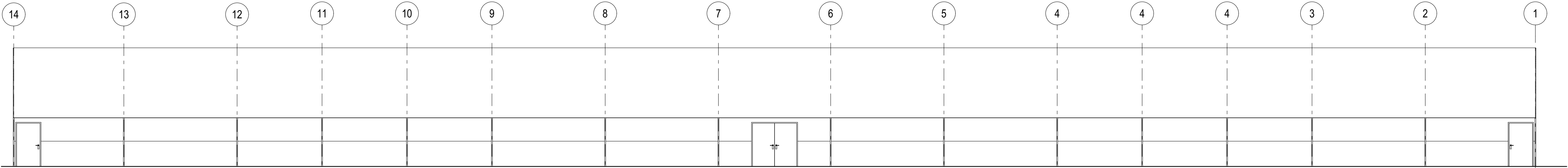
FLOOR PLAN
SCALE 1:110



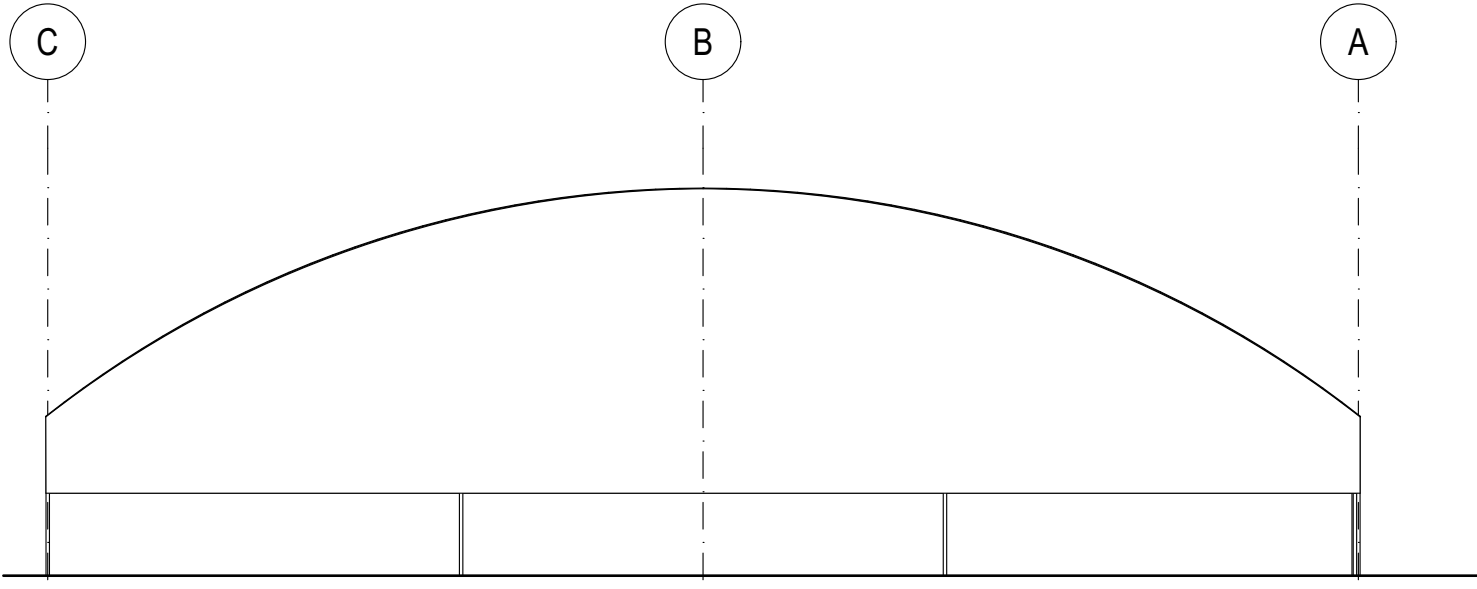
ELEVATION 1
SCALE 1:110



ELEVATION 2
SCALE 1:110



ELEVATION 3
SCALE 1:110



ELEVATION 4
SCALE 1:110

CLIENT:



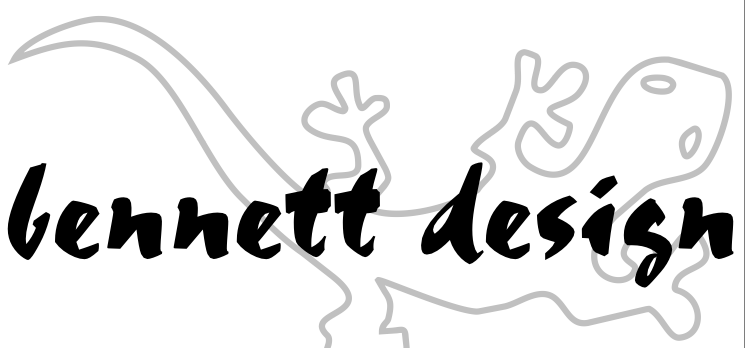
PROJECT:

CROCODILE FARMING PROJECT

SEC 1611 (255) ALPHATONIA ROAD LAMBELLS LAGOON, HUMPTY DOO NT 0836

TYPE B PEN ELEVATIONS

PRELIMINARY: DB2634		
DATE: 04/2020	DRAWN: NL/MS	CHECKED: DB
SCALE: AS SHOWN SHEET SIZE: A1	FP05	REVISION: G
© Copyright & Liability Notice These designs and drawings and the Copyright thereof are the property of Bennett Design P/L and are not to be used, retained or copied by either physical or electronic means without written or expressed permission. Bennett Design P/L accepts no responsibility for the completeness, accuracy or compatibility of electronically transferred documents. If necessary, recipients should request a hardcopy version for verification.		
DO NOT SCALE OFF THESE DRAWINGS		



A R C H I T E C T

P 08 8948 4607 | F 08 8918 8113 | ABN 51 083050024
www.bennettdesign.com.au | contact@bennettdesign.com.au

CLIENT:



PROJECT:

CROCODILE FARMING PROJECT

SEC 1611 (255) ALPHATONIA ROAD LAMBELLS LAGOON, HUMPTY DOO NT 0836

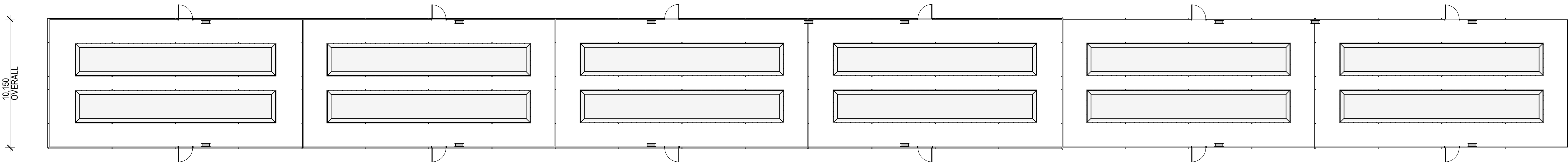
TYPE B PEN OVERALL PLAN & DETAILED PLAN

PRELIMINARY: DB2634

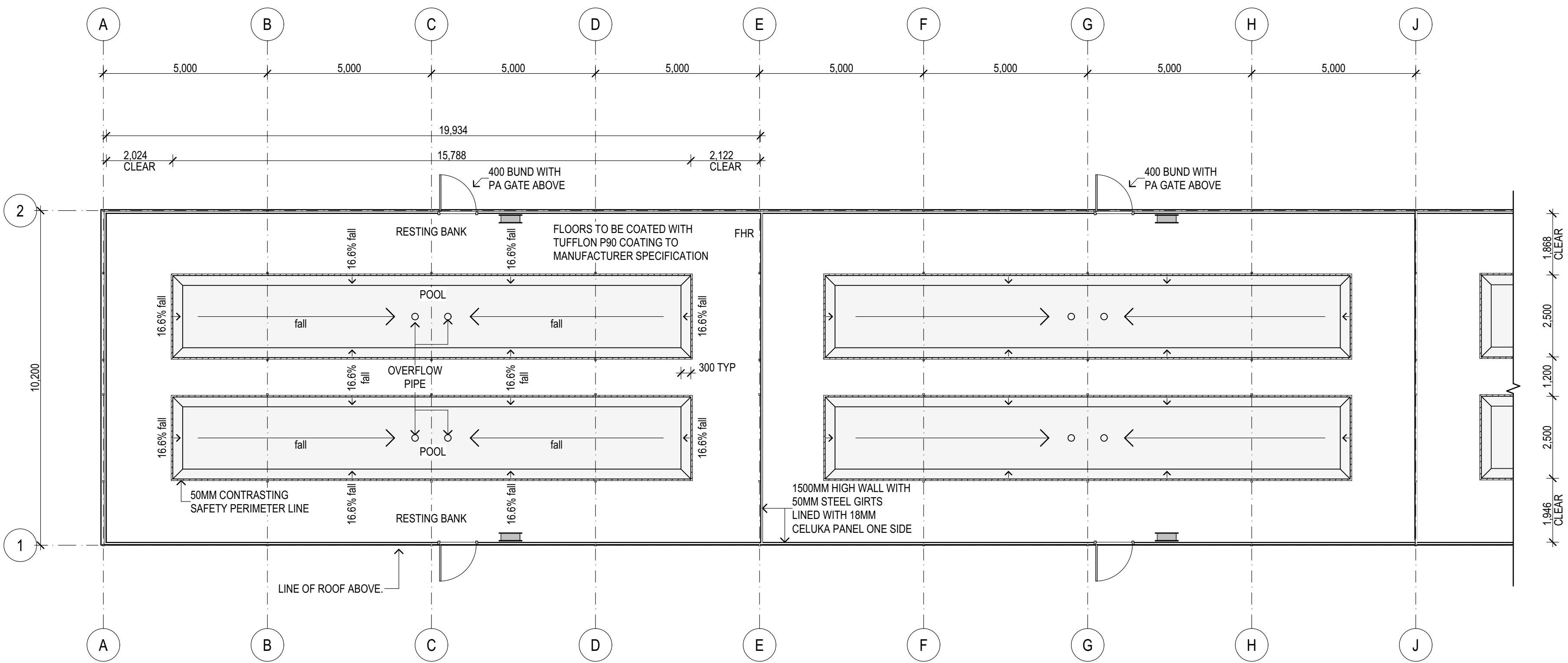
DATE: 04/2020	DRAWN: NL/MS	CHECKED: DB
SCALE: AS SHOWN SHEET SIZE: A1	GP03	REVISION: F

© Copyright & Liability Notice
These designs and drawings and the Copyright thereof are the property of Bennett Design P/L and are not to be used, retained or copied by either physical or electronic means without written or expressed permission. Bennett Design P/L accepts no responsibility for the completeness, accuracy or compatibility of electronically transferred documents. If necessary, recipients should request a hardcopy version for verification.

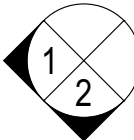
DO NOT SCALE OFF THESE DRAWINGS



TYPE B PEN OVERALL LAYOUT PLAN
SCALE 1:200



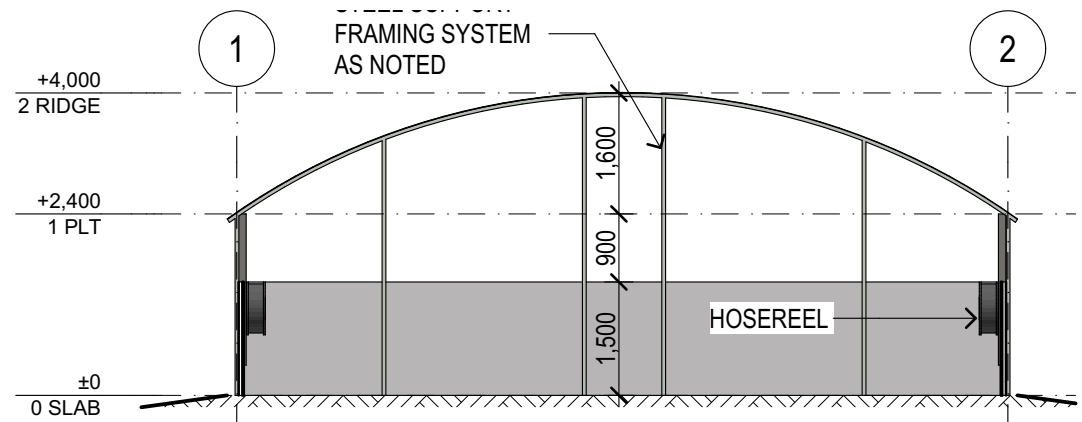
TYPE B PEN DETAILED FLOOR PLAN
SCALE 1:100



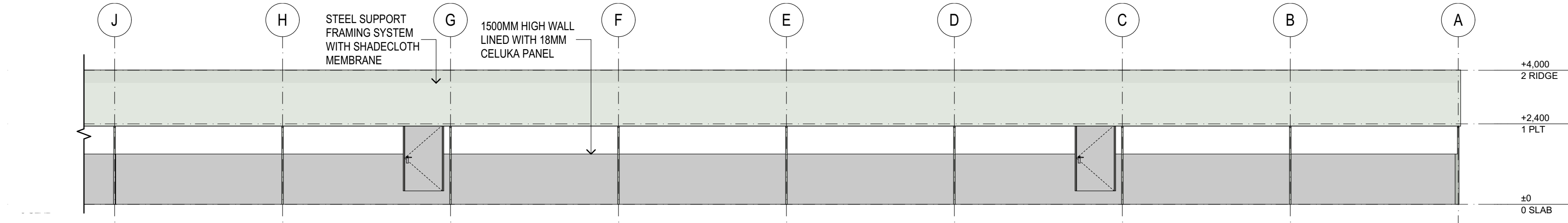
ELEVATIONS



GROWER PENS:
135 No PENS.



ELEVATION 1
SCALE 1:100



ELEVATION 2
SCALE 1:100

DATE: 04/2020	DRAWN: NL/MS	CHECKED: DB
SCALE: AS SHOWN SHEET SIZE: A1	GP04	REVISION: G

CLIENT:



PROJECT:

CROCODILE FARMING PROJECT

SEC 1611 (255) ALPHATONIA ROAD LAMBELLS LAGOON, HUMPTY DOO NT 0836

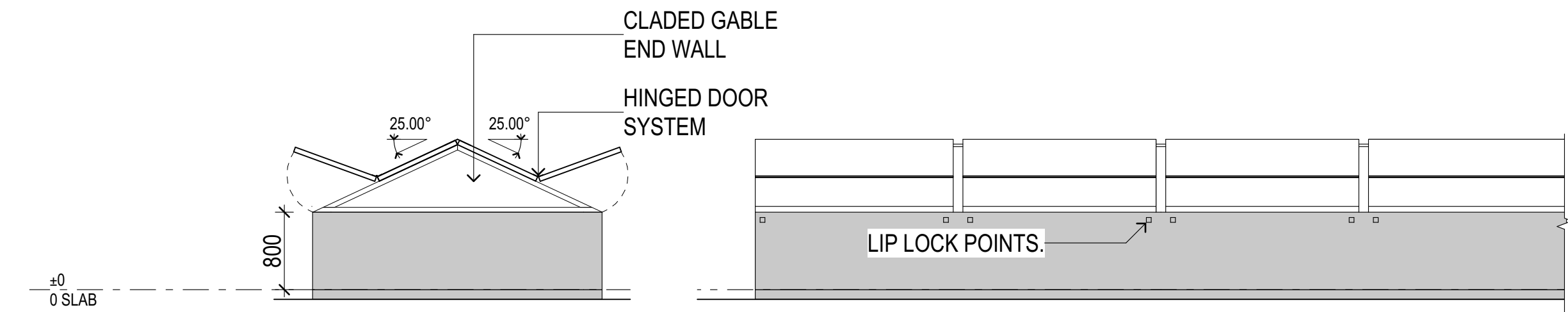
PEN PLAN AND ELEVATIONS

PRELIMINARY: DB2634

DATE: 06/2020	DRAWN: NL/DV	CHECKED: DB
SCALE: AS SHOWN SHEET SIZE: A1	HP01	REVISION: F

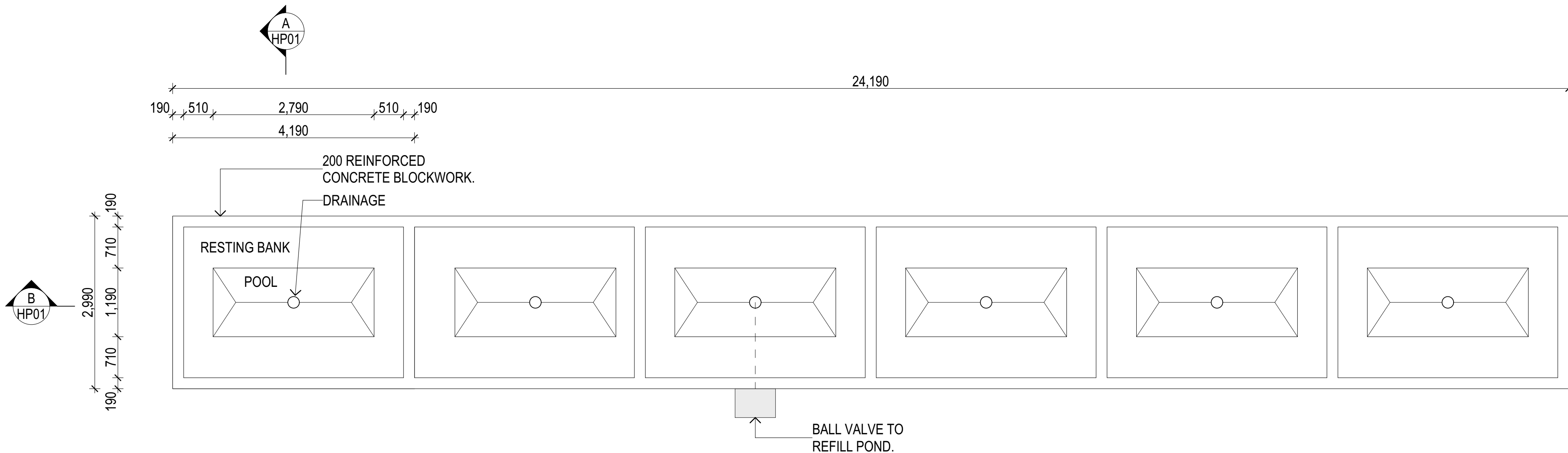
© Copyright & Liability Notice
These designs and drawings and the Copyright thereof are the property of Bennett Design P/L and are not to be used, retained or copied by either physical or electronic means without written or expressed permission. Bennett Design P/L accepts no responsibility for the completeness, accuracy or compatibility of electronically transferred documents. If necessary, recipients should request a hardcopy version for verification.

DO NOT SCALE OFF THESE DRAWINGS

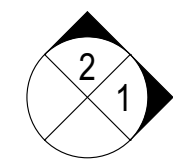


ELEVATION 1
SCALE 1:50

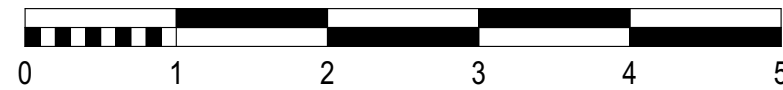
ELEVATION 2
SCALE 1:50

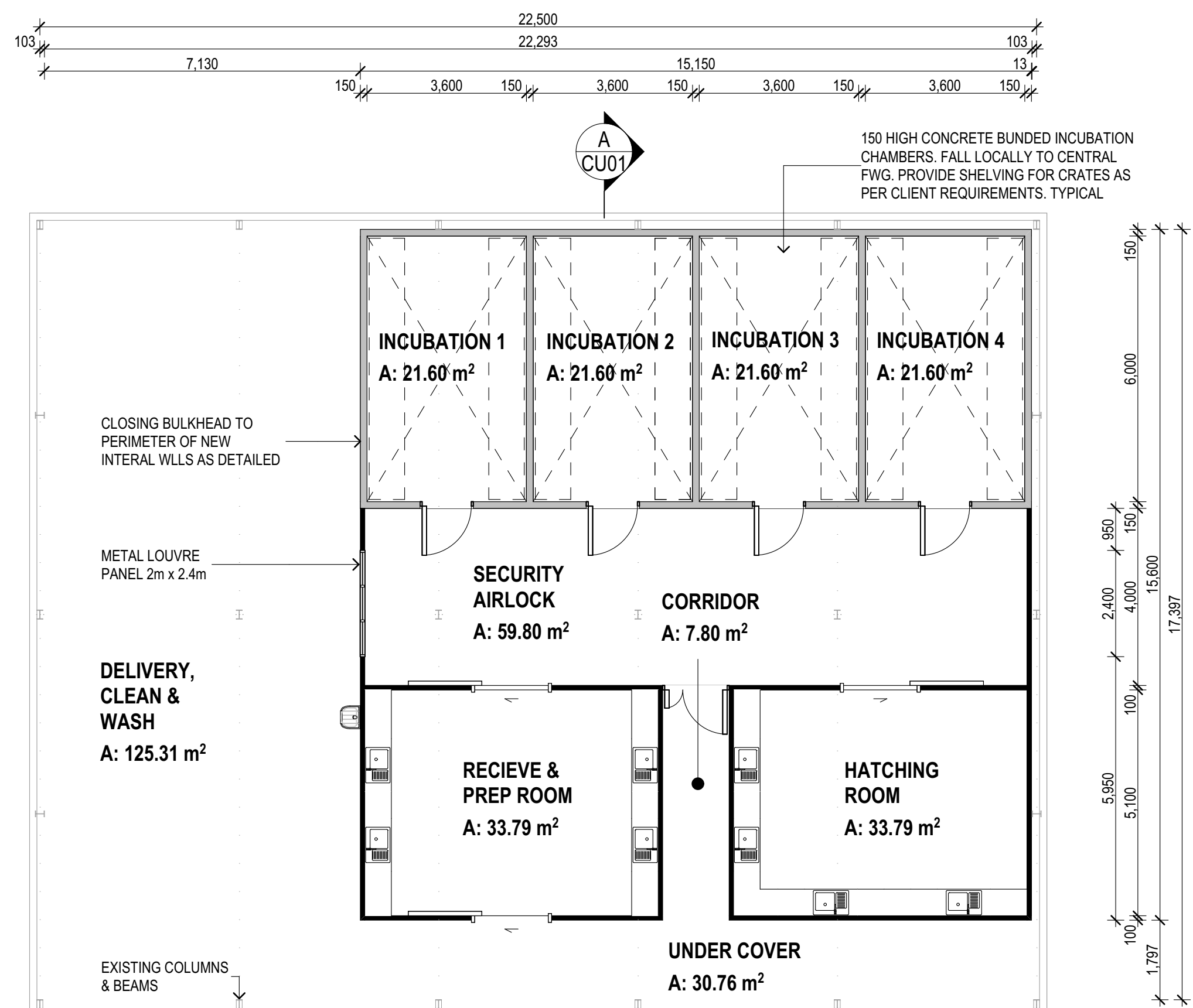


FLOOR PLAN
SCALE 1:50

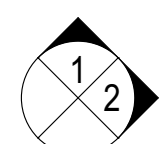
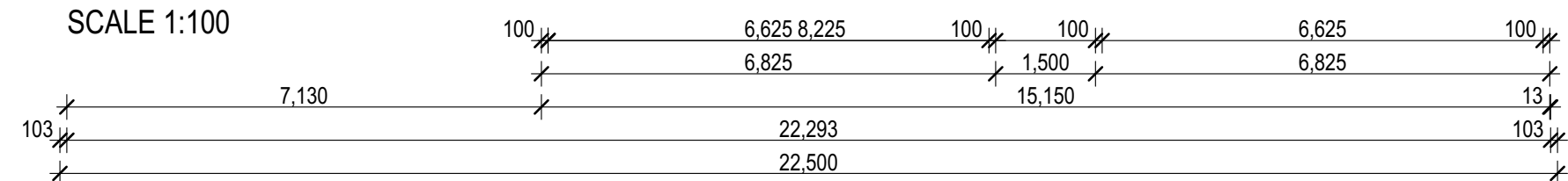


