EFFLUENT MANAGEMENT PLAN

FARLEY LIFESTYLE RESORT

WASTEWATER TREATMENT SYSTEM (WWTS)

PEOPLE • WATER • ENVIRONMENT

EFFLUENT MANAGEMENT PLAN (EMP)

Site Address:

283 & 303 Wollombi Road, Farley NSW 2320

Lots 2 & 4 DP810894

Client:

Vivacity Property Pty Ltd

Level 19, 1 O'Connell Street, Sydney NSW 2000

Prepared By:

True Water

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Document Control

Version History

Date	Version:	Revision Description	Approved By:
1.08.23	EMP V1 FLR	Draft	Dale James
17.08.23	EMP V1 FLR	Final Draft	James Mahoney

Executive Summary

Development	Farley Lifestyle Resort
Site Address	283 & 303 Wollombi Road, Farley NSW 2320
Lot and Plan	Lots 2 & 4 DP810894
Approval Authority	Maitland City Council (MCC)
Owners/Developer	Vivacity Property Pty Ltd
Contact Point	Tom Copping – Planning Manager
Contact Number	0425 555 383
Block Size	Approximately 30.7ha
Boundaries	Wollombi Road and other RU2/R1 zoned lots
Wastewater Load	Design Flow = 57,150L/day
Potable Water Supply	Chichester Dam catchment (Hunter Water)
Availability of Municipal Sewer	Delivery horizon between 5 to 15 years
Potential Constraints	Clay soils, underlying rock, ephemeral gullies
Treatment Standard	Tertiary Treatment
Effluent Dispersal Method	6,000m^2 Engineered Mound

Farley Lifestyle Resort is a residential lifestyle estate for over 50s to be development at Wollombi Road, Farley. The facility will include 254 2-bedroom dwellings, a clubhouse, and community recreation facilities. The site is an RU2/R1 zoned, approximately 30.7ha, mostly irregular-shaped parcel bordered by Wollombi Road and other RU2/R1 zoned lots. The site is not currently serviced by the municipal sewerage network and the timing of future connection is uncertain as mains are still in the process of being extended through neighbouring properties. Therefore, all sewage generated by the development must be treated and managed wholly within the site by a site-specific Wastewater Treatment System (WWTS).

Desktop research and site and soil assessment identified; clay soils, underlying rock, and ephemeral gullies running though the site as potential constraints to onsite wastewater management. Mitigation measures have been developed in consideration of constraints, risks, and the performance objectives outlined within relevant guidelines. Removal of contaminants, and the subsurface application of highly treated effluent are the primary mitigation measures.

Wastewater Treatment System

The Wastewater Treatment System (WWTS) will be sited achieving suitable buffers and offsets to sensitive receptors. The WWTS will consist of a 105kL Equalisation Chamber to even flow variance and maintain inflow to approximately 57,150L/day. The Biological Wastewater Treatment Plant (WWTP) will have a nominal treatment capacity of 60kL/day. The WWTP will provide advanced secondary treatment and effluent dispersal will be via 6,000m^2 of Engineered Mounds. Engineered Mounds will provide tertiary treatment (disinfection and nutrient reduction).

Engineered Mounds are the most favourable Effluent Dispersal System (EDS) as they provide effluent polishing and filtration, additional disinfection and nutrient reduction, rainfall shadowing, and enhanced evaporation. The quality of effluent dispersal from the Engineered Mounds is expected to meet Class A/A+.

Amenity, Public Health & Environment

The WWTS is designed to provide a 50-year life cycle and deliver beneficial outcomes when assessed from an economic, environmental, and social viewpoint. The type of WWTP and effluent dispersal system has been specifically chosen to maximise operational security and ensure reliable high quality effluent treatment.

To protect public health and the environment, the sizing of the WWTP and effluent dispersal system is inherently conservative. The 60kL WWTP is designed to be treat peak flows of 1.2 times the daily load for single one-off event, the WWTP is scalable and can be expanded at any time if required to manage unforeseen increases in flow. The WWTP will be below ground and have sealed gas-tight lids. Below ground installation provides favourable amenity and prevents visual impact, noise and odour. Air emissions shall be filtered thorough carbon filtration to prevent odour, and all mechanical items shall be below ground or housed within specially designed control boxes to prevent noise.

The Engineered Mounds disperse all effluent underground, 350mm below the turfed soil surface. The engineered mounds will be encircled by vegetation belts, the vegetation belts consist of native plants specifically chosen to aid in evapotranspiration and nutrient uptake.

Contents

Appendices

1 Introduction

This Effluent Management Plan (EMP) for the Farley Lifestyle Resort - Wastewater Treatment System (WWTS) has been developed on behalf of the Developer. The EMP forms part of the Integrated Environmental Management System (IEMS) which manages and mitigates risks arising from the treatment and dispersal of wastewater generated by the development.

To protect public health and the environment, a reliable and compliant WWTS must service the development. Environmental factors, human health and work health and safety are considered as part the Safety in Design process in order to design infrastructure which meets compliance requirements and satisfies stakeholder objectives.

The WWTS will employ Best Available Technique and Technology (BATT) for the site-specific management of wastewater. Wastewater infrastructure will be designed to deliver a 50-year life cycle and secure beneficial outcomes when assessed from an economic, environmental, and social viewpoint.

1.1 Purpose

The purpose of the EMP is to assess the site and its environmental factors and identify any potential constraints to site-specific wastewater management. The EMP estimates wastewater flow generated by the activity and details the most suitable method to sustainably manage wastewater wholly within the property boundaries.

1.2 Objective

The EMP is an important management tool, which will provide reasonable and practicable steps to deliver best practice operational measures and satisfy environmental duty of care. Specifically, the objective of the EMP is to:

- Ensure all wastewater is safely and sustainably managed wholly within the boundaries of the site,
- Deliver public health and environmental security,
- Safeguard and prevent impact to environmental health,
- Safeguard and prevent impact to public health,
- Drive improvements in infrastructure management and operation,
- Safeguard water systems,
- Prevent land or soil degradation,
- Enhance conservation measures within both the development area and the surrounding environment,
- Provide a conclusive basis for future assessment and monitoring.

1.3 Scope

The EMP is one of several management plans within the **Integrated Environmental Management System (IEMS)** which considers risk and constraints and provides mitigation or management measures. The scope of this EMP is to:

- Identify site specific constraints, hazards, risks and challenges,
- Identify environmental constraints, hazards and risks,
- Confirm environmental values,
- Consider potential impacts,
- Develop appropriate mitigation measures,
- Negate environmental impacts with the aim to achieve neutral or beneficial outcomes,
- Negate impacts to public health,
- Aid in water cycle management,

- Aid conservation measures within both the development area and the surrounding environment,
- Facilitate the sustainable dispersal of effluent.

The EMP is an important management tool which provides reasonable and practicable steps to deliver a sustainable wastewater solution to the proposed development. This EMP is an operational document which will be updated to reflect the operating conditions, the performance of the WWTS, and the recommendations of operational audits.

2 Roles and Responsibilities

2.1 Licensed Entity

The Developer will be the licensed entity. The Developer shall be responsible for:

- Compliance with all conditions of approvals and licenses,
- Ensuring compliance with the Integrate Environmental Management System (IEMS) including:
    - Maintaining all operation and management measures and requirements,
    - Implementing all control measures,
    - Maintaining all monitoring and response requirements,
    - Ensuring proper record keeping, reporting and auditing,
- Payment of all regulatory fees,
- Ensuring only suitably qualified specialists with experience specific to the WWTS undertake operation and management of the WWTS.

Licensed Entity:	Vivacity Property Pty Ltd
ACN:	629 979 237
Address:	Level 19, 1 O'Connell St, Sydney NSW 2000
Nominated Contact Person:	Tom Copping
Position:	Planning Manager
Mobile No:	0425 555 383
Email Address:	tom@vivacityproperty.com.au

2.2 Primary Regulator

Primary Regulator:	Maitland City Council
Contact Number:	02 4934 9700
Email:	info@maitland.nsw.gov.au
Contact Point:	TBC

2.3 Management Contractor

The nominated Management Contractor with specialist's experience managing and operating the WWTS is:

Management Contractor:	True Water Australia
Contact Number:	02 6645 3377
Email:	Maintenance
Contact Point:	Works & Services Group Manager

3 Legislation and Regulatory Requirements

3.1 Local Government Area (LGA) – Maitland City Council

The site is located within the Maitland City Council Local Government Area. The principal planning control for the site is the Maitland Local Environmental Plan 2011 (MLEP).

Maitland City Council is responsible for determining whether proposed WWTSs are suitable for the site where they are to be installed in the Local Government Area. In February 2020 Council adopted the On-Site Sewage Management Policy which outlines the design criteria to achieve sustainable wastewater management practices within the LGA.

Operating a Wastewater Treatment System (WWTS) is a prescribed activity under Section 68 (part F, item 10) of the Local Government Act 1993 and requires an Approval from Maitland City Council (WSC). The Approval ensures the activity meets environmental standards and protects environmental values during construction and operation. When Approval is issued, the IEMS, including this EMP, will be updated to reflect the listed conditions. The IEMS will be implemented to ensure compliance with the Council's approval conditions.

3.2 Associated Legislation and Regulatory Requirements

All tests & evaluations have been completed in accordance with, and this report has been prepared under, the guidelines and requirements of:

- Neutral or Beneficial Effect on Water Quality Assessment Guideline (2015)
- Department of Environment and Conservation - Use of Effluent by Irrigation (2004).
- Water Services Association of Australia (WSA, 2002) Sewerage Code of Australia.
- AS/NZS1547:2012 Onsite Domestic Wastewater Management
- NSW DLG Onsite Sewage Management for Single Households (1996)

Notes:

[1] While several of the above standards and guidelines are intended for single household domestic onsite sewage systems, the site assessment procedures, suggested risk management and compliance methods, and soil acceptance values are considered characteristic of general onsite WWTS assessment.

[2] Results and recommendations in this report are based on the direction and information supplied by the client and conditions present at the time of testing. Any changes affecting the design of the WWTS, the WWTP, or the proposed Effluent Dispersal Area (EDA) or alternate EDA may require a review of this report.

4 Project Overview

Farley Lifestyle Resort is a residential lifestyle estate for over 50s to be development at Wollombi Road, Farley. The facility will include 254 2-bedroom dwellings, clubhouse, and community recreation facilities. The site is an RU2/R1 zoned, approximately 30.7ha, mostly irregular-shaped parcel bordered by Wollombi Road and other RU2/R1 zoned lots. The site is not serviced by the municipal sewerage network and future connection is uncertain. Therefore, all sewage generated by the development must be treated and managed wholly within the site by a site-specific Wastewater Treatment System (WWTS).

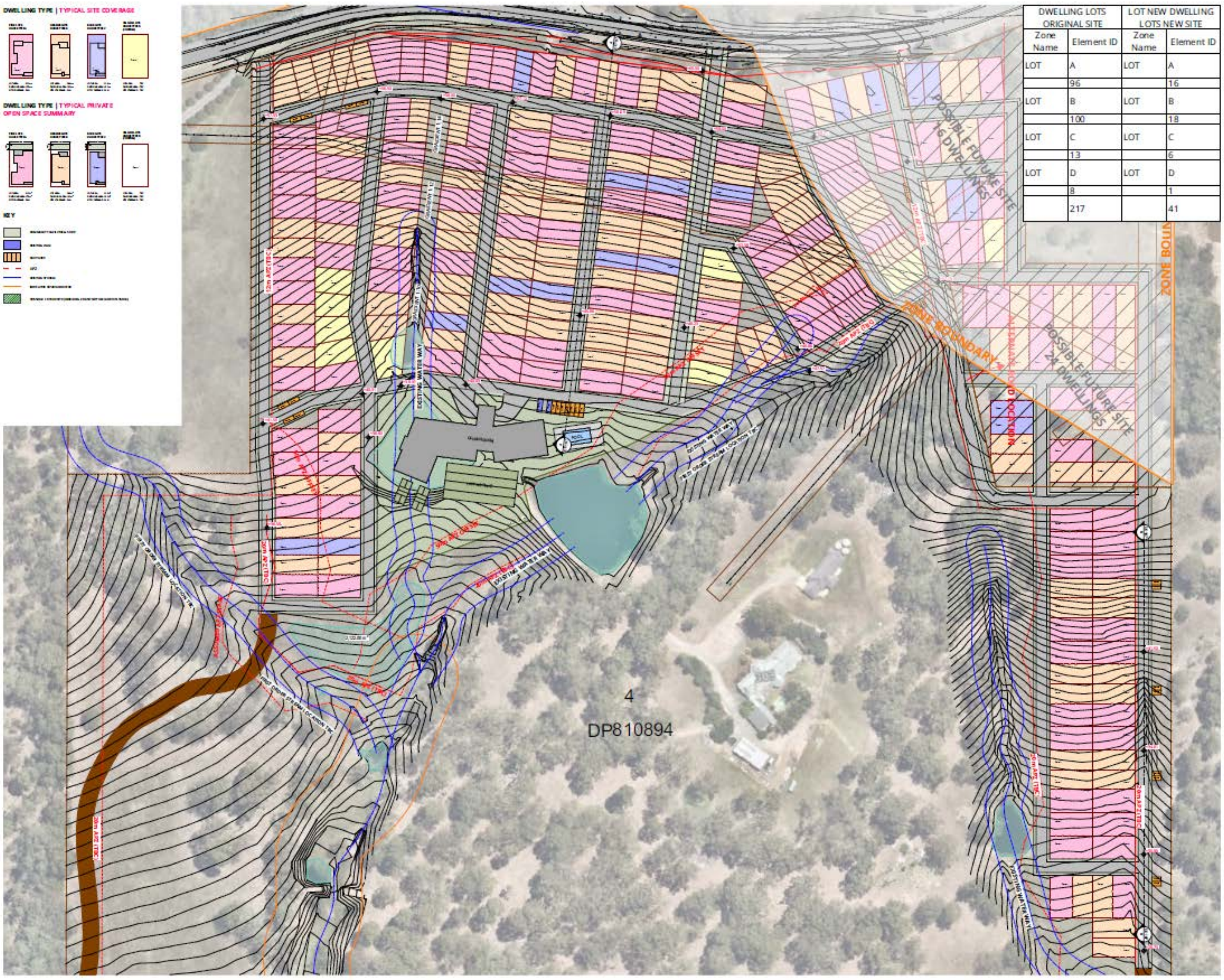

Figure 4.1 – Proposed Staging Plan for the Farley Lifestyle Resort development.

Desktop research and site and soil assessment identified; slope, clay soils, underlying bedrock, a sensitive environment, and ephemeral gullies running though the site as constraints to onsite wastewater management. To ensure the type of WWTP and effluent dispersal system chosen was best suited to address constrains were a detailed options assessment was been completed.

4.1 Wastewater Treatment System (WWTS)

Various servicing options have been assessed, the most responsible servicing option is a Biological Wastewater Treatment Plant (WWTP) and Engineered Mounds. The WWTP will have a nominal treatment capacity of 60kL/day and provide advanced secondary treatment, 6,000m^2 of Engineered Mounds will provide tertiary treatment (additional filtration, disinfection, and nutrient reduction).

The site totals approximately 30.7 hectares. The most favourable location on the site for effluent dispersal, considering soil quality and depth and offsets to environmental values, is the southwest corner of the site. The WWTP will be installed below ground, fenced, and surrounded in thick vegetative buffers. Siting of the WWTP will ensure suitable buffers and offsets to dwellings and property boundaries and sensitive receptors.

The WWTP will utilise a Moving Bed Biofilm Reactor (MBBR) treatment process and employ a multi barrier treatment chain. The WWTP and will consist of:

- Equalisation tank to balance flows,
- Solid liquid separation tank
- Kubota MBBR Treatment Plant consisting of a multi train bioreactor with an integrated MBBR process,
- Chlorine disinfection system to disinfect effluent,
- An odour control system consisting of carbon filters to remove and treat odour,
- Bioreactor aeration blowers located within the control room,
- Effluent storage tank,
- Control and monitoring system including flow meter,

The WWTP will be installed below ground and have sealed gas tight lids. The WWTP utilises aeration, and all air will pass through a carbon odour filter to remove odour prior to release. Below ground installation provides favourable amenity and prevents visual impact, noise, and odour. Effluent dispersal shall be via Engineered Mounds. Engineered Mounds are favourable Effluent Dispersal Systems (EDS) as they provide effluent polishing, nutrient reduction, disinfection, rainfall shadowing, and enhanced evaporation. A conservative application rate of 9.5mm/day shall be adopted.

4.2 Influent and Effluent Limits

Effluent from the WWTS is expected to conform to quality limits as outlined in *Table 4.1.*

Table 4.1 - Influent and effluent release limits

Quality Characteristic	**Influent**	**WWTP Effluent**	**Engineered Mounds Effluent**
Inflow (L/day)	57,150	57,150	57,150
5 day BOD (mg/L)	200 - 400	20	<5
Suspended Solids (mg/L)	150 - 350	30	<5
pH (pH units)	6 – 8.5	6 – 8.5	6 – 8.5
Free Residual Chlorine (mg/L)	-	2	<1
E.coli (cfu/100mL)	-	<100	<10
Total Nitrogen (mg/L)	60 - 80	30	<5
Total Phosphorus (mg/L)	10 - 15	10	<2

5 Subject Site

Farley Lifestyle Resort is an approximately 30.7ha, mostly irregular-shaped lot (Lots 2 & 4 DP810894). The site is gently sloped from north to south. The site generally undulates towards the centre and south of the lot. Two dams are located centrally on the lot and will be dewatered and filled as part of the site earthworks. A central dam will be retained. Gullies running from the dams converge to a single ephemeral gully running towards the southwestern corner. Another smaller gully runs partway down the eastern boundary to the southeastern corner.

The allotment has two existing dwellings on a slight rise. The land adjacent to the houses is primarily pasture fields and light bushland. Bush and native vegetation consist of regrowth and the site has no environmental conservation value. The site is primarily bordered by bushland to the west, south and east.

There is sufficient land available for sustainable onsite effluent management that achieves required buffers to all dwellings, property boundaries and environmental features as required by legislation, guidelines, and codes.

Figure 5.1 – Six Maps image of lot showing existing dwellings and dams.

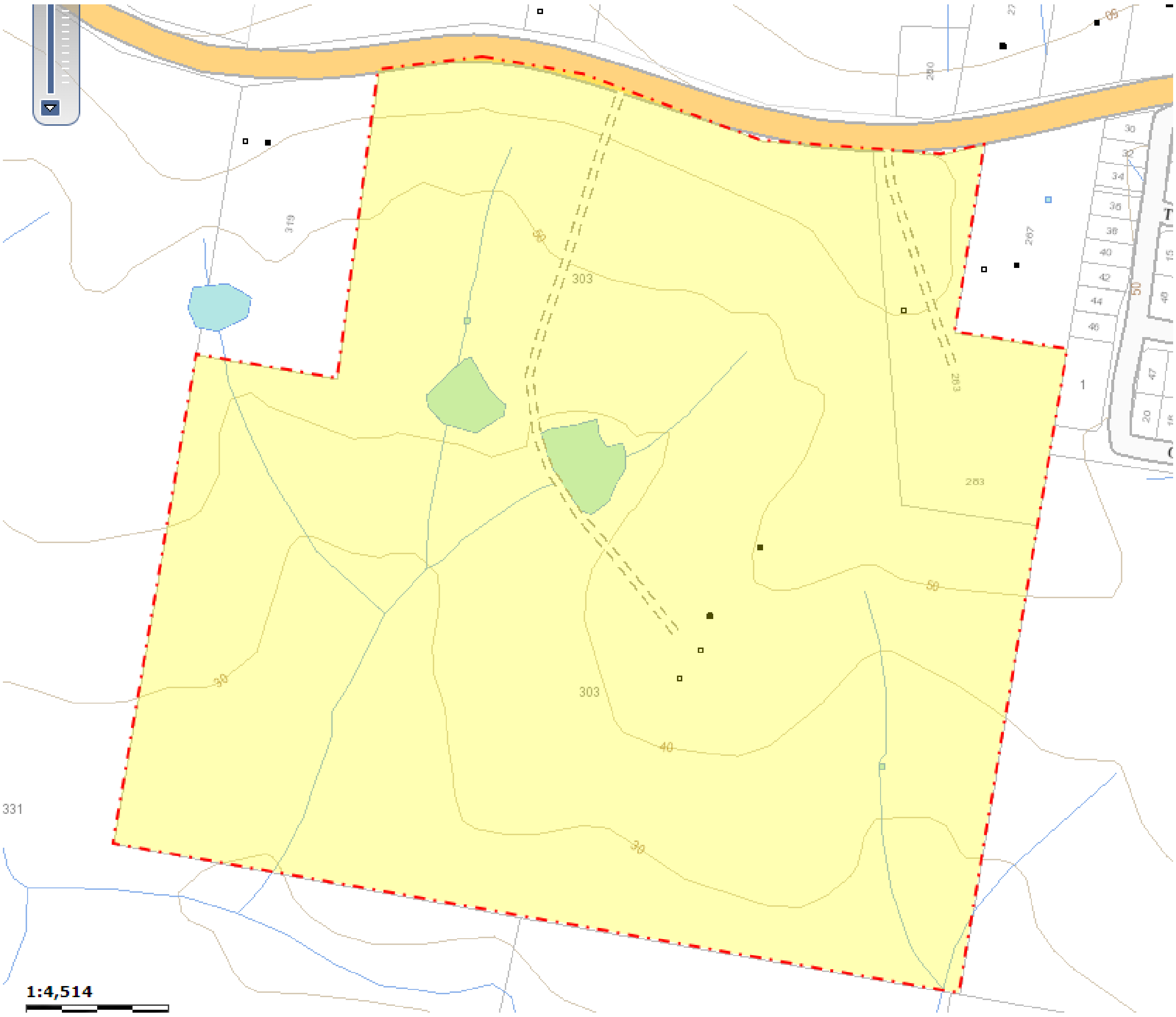

Figure 5.2 – Six Maps base maps view of lot.

5.1 Climate

Bureau of Meteorology average rainfall and evaporation records from sites northeast from Farley Lifestyle Village indicate that the region has a relatively dry climate. The nearest available average rainfall data is from Patterson (Tocal AWS) Station 061250 (~13km from site). The nearest evaporation data is also from the Patterson (Tocal AWS) Station. The highest recorded annual rainfall data from Patterson (Tocal AWS) Station 061250 was 1359mm in 2022.

The recorded mean maximum temperatures for the station are 17.5°C and 30.0°C. The mean minimum temperatures for the station are 6.2°C and 17.8°C.

Table 5.1 – Monthly mean rainfall and mean evaporation Patterson (Tocal AWS) Station 061250

Climate (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Rainfall	107	119.5	124.4	84.4	68	74.7	43.8	37.3	49.3	67.7	84.1	79.4	943
Mean Evaporation	189.1	148.4	130.2	96	74.4	63	74.4	102.3	132	161.2	174	204.6	**1549.6**
Deficit	-82.1	-28.9	-5.8	-11.6	-6.4	11.7	-30.6	-65	-82.7	-93.5	-89.9	-125.2	**-606.6**

The site has an evaporation deficit of 606.6mm/year, 1.7mm/day. The evaporation deficit if favourable for onsite effluent dispersal, as the deficit reduces drainage and increases moisture lost to the atmosphere.

5.2 Geology and Soil

In April 2023, Green Geotechnics was engaged to undertake a preliminary geotechnical investigation. Soil data has been adopted from the *Preliminary Geotechnical Investigation* and is attached as *Appendix G - Preliminary Geotechnical Investigation report by Green Geotechnics, April 2023.*

The report identified bedrock throughout the site and detailed topsoil to a maximum depth of 400mm, overlying clay soil to a maximum depth of 1850mm, overlying sandstone bedrock. As per *Table 3* of the report the greatest soil depth was identified in boreholes 8 and 9.

TABLE 3.1 – Bedrock Summary Table

Borehole ID	Depth to Top of Rock	Depth of Auger Refusal
BH1	0.85m	1.00m
BH2	1.10m	1.30m
BH3	0.90m	1.00m
BH4	0.85m	0.95m
BH5	1.05m	1.20m
BH6	1.15m	1.40m
BH7	1.10m	1.20m
BH8	1.75m	2.10m
BH9	1.85m	2.50m

6.1 - Soil Depth as per Table 3, Preliminary Geotechnical Investigation

Boreholes 8 and 9 are located in an area of approximately 1 hectare in the southwest of the site. The below table provides a summary of the soil structure and soil horizons. The below table provides a summary of Boreholes 8 and 9.

Table 6.2 – Summary of soil structure as per Preliminary Geotechnical Investigation report – Boreholes 8 & 9

Soil Horizon	Average Depth (m)	Texture	Structure	Indicative permeability
1	0.0 – 0.15	Clayey Sandy Silty	Moderately structured	0.12 – 0.5
2	0.15 – 0.8	Sandy Silty Clay	Moderately Strongly structured	0.6 – 0.5
3	0.8 – 1.3	Silty Sandy Clay	Moderately Strongly structured	0.6 – 0.5
4	1.3 - 1.8	Gravelly Sandy Clay	Moderately structured	0.6 – 0.12
Bedrock	>1.8	Sandstone	-	< 0.06

5.3 Topography, Surface Drainage and Flooding

As per the preliminary geotechnical investigation. *"The site slopes from north to south with a fall of approximately 45metres from Reduced Level (RL) 65 meters Australian Height Datum (AHD) at the driveway interface with Wollombi Road, to RL 20 metres AHD in the south west corner of the site. The site is characterised by a series of gently undulating slopes which have been formed from several intersecting creek lines and overland flow channels. The creeks fee two medium sized farm dams"*. Further information is provided within *Appendix G - Preliminary Geotechnical Investigation report by Green Geotechnics, April 2023.*

5.4 Groundwater

Groundwater information has been adopted from the - *Preliminary Geotechnical Investigation report by Green Geotechnics, April 2023.* The report is attached as *Appendix G - Preliminary Geotechnical Investigation report by Green Geotechnics, April 2023.*

"Groundwater seepage was not observed during auger drilling of the boreholes, including those drilled adjacent to creek lines, and therefore no design groundwater level is applicable to the site."

5.5 Water Bores

No groundwater bores were identified on the lot or within the 250m zone of influence (see Figure 6.1). The risk of nearby groundwater bore contamination is further mitigated by a medium clay soil type limiting wastewater drainage towards identified water bores, advanced secondary treatment with nutrient reduction, conservative disposal area sizing and adherence to *Australian / New Zealand Standard 1547:2012* setbacks.

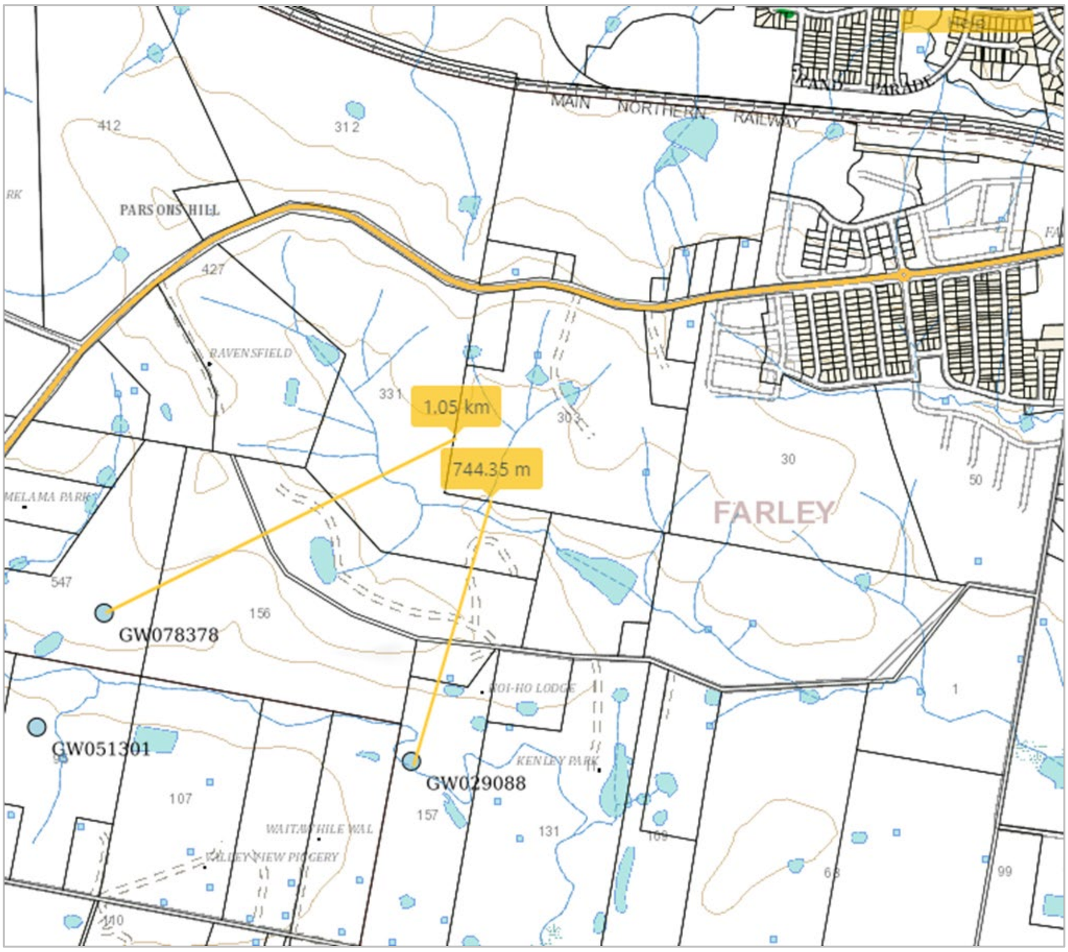

Figure 6.2 – Farley Lifestyle Resort - Location of boreholes in relation to the site (MinView Maps)

5.6 Flora and Fauna

Reporting on flora and fauna is provided within *Appendix H – Biodiversity Development Assessment Report – Firebird ecoSultants (2023)*.

5.7 Biodiversity

Regional biodiversity networks and corridors prevent incremental habitat loss, fragmentation, and degradation Reporting on biodiversity is provided within *Appendix H – Biodiversity Development Assessment Report – Firebird ecoSultants (2023)*.

6 Land Capability – Effluent Dispersal

Site and soil constraint assessment (*Table 7.1) c*ombining the results of desktop research, site investigation and soil analysis, lists and assesses the risk of each of the possible design constraints.

Table 7.1 – Site and Soil Constraint Assessment

Site or Soil Constraint	Assessment of Possible Constraint	Level of Risk	Mitigation Measures
Small lot size	Site is 30.7ha, effluent dispersal area is available	Low	N/A
Steep slope	Gently sloped with grades of 5-10%	Low	N/A
Slope instability	Gently sloped with grades of 5-10%	Low	N/A
Geology	No major discontinuities	Low	N/A
Shallow soil	Soil to 1.85m in proposed Dispersal Area	Low	N/A
Very shallow soil over bedrock	Soil to 1.85m in proposed Dispersal Area	Low	N/A
Seasonal waterlogging over perched water tables	Site is well drained	Low	N/A
Shallow permanent water table	Elevated site with suitable drainage and deep groundwater	Low	N/A
Groundwater quality risk (cat. 1 & 2)	Category 5 observed	Low	N/A
Soils with low permeability (cat. 6)	Category 5 observed	Medium	N/A
Dispersive or sodic soils	Not identified	Low	N/A
Acid sulfate soils	Not mapped as at risk for acid sulfate soils	Low	N/A
Soil salinity	Soil conductivity in normal range	Low	N/A
Susceptible ecological area or downslope water bodies	Ephemeral gullies >40m, ecological areas will not be impacted	Low	N/A
Highly disturbed area or fill	Not identified	Low	N/A
Waterway / gully	No mapped waterways (>100m) or gullies (>40m) near Dispersal Area	Low	N/A
Registered bores	Located >250m from site boundaries	Low	N/A
Climate data (Bureau of Meteorology)	Mean Rainfall 943mm, Evaporation 1550mm - Mean temperatures: Max 30.0 – 17.5˚C, Min 17.8 – 6.2˚C	Low	N/A
Cold or wet climate	Mean evaporation >1000mm/year	Low	N/A
Hot or dry climate	Mean rainfall >500mm & <1000mm/year	Low	N/A
Potential for flooding	Not identified	Low	N/A

6.1 Potential Risk Constraints

Risk assessment identified Clay soil as a moderate potential risk to wastewater management.

6.2 Mitigation Measures

The above risks / constraints are best mitigated by:

- Advanced Secondary Treatment (Disinfection and Nutrient Removal) by WWTP,
- Tertiary Treatment by Engineered Mound,
- Compact Effluent Dispersal Area - Engineered Mounds,
- Subsurface effluent dispersal via Engineered Mounds that will provide over 0.6m separation between applied effluent and the surface of the native soil,
- Conservative effluent dispersal rates (Design Loading Rates/DLR),
- Soil Amelioration to improve soil health and pH.

7 Design Flows

The proposed development will include 254 senior living allotments and various communal facilities. The development will be a gated site with controlled access.

Dwellings will have a maximum of 2 bedrooms and will be fitted with full water reduction fixtures. The residential village is geared exclusively towards over 50's still wanting and able to pursue active and independent lifestyles. Occupancy will be 2EP and dependants are discouraged. Due to the nature of senior living a significant portion of the dwellings will likely be inhabited by widowers (1EP), while other dwellings will be vacant when owners travel or holiday (0EP). Design calculations consider average daily flow and peak daily flow. Considering tenancy across the site average daily flow will be calculated using 1.5EP and peak daily flow will be calculated using 2EP.

The standard daily design flow for full water reduction fixtures as allocated by the VIC EPA Code of Practice is 150L/day. However, retirees and over 50s are generally more responsible water users and daily water usage in activities such as clothes washing, cleaning, and cooking is generally more efficient. The wastewater load generated by retirees would likely be closer to the figure allocated by the AS/NZS:1547 for roof water with full water reduction fixtures of 120L/person/day.

For the purpose of conservative wastewater load estimation 150L/person/day, shall be applied. Considerations to calculate the daily inflow and the peak inflow include:

- 1.2EP per dwelling for Low inflow,
- 1.5EP per dwelling for Average inflow,
- 1.8EP per dwelling for Peak inflow,
- 150L/person/day.

Table 8.1 – Annual Average and Peak Inflow Calculations

LowFlow (AF)	254 lots	x 1.2EP	x 150L/person =	**45,720Litres/day**
Average Flow (AF)	254 lots	x 1.5EP	x 150L/person =	**57,150Litres/day**
Peak Flow (PF)	254 lots	x 1.8EP	x 150L/person =	**68,580Litres/day**

Table 8.2 – Inflow relative to staging

Stage	**No. dwellings (per stage)**	**Average Flow (L/day)**
1	207	46,575
2	47	10,575

The WWTS will include a 105kL Equalisation Chamber to even flow variance and ensure peak inflow is buffered and controlled. The daily inflow volume will be 57,150Litres/day.

8 Wastewater Management System

Wastewater treatment will be provided by a Kubota Johkasou (self-contained purification system). Johkasou Wastewater Treatment Plants (WWTPs) have been developed and manufactured in Japan for many decades. The competitive nature of the Japanese market has driven research and development to provide ever smaller, more economical, environmentally friendly, and sustainable effluent treatment solutions. The WWTP specified for this site has been chosen for several reasons:

- Kubota is a global industry leader, Johkasou are mass manufactured under strict quality controls, and all plants conform with internationally recognised ISO standards, ensuring guaranteed outcomes,
- Kubota Johkasou provide surety of installation, commissioning, operation and treatment quality, due to millions of past installations and ISO Accreditations,
- Unlike many custom built WWTPs (referred to in Australia as Packaged Plants), mass produced Johkasou have a long history of successful operation.

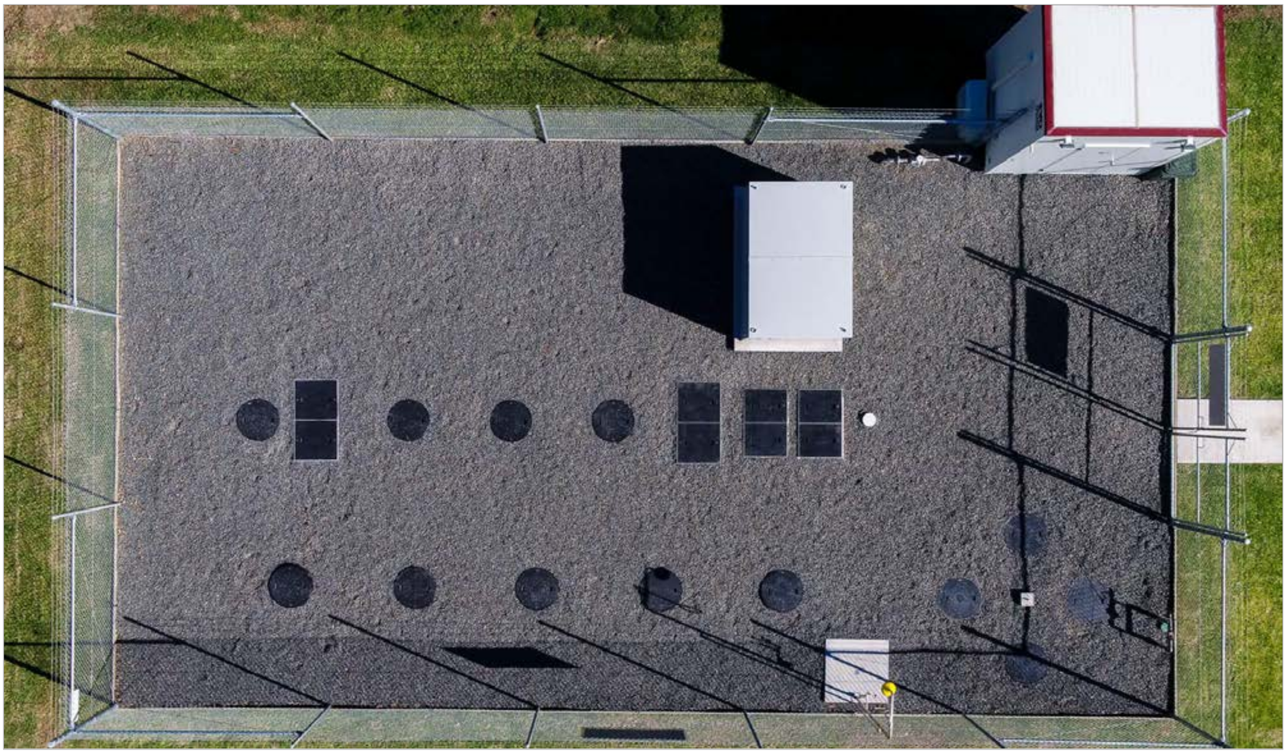

Figure 9.1 – 40kL Kubota WWTP for Water Utility within fenced compound

8.1 Treatment Process

The WWTP employs a highly refined Media Bed Biofilm Reactor (MBBR) treatment process. MBBR treatment is reliable and efficient while limiting mechanisation and power consumption. The MBBR process consists of various chambers, each with a separate type of specialised plastic carriers (media). Each carrier is designed to target specific types of microorganism, grow specific types of biofilms, and provide biological filtration of wastewater. Each chamber and carrier/media undertake a specific role in the removal of contaminants from the wastewater stream.

Biofilm processes require less space, less power, and less mechanisation than other treatment options as biomass is more highly concentrated, and efficiency is less dependent on aeration and final sludge separation.

8.2 Treatment System

Kubota is ISO:9001 and ISO:14001 accredited and produce manufactured WWTPs that are tried and tested globally, and guaranteed to achieve the design treatment level. An Equalisation Chamber shall be installed prior to the WWTP to regulate diurnal flows and influent concentrations. The WWTP utilises the following processes to achieve treated water quality:

- Solid Liquid Separation
- Anaerobic Filtration
- Moving Bed Filtration
- Carrier Filtration
- Treated Water Clarification
- Disinfection

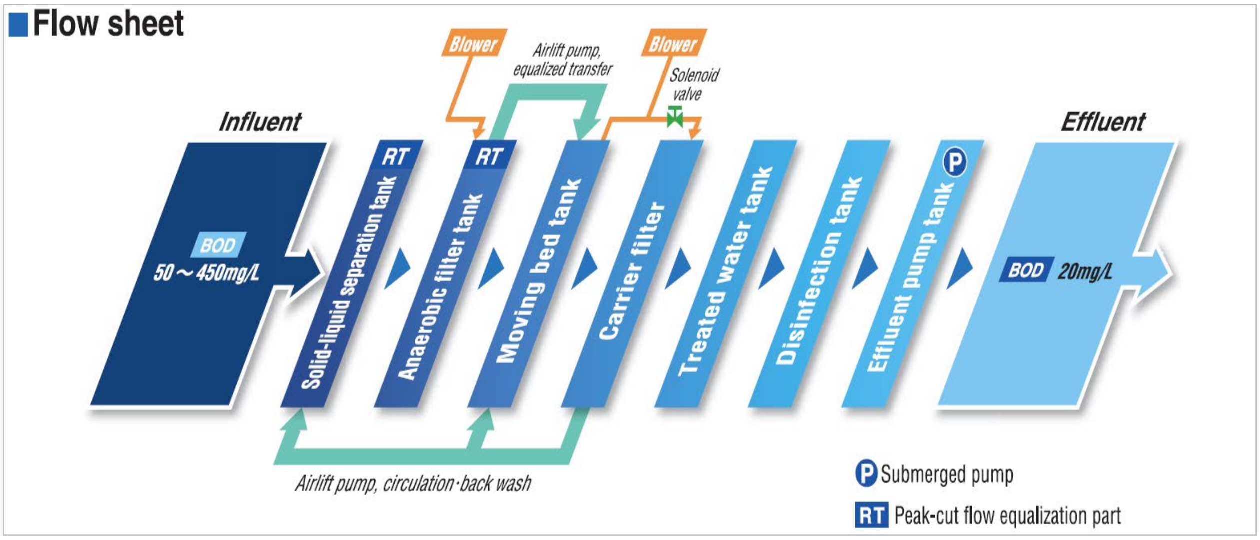

Figure 9.2 – Flow path of Kubota WWTP

8.2.1 Solid Liquid Separation Chamber

This chamber is designed to physically separate the solids from the incoming wastewater stream. A baffle forces water to the bottom of the chamber to increase pressure and aid in solids separation.