ELEVATIONS





FLOOR PLAN
SCALE 1:100

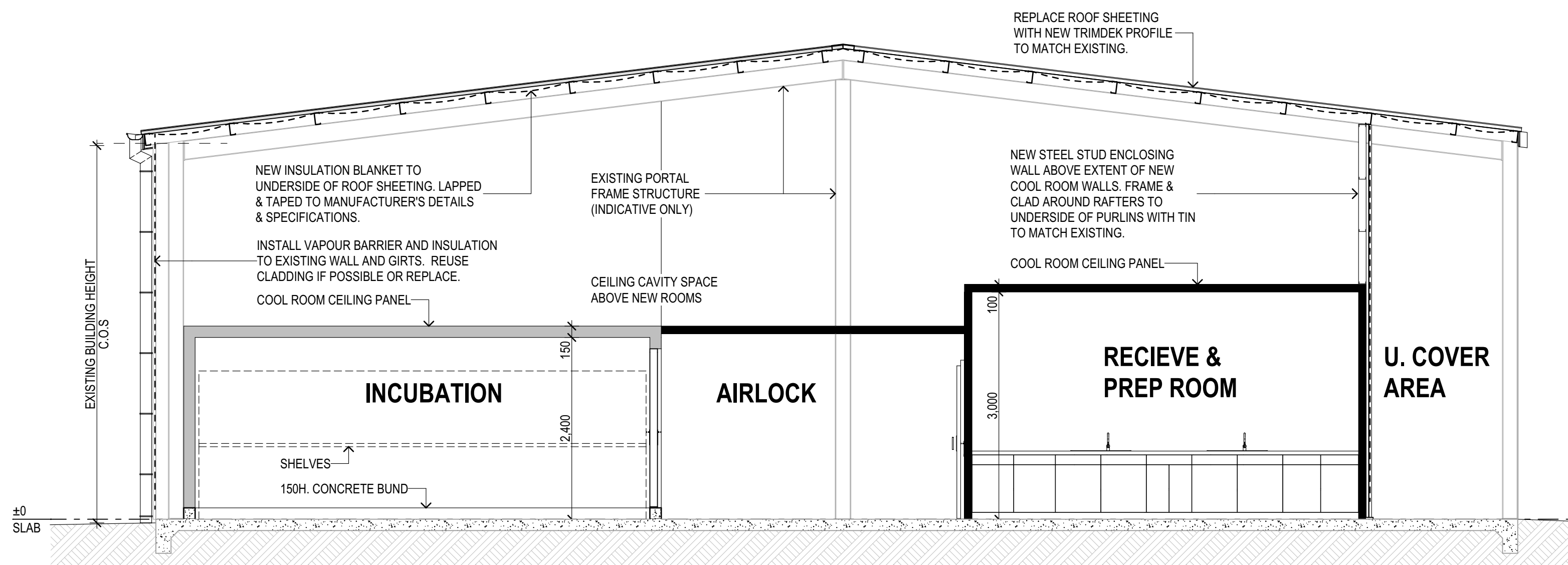
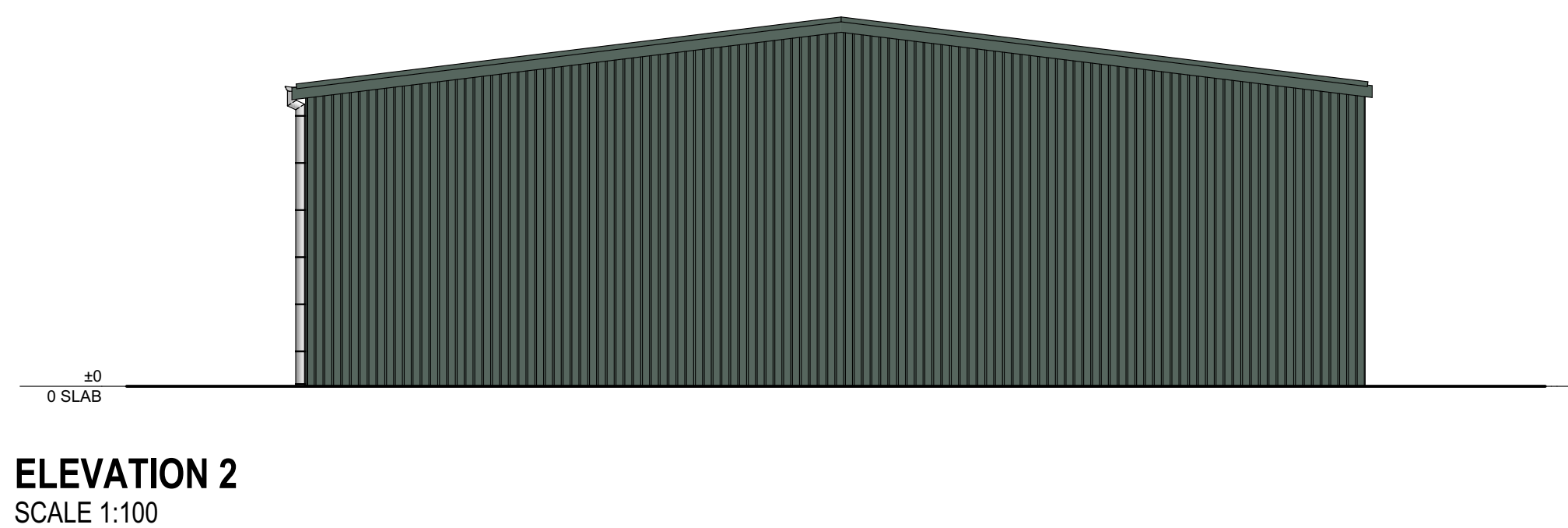
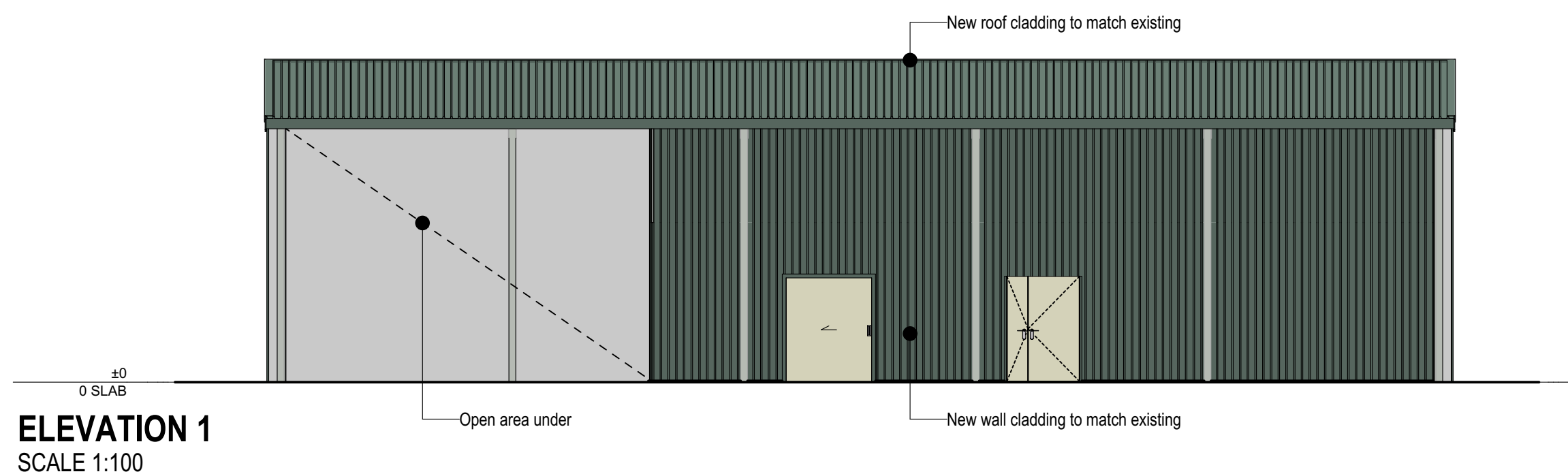


ELEVATIONS



- EXISTING SHED WALLS & STRUCTURE
- 100MM COOL ROOM PANEL AS SELECTED
- 150MM COOL ROOM PANEL AS SELECTED

WALL LEGEND



SECTION A
SCALE 1:50

CLIENT:



PROJECT:

CROCODILE FARMING PROJECT

SEC 1611 (255) ALPHATONIA ROAD LAMBELLS LAGOON, HUMPTY DOO NT 0836

INCUBATION BUILDING PLAN, ELEVATIONS & SECTIONS

PRELIMINARY: DB2634

DATE: 06/2020	DRAWN: NL/JK	CHECKED: DB
SCALE: AS SHOWN SHEET SIZE: A1	CU01	REVISION: C

© Copyright & Liability Notice
These designs and drawings and the Copyright thereof are the property of Bennett Design P/L and are not to be used, retained or copied by either physical or electronic means without written or expressed permission. Bennett Design P/L accepts no responsibility for the completeness, accuracy or compatibility of electronically transferred documents. If necessary, recipients should request a hardcopy version for verification.

DO NOT SCALE OFF THESE DRAWINGS

NOTES AND LEGEND

INSULATION & SARKING

7.04.01 INSULATION UNDER CLADDING
INSTALL INSULATION BLANKET
AND VAPOUR BARRIER BEHIND
WALL CLADDING TO ALL OFFICE
SPACES



ARCHITECT

P 08 8948 4607 | F 08 8918 8113 | ABN 51 083050024
www.bennettdesign.com.au | contact@bennettdesign.com.au

CLIENT:



PROJECT:

CROCODILE
FARMING
PROJECT

SEC 1611 (255) ALPHATONIA
ROAD LAMBELLS LAGOON,
HUMPTY DOO NT 0836

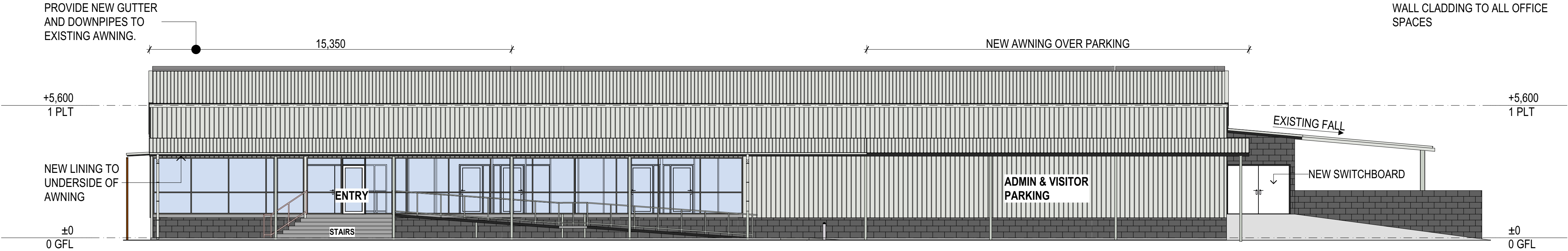
OFFICE AND COLD STORE
ELEVATIONS

PRELIMINARY: DB2634

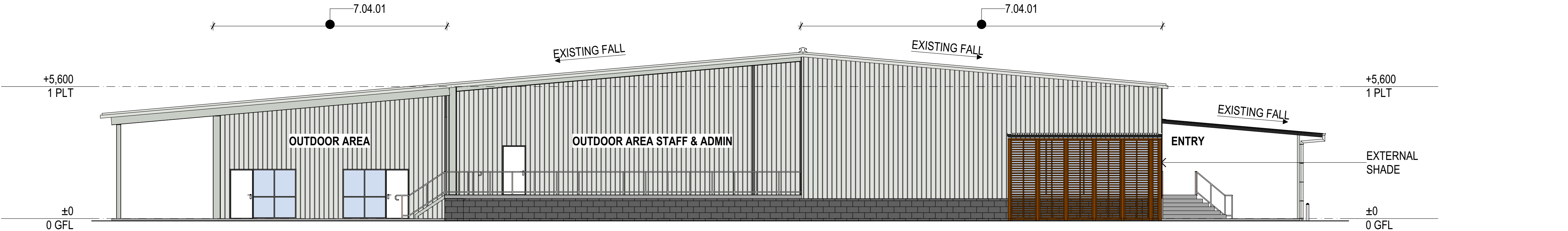
DATE: 06/2020	DRAWN: NL/DV	CHECKED: DB
SCALE: AS SHOWN SHEET SIZE: A1	AD3	REVISION: C

© Copyright & Liability Notice
These designs and drawings and the Copyright thereof are the property of
Bennett Design P/L and are not to be used, retained or copied by either
physical or electronic means without written or expressed permission.
Bennett Design P/L accepts no responsibility for the completeness, accuracy
or compatibility of electronically transferred documents. If necessary,
recipients should request a hardcopy version for verification.

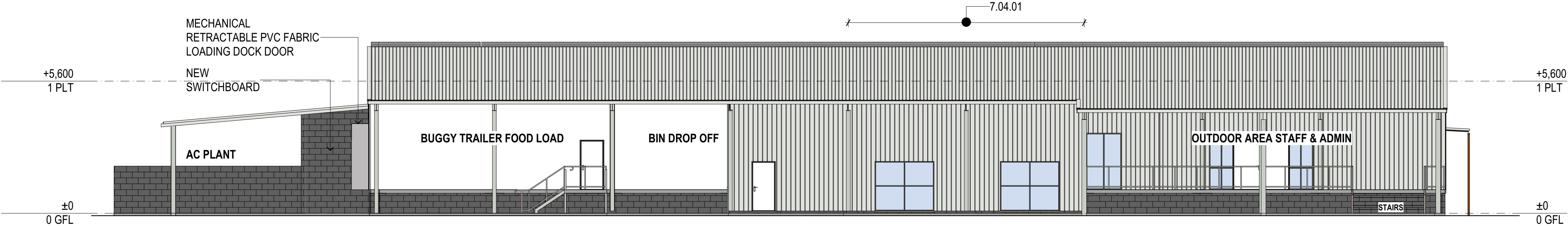
DO NOT SCALE OFF THESE DRAWINGS



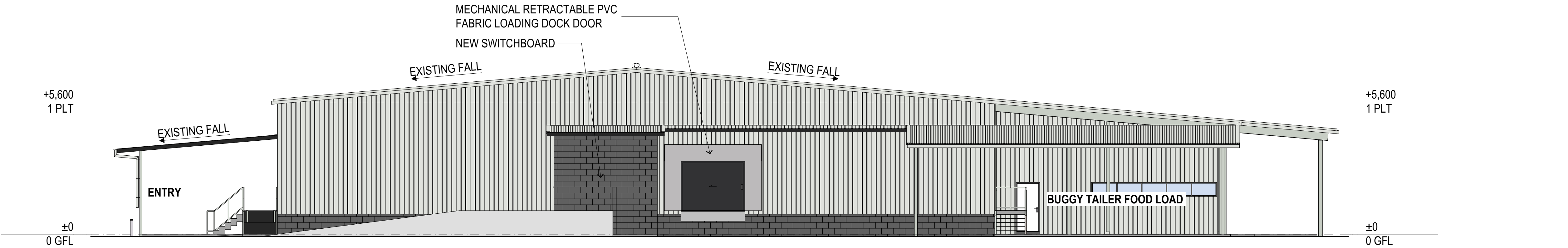
ELEVATION 1
SCALE 1:100



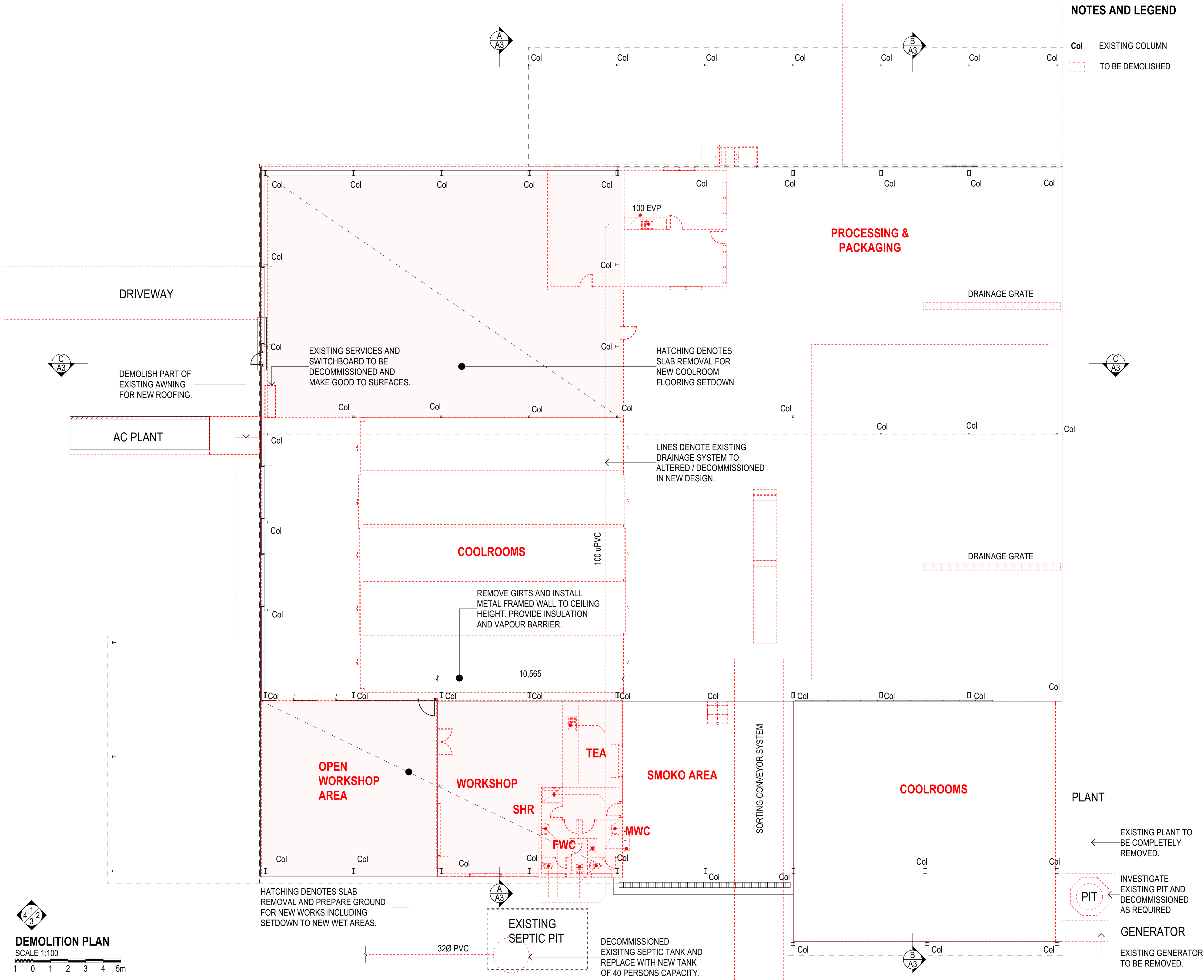
ELEVATION 2
SCALE 1:100



ELEVATION 3
SCALE 1:100



ELEVATION 4
SCALE 1:100



NOTES AND LEGEND

- Col EXISTING COLUMN
TO BE DEMOLISHED

bennett design
ARCHITECT
P 08 8948 4607 | F 08 8918 8113 | ABN 51 083050024
www.bennettdesign.com.au | contact@bennettdesign.com.au

CLIENT:



PROJECT:

**CROCODILE
FARMING
PROJECT**

SEC 1611 (255) ALPHATONIA
ROAD LAMBELLS LAGOON,
HUMPTY DOO NT 0836

**OFFICE AND COLD STORE
EXISTING FLOOR PLAN**

EXISTING PLANT TO
BE COMPLETELY
REMOVED.

INVESTIGATE
EXISTING PIT AND
DECOMMISSIONED
AS REQUIRED

GENERATOR
EXISTING GENERATOR
TO BE REMOVED.