8.2.2 Anaerobic Filtration Chamber

The chamber contains a spherical-skeleton type filter media. Water enters at the bottom of the chamber and passes upward through the static media bed. Bacterial growth on the surface of the filter media provides anaerobic treatment, capturing suspended solids and reducing BOD^5. Bacteria in the chamber aids in converting nitrates to gaseous nitrogen.

8.2.3 Moving Bed Filtration - Fluidised Media Chamber 1

This chamber contains a cylindrical type of foam media. The media is constantly moved/fluidised by aeration. Organic matter is decomposed, and ammonium nitrogen is oxidised by micro-organism/bacteria on the contact media surface.

8.2.4 Carrier Filter - Fluidised Media Chamber 2

This chamber contains a hollow type of fluidized media for aerobic treatment. The media type is different to the media within Fluidised Media Chamber 1 and different microorganisms are active. Organic matter is decomposed, and the ammonium nitrogen is oxidised by micro-organism/bacteria on the contact media surface.

8.2.5 Treated Water Chamber

This chamber is filled with a small media functioning as filtration. Pre-treated effluent enters at the bottom of the chamber then flows upward through the media, suspended solids are captured and settled to the bottom. A large percentage of treated water is recirculation to the previous chamber, repeating treatment for more and more suspended solid removal. Backwash of media occurs daily with backwashed water returned to the Solid Liquid Separation chamber. To aid in the reduction of nitrogen, a small volume of the treated water is continually transferred to the sedimentation chamber.

8.2.6 Disinfection Chamber

This treated water passes over a tablet chlorination system certified by the Japanese government. Treated Water is then retained within Disinfection Chamber to increase contact time and reduce bacterial and viral concentrations.

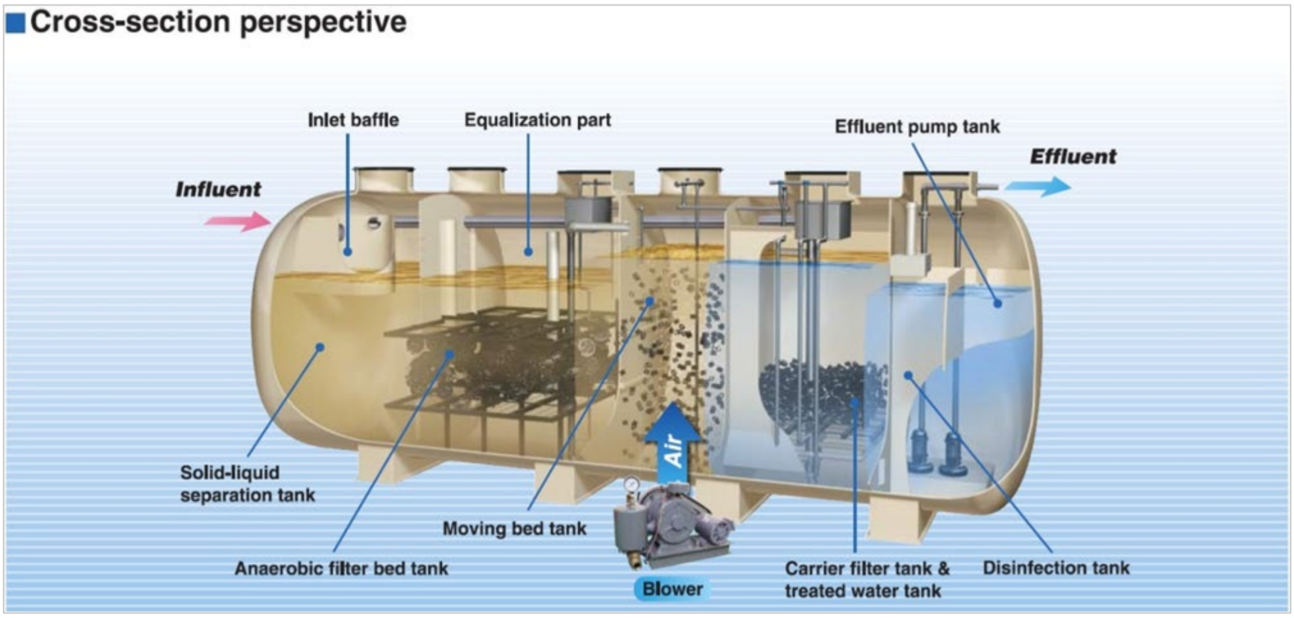

Figure 9.3 – Typical Section Diagram of Kubota Advanced WWTP

8.3 Design Flow and Contaminant Concentration for the Kubota WWTP

Prior to influent entering the WWTP raw sewage enters an equalisation chamber. The Equalisation Chamber is designed to regulate diurnal flows and concentrations. The EQ Chamber stores and mixes sewage and averages out concentrations before influent is dosed at a specific volume into the WWTP.

The scope of the project requires treatment of 57,150L/day of sewage per day. The WWTP will have a daily design flow of 60kL/day. The Kubota WWTP is designed to manage single peak flows of up to 1.2x the design flow.

The WWTP will include flow monitoring and a telemetry unit. All daily flows will be recorded by the Monitoring platform. Flow monitoring provides the operators the ability to monitor daily volume and ensure flows do not exceed specified volumes.

The WWTP is for the treatment of sewage and wastewater of low to medium concentration. Industrial waste, trade waste, chemicals, oil, grease, chemicals, high strength cleaning products should not enter the system. Pre-treatment devices such as grease arrestors and sediment traps are to be installed if influent concentrations exceed general concentration limits outlined in *Table 9.1 – Influent Concentrations Limits (maximums).*

Table 9.1 – Influent Concentrations Limits (maximums)

	BOD (mg/L)	**SS** (mg/L)	**Oil / Grease** (mg/L)	**TN** (mg/L)	**TP** (mg/L)	**pH** Range
Raw Influent – Low	300	200	50	60	10	6 - 8.5
Raw Influent – Medium	400	300	60	80	15	6 - 8.5
Raw Influent – High	500	400	70	100	20	6 - 8.5

8.4 Control and Monitoring of Infrastructure

Suitable control and monitoring of the WWTS are vital for correct operation of the system and the success of long-term management. System control and monitoring must be automated where possible to reduce the involvement of the property owner and site staff. The plant will be monitored remotely with maintenance provided by True Water technicians.

Risk mitigation is a key focus in the design of the proposed WWTS. Each stage of the process is focused on providing stable and secure sewage infrastructure that limits risk to public health and the environment. There are two monitoring functions: operational monitoring and performance monitoring.

Figure 9.4 – 40kL Kubota WWTP for Water Utility - Plant room, electrical box, and monitoring unit (foreground) site office (background)

Operational monitoring refers to the day-to-day function of the WWTS and includes the monitoring of mechanical function. A telemetry system is integrated into the wastewater system to monitor the function of the WWTS and provide real time notification of events which allows immediate response. Real time monitoring includes; daily flow, operational levels, power supply and pump operation, with all parameters automatically logged and actioned by the True Water Customer Resource Management (CRM) system.

9 Effluent Dispersal System (EDS)

Considering available area, stakeholder landscaping, and privacy requirements, Engineered Mounds are the most suitable effluent dispersal method. Mounds provide improved environmental and operational security by performing additional effluent polishing prior to the release of effluent.

Engineered Mounds are constructed with 1 in 3 slope and a low permeability soil capping that sheds rainfall, excluding it from the effluent dispersal area. Unlike other effluent dispersal methods, rainfall does not infiltrate the basal land area of the mound reserved for disposal of effluent. Therefore, effluent can be safely applied at a similar rate during wet weather as dry weather. This eliminates the need for wet weather storage as is required with irrigation or beds where precipitation is included in the soil water balance. Engineered Mound features that impact water balance include:

- Engineered Mounds increase surface area for atmospheric evaporation and solar energy adsorption,
- Engineered Mounds provide an umbrella against rainfall (rainfall shadow) and provide a level of flood resilience,
- Action of capillary rising flow, along with Bernoulli and Venturi forces, distribute water evenly and against the force of gravity, contrary to the one-dimensional flows used in subsurface water balance models.

Engineered Mounds have been shown to remove >55% of nitrogen from secondary effluent (Blasing & Converse 2004), provide a 2-3 reduction of thermo-tolerant Coliforms and up to 99% phosphorus reduction from primary effluent (Geary et al, 2005). Due to the scarcity of specific performance data, True Water completed 12 months of research in 2017/18. Nutrient concentrations entering and leaving the Engineered Mound were measured and the nutrient reduction assessed. Research identified, that when applied with tertiary treated effluent, mounds provided a Total Nitrogen reduction of 88% and a Total Phosphorus reduction of 89%.

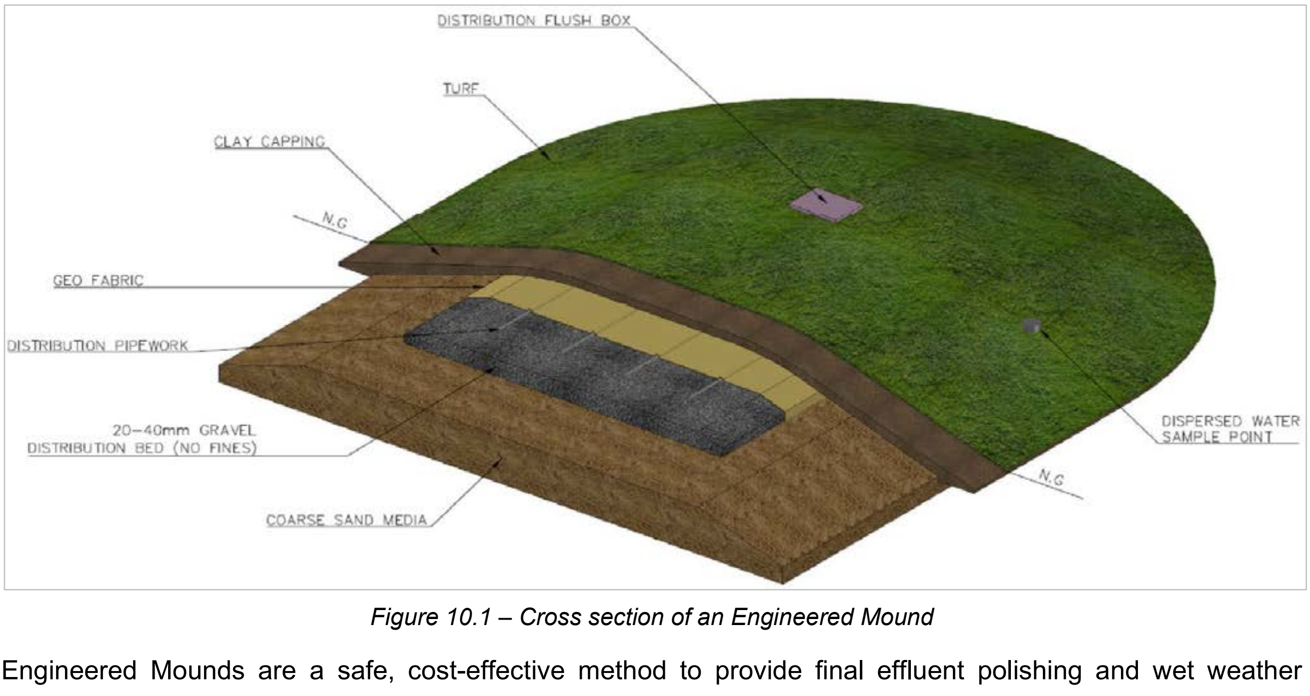

Figure 10.1 – Cross section of an Engineered Mound

Engineered Mounds are a safe, cost-effective method to provide final effluent polishing and wet weather storage. Treated water is distributed through a large volume media bed. The distributed treated water slowly moves within the volume media bed through pore spaces encountering aerobic and anaerobic zones and is subject to a variety of microbial reduction and incorporation processes. Mounds provide a permeable barrier between the effluent dispersal point and the environment, delivering additional retention and treatment of effluent before it can enter the environment.

9.1 Sizing of Effluent Dispersal Area (EDA) – Engineered Mound

Australian Standards AS1547:2012 - Table N1, allocates a Design Loading Rate (DLR) for primary effluent dispersal to mounds. However, mound literature recommends loading rates be doubled when applying secondary or advanced secondary treated effluent. Therefore, considering advanced secondary treatment provided by the WWTP a suitable application rate for the engineered mounds site on moderately structured light clay loam is 10mm/day.

Local and state government throughout NSW & QLD have adopted the recommendation of the doubling of application rates when treated effluent is applied. Some legislators have adopted the recommendation within local government wastewater strategies. The below table is from Local Approval Policy 2018 and reflects the adoption of increased application rates for mounds when treated effluent is applied.

Table 4: soil categories and Design Irrigation/Loading Rates (DIR/DLR) for effluent disposal areas

Soil Category	Soil texture	Structure	DESIGN IRRIGATION/LOADING RATE (DIR/DLR) mm/ day					
			Absorption trenches & beds		ETA beds & trenches	Secondary treated effluent mounds	Drip and spray irrigatio n	LPED irrigation
			Primary treated effluent	Secondary treated effluent				
1	Gravels & sands	Structureless	Governed by clogging layer. Specialist design required.		Not suitable.	Specialist design required	5	Not suitable.
2	Sandy loams	Weakly structured massive	15	50		50		4
3	Loams	High/moderate structured	15	50		50	4	3.5
		Weakly structured or massive	10	30		30		
4	Clay loams	High/moderate structured	10	30	12	30	3.5	3
		Weakly structured	6	20	8	20		
		Massive	4	10	5	10		
5	Light clays	Strongly structured	5	12	8	12	3	2.5
		Moderately structured		10	5	10		
		Weakly structured or massive		8		8		
6	Medium to heavy clays	Strongly structured	Soil permeability testing required.		5 Secondary treated effluent only.	Soil permeability testing required.	2	Not suitable.

Figure 10.2 – Design Irrigation/Loading Rates

Table 10.1 – STEP 1 - Mound Basal Area Calculations

Flow - Mound Basal Area	= Q/DLR
	= 57,150 / 10mm/day
	= 5,715m²

To manage peak flows the required basal area of the Engineered Mound is 5,715m^2. Inherent in all infrastructure sizing should be the minimisation of risk and allowance for redundancy. Therefore, the total Engineered Mound's basal area will be increased to 6,000m^2.

Table 10.2 – STEP 2 - Design Loading Rate Calculations

Design Loading Rate	DLR = Q/Area
	= 57,150 / 6,000
	= 9.5mm/day

The DLR to the Engineered Mounds will be 9.5mm/day.

9.2 Surface Drainage

Stormwater runoff will be directed to gentle swale drains which will convey water away from the Engineered Mound. Stormwater management will comply with the site stormwater management plan and conditions of the local government consent.

9.3 Vegetation and Native Planting

A vegetative screen shall be established around each mound to aid in the evapotranspiration of moisture and to maximise nutrient uptake and prevent nutrient migration. The screen will be 1-2 metres wide and will be located around the Engineered Mounds. Species will be selected considering moisture and nutrient uptake capacity, deep root penetration and root density. The vegetative screen will consist of select native species such as Lomandra.

9.4 Siting and Configuration of the Engineered Mounds

The Engineered Mounds will be located in the southwestern corner of the site. The Engineered Mounds will be installed on the natural contour and will be located to maintain suitable buffers to property boundaries and environmental features.

Figure 10.3 – Two newly commissioned Engineered Mounds at a Council owned Caravan Park

9.5 Earthworks and Soil Amelioration

Earthworks and soil amelioration will be undertaken to prepare soils prior to the installation of each Engineered Mound. Earthworks will ensure topsoil is retained the mound base is levelled, and soils are ameliorated with lime and gypsum to increase absorption.

10 Nutrient Management

Nutrients, nitrogen, and phosphorus will be managed within both the Kubota WWTP and the Engineered Mounds. AAF of 57,150L/day has been adopted to calculate the daily load for accumulative nutrient loading.

10.1 Mass Balance

The mass balance provides an overview of nutrient reduction within each stage of the wastewater treatment process.

Table 11.1 – Mass Balance

Flow (kL/day)	57.15	**EDA (m2)**	6,000
Mass Balance Calculation			
Process Stage	**Influent**	**Total Nitrogen**	**Total Phosphorus**
Treatment System Influent 57.15kL/day x 365	20,859,750	60mg/litre	10mg/litre
WWTP Nutrient Reduction		30mg/litre	10mg/litre
Engineered Mounds Nutrient Reduction		5mg/litre	2mg/litre
Total Nutrient Volume 57.15kL/day x 365 x Conc		**104.2 kgs**	**42.1 Kgs**
Total annual Load per metre Total Nutrient Volume / 6,000		17grams/m^2/year	7grams/m^2/year
Vegetation / Biomass Uptake		750kg/ha x 0.6ha = 450kg/year	60kg/ha x 0.6ha = 36kg/year
Assimilation & Volitisation		10% = 10.4kg/year	
Soil Sorption			800kg/ha/m^3 x 0.6ha x 1.8soil column/50years = 17.28kg/year
Total Uptake		**460.4kg/year**	**53.28kg/year**
Mass Balance = Discharge – Total Uptake			
Mass Nutrient Balance		**-356.2 Kg**	**-11.18 Kg**

11 Monitoring, Operation, Maintenance, and Management

Maintenance and servicing are to be carried out in strict compliance with the conditions of the regulatory approval, and in accordance with the system manufacturer. The WWTS will function compliantly when proper monitoring, operation, maintenance, and management processes are implemented.

Should influent flows or concentrations exceed limits outlined within this EMP, it is the owner's responsibility to arrange additional infrastructure capacity as required to compliantly treat and disperse wastewater.

Table 12.1 – Maintenance Management Information

Management Type	Reporting	Frequency
Telemetry	All Operation • *High Level* • *Daily Flow* • *Power Outage* • *Pump Outage* • *Fault Check*	Daily – Automated
General Onsite Visual Inspection	Grease Arrestor WWTP Transfer Pumps	Weekly – Site Staff A4 Inspection sheet
Maintenance and Servicing	Grease Arrestor WWTP Transfer Pumps Transfer Pipe • *Inflow* • *Outflow* • *Visual inspection* Engineered Mounds • *Mowing* • *Visual inspection*	3 Monthly – True Water CRM and automated Service & Maintenance database
Annual Audit	Assessment of all items listed above	Annually

11.1 Telemetry

The True Water Works & Services Group provide 24/7/365 monitoring for wastewater infrastructure throughout Australia and will provide all monitoring of the Farley Lifestyle Resort WWTS.

11.2 General Onsite Visual Inspection

The following items will be completed by the site staff to aid in the management of the WWTS.

- Check and if required clean all grease arrestors or sediment traps,
- Maintain records of all required documentation including maintenance reports and audits,
- Ensure cleaning products utilised within the site are suitable for disposal through the WWTP,
- Maintain suitable signage to inform stakeholders and residents not to discharge foreign matter such as nappies, sanitary napkins, and waste into the drainage system,
- Ensure storm water and runoff is directed away from dispersal area,
- Visually inspect the EDA each month including vegetation, fencing and signage.

11.3 Maintenance and Servicing

The True Water Works & Services Group provide maintenance and servicing for wastewater infrastructure throughout Australia. True Water will provide all maintenance and servicing of the Farley Lifestyle Resort WWTS.

11.4 Annual Audit and Reporting

The True Water Design and Consultancy Group provide annual auditing of wastewater infrastructure throughout Australia. True Water will undertake the annual audit of the Farley Lifestyle Resort WWTS.

11.5 Emergency Contacts

Table 12.2 – Emergency Contact Details

Organisation	Response Personnel Responsibilities	Contact Information	Hours of Operation
User	• General Operation and management • Routine visual inspection • Booking and organising pump out and management • Assess incident and decide on necessary actions relating to WWTP		
True Water	• Assess incident and decide on necessary actions relating to WWTP • Telemetry monitoring	(02) 6645 3377	Business Hours
True Water – Technical Assistance	• Assess incident and decide on necessary actions relating to WWTP	0429 931 221	After Hours

The Emergency Management Plan is detailed within Farley Lifestyle Resort Health and Environment Management Plan (HEMP).

12 Conclusion

Farley Lifestyle Resort is a residential lifestyle estate to be development at Wollombi Road, Farley. The facility will include 254 over 50s 2-bedroom dwellings, and community recreation facilities. The site is an RU2/R1 zoned, approximately 30.7ha, mostly irregular-shaped parcel bordered by Wollombi Road and other RU2/R1 zoned lots.

Various servicing options have been assessed. The most viable servicing option is a site-specific Wastewater Treatment Plant (WWTP). Therefore, the proposed WWTS will require approval for Section 68 (F10) of the Local Government Act 1993.

All wastewater generated within the site will be captured by the sewage drainage system and transferred to a single Wastewater Treatment Plant (WWTP) for treatment. The WWTS will consist of an MBBR WWTP installed below ground, with sealed gas tight access lids and ventilation via a carbon odour filter unit. Below ground installation improves amenity, prevents visual impact, prevents noise, and reduces odour. Effluent dispersal shall be via Engineered Mounds.

All WWTS infrastructure shall be sited considering suitable buffers and offsets to environmental features, buildings, and property boundaries. Metering and automated monitoring of flows will be implemented.

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14 Acronyms and Abbreviations

AF	Average Flow
AAF	Annual Average Flow
Council	Maitland City Council
DLR	Design Loading Rate
DSS	Desired Standards of Service
EDA	Effluent Dispersal Area
EDS	Effluent Dispersal System
EP	Equivalent Persons
HAZMAT	Hazardous Materials
IEMS	Integrated Environmental Management System
IMP	Infrastructure Management Plan
MBBR	Moving Bed Biofilm Reactor
PF	Peak Flow
SDS	Safety Data Sheet
STP	Sewage Treatment Plant
STS	Sewage Treatment System
WWS	Wet Weather Storage
WWTP	Wastewater Treatment Plant
WWTS	Wastewater Treatment System

15 Glossary

Approved or Approval	A documented statement of approval by the site supervisor and/or all relevant Regulating Authorities.
Biochemical Oxygen Demand (BOD)	The amount of dissolved oxygen required by bacteria to stabilize, digest, and purify wastewater under aerobic conditions; an indirect measure of the amount of organic matter in wastewater; a measure of the relative strength of wastewater expressed in mg/L.
Business day	Any day other than a Saturday, Sunday, or public holiday.
Certificate of Completion	Certification issued by the Contractor to certify that all Works have been completed to the Manufacturer's requirements and specifications and as per the approved plans and specifications.
Certificate of Operation	Certification of compliance with the operating licence and/or warranty conditions. A Certificate of Operation is provided on completion of each Routine Operational Assessment.
Commission	The running and checking of the WWTS or WWTP at Completion of Works to ensure proper operation.
Compliance	Adherence to all operational parameters as specified by the Regulating Authority and/or the Contractor/Manufacturer.
Completion of Works	The completion of the WWTS or WWTP installation in accordance with the plans and specifications and successful Commission.
Concentration	Quantification of the concentration of specific contaminants within wastewater, influent or effluent.
Confidential Information	All information, trade secrets and knowledge of or disclosed by a party (**Discloser**) to another party (**Receiver**) that: • is by its nature confidential, • is designated or marked by the Discloser as confidential, or • the Receiver knows or ought to know is confidential, and includes the terms of this agreement and any information provided or received by a party pursuant to this agreement, but does not include information which: • is or becomes public knowledge other than by breach of this agreement or any other confidentiality obligation, or • is independently developed by a party while having no knowledge of or access to the other party's Confidential Information.
Controlled Access	The limitation of public or livestock access to a site to minimise the likelihood of direct physical contact with effluent.
Document Register	The register of project specific documents, policies or guidelines.

E.Coli (Escherichia coli)	A member of the faecal coliform group of bacteria, and indicative of faecal contamination.
Environmental Performance	The performance of WWTS or WWTP relative to protection of both public health and the natural and physical environment.
Effluent	Water derived from sewage and wastewater, treated to a level appropriate for its intended dispersal.
Effluent Dispersal Area (EDA)	The designated area in which effluent is applied to the environment.
Effluent Sample	The onsite checking of pH, turbidity, and Free Residual Chlorine within effluent.
Effluent Test	The laboratory testing of contaminants with effluent.
Factor of Safety	The proportionate increase in designed capacity or performance of an WWTS or WWTP aimed at reducing the risk of adverse impacts on public or environmental health.
Faecal Coliforms (Fc)	Indicator bacteria common to the digestive systems of warm–blooded animals that is cultured in standard tests to indicate either contamination from sewage and wastewater or the level of disinfection; generally measured as number of colonies/100mL.
HACCP	Hazard Analysis and Critical Control Point. An industry recognised Risk Management system that identifies, evaluates and controls hazards including aspects of water quality significant to effluent dispersal.
GST	Goods & Services Tax – a tax levied by the Federal Government on the supply of goods and services.
Influent	Raw sewage and wastewater flowing into the WWTS or WWTP. Influent parameters must be within the parameters specified for the WWTS or WWTP.
Irrigation	The dispersal of effluent to land or soil.
Laboratory Test	The laboratory testing of contaminants within raw sewage and wastewater, Influent or effluent.
Effluent Dispersal System (EDS)	The system constructed to apply effluent to land, including, irrigation systems, mounds, and others.
Maintenance Report	The written report outlining the inspection, checks, effluent sampling and maintenance activities completed during a Routine maintenance of the WWTS or WWTP.
Manufacturer	A person or company that makes the products used within the WWTS or WWTP.
Monitor	Check, supervise, observe, or measure the parameters and variables, as well as the performance of the WWTS and WWTP.

Non–Compliance	The failure to adhere to operational parameters as specified by the regulating authority or the Manufacturer.
Notice to Rectify	A notice issued to the operator or owner of the WWTS or WWTP stating infrastructure operation does not satisfy the operating licence or warranty conditions and must be rectified.
Operating Licence	The licence to operate the WWTS infrastructure issued by the regulating authority.
Performance Audit	The audit of all wastewater treatment infrastructure, and the reporting of infrastructure compliance and performance for the preceding 12month period.
Performance objectives	Measurable operational parameters required for a WWTS or WWTP to be compliant under the condition of the Regulatory Authorities and the Manufacturer.
Qualified Installer	A person who is trained and accredited by the Manufacturer as being proficient in the installation, Commission, and Quality Assurance of a WWTS or WWTP.
Qualified Technician	A person who is trained and accredited by the Manufacturer in the operation, servicing, maintenance, and operation of the installed WWTS or WWTP.
Quality Assurance	A series of tests and checks undertaken by the Contractor to ensure installation of components meet all requirements and guidelines.
Regulatory Authority	An authority or body that is empowered by statute or regulation to approve and set conditions for the operation, Monitoring, and management of a WWTS or WWTP.
Risk Assessment	The overall process of risk identification, risk analysis and risk evaluation using available information to predict how often hazards or specified events may occur (likelihood) and the magnitude of their consequences.
Risk Management	The systematic evaluation of the WWTS or WWTP, the identification of hazards and hazardous events, the assessment of risks, and the development and implementation of preventive strategies to manage the risks.
Routine Inspection	The routine inspection of the WWTS or WWTP by a trained person in strict adherence with the Routine Inspection Checklist.
Routine Operational Assessment	The routine (usually at three-month intervals) assessment of the maintenance, management and operation of the WWTS or WWTP by a Qualified Technician.
Routine Maintenance	The routine maintenance (usually at three-month intervals) of the WWTS or WWTP by a Qualified Technician to ensure satisfactory performance and compliance.

Sewage/Wastewater	The discharge from sanitary fixtures and sanitary appliances.
Sewage Treatment Plant (STP)	The plant and equipment used to treat sewage and wastewater.
Sewage Treatment System (STS)	All infrastructure from the inlet of the STP to the outlet of the Effluent Dispersal Area (EDA), including all components, tanks, treatment plants, processes and Effluent Dispersal System (EDS) required to treat sewage and wastewater and dispersal the Effluent to the environment.
Site Officer	The representative of the Principal or Contractor assigned to monitor, manage, coordinate, or sign off on the works.
Suspended Solids (SS)	Small solid particles which remain in suspension in water as a colloid or due to the motion of the water, and an important indicator of water quality and expressed in terms of milligrams per litre (mg/L).
Total Nitrogen (TN)	Measure of the complete nitrogen content in sewage and wastewater including nitrate (NO3), nitrite (NO2), ammonia (NH3), ammonium (NH4), and organic nitrogen, expressed as milligrams per litre (mg/L).
Total Phosphorus (TP)	Sum of all forms of phosphorus in effluent. Chemical element and nutrient essential for all life forms, occurring as orthophosphate, pyrophosphate, tripolyphosphate and organic phosphate forms, expressed as milligrams per litre (mg/L)
Treatment Quality	Effluent quality as detailed within the Regulatory Approval.
Treated Water / Effluent	Water derived from sewage and wastewater and treated to a level appropriate for its intended dispersal.
Wastewater Treatment Plant (WWTP)	The plant and equipment used to treat sewage and wastewater.
Wastewater Treatment System (WWTS)	All infrastructure from the inlet of the WWTP to the outlet of the Effluent Dispersal Area (EDA), including all components, tanks, treatment plants, processes, and Effluent Dispersal System (EDS) required to treat sewage and wastewater and dispersal the Effluent to the environment.

Appendix A

WWTS Plans & Layout

FARLEY LIFESTYLE RESORT
KUBOTA WASTEWATER TREATMENT PLANT

TRUEWATER AUSTRALIA
PEOPLE • WATER • ENVIRONMENT

DRAWING SCHEDULE	
DRG NO.	DRAWING TITLE
FLR-WWTP-G-0001	COVER SHEET, LOCALITY PLAN AND DRAWING SCHEDULE
FLR-WWTP-G-0002	INSTRUMENTATION LIST
FLR-WWTP-G-0003	PROCESS FLOW DIAGRAM
FLR-WWTP-G-0004	SITE PLAN
FLR-WWTP-H-0005	SITE PLAN - INDICATIVE LAYOUT
FLR-WWTP-H-0006	SITE PLAN - GENERAL LOCALITY PLAN
FLR-WWTP-H-0007	SITE PLAN - WWTP AND MOUND LOCALITY PLAN
FLR-WWTP-H-0008	SITE PLAN - MOUND SUPPLY PLAN
FLR-WWTP-G-0009	KUBOTA WASTEWATER TREATMENT PLANT
FLR-WWTP-H-0010	KUBOTA WWTP FINISHED COMPOUND LAYOUT
FLR-WWTP-H-0011	KUBOTA WWTP HYDRAULICAL LAYOUT
FLR-WWTP-H-0012	KUBOTA WWTP AIRLINE & ELECTRICAL CONFIGURATION
FLR-WWTP-H-0013	KUBOTA WWTP ELEVATION DETAIL
FLR-WWTP-G-0014	ENGINEERED MOUND
FLR-WWTP-H-0015	ENGINEERED MOUND DETAIL
FLR-WWTP-H-0016	ENGINEERED MOUND CROSS SECTION & LANDSCAPING
FLR-WWTP-H-0017	ENGINEERED MOUND 3D CROSS SECTION

JOB STATUS: CONCEPT	PROJECT: FARLEY LIFESTYLE RESORT WWTP, 303 WOLLOMBI RD, FARLEY NSW 2320	CLIENT: Vivacity
DRAWING TITLE: COVER SHEET, LOCALITY PLAN AND DRAWING SCHEDULE		
REV.: D — DRAWING NO.: FLR-WWTP-G-0001	SCALE: 1:4000 — DISCLAIMER: ALL DIMENSIONS TO BE CHECKED ON SITE BY CONTRACTOR PRIOR TO CONSTRUCTION. USE WRITTEN DIMENSIONS ONLY.	

GENERAL LEGEND

25	25mm POLYETHYLENE LINE (TREATED EFFLUENT)
32	32mm POLYETHYLENE LINE (TREATED EFFLUENT)
40	40mm POLYETHYLENE LINE (TREATED EFFLUENT)
50	50mm POLYETHYLENE LINE (TREATED EFFLUENT)
63	63mm POLYETHYLENE LINE (TREATED EFFLUENT)
-20-	20mm UPVC PIPE
-25-	25mm UPVC PIPE
-40-	40mm UPVC PIPE
-50-	50mm UPVC PIPE
-100-	100mm UPVC Pipe
50	50mm DWV PIPE
100	100mm DWV PIPE
150	150mm DWV PIPE
25PW	25mm POTABLE WATER POLY LINE
32PW	32mm POTABLE WATER POLY LINE
40PW	40mm POTABLE WATER POLY LINE
415V	415V POWER SUPPLY
240V	240V POWER SUPPLY
	STP INTERNAL ELECTRICAL AND COMMUNICATIONS
	17mm PC/RG DRIP LINE
	AIR LINE

- FLUSH BOX W/ FLUSH VALVE
- INDEXING VALVE
- SPRINKLER HEAD
- S — SAMPLE TESTING POINT

- T — ON-SITE TAP - WATER POINT LOCATION
- HR — HOSE REEL
- FH — FIRE HYDRANT
- SG — SIGHT GLASS
- P — POWER LOCATION - SINGLE PHASE
- P — POWER LOCATION - THREE PHASE

- VALVE - GENERIC
- VALVE - NORMALLY CLOSED
- BALL VALVE
- BALL VALVE - NORMALLY CLOSED
- GATE VALVE
- GATE VALVE - NORMALLY CLOSED
- KNIFE EDGE GATE VALVE
- KNIFE EDGE GATE VALVE NORMALLY CLOSED
- BUTTERFLY VALVE
- GLOBE VALVE
- BACKFLOW PREVENTER
- NON RETURN VALVE
- DIAPHRAGM VALVE
- PLUG VALVE
- PRESSURE REGULATING VALVE (SELF CONTAINED PRV OR PSV)
- SAFETY/RELIEF VALVE
- VAC PRESS — PRESSURE & VACUUM RELIEF VALVE
- FLAP VALVE
- FOOT VALVE
- SLIDE VALVE
- PENSTOCK
- STOPBOARD FRAME
- STOPBOARD/BULKHEAD GATE (NORMALLY OPEN)
- STOPBOARD/BULKHEAD GATE (NORMALLY CLOSED)

- THREE PORT VALVE
- FOUR PORT VALVE W/ SOLENOID
- THREE WAY SOLENOID VALVE
- SOLENOID VALVE
- BACK PRESSURE VALVE

- REDUCER
- FLEXIBLE HOSE

- STATICALLY LOADED
- SPRING LOADED
- WEIGHT ACTUATOR
- FLOAT ACTUATOR
- H — MANUAL OPERATED VALVE - GENERIC
- MOTOR OPERATED VALVE - GENERIC
- CONTROL VALVE OPENS ON FAILURE OF ACTUATING ENERGY
- CONTROL VALVE CLOSES ON FAILURE OF ACTUATING ENERGY
- CONTROL VALVE RETAINS POSITION ON FAILURE OF ACTUATING ENERGY
- PNEUMATIC CYLINDER ACTUATOR (GENERIC - SINGLE ACTUATING)
- PNEUMATIC CYLINDER ACTUATOR (SINGLE ACTUATING, SPRING RETURN) OPENS ON FAILURE OF ACTUATING ENERGY
- PNEUMATIC CYLINDER ACTUATOR (SINGLE ACTUATING, SPRING RETURN) CLOSES ON FAILURE OF ACTUATING ENERGY
- PNEUMATIC CYLINDER ACTUATOR (SINGLE ACTUATING, SPRING RETURN) RETAINS POSITION ON FAILURE OF ACTUATING ENERGY
- PNEUMATIC CYLINDER ACTUATOR (GENERIC - DOUBLE ACTUATING)
- PNEUMATIC CYLINDER ACTUATOR (DOUBLE ACTUATING) OPENS ON FAILURE OF ACTUATING ENERGY
- PNEUMATIC CYLINDER ACTUATOR (DOUBLE ACTUATING) CLOSES ON FAILURE OF ACTUATING ENERGY
- PNEUMATIC CYLINDER ACTUATOR (DOUBLE ACTUATING) RETAINS POSITION ON FAILURE OF ACTUATING ENERGY

- MASS FLOWMETER
- ULTRASONIC FLOWMETER
- MAGNETIC FLOWMETER
- TURBINE FLOWMETER
- POSITIVE DISPLACEMENT FLOWMETER

- EXHAUST FAN
- WEIR
- DECANTER
- PULSATION DAMPENER

- SPRAY NOZZLE
- AIR DIFFUSER
- DIFFUSER

- HUMIDIFIER
- WEIGHTED NON-RETURN INLET DAMPER
- DAMPER
- pH, TURBIDITY, CONDUCTIVITY PROBE
- INJECTOR
- AIR LIFT
- AIR OR GAS FILTER
- MEMBRANE FILTER

- STRAINER
- Y STRAINER
- DISK FILTER
- STEAM TRAP
- FLEXIBLE COUPLING
- EXPANSION JOINT

- FLANGE
- CAP FLANGE
- HOSE COUPLING
- PRESSURE UNION

- IA — SERVICE SUPPLY
- TP # — TIE-IN POINT
- FALL — DIRECTION OF FALL

- SCREW CONVEYOR
- BELT CONVEYOR
- VACUUM BREAKER

- PUMP, CENTRIFUGAL
- PUMP, SUBMERSIBLE
- PUMP, AXIAL
- PUMP, SUBMERGED SUCTION
- PUMP, POSITIVE DISPLACEMENT
- PUMP, METERING
- PUMP, ROTARY LOBE
- BLOWER OR FAN
- AIR COMPRESSOR GENERAL
- COMPRESSOR POSITIVE DISPLACEMENT
- COMPRESSOR CENTRIFUGAL
- SAFETY SHOWER C/W EYE WASH
- STATIC MIXER
- VIBRATOR
- MACERATOR
- HEATING/COOLING COIL
- AIR HEATER
- AIR COOLER
- FLOATING SURFACE AERATOR
- FIXED SURFACE AERATOR
- MIXER
- BAR SCREEN
- SCREW SCREEN
- AERATOR

- PRESSURE GAUGE
- INSTRUMENT, FRONT MOUNTED IN CENTRAL PANEL
- INSTRUMENT, REAR MOUNTED IN CENTRAL PANEL
- INSTRUMENT, FRONT MOUNTED IN LOCAL PANEL
- INSTRUMENT, REAR MOUNTED IN LOCAL PANEL
- COMPUTER INTERFACE WITH SHARED FUNCTIONS FOR DISPLAY & CONTROL LOCALLY MOUNTED
- COMPUTER INTERFACE WITH SHARED FUNCTIONS FOR DISPLAY & CONTROL CENTRAL PANEL MOUNTED
- COMPUTER INTERFACE WITH SHARED FUNCTIONS FOR DISPLAY & CONTROL LOCAL PANEL MOUNTED
- STATUS INDICATOR LOCALLY MOUNTED
- STATUS INDICATOR, FRONT MOUNTED IN CENTRAL PANEL
- STATUS INDICATOR, REAR MOUNTED INCENTRAL PANEL
- STATUS INDICATOR, FRONT MOUNTED IN LOCAL PANEL
- STATUS INDICATOR, REAR MOUNTED IN LOCAL PANEL
- PLC — PLC
- JUNCTION BOX - PUMP CONNECTION
- CONNECTION BOX - M3 GEL CLIPS

- M — MOTOR CONTROL CENTRE
- VSD — VARIABLE SPEED DRIVE
- MF — MOTOR MF = FIXED. MV = VARIABLE
- MF — MOTOR - SUBMERSIBLE MF = FIXED. MV = VARIABLE
- I M — MANUAL INTERLOCK WITH DESIGNATED MAN/PLC SELECTOR SWITCH

- EARTH
- AUDIBLE ALARM

- DWG NUMBER — CONTINUATION TAG
- X X — LIMIT OF CONTRACT/ SPEC. CHANGE

REV	DATE	REVISIONS	DRAWN	DESIGN	APP	REF NO.	REFERENCE DRAWING	NUMBER
A	15/08/23	CONCEPT DESIGN	CDN	JM	JM	-	-	-
B	30/08/23	AMENDED MOUND SIZE AND LOCATIONS	CDN	JM	JM	-	-	-
C	01/09/23	AMENDED WWTP AND MOUND SIZE AND LOCATIONS	CDN	JM	JM	-	-	-
D	06/09/23	ADDED UPDATED PCT VEGETATION ZONING	CDN	JM	JM	-	-	-
							APPROVED BY	**INITIAL**
							James Mahoney	
							Daniel Mahoney	

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CLIENT
Vivacity

PROJECT
FARLEY LIFESTYLE RESORT WWTP, 303 WOLLOMBI RD, FARLEY NSW 2320

JOB STATUS
CONCEPT

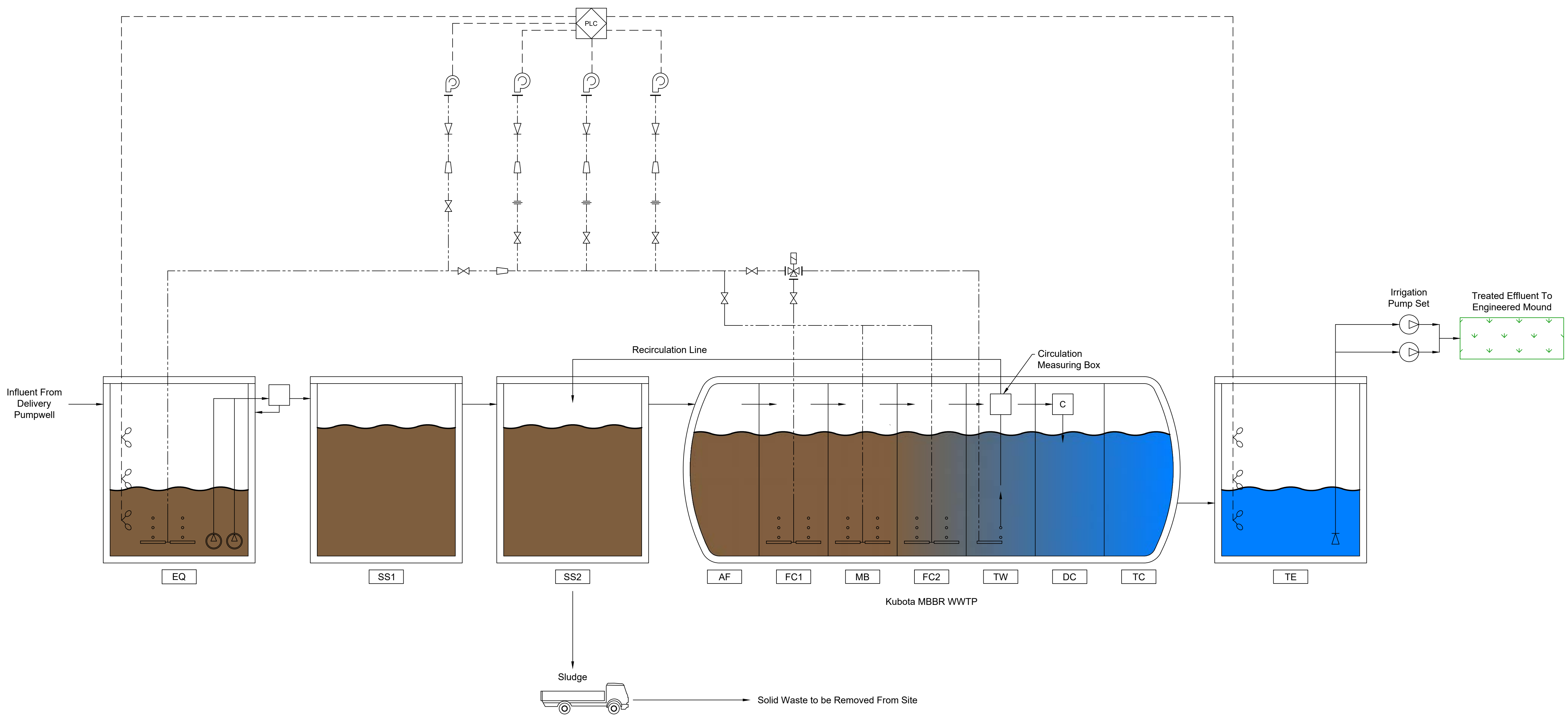
DRAWING TITLE
INSTRUMENTATION LIST

DISCLAIMER
ALL DIMENSIONS TO BE CHECKED ON SITE BY CONTRACTOR PRIOR TO CONSTRUCTION. USE WRITTEN DIMENSIONS ONLY.

SCALE: NTS

DRAWING NO. **FLR-WWTP-G-0002**

REV. **D**



REV	DATE	REVISIONS	DRAWN	DESIGN	APP	REF NO.	REFERENCE DRAWING	NUMBER
A	15/08/23	CONCEPT DESIGN	CDN	JM	JM	-	-	-
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D	06/09/23	ADDED UPDATED PCT VEGETATION ZONING	CDN	JM	JM	-	-	-
							APPROVED BY	INITIAL
							James Mahoney	
							Daniel Mahoney	

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PROJECT	FARLEY LIFESTYLE RESORT WWTP, 303 WOLLOMBI RD, FARLEY NSW 2320
JOB STATUS	CONCEPT
DRAWING TITLE	PROCESS FLOW DIAGRAM
DISCLAIMER	ALL DIMENSIONS TO BE CHECKED ON SITE BY CONTRACTOR PRIOR TO CONSTRUCTION. USE WRITTEN DIMENSIONS ONLY.
SCALE:	NTS
DRAWING NO.	FLR-WWTP-G-0003
REV.	D

SITE PLAN

REV	DATE	REVISIONS	DRAWN	DESIGN	APP	REF NO.	REFERENCE DRAWING	NUMBER
A	15/08/23	CONCEPT DESIGN	CDN	JM	JM	-	-	-
B	30/08/23	AMENDED MOUND SIZE AND LOCATIONS	CDN	JM	JM	-	-	-
C	01/09/23	AMENDED WWTP AND MOUND SIZE AND LOCATIONS	CDN	JM	JM	-	-	-
D	06/09/23	ADDED UPDATED PCT VEGETATION ZONING	CDN	JM	JM	-	-	-
							APPROVED BY	INITIAL
							James Mahoney	
							Daniel Mahoney	

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PROJECT
FARLEY LIFESTYLE RESORT WWTP, 303 WOLLOMBI RD, FARLEY NSW 2320

DISCLAIMER
ALL DIMENSIONS TO BE CHECKED ON SITE BY CONTRACTOR PRIOR TO CONSTRUCTION. USE WRITTEN DIMENSIONS ONLY.

SCALE: NTS

JOB STATUS
CONCEPT

DRAWING TITLE
SITE PLAN

DRAWING NO.
FLR-WWTP-G-0004

REV.
D

REV	DATE	REVISIONS	DRAWN	DESIGN	APP	REF NO.	REFERENCE DRAWING	NUMBER
A	15/08/23	CONCEPT DESIGN	CDN	JM	JM	-	-	-
B	30/08/23	AMENDED MOUND SIZE AND LOCATIONS	CDN	JM	JM	-	-	-
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							APPROVED BY	INITIAL
							James Mahoney	
							Daniel Mahoney	

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PROJECT	JOB STATUS
FARLEY LIFESTYLE RESORT WWTP, 303 WOLLOMBI RD, FARLEY NSW 2320	CONCEPT
	DRAWING TITLE: SITE PLAN - INDICATIVE LAYOUT
DISCLAIMER: ALL DIMENSIONS TO BE CHECKED ON SITE BY CONTRACTOR PRIOR TO CONSTRUCTION. USE WRITTEN DIMENSIONS ONLY. SCALE: 1:3000	DRAWING NO.: FLR-WWTP-H-0005 REV.: D

REV	DATE	REVISIONS	DRAWN	DESIGN	APP	REF NO.	REFERENCE DRAWING	NUMBER
A	15/08/23	CONCEPT DESIGN	CDN	JM	JM	-	-	-
B	30/08/23	AMENDED MOUND SIZE AND LOCATIONS	CDN	JM	JM	-	-	-
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							APPROVED BY	INITIAL
							James Mahoney	
							Daniel Mahoney	

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PROJECT
FARLEY LIFESTYLE RESORT WWTP, 303 WOLLOMBI RD, FARLEY NSW 2320

JOB STATUS
CONCEPT

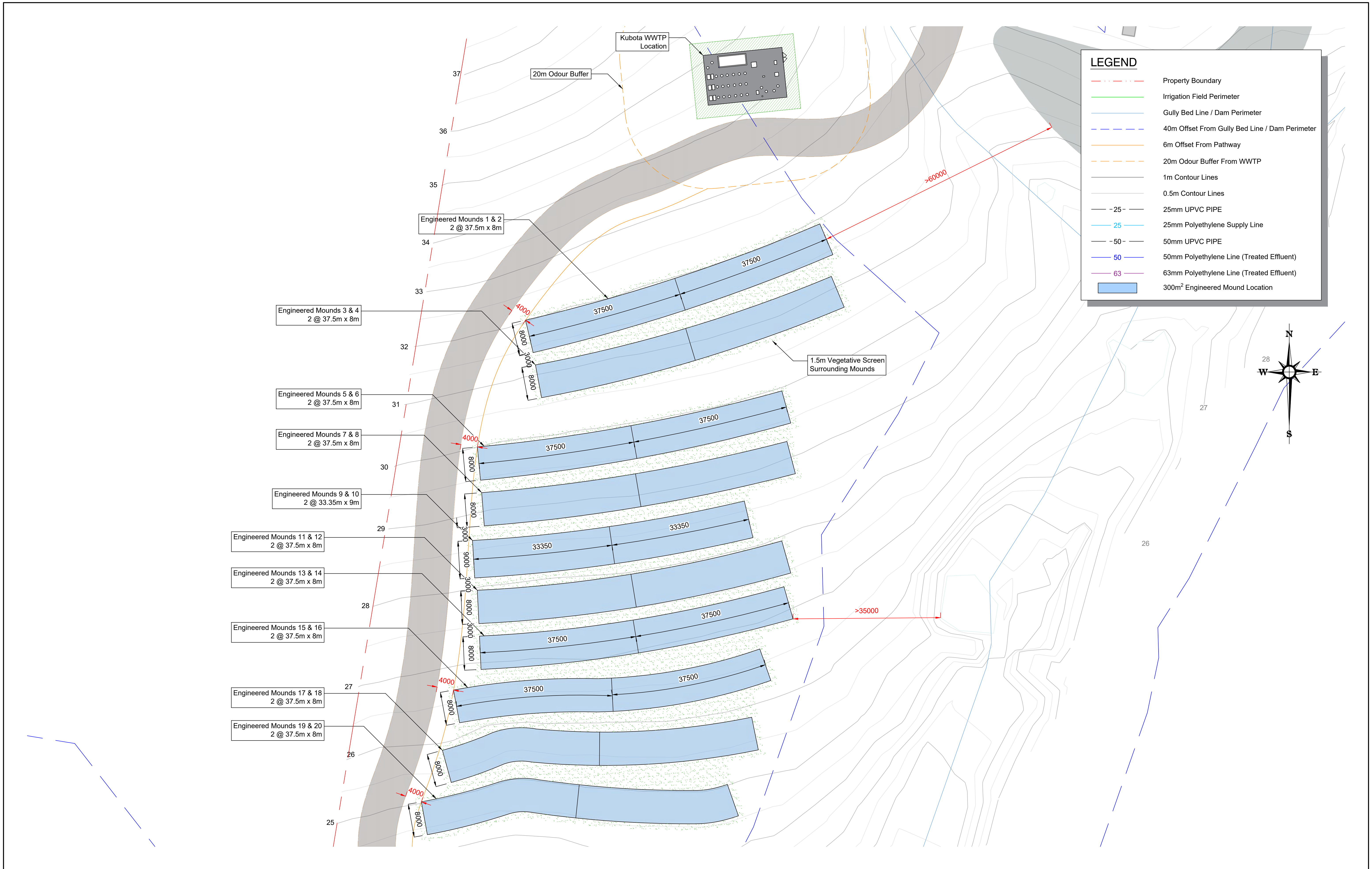
DRAWING TITLE
SITE PLAN - GENERAL LOCALITY PLAN

DISCLAIMER
ALL DIMENSIONS TO BE CHECKED ON SITE BY CONTRACTOR PRIOR TO CONSTRUCTION. USE WRITTEN DIMENSIONS ONLY.

SCALE: 1:3000

DRAWING NO. **FLR-WWTP-H-0006**

REV. **D**



REV	DATE	REVISIONS	DRAWN	DESIGN	APP	REF NO.	REFERENCE DRAWING	NUMBER
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							APPROVED BY	INITIAL
							James Mahoney	
							Daniel Mahoney	

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PROJECT
FARLEY LIFESTYLE RESORT WWTP, 303 WOLLOMBI RD, FARLEY NSW 2320

JOB STATUS
CONCEPT

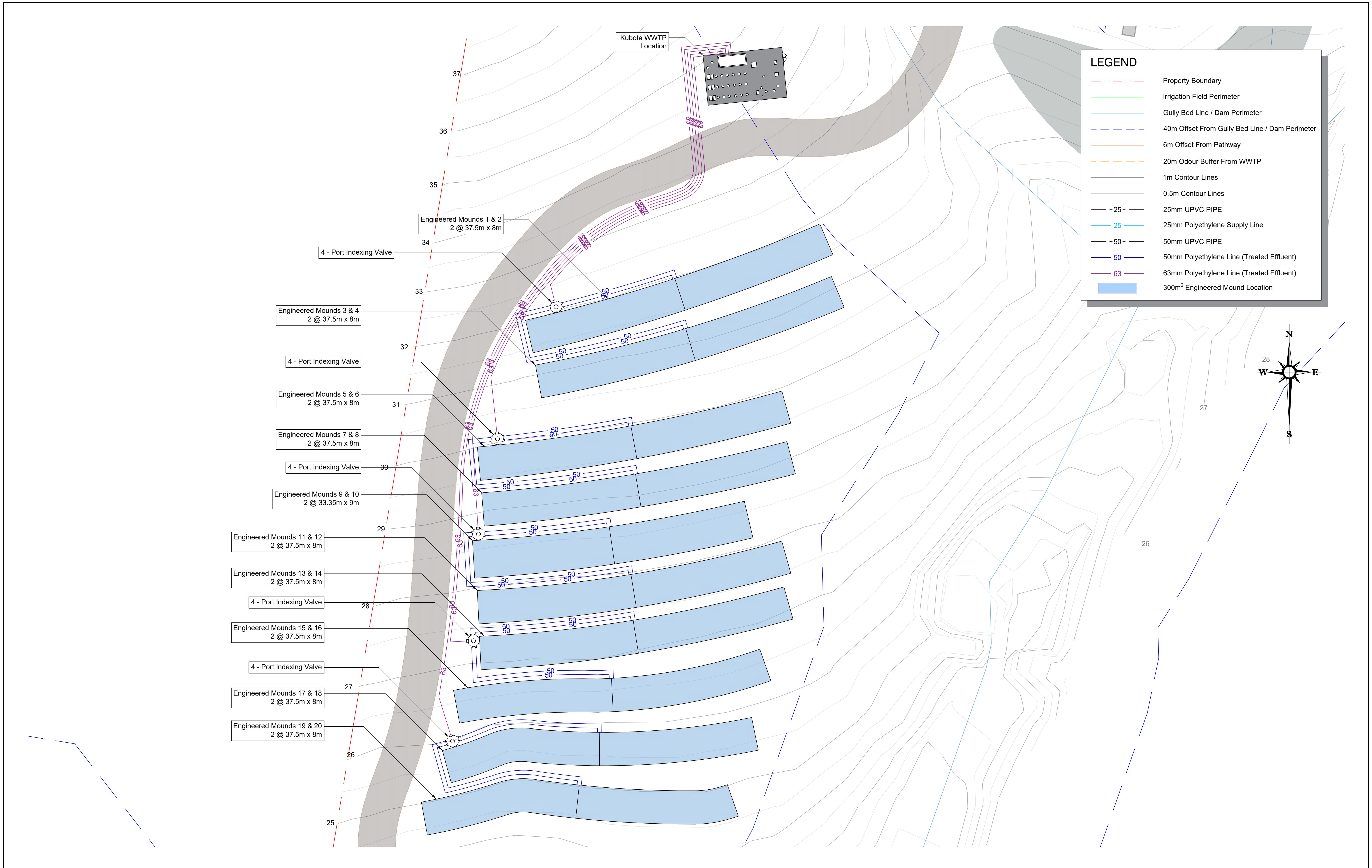
DRAWING TITLE
SITE PLAN - WWTP AND MOUND LOCALITY PLAN

DISCLAIMER
ALL DIMENSIONS TO BE CHECKED ON SITE BY CONTRACTOR PRIOR TO CONSTRUCTION. USE WRITTEN DIMENSIONS ONLY.

SCALE: 1:800

DRAWING NO. **FLR-WWTP-H-0007**

REV. **D**



REV	DATE	REVISIONS	DRAWN	DESIGN	APP	REF NO.	REFERENCE DRAWING	NUMBER
A	15/08/23	CONCEPT DESIGN	CDN	JM	JM	-	-	-
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C	01/09/23	AMENDED WWTP AND MOUND SIZE AND LOCATIONS	CDN	JM	JM	-	-	-
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							APPROVED BY	INITIAL
							James Mahoney	
							Daniel Mahoney	

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PROJECT
FARLEY LIFESTYLE RESORT WWTP, 303 WOLLOMBI RD, FARLEY NSW 2320

JOB STATUS
CONCEPT

DRAWING TITLE
SITE PLAN - MOUND SUPPLY PLAN

DISCLAIMER
ALL DIMENSIONS TO BE CHECKED ON SITE BY CONTRACTOR PRIOR TO CONSTRUCTION. USE WRITTEN DIMENSIONS ONLY.

SCALE: 1:800

DRAWING NO. **FLR-WWTP-H-0008**

REV. **D**

KUBOTA WASTEWATER TREATMENT PLANT

REV	DATE	REVISIONS	DRAWN	DESIGN	APP	REF NO.	REFERENCE DRAWING	NUMBER
A	15/08/23	CONCEPT DESIGN	CDN	JM	JM	-	-	-
B	30/08/23	AMENDED MOUND SIZE AND LOCATIONS	CDN	JM	JM	-	-	-
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							APPROVED BY	INITIAL
							James Mahoney	
							Daniel Mahoney	

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PROJECT
FARLEY LIFESTYLE RESORT WWTP, 303 WOLLOMBI RD, FARLEY NSW 2320

DISCLAIMER
ALL DIMENSIONS TO BE CHECKED ON SITE BY CONTRACTOR PRIOR TO CONSTRUCTION. USE WRITTEN DIMENSIONS ONLY.

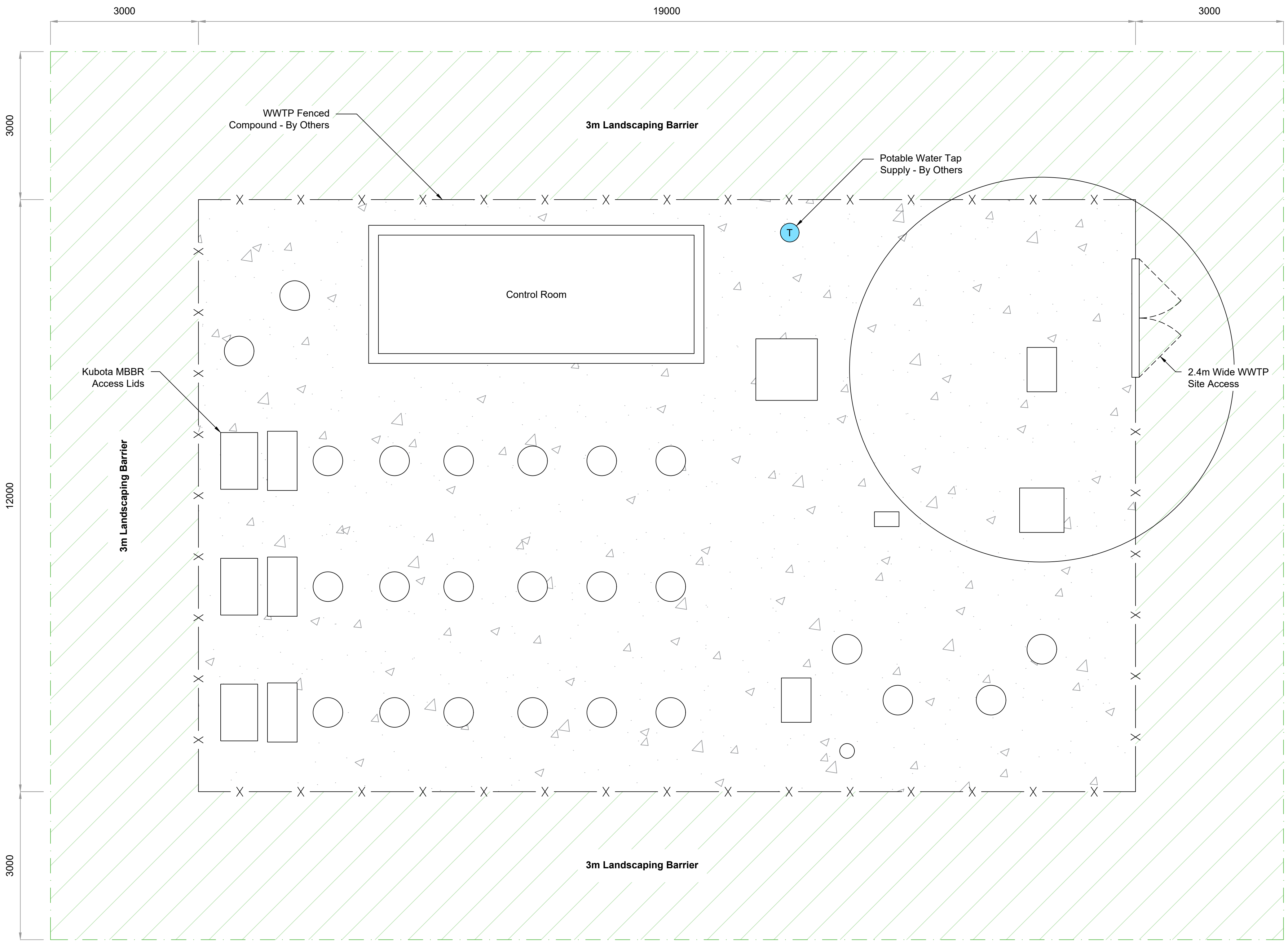
SCALE: NTS

JOB STATUS
CONCEPT

DRAWING TITLE
KUBOTA WASTEWATER TREATMENT PLANT

DRAWING NO.
FLR-WWTP-G-0009

REV.
D



WWTP FINISHED COMPOUND PLAN

REV	DATE	REVISIONS	DRAWN	DESIGN	APP	REF NO.	REFERENCE DRAWING	NUMBER
A	15/08/23	CONCEPT DESIGN	CDN	JM	JM	-	-	-
B	30/08/23	AMENDED MOUND SIZE AND LOCATIONS	CDN	JM	JM	-	-	-
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							APPROVED BY	INITIAL
							James Mahoney	
							Daniel Mahoney	

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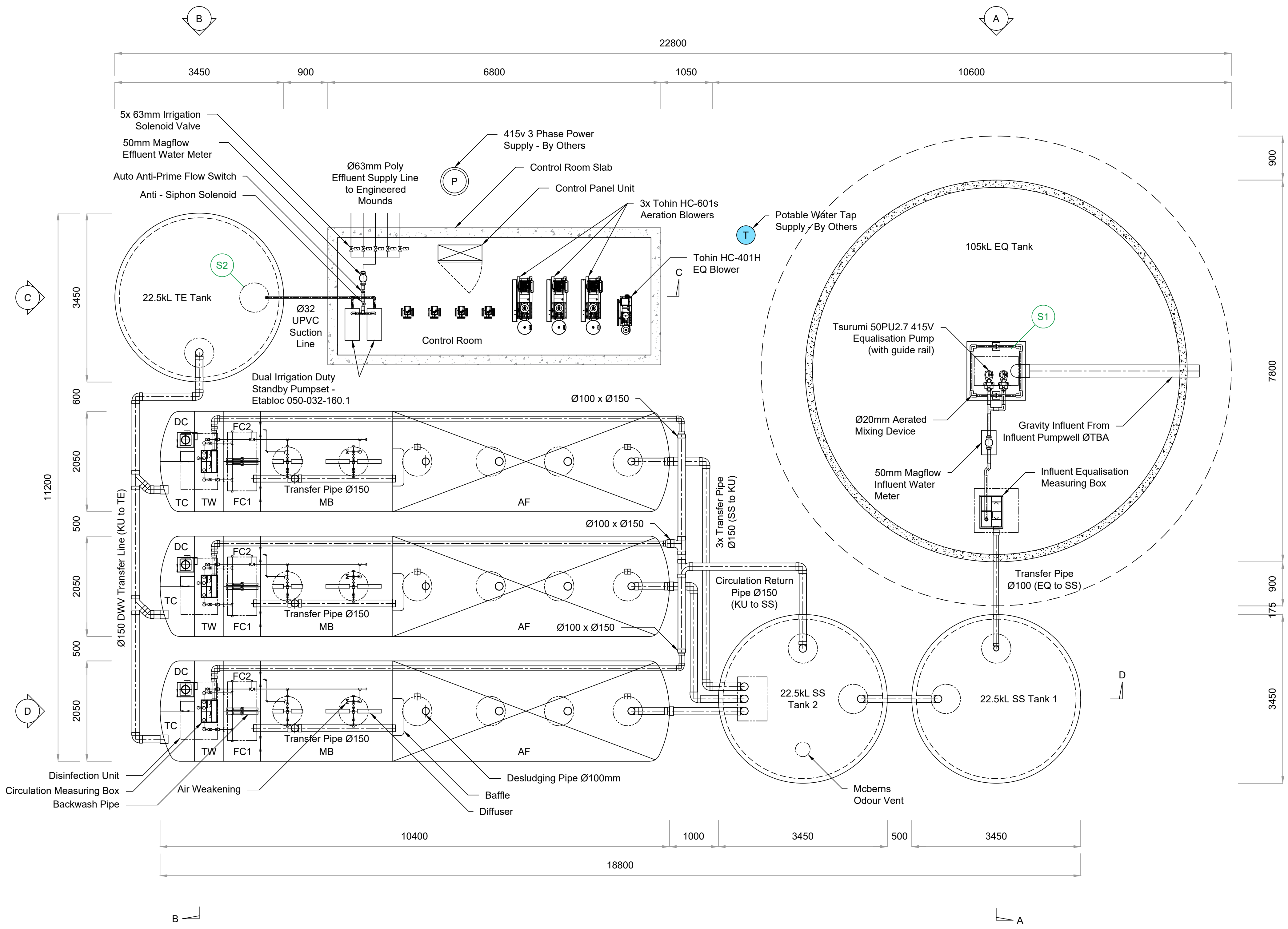
PROJECT	JOB STATUS
FARLEY LIFESTYLE RESORT WWTP, 303 WOLLOMBI RD, FARLEY NSW 2320	CONCEPT
	DRAWING TITLE: KUBOTA WWTP FINISHED COMPOUND LAYOUT
DISCLAIMER: ALL DIMENSIONS TO BE CHECKED ON SITE BY CONTRACTOR PRIOR TO CONSTRUCTION. USE WRITTEN DIMENSIONS ONLY. SCALE: 1:95	DRAWING NO.: FLR-WWTP-H-0010 REV.: D



WWTP PLAN VIEW

REV	DATE	REVISIONS	DRAWN	DESIGN	APP	REF NO.	REFERENCE DRAWING	NUMBER
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							APPROVED BY	INITIAL
							James Mahoney	
							Daniel Mahoney	

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PROJECT
FARLEY LIFESTYLE RESORT WWTP, 303 WOLLOMBI RD, FARLEY NSW 2320

JOB STATUS
CONCEPT

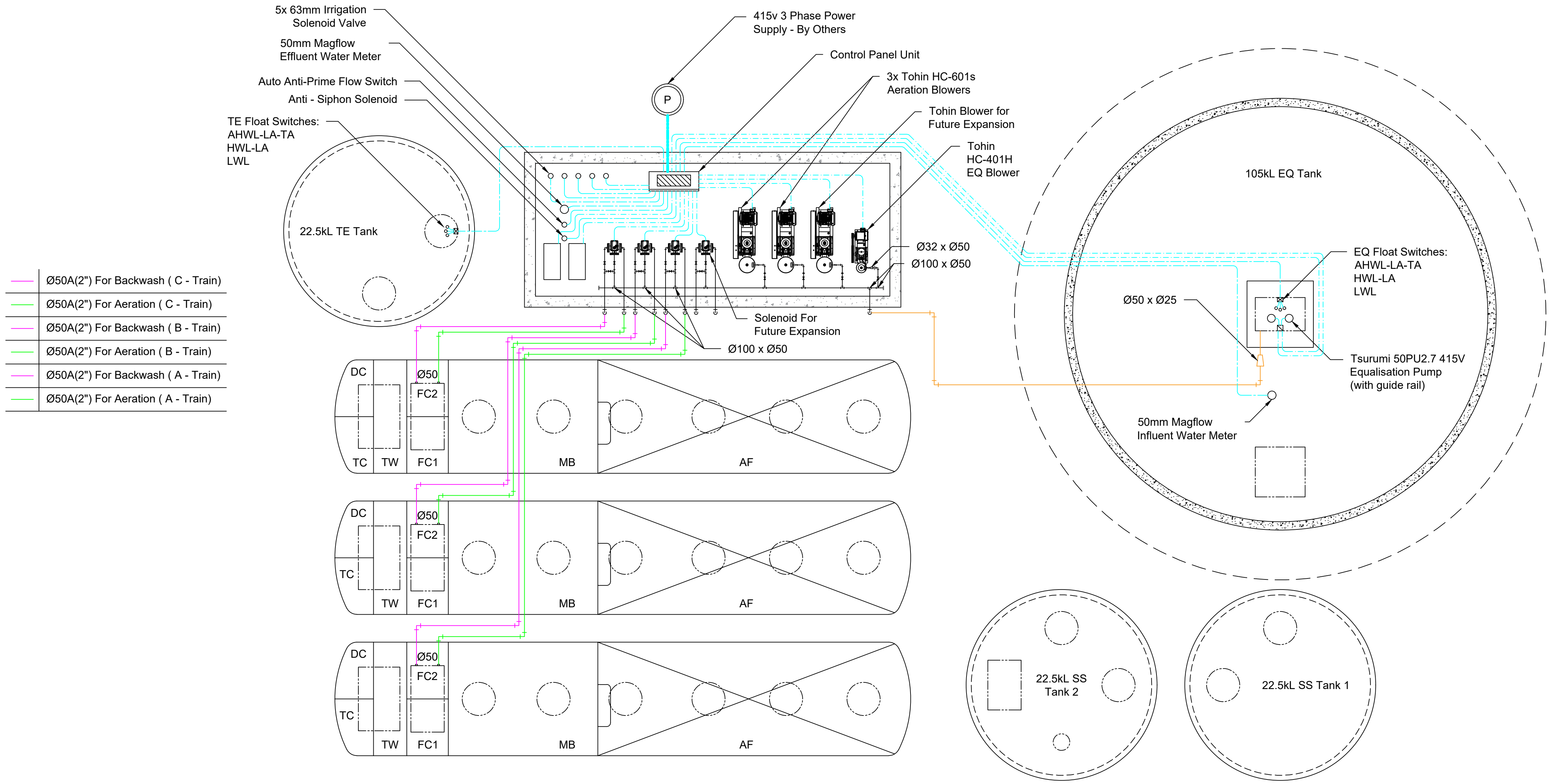
DRAWING TITLE
KUBOTA WWTP HYDRAULICAL LAYOUT

DISCLAIMER
ALL DIMENSIONS TO BE CHECKED ON SITE BY CONTRACTOR PRIOR TO CONSTRUCTION. USE WRITTEN DIMENSIONS ONLY.

SCALE: 1:95

DRAWING NO. **FLR-WWTP-H-0011**

REV. **D**



WWTP AIR AND ELECTRICAL PLAN

REV	DATE	REVISIONS	DRAWN	DESIGN	APP	REF NO.	REFERENCE DRAWING	NUMBER
A	15/08/23	CONCEPT DESIGN	CDN	JM	JM	-	-	-
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							APPROVED BY	INITIAL
							James Mahoney	
							Daniel Mahoney	

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PROJECT
FARLEY LIFESTYLE RESORT WWTP, 303 WOLLOMBI RD, FARLEY NSW 2320

JOB STATUS
CONCEPT

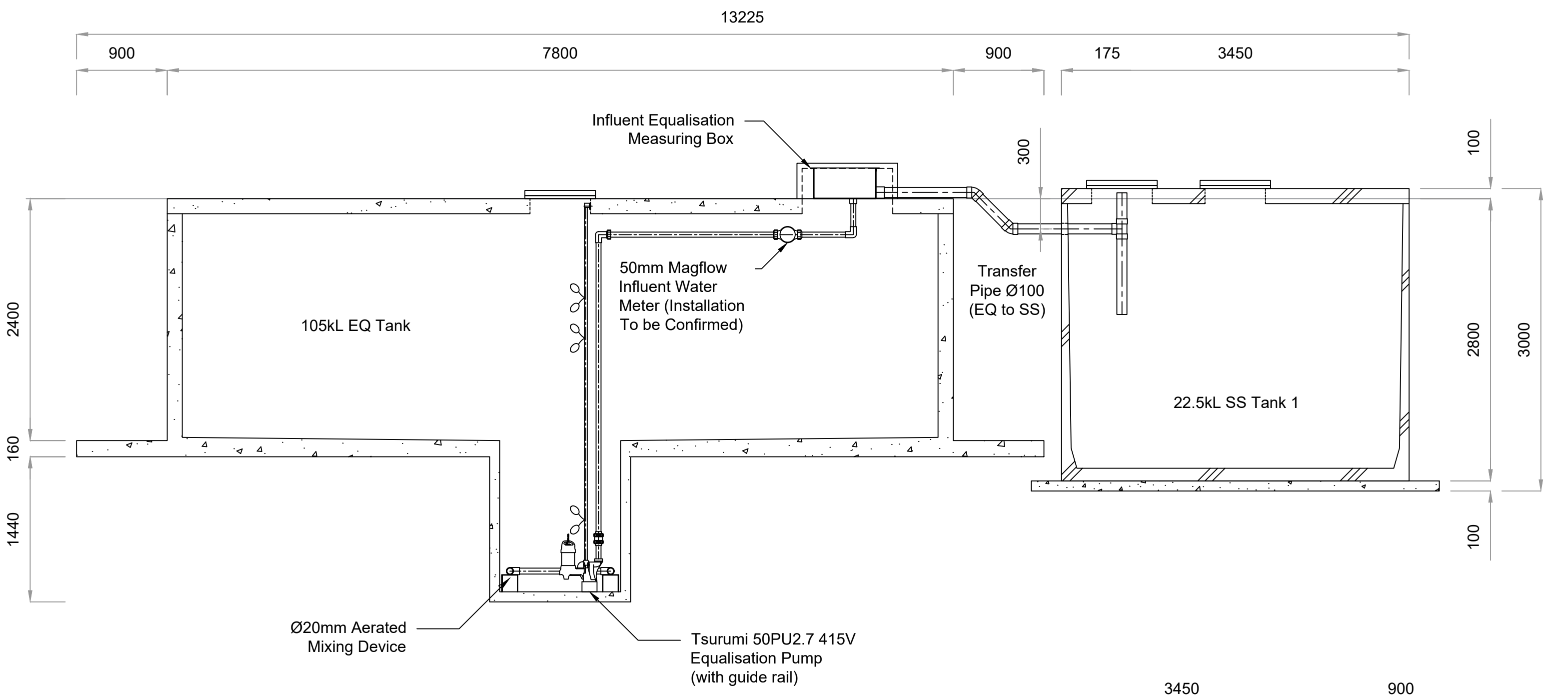
DRAWING TITLE
KUBOTA WWTP AIRLINE & ELECTRICAL CONFIGURATION

DISCLAIMER
ALL DIMENSIONS TO BE CHECKED ON SITE BY CONTRACTOR PRIOR TO CONSTRUCTION. USE WRITTEN DIMENSIONS ONLY.

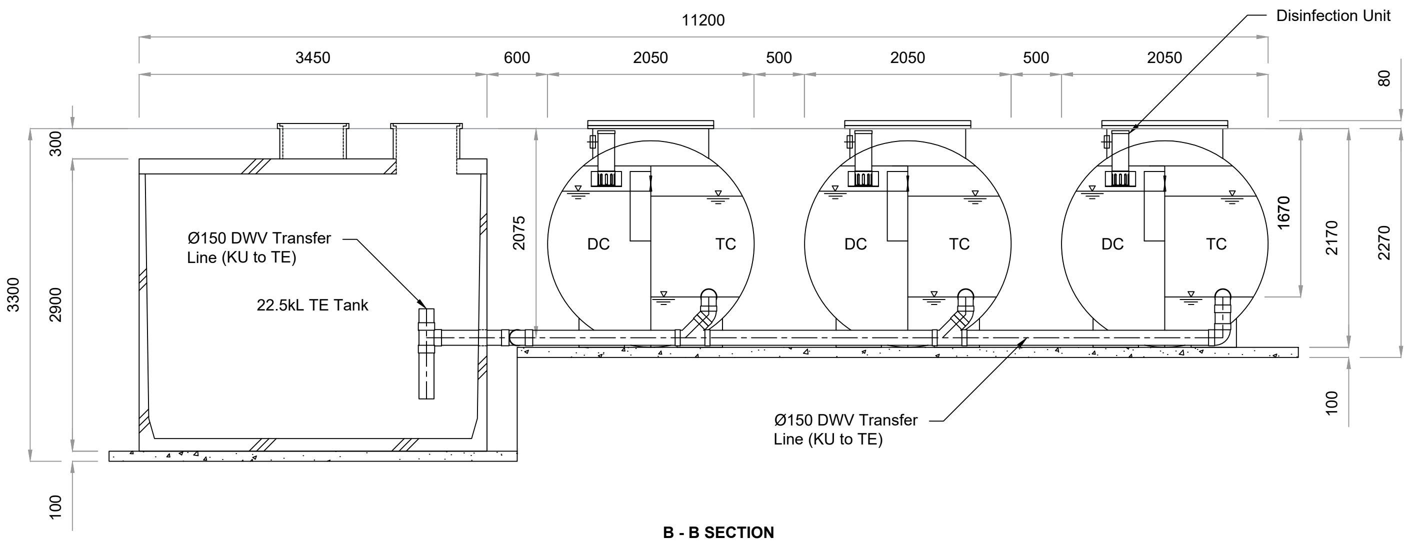
SCALE: 1:95

DRAWING NO. FLR-WWTP-H-0012

REV. D



A - A SECTION



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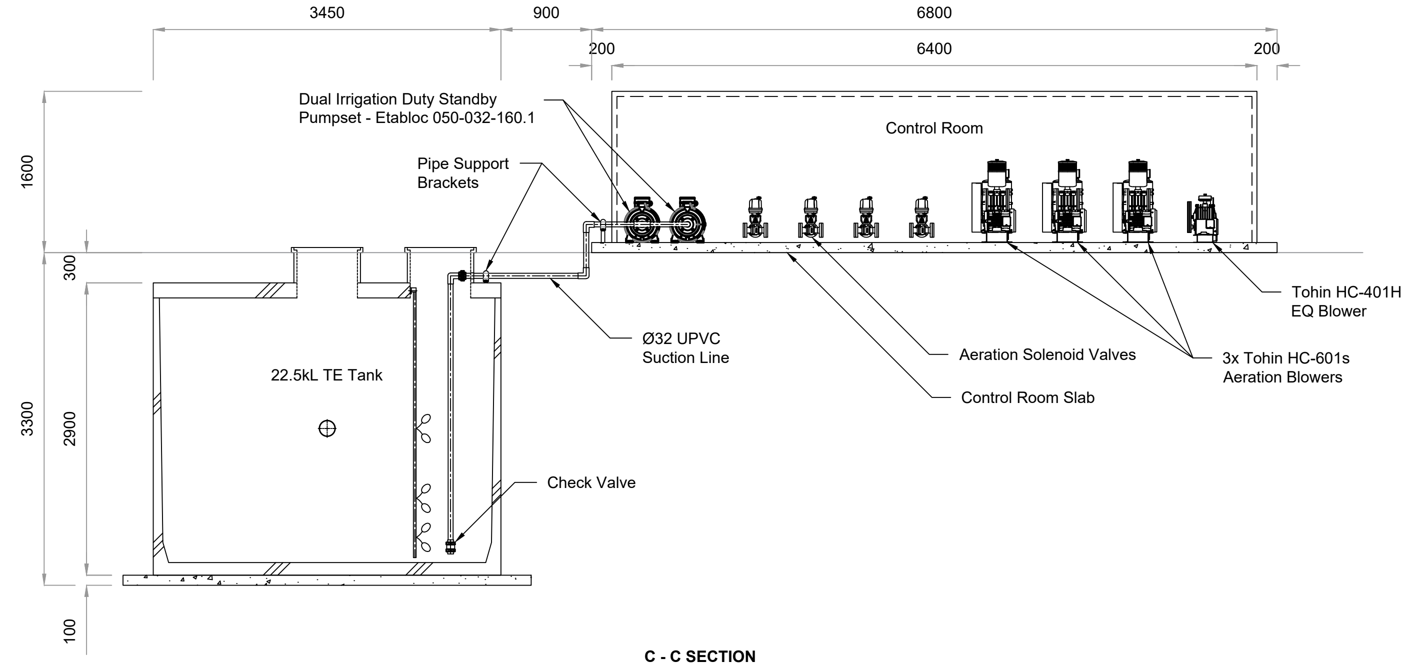
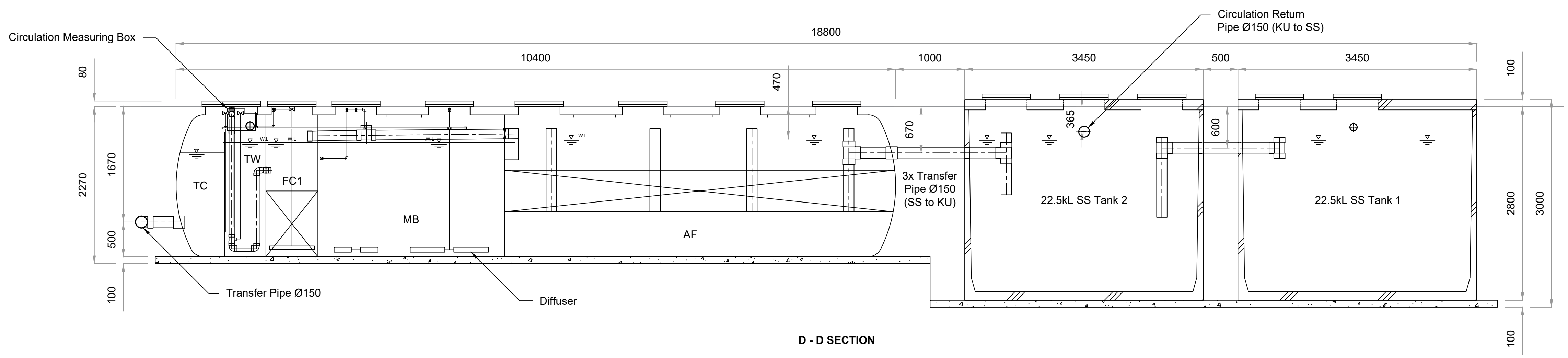


C - C SECTION



D - D SECTION

REV	DATE	REVISIONS	DRAWN	DESIGN	APP	REF NO.	REFERENCE DRAWING	NUMBER
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							James Mahoney	
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PROJECT
FARLEY LIFESTYLE RESORT WWTP, 303 WOLLOMBI RD, FARLEY NSW 2320

DISCLAIMER
ALL DIMENSIONS TO BE CHECKED ON SITE BY CONTRACTOR PRIOR TO CONSTRUCTION. USE WRITTEN DIMENSIONS ONLY.