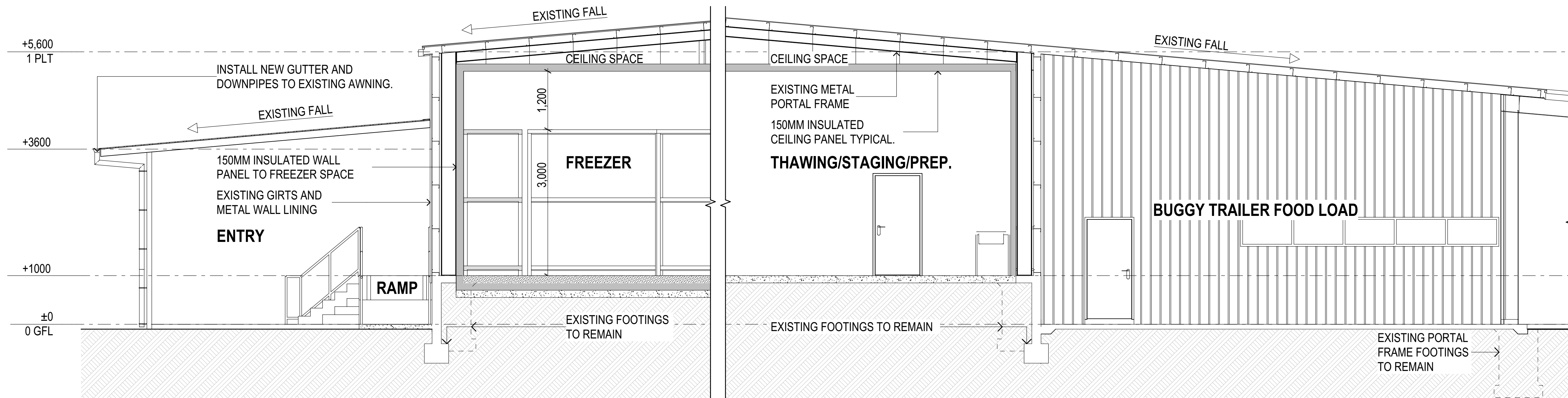
PRELIMINARY: DB2634

DATE: 06/2020	DRAWN: NL/DV	CHECKED: DB
SCALE: AS SHOWN SHEET SIZE: A1	AD1	REVISION: C

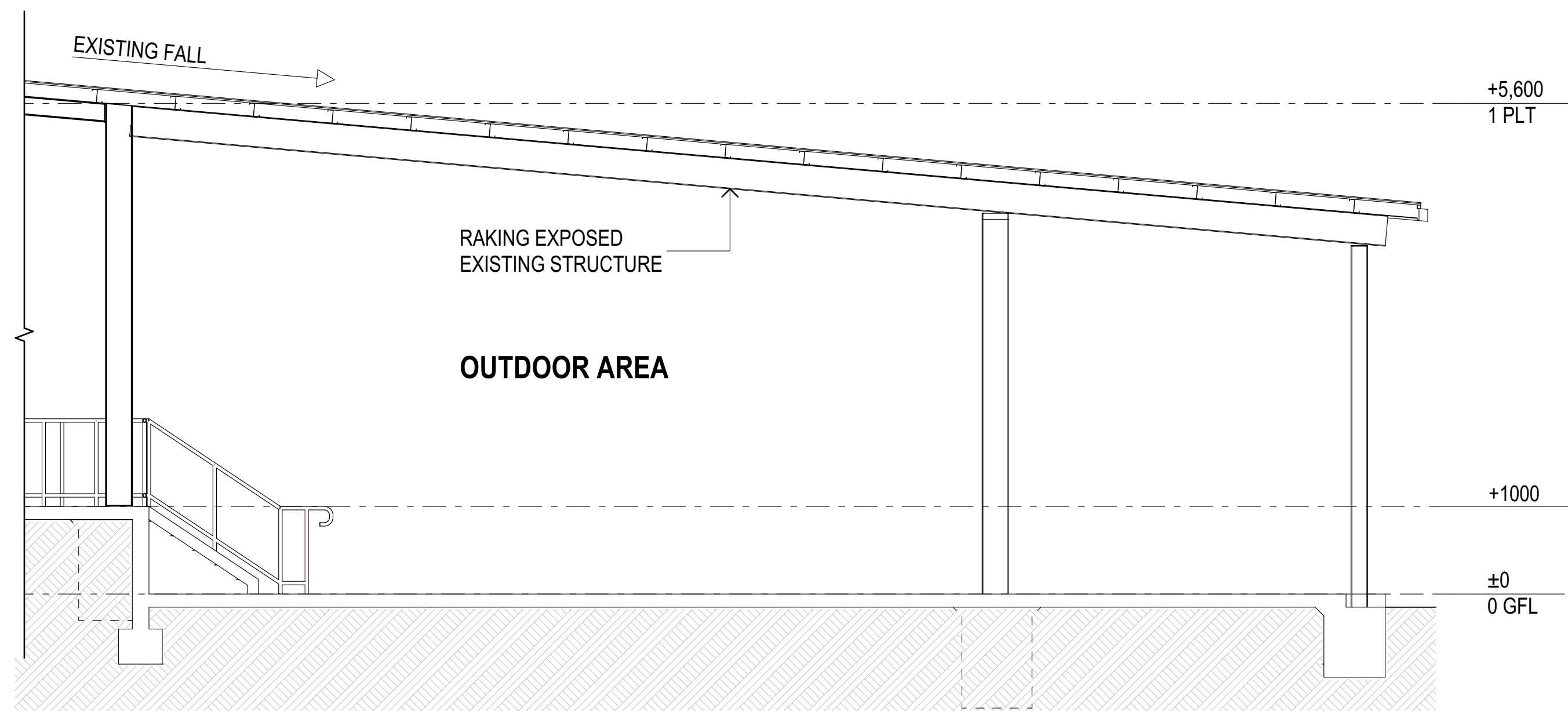
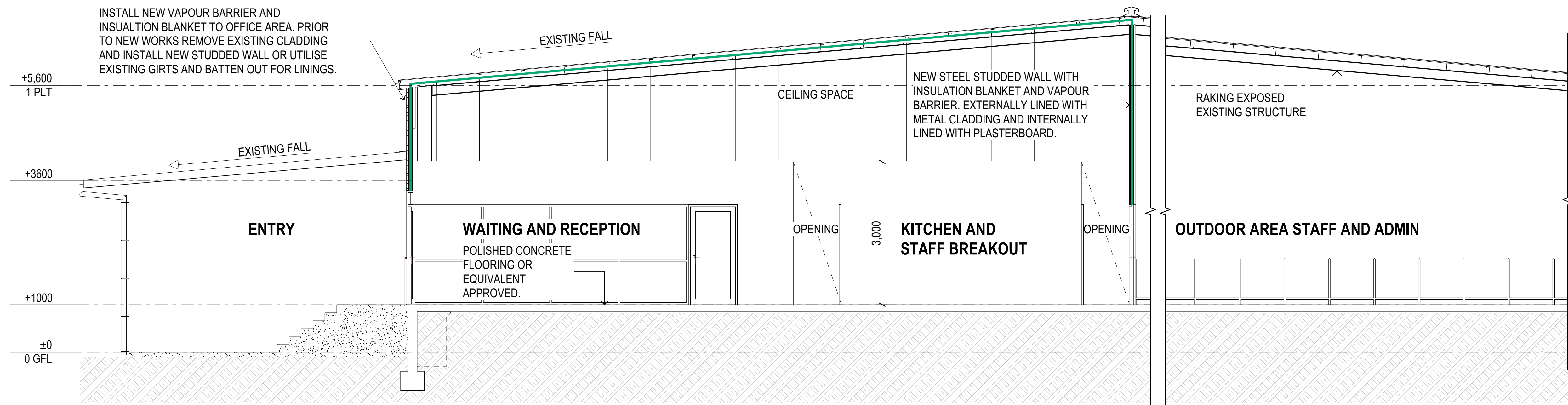
© Copyright & Liability Notice
These designs and drawings and the Copyright thereof are the property of
Bennett Design P/L and are not to be used, retained or copied by either
physical or electronic means without written or expressed permission.
Bennett Design P/L accepts no responsibility for the completeness, accuracy
or compatibility of electronically transferred documents. If necessary,
recipients should request a hardcopy version for verification.

DO NOT SCALE OFF THESE DRAWINGS

DO NOT SCALE OFF THESE DRAWINGS



SECTION A
SCALE 1:50
AD2



SECTION B
SCALE 1:50
AD2

KEY:

DENOTES PERIMETER TO
INSTALL INSULATION BLANKET
AND VAPOUR BARRIER OVER
ALL OFFICE SPACES TYPICAL.

CLIENT:



PROJECT:

CROCODILE FARMING PROJECT

SEC 1611 (255) ALPHATONIA
ROAD LAMBELLS LAGOON,
HUMPTY DOO NT 0836

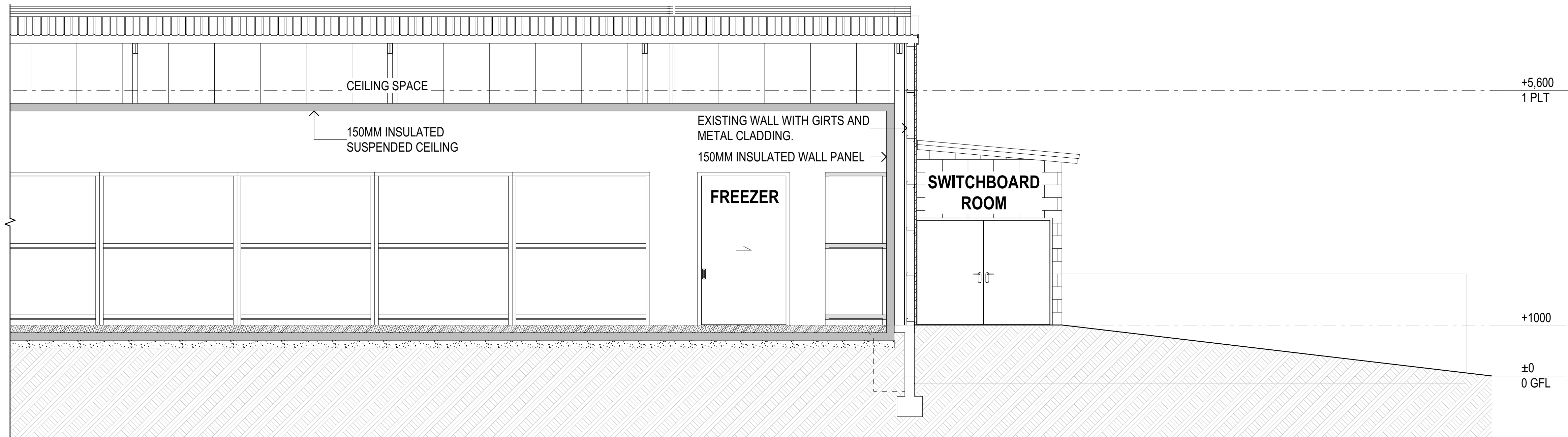
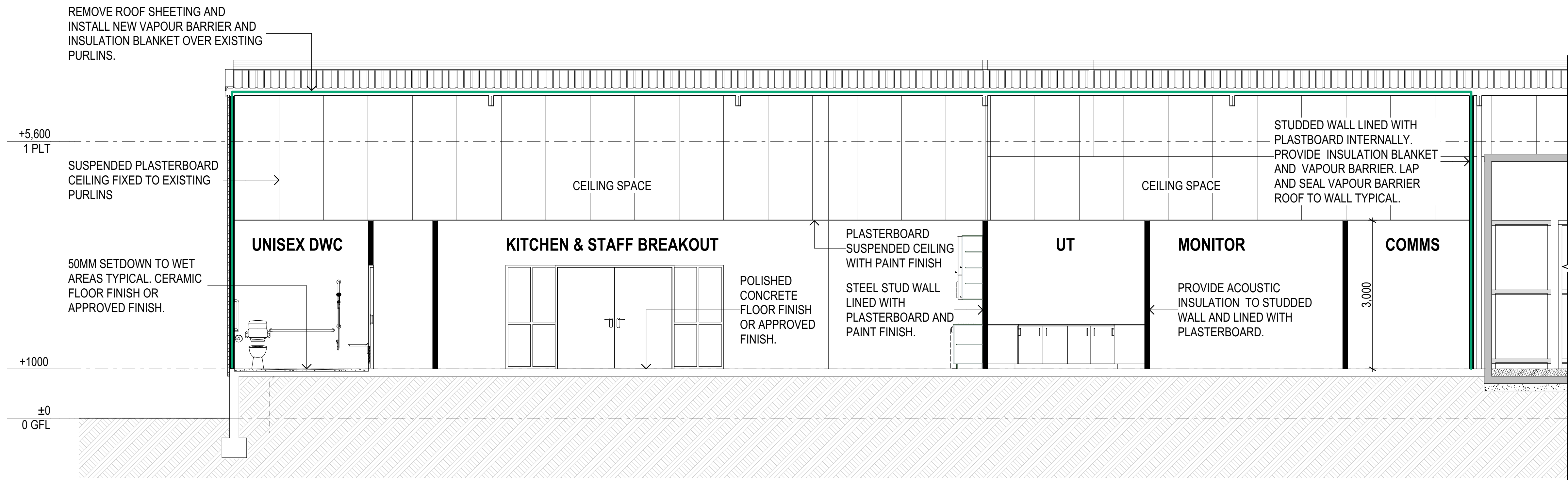
OFFICE AND COLD STORE SECTION A & B

PRELIMINARY: DB2634

DATE: 06/2020	DRAWN: NL/DV	CHECKED: DB
SCALE: AS SHOWN SHEET SIZE: A1	AD4	REVISION: B

© Copyright & Liability Notice
These designs and drawings and the Copyright thereof are the property of
Bennett Design P/L and are not to be used, retained or copied by either
physical or electronic means without written or expressed permission.
Bennett Design P/L accepts no responsibility for the completeness, accuracy
or compatibility of electronically transferred documents. If necessary,
recipients should request a hardcopy version for verification.

DO NOT SCALE OFF THESE DRAWINGS



SECTION C
SCALE 1:50

C
AD2

KEY:

DENOTES PERIMETER TO
INSTALL INSULATION BLANKET
AND VAPOUR BARRIER OVER
ALL OFFICE SPACES TYPICAL.



A R C H I T E C T

P 08 8948 4607 | F 08 8918 8113 | ABN 51 083050024
www.bennettdesign.com.au | contact@bennettdesign.com.au

CLIENT:



PROJECT:

CROCODILE FARMING PROJECT

SEC 1611 (255) ALPHATONIA
ROAD LAMBELLS LAGOON,
HUMPTY DOO NT 0836

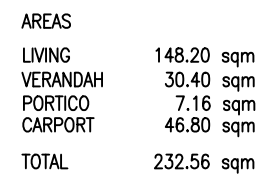
OFFICE AND COLD STORE SECTION C

PRELIMINARY: DB2634

DATE: 06/2020	DRAWN: NL/DV	CHECKED: DB
SCALE: AS SHOWN SHEET SIZE: A1	AD5	REVISION: B

© Copyright & Liability Notice
These designs and drawings and the Copyright thereof are the property of
Bennett Design P/L and are not to be used, retained or copied by either
physical or electronic means without written or expressed permission.
Bennett Design P/L accepts no responsibility for the completeness, accuracy
or compatibility of electronically transferred documents. If necessary,
recipients should request a hardcopy version for verification.

DO NOT SCALE OFF THESE DRAWINGS



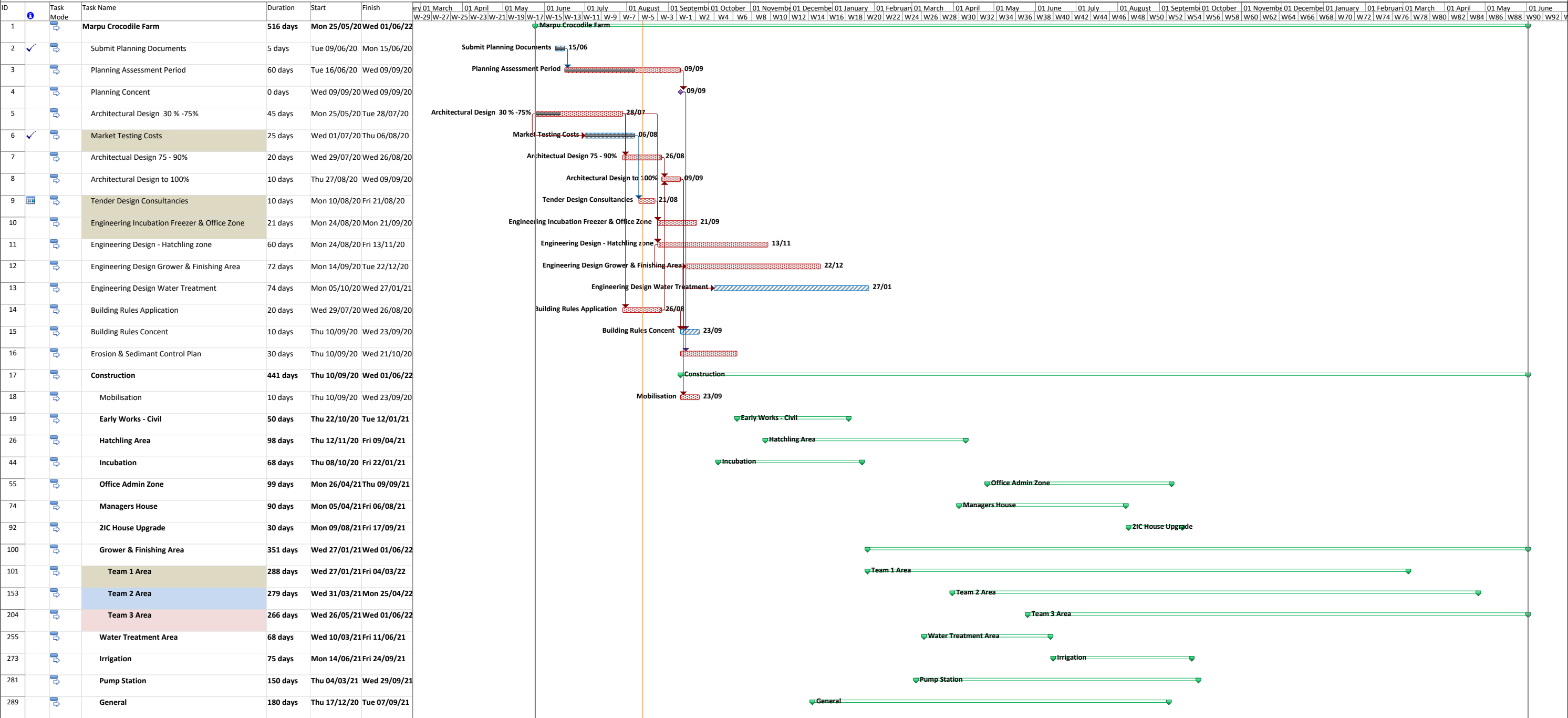
SCALE 1 : 125

PROJECT DESCRIPTION PROPOSED MANAGERS RESIDENCE		STRUCTURAL ENGINEER					SHEET No. A01	DRAWING No.	PAPER SIZE A3
Dave Bennet Design							ISSUE DATE 27 / 03 / 20	DESIGNED DENNIS	SCALE 1 : 125
DRAWING TITLE FLOOR PLAN							JOB REFERENCE No.	© THIS DRAWING IS COPYRIGHT AND CANNOT BE COPIED IN PART OR IN WHOLE WITHOUT THE PRIOR PERMISSION FROM McT DESIGN & CONSTRUCTION P.O. BOX 660 PARAP PHONE: 0401 172 111	
				REVISION	REVISION DESCRIPTION	DATE			

APPENDIX E CONSTRUCTION SCHEDULE



Crocodile Farm
Lambell Lagoon Northern Territory



APPENDIX F MEDLI MODEL SUMMARY AND REPORTS

MEDLI Summary: Lambells Lagoon Crocodile Farm

Model for Effluent Disposal using Land Irrigation (MEDLI) modelling has been used to model the irrigation area and storage requirements for the base case wastewater volumes and predicted effluent quality (combined effluent streams), under various recycling and reuse scenarios for Lambells Lagoon Crocodile Farm.

The following inputs were used for the MEDLI model:

Climate: A 100-year climate file for the Middle Point Rangers station was obtained from the SILO database (a climate database managed by the Queensland Department of Environment and Science) to input rainfall and evaporation data. Whilst 100 years of data is available, the model was run from 1950 to 2019, to account for recent impacts of climate change that may affect the model outputs.

Soil type: The default MEDLI soil type, *red earth* was used in the model, as the default parameters are representative of Kandosols as defined by the Australian Soil Classification and identified from mapping at the Crocodile Farm site.

Crop type: The default planting parameters for Forage Sorghum Crop were used in the model as they are representative of the potential crop selection for the Crocodile Farm site. The default crop also has a maximum crop coefficient of 0.8, and according to the NT *Guidelines for Land Capability Assessment for On-site Wastewater Management* (DOH, 2014), a crop factor of 0.8-1.0 would be appropriate for irrigation design purposes, based on the generally high year-round daytime temperatures in the NT.

Irrigation method: The irrigation method modelled was a centre pivot system with irrigation triggered when the soil water deficit reaches 0mm. The irrigation was applied at a rate to return the soil water to 100% of the DUL each day, however irrigation is prevented when rain events result in soil saturation. The model was run using various different irrigation areas in order to determine the best outcome for the water and nutrient balance. A “dry-run” was also modelled for the irrigation area, where the irrigation inputs were removed, in order to determine the natural conditions and deep drainage rates for the area without any irrigation inputs.

The model was set to prevent irrigation when soils become saturated (i.e. during or following rain events). Based on the assumptions used in relation to rainfall, evaporation, soil and crop types, this prevents irrigation for approximately 13% of the year at the Crocodile Farm site (or 47 days). In reality with high evaporation rates, it is possible that irrigation may still occur on days that experience minor rainfall events provided conditions in a site-specific Irrigation Management Plan are adhered to.

Storage and irrigation requirements

The design includes waste water storage capacity in the FTW lagoon and wastewater storage ponds. To provide an indication of the storage requirements that will need to be considered in detailed design, the MEDLI model was run for the combined wastewater stream, accounting for rainfall and evaporation impacts to the final effluent volume entering the wastewater storage ponds. The FTW system was included in the model to allow for rainfall impacts during the treatment process and assist in appropriately sizing the storage ponds.

Various different scenarios were modelled to determine the storage and irrigation area combinations required to minimise release of nutrients to the environment by effluent overflow, or as a result of runoff or seepage from the irrigation areas. The NSW DEC *Use of Effluent by Irrigation* as a general guideline indicate that uncontrolled discharges from ponds due to prolonged rainfall events may be permitted in 50% of years

for low-strength effluent (subject to site-specific considerations). This was adopted as the design criteria for the wastewater storage ponds at the Crocodile Farm for the purpose of the MEDLI model.

The MEDLI model was run with different reuse assumptions (0%, 25%, 50% and 75%) and the storage and irrigation area requirements derived for each assumption are documented in Table 1.

Table 1. Wet weather storage and irrigation area requirements vs reuse percentage

% recycled for reuse in farm	Wet weather storage volume (ML)	Irrigation area (ha)
0%	100	130
	110	120
	120	100
25%	70	130
	80	120
	90	100
50%	50	120
	60	100
75%	30	120
	40	100

The MEDLI modelling indicates that water efficiency and the volume of recycled water that can be reused are key factors that will determine the wet weather storage requirements. With a high level of water efficiency and reuse (>75%), hydraulic and nutrient balance can be achieved with 120 ha of irrigation area and a 30 ML storage (allowing for design overflows to occur in 50% of years associated with prolonged rainfall events). The storage volume increases as efficiency and reuse is reduced as greater volumes of water (wastewater and rainfall combined) need to be stored during periods when irrigation cannot occur.

Another variable that influences that storage requirements is the volume of rainfall entering the pens and mixing with the wastewater stream. In the current model, which accounts for 100% of rainfall directly entering the pens, rainfall inflows account for approximately 20 ML of the storage volume. A low permeability shade cloth could achieve a 40% reduction in rainfall entering the system.

Whilst there is sufficient land availability to construct large storages, the cost and feasibility of managing such storages may be limiting. The MEDLI modelling indicates that allowing for storage overflows to occur in 50% of years, any of the irrigation area and storage combinations provided Table 1, would meet the objective of 98 - 99 % of water being contained onsite (i.e. while overflow will occur, the relative volumes will be small). To achieve 100% containment of all water on site across all weather events would require construction of very large wet weather storages, which would then be largely empty most of the time. Assuming the treated effluent will contain very low concentrations of nutrients, which would be further diluted by rainfall in the storage, it is considered that there is minimal environmental benefit to be achieved by constructing zero discharge storages.

If once operations commence, the actual effluent volumes or quality are found to be higher than predicted, then the staging of the development and large available land area allows for additional irrigation areas and/or storages to be added progressively to achieve the water quality objectives established in the EPL.

Effluent assessment

A MEDLI assessment was undertaken on the combined wastewater streams. The effluent volumes and quality used in the scenario are summarised in Table 2 and Table 3.

The volumes account for forecast water use (1,365 kl/day), with allowance made for rainfall inputs to the pens during the wet season, which will increase wastewater volumes. The effluent quality is based on the estimated combined effluent quality prior to primary or secondary treatment. In reality, the actual wastewater quality to be irrigated would be lower in nutrients following treatment; however, this will not make a difference

to the model outputs because the limiting factor at the Crocodile Farm site is water volumes not nutrient concentrations.

Table 2. Daily effluent volume per month (m3)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean/yr
1724	1705	1574	1365	1365	1365	1365	1365	1365	1365	1365	1488	1450

Table 3. Effluent quality entering ponds

Contaminant	Concentration (mg/L)
Total nitrogen	18
Total phosphorus	4
Total dissolved salts	267
Total solids	20

The most conservative wet weather storage requirements from Table 1 (i.e. calculated by the MEDLI model with 0% reuse) were used to run the remainder of the scenario. Whilst the Crocodile Farm will be aiming for a high level of water efficiency and reuse, which will reduce storage requirements, the worst-case scenario is modelled here for the purpose of demonstrating the feasibility of a sustainable effluent reuse scheme at the site. For comparison sake, the 50% reuse scenario was also modelled and described in this section.

The results of the pond water balance and land water and nutrient balances modelled by MEDLI are outlined in Table 4,

Table 5 and Table 6. The full MEDLI reports (for these scenarios) is included in Attachment A and B. Reports for other scenarios can also be provided on request.

Table 4. Wet weather storage pond performance

	Units	No reuse	50% reuse
Pond volume	ML	120	50
No. of overflow events	events/year	0.53	0.57
Overflow	m3/year	6106	3017
No. of overflow days	days/year	6.14	2.77
Effluent reuse (through irrigation)	Fraction	0.99	0.99

Table 5. Land water balance

	Unit	No reuse 100 ha	50% reuse 120ha	Dry run
Irrigation area	ha	100	120	-
Rain	mm/year	1481	1481	1481
Irrigation	mm/year	511	225	0
Irrigation	m3/year	511,178	270,573	0
Soil evaporation	mm/year	578	407	416
Transpiration	mm/year	555	509	362
Rain runoff	mm/year	58	58	64
Irrigation runoff	mm/year	0	0	0
Deep drainage	mm/year	802	733	639

Table 6. Land nutrient balance

	Unit	No reuse nitrogen	No reuse phosphorus	50% reuse nitrogen	50% reuse phosphorus
Irrigation load	kg/ha/yr	92.06	21.00	76.74	17.51
Irrigation runoff	kg/ha/yr	0	0	0	0
Plant uptake	kg/ha/yr	122.34	16.48	106.6	12.98
Leached	kg/ha/yr	2.66	0.04	2.39	0.04

No reuse

With a wet weather storage capacity of 120 ML and an irrigation area of 100 ha (Attachment A), there would be pond overflows 0.53 times a year, or 5.3 events every 10 years, and the effluent reuse (through irrigation) is at 99%. The effluent reuse is defined as the proportion of effluent inflow + net rain gain that is irrigated from the pond. The probability of at least 90% reuse is also 94% which is a desired outcome for MEDLI.