SCALE: 1:75

JOB STATUS
CONCEPT

DRAWING TITLE
KUBOTA WWTP ELEVATION DETAIL

DRAWING NO. **FLR-WWTP-H-0013**

REV. **D**

ENGINEERED MOUND

REV	DATE	REVISIONS	DRAWN	DESIGN	APP	REF NO.	REFERENCE DRAWING	NUMBER
A	15/08/23	CONCEPT DESIGN	CDN	JM	JM	-	-	-
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							APPROVED BY	INITIAL
							James Mahoney	
							Daniel Mahoney	

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PROJECT

FARLEY LIFESTYLE RESORT WWTP, 303 WOLLOMBI RD, FARLEY NSW 2320

DISCLAIMER
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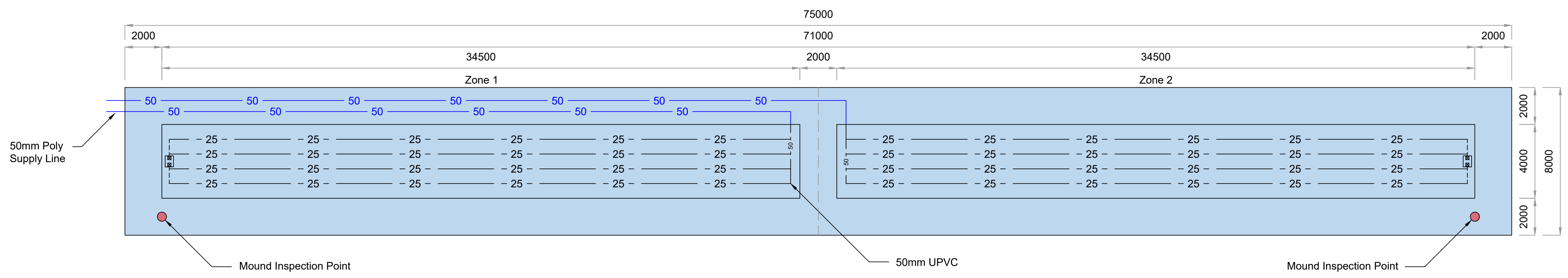
SCALE: NTS

JOB STATUS: CONCEPT

DRAWING TITLE: ENGINEERED MOUND

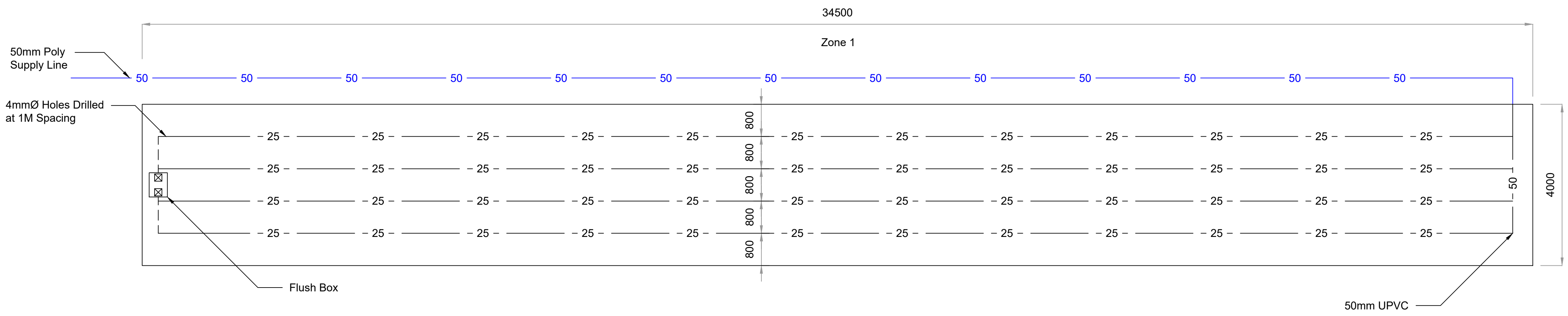
DRAWING NO.: FLR-WWTP-G-0014

REV.: D



ENGINEERED MOUND

SCALE 1:275

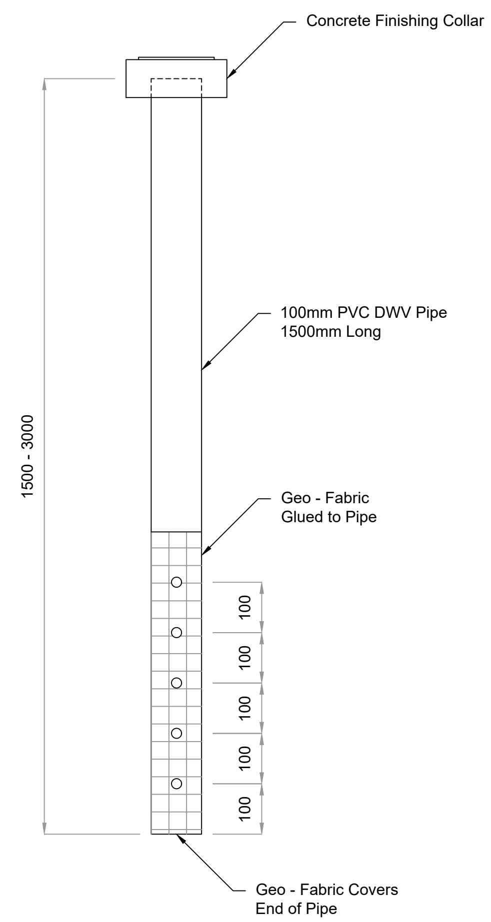


DISTRIBUTION TRANSPIRATION BED DETAIL

SCALE 1:130

LEGEND

- Property Boundary
- Irrigation Field Perimeter
- Gully Bed Line / Dam Perimeter
- 40m Offset From Gully Bed Line / Dam Perimeter
- 6m Offset From Pathway
- 20m Odour Buffer From WWTP
- 1m Contour Lines
- 0.5m Contour Lines
- 25 — 25mm UPVC PIPE
- 25 — 25mm Polyethylene Supply Line
- 50 — 50mm UPVC PIPE
- 50 — 50mm Polyethylene Line (Treated Effluent)
- 63 — 63mm Polyethylene Line (Treated Effluent)
- $300m^2$ Engineered Mound Location



ENGINEERED MOUND INSPECTION PORT DETAIL

REV	DATE	REVISIONS	DRAWN	DESIGN	APP	REF NO.	REFERENCE DRAWING	NUMBER
A	15/08/23	CONCEPT DESIGN	CDN	JM	JM	-	-	-
B	30/08/23	AMENDED MOUND SIZE AND LOCATIONS	CDN	JM	JM	-	-	-
C	01/09/23	AMENDED WWTP AND MOUND SIZE AND LOCATIONS	CDN	JM	JM	-	-	-
D	06/09/23	ADDED UPDATED PCT VEGETATION ZONING	CDN	JM	JM	-	-	-

APPROVED BY	INITIAL
James Mahoney	
Daniel Mahoney	

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Vivacity

PROJECT
FARLEY LIFESTYLE RESORT WWTP, 303 WOLLOMBI RD, FARLEY NSW 2320

JOB STATUS
CONCEPT

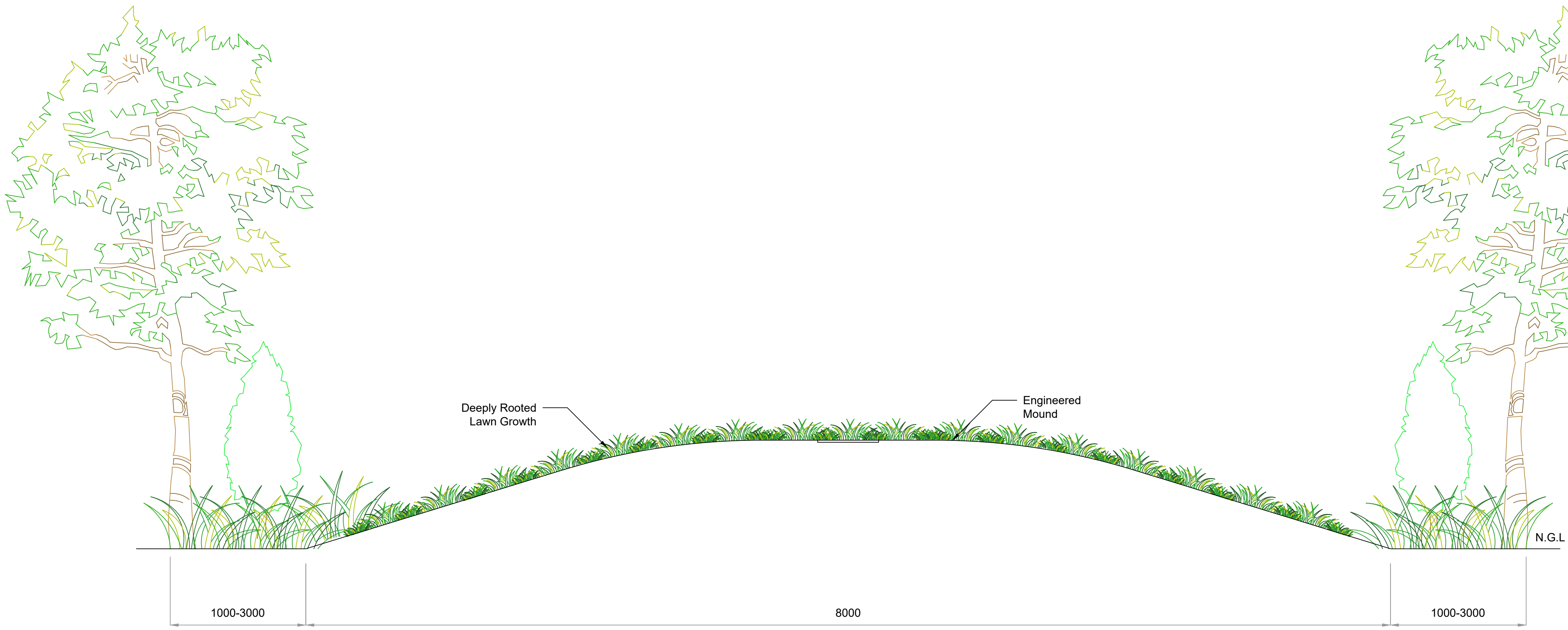
DRAWING TITLE
ENGINEERED MOUND DETAIL

DISCLAIMER
ALL DIMENSIONS TO BE CHECKED ON SITE BY CONTRACTOR PRIOR TO CONSTRUCTION. USE WRITTEN DIMENSIONS ONLY.

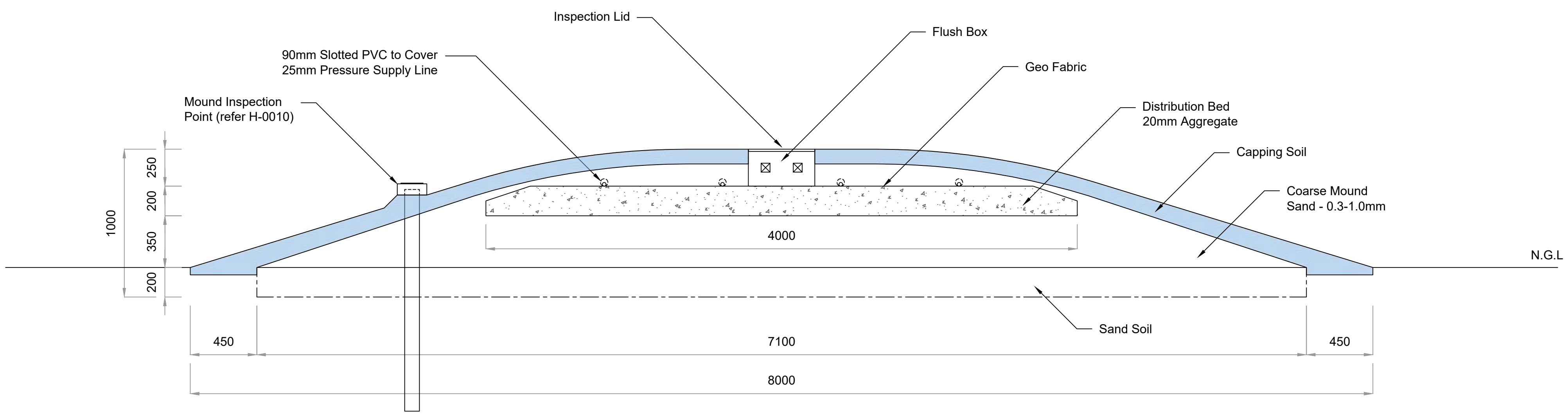
SCALE: NTS

DRAWING NO. **FLR-WWTP-H-0015**

REV. **D**



MOUND LANDSCAPING CROSS SECTION



MOUND DETAILED CROSS SECTION

REV	DATE	REVISIONS	DRAWN	DESIGN	APP	REF NO.	REFERENCE DRAWING	NUMBER
A	15/08/23	CONCEPT DESIGN	CDN	JM	JM	-	-	-
B	30/08/23	AMENDED MOUND SIZE AND LOCATIONS	CDN	JM	JM	-	-	-
C	01/09/23	AMENDED WWTP AND MOUND SIZE AND LOCATIONS	CDN	JM	JM	-	-	-
D	06/09/23	ADDED UPDATED PCT VEGETATION ZONING	CDN	JM	JM	-	-	-
							APPROVED BY	**INITIAL**
							James Mahoney	
							Daniel Mahoney	

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DISCLAIMER
ALL DIMENSIONS TO BE CHECKED ON SITE BY CONTRACTOR PRIOR TO CONSTRUCTION. USE WRITTEN DIMENSIONS ONLY.

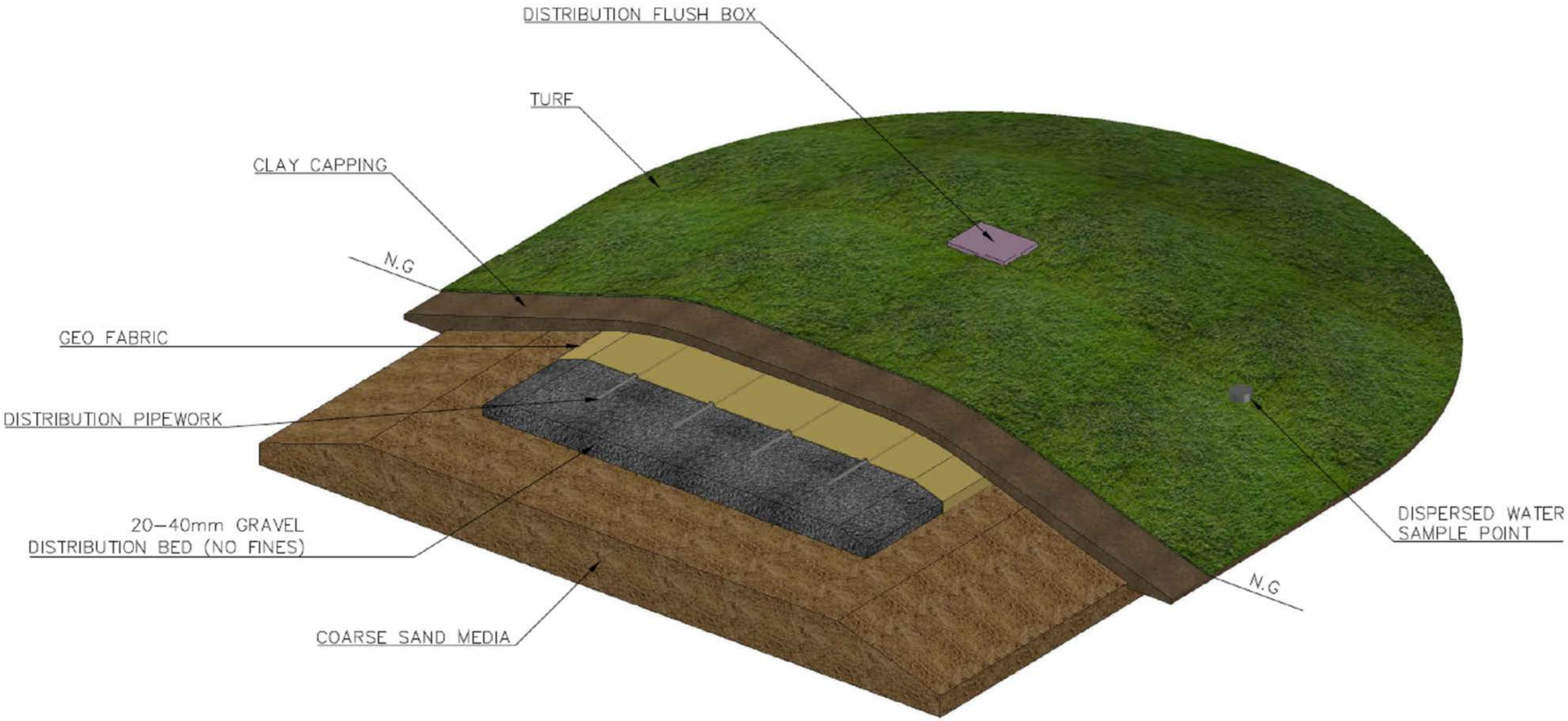
SCALE: 1:40

JOB STATUS
CONCEPT

DRAWING TITLE
ENGINEERED MOUND CROSS SECTION & LANDSCAPING

DRAWING NO. **FLR-WWTP-H-0016**

REV. **D**



REV	DATE	REVISIONS	DRAWN	DESIGN	APP	REF NO.	REFERENCE DRAWING	NUMBER
A	15/08/23	CONCEPT DESIGN	CDN	JM	JM	-	-	-
B	30/08/23	AMENDED MOUND SIZE AND LOCATIONS	CDN	JM	JM	-	-	-
C	01/09/23	AMENDED WWTP AND MOUND SIZE AND LOCATIONS	CDN	JM	JM	-	-	-
D	06/09/23	ADDED UPDATED PCT VEGETATION ZONING	CDN	JM	JM	-	-	-
							APPROVED BY	**INITIAL**
							James Mahoney	
							Daniel Mahoney	

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PROJECT
FARLEY LIFESTYLE RESORT WWTP, 303 WOLLOMBI RD, FARLEY NSW 2320

JOB STATUS
CONCEPT

DRAWING TITLE
ENGINEERED MOUND 3D CROSS SECTION

DISCLAIMER
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SCALE: NTS

DRAWING NO. **FLR-WWTP-H-0017**

REV. **D**

Appendix B

Risk Management Plan

RISK MANAGEMENT PLAN

FARLEY LIFESTYLE RESORT

WASTEWATER TREATMENT SYSTEM (WWTS)

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RISK MANAGEMENT PLAN (RMP)

Site Address:

283 & 303 Wollombi Road, Farley NSW 2320

Lots 2 & 4 DP810894

Client:

Vivacity Property Pty Ltd

Level 19, 1 O'Connell Street, Sydney NSW 2000

Prepared By:

True Water

02 6645 3377

PO Box 351 Maclean NSW 2463

Document Control

Version History

Date	Version:	Revision Description	Approved By:
1.08.23	RMP V1 FLR	Draft	Dale James
3.08.23	RMP V1 FLR	Final Draft	James Mahoney

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Executive Summary

Development	Farley Lifestyle Resort
Site Address	303 Wollombi Road, Farley NSW 2320
Lot and Plan	Lot 4 DP810894
Approval Authority	Maitland City Council (MCC)
Owners/Developer	Vivacity Property Pty Ltd
Contact Point	Tom Copping – Planning Manager
Contact Number	0425 555 383
Block Size	Approximately 30.7ha
Boundaries	Wollombi Road and other RU2/R1 zoned lots
Wastewater Load	Annual Average Flow (AAF) = 57,150L/day Peak Flow (PF) = 68,580L/day
Potable Water Supply	Chichester Dam catchment (Hunter Water)
Availability of Municipal Sewer	Wastewater Utility delivery horizon between 5 to 10 years
Potential Constraints	Available area for effluent dispersal, no potential constraints identified
Treatment Standard	Secondary (disinfection and nutrient reduction)
Effluent Dispersal Method or System	5,715m2 Engineered Mound

Farley Lifestyle Resort is a residential lifestyle estate for over 50s to be development at Wollombi Road, Farley. The facility will include 254 2-bedroom dwellings, a clubhouse, and community recreation facilities. The site is an approximately 30.7ha, mostly irregular-shaped parcel bordered by Wollombi Road and other RU2/R1 zoned lots. The site is not serviced by the municipal sewerage network and future connection is uncertain. Therefore, all sewage generated by the development must be treated and managed wholly within the site by a site-specific Wastewater Treatment System (WWTS). Therefore, the proposed WWTS will require approval for Section 68 (F10) of the Local Government Act 1993.

The estimated design flow for the site is Annual Average Flow (AAF) of 57,150Litres/day and a Peak Flow (PF) of 68,580Litres/day. Metering and automated monitoring of flows will be implemented. In the event the wastewater generation exceeds design load, the WWTS capacity will be increased.

The proposed WWTS is not a Recycled Water Scheme or an Effluent Reuse Scheme. Secondary treated effluent will be dispersed underground through 5,715m^2 of Engineered Mounds. Effluent dispersal has no secondary use, there will be no crop irrigation or agricultural use, the purpose is solely treated effluent dispersal.

The Wastewater Treatment System (WWTS) will be sited achieving suitable buffers and offsets to sensitive receptors. The WWTP will be below ground and have sealed gas tight lids. Below ground installation provides favourable amenity and prevents visual impact, noise and odour. Engineered Mounds are favourable Effluent Dispersal System's (EDS) as they provide effluent polishing, nutrient reduction, rainfall shadowing, and enhanced evaporation. A conservative annual average application rate of 10mm/m^2/day shall be adopted.

Contents

1 Introduction

This Risk Management Plan (RMP) for the Farley Lifestyle Resort - Wastewater Treatment System (WWTS) has been developed on behalf of the Developer. The RMP forms part of the Integrated Environmental Management System (IEMS) which manages and mitigates risks arising from the treatment and dispersal of wastewater generated by the development.

The site is not serviced by the municipal sewage network and requires site-specific management. The WWTS will be located on Lot 4 DP810894 (the Site) with the Annual Average Flow (AAF) of 57,150Litres/day and a Peak Flow (PF) of 68,580Litres/day.

To protect public health and the environment, a reliable and compliant WWTS must service the development. Wastewater infrastructure will be designed to deliver beneficial economic, environmental, and social outcomes across a minimum 50-year infrastructure life cycle.

The WWTS design will consider the Best Available Technique and Technology (BATT) for the site-specific management of wastewater. Environmental factors, human health and work health and safety are considered as part the Safety in Design process to deliver infrastructure which best addresses regulatory requirements and stakeholder objectives.

1.1 Purpose

The RMP identifies risks associated with the operation of the WWTS infrastructure and the long-term application of treated effluent. The RMP establishes suitable management and mitigation measures, including control and preventative measures to mitigate risk and prevent impact to public health or the environment.

1.2 Objective

The RMP is an important management tool which will provide reasonable and practicable steps to deliver best practice operational measures and satisfy environmental duty of care. Specifically, the objective of the RMP is to:

- Ensure all wastewater is safely and sustainably managed wholly within the boundaries of the site,
- Deliver public health and environmental security,
- Prevent negative impact to public health
- Prevent negative impact to environmental health,
- Drive improvements in infrastructure management and operation,
- Aid in the delivery of beneficial outcomes within the development area and surrounding environment.

1.3 Scope

The scope of the RMP includes:

- STEP 1: Confirm operating environment:
    - WWTS type, configuration, and size,
    - List site considerations,
- STEP 2: Identify risks and hazards:
    - Identify potential risks and hazards related to:
        - infrastructure operation,
        - mismanagement or failure,
- STEP 3: Assess and analyse all risks:
    - Assess the likelihood of each risk or hazard,

    - Assess the consequence of each risk or hazard,
    - Quantify the risk or hazard and confirm the risk rating.
- STEP 4: Implement controls:
    - Ensure suitable operational measures are in place to prevent potential public health or environmental impacts,
    - Establish suitable response and contingency plans for each potential public health or environmental risk.
- STEP 5: Check controls
    - Review control measures,
    - Ensure operators are aware of risks and trained in applying preventative measures, responses, and contingency plans.
- STEP 6: Maintain and continually improve controls
    - Provide basis for annual audit of:
        - operations and compliance,
        - trigger and response,
        - suitability of control measures.

1.4 The Consultants

True Water is a whole of life cycle wastewater management specialist. True Water specialise in the design, delivery, and operation of small scale municipal WWTSs, and small to large scale site-specific WWTSs. Our whole of life experience informs infrastructure design and delivery, providing scalable wastewater treatment systems that satisfy Utility specification and provide decades of service. True Waters experience includes:

- Acquisition of >2,000 local and state government approvals for site-specific WWTSs, including WWTSs servicing up to 4,000EP,
- Delivery of >1,500 WWTSs throughout Australia and the Pacific including single WWTSs servicing 5,000EP,
- Management of WWTSs for federal, state, and local government and multinationals throughout Australia and the Pacific.

2 Roles and Responsibilities

2.1 Licensed Entity

The Developer will be the licensed entity. The Developer shall be responsible for:

- Compliance with all conditions of approvals,
- Ensuring compliance with the Integrated Environmental Management System (IEMS) including:
    - Maintaining all operation and management measures and requirements,
    - Implementing all control measures,
    - Maintaining all monitoring and response requirements,
    - Ensuring proper record keeping, reporting and auditing,
- Payment of all regulatory fees,
- Ensuring only specialists with experience specific to the WWTS undertake management of the WWTS.

Licensed Entity:	Vivacity Property Pty Ltd
ACN:	629 979 237
Address:	Level 19, 1 O'Connell St, Sydney NSW 2000
Nominated Contact Person:	Tom Copping
Position:	Planning Manager
Mobile No:	0425 555 383
Email Address:	tom@vivacityproperty.com.au

Primary Regulator:	Maitland City Council
Contact Number:	02 4934 9700
Email:	info@maitland.nsw.gov.au
Contact Point:	Matthew Prendergas

Management Contractor:	True Water Australia
Contact Number:	02 6645 3377
Email:	Maintenance
Contact Point:	Works & Services Group Manager

3 Operating Environment

The WWTS shall service Farley Lifestyle Resort, a residential lifestyle estate for over 50's to be development at Wollombi Road, Farley. The facility will include 254 dwellings, a clubhouse, and community recreation facilities. . The site is an approximately 30.7ha, mostly irregular-shaped parcel bordered by Wollombi Road and other RU2/R1 zoned lots. The site is not serviced by the municipal sewerage network and future connection is uncertain. Therefore, all sewage generated by the development must be treated and managed wholly within the site by a site-specific Wastewater Treatment System (WWTS).

The WWTS will employ a multi barrier treatment process, and will consist of:

- Equalisation tank to regulate flows,
- Kubota Wastewater Treatment Plant utilising multi train bioreactor with integrated MBBR process,
- Disinfection system to disinfect effluent,
- An odour control system consisting of carbon filters to remove and treat odour,
- Bioreactor aeration blowers located within the control building,
- Treated Effluent Storage Tank,
- Control and monitoring system including flow meter,
- Media filtration Effluent Dispersal System.

Effluent from the WWTS will conform to quality limits as outlined in *Table 3.1*.

Table 3.1 - Influent and effluent quality limits

Quality Characteristic	Influent	WWTP Effluent	Engineered Mounds Effluent
Hydraulic Flow (L/day)	57,150	57,150	57,150
5 day BOD (mg/L)	250 - 380	20	<1
Suspended Solids (mg/L)	150 - 350	30	<1
pH (pH units)	6 – 8	6 - 8	6 - 8
Free Residual Chlorine (mg/L)	-	2	<1
E.coli (cfu/100mL)	-	<100	<10
Total Nitrogen (mg/L)	60 - 80	30	<3
Total Phosphorus (mg/L)	10 - 15	10	<1
Electrical Conductivity (µs/cm)	<1600	<1600	<500

3.1 Operational Framework

True Waters Integrated Environmental Management System (IEMS) directs and informs all activities throughout the infrastructure's lifecycle. The IEMS is a conclusive quality management process specifically designed to deliver stakeholder objectives, secure compliance, and protect public health and the environment. Relative to risk management, the IEMS is implemented to address, manage, and mitigate risks, reduce potential for harm to public health or the environment, and maintain compliance with regulatory requirements.

3.2 Wastewater Infrastructure - Pre-Risk Assessment

The WWTS utilises tried and tested technologies in order to provide reliability, reduce risk and simplify life cycle management requirements. Each infrastructure component has been refined over many decades, ensuring surety of operation and allowing comprehensive asset management processes to be implemented.

The WWTS employs a multi barrier approach to wastewater treatment and risk management. Control and monitoring points are located throughout each section of the wastewater infrastructure and telemetry monitoring automatically reports standard and abnormal operation.

Wastewater infrastructure can be assigned to the following sections:

- Reticulated Sewer System
- Wastewater Treatment Plant (WWTP)
- Effluent Dispersal System (EDS)

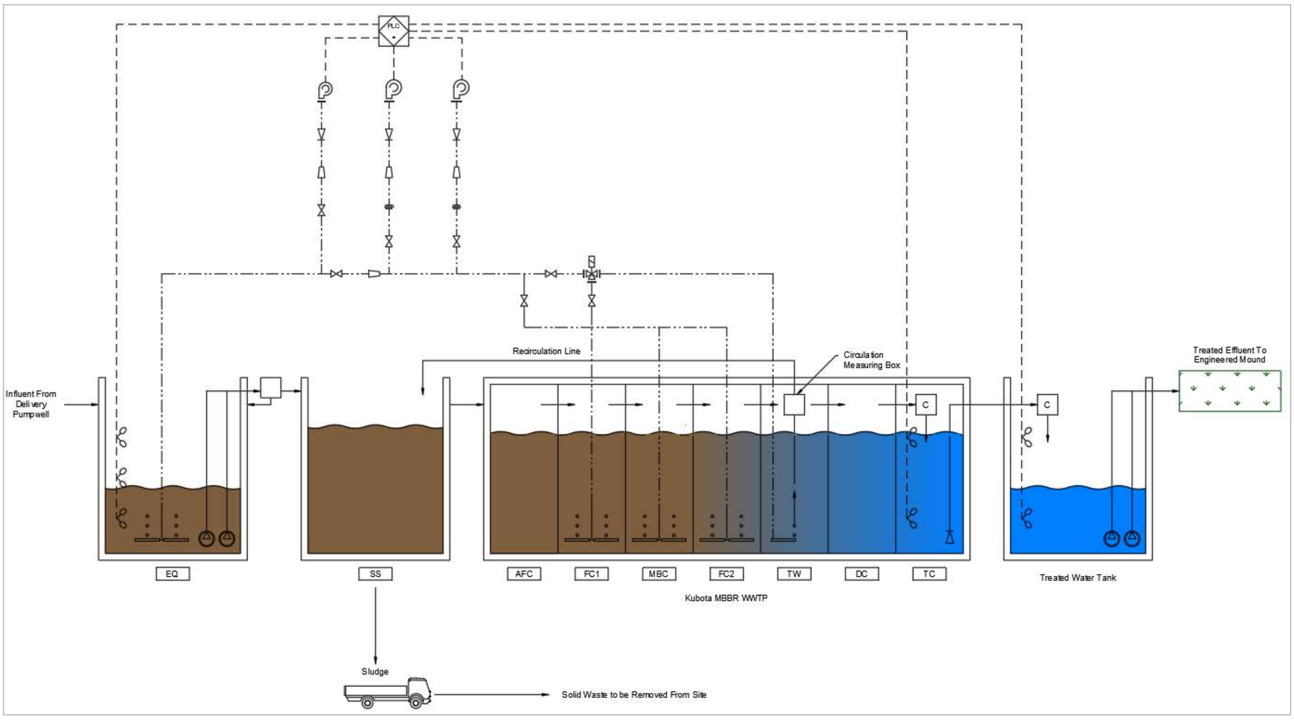


Figure 3.1 – Process Flow of Kubota Advanced WWTP

3.2.1 Reticulated Sewer System

The Reticulated Sewer System captures and conveys wastewater to a central location for treatment. The Reticulated Sewer System is external to the WWTS and not within the WWTS scope. However, improper operation of the Reticulated Sewer System has potential to impact the operation of the WWTS, therefore the Reticulated Sewer System must be considered within the risk assessment. The design and construction of the Reticulated Sewer System must comply strictly with established industry standards and will be approved by the LGA.

Table 3.2 - Reticulated Sewer System component descriptions

Component	**Description**
Grease Arrestor or Pre-treatment Devices (when applicable)	Grease Arrestors must be installed to remove grease, oil, and fat from the waste stream of any non-domestic kitchen. Pre-treatment Devices will be installed on any waste stream that generate contaminant concentrations greater than the maximum influent strength limits as detailed within *Table 3.1*. The design, management and operation of Grease Arrestors or Pre-treatment Devices is the responsibility of the property owner and will strictly comply with the Trade Waste Policy. Grease Arrestors and Pre-treatment Devices are outside the scope of the WWTS.
Sewage Drainage System	The Sewage Drainage System is a network of pipes that captures and conveys raw sewage. The Sewage Drainage System shall be installed in accordance with the *Plumbing and Drainage Code (AS/NZS:3500)* and all other relevant codes and guidelines. The LGA will inspect and approve all plumbing works. The Sewage Drainage System is outside the scope of the WWTS.
Sewage Pump Station	Sewage Pump Stations receive sewage from the sewage drainage system. The Sewage Pump Station will satisfy WSAA requirements and include duty and standby transfer pumps which discharge sewage to the sewage rising main. The Sewage Pump Stations will include an automated controller, the controller will include pump monitoring and high-level alarm. The design, delivery, management, and compliant operation of Sewage Pump Stations is the responsibility of the property owner and the LGA. Sewage Pump Stations are outside the scope of the WWTS.
Sewage Rising Main	The Sewage Rising Main is a high-density polyethylene pipe installed and marked as per industry standards. The Sewage Rising Main receives raw sewage from the outlet of the sewage pump station and transfers it to inlet of the WWTP. The design, delivery, management and compliant operation of the Sewage Rising Main is the responsibility of the property owner and the LGA. The Sewage Rising Main is outside the scope of the WWTS.

3.2.2 Wastewater Treatment Plant

A Kubota Wastewater Treatment Plant (Kubota WWTP) shall service the site. The Kubota WWTP employs a multi barrier approach to wastewater treatment and employs a highly refined Media Bed Biofilm Reactor (MBBR) treatment process. MBBR treatment enables reliable and efficient wastewater treatment using limited mechanisation and low energy consumption.

The Kubota MBBR process consists of various chambers, each with a separate type of specialised plastic carrier (media). Each carrier is designed to target specific types of microorganism, grow specific types of biofilms, and provide biological filtration of wastewater. Each chamber and carrier/media type undertake a specific role in the removal of contaminants from the wastewater stream.

The Kubota WWTP is a scalable treatment device that allows for the staged delivery or the increased capacity of wastewater treatment infrastructure if required. The wastewater treatment process is designed to limit technical complication and facilitate sustainable operation across infrastructure lifecycle.

Kubota Corporation is AAA rated and a global leader in water technologies who mass produce WWTPs under strict quality controls. Millions of Kubota WWTPs are in operation globally. The WWTPs are tried and tested, provide surety of installation and operation, and are guaranteed to achieve the design treatment level when operated in compliance with the manufacturer’s specification.

Table 3.3 - WWTP component descriptions

Component	Description
Equalisation Tank (EQ Tank)	The Equalisation Tank (EQ) prevents shock loading and regulates diurnal flow. The EQ provides wastewater storage, then doses wastewater via the duty and standby EQ Pump set to the SLS Tank.
Kubota WWTP Solid Liquid Separation Tank (SLS Tank)	The Solid Liquid Separation Tank (SLS) provides primary treatment through physical separation of solids from the incoming wastewater stream. Wastewater is directed to the bottom of the chamber to increase pressure and aid in solids separation. Primary treated wastewater leaves the tank via gravity drainage to the Kubota WWTP .
Kubota Wastewater Treatment Plant (Kubota WWTP)	The Kubota WWTP is a fibre reinforced plastic, wastewater purification system that employs the moving media bed filtration method, to strip contaminants and purify influent. Kubota WWTPs have no internal mechanical moving parts. Internal transfer is through airlifts that are operated by a low-pressure air supply. Air flow is provided by a rotary blower unit located within the control box. The air supply operates the transfer and recirculation systems within the Kubota WWTPs, which automatically adjusts the rate of transfer and recirculation depending on incoming flows and water level. The air supply aerates the media beds, supporting aerobic bacteria that provide filtration and purification. The air supply cleans the primary filter and activates the moving media bed, media filters and recirculation system, and automatic backwash system. There are approximately 10,000,000 MBBR units in operation in Japan. Each year the Japanese Government's Ministry of Building tests the effluent quality of every unit to confirm compliance, assess performance, and drive continual improvement of technology and regulation. The benefits of this rigorous testing regime is inherent in the performance and compliance of the Kubota WWTP. The Kubota WWTP is the

Component	Description
	result of more than 50 years of government supported Japanese research and development, and government testing. The manufacture and production of the Kubota WWTP is completed adhering to ISO:9001 and ISO:14001 international standards and adheres to Japanese federal legislation concerning design, structural conformity, and performance standards. Japan’s onsite WWTP manufacturing industry is the world’s most highly regulated, competitive, and comprehensive.
Kubota WWTP Disinfection Unit	The Kubota WWTP employs the Japanese governments specified and validated chlorine Disinfection Unit which is operational in more than 10,000,000 Japanese MBBR WWTPs. The Disinfection Unit is a Japanese Ministry of Building legislated requirement that must satisfy federal government design requirements to ensure performance. The Japanese Ministry of Building monitors each of the 10,000,000 MBBR WWTPs and Disinfection Units. Each is tested annually with all data driving further regulatory refinement and improvement. Treated effluent passes through the Disinfection Unit. The contact rate of the chlorination unit can be varied to achieve suitable Free Residual Chlorine (FRC) level within the Treated Effluent Chamber.
Kubota WWTP Treated Effluent Chamber	The Treated Effluent Chamber provides suitable retention time (at peak flow) for chlorine contact. The dose rate of the chlorination unit can be varied to achieve suitable Free Residual Chlorine (FRC) levels within the Effluent Tank. To ensure suitable pathogen removal FRC should be >0.5mg/L. To prevent environmental impact FRC should be <2mg/L.
Control Box	The weatherproof Control Box is located within five metres of the Kubota WWTP. The Control Box contains the monitoring unit, air blowers, flow meter, and wireless telemetry unit. The Control Box is constructed from marine grade aluminium and powder coated to ensure maximum durability and functional life. The Control Box includes mountings for blowers designed to prevent vibration and noise transmission and the box is insulated to limit noise transfer.
Odour control (Carbon filtration)	Wastewater treatment produces gases and odour. A carbon filtration unit (McBerns or similar) is fitted to the WWTP to remove odour from air emissions.
Flow Meter	Flow metering is coupled to the telemetry unit and records daily flows. The Flow Meter is installed on the outlet of the WWTP. Flow metering is critical in the identification of hydraulic overloading, storm water cross connection, ground water and surface water ingress.
Monitoring Unit	The Monitoring Unit monitors; chamber water levels, pump function, blower function, water meter output, power draw, and other parameters to monitor WWTP function. The Monitoring Unit is set to recognise abnormal operation or fault and immediately

Component	Description
	reports to True Water via wireless telemetry. The Monitoring Unit is programmed to send a status report each day via the telemetry unit.
Telemetry Unit	The WWTP monitoring unit communicates directly to the Telemetry Unit. The monitoring unit monitors WWTS function and reports to the wireless telemetry. The telemetry relays information to the CRM database and automatically notifies technicians and managers via SMS and email for any abnormal operation or fault. Telemetry monitoring ensures data required to assess the ongoing performance of the WWTS is recorded daily. Daily status reports provide the ability to track trends and function. This information is used to provide a complete understanding of infrastructure management, and to inform review and audit. Auditors consider each day of the WWTP operation to inform management decisions and drive continual improvement.

3.2.3 Effluent Dispersal System (EDS)

Disinfected treated effluent is discharged from the treated effluent chamber and transferred to the Effluent Dispersal System. The EDS is located in consideration of suitable setbacks/buffers to sensitive receptors. The location, design, and size of the EDS is carefully considered to ensure the sustainable long-term application of treated effluent.

Similar to the Kubota WWTP, the EDS is a scalable system that allows for the staged delivery or the increased capacity of Wastewater Treatment System as/if required. The design of Effluent Dispersal System components are intended to limit complexity, secure trouble-free operation, and limit operational risk across infrastructure lifecycle.

Table 3.4 - Effluent Dispersal System component descriptions

Component	Description
Effluent Storage Tank	The Effluent Storage Tank receives treated effluent from the Kubota WWTP. The Effluent Storage Tank provides a management point for all treated effluent prior to application. Secondary chlorination can be applied if/as required to maintain suitable FRC.
Effluent Duty/Standby Pump Set	Treated effluent within the effluent storage is transferred via the Effluent Duty/Standby Pump Set to the distribution main. The duty/standby pump configuration will provide redundancy ensuring that in the case of pump failure the second pump is automatically activated, and an alarm is triggered via the monitoring unit. The duty/standby configuration provides service continuity while the faulty pump can be replaced or repaired.
Distribution Main	The Distribution Main is a high-density lilac polyethylene pipe. The Distribution Main is installed at suitable depth and marked as per industry standards. The Distribution Main transfers effluent between the effluent duty/standby pump set and the Effluent Dispersal System.

Component	Description
Engineered Mounds	The effluent dispersal system consists of Engineered Mounds. Engineered Mounds provide a permeable barrier *(700mm of filtration)* between the application point and the environment. Treated effluent is distributed through a large media volume. As it slowly moves through pore spaces the effluent encounters aerobic and anaerobic zones and is subject to a variety of microbial reduction and incorporation processes. The Engineered Mounds employed by True Water are essentially a highly refined Wisconsin Mound. True Water have designed and constructed hundreds of mounds in varying climatic conditions throughout Australia. Mounds constructed prior to 2010 were built based on academic literature and the AS/NZS:1547. Since 2010 True Waters' studies, research and assessment of mound performance have resulted in multiple refinements. Refinements employed within True Waters Engineered Mounds include: bathing of the basal area, keying of the mound toe, widening of the distribution bed, increased peak radius, and distribution flush system. True Water continues to research and develop Engineered Mounds with data collected from operational Engineered Mounds informing continual refinement and improvements in design and construction. Mounds receiving primary effluent have been shown to remove >55% of nitrogen (Blasing & Converse 2004), provide a 2-3 reduction of thermo-tolerant Coliforms and up to 99% phosphorus reduction from primary effluent (Geary et al, 2005). Due to the scarcity of specific performance data True Water completed 12 months of research in 2017/18. Nutrient concentrations entering and leaving two operational Engineered Mounds were measured and the nutrient reduction assessed. Research identified, that when applied with secondary treated effluent, mounds provided a Total Nitrogen reduction of 88% and a Total Phosphorus reduction of 89%.
Vegetative Uptake Belts	A Vegetative Uptake Belt shall be planted around the perimeter of the Engineered Mounds. Vegetative Uptake Belts assist in nutrient and moisture uptake. The Vegetative Uptake Belts will be 2-3metres in width. Species selection will be primarily for moisture and nutrient recycling characteristics, suitable endemic vegetation types including *Melaleuca*, and native grasses such as *Lomandra Hystrix* are recommended.

4 Risk Assessment

This section outlines the risk assessment undertaken by the True Water risk assessment team. The outcomes of the risk assessment have been incorporated into a series of tables (Section 4.3) which identify hazards and hazardous events, unmitigated and residual risk rankings, as well as control measures. Control measures provide improved operational control while limiting risk. The factors and considerations identified by the risk assessment team contribute to the overall design, management, and operational processes of the WWTS.

The risk assessment team, and True Water as a whole, understand the importance of responsible risk management to maintain successful operation, and provide a supportive basis for ongoing risk mitigation within the WWTSs operations and the Company's general operations. These include:

- Use of high-quality components,
- Quality assurance of all components,
- Supervision and quality assurance of all installations and works,
- Automated monitoring and recording,
- Continuous training, research, and development,
- Multi barrier wastewater treatment and risk management processes,
- Multiple physical barriers to prevent human contact and protect public health and safety,
- Treatment performance and effluent quality that exceed regulatory requirements,
- Maintaining the Integrated Environmental Management System (IEMS),
- Scheduled audit.

4.1 Methodology

Effective risk management involves identifying all potential hazards and hazardous events, and assessing the level of risk each hazard presents to public and environmental health.

The methodology employed identifies and documents hazards and hazardous events, and then estimates risk. The identification and assessment of hazards and hazardous events was achieved through targeted research, detailed scenario analysis, and risk questionnaires. Risk is assessed through a qualitative and quantitative consideration of likelihood and consequence.

4.2 Hazard Identification

Hazard identification allows planning and mitigation processes to be implemented. A detailed assessment of all components within the infrastructure is completed. In identifying potential risks, the risk assessment team considered operational hazards under the following infrastructure sections:

- Reticulated Sewer System
- Wastewater Treatment Plant (WWTP)
- Effluent Dispersal System (EDS)

The risk assessment team considered each stage of the wastewater treatment and purification process within each infrastructure section. Potential hazards for each stage were identified, with causes and impacts of the hazards detailed within the risk assessment.

4.3 Risk Assessment

4.3.1 Qualitative Measures of Likelihood

Level	Descriptor	Example description
A	Rare	May occur only in exceptional circumstances. May occur once in 100 years
B	Unlikely	Could occur within 20 years or in unusual circumstances
C	Possible	Might occur or should be expected to occur within a 5 to 10 year period
D	Likely	Will probably occur within a 1 to 5 year period
E	Almost certain	Is expected to occur with a probability of multiple occurrences within a year

4.3.2 Qualitative Measures of Consequence or Impact

Level	Descriptor	Example description
1	Insignificant	Insignificant impact or not detectable
2	Minor	Health - Minor impact to single person Environment - Potentially harmful to ecosystem with impacts contained to immediate area
3	Moderate	Health - Minor impact for multiple people Environment - Potentially harmful to ecosystem with impacts contained to site
4	Major	Health - Major impact for single person Environment - Harmful to local ecosystem with impacts to neighbouring environment
5	Catastrophic	Health - Major impact for multiple people Environment - Harmful to regional ecosystem and threatened species, widespread impacts

4.3.3 Qualitative Risk Estimation

Likelihood	**Consequence**				
	1 Insignificant	**2 Minor**	**3 Moderate**	**4 Major**	**5 Catastrophic**
A- Rare	Low	Low	Low	High	High
B- Unlikely	Low	Low	Moderate	High	Very High
C- Possible	Low	Moderate	High	Very High	Very High
D- Likely	Low	Moderate	High	Very High	Very High
E- Almost certain	Low	Moderate	High	Very High	Very High

Source: *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks.*

4.3.4 Risk Assessment - Reticulated Sewer System

Component	Hazardous Event	Impact	Unmitigated Risk					Control Strategy	Mitigated Risk				
			Likelihood		Consequence		Risk		Likelihood		Consequence		Risk
Grease Arrestor or Pre-treatment Devices	Build up and overflow of grease, oil, and fat Failure to pump out grease, oil, and fat Undersizing grease arrestor or pre-treatment devices Poor installation of grease arrestor or pre-treatment devices Poorly assessed or poorly regulated	Oil, Grease and fat entering the wastewater stream Blockage and overflow to the environment Potential human contact with raw sewage and grease, oil, and fat Impact to wastewater treatment and effluent quality Danger to public and environmental safety	E	Almost Certain	4	Major	Very High	Sized, constructed, and deliniated in accordance with regulations & codes and approved by the LGA Suitable shape to remove grease, oil & fat Monthly testing of grease, oil, & fat levels, scheduled / reactive cleaning as required. WWTS agent checks every 90days. Proper regulatory assessment/enforcement	B	Unlikely	4	Major	Very High
Sewage Drainage System	Inappropriate discharge of, items, objects, substances or trade waste into the sewage pump station Cracks, breaks, failures in piping resulting in stormwater and sediment ingress Faulty installation of drainge components such as ORG's & IO's Excessive potable water use Cross connection of stormwater drainage Poorly assessed or poorly regulated	Blockage and sewage overflow to the environment Potential human contact with raw sewage Blockage of the sewage pump well and or WWTP Impact to wastewater treatment process resulting in reduction of effluent quality Hydraulic overload of the WWTS resulting in reduction of effluent quality Danger to public and environmental safety	E	Almost Certain	4	Major	Very High	Sized, constructed, and deliniated in accordance with regulations & codes and approved by the LGA Flow monitoring at the WWTP to identify hydraulic overload and stormwater ingress Solid separation process in WWTP to prevent blockage by foreign objects Education of end users re water efficiency, and 5-star fixtures and appliances Proper regulatory assessment/enforcement	B	Unlikely	4	Major	Very High
Sewage Pump Station	Inappropriate discharge of, items, objects, substances or trade waste into the sewage pump station Cracks, breaks, failures in piping resulting in stormwater and sediment ingress Faulty or poor quality sizing, design, and installation of pump well and components. Cross connection of stormwater drainage Vehicle damage or root intrusion Power supply interruption or electircal component failure Poorly assessed or poorly regulated	Blockage and overflow to the environment Potential human contact with raw sewage Pump failure Corrosion Danger to public and environmental safety	E	Almost Certain	3	Moderate	High	Sized, constructed, and deliniated in accordance with regulations & codes and approved by the LGA Infrastructure inspection will: • prevent build-up of harmful substances • prevent component failure • detect stormwater discharge Telemetry monitoring will detect component failure Education of end users re water efficiency, and 5-star fixtures and appliances Proper regulatory assessment/enforcement	C	Possible	2	Minor	Moderate
Sewage Rising Main	Faulty installation of components Damage or breakage	Potential human contact with raw or partially treated sewage Danger to public and environmental safety	B	Unlikely	3	Moderate	Moderate	Sized, constructed, and deliniated in accordance with regulations & codes and approved by the LGA Proper regulatory assessment/enforcement	A	Rare	2	Minor	Low

4.3.5 Risk Assessment – Wastewater Treatment Plant

Component	Hazardous event	Impact	Unmitigated Risk						Control Strategy	Mitigated Risk					
			Likelihood		Consequence		Risk			Likelihood		Consequence		Risk	
WWTP Equalisation Tank	Inappropriate discharge of, items, objects, substances or trade waste into the sewage pump station Poor management, cleaning, maintenance Power supply interruption or electircal component failure Damage to tank Replacement of specified pumps or components with sub standard equipment. Poorly regulated	Oil, Grease and fat entering the wastewater stream Failure of EQ Pumps Impact to wastewater treatment and effluent quality Danger to public and environmental safety	B	Unlikely	3	Moderate	Moderate		Sized, constructed in accordance with regulations & manufacturer specifications Strict Quality Assurance Compliance with IEMS Suitable monitoring and inspection processes, including telemetry monitoring Management and maintenance by a management company with high level knowledge understanding of the WWTP Education of end users re water efficiency, and 5-star fixtures and appliances Proper regulatory enforcement	B	Unlikely	2	Minor	Low	
WWTP Solid Liquid Separation Tank	Inappropriate discharge of, items, objects, substances or trade waste into the sewage pump station Poor management, cleaning, maintenance Damage to tank Poorly regulated	Oil, Grease and fat entering the wastewater stream Impact to wastewater treatment and effluent quality Overflow and danger to public and environmental safety	B	Unlikely	3	Moderate	Moderate		Sized, constructed in accordance with regulations & manufacturer specifications Strict Quaility Assurance Compliance with IEMS Suitable monitoring and inspection processes, including telemetry monitoring Management and maintenance by a management company with high level knowledge understanding of the WWTP Proper regulatory enforcement	B	Unlikely	2	Minor	Low	
Wastewater Treatment Plant	Replacement of specified components with sub standard equipment. Inappropriate discharge of, items, objects, substances, trade waste, or influent with high contaminant concentrations Poor management, monitoring, reporting, cleaning, maintenance, servicing Vandalism or damage Odour realease Power supply interruption or electircal component failure Substandard effluent release Poorly regulated	Oil, Grease and fat entering the wastewater stream Failure of treatment process Impact to wastewater treatment and reduction of effluent quality Overflow and danger to public and environmental safety	E	Almost Certain	4	Major	Very High		Sized, constructed in accordance with regulations & manufacturer specifications Strict Quaility Assurance Compliance with IEMS Suitable monitoring and inspection processes, including telemetry monitoring Management and maintenance by a True Water and application of high level knowledge understanding of the WWTP Education of end users re water efficiency, and 5-star fixtures and appliances Locate below ground in fenced compound Proper regulatory enforcement	B	Unlikely	2	Minor	Low	
Disinfection Unit and Treated Effluent Chamber	Replacement of specified components with sub standard equipment. Poor management, monitoring, reporting, cleaning, maintenance, servicing Incorrect setting on chlorination unit Unauthorised Bypass Substandard effluent Poorly regulated	Reduced disinfection of effluent Excess clorination of effluent Danger to public and environmental safety	D	Likely	3	Moderate	High		Sized, constructed in accordance with regulations & manufacturer specifications Maintain suitable residual chlorine level Compliance with IEMS Suitable monitoring and inspection processes Management and maintenance by a True Water and application of high level knowledge understanding of the WWTP Proper regulatory enforcement	B	Unlikely	2	Minor	Low	

Component	Hazardous event	Impact	Unmitigated Risk					Control Strategy	Mitigated Risk				
			Likelihood		Consequence		Risk		Likelihood		Consequence		Risk
Control Box/Room	Replacement of specified components with sub standard equipment. Faulty components or poor quality installation of components Vandalism or damage	Impacts to WWTP and danger to public and environmental safety from redcution in effluent quality	B	Unlikely	2	Minor	Low	Sized, constructed in accordance with manufacturer specifications Strict Quaility Assurance Compliance with IEMS Management and maintenance by a True Water and application of high level knowledge understanding of the WWTP Proper regulatory enforcement	A	Rare	1	Insignifica nt	Low
Odour Control (Carbon filtration unit)	Replacement of specified components with sub standard equipment. Gas tight lids damaged Gas tight lids not properly secured Under sized carbon filtration Vandalism or damage	Release of odour and reduction in ammenity within immeiate proximity of the WWTP	C	Possible	2	Minor	Moderate	Sized, constructed in accordance with regulations & manufacturer specifications Strict Quaility Assurance Compliance with IEMS Suitable monitoring and inspection Proper regulatory enforcement	B	Unlikely	2	Minor	Low
Flow Meter	Blockage Power supply interruption or electircal component failure Unauthorised disconnection or removal Replacement of specified components with sub standard equipment. Damage Poorly regulated	Impacts to WWTP and possible overflow resulting in danger to public and environmental safety. Failure to identify improper WWTP operation Failure to identify hydrualic overload	D	Likely	3	Moderate	High	Sized and installed in accordance with manufacturer specifications Strict Quaility Assurance Compliance with IEMS Suitable monitoring and inspection processes, including telemetry monitoring Management and maintenance by a True Water and application of high level knowledge understanding of the WWTP Locate within fenced compound Proper regulatory enforcement	B	Unlikely	2	Minor	Low
Monitoring Unit	Replacement of specified components with sub standard equipment. Power supply interruption or electircal component failure Unauthorised disconnection or removal Damage Poorly regulated	Failure to identify improper WWTP operation Failure to identify hydrualic overload Failure to identify power outage Potential for overflow or poor quality effluent release Danger to public and environmental safety	D	Likely	4	Major	Very High	Strict Quaility Assurance Compliance with IEMS Suitable monitoring and inspection processes, including telemetry monitoring Management and maintenance by a True Water and application of high level knowledge understanding of the WWTP Locate within control box within fenced compound Proper regulatory enforcement	B	Unlikely	2	Minor	Low
Telemetry Unit	Replacement of specified components with sub standard equipment. Power supply interruption or electircal component failure Unauthorised disconnection or removal Damage Poorly regulated	Failure to identify improper WWTP operation Failure to identify hydrualic overload Failure to identify power outage Potential for overflow or poor quality effluent release Danger to public and environmental safety	D	Likely	4	Major	Very High	Strict Quaility Assurance Compliance with IEMS Suitable monitoring and inspection processes, including telemetry monitoring Management and maintenance by a True Water and application of high level knowledge understanding of the WWTP Locate within control box within fenced compound Proper regulatory enforcement	B	Unlikely	2	Minor	Low

4.3.6 Risk Assessment – Effluent Dispersal System

Component	Hazardous event	Impact	Unmitigated Risk					Control Strategy	Mitigated Risk				
			Likelihood		Consequence		Risk		Likelihood		Consequence		Risk
Effluent Storage Tank	Poor management, monitoring, reporting, cleaning, maintenance, servicing Unauthorised Bypass Damage Substandard effluent Poorly regulated	Impacts to WWTP and possible overflow of effluent resulting in danger to public and environmental safety Algal bloom and deterioration of effluent quality Uncontrolled release of effluent and danger to public and environmental safety Potential human contact with treated effluent	C	Possible	2	Minor	Moderate	Sized and installed in accordance with manufacturer specifications Maintain suitable residual chlorine level Strict Quaility Assurance Compliance with IEMS Suitable monitoring and inspection processes, including telemetry monitoring Management and maintenance by a True Water and application of high level knowledge understanding of the WWTP Locate within fenced compound Proper regulatory enforcement	B	Unlikely	2	Minor	Low
Effluent Duty/Standby Pump Set	Replacement of specified components with sub standard equipment. Poor management, monitoring, reporting, cleaning, maintenance, servicing Unauthorised Bypass Damage Substandard effluent Poorly regulated	Impacts to WWTP and possible overflow of effluent resulting in danger to public and environmental safety Uncontrolled release of effluent and danger to public and environmental safety Potential human contact with treated effluent	C	Possible	2	Minor	Moderate	Sized and installed in accordance with manufacturer specifications Strict Quaility Assurance Compliance with IEMS Suitable monitoring and inspection processes, including telemetry monitoring Management and maintenance by a management company with high level knowledge understanding of the WWTP Locate within fenced compound Proper regulatory enforcement	B	Unlikely	2	Minor	Low
Distribution Main	Faulty installation of components Damage or breakage Poorly regulated	Uncontrolled release of effluent and danger to public and environmental safety Potential human contact with treated effluent	B	Unlikely	3	Moderate	Moderate	Sized, constructed, and deliniated in accordance with regulations & codes Strict Quaility Assurance Compliance with IEMS Suitable monitoring and inspection processes, Proper regulatory enforcement	A	Rare	2	Minor	Low
Engineered Mounds	Faulty installation of components Damage or vandalism Unauthorised bypass Overloading Removal of vegetaion or turf covering	Point loading of effluent release Reduced effluent pollishing Seepage Reduced evaporation Reduced nutrient reduction	B	Unlikely	3	Moderate	Moderate	Suitable application rate and >95% dosing uniformity Strict Quaility Assurance Constructed specifically to meet design specification Compliance with IEMS	A	Rare	2	Minor	Low

Component	**Hazardous event**	**Impact**	**Unmitigated Risk**					**Control Strategy**	**Mitigated Risk**				
			Likelihood		**Consequence**		**Risk**		**Likelihood**		**Consequence**		**Risk**
								Suitable monitoring and inspection processes, including telemetry monitoring Management and maintenance by a management company with high level knowledge understanding of the WWTP Proper regulatory enforcement					
Vegetative Uptake Belts	Damage or vandalism Improper management Removal of vegetaion	Reduced evaporation Reduced nutrient uptake	C	Possible	1	Insignificant	Low	Compliance with IEMS Suitable monitoring and inspection processes Management and maintenance by a management company with high level knowledge understanding of the WWTP Proper regulatory enforcement	A	Rare	1	Insignificant	Low

4.4 Uncertainty Levels and Significant Risks

A significant risk is a risk with a high probability of occurrence which will result in major or catastrophic consequences. Based on this risk assessment, and the implementation of suitable controls, residual significant risks are associated with the Reticulated Sewer System.

Some level of uncertainty is inherent in the estimation of risk. The degree of uncertainty depends on the variability of the hazard itself. The following table lists significant hazards identified and outlines the uncertainty associated with these hazards.

Table 4.1 - Uncertainty levels and Significant Risks

Hazard	Description
Inappropriate discharge of, items, objects, substances, trade waste, or influent with high contaminant concentrations	The discharge of inappropriate items or substances (chemicals, grease, oil, or fat) has the potential to impact treatment processes, reducing treatment quality. Monitoring and inspection will reduce the likelihood of adverse impacts, however residual risk is present. True Water notify stakeholders when inappropriate items or substances are identified, however it is the responsbility of the owner and regulator to address this hazard.
Cracks, breaks, failures in piping or faulty installation of drainge components resulting in stormwater and sediment ingress or cross connection	Stormwater ingress has the potential to impact treatment processes, reducing treatment quality. Telemetry flow monitoring enables identification of flows associated with rainfall events, reducing the potential or adverse impacts, however residual risk is present. True Water notify stakeholders if stormwater ingress is identified, however it is the responsbility of the owner and regulator to address this hazard.
Excess potable water use or increases in site tenancy resulting in hydraulic overload	Excess potable water use or increased site tenancy may result in hydraulic overload with the potential to impact treatment processes, reducing treatment quality. Telemetry monitoring will immediately identify hydraulic overload and reduce the likelihood of adverse impacts however residual risk is present. True Water notify stakeholders when hydraulic overload is identified, however it is the responsbility of the owner and regulator to address this hazard.
Power outage	Telemetry monitoring immediately identifies power outage enabling immediate control and response measures to prevent adverse impacts, however residual risk is present. It is the responsibility of the owner and regulator to prevent unauthorized disconnection of the telemetry monitoring unit.
Mismanagement	Mismanagement is usually a result of engaging unqualified personnel, or organisations without suitable expertise, and presents a high residual risk. It is the responsibility of the owner and regulator to prevent mismanagement.
Poor regulatory framework and enforcement	A poor regulatory framework and/or lack of enforcement enables mismanagement and negligence, presenting a high residual risk. Failure to enforce minimum operational standards is frequently linked to infrastructure failure.

5 Site Controls and Preventative Measures

Site controls and preventative measures shall be implemented across the WWTS lifecycle. Site controls and preventative measures are applied to; prevent impacts to stakeholders, prevent impacts to public health, and prevent impacts to the environment.

In establishing site controls and preventative measures to mitigate risks, the key principles to be applied include; risk elimination, risk minimisation, containment, and management controls.

Site controls and preventative measures shall consider the following six factors:

- Factor 1: Water
- Factor 2: Soil
- Factor 3: Air
- Factor 4: Noise emissions
- Factor 5: Waste
- Factor 6: Hazardous Materials

5.1 Site Controls and Preventative Measures - Construction of WWTS

General

To minimise impacts to the site, to reduce risk, to improve quality, and improve safety, the majority of the WWTS construction is completed within a factory/workshop environment. The delivery of the WWTS is completed in two stages:

- Offsite Manufacture *(Factory/Workshop)* – approximately 90% of total man hours,
- Onsite Installation/Delivery – approximately 10% of total man hours.

Offsite Manufacture

- The WWTS will be manufactured offsite within a factory/workshop environment.
- Offsite manufacture removes all environmental risks associated with onsite construction and manufacturing.
- Offsite manufacture prevents any potential impacts to water, soil and air, and prevents noise emissions. It prevents waste being generated at the site, and prevents the use of hazardous materials at the site.
- All offsite manufacturing processes will comply with True Waters established and accredited, quality, environment, and safety processes.
  - ISO9001 - Quality Certification
  - ISO14001 - Environmental Certification
  - ISO45001 - Safety Certification

Onsite Installation / Delivery

- The onsite installation and delivery of the WWTS shall be limited to the delivery and configuration of the manufactured WWTP components and the Effluent Dispersal System.
- The IEMS will provide a structured approach to all activities and tasks during WWTS construction. IEMS documents relative to the construction of the WWTS include:
  - Environmental Management Policy

o Work Health and Safety Policy o Safety Management System o Audit Policy o Effluent Management Plan o Risk Management Plan o Health and Environmental Management Plan o WWTP Installation Guideline o Works Execution Plan - Construction o Environmental Management Plan - Construction o Work Health and Safety Management Plan - Construction o Subcontractor Management Plan • Compliance with the IEMS will ensure WWTS delivery is in accordance with; o Work health and safety requirements, o Environmental regulations, o Stakeholder objectives, o Best practice principles, o Contractual obligations.
Factor 1: Water Site controls and preventative measures to prevent contamination or polution of waters *(surface water, waterways, water bodies, ground water).* • Offsite Manufacture o Offsite manufacture of the WWTS will not release contaminants or pollutants to waters. *(elimination)* • Onsite Installation / Delivery o Onsite Installation / Delivery of the WWTS will not release of water or wastewater to the environment and will not release contaminants or pollutants to waters. *(elimination)* o Suitable surface water and stormwater diversion and management is maintained throughout the site to prevent surface water and stormwater being impacted. *(elimination)* o A Sediment Control Plan will be implemented as part of the Works Execution Plan – Construction to prevent sediment entering water ways. *(elimination)*
Factor 2: Soil Site controls and preventative measures to prevent contamination or polution of soil. • Offsite Manufacture o Offsite manufacture of the WWTS will not release contaminants or pollutants to soil. *(elimination)* • Onsite Installation / Delivery o Onsite Installation / Delivery of the WWTS will generate contaminants or pollutants and will not release contaminants or pollutants to soil. *(elimination)* o Suitable surface water and stormwater diversion and management is maintained throughout the site to prevent erosion. *(elimination)* o A Sediment Control Plan will be implemented as part of the Works Execution Plan – Construction to prevent erosion. *(elimination)*

Factor 3: Air

Site controls and preventative measures to prevent contamination or polution of air.

Odour

- Offsite Manufacture
  - Offsite manufacture of the WWTS will not generate odour. *(elimination)*
- Onsite Installation / Delivery
  - Onsite Installation / Delivery of the WWTS will not generate odour. *(elimination)*

Airbourne Pollution

- Offsite Manufacture
  - Offsite manufacture of the WWTS will not generate airborne pollution. *(elimination)*
- Onsite Installation / Delivery
  - Use of machinery will release engine emissions into the atmosphere. Limitation measures include:
    - Minimising the duration of machinery operation and maximising work efficiency, *(minimisation)*
    - Limiting vehicle movements, *(minimisation)*
    - Machinery to be maintained in proper working order and fitted with suitable emissions reduction systems. *(minimisation)*

Airbourne Particles and Dust

- Offsite Manufacture
  - Offsite manufacture of the WWTS will not generate airborne particles or dust. *(elimination)*
- Onsite Installation / Delivery
  - Use of heavy vehicles and machinery has potential to cause dust and airborne particles. Mitigation measures include:
    - Maximum vehicle speed limit of 10km/hr, *(minimisation)*
    - Limiting vehicle movements, *(minimisation)*
    - Working during suitable weather conditions, *(elimination)*
    - Restrict vehicle movements to sealed roads or constructed access tracks wherever possible, *(minimisation)*
    - Machinery maintained in proper working order, *(minimisation)*
    - Adherence to prescribed tasks, *(minimisation)*
    - Dust suppression (watering down). *(minimisation)*

Factor 4: Noise Emissions

Site controls and preventative measures to limit noise emissions.

- Offsite Manufacture
  - Offsite manufacture of the WWTS will not generate any noise. *(elimination)*
- Onsite Installation / Delivery
  - Construction requires heavy vehicles and machinery, and involves tasks such as mechanical excavation and backfilling, craning, and movement of machinery on the site. Mitigation measures include:
    - Fit for purpose machinery, *(minimisation)*
    - Adherence to prescribed working hours, *(minimisation)*
    - Machinery maintained in proper working order, *(minimisation)*
    - Correct machinery operation and adherence to speed limits, *(minimisation)*

Factor 5: Waste

Site controls and preventative measures to prevent waste and associated pollution.

- Offsite Manufacture
  - Offsite manufacture of the WWTS will prevent onsite waste generation. *(elimination)*
- Onsite Installation / Delivery
  - Waste generation will be minimised, *(minimisation)*
  - Reuse of materials where possible, *(recycle)*
  - All waste will be stored within a single waste disposal point during construction, *(containment)*
  - Waste will be disposed of appropriately using approved waste disposal facilities. *(disposal)*

Factor 6: Hazardous Materials

Site controls and preventative measures to prevent contamination or pollution due to hazardous materials.

- Offsite Manufacture
  - Offsite manufacture of the WWTS will limit the onsite use of hazardous materials *(minimisation)*
- Onsite Installation / Delivery
  - Chemical or hazardous substances required for the onsite delivery and installation of the manufactured WWTS components shall be strictly limited to pipe adhesive and fuel for machinery. *(minimisation)*
  - The joining of piping between WWTS components shall require the use of pipe adhesive. Pipe adhesive shall:
    - Be stored as per safety data sheets, *(management)*
    - Be limited to a maximum 500mL container volume, *(minimisation)*
    - Be used in compliance with safety data sheets. *(management)*
  - Excavation requires the use of machinery. Machinery will be filled with fuel before entering site, due to the small scale of the works, refuelling of machinery is minimised. Refuelling will:
    - Be completed as per the Works Execution Plan – Construction, *(management)*
    - Be undertaken by suitably trained personnel, *(management)*
    - Occur within a designated location, *(management)*
    - Have suitable measures implemented to prevent spill. *(containment)*
    - Spill kits shall be readily accessible for use if required. *(management)*

5.2 Site Controls and Preventative Measures - Operation of WWTS

General

- The WWTS consist of a Kubota Wastewater Treatment Plant and the Effluent Dispersal System. The Kubota Wastewater Treatment Plant and the Effluent Dispersal System have been specifically chosen to prevent impacts to stakeholders, prevent impacts to public health, and prevent impacts to the environment.
- True Waters Integrated Environmental Management System (IEMS) directs and informs all activities throughout infrastructures lifecycle. The IEMS is a conclusive quality management process specifically designed to deliver stakeholder objectives, secure compliance, and protect public health and the environment.
- IEMS documents relative to the operation of the WWTS include:
    - Environmental Management Policy
    - Quality Management Policy
    - Quality Management System
    - Work Health and Safety Policy
    - Trade Waste Policy
    - Compliance Policy
    - Audit Policy
    - Effluent Management Plan
    - Risk Management Plan
    - Health and Environmental Management Plan
    - Subcontractor Management Plan
    - Commissioning Management Plan
    - Sustainable Management Guideline
    - Maintenance and Management Guideline
    - Sampling and Testing Guideline
    - WWTS Operation and Maintenance Manuals
- Compliance with the IEMS will ensure WWTS operation is in accordance with;
    - Work health and safety requirements,
    - Environmental regulations and regulatory approvals,
    - Stakeholder objectives,
    - Best practice principles,
    - Contractual obligations.

Factor 1: Water

The operation of the WWTS will include site controls and preventative measures to prevent contamination or pollution of waters *(surface water, waterways, water bodies, ground water).*

- The WWTS will not release treated effluent to surface water, waterways, water bodies, or ground water. *(elimination)*
- Treated effluent dispersal will be direct to soil and at suitable dispersal rates. *(minimisation)*
- Run-off, pooling, and seepage of treated effluent will be prevented. *(elimination)*
- Treated effluent contaminant concentrations will comply with regulatory approvals. *(elimination)*
- Suitable surface water and stormwater management will be maintained throughout the site, including:

  - Roof water from buildings will be diverted away from the WWTS, *(minimisation)*
  - Hosing or cleaning of plant and equipment will not enter the WWTS, *(elimination)*
  - Surface water will be directed away from the WWTS. *(minimisation)*
- A groundwater monitoring program shall be established to monitor groundwater beneath the Effluent Dispersal Area. Monitoring of levels of potential contaminants shall include; Total Nitrogen, Total Phosphorus, and E.Coli.

Factor 2: Soil

The operation of the WWTS will include site controls and preventative measures to prevent contamination or pollution of soil.

- Treated effluent dispersal will be at suitable dispersal rates. *(minimisation & management)*
- Run-off, pooling, and seepage of treated effluent will be prevented. *(elimination)*
- Treated effluent contaminant concentrations will comply with regulatory approvals. *(elimination)*
- Suitable surface water and stormwater diversion and management will be maintained throughout the site to prevent erosion within the effluent despersal area. *(elimination)*

Factor 3: Air

The operation of the WWTS will include site controls and preventative measures to prevent contamination or pollution of air.

Odour

Wastewater treatment releases gases to the atmosphere, the release of these gases has the potential to create odour.
Odours must not cause nuisance to any sensitive receptor. Measures to minimise odour release include:

- The Kubota WWTP is sealed with gas tight lids to prevent uncontrolled relase of gases. *(elimination)*
- The Kubota WWTP will release air emissions through high level vents and/or odour filtration systems. (*management)*
- High quality treated effluent removes contaminants and reduces odour. *(minimisation)*
- Treated effluent will be released subsoil (>300mm underground). Subsoil release prevents odour release. *(elimination)*
- To reduce the release of gases associated with sludge, the Kubota WWTP shall be desludged annually. *(minimisation)*
- Annual desludging is to be supervised by a trained technician, desludging will occur over 4hours. Occupants of all dwellings within 50metres of the WWTP shall be notified of desludging 7days prior. *(minimisation & management)*

WWTS operation should be odour free. However, if an odour complaint is received, an investigation will be undertaken to identify the source and correct the cause. (*management)*

Airbourne Pollution/Emissions

Wastewater treatment releases gases to the atmosphere, including carbon dioxide and methane. Annual desludging of the Kubota WWTP will aid in reducing the emission of gases. *(minimisation & management)*

Airbourne Particles and Dust

Operation of the WWTS will not generate airborne particles or dust. *(elimination)*

Factor 4: Noise Emissions

Site controls and preventative measures to prevent noise polution.

- All mechanical items will be housed below ground or within weatherproof boxes. *(minimisation)*
- Weatherproof boxes shall be insulated to minimise noise transmission. *(minimisation)*
  - The sound pressure source level from pumps and any other mechanical equipment is 30 dB (A) within one meter of the equipment housing, *(minimisation)*
  - The WWTP will be located considering distance attenuation, noise emissions from the Kubota WWTP will not impact sensitive receptors. *(minimisation & management)*
- Sound levels at residential receiver locations from the WWTP will be below background levels and therefore inaudible at residential dwelling locations. *(minimisation)*
- Noise monitoring must be undertaken when requested by the administering authority or if required to investigate a complaint. If a noise complaint is received the cause will be identified and rectified. *(management)*

Factor 5: Waste

The operation of the WWTS will include site controls and preventative measures to reduce waste and prevent potential impacts from waste.

General Waste

- Waste generated through WWTS activities shall be minimised. *(minimisation)*
- All waste will be stored within a single waste disposal point during construction. *(containment)*
- Waste will be disposed of appropriately using approved waste disposal facilities. *(disposal)*

Sludge

- Sludge is to be removed from site on an annual basis by a registered waste contractor. Sludge will be disposed of at a registered waste disposal centre. The registered waste contractor and the registered waste disposal centre may change from time to time. Record offsite movement of regulated waste as follows:
  - The date, quantity and type of waste removed, *(management)*
  - The name of the waste transporter and/or disposal operator that removed the waste, *(management)*
  - The intended treatment/disposal destination of the waste. *(management)*
- The treatment and storage of sludge is undertaken in a manner to prevent:
  - The release to waters, *(elimination)*
  - The release of odour producing compounds, *(minimisation)*
  - The release of dust. *(elimination)*

Factor 6: Hazardous Materials

The operation of the WWTS will include site controls and preventative measures to prevent contamination or pollution due to hazardous materials.

- The design of the WWTS does not require the use of chemicals for treatment other than chlorine for disinfection.
  - Chlorine will not be stored onsite, *(elimination)*
  - Mechanised dosing equipment that may malfunction or leak shall not be employed, *(minimisation)*
  - The chlorine disinfection system will be sealed wholly with the WWTP and only tablet form chlorine shall be utilised, *(minimisation)*

- Chlorination tablets (3-5kg) are refilled within the system quarterly, *(minimisation)*
- Proper handling of chlorine tablets will be employed to prevent impact to the immediate environment, *(minimisation)*
- All waste generated in the handling and transport of chlorine shall be disposed of using established waste disposal services. *(disposal)*

6 Document Management and Reporting

True Water employs a Total Asset Management system for the management and maintenance of wastewater infrastructure throughout its lifecycle. This system includes document management and reporting capabilities which ensure document integrity is maintained, and reporting is consistent and accurate. Continuous documentation and recording of activities undertaken occurs throughout True Water's operations. All documentation is processed and stored in electronic form.

A process checklist exists for each core reoccurring activity (i.e. WWTP maintenance or EDS inspection) which will be completed using an electronic device. Each checklist is stored immediately upon completion and is attached to any relevant assets within the Asset Register. This allows personnel to retrieve documents specific to certain assets quickly and efficiently.

To maintain the validity of documentation, a continuous audit process is in place to assess existing documentation.

The Annual Audit completed by the Environmental Management Team includes review of management and maintenance documentation. The IEMS and associated management plans are reviewed and updated as required upon completion of the Annual Audit.

6.1 Document Review

This Risk Managemenet Plan will be periodically reviewed by the Environmental Management Team to ensure the Plan remains relevant in regards to:

- The operation of the WWTS,
- The water quality criteria for effluent relevant to the site, and public health & environmental factors,
- Best practice industry standards for the dispersal of effluent,
- Current regulation or legislation.

If the review indicates the Plan should be updated, the Environmental Management Team will amend the Plan to reflect the findings of the review.

A routine review of the standardised forms and process checklists is conducted to ensure that all operations, activities and records meet specified criteria.

If the review indicates that a form or process checklist should be changed, the document will be amended to reflect the findings of the review.

6.2 Internal reporting

Internal reports are produced to ensure internal decision making is accurately informed. Reports produced internally are utilised at various levels of the organisation.

6.3 External Reporting

External reporting to regulatory bodies, customers, and other stakeholders ensures wastewater treatment and management is open and transparent. Reports will be produced annually, or in accordance with regulatory approval requirements.

Appendix C

True Water ISO Cert 9001, 14001 and 45001

True Water ISO Cert 9001

CERTIFICATE OF REGISTRATION

True Water Australia

6b Ironbark Drive, Townsend, NSW 2463, Australia

Has been assessed and certified by Compass Assurance Services to the following management systems, standards and guidelines:

ISO 9001:2015

QUALITY MANAGEMENT SYSTEMS

The scope of the certification covers the following activities:

Provision of wastewater and sewage treatment technologies to Australia and the Pacific. Services include consultancy, delivery, project management, engineering, asset management (servicing and maintenance) and operation (remote monitoring and response).

Managing Director

CERTIFICATION DATE:	DATE OF ISSUE:	EXPIRY DATE:	CERTIFICATE #:
4 August 2022	31 August 2022	4 August 2025	4000-2765-02

True Water ISO Cert 45001

CERTIFICATE OF REGISTRATION

True Water Australia

6b Ironbark Drive, Townsend, NSW 2463, Australia

Has been assessed and certified by Compass Assurance Services to the following management systems, standards and guidelines:

ISO 45001:2018

OCCUPATIONAL HEALTH AND SAFETY MANAGEMENT SYSTEMS

The scope of the certification covers the following activities:

Provision of wastewater and sewage treatment technologies to Australia and the Pacific. Services include consultancy, delivery, project management, engineering, asset management (servicing and maintenance) and operation (remote monitoring and response).

Managing Director

CERTIFICATION DATE:	DATE OF ISSUE:	EXPIRY DATE:	CERTIFICATE #:
4 August 2022	31 August 2022	4 August 2025	4075-2765-01

True Water ISO Cert 14001

CERTIFICATE OF REGISTRATION

True Water Australia

6b Ironbark Drive, Townsend, NSW 2463, Australia

Has been assessed and certified by Compass Assurance Services to the following management systems, standards and guidelines:

ISO 14001:2015

ENVIRONMENTAL MANAGEMENT SYSTEMS

The scope of the certification covers the following activities:

Provision of wastewater and sewage treatment technologies to Australia and the Pacific. Services include consultancy, delivery, project management, engineering, asset management (servicing and maintenance) and operation (remote monitoring and response).

Managing Director

JAS-ANZ

CERTIFICATION DATE:	DATE OF ISSUE:	EXPIRY DATE:	CERTIFICATE #:
4 August 2022	31 August 2022	4 August 2025	4074-2765-01

COMPASS
-ASSURANCE SERVICES-

Compass Assurance Services Pty Ltd
Level 1, 135 Queen Street, Cleveland, 4163 QLD
1300 495 855 | www.cas.com.au

Appendix D

Kubota ISO Cert 9001 and 14001

Kubota ISO Cert 9001

Union of Japanese
Scientists and Engineers (JUSE)
ISO Registration Center

JAB
CM008

CERTIFICATE OF REGISTRATION

Reg.No.: JUSE-RA- 786

Registered Client: Kubota Corporation

Standard against which the audit places:
JIS Q 9001:2015(ISO 9001:2015)

Date of the first Registration:
April 21, 2003

Period of Validity: April 21, 2018 to April 20, 2021

We hereby certify the Quality Management Systems of the above firm as indicated on the attached document"Description of Certificate" based on the above standard.

This certificate is the result of the strict assessment carried out by the JUSE Registration System for Assessment.

Date of Issue: April 21, 2003
Date of Renewal: April 21, 2018
Date of Revision: February 18, 2019

Shinichi Sasaki
President

Masato Onodera
Director
ISO Registration Center

Union of Japanese Scientists and Engineers (JUSE)

2-7-1, Nishishinjuku, Shinjuku-Ku, Tokyo, 163-0704, JAPAN

These Documents Consist of "Certificate of Registration" and "Description of Certificate".

Union of Japanese
Scientists and Engineers (JUSE)
ISO Registration Center

DESCRIPTION OF CERTIFICATE

Name of Certification:
Quality Management Systems

Reg.No.: JUSE-RA- 786

Registered Client: Kubota Corporation, Environmental Solutions Division, Environmental Systems Business Unit

Chief Executive: Shinichi Fukuhara, General Manager of Environmental Systems Business Unit

Address: Kyobashi Trust Tower, 1-3, Kyobashi 2-chome, Chuo-ku, Tokyo, 104-8307 Japan
(Kubota Corporation, Tokyo Head Office; Kubota Membrane Co., Ltd., Tokyo Office, Engineering Dept.)
Refer to "Description of Certificate (in Detail) "

Standard against which the audit places:
JIS Q 9001:2015(ISO 9001:2015)

Scope of Registration held:
Design & Development and Production of the Small-sized Plastic Septic Tank and Bathtub, and Design & Development, Production Trust Management of the Medium/Large-sized Plastic Septic Tank; Reserch & Development, Design, Production and After-sales Service of Membrane Unit, Membrane Cartridge and All Its Related Spare Parts

Date of Issue: April 21, 2003
Date of Renewal: April 21, 2018
Date of Revision: February 18, 2019

Masato Onodera

Masato Onodera
Director
ISO Registration Center

Union of Japanese Scientists and Engineers (JUSE)

Kubota ISO Cert 14001

Union of Japanese
Scientists and Engineers (JUSE)
ISO Registration Center

CERTIFICATE OF REGISTRATION

JAB
CM008

Reg.No.: JUSE-EG- 031

Registered Client: Kubota Co., Ltd., KMEW Co., Ltd.