The plant uptake of nitrogen is higher than the effluent load added and therefore sufficient to manage the applied effluent. Based on the model inputs, the results show a small quantity of nitrate leaching at a concentration of 0.33mg/L. These levels meet the performance criteria for assessment of MEDLI outputs; however, the potential impacts of nitrogen leaching will need to be appropriately monitored through the sites groundwater monitoring program. Leaching of nutrients has a direct correlation with deep drainage which changes based on soil types. The soil type modelled in this scenario experiences high deep drainage rates due to its sandy nature and may change based on actual site conditions, which will be determined by on site soil assessments.

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

50% reuse

With a wet weather storage capacity of 50 ML and an irrigation area of 120 ha (Attachment B), there would be pond overflows 0.57 times a year, or 5.7 events every 10 years, and the effluent reuse (through irrigation) is at 99%. The probability of at least 90% reuse is also 97%.

The plant uptake of nitrogen is higher than the effluent load added and therefore sufficient to manage the applied effluent. Based on the model inputs, the results show a small quantity of nitrate leaching at a concentration of 0.33mg/L. The plant uptake of phosphorus is also lower than the effluent load added with negligible leaching of phosphorus.



Attachment A. MEDLI Report: No Reuse

Enterprise: New Enterprise with 120000.00 m3 storage pond volume and 100.00 ha irrigation area

Description:
New Subject

Client: New Client

MEDLI User: ECOZ\emma.lewis

Scenario Details:

MEDLI REPORT - FULL RUN



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

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

Climate Statistics:

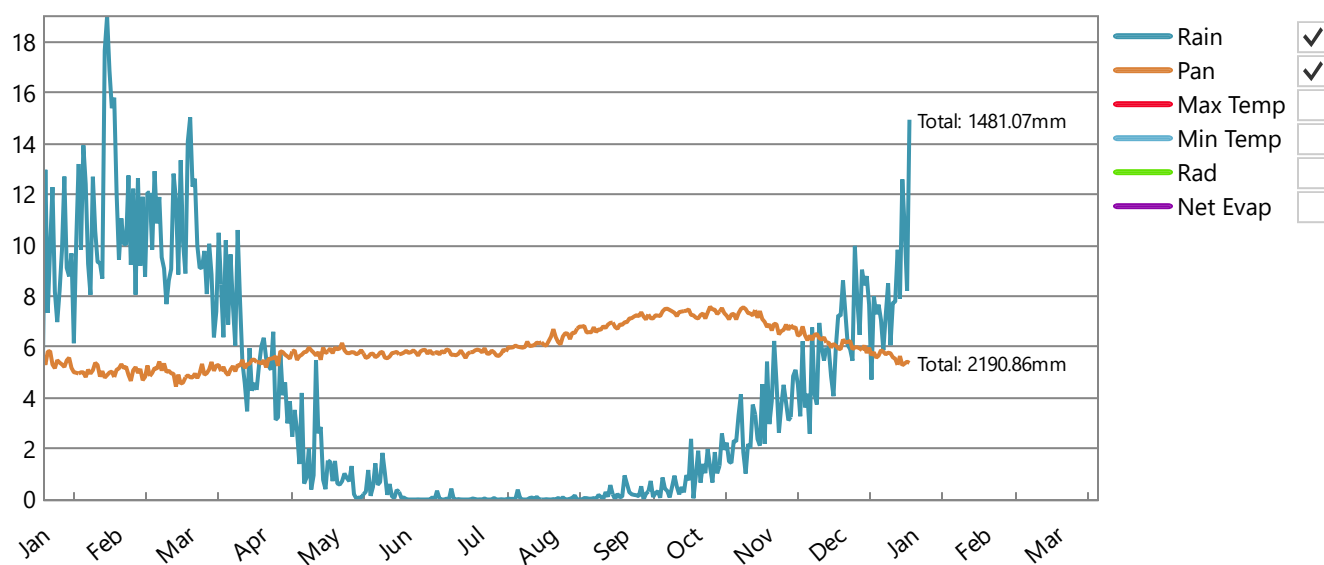
	5th ▾	Percentile	50th Percentile	95th ▾	Percentile
Rainfall (mm/year)		909	1441		2038
Pan Evaporation (mm/year)		1917	2189		2432

Climate Data:

☒ Chart ☐ Table

☐ Monthly ☒ Daily

Daily Average Across Run Period



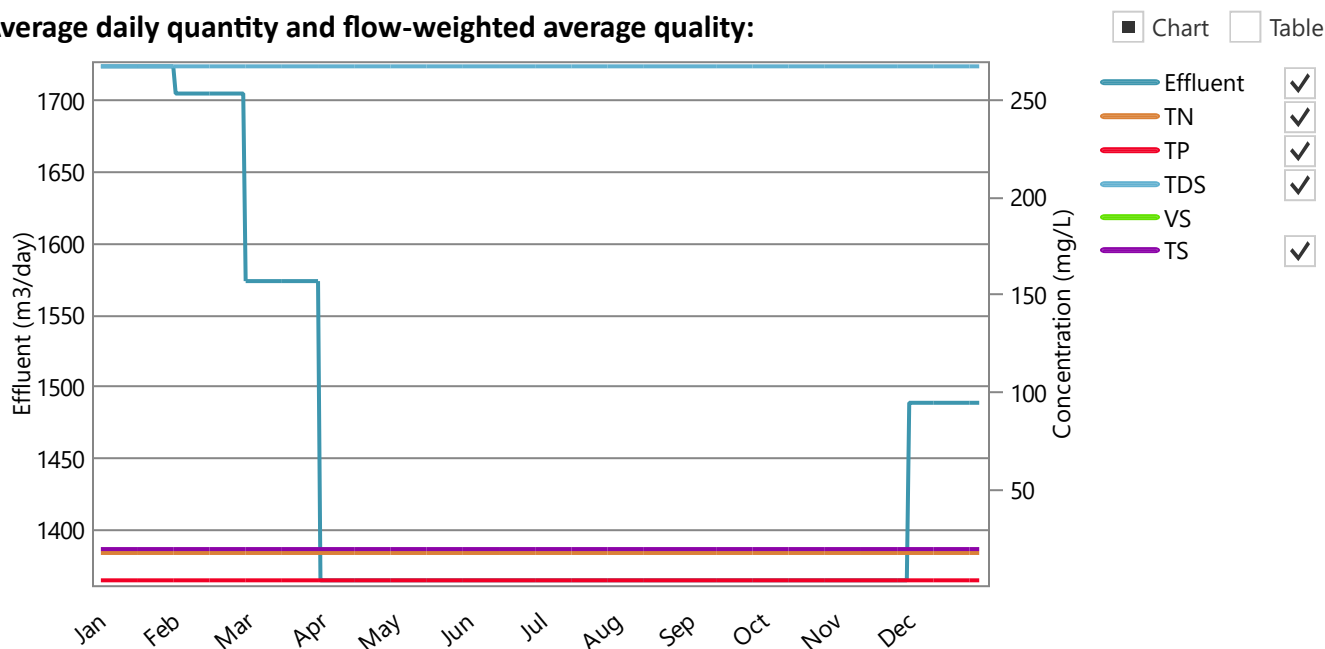
DESCRIPTION

medli

Effluent type: New Generic System

Wastestream before any recycling or pretreatment

Average daily quantity and flow-weighted average quality:



Wastestream after any recycling and pretreatment if applicable

Effluent quantity: **529774.61 m3/year** or 1450.47 m3/day (Min-Max: 1365.00 - 1724.00)

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

	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	18.00 (18.00 - 18.00)	9535.94 (9529.43 - 9556.24)
Total Phosphorus	4.00 (4.00 - 4.00)	2119.10 (2117.65 - 2123.61)
Total Dissolved Salts	267.00 (267.00 - 267.00)	141449.82 (141353.27 - 141750.83)
Volatile Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total Solids	20.00 (20.00 - 20.00)	10595.49 (10588.26 - 10618.04)

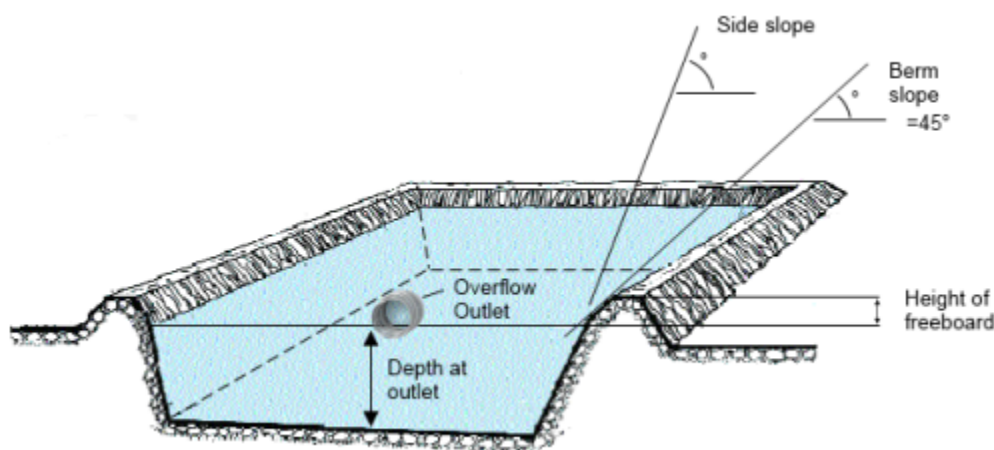
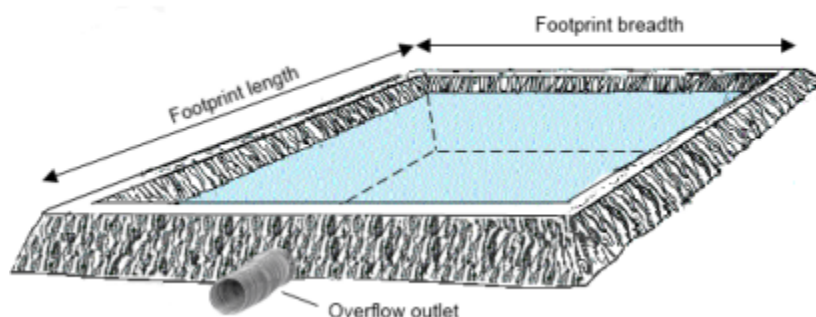
DESCRIPTION

medli

Pond system: 2 facultative, aerobic or storage ponds

Pond system details:

	Pond 1	Pond 2
Maximum pond volume (m3)	30000.00	120000.00
Minimum allowable pond volume (m3)	0.00	0.00
Pond depth at overflow outlet (m)	1.50	3.00
Maximum water surface area (m2)	20095.74	40270.91
Pond footprint length (m)	203.68	287.00
Pond footprint width (m)	103.44	145.10
Pond catchment area (m2)	21068.27	41643.38
Average active volume (m3)	29990.27	14229.80



Irrigation pump limits:

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

Shandying water:

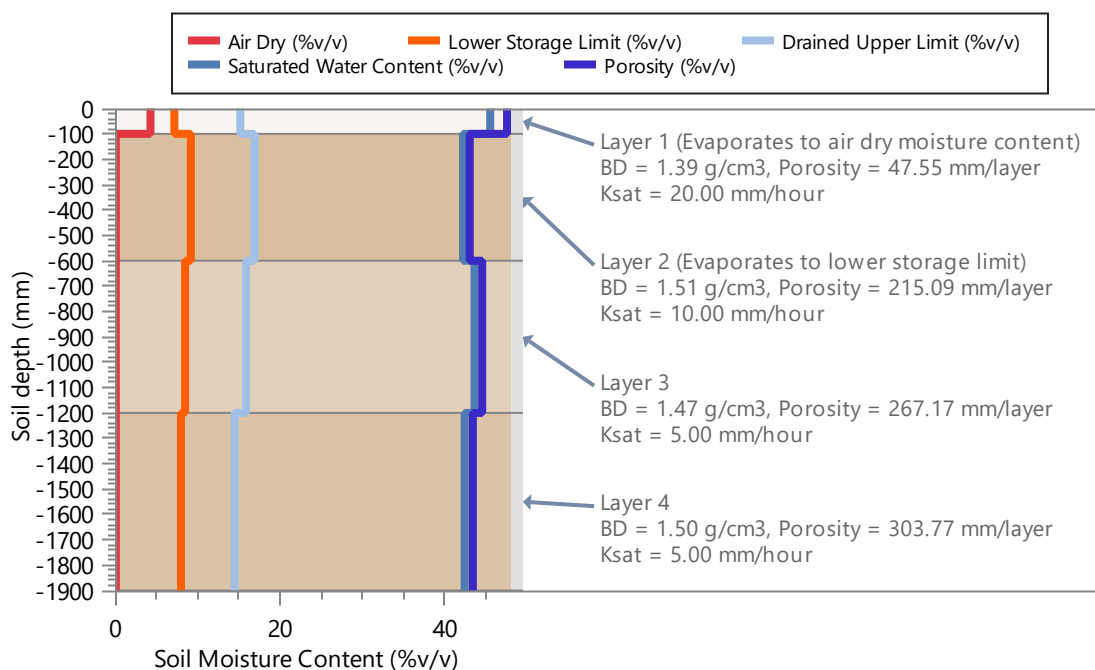
Annual allocation of fresh water available for shandying (m3/year)	0.00
Maximum rate of application of fresh water (ML/day)	0.00
Nitrogen concentration (mg/L)	0.00
Salinity (dS/m)	0.00
Minimum shandy water is used	False

Land: New Paddock

Area (ha): 100.00

Soil Type: Red Earth, 1900.00 mm defined profile depth

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



Plant Data: Continuous Forage Sorghum Crop

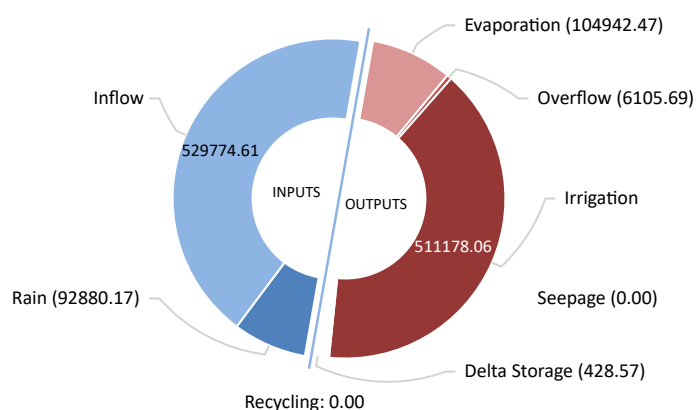
Average monthly cover (fraction) (minimum - maximum)	0.39 (0.01 - 0.71)
Maximum crop factor at 100% cover (mm/mm) (Maximum crop coefficient 0.8 x Pan coefficient 1)	0.80
Total plant cover (both green and dead) left after harvest (fraction)	0.00
Maximum potential root depth in defined soil profile (mm)	1900.00
Salt tolerance	Tolerant
Salinity threshold EC sat. ext. (dS/m)	8.30
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.11



Pond System Water Performance - Overflow: 2 facultative, aerobic or storage ponds

Capacity of wet weather storage pond: **120000 m3**

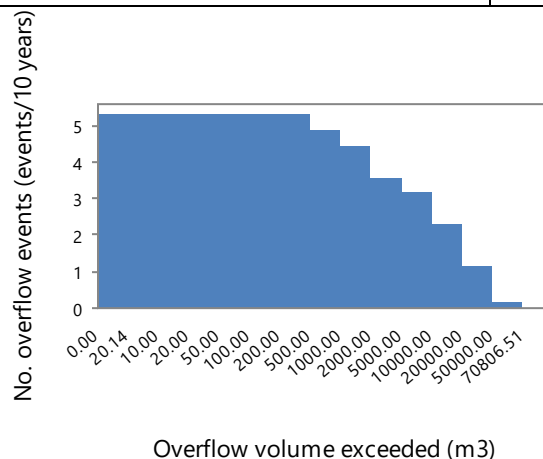
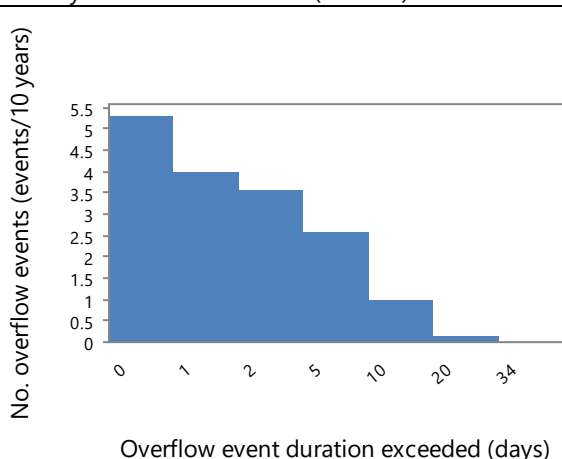
Pond System Water Balance (m3/year)



Name	Value
Rain	92880.17
Inflow	529774.61
Recycling	0.00
Evaporation	104942.47
Overflow	6105.69
Irrigation	511178.06
Seepage	0.00
Delta Storage	428.57

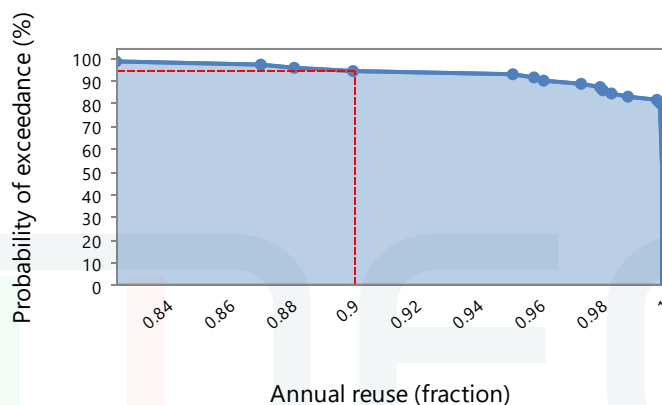
Overflow Diagnostics

Volume of overflow (m3/year)	6105.69
No. days pond overflows (days/year)	3.24
Average duration of overflow (days)	6.14
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	0.99
Probability of at least 90% reuse (fraction)	0.94



[Export plot](#)

[Export plot](#)

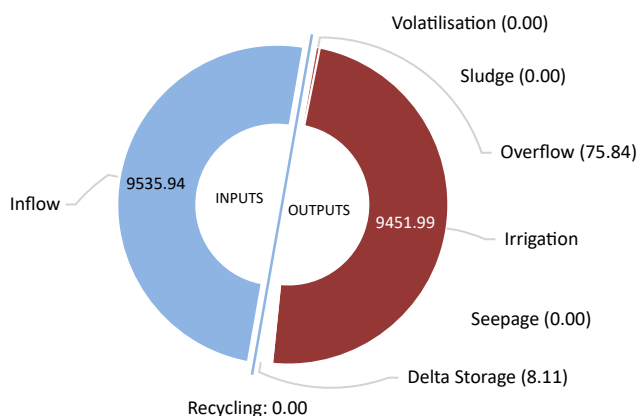


[Export plot](#)

Pond System Performance - Nutrient: 2 facultative, aerobic or storage ponds

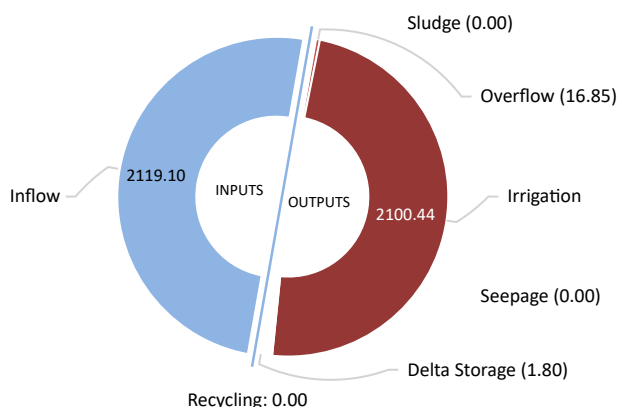
Pond System Nutrients and Salt Balance:

Nitrogen Balance (kg/year)



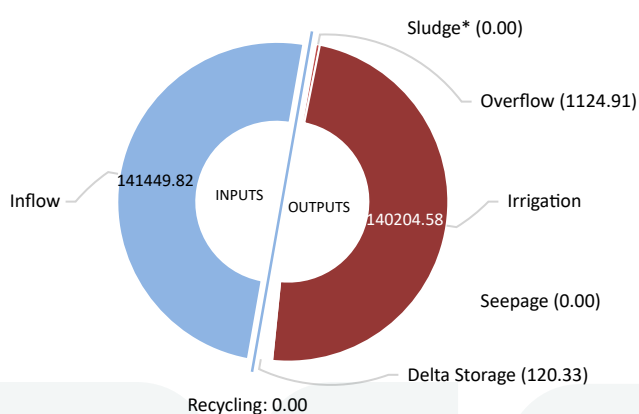
Name	Value
Inflow	9535.94
Recycling	0.00
Volatilisation	0.00
Sludge	0.00
Overflow	75.84
Irrigation	9451.99
Seepage	0.00
Delta Storage	8.11

Phosphorus Balance (kg/year)



Name	Value
Inflow	2119.10
Recycling	0.00
Sludge	0.00
Overflow	16.85
Irrigation	2100.44
Seepage	0.00
Delta Storage	1.80

Salt Balance (kg/year)



Name	Value
Inflow	141449.82
Recycling	0.00
Sludge*	0.00
Overflow	1124.91
Irrigation	140204.58
Seepage	0.00
Delta Storage	120.33

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

Pond System Sludge Accumulation: 0.00 kg dwt/year

Pond System Performance - Nutrient: 2 facultative, aerobic or storage ponds

Pond Nutrient Concentrations and Salinity:

Average across simulation period	Pond 1	Pond 2
Average nitrogen concentration of pond liquid (mg/L)	18.32	13.64
Average phosphorus concentration of pond liquid (mg/L)	4.07	3.03
Average salinity of pond liquid (dS/m)	0.42	0.32

Value on final day of simulation period	Pond 1	Pond 2
Final nitrogen concentration of pond liquid (mg/L)	18.93	N.D.*
Final phosphorus concentration of pond liquid (mg/L)	4.21	N.D.*
Final salinity of pond liquid (dS/m)	0.44	N.D.*

* Not determined. Pond is empty.