Standard against which the audit places:

JIS Q 14001:2015(ISO 14001:2015)

Date of the first Registration:

May 18, 2000

Period of Validity: May 18, 2018 to May 17, 2021

We hereby certify the Environmental Management Systems of the above firm as indicated on the attached document"Description of Certificate " based on the above standard.

This certificate is the result of the strict assessment carried out by the JUSE Registration System for Assessment.

Date of Issue: May 18, 2000
Date of Renewal: May 18, 2018

Shinichi Sasaki
Shinichi Sasaki
President

Masato Onodera
Masato Onodera
Director
ISO Registration Center

Union of Japanese Scientists and Engineers (JUSE)

2-7-1, Nishishinjuku, Shinjuku-Ku, Tokyo, 163-0704, JAPAN

These Documents Consist of "Certificate of Registration" and "Description of Certificate".

Union of Japanese
Scientists and Engineers (JUSE)
ISO Registration Center

DESCRIPTION OF CERTIFICATE

JAB
CM008

Name of Certification:
Environmental Management Systems

Reg.No.: JUSE-EG- 031

Registered Client: Kubota Co., Ltd., KMEW Co., Ltd.,
Shiga Plant

Chief Executive: Takashi Uchikawa, Plant Manager

Address: 2-1, Takamatsu-cho, Konan-shi, Shiga
520-3211, Japan.

Standard against which the audit places:
JIS Q 14001:2015(ISO 14001:2015)

Scope of Registration held:
Production and delivery of roof materials, and research and development, production and delivery of FRP products.

Date of Issue: May 18, 2000
Date of Renewal: May 18, 2018

Masato Onodera
Masato Onodera
Director
ISO Registration Center

Union of Japanese Scientists and Engineers (JUSE)

Appendix E

Kubota Wastewater Treatment Equipment - KTZ

For Earth, For Life
Kubota

Kubota FRP Johkasou, Wastewater Treatment Plant 【Large-Size Johkasou】

Solid-liquid separation anaerobic filter moving bed biofilm reactor (MBBR) process

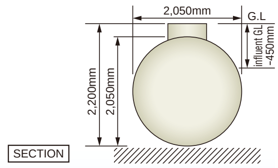
KTZ

Flow rate (m^3/day) **10.0 ~**

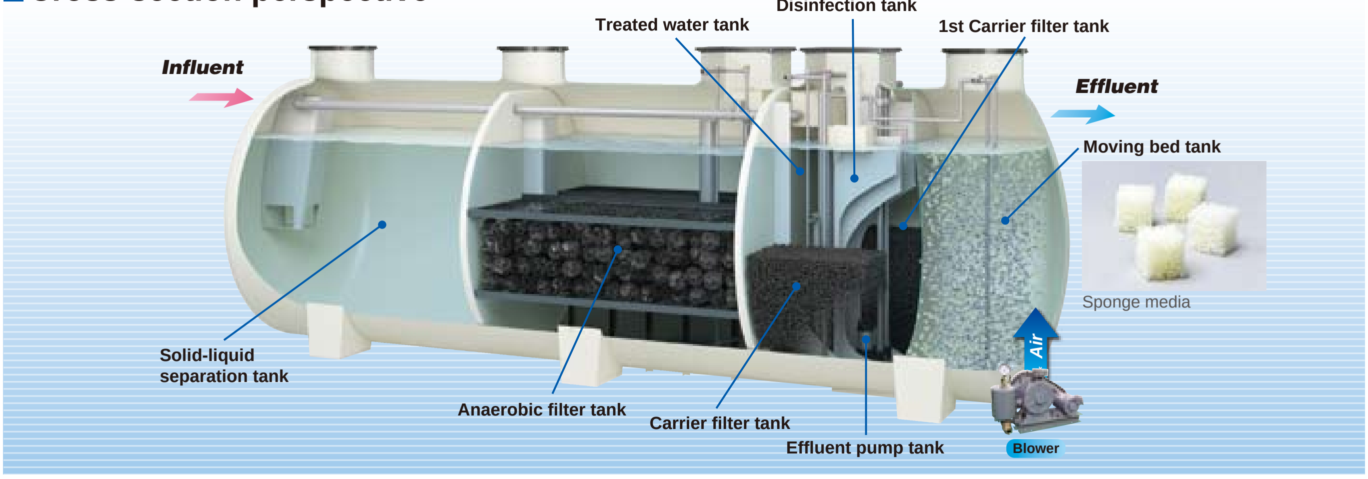
N removal

- BOD and Nitrogen removal, more compact than the old model.
- Sponge media is applied in Moving bed tank.

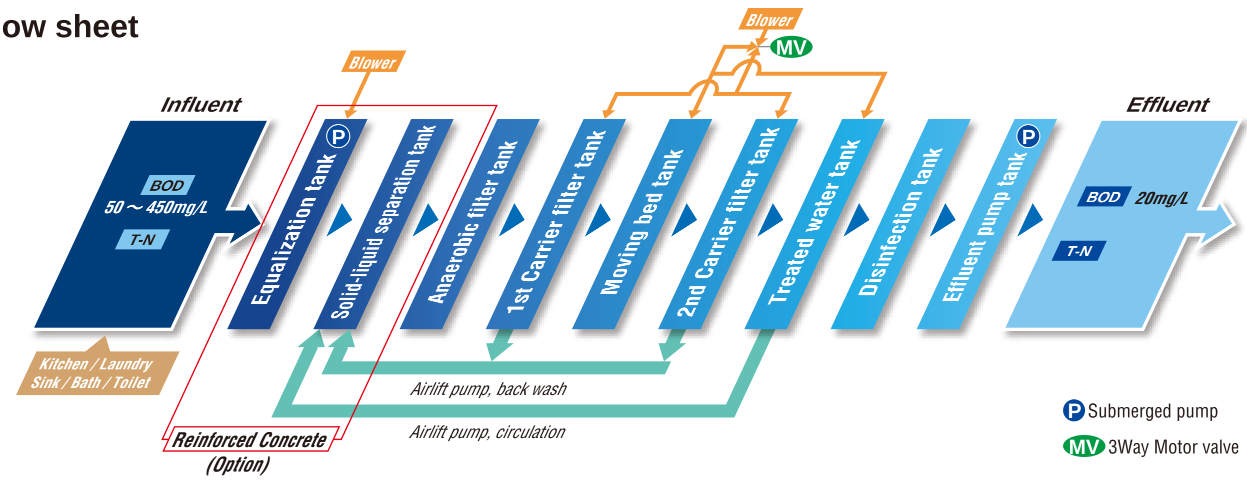
■ϕ2,050



■Cross-section perspective



■Flow sheet



■Specifications (BOD 200mg/L→20mg/L, T-N 80mg/L→20mg/L, influent 12 hrs/day)

Flow rate	m^3/day	10	20	40	80	100	120
Equalization tank (RC)	m^3	—*	10.00	20.00	40.00	50.00	60.00
Solid Liquid Separation Tank (RC)	m^3	—*	6.67	13.33	26.67	33.33	40.00
FRP Tank size (ϕ2,050 x 2,200H)	L (mm)	9,700	9,700	9,700+9,700	9,700+9,700 +9,700+9,700	9,700+9,700+9,700 +9,700+9,700	9,700+9,700+9,700 +9,700+9,700+9,700
Rated power (415V)	kW	1.95	2.70	3.40	7.05	8.95	9.70

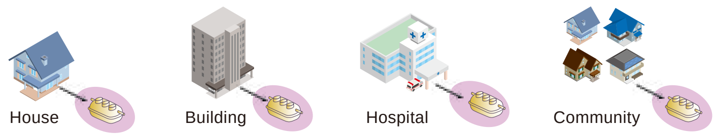
■Specifications (BOD 200mg/L→20mg/L, T-N 45mg/L→20mg/L, influent 12 hrs/day)

Flow rate	m^3/day	10	20	40	80	100	120
Equalization tank (RC)	m^3	—*	10.00	20.00	40.00	50.00	60.00
Solid Liquid Separation Tank (RC)	m^3	—*	6.67	13.33	26.67	33.33	40.00
FRP Tank size (ϕ2,050 x 2,200H)	L (mm)	7,750	5,750	9,550	9,550+9,550	8,250+8,250+8,250	9,550+9,550+9,550
Rated power (415V)	kW	1.60	1.95	3.40	5.25	6.05	6.70

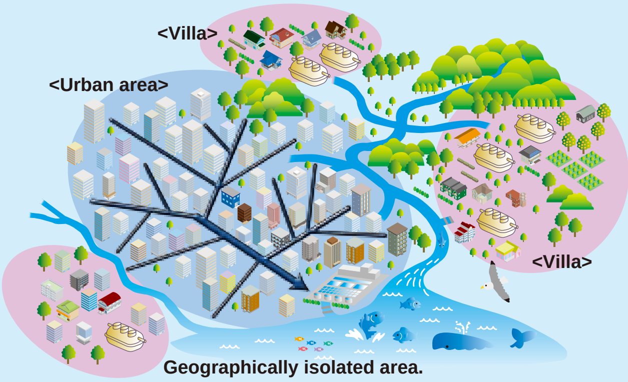
(*)For Flow rate 10m^3/day, both Equalization Tank and Solid Liquid Separation Tank fit in FRP tank.

Application for Johkasou

On-site treatment



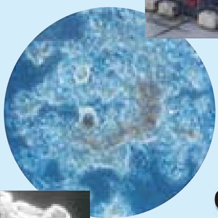
Off-site treatment

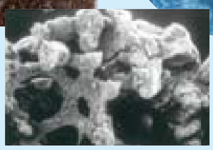


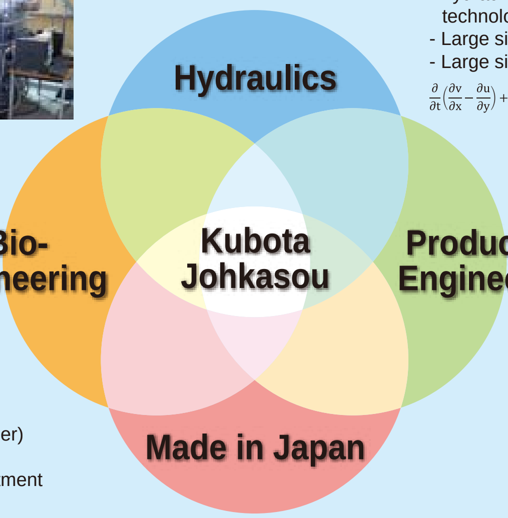
Geographically isolated area.
Pipe laying is not possible by urbanization.

- Off-site treatment and On-site treatment can be complement with each other.
  - Off-site treatment: As Efficient system for city
  - On-site treatment: As quick installation/availability
- Planner can choose the optimal one with considering each advantages and features of area/site.

Feature of Kubota Johkasou







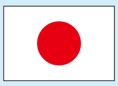
Kubota
- Small & Large size Pipe hydraulics and its network technology
- Large size pump hydraulics
- Large size valve hydraulics

$$\frac{\partial}{\partial t}\left(\frac{\partial v}{\partial x}-\frac{\partial u}{\partial y}\right)+u\frac{\partial}{\partial x}\left(\frac{\partial v}{\partial x}-\frac{\partial u}{\partial y}\right)+v\frac{\partial}{\partial y}\left(\frac{\partial v}{\partial x}-\frac{\partial u}{\partial y}\right)=\frac{\mu}{\rho}\left[\frac{\partial^2}{\partial x^2}\left(\frac{\partial v}{\partial x}-\frac{\partial u}{\partial y}\right)+\frac{\partial^2}{\partial y^2}\left(\frac{\partial v}{\partial x}-\frac{\partial u}{\partial y}\right)\right]$$

Kubota
- Large scale STP
- MBR process (pioneer)
- Advanced treatment
- Human excreta treatment

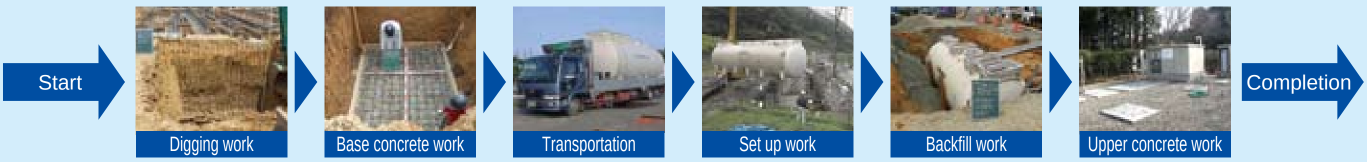
Kubota
- Tractor,
- Combine harvester
- Backhoe
- Engine
- Pipes
- Pumps
- Valves
- Membrane

etc.



Kubota
- Shiga Plant
- FRP Subcontract factory fully instructed by Shiga Plant

Installation work



Johkasou Business Unit, KUBOTA Corporation

KUBOTA JOHKASOU SYSTEM CO LTD

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Tokyo Head office:
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Phone: +84-24-3974 9192 Fax: +84-24-3974 9189

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Appendix F

Review of Nutrient Reduction by Mound Systems

A Review of Nutrient Reduction by Wisconsin Mound Systems.

D.A. Foley BAppSc (Hons 1), PhD

October 2015

Wisconsin mounds (mounds) are a type of effluent dispersal system that that also provides secondary, tertiary, or ancillary treatment of applied primary, secondary or tertiary treated effluent. Mounds incorporate a media filter (sand) raised above the subsurface soil environment that optimizes aerobic, anaerobic, and capillary flow processes, increases solar and wind exposure, and limits rainfall ingress to provide optimum homogonous conditions for microbial treatment processes.

The purpose of this review is to provide a peer reviewed basis for a claimed minimum 50% reduction of total nitrogen and total phosphorus from advanced secondary treated water applied to a Wisconsin type mound, before dispersal to the subsoil environment. With optimum microbial filter treatment conditions, at least a modest nutrient reduction by sand mounds could be expected.

Reductions of up to 90% of nitrogen and phosphorus from effluent entering mound systems are supported by overseas studies concerning the development and design of mounds (Seigrist et al. 2000, Converse 1999, Blasing and Converse 2003). However, a review of Australian studies concerning nutrient reduction by Wisconsin mounds, secondary or advanced treatment systems and soil application systems are often inconsistent or inconclusive.

The Wisconsin mound was originally designed as a replacement for a failed community decentralised sewage system. Three 30m wide subsurface adsorption cells installed in 1981 showed ponding, surface breakout, high levels of CO2 and methane and low levels of oxygen beneath the beds but six replacement mounds showed no evidence of ponding after two years of operation (Tyler, Converse & Parker 1985). These mounds were installed for a decentralised scheme in the US State of Wisconsin leading to the origin of the term Wisconsin mound. Subsequently it was found that mounds also worked favourably for domestic sites with high water tables and shallow impermeable soils (Converse & Tyler 1987).

Most soil application systems can sustainably provide BOD and SS removal of greater than 90% and purification of faecal Coliforms and viruses of greater than 99.99% by filtration, sorption, and biodegradation processes (Siegrist et al. 2000). However, removal of nutrients including nitrogen and phosphorus is more dependent on conditions present within soil adsorption systems including soil saturation and retention time.

A 10-20% reduction of nitrogen can normally be achieved by a conventional soil adsorption system (Siegrist & Jenssen 1989, Westby et al. 1997, Converse 1999, cited by Siegrist et al. 2000). In soil systems designed for nutrient reduction, removal rates of over 50% can be normally achieved (Lance et al. 1976, Laak 1982; Seigrist & Jenssen 1989, Converse 1999, cited by Siegrist et al. 2000).

Westby et al. (1997 cited by Siegrist et al. 2000) found greater than 85% nitrogen removal for a dosed Wisconsin mound system. Blasing and Converse (2003) found nitrogen reduction of at least 55% for Wisconsin mounds using AWTS treated effluent.

Similar high nutrient reduction rates were reported for a recent Australian mound study at Port Stevens by Whitehead & Geary (2009). Previously Gardner, Geary & Gordon (1997) claimed that nitrogen and phosphorus is rarely removed by secondary treatment processes including sand mounds.

Sauer et al. (1975) shows at least 40% total nitrogen reduction and 20-25% orthophosphate reduction for two experimental in-ground sand filters. Contemporary studies by the same authors, and others on the publication index, suggest that most secondary systems, including sand filters, effectively remove nitrogen and phosphorus from wastewater. More recent peer reviewed literature from overseas reporting trials of mounds and other soil application systems (Siegrist et al. 2000) supports a 50% to 85% reduction of total nitrogen in primary or secondary treated effluent applied to mounds.

It is understandable that Australian regulators take a conservative approach to nutrient reduction claims for domestic treatment systems, particularly where surface spray irrigation predominates. Surface spray application does not ensure effective subsoil absorption and treatment. However, one of the few Australian studies into subsoil adsorption systems suggests that nitrogen from primary septic tank effluent is not detectable more than a few meters away from a properly designed and installed bed or trench (Gerritse et al. 1995).

The reduction and fate of phosphorus in applied effluent to subsoil or mounds is not widely reported. Siegrist et al. (2000) and other overseas studies (including Converse & Tyler) generally do not include phosphorus reduction results. Some Australian soils have poor phosphorus sorption ability, and some Australian plants are reportedly sensitive to high phosphorus concentrations. Phosphorus may be of more concern in Australia than overseas particularly in shallow soils low in iron and aluminium oxides. However, Gerritse et al. (1995) monitoring groundwater near a 6-7 year old septic system showed phosphate had not moved beyond 5m from the leach drain.

Whitehead and Geary (2009) suggest phosphorus removal rates by mounds of over 95% comparing influent to local ground water, but as a limited study, the reported results are inconclusive. Detailed studies on phosphorus removal by mound systems are limited. Part of the difficulty of determining the removal rate of phosphorus by mounds is uncertainty and variability in the concentration of phosphorus in the wastewater stream before treatment. Phosphorus also undergoes conversion between soluble and insoluble forms under different conditions and while systems can absorb a given concentration of phosphorus, they can eventually release more phosphorus then applied.

Centralised sewage schemes accept and mix trade waste and stormwater infiltration so are not a reliable indicator of phosphorus concentrations in domestic wastewater. The voluntary ban on phosphorus in laundry powders from 2015 is only one of a range of factors that may influence the concentration of phosphorus in wastewater streams. Literature suggests that the fate of phosphorus from domestic wastewater is complex. For mound and soil systems in general, there is uncertainty as to the removal percentage estimate for phosphorus as generally the concentration in wastewater streams is highly variable.

Sands are known to have poor phosphorus absorption qualities but still provide up to 200,000mg/m^3 of adsorption storage to act as a reservoir for plants. The large surface area of sand media also supports a microbial biomass in the mound about which the total biomass and biological uptake and distribution of phosphorus and nitrogen is relatively unknown.

Phosphorus adsorption capacity is determined by the equilibrium concentration, but soil adsorption increases at concentrations beyond equilibrium (Siegrist et al. 2000). Plant uptake of phosphorus also increases as the soil concentration increases, confounding estimates. This may be why there is a general absence of concern about phosphorus overseas, and why the limited local studies are often inconclusive.

Conclusion

Mounds are accepted and proven as an effective treatment/dispersal system that prevents ground water pollution for even the most sensitive constrained high water table sites. As well as providing BOD and SS removal of greater than 90% they are designed for maximum nutrient removal well beyond the standard 20% assumed for most subsoil application systems or the 50% for standard nutrient removal system.

Table 1 demonstrates the difference between the claimed reduction and the range of reduction values suggested by the literature. Therefore the 50% removal of TN and TP by mounds is considered conservative.

Table 1. Potential reduction of nitrogen and phosphorus from reclaimed effluent from mounds as reported by available literature and the reduction claimed.

	Total Nitrogen	Total Phosphorus
Literature range for mound reduction	20% to 90%	33% to 99%
Minimum claimed reduction	50%	50%

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Appendix G

Preliminary Geotechnical Investigation – Green Geotechnics (2023)

GREEN
GEOTECHNICS

PRELIMINARY GEOTECHNICAL INVESTIGATION

FOR

VIVACITY PROPERTY

303 WOLLOMBI ROAD, FARLEY

REPORT GG11027.001
28 APRIL 2023

Preliminary Geotechnical Investigation for proposed residential subdivision at 303 Wollombi Road, Farley

Prepared for

Vivacity Property
PO Box H72
Australia Square NSW 1215

Prepared by

Green Geotechnics Pty Limited
PO Box 3244
Rouse Hill, NSW, 2155
ABN: 786 438 493 89
www.greengeo.com.au
matt@greengeo.com.au

28 April 2023

Document Authorisation

Our Ref: GG11027.001

For and on behalf of Green Geotechnics

Matthew Green
Principal Engineering Geologist

Document Control

Revision	Description	Format	Date	Author	Distributed to
-	Final	PDF	28/4/2023	MG	Vivacity Property (Client)

Table of Contents

FIGURES

APPENDICIES

1. INTRODUCTION

This report presents the results of a preliminary geotechnical investigation carried out by Green Geotechnics Pty Limited for a proposed residential subdivision at 303 Wollombi Road, Farley.

We understand that the subdivision will be serviced by on-site wastewater treatment systems, and therefore a preliminary geotechnical investigation of the site is required to determine the sites suitability.

The purpose of the investigation was to:

- assess the subsurface conditions over the site,
- assess bedrock levels across the site, and
- determine groundwater levels.

2. FIELDWORK DETAILS

The fieldwork was carried out on 19 April 2023 and comprised a site walkover together with the drilling of nine (9) boreholes numbered BH1 to BH9. The boreholes were drilled using rotary solid flight augers attached to a utility mounted drilling rig supplied and operated by Coffey Testing.

The site location is shown in the attached Figure A. The borehole locations, as shown on Figure B, were nominated by the client and were located using a hand portable GPS. Photographs of the site showing the borehole locations are provided in Figure C.

The strength of the soils encountered in the boreholes was assessed by undertaking Dynamic Cone Penetrometer (DCP) tests adjacent to each borehole. The strength of the weathered bedrock was assessed by observation of the auger penetration resistance when using a tungsten carbide drilling bit, together with examination of the recovered rock cuttings.

Groundwater observations were made in all boreholes during drilling, on completion of drilling and a short time after completion of drilling. No longer term groundwater monitoring was carried out.

The fieldwork was completed in the full-time presence of our principal geologists who set out the boreholes, nominated the sampling and testing, and prepared the borehole logs. The logs are attached to this report, together with a glossary of the terms and symbols used in the logs.

For further details of the investigation techniques adopted, reference should be made to the attached explanation notes.

Environmental and contamination testing of the soils was beyond the agreed scope of the works.

3. RESULTS OF INVESTIGATION

3.1 Site Description

The site is identified as Lot 4 in DP810894 and comprises a rural acreage property with an area of approximately 30 hectares. At the time of the fieldwork the site was occupied by two single level residential dwellings which are accessed via a gravel driveway leading from Wollombi Road. The eastern of the two dwellings is serviced by three above ground water tanks and the western dwelling has an in-ground swimming pool in the rear garden area together with a separate shed.

The dwellings are located centrally on the allotment and are surrounded by open grassed pastures and areas of undulating bushland.

The ground surface on the site slopes from north to south with a fall of approximately 45 metres from Reduced Level (RL) 65 meters Australian Height Datum (AHD) at the driveway interface with Wollombi Road, to RL 20 metres AHD in the south west corner of the site. The site is characterised by a series of gently undulating slopes which have been formed from several intersecting creek lines and overland flow channels. The creeks fee two medium sized farm dams which are located to the north west of the dwellings.

The overland flow paths and creeks have gentle incised slopes, however the creek in the vicinity of BH7 has eroded through the overlying soil horizon to expose the underling sandstone bedrock.

There are numerous small boulders of sandstone bedrock littered throughout the site, most notably in the areas of bushland.

To the north of the site is Wollombi Road and to the south and west is bushland. To the east of the site is further bushland and to the north east is a rural residential property identified as 283 Wollombi Road.

3.2 Regional Geology & Subsurface Conditions

The 1:100,000 Coastal Quaternary series geological map of Newcastle (Geological Survey of NSW, Geological) indicates that the site is underlain by Permian Age bedrock belonging to the Dalwood Group. Bedrock within this formation comprises sandstone, lithic sandstone, conglomerate, siltstone and basalt.

For the development of a site-specific geotechnical model, the observed subsurface conditions from the boreholes have been grouped into four (4) geotechnical units which are summarised as follows:

Unit 1 – Topsoil / Fill:

Topsoil and fill materials comprising of a silty clay, silty sandy clay, clayey silt and sandy silt were encountered across the site to depths of 0.15 to 0.4 metres, however, were typically present to depths of around 0.2 metres. The soils contain traces of organics and in some areas have been reworked with gravel and rounded cobble inclusions. Sandstone cobbles and boulders were also noted at surface level scattered across the site. The topsoil/fill materials were assessed to be dry to moist.

Unit 2 – Natural Sands (BH7 only):

Natural clayey silty sands and silty clayey sands were encountered below the topsoil in BH7 to a depth of 0.75 metres. The sands were assessed to be moist and medium dense/very stiff.

Unit 3 – Natural Clayey Soils:

Natural clayey soils were encountered in all test locations underling the topsoil and fill and extend to depths of 0.85 to 1.85 metres, being shallowest over the central and eastern portion of the site, and deepest in BH8 and BH9 on the western side of the creek. The natural clays were assessed to be generally dry to moist and stiff to very stiff, however the deeper soils in BH8 and BH9 were assessed to be firm becoming firm to stiff with depth. The clays are mostly medium and occasionally high plasticity with some sand and traces of sandstone gravel.

Unit 3 – Shale Bedrock:

Sandstone bedrock as encountered across the site in all boreholes at depths of 0.85 to 1.85 metres and could not be penetrated with a tungsten carbide drilling bit below depths of 0.95 to 2.5 metres.

The bedrock was assessed to be mostly low to medium strength, however, will likely increase to high strength with depth. The bedrock over the central and eastern portion of the site has a very limited weathering profile of less than 0.3 metres of overlying weaker rock, however the bedrock in BH8 and BH9 has an upper weathered zone around 0.4 to 0.6 metres thick of very low strength Class V bedrock.

The depth to bedrock and refusal depth at each borehole location is summarised below in Table 3.1.

TABLE 3.1 – Bedrock Summary Table

Borehole ID	Depth to Top of Rock	Depth of Auger Refusal
BH1	0.85m	1.00m
BH2	1.10m	1.30m
BH3	0.90m	1.00m
BH4	0.85m	0.95m
BH5	1.05m	1.20m
BH6	1.15m	1.40m
BH7	1.10m	1.20m
BH8	1.75m	2.10m
BH9	1.85m	2.50m

Groundwater seepage was not observed during auger drilling of the boreholes, including those drilled adjacent to creek lines, and therefore no design groundwater level is applicable to the site. Area of the site are however wet and boggy as a result of overland flow.

4. GENERAL RECOMMENDATIONS

Occasionally, the subsurface conditions may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact this office.

This report has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose. If there is any change in the proposed development described in this report then all recommendations should be reviewed.

Copyright in this report is the property of Green Geotechnics. We have used a degree of care, skill and diligence normally exercised by consulting engineers in similar circumstances and locality. No other warranty expressed or implied is made or intended. Subject to payment of all fees due for the investigation, the client alone shall have a licence to use this report. The report shall not be reproduced except in full.

REPORT INFORMATION

Introduction

These notes have been provided to amplify Green Geotechnics report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

Green Geotechnics reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several limitations, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. The borehole must be flushed, and any water must be extracted from the hole if further water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, GG will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, GG cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, Green Geotechnics will be pleased to assist with investigations or advice to resolve the matter.

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, GG requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

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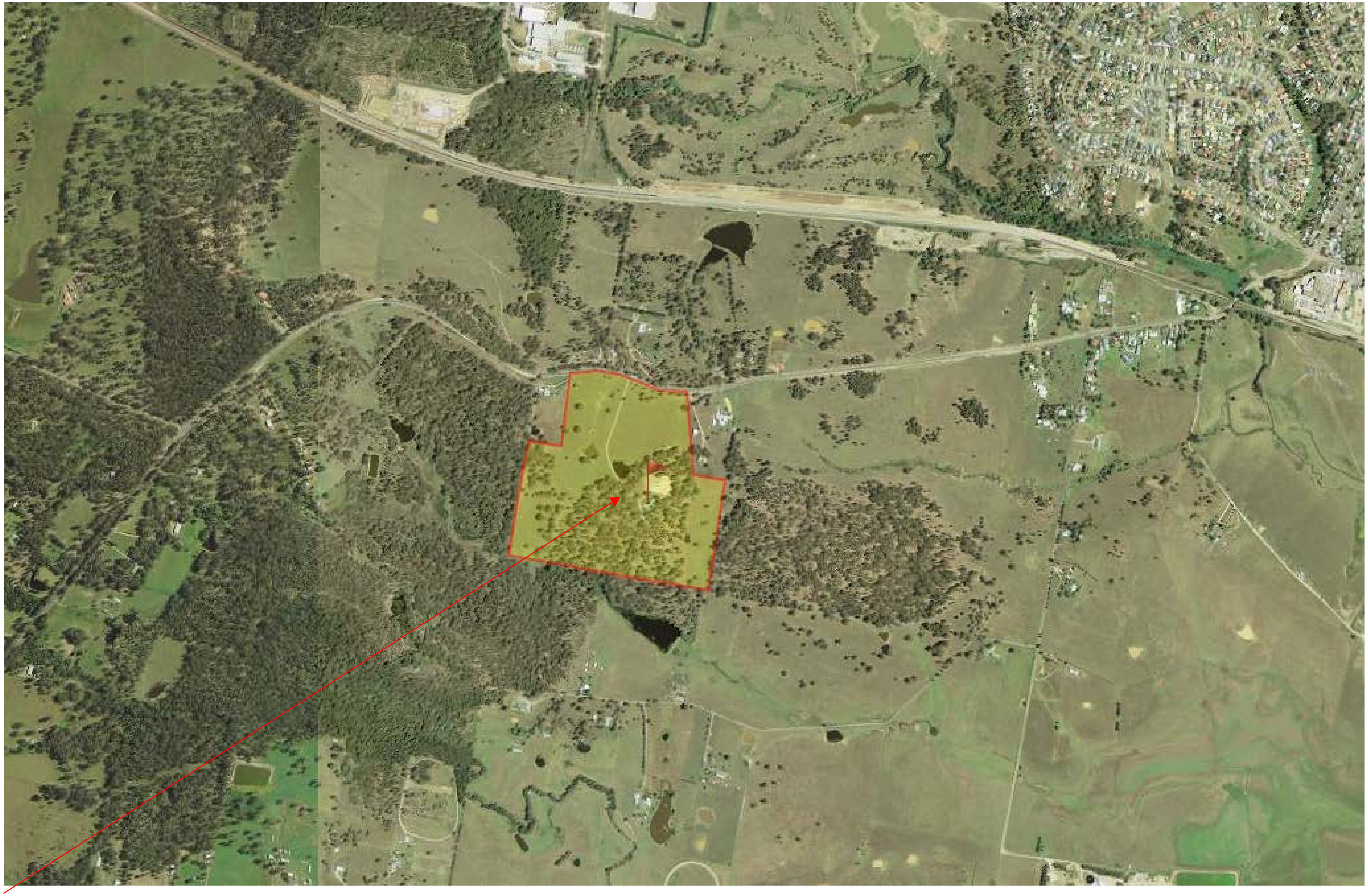
FIGURES



Subject Site

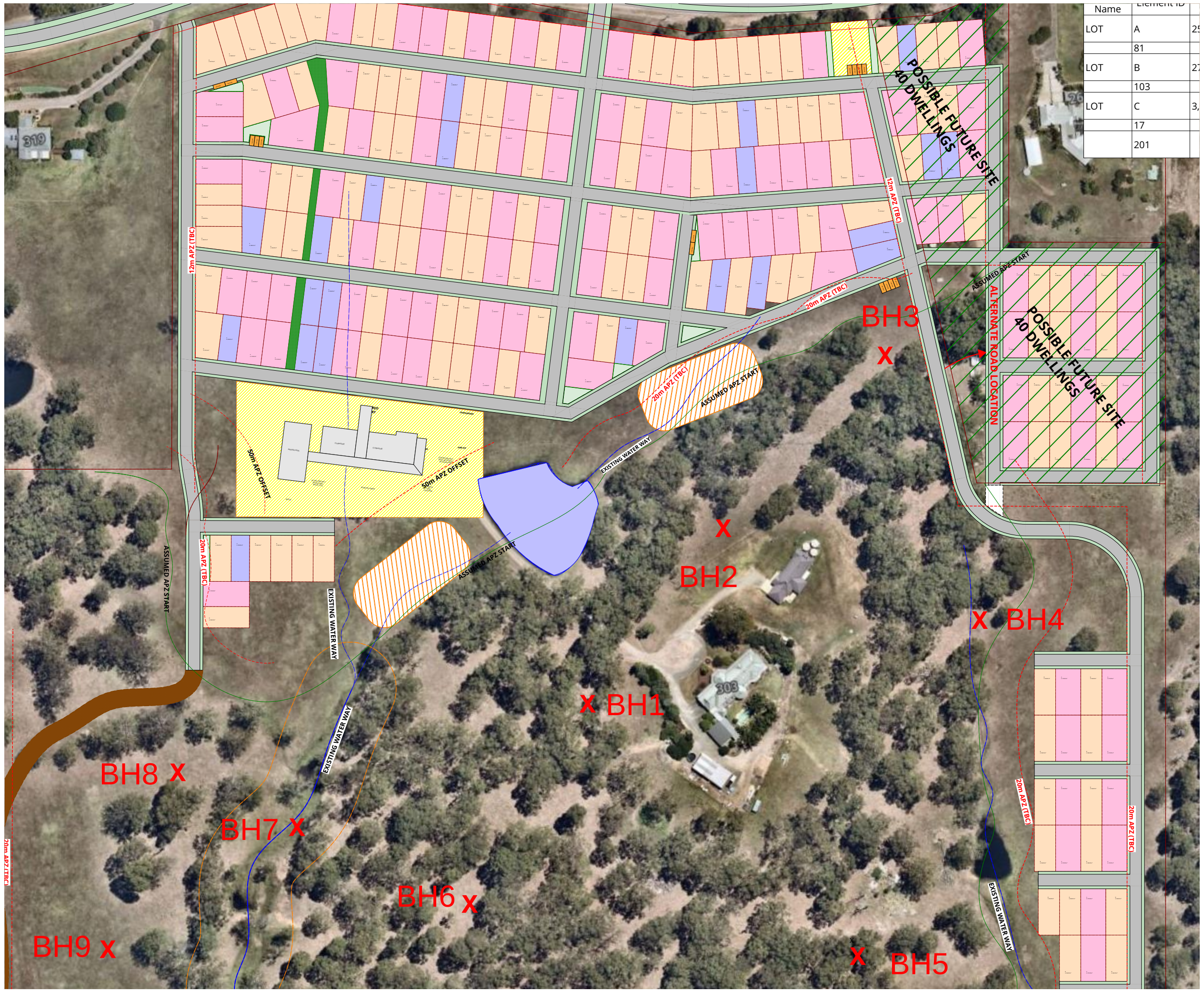
GREEN GEOTECHNICS	Project No: GG11027.001	Geotechnical Investigation 303 Wollombi Road, Farley **SITE LOCATION PLAN**	Figure No: GG11027.001A
	Client: Vivacity Property		Drawn By: MG
	Date: 28 April 2023		Scale: Unknown

Legend:

= Borehole

= DCP

= Test Pit



Project No: GG11027.001	Figure No: GG11027.001B
Client: Vivacity Property	Drawn By: MG
Date: 28 April 2023	Scale: Unknown

Geotechnical Investigation
303 Wollombi Road, Farley

TEST LOCATION PLAN

GREEN GEOTECHNICS

Position of BH1

Position of BH2

GREEN GEOTECHNICS	Project No: GG11027.001	Geotechnical Investigation 303 Wollombi Road, Farley	Page: 1 of 5
	Client: Vivacity Property		
	Date: 28 April 2023	**SITE PHOTOGRAPHS**	

Position of BH3

Position of BH4

GREEN GEOTECHNICS	Project No: GG11027.001	Geotechnical Investigation 303 Wollombi Road, Farley	Page: 2 of 5
	Client: Vivacity Property		
	Date: 28 April 2023	**SITE PHOTOGRAPHS**	

Position of BH5

Position of BH6

Position of BH7

View of rock in creek near BH7

GREEN GEOTECHNICS	Project No: GG11027.001	Geotechnical Investigation 303 Wollombi Road, Farley	Page: 4 of 5
	Client: Vivacity Property		
	Date: 28 April 2023	**SITE PHOTOGRAPHS**	

Position of BH8

Position of BH9

GREEN GEOTECHNICS	Project No: GG11027.001	Geotechnical Investigation 303 Wollombi Road, Farley **SITE PHOTOGRAPHS**	Page: 5 of 5
	Client: Vivacity Property		
	Date: 28 April 2023		

APPENDIX A – BOREHOLE LOGS & DCP TEST RESULTS

GEOTECHNICAL LOG - NON CORED BOREHOLE

GREEN GEOTECHNICS

Project No: GG11027
Address: 303 Wollombi Road, Farley
Client: Vivacity Property

Date Logged : 19/04/2023
Logged By: MG
Checked By: MG

BOREHOLE NO.: BH 1
Sheet 1 of 1

WATER TABLE	SAMPLES	DEPTH (M)	DESCRIPTION (Soil type, colour, grain size, plasticity, minor components, observations)	USC SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			TOPSOIL: Silty CLAY: Brown, low to medium plasticity, fine grained sand and rootlets	CL		D-M
			Silty CLAY: Orange mottled red brown, medium to high plasticity.	CI-CH	STIFF	M
		0.5	Silty Sandy CLAY: Pale grey mottled orange, low to medium plasticity, (friable) residual.	CL-CI	STIFF	D-M
		1.0	SANDSTONE: Pale grey, fine to medium grained, estimated moderately weathered, low strength (Class IV).			D
			REFUSAL AT 1.0m ON SANDSTONE (CLASS IV) BEDROCK.			
		1.5				
		2.0				
		2.5				

D - Disturbed sample | U - Undisturbed tube sample | B - Bulk sample
S - Chemical Sample | SPT - Standard Penetration Test
WT - Standing Water Table | SP - Water Seepage Level

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

Contractor: Coffee Testing
Equipment: UTE
Hole Diameter (mm): 100mm
Angle from Vertical (^{o}): 0°
Drill Bit: Spiral TC

GEOTECHNICAL LOG - NON CORED BOREHOLE

GREEN GEOTECHNICS

Project No: GG11027
Address: 303 Wollombi Road, Farley
Client: Vivacity Property

Date Logged : 19/04/2023
Logged By: MG
Checked By: MG

BOREHOLE NO.: BH 2
Sheet 1 of 1

WATER TABLE	SAMPLES	DEPTH (M)	DESCRIPTION (Soil type, colour, grain size, plasticity, minor components, observations)	USC SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			TOPSOIL/ FILL: Sandy Silty CLAY: Brown with medium plasticity with rootlets and rounded cobbles and angular gravel.	CL-CI		M
		0.5	Sandy Silty CLAY: Pale brown mottled red and grey, medium to high plasticity with a trace of ironstone gravel.	CI-CH	STIFF	M
		1.0	Silty Sandy CLAY: Pale brown to orange, medium plasticity with fine grained sand (residual).	CI	STIFF	D-M
			SANDSTONE: Pale orange to red grey, fine to medium grained, estimated moderately weathered / highly weathered, low to medium strength (Class IV).			D
		1.5	REFUSAL AT 1.3m ON SANDSTONE (Class IV).			
		2.0				
		2.5				

D - Disturbed sample U - Undisturbed tube sample B - Bulk sample
S - Chemical Sample SPT - Standard Penetration Test
WT - Standing Water Table SP - Water Seepage Level

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

Contractor: Coffee Testing
Equipment: UTE
Hole Diameter (mm): 100mm
Angle from Vertical (^{o}): 0°
Drill Bit: Spiral TC

GEOTECHNICAL LOG - NON CORED BOREHOLE

GREEN GEOTECHNICS

Project No: GG11027
Address: 303 Wollombi Road, Farley
Client: Vivacity Property

Date Logged : 19/04/2023
Logged By: MG
Checked By: MG

BOREHOLE NO.: BH 3
Sheet 1 of 1

WATER TABLE	SAMPLES	DEPTH (M)	DESCRIPTION (Soil type, colour, grain size, plasticity, minor components, observations)	USC SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			TOPSOIL/ FILL (reworked soil): Clayey SILT: Grey brown, low plasticity with trace of rootlets and rounded gravel.	CL		D-M
			Clayey SILT: Grey brown, low to medium plasticity, brown with a trace of gravel.	ML - M	STIFF	D-M
		0.5	Sandy Silty CLAY: Grey brown mottled orange, low to medium plasticity (residual).	CL-CI	STIFF	D-M
		1.0	SANDSTONE: Pale brown to red brown, fine to medium grained, estimated highly weathered, low to medium strength (Class IV).			D
			REFUSAL AT 1.0m ON SANDSTONE (Class IV).			
		1.5				
		2.0				
		2.5				

D - Disturbed sample | U - Undisturbed tube sample | B - Bulk sample
S - Chemical Sample | SPT - Standard Penetration Test
WT - Standing Water Table | SP - Water Seepage Level

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

Contractor: Coffee Testing
Equipment: UTE
Hole Diameter (mm): 100mm
Angle from Vertical (^{o}): 0°
Drill Bit: Spiral TC