Irrigation Performance:

Water Use: (assumes 100% Irrigation Efficiency)

Pond water irrigated (m3/year)	511178.06
Average Shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Total water irrigated (m3/year)	511178.06
Proportion of irrigation events requiring shandying (fraction of events)	0.00
Proportion of years shandying water allocation of 0 m3/year is exceeded (fraction of years)	0.00
Average exceedance as a proportion of annual shandy water allocation (fraction of allocation) (minimum - maximum)	0.00 (0.00 - 0.00)

Irrigation Quality:

Average nitrogen concentration of irrigation water - before ammonia loss during irrigation (mg/L)	18.49
Average nitrogen concentration of irrigation water - after ammonia loss during irrigation (mg/L)	18.01
Average phosphorus concentration of irrigation water (mg/L)	4.11
Average salinity of irrigation water (dS/m)	0.43

Irrigation Diagnostics:

Proportion of Days no irrigation occurs for some other reason (fraction)	0.14
Proportion of Days irrigation occurs (fraction)	0.86

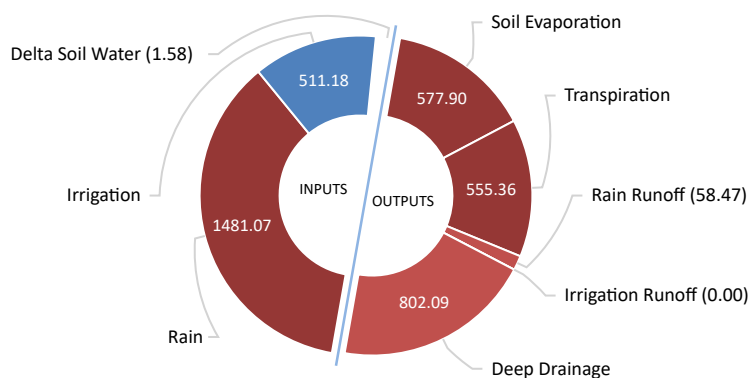
Land Performance - Soil Water

Paddock: **New Paddock, 100 ha**

Soil Type: **Red Earth, 136.40 mm PAWC at maximum root depth**

Land Water Balance (mm/year):

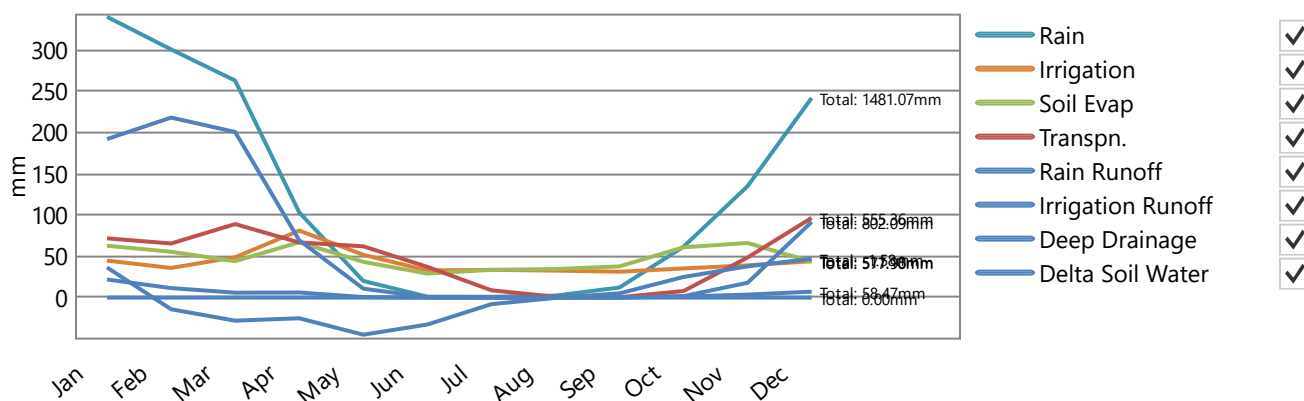
☒ mm/year ☐ % Total inputs



Name	Value
Rain	1481.07
Irrigation	511.18
Soil Evaporation	577.90
Transpiration	555.36
Rain Runoff	58.47
Irrigation Runoff	0.00
Deep Drainage	802.09
Delta Soil Water	-1.58

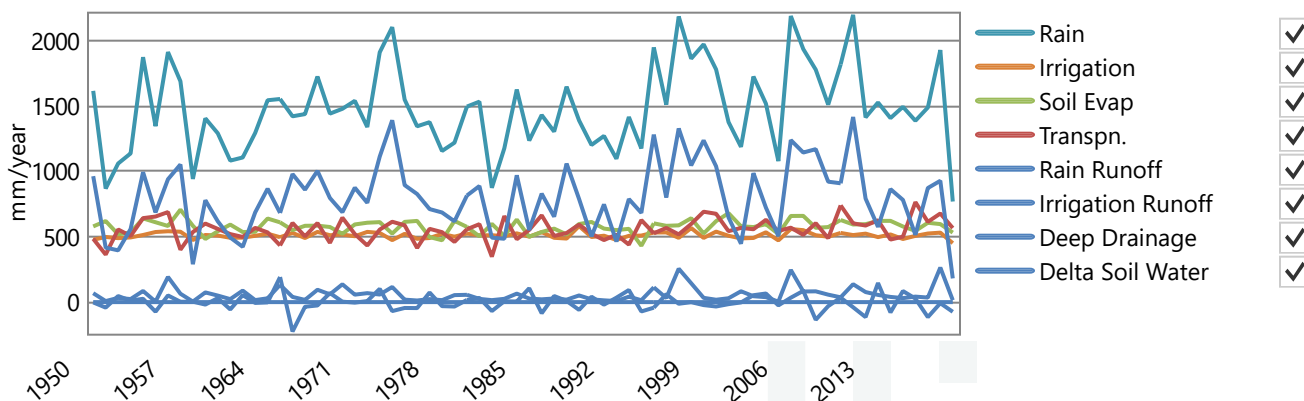
Average Monthly Totals (mm):

☒ Chart ☐ Table



Average Annual Totals (mm/year):

☒ Chart ☐ Table



Land Performance - Soil Nutrient

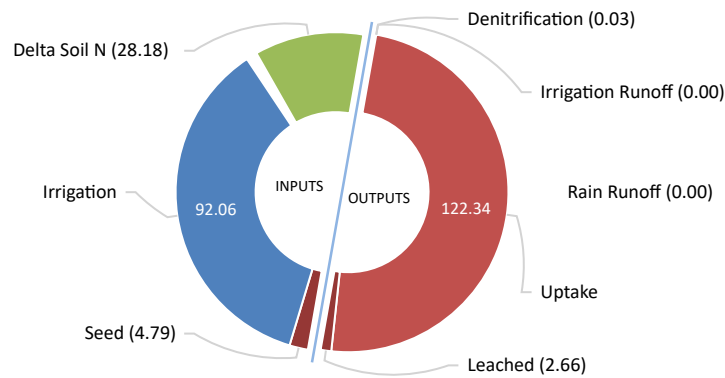
Paddock: **New Paddock, 100 ha**

Soil Type: **Red Earth**

Irrigation ammonium volatilisation losses (kg/ha/year): 2.46

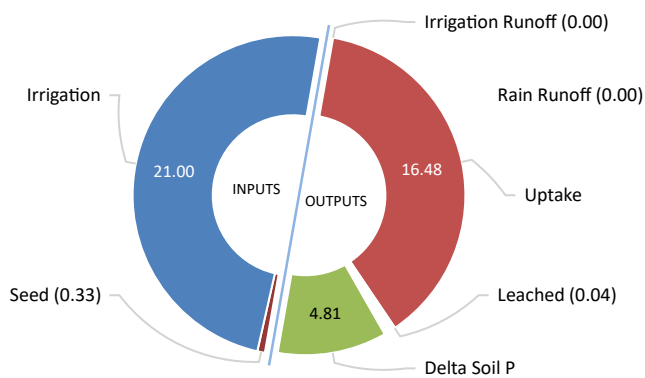
Proportion of total nitrogen in irrigated effluent as ammonium (fraction): 0.10

Land Nitrogen Balance (kg/ha/year)



Name	Value
Seed	4.79
Irrigation	92.06
Denitrification	0.03
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	122.34
Leached	2.66
Delta Soil N	-28.18

Land Phosphorus Balance (kg/ha/year)



Name	Value
Seed	0.33
Irrigation	21.00
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	16.48
Leached	0.04
Delta Soil P	4.81

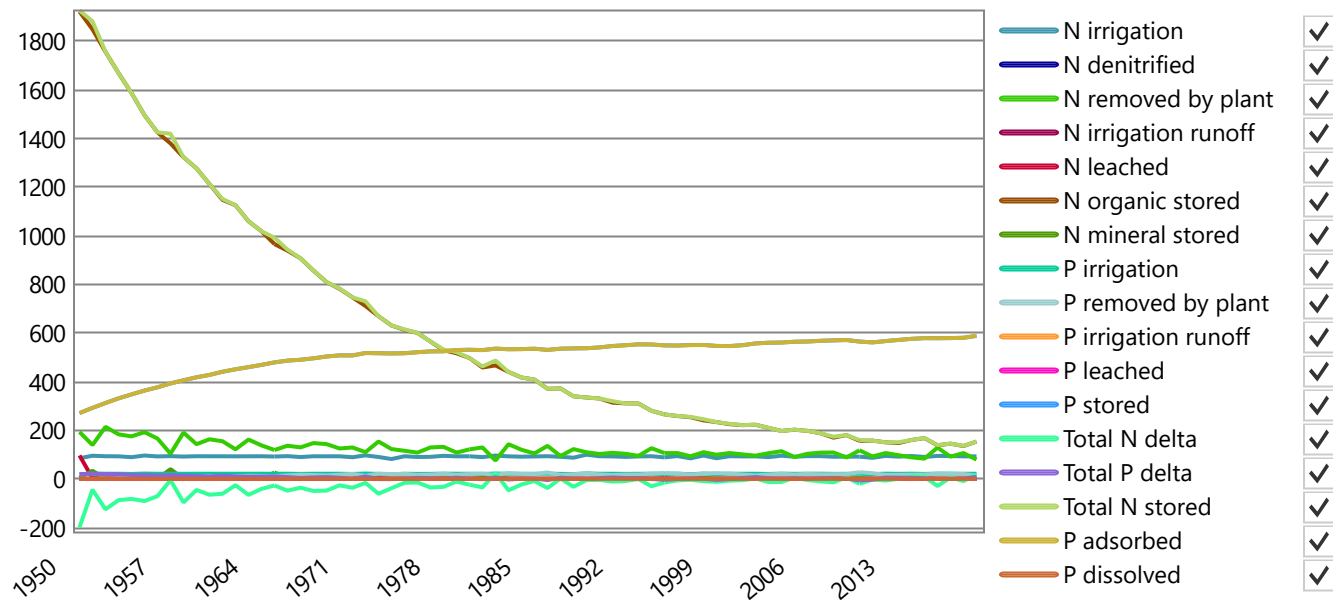
medli

Land Performance - Soil Nutrient

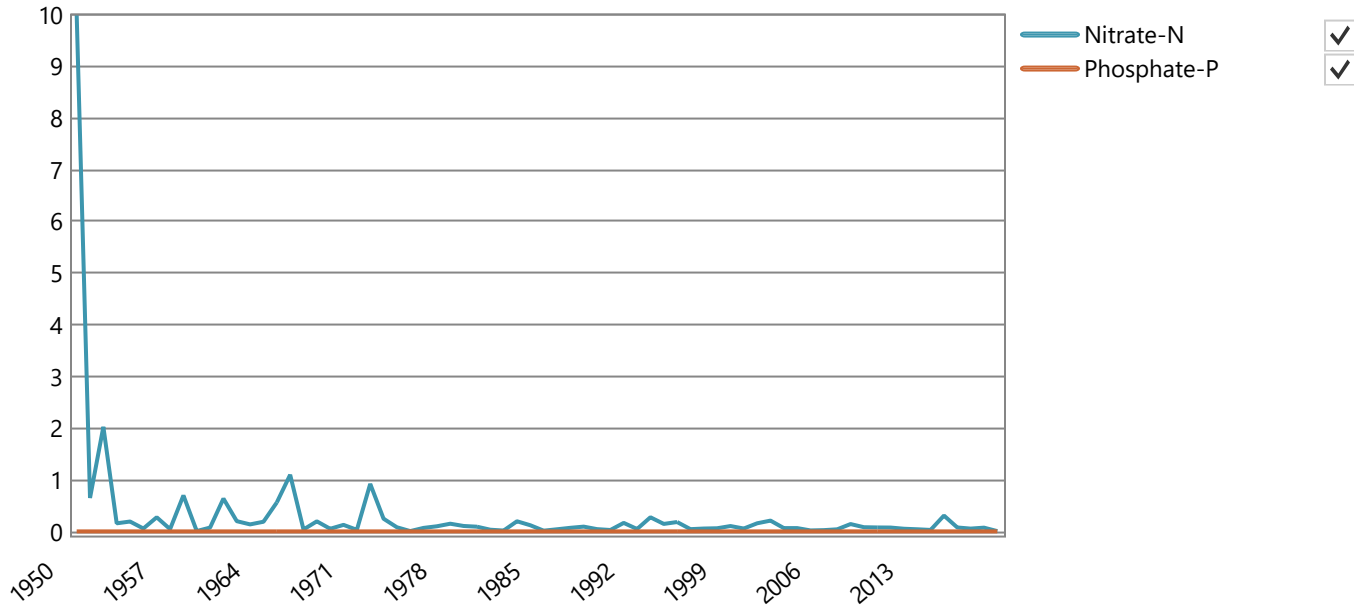
Paddock: New Paddock, 100 ha

Soil Type: Red Earth

Annual Nutrient Totals (kg/ha):



Annual Nutrient Leaching Concentration (mg/L):



Plant Performance and Nutrients

Paddock: **New Paddock, 100 ha**

Soil Type: **Red Earth**

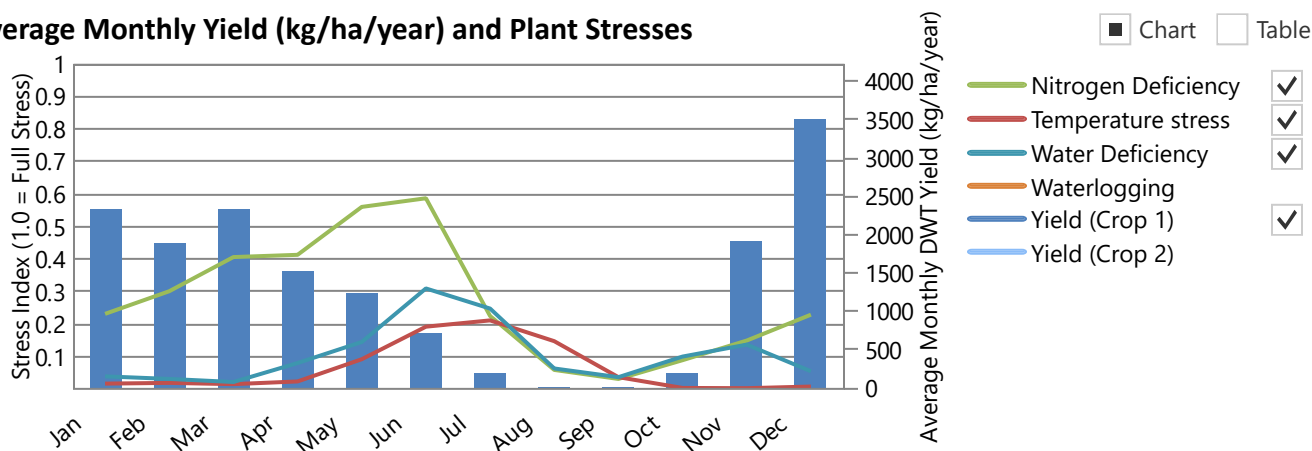
Plant: **Continuous Forage Sorghum Crop**

Average annual shoot dry matter yield (kg/ha/year)	16010.40 (9900.80 - 24183.61)
Average monthly plant (green) cover (fraction) (minimum - maximum)	0.39 (0.01 - 0.71)
Average monthly root depth (mm) (minimum - maximum)	918.77 (47.94 - 1524.44)

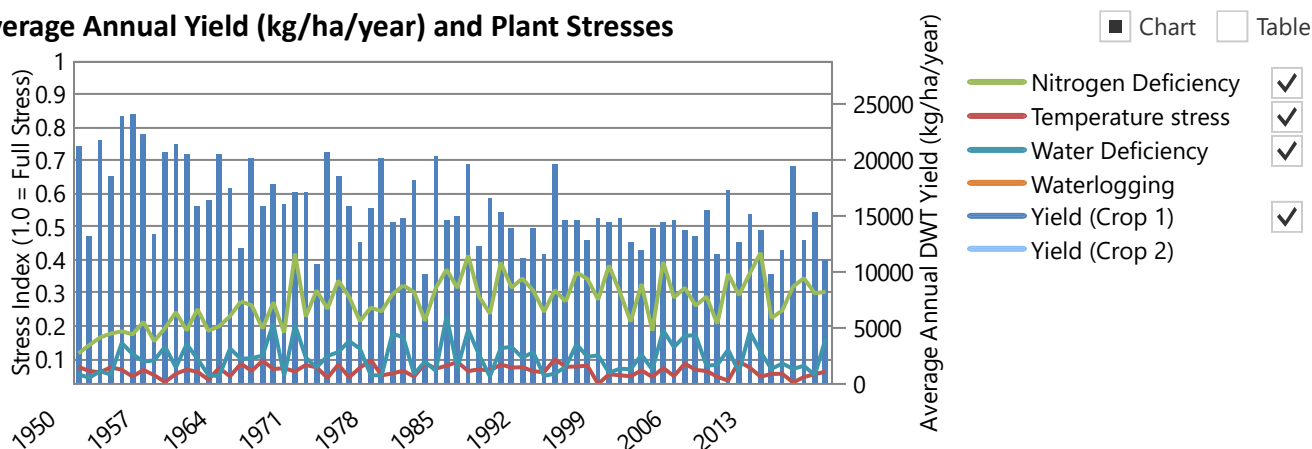
Nutrient Uptake (minimum - maximum):

Average annual net nitrogen removed by plant uptake (kg/ha/year)	122.34 (75.55 - 214.13)
Average annual net phosphorus removed by plant uptake (kg/ha/year)	16.48 (0.48 - 27.52)
Average annual shoot nitrogen concentration (fraction dwt)	0.01 (0.01 - 0.01)
Average annual shoot phosphorus concentration (fraction dwt)	0.001 (0.000 - 0.002)

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



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



No. of harvests/year: 2.60 (normal), 1.01 (forced by crop death due to nitrogen stress (0.53), water stress (0.49))

No. days without crop/year (days/year): 106.04 due to water stress (106.04)

Land Performance

Paddock: New Paddock, 100 ha

Soil Type: Red Earth

Plant: Continuous Forage Sorghum Crop

Salt tolerance	Tolerant
Salinity threshold EC sat. ext. (dS/m)	8.30
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.11
No. years assumed for leaching to reach steady-state (years)	10.00

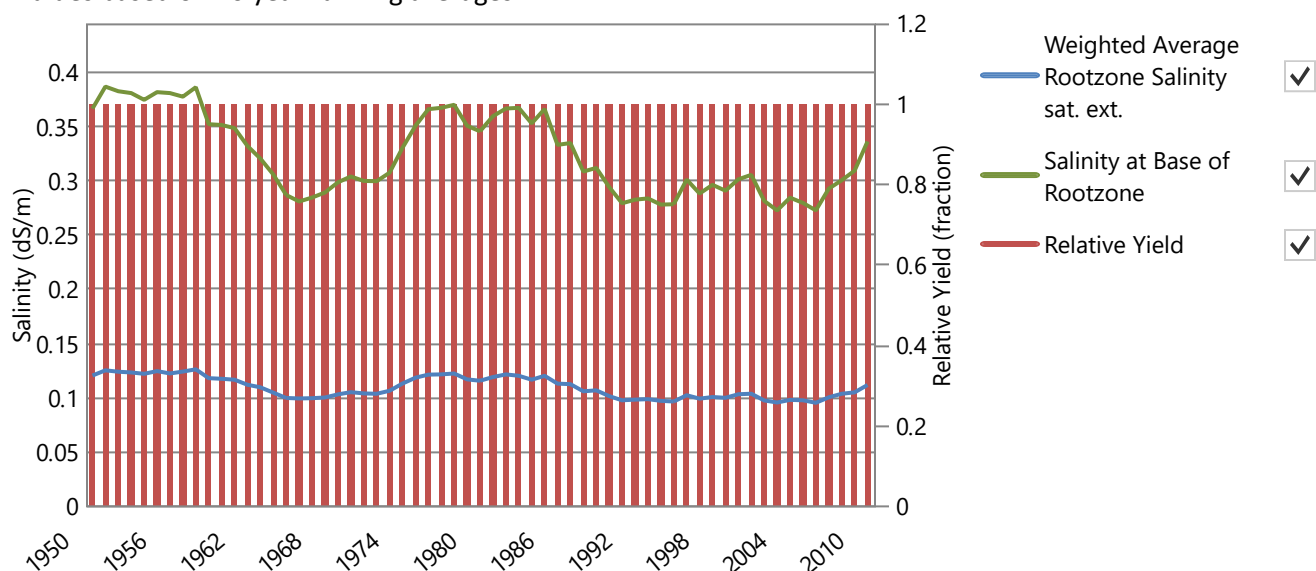
Soil Salinity:

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.13
Salt added by rainfall (kg/ha/year)	273.14
Average annual effluent salt added & leached at steady state (kg/ha/year)	1675.18
Average leaching fraction based on 10 year running averages (fraction)	0.56
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.11
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	0.32
Relative crop yield expected due to salinity (fraction)	1.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (fraction)	0.00

Average Annual Rootzone Salinity and Relative Yield:

☒ Chart ☐ Table

All values based on 10 year running averages

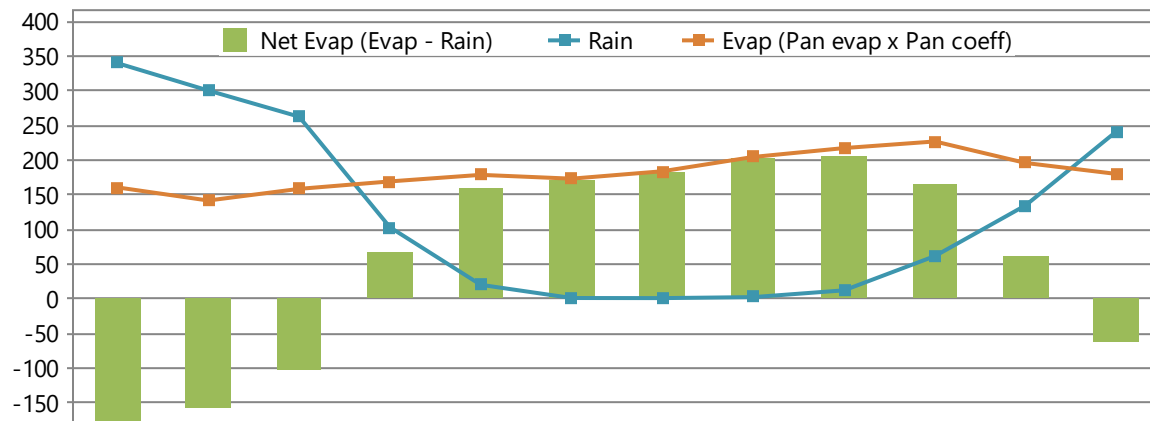


Sustainability Diagnostics: New Enterprise

Averaged Historical Climate Data Used in Simulation (mm)

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

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



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

DIAGNOSTICS

medli

Sustainability Diagnostics: New Enterprise

Pond System: 2 facultative, aerobic or storage ponds

New Generic System - 529774.61 m3/year or 1450.47 m3/day generated on average

Effluent entering pond system after any pretreatment and recycling

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

Constituent	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	18.00 (18.00 - 18.00)	9535.94 (9529.43 - 9556.24)
Total Phosphorus	4.00 (4.00 - 4.00)	2119.10 (2117.65 - 2123.61)
Total Dissolved Salts	267.00 (267.00 - 267.00)	141449.82 (141353.27 - 141750.83)
Volatile Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total Solids	20.00 (20.00 - 20.00)	10595.49 (10588.26 - 10618.04)

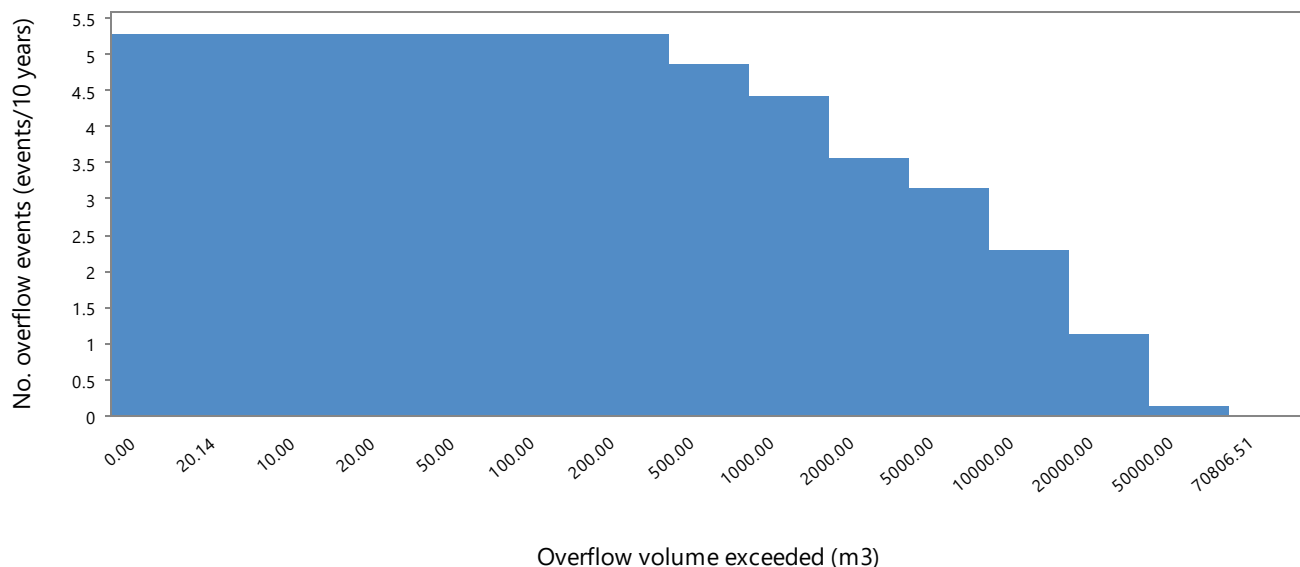
Last pond (Wet weather store): 120000.00 m3

Theoretical hydraulic retention time (days)	82.73
Average volume of overflow (m3/year)	6105.69
No. overflow events per year exceeding threshold* of 20.14 m3 (no./year)	0.53
Average duration of overflow (days)	6.14
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	0.99
Probability of at least 90% effluent reuse (fraction)	0.94
Average salinity of last pond (dS/m)	0.32
Salinity of last pond on final day of simulation (dS/m)	0.38
Ammonia loss from pond system water area (kg/m2/year)	0.00

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

Overflow exceedance:

☒ Chart ☐ Table



[Export plot](#)



Sustainability Diagnostics: New Enterprise

Irrigation Information

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

	Quantity/year	Quantity/ha/year
Total irrigation applied (m3)	511178.06	5111.78
Total nitrogen applied (kg)	9206.24	92.06
Total phosphorus applied (kg)	2100.44	21.00
Total salts applied (kg)	140204.58	1402.05

Shandying

Annual allocation of fresh water for shandying (m3/year)	0.00
Average Shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Average exceedance as a proportion of annual shandy water allocation (% of allocation) (minimum - maximum)	0.00 (0.00 - 0.00)
Proportion of irrigation events requiring shandying (fraction of events)	0.00
Minimum shandy water is used	False

Irrigation Issues

Proportion of Days irrigation is prevented when triggered (fraction)	0.00
Proportion of Days no irrigation occurs for some other reason (fraction)	0.14
Proportion of Days irrigation occurs (fraction)	0.86

Sustainability Diagnostics: New Enterprise

Paddock Land: New Paddock: 100 ha

Irrigation: Centre Pivot with 0.26% ammonium loss during irrigation

Irrigation triggered every 1 days
Irrigate up to a soil water content of 1.00 fraction of profile drained upper limit
Irrigation window from 1/1 to 31/12 including the days specified
A minimum of 0 days must be skipped between irrigation events

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	339.8	300.4	262.7	103.2	20.2	1.1	1.0	2.4	12.2	61.6	134.9	241.6	1481.1
Irrigation	44.8	35.9	48.8	81.1	51.8	32.9	33.6	32.7	31.3	35.3	39.0	44.0	511.2
Soil Evap	62.8	55.5	44.1	67.0	43.3	29.1	33.6	34.5	37.8	60.9	66.1	43.4	577.9
Transpn.	71.7	65.5	89.0	66.7	62.1	37.2	8.9	1.0	0.4	7.9	48.6	96.5	555.4
Rain Runoff	21.9	11.5	5.9	6.1	0.7	0.0	0.0	0.0	0.2	1.4	3.6	7.2	58.5
Irr. Runoff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Drainage	191.8	217.9	200.5	69.5	10.9	0.3	0.0	0.0	0.0	1.7	17.9	91.6	802.1
Delta	36.5	-14.1	-28.0	-25.0	-44.9	-32.6	-7.9	-0.4	5.1	24.9	37.8	47.0	-1.6

Soil Nitrogen Balance

Average annual effluent nitrogen added (kg/ha/year)	92.06
Average annual soil nitrogen removed by plant uptake (kg/ha/year)	122.34
Average annual soil nitrogen removed by denitrification (kg/ha/year)	0.03
Average annual soil nitrogen leached (kg/ha/year)	2.66
Average annual nitrate-N loading to groundwater (kg/ha/year)	2.66
Soil organic-N kg/ha (Initial - Final)	1984.50 - 153.30
	141.30 - 0.03
Average nitrate-N concentration of deep drainage (mg/L)	0.33
Max. annual nitrate-N concentration of deep drainage (mg/L)	10.00

Soil Phosphorus Balance

Average annual effluent phosphorus added (kg/ha/year)	21.00
Average annual soil phosphorus removed by plant uptake (kg/ha/year)	16.48
Average annual soil phosphorus leached (kg/ha/year)	0.04
Dissolved phosphorus (kg/ha) (Initial - Final)	0.01 - 0.02
Adsorbed phosphorus (kg/ha) (Initial - Final)	251.51 - 588.43
Average phosphate-P concentration in rootzone (mg/L)	0.02
Average phosphate-P concentration of deep drainage (mg/L)	0.01
Max. annual phosphate-P concentration of deep drainage (mg/L)	0.01
Design soil profile storage life based on average infiltrated water phosphorus concn. of 1.09 mg/L (years)	227.49

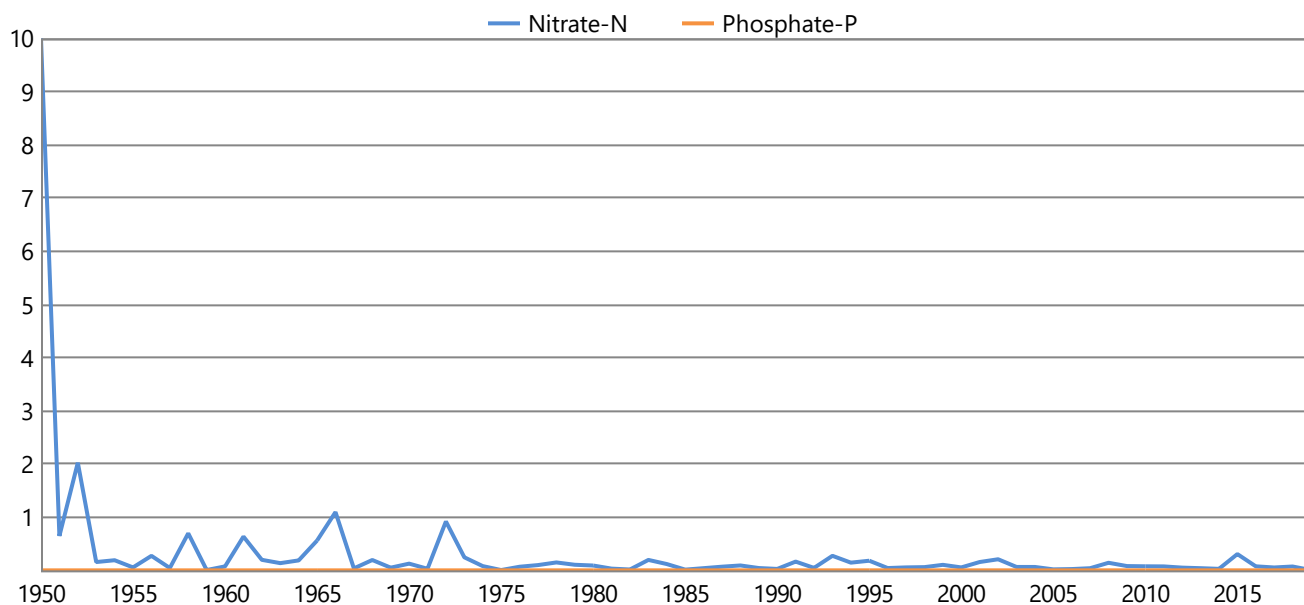


Sustainability Diagnostics: New Enterprise

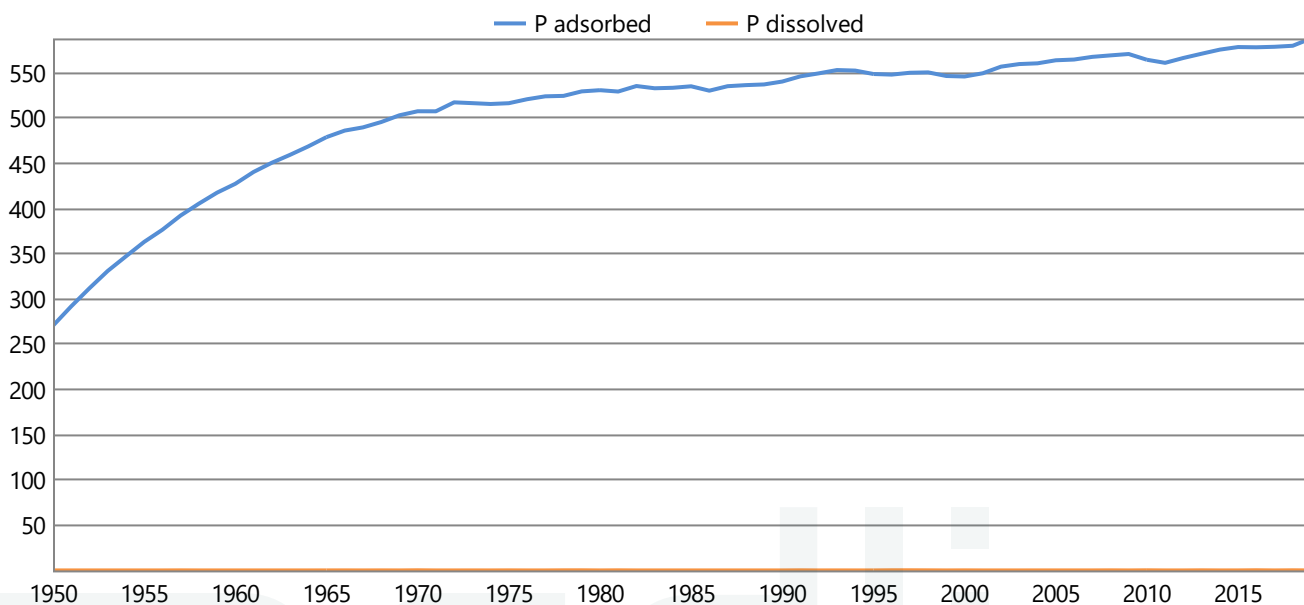
Paddock Land: New Paddock: 100 ha

Irrigation: Centre Pivot with 0.26% ammonium loss during irrigation

Annual nutrient leachate concentration (mg/L)



Annual Phosphate-P in soil (kg/ha)



Sustainability Diagnostics: New Enterprise

Paddock Plant Performance: New Paddock: 100 ha

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

Average annual shoot dry matter yield (kg/ha/year)	16010.40 (9900.80 - 24183.61)
Average monthly plant (green) cover (fraction)	0.39 (0.01 - 0.71)
Average monthly crop factor (fraction)	0.31 (0.01 - 0.57)
Total plant cover (both green and dead) left after harvest (fraction)	0.00
Average monthly root depth (mm)	918.77 (47.94 - 1524.44)
Average number of normal harvests per year (no./year)	2.60 (1.00 - 4.00)
Average number of normal harvests for last five years only (no./year)	2.40
Average number of crop deaths per year (no./year)	1.01 (1.00 - 2.00)
Average number of crop deaths for last five years only (no./year)	1.00
Average annual nitrogen deficiency index (0 = no stress, 1 = full stress) (coefficient)	0.27 (0.12 - 0.42)
Average January temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.02 (0.00 - 0.05)
Average July temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.21 (0.07 - 0.36)
Average monthly water stress index (0 = no stress, 1 = full stress) (coefficient)	0.11 (0.02 - 0.31)
Average monthly waterlogging index (0 = no stress, 1 = full stress) (coefficient)	0.00 (0.00 - 0.00)
No. days without crop/year (days)	106.04

Soil Salinity - Plant salinity tolerance: Tolerant

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

All values based on 10 year running averages

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.13
Salt added by rainfall (kg/ha/year)	273.14
Average annual effluent salt added & leached at steady state (kg/ha/year)	1675.18
Average leaching fraction based on 10 year running averages (fraction)	0.56
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.11
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	0.32
Relative crop yield expected due to salinity (fraction)	1.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (fraction)	0.00



Run Messages

Messages generated when the scenario was run:

Full run chosen



Attachment B. MEDLI Report: 50% Reuse

Enterprise: New Enterprise with 50000.00 m3 storage pond volume and 120.00 ha irrigation area

Description:

New Subject

Client: New Client

MEDLI User: ECOZ\emma.lewis

Scenario Details:

MEDLI REPORT - FULL RUN



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

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

Climate Statistics:

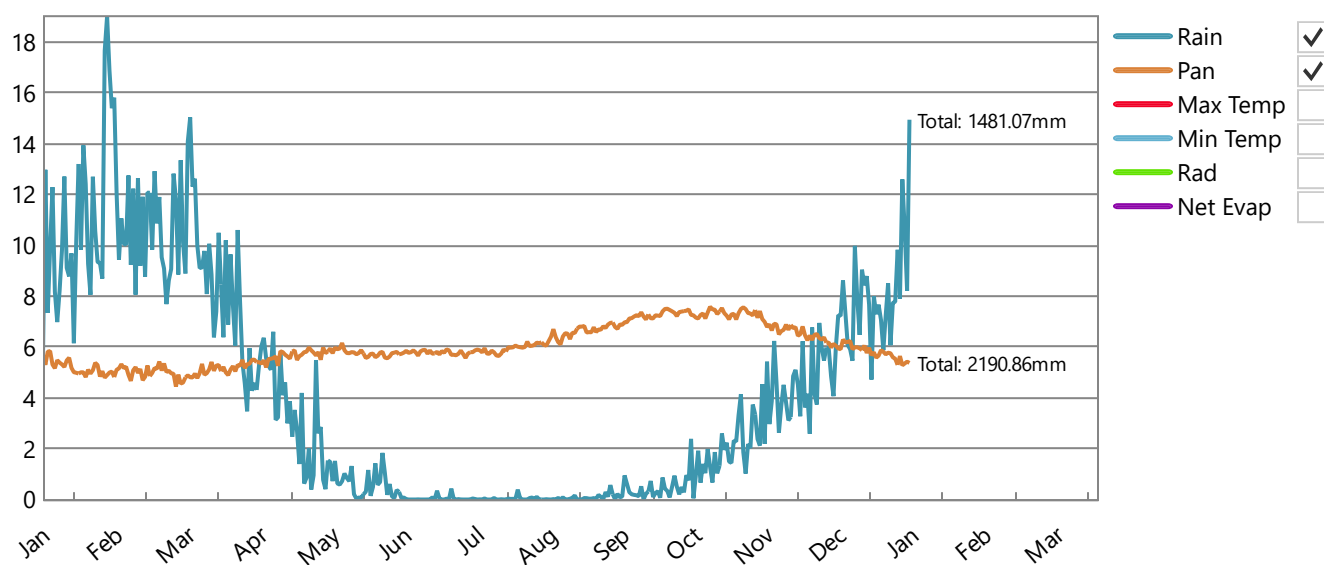
	5th ▾	Percentile	50th Percentile	95th ▾	Percentile
Rainfall (mm/year)		909	1441		2038
Pan Evaporation (mm/year)		1917	2189		2432

Climate Data:

☒ Chart ☐ Table

☐ Monthly ☒ Daily

Daily Average Across Run Period



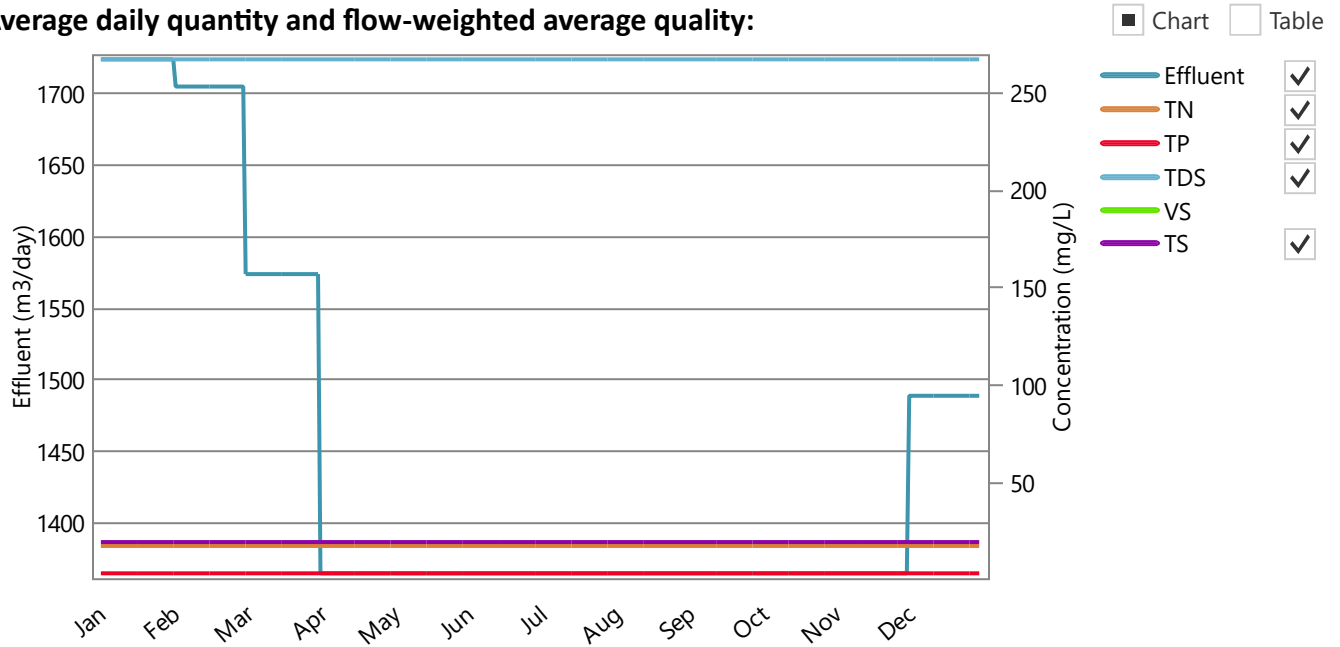
DESCRIPTION

medli

Effluent type: New Generic System

Wastestream before any recycling or pretreatment

Average daily quantity and flow-weighted average quality:



Recycling

Recycle 682 m3/day from Pond 1 ceasing when salinity reaches 100 dS/m and resuming when salinity falls to 0 dS/m.

Wastestream after any recycling and pretreatment if applicable

Effluent quantity: **529774.61 m3/year** or 1450.47 m3/day (Min-Max: 1365.00 - 1724.00)

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

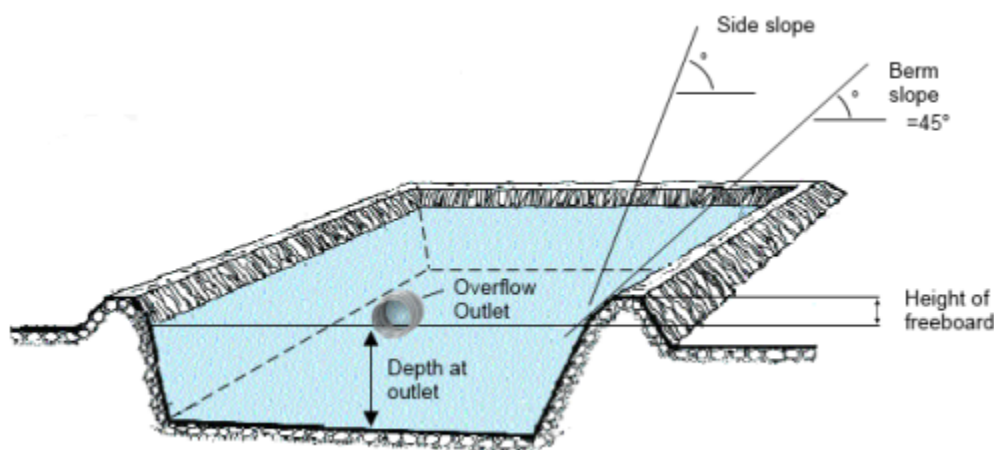
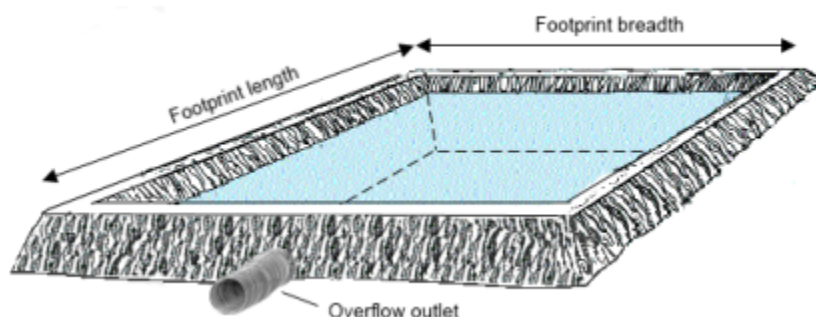
	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	34.82 (18.00 - 39.95)	18446.36 (18040.78 - 19015.02)
Total Phosphorus	7.74 (4.00 - 8.88)	4099.19 (4009.06 - 4225.56)
Total Dissolved Salts	516.49 (267.00 - 592.61)	273621.06 (267604.94 - 282056.07)
Volatile Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total Solids	20.00 (20.00 - 20.00)	10595.49 (10588.26 - 10618.04)



Pond system: 2 facultative, aerobic or storage ponds

Pond system details:

	Pond 1	Pond 2
Maximum pond volume (m3)	30000.00	50000.00
Minimum allowable pond volume (m3)	0.00	0.00
Pond depth at overflow outlet (m)	1.50	3.00
Maximum water surface area (m2)	20095.74	16841.67
Pond footprint length (m)	203.68	186.73
Pond footprint width (m)	103.44	94.97
Pond catchment area (m2)	21068.27	17732.85
Average active volume (m3)	29986.36	3286.25



Irrigation pump limits:

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

Shandying water:

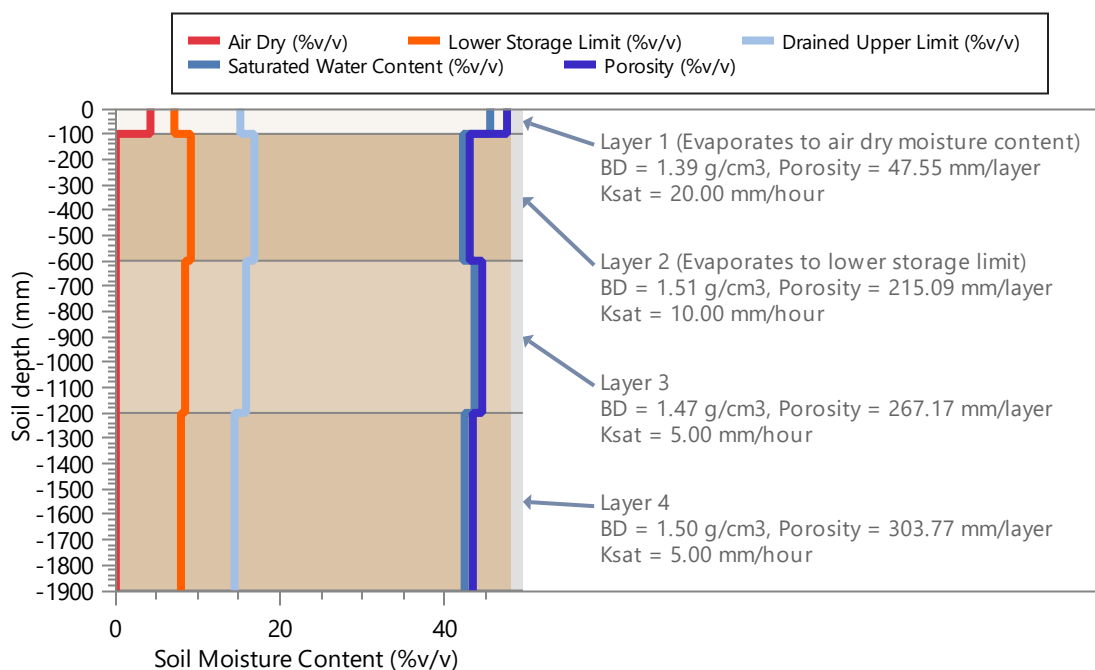
Annual allocation of fresh water available for shandying (m3/year)	0.00
Maximum rate of application of fresh water (ML/day)	0.00
Nitrogen concentration (mg/L)	0.00
Salinity (dS/m)	0.00
Minimum shandy water is used	False