GEOTECHNICAL LOG - NON CORED BOREHOLE

GREEN GEOTECHNICS

Project No: GG11027
Address: 303 Wollombi Road, Farley
Client: Vivacity Property

Date Logged : 19/04/2023
Logged By: MG
Checked By: MG

BOREHOLE NO.: BH 4
Sheet 1 of 1

WATER TABLE	SAMPLES	DEPTH (M)	DESCRIPTION (Soil type, colour, grain size, plasticity, minor components, observations)	USC SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			TOPSOIL/ REWORKED SOIL: Sandy Clayey SILT: Brown with rootlets and sandstone cobbles.	ML		D-M
			Silty CLAY: Red brown mottled orange, medium to high plasticity with a trace of ironstone gravel.	CI-CH	FIRM TO STIFF	M
		0.5				
			Silty Sandy CLAY: Pale brown to grey, medium plasticity.	CI	FIRM TO STIFF	M
					STIFF	D-M
			SANDSTONE: Grey to brown, fine grained, estimated moderately to highly weathered, low to medium strength (Class IV).			D
		1.0	REFUSAL AT 0.95m ON STANDSTONE BEDROCK (Class IV).			
		1.5				
		2.0				
		2.5				

D - Disturbed sample | U - Undisturbed tube sample | B - Bulk sample
S - Chemical Sample | SPT - Standard Penetration Test
WT - Standing Water Table | SP - Water Seepage Level

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

Contractor: Coffee Testing
Equipment: UTE
Hole Diameter (mm): 100mm
Angle from Vertical (°): 0°
Drill Bit: Spiral TC

GEOTECHNICAL LOG - NON CORED BOREHOLE

GREEN GEOTECHNICS

Project No: GG11027
Address: 303 Wollombi Road, Farley
Client: Vivacity Property

Date Logged : 19/04/2023
Logged By: MG
Checked By: MG

BOREHOLE NO.: BH 5
Sheet 1 of 1

WATER TABLE	SAMPLES	DEPTH (M)	DESCRIPTION (Soil type, colour, grain size, plasticity, minor components, observations)	USC SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			TOPSOIL: Clayey Sandy SILT: brown, low plasticity with fine grained sand, rootlets with some sandstone cobble.	NL		D-M
		0.5	Silty CLAY: Red brown mottled grey brown, medium to high plasticity.	CI-CH	STIFF	M
		1.0	Sandy Silty CLAY: Pale grey mottled red and orange, medium plasticity with a trace of ironstone gravel.	CI	STIFF	M
			SANDSTONE: Red to brown, fine to medium grained, estimated moderately to highly weathered, low strength (Class IV)			D
		1.5	REFUSAL AT 1.2m ON SANDSTONE (CLASS IV).			
		2.0				
		2.5				

D - Disturbed sample U - Undisturbed tube sample B - Bulk sample
S - Chemical Sample SPT - Standard Penetration Test
WT - Standing Water Table SP - Water Seepage Level

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

Contractor: Coffee Testing
Equipment: UTE
Hole Diameter (mm): 100mm
Angle from Vertical (^{o}): 0°
Drill Bit: Spiral TC

GEOTECHNICAL LOG - NON CORED BOREHOLE

GREEN GEOTECHNICS

Project No: GG11027	Date Logged : 19/04/2023
Address: 303 Wollombi Road, Farley	Logged By: MG
Client: Vivacity Property	Checked By: MG

BOREHOLE NO.: BH 6

Sheet 1 of 1

WATER TABLE	SAMPLES	DEPTH (M)	DESCRIPTION (Soil type, colour, grain size, plasticity, minor components, observations)	USC SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			TOPSOIL: Sandy Clayey SILT: Brown and grey, low plasticity with rootlets.	ML		D
			Gravelly Sandy Silty CLAY: Grey to brown with low plasticity with sandstone gravel and cobbles.	CL	STIFF	M
		0.5	Sandy Silty CLAY: Orange brown, mottled red brown, medium plasticity.	CI	VERY STIFF	D-M
			Silty Sandy CLAY: Pale grey mottled red orange, low to medium plasticity with a trace of sandstone gravel.	CL-CI	STIFF	D-M
		1.0	SANDSTONE: Dark red to brown, fine to medium grained, estimated highly weathered, low strength (Class V).			D
			SANDSTONE: Pale grey, fine to medium grained, estimated moderately to highly weathered, low to medium strength (Class IV).			D
			REFUSAL AT 1.4m ON SANDSTONE (CLASS IV).			
		1.5				
		2.0				
		2.5				

D - Disturbed sample	U - Undisturbed tube sample	B - Bulk sample	Contractor: Coffee Testing
S - Chemical Sample	SPT - Standard Penetration Test		Equipment: UTE
WT - Standing Water Table	SP - Water Seepage Level		Hole Diameter (mm): 100mm
NOTES:	See explanation sheets for meaning of all descriptive terms and symbols		Angle from Vertical (^{o}): 0°
			Drill Bit: Spiral TC

GEOTECHNICAL LOG - NON CORED BOREHOLE

GREEN GEOTECHNICS

Project No: GG11027
Address: 303 Wollombi Road, Farley
Client: Vivacity Property

Date Logged : 19/04/2023
Logged By: MG
Checked By: MG

BOREHOLE NO.: BH 7

Sheet 1 of 1

WATER TABLE	SAMPLES	DEPTH (M)	DESCRIPTION (Soil type, colour, grain size, plasticity, minor components, observations)	USC SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			TOPSOIL: Silty SAND: Grey to brown, fine grained with rootlets and sandstone gravel.	SM		M
			Clayey Silty SAND: Red to brown, fine to medium grained with sandstone gravel.	SM	MEDIUM DENSE	M
		0.5				
			Silty Clayey SAND: Grey to brown orange, fine to medium grained with sandstone gravel, low plasticity fines.	SC	VERY STIFF	M
			Gravelly Sandy CLAY: Grey to red brown, low plasticity with fine to medium grained sand and sandstone cobbles.	CL	VERY STIFF	D-M
		1.0				
			SANDSTONE: pale grey and red, fine to medium grained, estimated high to medium weathered, low to medium strength (Class IV)			D
			REFUSAL AT 1.2m ON SANDSTONE (CLASS IV).			
		1.5				
		2.0				
		2.5				

D - Disturbed sample
U - Undisturbed tube sample
B - Bulk sample
S - Chemical Sample
SPT - Standard Penetration Test
WT - Standing Water Table
SP - Water Seepage Level

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

Contractor: Coffee Testing
Equipment: UTE
Hole Diameter (mm): 100mm
Angle from Vertical (^{o}): 0°
Drill Bit: Spiral TC

GEOTECHNICAL LOG - NON CORED BOREHOLE

GREEN GEOTECHNICS

Project No: GG11027
Address: 303 Wollombi Road, Farley
Client: Vivacity Property

Date Logged : 19/04/2023
Logged By: MG
Checked By: MG

BOREHOLE NO.: BH 8
Sheet 1 of 1

WATER TABLE	SAMPLES	DEPTH (M)	DESCRIPTION (Soil type, colour, grain size, plasticity, minor components, observations)	USC SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			TOPSOIL: Clayey Sandy SILT: Brown, low plasticity with rootlets.	ML		M
		0.5	Sandy Silty CLAY: Orange brown, medium plasticity, becoming red brown.	CI	FIRM FIRM TO STIFF	M
		1.0	Sandy CLAY: Pale grey to red orange, low to medium plasticity with ironstone and sandstone gravel.	CL-CI	STIFF	M
		1.5	Gravelly Silty Sandy CLAY: Orange mottled grey, low to medium plasticity with sandstone gravel.	CL-CI	VERY STIFF	D-M
		2.0	SANDSTONE: Pale grey to red brown, fine to medium grained, estimated highly weathered, very low to low strength (Class V)			D
		2.5	REFUSAL AT 2.1m ON SANDSTONE (Class IV).			

D - Disturbed sample
U - Undisturbed tube sample
B - Bulk sample
S - Chemical Sample
SPT - Standard Penetration Test
WT - Standing Water Table
SP - Water Seepage Level

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

Contractor: Coffee Testing
Equipment: UTE
Hole Diameter (mm): 100mm
Angle from Vertical (^{o}): 0°
Drill Bit: Spiral TC

GEOTECHNICAL LOG - NON CORED BOREHOLE

GREEN GEOTECHNICS

Project No: GG11027
Address: 303 Wollombi Road, Farley
Client: Vivacity Property

Date Logged : 19/04/2023
Logged By: MG
Checked By: MG

BOREHOLE NO.: BH 9
Sheet 1 of 1

WATER TABLE	SAMPLES	DEPTH (M)	DESCRIPTION (Soil type, colour, grain size, plasticity, minor components, observations)	USC SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			TOPSOIL: Sandy SILT: Grey to brown, low plasticity with rootlets.	ML		M
		0.5	Silty CLAY: Red brown to orange brown, medium to high plasticity.	CI-CH	FIRM	M
		1.0	Silty Sandy CLAY: Pale grey, mottled red orange, low to medium plasticity with fine to medium grained sand.	CL-CI	STIFF	M
		1.5	Gravelly Sandy CLAY: Pale grey and pale grey mottled orange, medium plasticity.	CI	STIFF TO VERY STIFF	M D-M
		2.0 2.5	SANDSTONE: Orange brown to grey, fine to medium grained, estimated highly weathered, very low to low strength (Class V).			D
			REFUSAL AT 2.5m ON SANDSTONE (CLASS IV)			

D - Disturbed sample | U - Undisturbed tube sample | B - Bulk sample
S - Chemical Sample | SPT - Standard Penetration Test
WT - Standing Water Table | SP - Water Seepage Level

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

Contractor: Coffee Testing
Equipment: UTE
Hole Diameter (mm): 100mm
Angle from Vertical (^{o}): 0°
Drill Bit: Spiral TC

Dynamic Cone Penetrometer Test Report

Project Number: GG11027
Site Address: 303 Wollombi Road, Farley
Test Date: 19/04/2023

Test Method: **AS1289.6.3.2**

Technician: MG

Test No	BH1	BH2	BH3	BH4	BH5	BH6
Starting Level	Surface Level	Surface Level	Surface Level	Surface Level	Surface Level	Surface Level
Depth (m)	Penetration Resistance (blows / 150mm)					
0.00 - 0.10	2	2	4	2	4	5
0.10 - 0.20	5	4	12	2	20	10
0.20 - 0.30	10	7	11	3	19	12
0.30 - 0.40	5	6	8	2	5	17
0.40 - 0.50	6	7	7	3	5	14
0.50 - 0.60	6	7	8	3	4	6
0.60 - 0.70	9	7	8	4	5	7
0.70 - 0.80	Bounce at 0.70m	8	7	4	6	10
0.80 - 0.90		6	10	Bounce at 0.90m	11	14
0.90 - 1.0		6	11		11	Bounce at 0.90m
1.0 - 1.10		6	17		Bounce at 1.05m	
1.10 - 1.20		6	Bounce at 1.2m			
1.20 - 1.30		Bounce at 1.30m				
1.30 - 1.40						
1.40 - 1.50						
1.50 - 1.60						
1.60 - 1.70						
1.70 - 1.80						
1.80 - 1.90						
1.90 - 2.0						

Remarks: * Pre drilled prior to testing

Dynamic Cone Penetrometer Test Report

GREEN GEOTECHNICS

Project Number: GG11027
Site Address: 303 Wollombi Road, Farley
Test Date: 19/04/2023

Page: 2 of 2

Test Method: **AS1289.6.3.2**

Technician: MG

Test No	BH7	BH8	BH9			
Starting Level	Surface Level	Surface Level	Surface Level			
Depth (m)	Penetration Resistance (blows / 150mm)					
0.00 - 0.10	3	2	2			
0.10 - 0.20	3	1	1			
0.20 - 0.30	4	2	2			
0.30 - 0.40	6	1	2			
0.40 - 0.50	9	2	2			
0.50 - 0.60	14	3	2			
0.60 - 0.70	17	2	2			
0.70 - 0.80	17	3	2			
0.80 - 0.90	15	5	3			
0.90 - 1.0	12	6	4			
1.0 - 1.10	16	5	4			
1.10 - 1.20	Bounce at 1.2m	10	5			
1.20 - 1.30		10	4			
1.30 - 1.40		10	4			
1.40 - 1.50		14	4			
1.50 - 1.60		11	4			
1.60 - 1.70		10	6			
1.70 - 1.80		10	13			
1.80 - 1.90		10	16			
1.90 - 2.0		Bounce at 1.90m	Bounce at 1.8m			

Remarks: * Pre drilled prior to testing

SAMPLING & IN-SITU TESTING

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock. Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure. Undisturbed samples are taken by pushing a thin walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength and are necessary for laboratory determination of shear strength and compressibility.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator.

Large Diameter Augers

Boreholes can be drilled using a large diameter auger, typically up to 300 mm or larger in diameter mounted on a standard drilling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration.

Diamond Core Rock Drilling

A continuous core sample of can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter (NMLC). The borehole is advanced using a water or mud flush to lubricate the bit and removed cuttings.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1. The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable, and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as: 15, 30/40 mm.

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.

- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

SOIL DESCRIPTIONS

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle Size (mm)
Boulder >200	Boulder >200
Cobble 63 - 200	Cobble 63 - 200
Gravel 2.36 - 63	Gravel 2.36 - 63
Sand 0.075 - 2.36	Sand 0.075 - 2.36
Silt 0.002 - 0.075	Silt 0.002 - 0.075
Clay <0.002	Clay <0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle Size (mm)
Coarse Gravel	20 – 63
Medium Gravel	6 – 20
Fine Sand	2.36 – 6
Coarse Sand	0.6 – 2.36
Medium Sand	0.2 – 0.6
Fine Sand	0.075 – 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion
And	Specify
Adjective	20 - 35%
Slightly	12 - 20%
With some	5 - 12%
With a trace of	0 - 5%

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained Shear Strength (kPa)
Very soft	VS	<12
Soft	S	12 - 25
Firm	F	25 - 50
Stiff	ST	50 - 100
Very stiff	VST	100 - 200
Hard	H	200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (DCP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N Value	CPT qc value (MPa)
Very loose	VL	<4	<2
Loose	L	4 - 10	2 -5
Medium Dense	MD	10-30	5-15
Dense	D	30-50	15-25
Very Dense	VD	>50	>25

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

ROCK DESCRIPTIONS

GREEN GEOTECHNICS

Rock Strength

The Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 1993. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $IS_{(50)}$ MPa	Approximate Unconfined Compressive Strength MPa*
Extremely low	EL	<0.03	<0.6
Very low	VL	0.03 - 0.1	0.6 - 2
Low	L	0.1 - 0.3	2 - 6
Medium	M	0.3 - 1.0	6 - 20
High	H	1 - 3	20 - 60
Very high	VH	3 - 10	60 - 200

* Assumes a ration of 20:1 for UCS to $IS_{(50)}$

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable.
Moderately weathered	MW	Staining and discolouration of rock substance has taken Place.
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh stained	FS	Rock substance unaffected by weathering but staining visible along defects.
Fresh	FR	No signs of decomposition or staining.

Degree of Fracturing

The following classification applies to the spacing of natural fractures in core samples (bedding plane partings, joints and other defects, excluding drilling breaks

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured Core	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and loner sections
Unbroken	Unbroken Core lengths mostly > 1000 mm

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	2 m

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$RQD\ \% = \frac{\text{cumulative length of 'sound' core sections} \geq 100\text{ mm long}}{\text{total drilled length of section being assessed}}$$

'sound' rock is assessed to be rock of low strength or better. The RQD applies only to natural fractures. If the core is broken by drilling/handling, then the broken pieces are fitted back together and are not included in the calculation of RQD.

ABBREVIATIONS

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core Drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

Z	Water seep
V	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
S	Chemical sample
U50	Undisturbed tube sample (50mm)
W	Water sample
PP	Pocket Penetrometer (kPa)
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

GREEN GEOTECHNICS

UNIFIED SOIL CLASSIFICATION TABLE

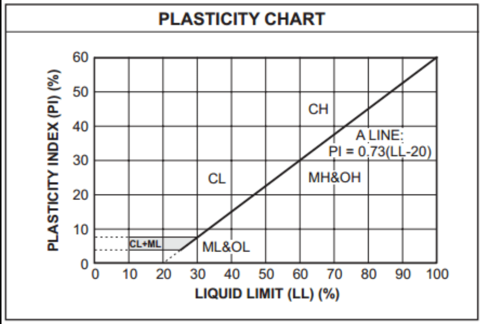
Major divisions			Field Identification Procedures (Excluding particles larger than 75um and basing fractions on estimated weights)	Group Symbols	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria
Coarse-grained soils More than half of the material is large that 75um sieve size[b]	Gravels More than half of the coarse fraction is larger than a 4mm sieve	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes	*GW*	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name: indicative approximate percentages of sand and gravel; maximum size; angularity; surface condition, and hardness of the coarse grains; local of geologic name and other pertinent descriptive information; and symbols in parentheses For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics Example: *Silty Sand*, gravelly; about 20% hard, angular gravel particles 12mm maximum size; rounded and subangular sand grains, coarse to fine, about 15% non-plastic fines low dry strength; well compacted and moist in place; alluvial sand; *(SM)*	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			Predominantly one size or range of sizes with some intermediate sizes missing	*GP*	Poorly graded gravels, grave-sand mixtures, little or no fines		Not meeting all graduation requirements for *GW*
		Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)	*GM*	Silty gravels, poorly graded gravel-sand-silt mixtures		Atterberg limits below "A" line or *PI* less than 4 — Above "A" line with *PI* between 4 and 7 are borderline cases of requiring use of dual symbols
			Plastic fines (for identification procedures see *CL* below)	*GC*	Clayey gravels, poorly graded gravel-sand-clay mixtures		Atterberg limits above "A" line with *PI* greater than 7
	Sands More than half of the coarse fraction is smaller than a 4mm sieve	Clean sands (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes	*SW*	Well graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			Predominantly one size or range of sizes with some intermediate sizes missing	*SP*	Poorly graded sands, gravelly sands, little or no fines		Not meeting all graduation requirements for *SW*
		Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)	*SM*	Silty sands, poorly graded sand-silt mixtures		Atterberg limits below "A" line or *PI* less than 5 — Above "A" line with *PI* between 4 and 7 are borderline cases of requiring use of dual symbols
			Plastic fines (for identification procedures see *CL* below)	*SC*	Clayey sands, poorly graded sand-clay mixtures		Atterberg limits above "A" line with *PI* greater than 7

The 75um sieve size is about the particle visible to the naked eye

Use grain size curve in identifying the fractions as given under field identification

Determine percentages of gravel and sand from grain size curve
Depending on percentage of fines (fraction smaller than 75um sieve size)
coarse grained soils are classified as follows
Less than 5% — GW, GP, SW, SP
More than 12% — GM, GC, SM, SC
5 to 12% — Borderline cases requiring use of dual symbol

Major divisions		Identification Procedures of Fractions Smaller than 380 um Sieve Size: Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)	Group Symbols	Typical Names	Information Required for Describing Soils
Find-grained soils More than half of the material is smaller than 75um sieve size	Silts and clays liquid limit less than 50	None to slight	Quick to slow	None	*ML*	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slit plasticity	Give typical name: indicative degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions Example: *Clayey Silt*, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; *(ML)*
		Medium to high	None to very slow	Medium	*CL*	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
		Slight to medium	Slow	Slight	*OL*	Organic silts and organic silt-clays of low plasticity	
	Silts and clays liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium	*MH*	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, clastic silts	
		High to very high	None	High	*CH*	Inorganic clays of high plasticity, fat clays	
		Medium to high	None to very slow	Slight to medium	*OH*	Organic clays of medium to high plasticity	
Highly Organic Soils		Readily identified by colour, odour, spongy feel and frequently by fibrous texture			*Pt*	Peat and other highly organic soils	



Plasticity Chart
For laboratory classification of fine-grained soils

Note: 1 Soils possessing characteristics of two groups are designated by combinations of group symbols (eg. GW-GC, well graded gravel-sand mixture with clay fines
2 Soils with liquid limits of the order of 35 to 50 may be visually classified as being of medium plasticity

Appendix H

Biodiversity Development Assessment Report – Firebird ecoSultants (2023)

Department of Planning and Environment

(Draft) Biodiversity Development Assessment Report
Proposed Residential Subdivision at
303 Wollombi Road, Farley 2320

Prepared by Sarah Jones, BAAS18020

Site Details:	303 Wollombi Road, Farley 2320 (Lot 4 DP 810894)			
Prepared by:	***Sarah Jones B.Env.Sc., G.Dip.DBPA (Design in Bushfire Prone Areas)*** ***Firebird ecoSultants Pty Ltd*** **A**BN – 16 105 985 993 PO Box 354, Newcastle NSW 2300 M: 0414 465 990 Email: sarah@firebirdeco.com.au T: 02 4910 3939 Fax: 02 4929 2727			
Prepared for:	Vivacity Property			
Reference No.	Farley – Vivacity Property			
Document Status & Date:	Version	Description	Date	Author(s)
	1	Version 1	14/08/2023	Sarah Jones

Summary

Development Description

Firebird ecoSultants Pty Ltd has been engaged by Vivacity Property, to provide a Biodiversity Development Assessment Report (BDAR) for a proposed residential subdivision ('the proposal') and associated infrastructure at 303 Wollombi Road, Farley 2320 (Lot 2 and 4 DP 810894) and ('the site' or 'the subject site'). See Figure 1-1 for the Location Map and Figure 1-2 for the Site Map.

The proposal includes a Torrens title subdivision (2 lots into 207 manufactured homes as well as 47 multi-dwelling sites) of 303 Wollombi Road, Farley 2320 (Lot 4 DP 810894) to provide development space for the construction of 207 dwellings as well as associated infrastructure such as site access, services and asset protection zones (APZ).

The site is ~32 ha in size and is located in the eastern periphery of the residential portion of Farley. The majority of the site is zoned as RU2 Rural Landscape, with the north-eastern corner of the site zoned as R1 General Residential.

The northern western half of the site is covered predominantly in native and exotic grasses with Spotted Gum and Ironbark tree species scattered throughout. Spotted Gum – Ironbark Forest vegetation occurs over the majority of the south eastern half of the site. Forest adjoins the site from the west, south and east. A residential subdivision is being developed in the adjoining property to the north-east. Medium and large rural lots occur to the north across Wollombi Road, followed by an approved subdivision.

There are five ephemeral gullies which occur within the site.

The site does not contain important mapped areas for threatened species or any mapped biodiversity values the site does however the gullies have been identified as Key fish habitat (see map extract below), and will be addressed in the SOEE. This requires consideration of Division 12 of the Fisheries Management Act 1994.

- The proposed operational footprint would include the same areas as the construction footprint indicated in Figure 1-2; that being the developed areas for the residential lots, site access and the APZs.

Refer to Appendix A for Site Plans.

Habitat Assessment

The following describes the habitat attributes of the study area;

• The study area provides open grassland habitat within the site's cleared exotic grassland areas which may provide habitat for species adapted to open areas.

The site contains two medium sized artificial dams in the centre of the site either side of the entry drive and a small dam in the south-east of the site.

• The site contains three Plant Community Types (PCT's) including:
  - PCT 3433: Hunter Coast Foothills Spotted Gum-Ironbark Grassy Forest
  - PCT 3444: Lower Hunter Spotted Gum-Ironbark Forest
  - PCT 4036: Hunter Coast Lake Flats Apple Forest

PCT 3433 covers the majority of the site.

• No Allocasuarinas or casuarinas occur within the study area which are a food source for species such as Calyptorhynchus lathami (Glossy Black-Cockatoo) – as such, the site provides limited habitat for these species.

• The site contains many hollow-bearing trees with variable hollow sizes which would likely provide habitat for a wide range of species, including microbats, hollow-dependant arboreal mammals, woodland birds and in some cases owls; however, none occur within the development footprint.

• The study area contains fallen logs and timber which may provide habitat for reptiles and foraging birds.

• No caves, tunnels, mines or culverts occur within the study area or the site.
• No stick nests occur within the study area or the site (at the time of surveys)
• No flying fox camps occur within or near the site**.**

Measures to avoid and minimise

A Significant Tree Survey has been undertaken within the site. This included trees that would provide habitat for potential threatened species that may utilise the site. All of these identified trees will be retained.

Avoidance and minimisation actions are outlined in Section 7.

Biodiversity Offsets Scheme (BOS) – Threshold Assessment

Based on the supplied plans provided by Perception Planning, the development enters the Biodiversity Offset Scheme due to:

- The proposed development will impact 5.26ha of native vegetation which exceeds the area clearing threshold of the site being 1ha.

Threatened Species

Threatened species that require assessment are initially identified based upon the following criteria:

· the distribution of the species includes the IBRA subregion in which the subject land occurs

· the study area is within any geographic constraints of the distribution of the species within the IBRA subregion.

· the species is associated with any of the PCTs identified within the study area

· the native vegetation cover within an assessment area including a 1500m buffer around the study area is equal to or greater than the minimum required for the species.

· the patch size that each vegetation zone is part of is equal to or greater than the minimum required for that species.

· the species is identified as an ecosystem or species credit species in the Threatened Biodiversity Data Collection.

The process for identifying threatened species which meet the above criteria is completed through the BAM Calculator. The PCTs identified within the study area, patch sizes and native vegetation cover, as outlined in Section 3, were entered into the BAM Calculator and a preliminary list of threatened species were identified.

Impacts, including direct, indirect, prescribed, and serious and irreversible impacts (SAII)

The subject site contains three (3) PCTs two of which contain two (2) separate vegetation zones.

- Vegetation zone 1 (PCT 3433) – Intact: This vegetation zones is made up of an intact canopy stratum, saplings of canopy species, numerous hollow-bearing trees and ground hollows and moderate density of native ground cover.
- Vegetation zone 2 (PCT 3433) – Derived Grassland: this vegetation zone is made up of a mix of native and exotic ground cover, lacking an upper and mid stratum
- Vegetation zone 1 (PCT 3444) – Moderate: This vegetation zone occurs in a moderate condition, with an intact canopy stratum, some hollow-bearing trees, high density of native ground cover. This area also contains a moderate density of shrub layer and some exotic grasses and forbs in the ground layer.
- Vegetation zone 2 (PCT 3444) – Derived Grassland: this vegetation zone is made up of a mix of native and exotic ground cover, lacking an upper and mid stratum
- PCT 4036 occurs on site however this PCT will not be impacted by removal of vegetation as the site has been designed to leave PCT 4036 intact and conserved.

Lower Hunter Spotted Gum Ironbark Forest is an NSW Threatened Ecological Community which has been identified on site within PCT 3433 and PCT 3444. Both of these PCTs will be directly impacted by the proposed vegetation clearing (ha). All PCTs will be indirectly impacted by changes in edge effects, noise, light pollution and dust from construction phase activities and post-development activities.

Most of the direct impacts to these PCT’s occur within vegetation zone 2 which is in a lower condition than vegetation zones 1 and. Impacts to vegetation zone 1 have largely been avoided by the positioning of the development footprint within the northern portion of the site.

All of the hollow-bearing trees and most of the ground hollows on site have been avoided. As such, the proposal has avoided significant impacts to nesting habitat for hollow-dependant threatened species.

It is recommended that the retained areas of the site are protected in perpetuity. See the recommendations in Section 3.1.2 of this BDAR for more information on these mitigation measures. Overall, the recommended mitigation measures would serve to minimise the net area of TEC loss and would ensure that the existing areas of retained TEC are protected.

To offset residual impacts of the proposal upon identified biodiversity values, the proposal would require a total of **7 x PCT 3433 VZ1, 30 x PCT 3433 VZ2 Ecosystem Credits** and **20 x PCT 3444 VZ1, 0 x PCT 3444 VZ2 Ecosystem Credits** (or equivalent).

Serious and Irreversible Impacts

The OEH (2017) *Guidance to Assist a Decision-maker to Determine a Serious and Irreversible Impact* lists the ecological communities and species that are ‘potential serious and irreversible impact (SAII) entities. There are no series and irreversible impact (SAII) entities relevant to this assess.

Mitigation measures

Mitigation measures are proposed to minimise potential impacts to the site's biodiversity values; these are summarised in Table 3-1. These include measures to be implemented in the pre-construction, construction and post-construction phases. It is considered that these measures would serve to minimise any potential direct or indirect impacts.

Final Recommendations

Table E1 Impacts that require an offset – ecosystem credits

Vegetation zone	**PCT**	**TEC/EC**	**Impact area** (ha)	**Number of ecosystem credits required**
VZ 1 Intact-under scrubbed	PCT 3433 - Hunter Coast Foothills Spotted Gum-Ironbark Grassy Forest	Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions	0.28ha	7
VZ 2 Derived Grassland	PCT 3433 - Hunter Coast Foothills Spotted Gum-Ironbark Grassy Forest	Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions	1.9ha	30
VZ 1 Moderate	PCT 3444 - Lower Hunter Spotted Gum-Ironbark Forest	Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions	1.18ha	20
VZ 2 Derived Grassland	PCT 3444 - Lower Hunter Spotted Gum-Ironbark Forest	Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions	1.9ha	0

Table E2 Impacts that require an offset – species credits

Common name	**Scientific name**	**Loss of habitat** (ha) or individuals	**Number of species credits required**

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Shortened forms

APZ	asset protection zone
BAM	Biodiversity Assessment Method
BAM-C	Biodiversity Assessment Method Calculator
BC Act	*Biodiversity Conservation Act 2016* (NSW)
BC Regulation	Biodiversity Conservation Regulation 2017 (NSW)
BDAR	Biodiversity Development Assessment Report
BOAMS	Biodiversity Offsets and Agreement Management System
BOS	Biodiversity Offsets Scheme
CEEC	critically endangered ecological community
DBH	diameter at breast height over bark
EC	ecological community listed under the EPBC Act
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cwlth)
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
EEC	endangered ecological community
HTW	high threat weed
IBRA	Interim Biogeographic Regionalisation for Australia
LLS Act	*Local Land Services Act 2013* (NSW)
MNES	matters of national environmental significance
NPW Act	*National Parks and Wildlife Act 1974* (NSW)
NSW	New South Wales
PCT	plant community type
SAII	serious and irreversible impact
SEARs	Secretary's Environmental Assessment Requirements
TBDC	Threatened Biodiversity Data Collection
TEC	threatened ecological community
VEC	vulnerable ecological community
Vegetation SEPP	*State Environmental Planning Policy (Vegetation in Non-Rural Areas) 2017* (NSW)

Declarations

i. Certification under clause 6.15 *Biodiversity Conservation Act 2016*

I certify that this report has been prepared based on the requirements of, and information provided under, the Biodiversity Assessment Method and clause 6.15 of the *Biodiversity Conservation Act 2016* (BC Act). Signature: Date:11/04/2023 BAM Assessor Accreditation no: BAAS18020

This BDAR has been prepared to meet the requirements of BAM 2020. Appendix A provides an assessment of compliance with the minimum information requirements outlined in BAM Appendix K.

ii. Details and experience of author/s and contributors

Authors and contributors

Name	BAM Assessor Accreditation no. (if relevant)	Position/Role	Tasks performed	Relevant qualifications
Sarah Jones	BAAS18020	Ecologist / Bushfire Planner	Principal Author / Fieldwork	B.Env.Sc., G.DIP.DBPA (Design for Bushfire Prone Areas)
Andrew Carty	BAAS19007	Ecologist/Botanist	Fieldwork	B.Envs.Sc. (Environmental Science)
Ollie Broun	N/A	Ecologist/ Bushfire Planner	Author/Fieldwork	B.Envs.Sc. (Environmental Science)
Kurtis Mumford	N/A	Ecologist/ Bushfire Planner	Fieldwork	B.Envs.Sc. (Environmental Science)

Theo Tasoulis	N/A	Ecologist/ Bushfire Planner	Fieldwork	B.Envs.Sc. (Environmental Science)

iii. Conflict of interest

I declare that I have considered the circumstances and there is no actual, perceived or potential conflict of interest.

This declaration has been made in the interests of full disclosure to the decision-maker. Full disclosure has also been provided to the client.

Signature:

Date: 04/11/2022

BAM Assessor Accreditation no: BAAS 18020

Stage 1: Biodiversity assessment

1. Introduction

Firebird ecoSultants Pty Ltd has been engaged by Vivacity Property, to provide a Biodiversity Development Assessment Report (BDAR) for a proposed residential subdivision and associated infrastructure at 303 Wollombi Road, Farley 2320 (Lot 4 DP 810894). See Figure 1 for Site Map and Figure 2 for the Site Location. This BDAR has been prepared to satisfy the requirements of the Biodiversity Conservation Act 2016 (BC Act). This assessment has been undertaken in accordance with the Biodiversity Assessment Method 2020.

1.1 Proposed development

1.1.1 Development overview

The proposal includes a Torrens title subdivision (2 lots into 207 manufactured homes) of 303 Wollombi Road, Farley 2320 (Lot 4 DP 810894) to provide development space for the construction of 207 dwellings as well as associated infrastructure such as site access, services and asset protection zones (APZ).

The development footprint has largely been located in the northern portion of the site, which is predominately covered by a mixture of native and exotic grasses and weeds.

The proposed development footprint is indicated in Figure 1-2. It totals an area of 12.66 ha of land/vegetation and encompasses the following areas:

- The designated area for residential lots, building envelopes and site access (12.66 ha)
- The site contains 23.962ha of native vegetation. The extent of native vegetation to be assessed in this BDAR (i.e. the area of native vegetation within or potentially impacted by the construction and operational footprint) is 5.26 ha. Derived Grassland found on site consisted of native and exotic grasses was determined by a native grassland assessment conducted in accordance with Appendix A – Method for calculating native vegetation extent in grassland areas that contain a mix of native and exotic species in disturbed plant community types of the document Reviewing Biodiversity Values Map and Threshold Tool area clearing threshold results (DP&E, 2023).

  Therefore, the ha area of Derived Grassland found on site were able to be reduced due to only having a cover percentage of 35% across the site

Table 1-1: Native grassland assessment

Plot (1mx1m)	Native grassland (%)	Exotic grassland (%)
1	100	75
2	100	45
3	100	10
4	95	15
5	100	30

6	100	10
7	100	90
8	95	40
9	90	10
10	100	25
Average	98	35

Given, there is 35% native groundcover using the Native Vegetation Extent adjustment ruleset we can calculate the extent of native vegetation found within Derived Grassland within PCT 3433 and 3444. If there is between 15% and 75% native groundcover – the calculation of native vegetation extent is adjusted by multiplying the proportion (%) of native groundcover by the total area to be cleared Reviewing Biodiversity Values Map and Threshold Tool area clearing threshold results (DP&E, 2023).

Using this ruleset, the extent of native grass cover within the site was calculated by;

PCT 3433 Derived Grassland: 5.6ha x 0.98 (total groundcover) = 5.4

5.4ha x 0.35 (native cover%) = 1.9ha

PCT 3444 Derived Grassland: 5.6ha x 0.98 (total groundcover) = 5.4

5.4ha x 0.35 (native cover%) = 1.9ha

- The proposed operational footprint would include the same areas as the construction footprint indicated in Figure 1; that being the developed areas for the residential lots and site access and the APZs.

Refer to Figure 1 for Site Map and Figure 2 for Location Map.

1.1.2 Location

The site is ~30.39 ha in size and is located in the eastern periphery of the residential portion of Farley. The majority of the site is zoned as RU2 Rural Landscape, with the north-eastern corner of the site zoned as R1 General Residential. The northern western half of the site is covered predominantly in native and exotic grasses with Spotted Gum and Ironbark tree species scattered throughout. Spotted Gum – Ironbark Forest vegetation occurs over the majority of the south eastern half of the site. Forest adjoins the site from the west, south and east. A residential subdivision is being developed in the adjoining property to the north-east. Medium and large rural lots occur to the north across Wollombi Road. There are five ephemeral gullies which occur within the site.

Refer to Figure 1 for Site Map and Figure 2 for Location Map.

1.1.3 Proposed development and the subject land

The proposal includes a Torrens title subdivision (2 lots into 207 manufactured homes as well as 47 multi-dwelling sites) of 303 Wollombi Road, Farley 2320 (Lot 4 DP 810894) to provide development space for the construction of 207 dwellings as well as associated infrastructure such as site access, services, and asset protection zones (APZ).

The study area is the area of land within the site that has been assessed in this report, which is the area of vegetation within the site that is relevant to this BDAR i.e., the area of vegetation within or potentially impacted by the construction and operational footprint. Land within the site that is not considered to be impacted by the proposal (either directly or indirectly) is considered to be outside the study area. In this case however, the entire site was surveyed.

1.1.4 Other documentation

This report has been not been written in conjunction with any other report.

1.2 Biodiversity Offsets Scheme entry

The proposed development area is mapped on the Biodiversity Values Map. In addition, the proposed clearing exceeds the minimum clearing threshold of the area which is 10,000m^{2}. The proposal therefore requires entry into the Biodiversity Offset Scheme.

1.3 Excluded impacts

The proposed development footprint primarily covers the north portion of the site. This area contains a vegetation zone in a lower condition (Vegetation zone 2) which is covered in native and exotic grasses. Only scattered native trees are located within this area, none of which have been identified as habitat trees. PCT 4036 which has a high vegetation integrity score will be wholly avoided by the proposal. Refer to Figure 3 to see the large areas of intact vegetation which have been avoided by the proposal.

Clause 6.8(3) of the BC Act specifies that the BAM is to exclude the assessment of the impacts of any clearing of native vegetation and loss of habitat on category 1-exempt land (as defined in Part 5A of the LLS Act), other than prescribed impacts (as defined in clause 6.1 of the Biodiversity Conservation Regulation 2017 (BC Regulation)). Prescribed impacts must therefore be assessed for category 1-exempt land.

1.4 Matters of national environmental significance

83 MNES records within a 10 km radius of the site were found. These included; 1 Wetland of international importance, 8 listed threatened ecological communities, 56 listed threatened species and 18 listed migratory birds. A review was conducted using the Commonwealth Department of Environment and Energy (DEE), EPBC Act Protected Matters Search Tool.

1.4.1 Database Searches

The following database searches were undertaken, in order to compile a list of threatened flora and fauna species predicted to occur in the area:

- Review of threatened fauna and flora records within a 10 km radius of the site, contained in the OEH Atlas of NSW Wildlife (NSW BioNet).
- Review of the MNES records within a 10 km radius of the site, using the Commonwealth Department of Environment and Energy (DEE), EPBC Act Protected Matters Search Tool.

1.5 Information sources

Information sources reviewed included, but were not limited to:

- Aerial Photograph Interpretation (API)
- Relevant guidelines, including:
  - OEH *Biodiversity Assessment Method*, 2020
  - *Surveying Threatened Plants and their Habitats (DPIE, 2020)*
  - *'Species credit' threatened bats and their habitats: NSW survey guide for the Biodiversity Assessment Method* (OEH, 2018)
  - *NSW Survey Guide for Threatened Frogs: A guide for the survey of frogs and their habitats for the Biodiversity Assessment Method (DPI&E, 2020)*
  - *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (Department of Environment and Conservation (DEC), 2004)
  - Environmental / planning reports relevant to the site / area, including: *Port Stephens Local Environmental Plan 2013*
  - *Maitland LEP 2011*
  - *Maitland (DCP) 2011;*
  - Any environmental / ecological reports relevant to the site or area, including vegetation mapping
  - Online tools and resources, including:
  - State Environmental Planning Policy (Koala Habitat Protection) 2020

BAM Calculator (OEH, 2020)

BioNet Vegetation Classification (OEH, 2020)

BioNet Threatened Biodiversity Data Collection (OEH, 2020)

Directory of Important Wetlands in Australia (Department of Environment

and Energy (DEE), 2010)

NSW Scientific Committee Final Determinations (NSW Scientific

Committee various dates)

Commonwealth Threatened Species Scientific Committee (TSSC) Final Determinations for threatened species (TSSC Various Dates)

OEH Threatened Species, Populations and Ecological Communities website

Commonwealth DEE Species, Profile and Threats Database

PlantNET NSW (Botanic Gardens Trust, 2018).

2. Methods

2.1 Site context methods

2.1.1 Landscape features

Have been determined by the following:

• This section details the landscape features occurring on the Subject Land or within the assessment area (i.e., a 1.5km buffer) surrounding the Subject Land. Refer to Section 3.2.

2.1.2 Native vegetation cover

The site contains ~30 ha of native vegetation. The extent of native vegetation relevant to this BDAR (i.e., the area of native vegetation within or potentially impacted by the construction and operational footprint) is 5.26 ha; see Figure 7 for the native vegetation extent within the site.

The site contains 23.962ha of native vegetation. The extent of native vegetation to be assessed in this BDAR (i.e. the area of native vegetation within or potentially impacted by the construction and operational footprint) is 5.26 ha. Derived Grassland found on site consisted of native and exotic grasses was determined by a native grassland assessment conducted in accordance with Appendix A – Method for calculating native vegetation extent in grassland areas that contain a mix of native and exotic species in disturbed plant community types of the document Reviewing Biodiversity Values Map and Threshold Tool area clearing threshold results (DP&E, 2023).

Therefore, the ha area of Derived Grassland found on site were able to be reduced due to only having a cover percentage of 35% across the site

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Given, there is 35% native groundcover using the Native Vegetation Extent adjustment ruleset we can calculate the extent of native vegetation found within Derived Grassland within PCT 3433 and 3444. If there is between 15% and 75% native groundcover – the calculation of native vegetation extent is adjusted by multiplying the proportion (%) of native groundcover by the total area to be cleared Reviewing Biodiversity Values Map and Threshold Tool area clearing threshold results (DP&E, 2023).

Using this ruleset, the extent of native grass cover within the site was calculated by;

PCT 3433 Derived Grassland: 5.6ha x 0.98 (total groundcover) = 5.4

5.4ha x 0.35 (native cover%) = 1.9ha

PCT 3444 Derived Grassland: 5.6ha x 0.98 (total groundcover) = 5.4

5.4ha x 0.35 (native cover%) = 1.9ha

2.2 Native vegetation, threatened ecological communities and vegetation integrity methods

2.2.1 Existing information

Plant Community Type/s (PCTs) on the site were identified according to the NSW PCT classification described in the BioNet Vegetation Classification.