Land: New Paddock

Area (ha): 120.00

Soil Type: Red Earth, 1900.00 mm defined profile depth

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



Plant Data: Continuous Forage Sorghum Crop

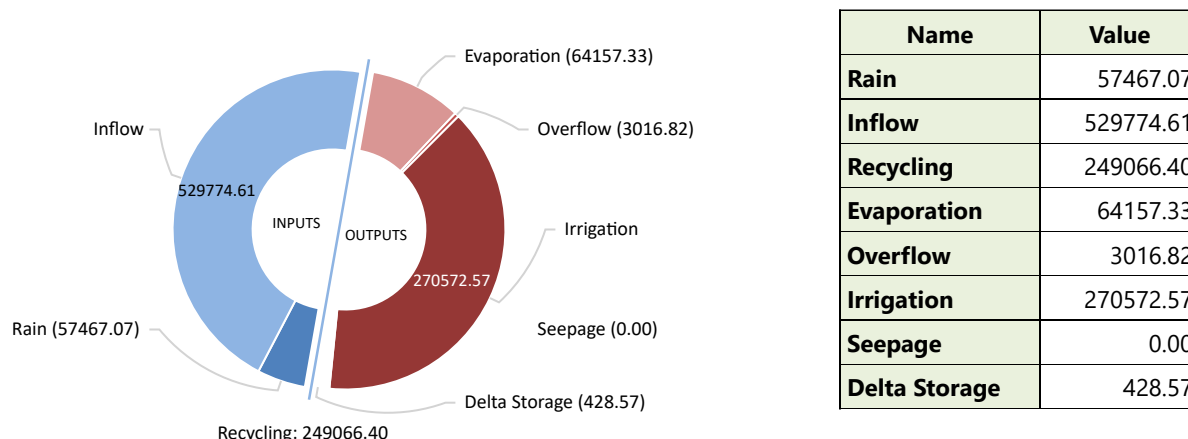
Average monthly cover (fraction) (minimum - maximum)	0.36 (0.01 - 0.71)
Maximum crop factor at 100% cover (mm/mm) (Maximum crop coefficient 0.8 x Pan coefficient 1)	0.80
Total plant cover (both green and dead) left after harvest (fraction)	0.00
Maximum potential root depth in defined soil profile (mm)	1900.00
Salt tolerance	Tolerant
Salinity threshold EC sat. ext. (dS/m)	8.30
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.11



Pond System Water Performance - Overflow: 2 facultative, aerobic or storage ponds

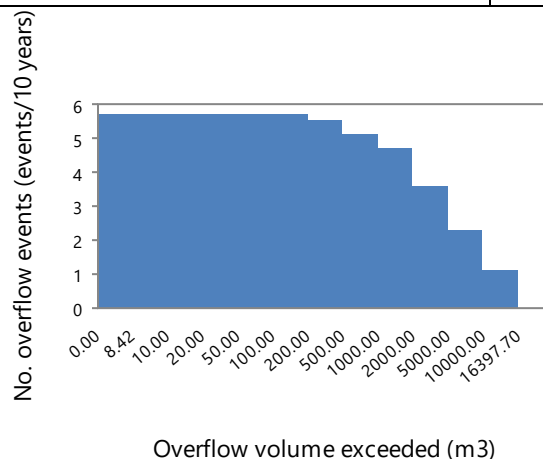
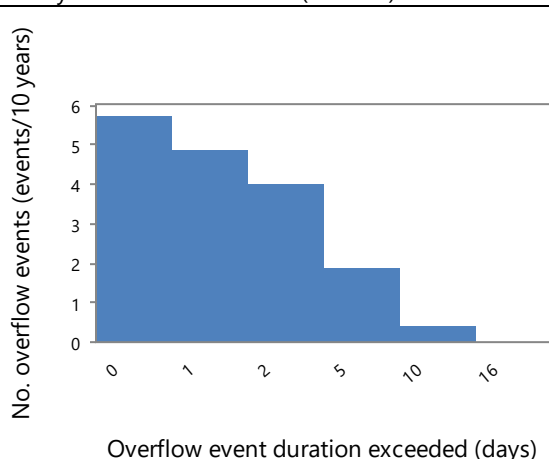
Capacity of wet weather storage pond: **50000 m3**

Pond System Water Balance (m3/year)



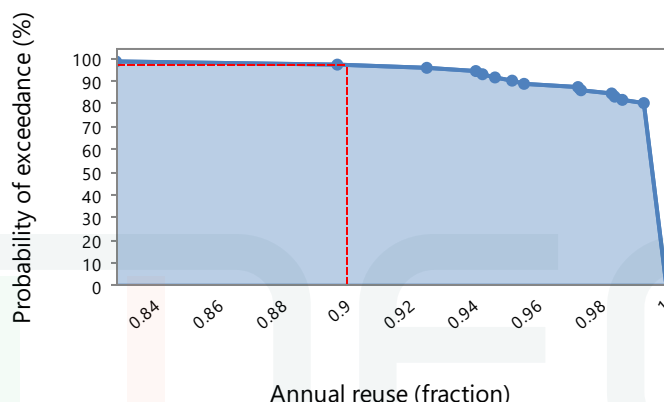
Overflow Diagnostics

Volume of overflow (m3/year)	3016.82
No. days pond overflows (days/year)	2.77
Average duration of overflow (days)	4.85
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	0.99
Probability of at least 90% reuse (fraction)	0.97



[Export plot](#)

[Export plot](#)

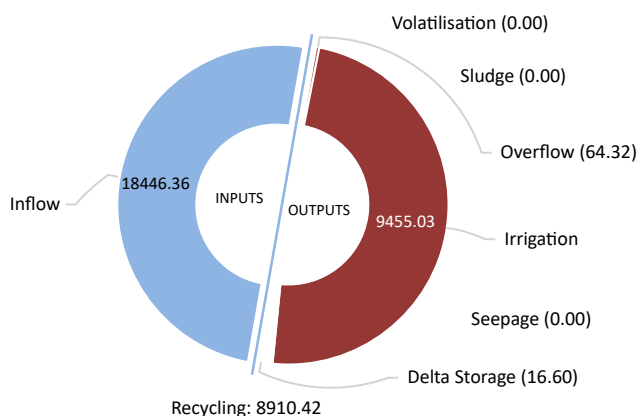


[Export plot](#)

Pond System Performance - Nutrient: 2 facultative, aerobic or storage ponds

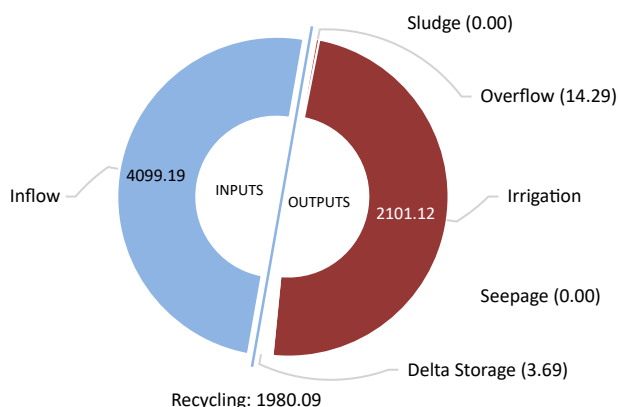
Pond System Nutrients and Salt Balance:

Nitrogen Balance (kg/year)



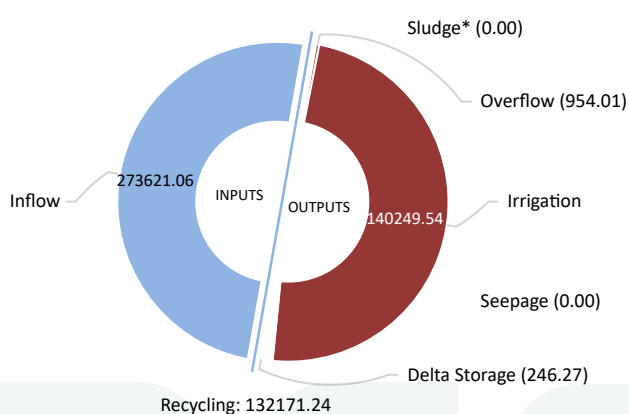
Name	Value
Inflow	18446.36
Recycling	8910.42
Volatilisation	0.00
Sludge	0.00
Overflow	64.32
Irrigation	9455.03
Seepage	0.00
Delta Storage	16.60

Phosphorus Balance (kg/year)



Name	Value
Inflow	4099.19
Recycling	1980.09
Sludge	0.00
Overflow	14.29
Irrigation	2101.12
Seepage	0.00
Delta Storage	3.69

Salt Balance (kg/year)



Name	Value
Inflow	273621.06
Recycling	132171.24
Sludge*	0.00
Overflow	954.01
Irrigation	140249.54
Seepage	0.00
Delta Storage	246.27

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

Pond System Sludge Accumulation: 0.00 kg dwt/year

Pond System Performance - Nutrient: 2 facultative, aerobic or storage ponds

Pond Nutrient Concentrations and Salinity:

Average across simulation period	Pond 1	Pond 2
Average nitrogen concentration of pond liquid (mg/L)	35.78	23.06
Average phosphorus concentration of pond liquid (mg/L)	7.95	5.12
Average salinity of pond liquid (dS/m)	0.83	0.53

Value on final day of simulation period	Pond 1	Pond 2
Final nitrogen concentration of pond liquid (mg/L)	38.74	N.D.*
Final phosphorus concentration of pond liquid (mg/L)	8.61	N.D.*
Final salinity of pond liquid (dS/m)	0.90	N.D.*

* Not determined. Pond is empty.

Irrigation Performance:

Water Use: (assumes 100% Irrigation Efficiency)

Pond water irrigated (m3/year)	270572.57
Average Shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Total water irrigated (m3/year)	270572.57
Proportion of irrigation events requiring shandying (fraction of events)	0.00
Proportion of years shandying water allocation of 0 m3/year is exceeded (fraction of years)	0.00
Average exceedance as a proportion of annual shandy water allocation (fraction of allocation) (minimum - maximum)	0.00 (0.00 - 0.00)

Irrigation Quality:

Average nitrogen concentration of irrigation water - before ammonia loss during irrigation (mg/L)	34.94
Average nitrogen concentration of irrigation water - after ammonia loss during irrigation (mg/L)	34.04
Average phosphorus concentration of irrigation water (mg/L)	7.77
Average salinity of irrigation water (dS/m)	0.81

Irrigation Diagnostics:

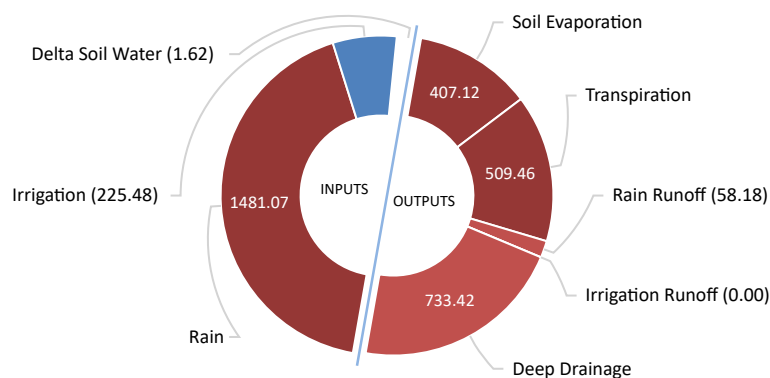
Proportion of Days no irrigation occurs for some other reason (fraction)	0.12
Proportion of Days irrigation occurs (fraction)	0.88

Land Performance - Soil Water

Paddock: **New Paddock, 120 ha**

Soil Type: **Red Earth, 136.40 mm PAWC at maximum root depth**

Land Water Balance (mm/year):

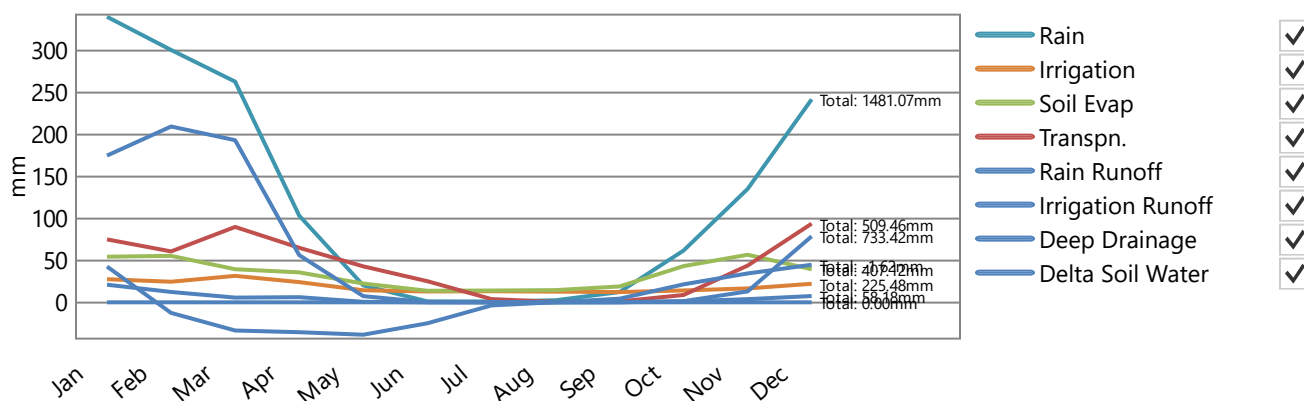


■ mm/year □ % Total inputs

Name	Value
Rain	1481.07
Irrigation	225.48
Soil Evaporation	407.12
Transpiration	509.46
Rain Runoff	58.18
Irrigation Runoff	0.00
Deep Drainage	733.42
Delta Soil Water	-1.62

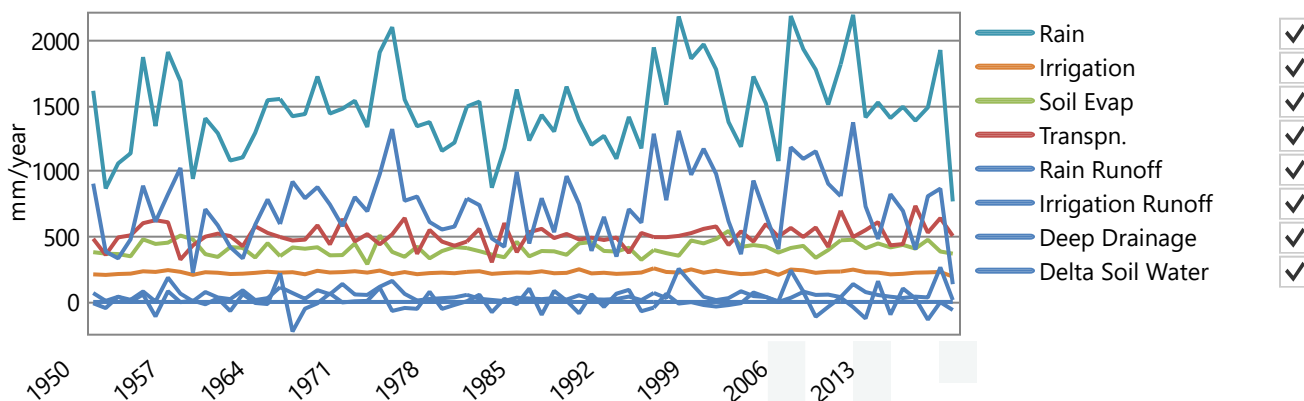
Average Monthly Totals (mm):

■ Chart □ Table



Average Annual Totals (mm/year):

■ Chart □ Table



Land Performance - Soil Nutrient

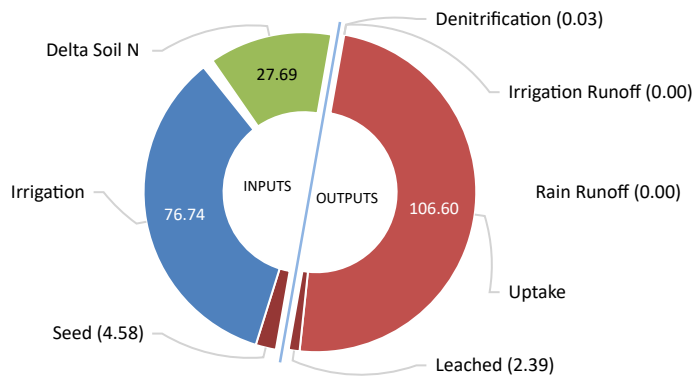
Paddock: **New Paddock, 120 ha**

Soil Type: **Red Earth**

Irrigation ammonium volatilisation losses (kg/ha/year): 2.05

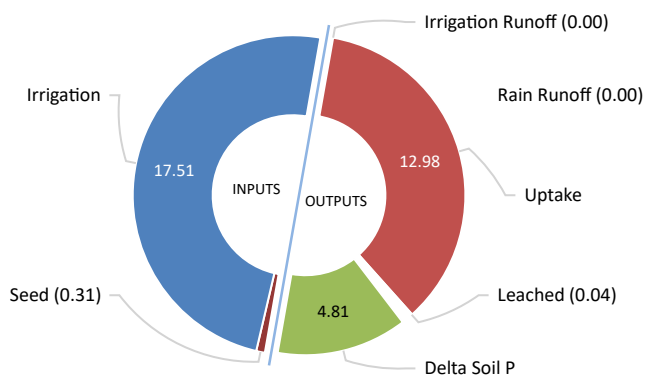
Proportion of total nitrogen in irrigated effluent as ammonium (fraction): 0.10

Land Nitrogen Balance (kg/ha/year)



Name	Value
Seed	4.58
Irrigation	76.74
Denitrification	0.03
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	106.60
Leached	2.39
Delta Soil N	-27.69

Land Phosphorus Balance (kg/ha/year)



Name	Value
Seed	0.31
Irrigation	17.51
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	12.98
Leached	0.04
Delta Soil P	4.81

PERFORMANCE

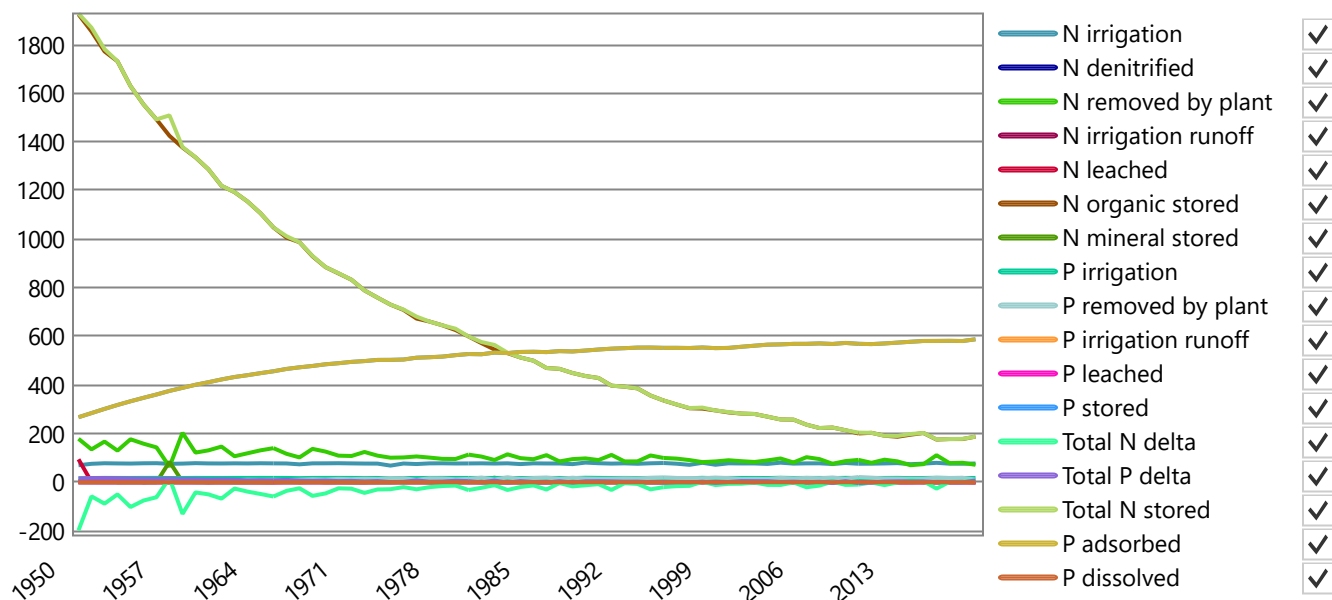


Land Performance - Soil Nutrient

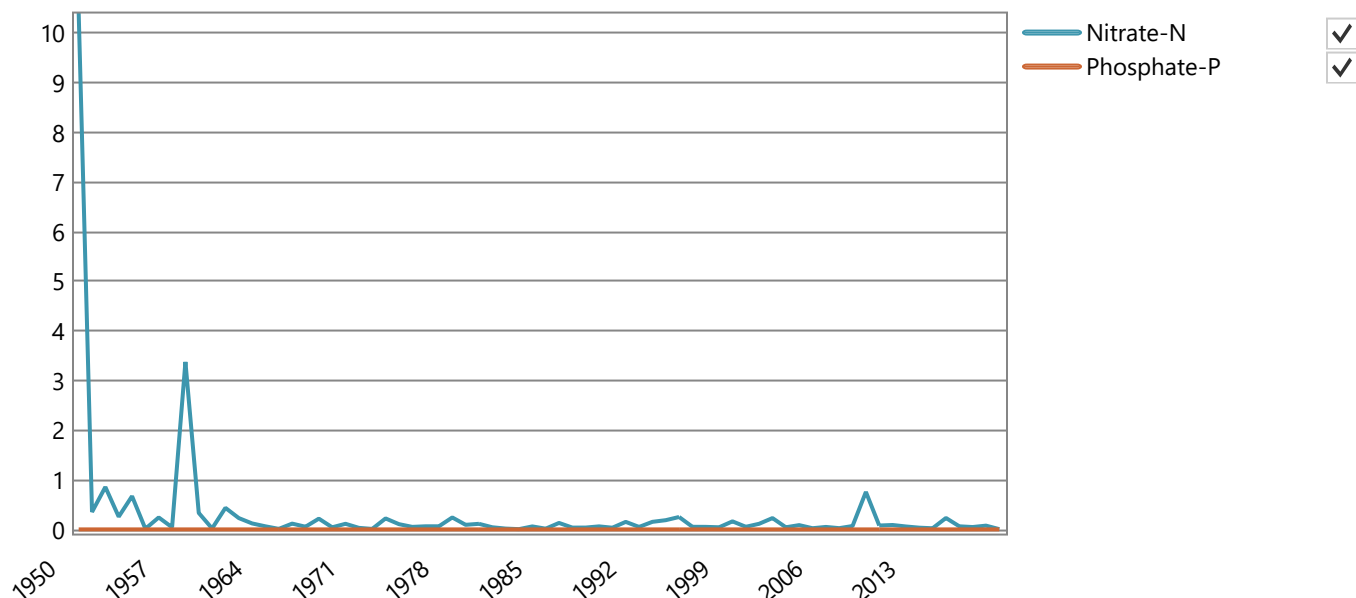
Paddock: **New Paddock, 120 ha**

Soil Type: **Red Earth**

Annual Nutrient Totals (kg/ha):



Annual Nutrient Leaching Concentration (mg/L):



PERFORMANCE



Plant Performance and Nutrients

Paddock: **New Paddock, 120 ha**

Soil Type: **Red Earth**

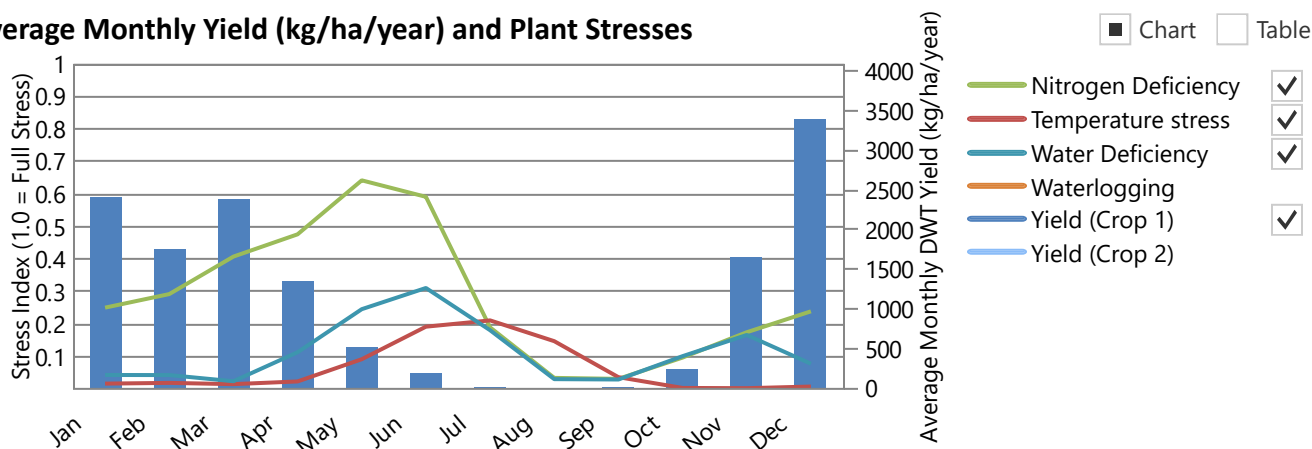
Plant: **Continuous Forage Sorghum Crop**

Average annual shoot dry matter yield (kg/ha/year)	14044.57 (7933.26 - 22021.79)
Average monthly plant (green) cover (fraction) (minimum - maximum)	0.36 (0.01 - 0.71)
Average monthly root depth (mm) (minimum - maximum)	882.85 (44.75 - 1547.87)

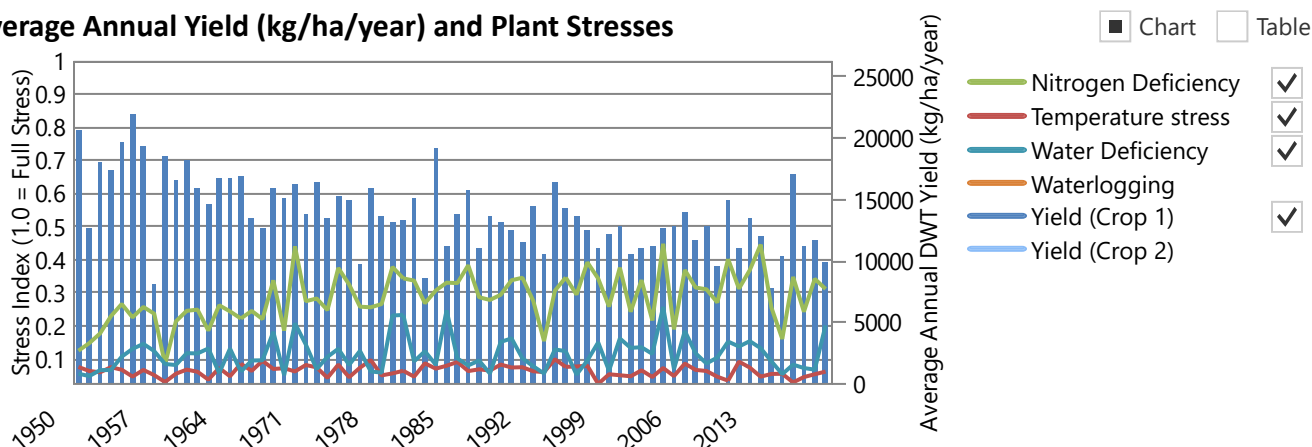
Nutrient Uptake (minimum - maximum):

Average annual net nitrogen removed by plant uptake (kg/ha/year)	106.60 (63.64 - 203.17)
Average annual net phosphorus removed by plant uptake (kg/ha/year)	12.98 (0.39 - 21.35)
Average annual shoot nitrogen concentration (fraction dwt)	0.01 (0.01 - 0.01)
Average annual shoot phosphorus concentration (fraction dwt)	0.001 (0.000 - 0.002)

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



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



No. of harvests/year: 2.41 (normal), 1.04 (forced by crop death due to nitrogen stress (0.64), water stress (0.40))

No. days without crop/year (days/year): 115.93 due to water stress (115.93)

Land Performance

Paddock: New Paddock, 120 ha

Soil Type: Red Earth

Plant: Continuous Forage Sorghum Crop

Salt tolerance	Tolerant
Salinity threshold EC sat. ext. (dS/m)	8.30
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.11
No. years assumed for leaching to reach steady-state (years)	10.00

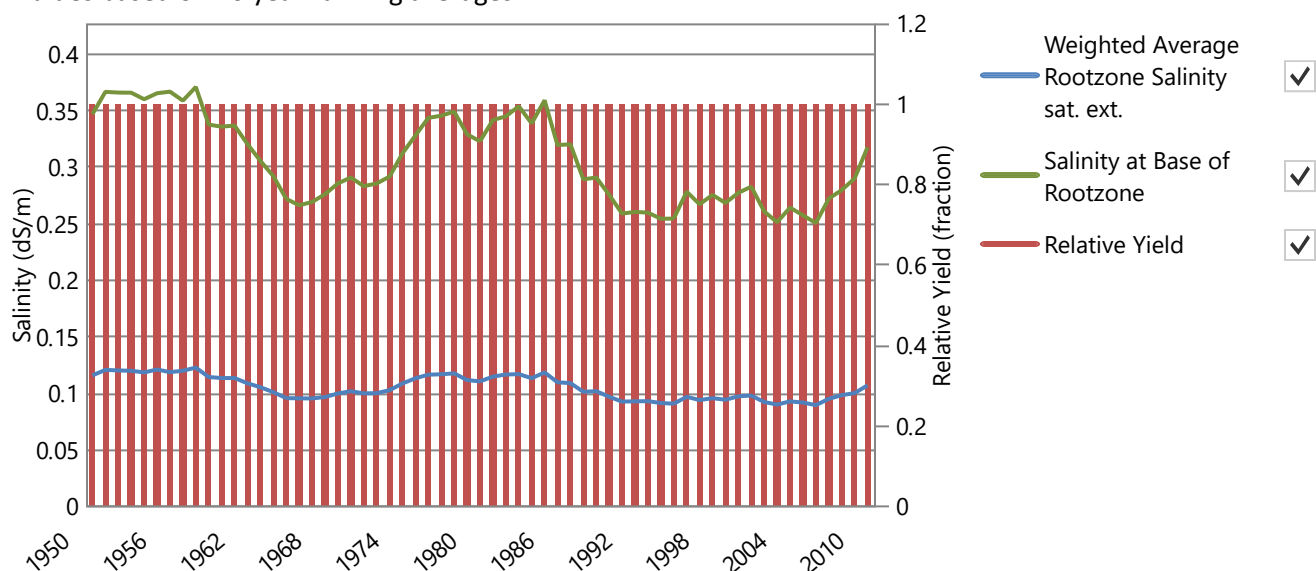
Soil Salinity:

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.14
Salt added by rainfall (kg/ha/year)	273.20
Average annual effluent salt added & leached at steady state (kg/ha/year)	1441.94
Average leaching fraction based on 10 year running averages (fraction)	0.59
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.11
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	0.31
Relative crop yield expected due to salinity (fraction)	1.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (fraction)	0.00

Average Annual Rootzone Salinity and Relative Yield:

☒ Chart ☐ Table

All values based on 10 year running averages

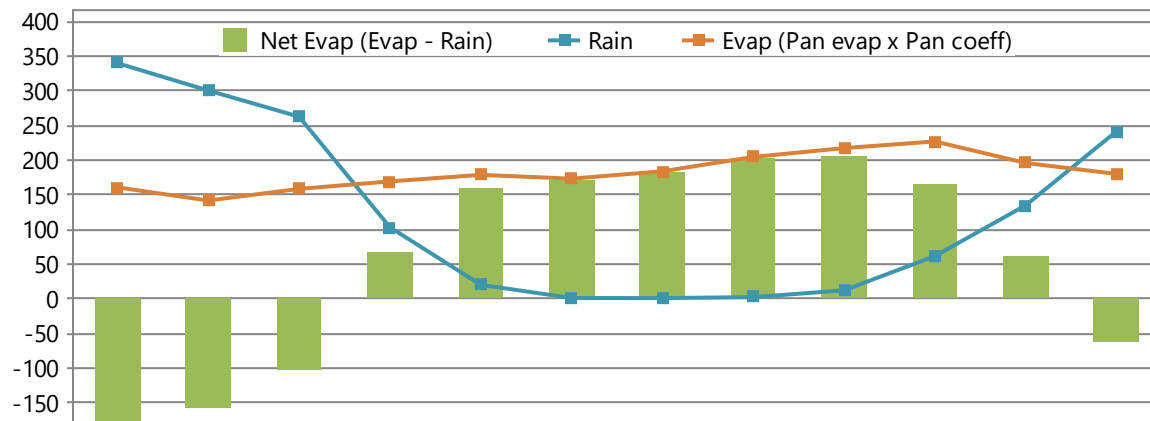


Sustainability Diagnostics: New Enterprise

Averaged Historical Climate Data Used in Simulation (mm)

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

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



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

Sustainability Diagnostics: New Enterprise

Pond System: 2 facultative, aerobic or storage ponds

New Generic System - 529774.61 m3/year or 1450.47 m3/day generated on average

Effluent entering pond system after any pretreatment and recycling

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

Constituent	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	34.82 (18.00 - 39.95)	18446.36 (18040.78 - 19015.02)
Total Phosphorus	7.74 (4.00 - 8.88)	4099.19 (4009.06 - 4225.56)
Total Dissolved Salts	516.49 (267.00 - 592.61)	273621.06 (267604.94 - 282056.07)
Volatile Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total Solids	20.00 (20.00 - 20.00)	10595.49 (10588.26 - 10618.04)

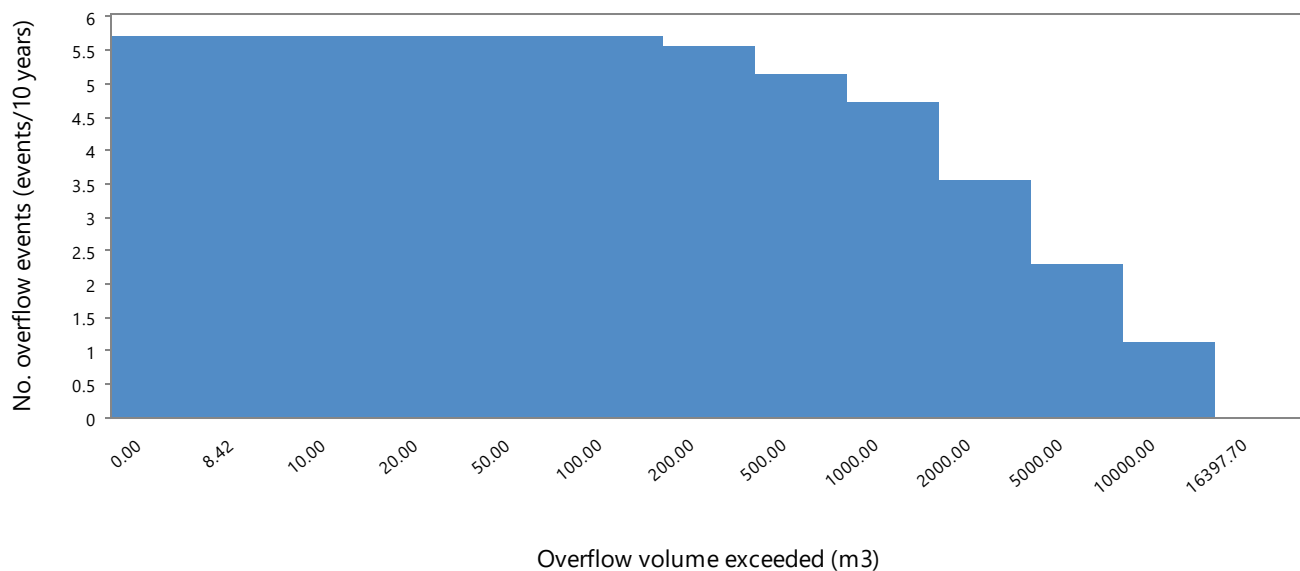
Last pond (Wet weather store): 50000.00 m3

Theoretical hydraulic retention time (days)	34.47
Average volume of overflow (m3/year)	3016.82
No. overflow events per year exceeding threshold* of 8.42 m3 (no./year)	0.57
Average duration of overflow (days)	4.85
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	0.99
Probability of at least 90% effluent reuse (fraction)	0.97
Average salinity of last pond (dS/m)	0.53
Salinity of last pond on final day of simulation (dS/m)	0.81
Ammonia loss from pond system water area (kg/m2/year)	0.00

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

Overflow exceedance:

☒ Chart ☐ Table



[Export plot](#)



Sustainability Diagnostics: New Enterprise

Irrigation Information

Irrigation: 120 ha total area (assumed 100% irrigation efficiency)

	Quantity/year	Quantity/ha/year
Total irrigation applied (m3)	270572.57	2254.77
Total nitrogen applied (kg)	9209.19	76.74
Total phosphorus applied (kg)	2101.12	17.51
Total salts applied (kg)	140249.54	1168.75

Shandying

Annual allocation of fresh water for shandying (m3/year)	0.00
Average Shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Average exceedance as a proportion of annual shandy water allocation (% of allocation) (minimum - maximum)	0.00 (0.00 - 0.00)
Proportion of irrigation events requiring shandying (fraction of events)	0.00
Minimum shandy water is used	False

Irrigation Issues

Proportion of Days irrigation is prevented when triggered (fraction)	0.00
Proportion of Days no irrigation occurs for some other reason (fraction)	0.12
Proportion of Days irrigation occurs (fraction)	0.88

Sustainability Diagnostics: New Enterprise

Paddock Land: New Paddock: 120 ha

Irrigation: Centre Pivot with 0.26% ammonium loss during irrigation

Irrigation triggered every 1 days
Irrigate up to a soil water content of 1.00 fraction of profile drained upper limit
Irrigation window from 1/1 to 31/12 including the days specified
A minimum of 0 days must be skipped between irrigation events

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	339.8	300.4	262.7	103.2	20.2	1.1	1.0	2.4	12.2	61.6	134.9	241.6	1481.1
Irrigation	27.5	24.5	31.5	24.0	14.3	12.9	13.2	12.7	12.2	14.1	16.5	22.1	225.5
Soil Evap	54.3	55.3	39.4	35.6	22.3	13.8	14.0	14.5	18.9	43.1	56.6	39.3	407.1
Transpn.	74.9	60.6	89.7	64.9	42.8	25.1	3.9	0.5	1.0	8.7	43.7	93.6	509.5
Rain Runoff	20.9	12.3	5.6	6.1	0.6	0.0	0.0	0.0	0.2	1.2	3.8	7.5	58.2
Irr. Runoff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Drainage	174.7	209.3	193.0	56.2	7.4	0.1	0.0	0.0	0.0	1.3	13.0	78.6	733.4
Delta	42.5	-12.6	-33.5	-35.6	-38.6	-25.0	-3.7	0.1	4.3	21.4	34.4	44.7	-1.6

Soil Nitrogen Balance

Average annual effluent nitrogen added (kg/ha/year)	76.74
Average annual soil nitrogen removed by plant uptake (kg/ha/year)	106.60
Average annual soil nitrogen removed by denitrification (kg/ha/year)	0.03
Average annual soil nitrogen leached (kg/ha/year)	2.39
Average annual nitrate-N loading to groundwater (kg/ha/year)	2.39
Soil organic-N kg/ha (Initial - Final)	1984.50 - 187.48
	141.30 - 0.02
Average nitrate-N concentration of deep drainage (mg/L)	0.33
Max. annual nitrate-N concentration of deep drainage (mg/L)	10.42

Soil Phosphorus Balance

Average annual effluent phosphorus added (kg/ha/year)	17.51
Average annual soil phosphorus removed by plant uptake (kg/ha/year)	12.98
Average annual soil phosphorus leached (kg/ha/year)	0.04
Dissolved phosphorus (kg/ha) (Initial - Final)	0.01 - 0.02
Adsorbed phosphorus (kg/ha) (Initial - Final)	251.51 - 587.94
Average phosphate-P concentration in rootzone (mg/L)	0.02
Average phosphate-P concentration of deep drainage (mg/L)	0.01
Max. annual phosphate-P concentration of deep drainage (mg/L)	0.01
Design soil profile storage life based on average infiltrated water phosphorus concn. of 1.06 mg/L (years)	268.55

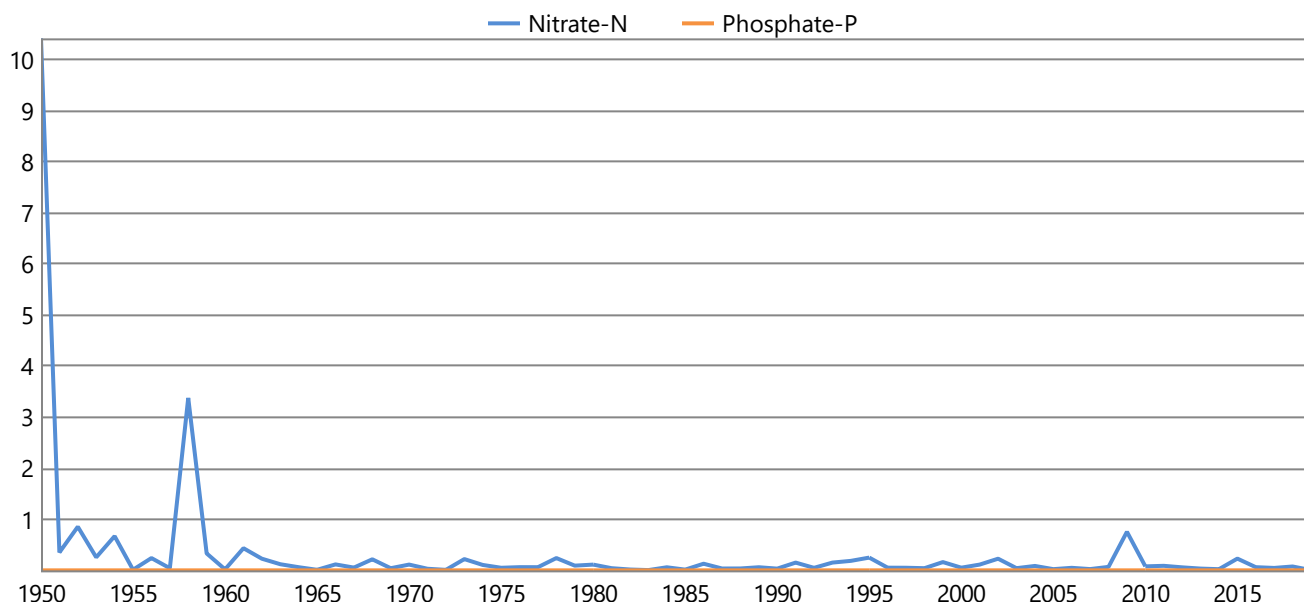


Sustainability Diagnostics: New Enterprise

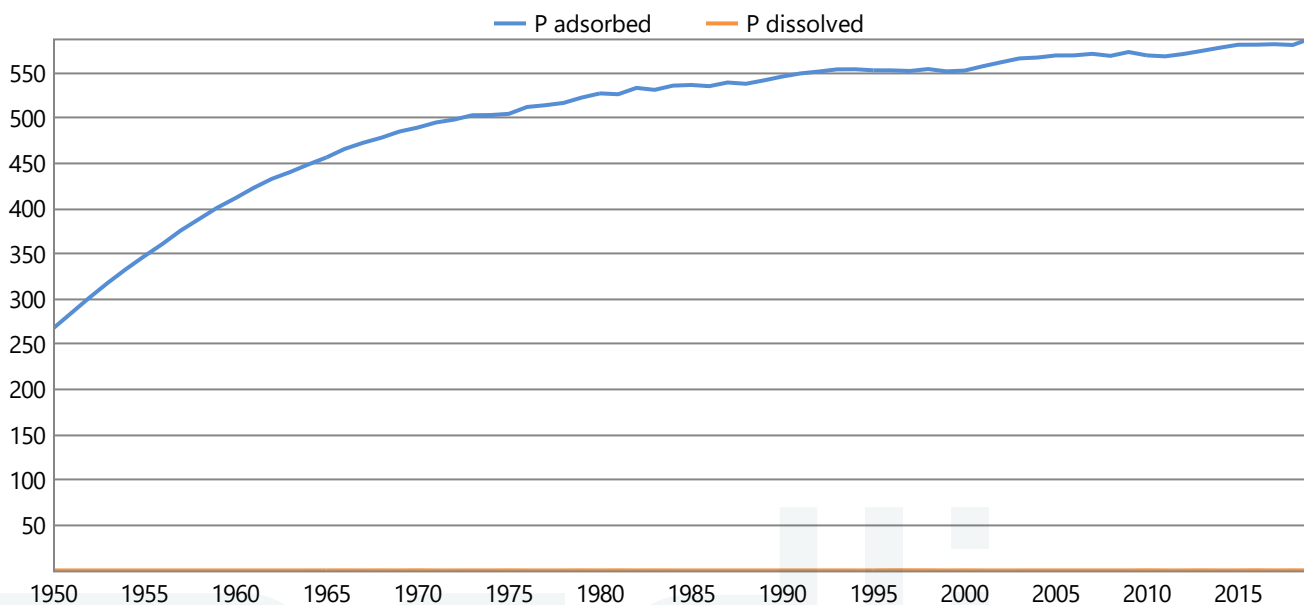
Paddock Land: New Paddock: 120 ha

Irrigation: Centre Pivot with 0.26% ammonium loss during irrigation

Annual nutrient leachate concentration (mg/L)



Annual Phosphate-P in soil (kg/ha)



Sustainability Diagnostics: New Enterprise

Paddock Plant Performance: New Paddock: 120 ha

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

Average annual shoot dry matter yield (kg/ha/year)	14044.57 (7933.26 - 22021.79)
Average monthly plant (green) cover (fraction)	0.36 (0.01 - 0.71)
Average monthly crop factor (fraction)	0.29 (0.01 - 0.57)
Total plant cover (both green and dead) left after harvest (fraction)	0.00
Average monthly root depth (mm)	882.85 (44.75 - 1547.87)
Average number of normal harvests per year (no./year)	2.41 (1.00 - 4.00)
Average number of normal harvests for last five years only (no./year)	2.40
Average number of crop deaths per year (no./year)	1.04 (1.00 - 2.00)
Average number of crop deaths for last five years only (no./year)	1.00
Average annual nitrogen deficiency index (0 = no stress, 1 = full stress) (coefficient)	0.29 (0.08 - 0.45)
Average January temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.02 (0.00 - 0.05)
Average July temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.21 (0.07 - 0.36)
Average monthly water stress index (0 = no stress, 1 = full stress) (coefficient)	0.11 (0.02 - 0.31)
Average monthly waterlogging index (0 = no stress, 1 = full stress) (coefficient)	0.00 (0.00 - 0.00)
No. days without crop/year (days)	115.93

Soil Salinity - Plant salinity tolerance: Tolerant

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

All values based on 10 year running averages

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.14
Salt added by rainfall (kg/ha/year)	273.20
Average annual effluent salt added & leached at steady state (kg/ha/year)	1441.94
Average leaching fraction based on 10 year running averages (fraction)	0.59
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.11
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	0.31
Relative crop yield expected due to salinity (fraction)	1.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (fraction)	0.00



Run Messages

Messages generated when the scenario was run:

Full run chosen



EcOz Environmental Consultants

EcOz Pty Ltd.

ABN 81 143 989 039

Level 1, 70 Cavenagh St,
GPO Box 381,
Darwin, NT 0801

T: +61 8 8981 1100

E: ecoz@ecoz.com.au

www.ecoz.com.au



QMS Certification Services



QMS Certification Services



QMS Certification Services