2.2.2 Mapping native vegetation extent

A patch is defined in the BAM as an area of intact native vegetation that occurs on the subject land. The patch may extend onto adjoining land beyond the footprint of the subject land, and for woody ecosystems, includes native vegetation separated by ≤100 metres from the next area of intact native vegetation. For non-woody vegetation, this gap is reduced to ≤30 metres. Intact vegetation must contain all structural layers (strata) characteristic of the PCT. Plot data should not be solely relied upon when determining whether vegetation is intact. If all structural growth form groups expected to exist within the community are present within the vegetation zone and/or adjoining off-site native vegetation, then the vegetation meets the definition of intact. For example, if all structural growth form groups except the shrub layer are present in the plots but species that belong to the shrub growth form group occur elsewhere within the vegetation zone, then the shrub growth form group is present, and the vegetation is intact.

There are large patches of native vegetation adjacent to the site's native vegetation. There is limited native shrub/ground layer of vegetation within the sites forested areas. This is likely due to the current and historic agricultural land practices in the Farley area. In any case the patch size has been assessed as >100ha.

2.2.3 Plot-based vegetation survey

Plot-based floristic vegetation surveys were undertaken within each PCT area in accordance with s.5.2.1.9 of the BAM on 19 May 2023. The 50 m x 20 m plots were sampled for the presence of flora species; see Figure 2-3 for the plot locations undertaken within the impacted PCTs (the study area) and see Appendix I for photos. The plots were carefully examined to identify all flora species present. This search continued until it was confident that all flora species within the plots were detected. Data collected for each species included:

- Stratum and layers in which each species occurs;
- Growth form for each species;
- Scientific and common name for each species;
- Percentage foliage cover (PFC) across the plot, of each species rooted in or overhanging the plot; and
- Abundance rating for each species.

Plant Community Type/s (PCTs) on the site were identified according to the NSW PCT classification described in the BioNet Vegetation Classification. Three (3) native PCTs have been identified within the site; these PCTs are described below. See Figure 6 for the plot locations undertaken within the impacted PCTs (the study area) and see Appendix I for photos.

2.2.4 Vegetation integrity survey

For the purposes of the BAM, a vegetation zone is an area of native vegetation on the site that is the same PCT and has a similar broad condition state. The site's impacted PCTs have been divided into several vegetation zones (as detailed in Table 2-4) (see Appendix I for photos). A patch size area has been assigned to each vegetation zone, as a class (as detailed in Table 4-3). See Appendix I for photos of each vegetation zone.

The site's impacted PCTs has been categorised into a vegetation zone (as detailed in Table 4-3) (see Appendix I for photos). A patch size area has been assigned to the vegetation zone, as a class (as detailed in Table 4-3).

Vegetation Integrity Scores

Each vegetation zone identified on the site has been surveyed to obtain a quantitative measure for each zone, of the composition, structure and function attributes listed in Table 3 of the BAM. These attributes are listed below:

- Growth form groups used to assess composition and structure:
  - Tree
  - Shrub
  - Grass and grass like
  - Forb
  - Fern
  - Other
- Attributes used to assess function:
  - Number of large trees
  - Tree regeneration
  - Tree stem size class
  - Total length of fallen logs
  - Litter cover
  - High threat exotic vegetation cover
  - Hollow-bearing trees

Plot-based surveys were conducted, in accordance with s.5.3.4 of the BAM on 19 May 2023. Survey plots were established around a central 50m transect and included:

- One 400 m² (20 m x 20 m) plot to assess the composition and structure attributes listed above.
- One 1000 m² (20 m x 50 m) plot to assess the function attributes: number of large trees, stem size class, tree regeneration and length of logs.
- Five 1 m² sub-plots to assess average litter cover (and other optional groundcover components).

See previous Figure 6 for plot locations. Vegetation survey data is provided in Appendix E.

2.3 Threatened flora survey methods

2.3.1 Review of existing information

Threatened species that require assessment are initially identified based upon the following criteria:

- the distribution of the species includes the IBRA subregion in which the subject land occurs

- the study area is within any geographic constraints of the distribution of the species within the IBRA subregion.
- the species is associated with any of the PCTs identified within the study area
- the native vegetation cover within an assessment area including a 1500m buffer around the study area is equal to or greater than the minimum required for the species.
- the patch size that each vegetation zone is part of is equal to or greater than the minimum required for that species.
- the species is identified as an ecosystem or species credit species in the Threatened Biodiversity Data Collection.

The process for identifying threatened species which meet the above criteria is completed through the BAM Calculator. The PCTs identified within the study area, patch sizes and native vegetation cover, as outlined in Section 3, were entered into the BAM Calculator and a preliminary list of threatened species were identified

2.3.2 Field surveys

Refer to Figure 6 Field survey locations

2.4 Threatened fauna survey methods

2.4.1 Review of existing information

The following database searches were undertaken, in order to compile a list of threatened flora and fauna species predicted to occur in the area:

Review of threatened fauna and flora records within a 10 km radius of the site, contained in the OEH Atlas of NSW Wildlife (NSW BioNet).

Review of the MNES records within a 10 km radius of the site, using the Commonwealth Department of Environment and Energy (DEE), EPBC Act Protected Matters Search Tool.

2.4.2 Habitat constraints assessment

The Southern Myotis (*Myotis macropus*) and Little Bentwing-bat (*Miniopterus australis*) are a dual Species and Ecosystem Credit Species (species credit species for breeding habitat). The habitat constraint listed for Southern Myotis (*Myotis Macropus)* species in the Threatened Biodiversity Data Collection (habitat constraint: hollow bearing trees, within 200m of riparian zone /other, includes rivers, creeks billabongs, lagoons, dams and other waterbodies on within 200m of the site) is present within the Study Area. As such, this species was determined as a candidate species. Refer to Figure 11 for Species Polygon. Habitat constrains for *Burhinus grallarius* were also present on site as this species requires fallen/standing dead timer including logs.
Habitat constraints for *Callocephalon fimbriatum* and *Calyptohynchus lathami* were present on site, these being hollow bearing eucalypt tree species the site also contains suitable habitat for *Haliaeetus leucogaster* as well as *Hieraaetus morphnoides* and *Lophoictinia isura* in the form of large mature eucalypt species in close proximity to large bodies of water.

The habitat constraint listed for *Anthochaera phrygia, Calidris canutus, Calidris ferruginea, Calidris tenuirostris, Charadrius leschenaultii, Charadrius mongolus, Lathamus discolor,* *Limicola falcinellus* and *Limosa lapponica baueri* were not present as the site has not been mapped on the important area habitat map.

2.4.3 Field surveys

Targeted species surveys have been undertaken for some of the candidate species credit species in accordance with section 5.3 of the BAM.

The following Table 2-1 identifies whether each of the confirmed candidate species are present or absent, based on the results of the targeted surveys (or assumed presence where targeted surveys have not been undertaken); The following sections 2.4.4.1 to 2.4.4.6 outline the survey effort and results for each species. Table 2-5 shows the weather conditions for each day during the survey effort.

Table 2-1: Presence or Absence of Candidate Species

Species Presence	Confirmed presence
Acacia bynoeana Bynoe's Wattle	No – surveyed
Angophora inopina Charmhaven Apple	No – surveyed
Burhinus grallarius Bush Stone-curlew	No – surveyed
Callistemon linearifolius Netted Bottle Brush	No – surveyed
Callocephalon fimbriatum Gang-gang Cockatoo (Breeding)	To be Surveyed at a later date in accordance with TBDC specified months.
Calyptorhynchus lathami Glossy Black-Cockatoo (Breeding)	To be Surveyed at a later date in accordance with TBDC specified months.
Cercartetus nanus Eastern Pygmy-possum	No – surveyed
Cynanchum elegans *White-Flowered Wax Plant*	No – surveyed
Delmar impar Striped Legless Lizard	No – surveyed
Eucalyptus Glaucina Salty Red Gum	No – surveyed
Eucalyptus parramattensis subsp. Decadens Eucalyptus parramattensis subsp. Decadens	No – surveyed
Eucalyptus pumila Pokolbin Mallee	No – surveyed
Grevillea parviflora subsp. Small-flower grevillea	No – surveyed

Haliaeetus leucogaster White-bellied Sea-Eagle	To be Surveyed at a later date in accordance with TBDC specified months.
Hieraaetus morphnoides Little Eagle	To be Surveyed at a later date in accordance with TBDC specified months.
Hoplocephalus stephensii Stephens' Banded Snake	To be Surveyed at a later date in accordance with TBDC specified months.
Litoria aurea Green and Golden Bell Frog	Surveys for species of threatened frogs will occur at a later date during the TBDC specified months.
Litoria brevipalmata Green-thighed Frog	Surveys for species of threatened frogs will occur at a later date during the TBDC specified months.
Lophoictinia isura Square-tailed Kite	To be Surveyed at a later date in accordance with TBDC specified months.
Myotis macropus Southern Myotis	To be Surveyed at a later date in accordance with TBDC specified months.
Ninox connivens Barking Owl	No – surveyed
Ninox strenua Powerful Owl (Breeding)	No – surveyed
Pandion cristatus Eastern Osprey	No – surveyed
Petauroides volans Southern Greater Glider	No – surveyed
Petauroides norfolcensis Squirrel Glider	No - surveyed
Phascogale tapoatafa Brush-tailed Phascogale	No – surveyed
Phascolarctos cinereus Koala	No – surveyed
Planigale maculata Common Planigale	No – surveyed
Pomaderris queenslandica Scant Pomaderris	No – surveyed
Prasophyllum sp. Wybong Prasophyllum sp. Wybong	To be Surveyed at a later date in accordance with TBDC specified months.
Prostanthera cineolifera Singleton Mint Bush	To be Surveyed at a later date in accordance with TBDC specified months.
Pterostylis chaetophora Pterostylis chaeterophora	To be Surveyed at a later date in accordance with TBDC specified months.

Rutidosis heterogams Heath Wrinklewort	No – surveyed
Spyridium burragorang - endangered population	No – surveyed
Syzygium paniculatum Magenta Lilly Pilly	No – surveyed
Tetratheca juncea Black-eyed Susan	To be Surveyed at a later date in accordance with TBDC specified months.
Tyto novaehollandiae Masked Owl (Breeding)	No – surveyed
Uperoleia mahonyi Mahony's Toadlet	Surveys for species of threatened frogs will occur at a later date during the TBDC specified months.

2.4.4 Targeted surveys for *Acacia bynoeana* (Bynoe's Wattle), *Angophora inopina* (Charmhaven Apple), *Eucalyptus glaucina* (Slaty Red Gum), *Eucalyptus parramattensis* (Parramatta Red Gum),

Areas of Potential Habitat in the Site:

Acacia bynoeana (Bynoe's Wattle), *Angophora inopina* (Charmhaven Apple), *Eucalyptus glaucina* (Slaty Red Gum), *Eucalyptus parramattensis* (Parramatta Red Gum)

Table 2-2: Potential Habitat on the Site for *Acacia bynoeana (Bynoe's Wattle), Angophora inopina (Charmhaven Apple), Eucalyptus glaucina (Slaty Red Gum), Eucalyptus parramattensis (Parramatta Red Gum)*

PCT	Vegetation Zone (VZ)	Potential Habitat?
PCT 3433 - Hunter Coast Foothills Spotted Gum-Ironbark Grassy Forest	Intact	Yes
PCT 3444 - Lower Hunter Spotted Gum-Ironbark Forest	Moderate	Yes

Survey Timing:

The TBCD specifies the appropriate times/months to survey for the above Flora Species as follows;

Acacia bynoeana (Bynoe's Wattle), *Angophora inopina* (Charmhaven Apple), *Eucalyptus glaucina* (Slaty Red Gum) and *Eucalyptus parramattensis* (Parramatta Red Gum) are all able to be surveyed Year-round.

See **Table 2-3** for dates that these species were surveyed on.

Table 2-3 Survey Effort:

Species	Date Surveyed
Acacia bynoeana (Bynoe's Wattle),	21/06/2023
Angophora inopina (Charmhaven Apple),	
Eucalyptus glaucina (Slaty Red Gum),	
Eucalyptus parramattensis (Parramatta Red Gum)	
Acacia bynoeana (Bynoe's Wattle),	

Survey Effort:

- **Field Transect Surveys**

The entirety of the site was systematically traversed by two ecologists to determine the presence of candidate flora species.

Results:

Field surveys conducted on the 21/06/2023 determined the presence of 4 *Eucalyptus parramattensis* (Parramatta Red Gum) as present on site, however the individuals present will not be removed or impacted by the proposal, due to the maintained nature of the site from the presence of livestock and mowing no saplings of the species were recorded as present on site. No other threatened flora species were found within the site despite best surveys efforts.

2.4.4 Targeted surveys for *Cynanchum elegans* (White-Flowered Wax Plant), *Pomaderris queenslandica* (Scant Pomaderris), *Rutidosis heterogama* (Heath Wrinklewort), *Spyridium burragorang*, *Syzygium paniculatum* (Magenta Lilly Pilly)

Areas of Potential Habitat in the Site:

Cynanchum elegans (White-Flowered Wax Plant), *Pomaderris queenslandica* (Scant Pomaderris), *Rutidosis heterogama* (Heath Wrinklewort), *Spyridium burragorang*, *Syzygium paniculatum* (Magenta Lilly Pilly)

Table 2-2: Potential Habitat on the Site for *Cynanchum elegans (White-Flowered Wax Plant), Pomaderris queenslandica (Scant Pomaderris), Rutidosis heterogama (Heath Wrinklewort), Spyridium burragorang, Syzygium paniculatum (Magenta Lilly Pilly)*

PCT	Vegetation Zone (VZ)	Potential Habitat?
PCT 3433 - Hunter Coast Foothills Spotted Gum-Ironbark Grassy Forest	Intact	Yes
PCT 3444 - Lower Hunter Spotted Gum-Ironbark Forest	Moderate	Yes

Survey Timing:

The TBCD specifies the appropriate times/months to survey for the above Flora Species as follows; *Cynanchum elegans* (White-Flowered Wax Plant), *Pomaderris queenslandica* (Scant Pomaderris), *Rutidosis heterogama* (Heath Wrinklewort), *Spyridium burragorang* can be surveyed during any month of the year (Year-Round).
Syzygium paniculatum (Magenta Lilly Pilly): April, May, June
See **Table 2-3** for dates that these species were surveyed on.

Table 2-3 Survey Effort:

Species	Date Surveyed
Cynanchum elegans (White-Flowered Wax Plant)	28/06/2023
Pomaderris queenslandica (Scant Pomaderris)	
Rutidosis heterogama (Heath Wrinklewort)	
Spyridium burragorang	

Syzygium paniculatum (Magenta Lilly Pilly)	

Survey Effort:

- **Field Transect Surveys**

The entirety of the site was systematically traversed by two ecologists to determine the presence of candidate flora species.

Results:

No target flora species were recorded on site despite sufficient survey effort.

2.4.3.1 Koala Assessment Protection SEPP 2021 (This was in the original BDAR document not sure if needed in this one)

A development proposal must be assessed under the development assessment process under the SEPP in LGAs where no approved Koala Plan of Management is in place. The includes all land:

with an area of at least 1 hectare, including adjoining land (meaning land the next cadastre over) within the same ownership, and

that is within an LGA to which the SEPP applies

The site is greater than 1 hectare and Farley occurs within the Maitland LGA which lies within the Central Coast Koala Management Area. There is no Koala Plan of Management for the Maitland LGA and so this development proposal must be assessed under the development assessment process under the Koala Habitat Protection SEPP 2021.

The definition of core koala habitat under the Koala SEPP 2021 includes a reference to highly suitable habitat. Highly suitable habitat is where 15% or greater of the total number of trees within any Plant Community Type (PCT) are the regionally relevant species of those listed in Schedule 2 of the SEPP.

An area of land is defined as – including both the development footprint and the surrounding area that may have indirect impacts from the development (that is contained within the subject lot and adjoining land within the same ownership). The Koala SEPP 2021 applies to both direct and indirect impacts to habitat on the site area, therefore all habitat on the landholding should be considered even if no vegetation is to be cleared, however this does not mean all habitat must be surveyed – see below.

- For development applications, to determine the size of the surrounding area that needs to be surveyed, the suitably qualified person needs to consider the extent of potential indirect impacts from the development, such as vehicle strikes, drowning in pools, increased risk of fire, disturbance, and impediments to movement. It is not always necessary to survey the entire landholding

- Historical koala occupation of the site area is determined by considering koala records within the last 18 years, within the following maximum distances from the external boundary of the site area: o 2.5 kilometres of the site (for North Coast, Central Coast, Central Southern Tablelands, South Coast KMAs).

The field survey undertaken found no evidence of P. cinereus (Koala) occurring in the site. A review of the OEH Atlas of NSW Wildlife indicated no historical records of Koala within the last 18 years.

The isolated nature of the site, lack of scats and no recordings of Koala's suggest that the site would not constitute 'Core Koala Habitat' as defined by SEPP. No further provisions of the Koala Habitat Protection SEPP apply.

2.4.4 Targeted surveys for Large Forest Owls; Ninox strenua (Powerful Owl), Ninox connivens (Barking Owl) and Tyto novaehollandiae (Masked Owl)

Areas of Potential Habitat in the Site:

The survey effort section details the areas of potential habitat on the site for *Ninox strenua* (Powerful Owl), *Ninox connivens* (Barking Owl) and *Tyto novaehollandiae* (Masked Owl).

Table 2-2: Potential Habitat on the Site for *Ninox strenua* (Powerful Owl), *Ninox connivens* (Barking Owl) and *Tyto novaehollandiae* (Masked Owl)

PCT	Vegetation Zone (VZ)	Potential Habitat?
PCT 3433 - Hunter Coast Foothills Spotted Gum-Ironbark Grassy Forest	Intact	Yes
PCT 3444 - Lower Hunter Spotted Gum-Ironbark Forest	Moderate	Yes

Survey Timing:

The TBCD specifies the appropriate times/months to survey for the above Owls, these months include; May, June, July, August. As such these species of Owls were targeted for surveys during these months. See **Table 2-3** for dates that these species were surveyed on.

Table 2-3 Survey Effort:

Species	Date Surveyed
Ninox strenua (Powerful Owl)	25th May 2023
Ninox connivens (Barking Owl)	29th May 2023
Tyto novaehollandiae (Masked Owl)	30th May 2023
	28th June 2023

Survey Effort:

- **Stag watching and quiet listening** – Stag watching and quiet listening was undertaken on four (4) separate nights, with larger hollows begins surveyed to detect the presence of threatened Owl species.

Results – No targeted owl species were seen or heard.

• **Call Playback Surveys** – Targeted call-playback surveys were undertaken for each owl species over four (4) separate nights. This survey method was only used over four (4) nights to limit the risk of potentially disrupting the breeding behaviour of any potentially occurring owls. The call playback method is also known to be unreliable because owls may choose to not respond to the call playback. If owls do respond to call playback the results are potentially misleading because the calls have drawn to bird into or near the site, thus giving misleading results as to the bird's home base.
Results – No targeted owl species were seen or heard.

• **Nocturnal Spotlighting** – The entire site was traversed during night hours on four (4) separate occasions. The purpose of this survey effort was to search for individuals within the site using a hand-held spotlight.
Results – No targeted owl species were seen or heard.

Results:

No targeted owl species were seen or heard despite survey efforts.

2.4.5 Targeted survey for arboreal mammals (excluding microbats); *Cercartetus nanus* (Eastern Pygmy-possum), *Petaurus norfolcensis* (Squirrel Glider), *Petauroides Volans* (Greater Glider) and *Phascogale tapoatafa* (Brush-tailed Phascogale).

Areas of Potential Habitat in the Site:

The survey effort section details the areas of potential habitat on the site for Cercartetus nanus (Eastern Pygmy-possum), *Petaurus norfolcensis* (Squirrel Glider), *Petauroides Volans* (Greater Glider) and *Phascogale tapoatafa* (Brush-tailed Phascogale).

Table 2-4: Potential Habitat on the Site for Cercartetus nanus (Eastern Pygmy-possum), *Petaurus norfolcensis* (Squirrel Glider), *Petauroides Volans* (Greater Glider) *and Phascogale tapoatafa* (Brush-tailed Phascogale).

PCT	Vegetation Zone (VZ)	Potential Habitat?
PCT 3433 - Hunter Coast Foothills Spotted Gum-Ironbark Grassy Forest	Intact	Yes
PCT 3444 - Lower Hunter Spotted Gum-Ironbark Forest	Moderate	Yes

Survey Timing:

The TBCD specifies the appropriate times/months to survey for the above arboreal mammals, the species *Petaurus norfolcensis* (Squirrel Glider) and *Petauroides Volans* (Greater Glider) are able to be surveyed year-round where-as,
Cercartetus nanus (Eastern Pygmy-possum); January, February, March, October, November, December.
Phascogale tapoatafa (Brush-tailed Phascogale); January, February, March, April, May, June, December.
As such targeted surveys were conducted during the specified months. See **Table 2-5** for dates that these species were surveyed on.

Table 2-5 Survey Effort:

Species	Date Surveyed
Spotlighting/Stag watching	
Petaurus norfolcensis (Squirrel Glider)	25th May 2023 29th May 2023 30th May 2023 28th June 2023
Petauroides Volans (Greater Glider)	
Phascogale tapoatafa (Brush-tailed Phascogale)	
Camera Trapping	
Petaurus norfolcensis (Squirrel Glider)	14th April 2023 – 28th March 2023
Petauroides Volans (Greater Glider)	
Phascogale tapoatafa (Brush-tailed Phascogale)	
Spotlighting/Stag watching	
Cercatetus nanus (Eastern Pygmy-possum)	
Elliot Trapping	
Cercatetus nanus (Eastern Pygmy-possum)	

Survey Effort:

- **Stag watching** – Stag watching was undertaken on four (4) separate nights (see **table 2-5** for surveyed dates), with suitable stags/ hollows being monitored for emergent movement of targeted species from dusk until nightfall.
Results – No targeted species were seen or heard.

- **Nocturnal Spotlighting** – The entire site was traversed during night hours on four (4) separate nights (see **table 2-5** for surveyed dates). The purpose of this survey effort was to search for individuals within the site using a hand-held spotlight.
Results – No targeted owl species were seen or heard.

- **Elliot Trapping** – Elliot trapping was deployed to determine the presence of *Cercatetus nanus* (see **Table 2-5** for surveyed dates).

Results:

No targeted arboreal mammal species were seen or captured on camera during targeted species surveys despite suitable survey practices. Elliot trapping will occur on site at a later date in accordance with Bam threatened species survey guidelines.

2.4.6 Targeted survey for microbats *Myotis macropus* (Southern Myotis)

Areas of Potential Habitat in the Site:

The survey effort section details the areas of potential habitat on the site for *Myotis Macropus* (Southern Myotis).

Table 2-8: Potential Habitat on the Site for *Myotis macropus* (Southern Myotis).

PCT	Vegetation Zone (VZ)	Potential Habitat?
PCT 3433 - Hunter Coast Foothills Spotted Gum-Ironbark Grassy Forest	Intact	Yes
PCT 3444 - Lower Hunter Spotted Gum-Ironbark Forest	Moderate	Yes

Survey Timing:

The TBCD specifies the appropriate times/months to survey for microbats, as such the *Myotis macropus* can only be surveyed during the months of; January, February, March, April, May, June, December. As such targeted surveys were conducted during the specified months. See **Table 2-9** for dates that these species were surveyed on.

Table 2-9 Survey Effort:

Species	Date Surveyed
ANABAT Recorders	
Myotis macropus (Southern Myotis)	28th March 2023 – 3rd April 2023

Survey Effort:

- **ANABAT Recorders** – Three (3) ANABAT we deployed on site to recorded possible calls of passing microbats during flight, this is used to detect species of microbats using the site for foraging and/or breeding purposes. (See **table 2-9 Survey effort** for survey dates).

Results:

Surveys are to be conducted at later date in accordance with TBDC survey timing guidelines.

2.4.7 Targeted survey for Avian species; *Callocephalon fimbriatum* (Gang-gang Cockatoo), *Calyptorhynchus lathmi* (Glossy Black-Cockatoo), *Haliaeetus leucogaster* (White-bellied Sea-Eagle), *Hieraaetus morphnoides* (Little Eagle) and *Lophoictinia isura* (Square-tailed Kite)

Areas of Potential Habitat in the Site:

The survey effort section details the areas of potential habitat on the site for *Callocephalon fimbriatum (Gang-gang Cockatoo), Calyptorhynchus lathmi (Glossy Black-Cockatoo), Haliaeetus leucogaster (White-bellied Sea-Eagle), Hieraaetus morphnoides (Little Eagle) and Lophoictinia isura (Square-tailed Kite).*

Table 2-10: Potential Habitat on the Site for *Callocephalon fimbriatum (Gang-gang Cockatoo), Calyptorhynchus lathmi (Glossy Black-Cockatoo), Haliaeetus leucogaster (White-bellied Sea-Eagle), Hieraaetus morphnoides (Little Eagle) and Lophoictinia isura (Square-tailed Kite)*.

PCT	Vegetation Zone (VZ)	Potential Habitat?
PCT 3433 - Hunter Coast Foothills Spotted Gum-Ironbark Grassy Forest	Intact	Yes
PCT 3444 - Lower Hunter Spotted Gum-Ironbark Forest	Moderate	Yes

Survey Timing:

The TBCD specifies the appropriate times/months to survey for the avian species these months include;

Burhinus grallarius (Bush Stone-curlew): Year-round (All months)

Callocephalon fimbriatum (Gang-gang Cockatoo): January, October, November, December

Calyptorhynchus lathmi (Glossy Black-Cockatoo): January, February, Marc, April, May, June, July, August, September

Haliaeetus leucogaster (White-bellied Sea-Eagle): July, August, September, October, November, December

Hieraaetus morphnoides (Little Eagle): August, September, October

Lophoictinia isura (Square-tailed Kite): January, October, November, December

As such targeted surveys were conducted during the specified months. See **Table 2-11 survey effort** for dates that these species were surveyed on**.**

Table 2-11 Survey Effort:

Species	Date Surveyed
Diurnal/Dusk Bird Watching	
*Burhinus grallarius (*Bush Stone-curlew)	21/06/2023 28/06/2023
Callocephalon fimbriatum (Gang-gang Cockatoo)	Surveys to be conducted during September in accordance with TBDC survey guidelines.
Calyptorhynchus lathmi (Glossy Black-Cockatoo)	Surveys to be conducted during September in accordance with TBDC survey guidelines.
Haliaeetus leucogaster (White-bellied Sea-Eagle)	Surveys to be conducted during September in accordance with TBDC survey guidelines.
Hieraaetus morphnoides (Little Eagle)	Surveys to be conducted during September in accordance with TBDC survey guidelines.
Lophoictinia isura (Square-tailed Kite)	Surveys to be conducted during September in accordance with TBDC survey guidelines.

Survey Effort:

- **Diurnal Bird Surveys –** The site was traversed during the day, monitoring large mature trees for sign of nesting or perching by predatory bird species as well as observing large stick and log piles for activity of *Burhinus gralllarius* (Bush Stone-curlew). Time was also spent listening out for possible calls of adult and juvenile individuals.
  Results – No species were recorded

- **Dusk Bird Surveys –** Large hollow bearing trees with large hollows for cockatoo species were monitored in the hours leading up to dusk for signs of roosting threatened avian species
  Results – Surveys to be conducted during September in accordance with TBDC survey guidelines.

Results: (update after surveys are complete)

No targeted avian species were sighted or heard on site during targeted species surveys despite suitable survey practices/effort. Raptor species are to be surveyed during September coinciding with BAM species survey guidelines.

2.4.8 Targeted survey for Frog Species; Litoria aurea (Green and Golden Bell Frog), Litoria brevipalmata (Green-thighed Frog), Crinia tinnula (Wallum Froglet) & Uperoleia mahonyi (Mahoney Toadlet)

Areas of Potential Habitat in the Site:

The survey effort section details the areas of potential habitat on the site for *Litoria aurea (Green and Golden Bell Frog), Litoria brevipalmata (Green-thighed Frog) & Uperoleia mahonyi (Mahoney Toadlet)*

Table 2-12: Potential Habitat on the Site for *Litoria aurea (Green and Golden Bell Frog), Litoria brevipalmata (Green-thighed Frog) & Uperoleia mahonyi (Mahoney Toadlet)*

PCT	Vegetation Zone (VZ)	Potential Habitat?
PCT 3433 - Hunter Coast Foothills Spotted Gum-Ironbark Grassy Forest	Intact	Yes
PCT 3444 - Lower Hunter Spotted Gum-Ironbark Forest	Moderate	Yes

Survey Timing:

The TBCD specifies the appropriate times/months to survey for the amphibian species these months include;

Litoria aurea (Green and Golden Bell Frog): January, February, March, November, December

Litoria brevipalmata (Green-thighed Frog): January, February, March, November, December

Uperoleia mahonyi (Mahony's Toadlet): January, February, March, October, November, December

As such targeted surveys were conducted during the specified months. See **Table 2-13 survey effort** for dates that these species were surveyed on**.**

Table 2-13 Survey Effort:

Species	Date Surveyed
Spotlighting/Call surveys	
Litoria aurea (Green and Golden Bell Frog)	Surveys for species of threatened frogs will occur at later date during the TBDC specified months.
Litoria brevipalmata (Green-thighed Frog)	
Uperoleia mahonyi (Mahony's Toadlet)	

Survey Effort:

- **Spotlighting –** The sites watercourses/bodies were monitored for the presence of threatened species.

Results – Surveys are to be conducted at later date in accordance with BAM survey guidelines.

- **Call Surveys –** Call playback surveys, species calls were played followed by quite listening to identify possible call-backs form targeted amphibian species.
Results – Surveys are to be conducted at later date in accordance with BAM survey guidelines.

Results: (update after surveys are complete)

Surveys are to be conducted at later date in accordance with BAM survey guidelines.

2.4.9 Targeted survey for Herpetofauna *Delmar impar* (Striped Legless Lizard), *Hoplocephalus stephensii* (Stephens' Banded Snake)

Areas of Potential Habitat in the Site:

The survey effort section details the areas of potential habitat on the site for *Delmar impar* (Striped Legless Lizard)*, Hoplocephalus stephensii* (Stephens' Banded Snake).

Table 2-8: Potential Habitat on the Site for *Litoria aurea (Green and Golden Bell Frog), Litoria brevipalmata (Green-thighed Frog), Crinia tinnula (Wallum Froglet) & Uperoleia mahonyi (Mahoney Toadlet)*

PCT	Vegetation Zone (VZ)	Potential Habitat?
PCT 3433 - Hunter Coast Foothills Spotted Gum-Ironbark Grassy Forest	Intact	Yes
PCT 3444 - Lower Hunter Spotted Gum-Ironbark Forest	Moderate	Yes

Survey Timing:

The TBCD specifies the appropriate times/months to survey for the amphibian species these months include;
Delmar impar (Striped Legless Lizard); September, October, November, December.
Hoplocephalus stephensii (Stephens' Banded Snake)**;** January, February, March, October, November, December.

As such targeted surveys were conducted during the specified months. See **Table 2-9 survey effort** for dates that these species were surveyed on**.**

Table 2-9 Survey Effort:

Species	Date Surveyed
Spotlighting/Call surveys	
Delmar impar (Striped Legless Lizard)	
Hoplocephalus stephensii (Stephens' Banded Snake)	

Survey Effort:

- **Transect Surveys –** Site was traversed looking under fallen timber and other debris for presence of threatened species.

Results – Surveys are to be conducted at later date in accordance with BAM survey guidelines

Results: (update after surveys are complete)

Surveys are to be conducted at later date in accordance with BAM survey guidelines.

Further Assessment of Candidate Species

N/A

Refer to Figure 6 Field survey locations

2.5 Weather conditions

Table 2-6: Environmental conditions during threatened species surveys

Survey Date	Conditions	
	Rainfall (mm)	Temperature
14/04/2023	4.5mm	14.6 – 23.1°
25/05/2023	0mm	1.8 – 23.4°
28/05/2023	0mm	16.4 – 4°
29/05/2023	0mm	7.3 – 21.5°
30/05/2023	0mm	7.7 – 20.7°
21/06/2023	0mm	-1.2 – 16.6°
28/06/2023	0mm	4.5 – 9.4°

2.6 Limitations

Surveys for multiple species are to be undertaken at later dates in accordance with BAM survey guidelines.

Licensing

Research was conducted under the following licences:

- NSW National Parks and Wildlife Service Scientific Investigation Licence SL100533;
- Animal Research Authority (Trim File No: TRIM 11/5655) issued by NSW Department of Primary Industries; and
- Animal Care and Ethics Committee Certificate of Approval (Trim File No: TRIM 11/5655) issued by Department of Primary Industries.

3. Site context

3.1 Assessment area

The study area is the area of land within the site that has been assessed in this report, which is the area of vegetation within the site that is relevant to this BDAR i.e., the area of vegetation within or potentially impacted by the construction and operational footprint. Land within the site that is not considered to be impacted by the proposal (either directly or indirectly) is considered to be outside the study area. In this case however, the entire site as surveyed.

3.2 Landscape features

Landscape features identified within the subject land and assessment area are shown on Figure 1 Site Map and Figure 2 Location Map, respectively. A discussion of relevant patch landscape features is provided below.

3.2.1 IBRA bioregions and IBRA subregions

Dominant landscape forms have been used to divide Australia into bioregions. The site is within the Sydney Basin IBRA bioregion and the Hunter IBRA subregion. The Upper Hunter IBRA subregion occurs close to the site, with the nearest adjacent subregion boundary being approximately ~5 km north of the site. See previous Figure 1-1 for the locations of IBRA regions/subregions within 1.5 km of the site

3.2.2 Rivers, streams, estuaries, and wetlands

There are five drainage canals which occur within the site. One 2nd order watercourse (in accordance with the Strahler stream ordering system in Appendix 3 of the BAM) enters the site from the south and diverts into three 1st order watercourses which extent into the northern portion of the site. One 1st order watercourse enters the south-east corner of the site and extends along the eastern boundary. (in accordance with the Strahler stream ordering system in Appendix 3 of the BAM). See previous Figure 1-1 for watercourses within 1.5 km of the site

3.2.3 Habitat connectivity

The site native vegetation extends onto larger highly fragmented patches of intact native vegetation, with the majority of the surrounding land being cleared for agricultural and residential purposes.

3.2.4 Karst, caves, crevices, cliffs, rocks, or other geological features of significance

No karst, caves, crevices, or cliffs were located on the site or within a 1,500 m buffer around the site.

3.2.5 Areas of outstanding biodiversity value

Under the BC Act, the Minister for the Environment may declare Areas of Outstanding Biodiversity Value (AOBV). These are special areas that contain irreplaceable biodiversity values that are considered important to NSW, Australia or globally. No listed AOBV occur within the site or within a 1,500 m buffer around the site.

3.2.6 NSW (Mitchell) landscape

Mitchell Landscapes are used to describe areas in NSW in a broad sense and group together areas with relatively homogenous geomorphology, soils and broad vegetation types and are mapped at a scale of 1:250000. The subject site is within the Newcastle Coastal Ramp landscape. This landscape region has an estimated cleared fraction of 0.54. See previous Figure 1-1 for the locations of Mitchell Landscapes within 1.5 km of the site.

3.2.7 Additional landscape features identified in SEARs

N/A

3.2.8 Soil hazard features

No soil hazards were identified on the site, however acid sulphate soil risk mapping from Esapde (NSW Soil and Land information) shows soil hazards within 600m of the site.

3.3 Native vegetation cover

All areas of native vegetation cover, within the site and within a 1,500 m buffer area surrounding the site, have been mapped; see Figure 3-1. It is estimated, from this mapping, that the native vegetation cover would be 50%.

Table 3-1: Native vegetation cover in the assessment area

Assessment area (ha)	~5.26ha
Total area of native vegetation cover (ha)	~19.85ha
100	100%
Class (0-10, >10-30, >30-70 or >70%)	>70%

4. Native vegetation, threatened ecological communities and vegetation integrity

4.1 Native vegetation extent

Refer to Figure 7 Native vegetation extent

4.1.2 Areas that are not native vegetation

Derived Grassland found on site consisted of native and exotic grasses was determined by a native grassland assessment conducted in accordance with Appendix A – Method for calculating native vegetation extent in grassland areas that contain a mix of native and exotic species in disturbed plant community types of the document Reviewing Biodiversity Values Map and Threshold Tool area clearing threshold results (DP&E, 2023).

Therefore, the ha area of Derived Grassland found on site were able to be reduced due to only having a cover percentage of 35% across the site

Table 1-1: Native grassland assessment

Plot (1mx1m)	Native grassland (%)	Exotic grassland (%)
1	100	75
2	100	45
3	100	10
4	95	15
5	100	30
6	100	10
7	100	90
8	95	40
9	90	10
10	100	25
Average	98	35

Given, there is 35% native groundcover using the Native Vegetation Extent adjustment ruleset we can calculate the extent of native vegetation found within Derived Grassland within PCT 3433 and 3444. If there is between 15% and 75% native groundcover – the calculation of native vegetation extent is adjusted by multiplying the proportion (%) of native groundcover by the total area to be cleared Reviewing Biodiversity Values Map and Threshold Tool area clearing threshold results (DP&E, 2023).

Using this ruleset, the extent of native grass cover within the site was calculated by;

PCT 3433 Derived Grassland: 5.6ha x 0.98 (total groundcover) = 5.4

5.4ha x 0.35 (native cover%) = 1.9ha

PCT 3444 Derived Grassland: 5.6ha x 0.98 (total groundcover) = 5.4

5.4ha x 0.35 (native cover%) = 1.9ha

Using this calculation, we can assess that within the development area there is 7.4ha of exotic vegetation.

4.2 Plant community types

4.2.1 Identifying Plant Community Types

Review of Existing Information

Table 4-1 Review of Existing Information on the Site's PCTs

Vegetation Mapping Project	Response
Greater Hunter Native Vegetation Mapping v4.0. VIS ID 3855	Three PCT's have been mapped within the site: • PCT 3433 – Hunter Coast Foothills Spotted Gum-Ironbark Grassy Forest.
	• PCT 3444 – Lower Hunter Spotted Gum-Ironbark Forest
	• PCT 4036 – Hunter Coast Lake Flats Apple Forest

The PCT's identified within the site were found to be consistent with the PCT's mapped on the Greater Hunter Native Vegetation Mapping v4.0. VIS ID 3855. The distribution of the site's PCTs is indicated in figure 8. See Appendix I. for photos.

4.2.2.1 PCT overview

Table 4-2 Plant Community Types within the site that are impacted by the proposal

PCT 3433 – Hunter Coast Foothills Spotted Gum-Ironbark Grassy Forest	
PCT ID	3433
PCT name	Hunter Coast Foothills Spotted Gum-Ironbark Grassy Forest
Vegetation formation	Dry Sclerophyll Forests (Shrub/ grass sub- formation)
Vegetation class	Hunter-Macleay Dry Sclerophyll Forests
Per cent cleared value (%)	69%
Extent within subject land (ha)	20.1
PCT 3444 – Lower Hunter Spotted Gum-Ironbark Forest	
PCT ID	3444
PCT name	Lower Hunter Spotted Gum-Ironbark Forest
Vegetation formation	Dry Sclerophyll Forests (Shrub/ grass sub- formation)
Vegetation class	Hunter-Macleay Dry Sclerophyll Forests
Per cent cleared value (%)	62%
Extent within subject land (ha)	7.84
PCT 4036 – Hunter Coast Lake Flats Apple Forest	

PCT ID	4036
PCT name	Hunter Coast Lake Flats Apple Forest
Vegetation formation	Forested Wetland
Vegetation class	Coastal Floodplain Wetland
Per cent cleared value (%)	85%
Extent within subject land (ha)	2.65

4.2.2.2 Condition states

The sites two PCT's 3433 and 4036 have been classed as intact-Under-scrubbed and intact respectively, this is due to intact canopy stratum with large mature trees consisting of hollow bearing trees, along with ground cover stratums consisting of high abundance of native species, it is noted that these PCT's currently have cattle grazing occurring within. PCT 3444 has been classed as disturbed due to having few trees and a high abundance of exotic ground cover species, this PCT is also used for cattle grazing purposes.

4.2.2.3 Justification of PCT selection

Surveys undertaken by Firebird ecoSultants have confirmed the presence of several typical species associated with PCT 3433, including; *Corymbia maculata* (Spotted Gum), *Eucalyptus siderophloia* (Grey ironbark), *Microlaena stipoides* (Weeping Grass), *Panicum simile* (two colour panic).

PCT 3444, including; *Eucalyptus siderophloia* (Grey ironbark), *Eucalyptus crebra* (Narrow-leaved Ironbark), *Microlaena stipoides* (Weeping Grass), *Eragrostis brownie* (Brown Lovegrass)

PCT 4036, including; *Eucalyptus tereticornis* (Forest Red Gum), *Microlaena stipoides* (Weeping Grass), *Eragrostis brownie* (Brown Lovegrass), *Hydrocotyle sibthorpioides*.

4.2.2.5 Alignment with EPBC Act listed ECs

N/A

4.3 Threatened ecological communities

PCT 3433 is associated with the endangered ecological community: Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions.

PCT 3444 is associated with the endangered ecological community: Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions.

PCT 4036 has no associated TEC/EC.

4.4 Vegetation zones

For the purposes of the BAM, a vegetation zone is an area of native vegetation on the site that is the same PCT and has a similar broad condition state. The site's impacted PCTs have been divided into several vegetation zones (as detailed in Table 4-3) (see Appendix I for photos). A patch size area has been assigned to each vegetation zone, as a class (as detailed in Table 4-3). See Appendix I for photos of each vegetation zone

Table 4-3 Vegetation zones and patch sizes

PCT	Vegetation Zone (VZ) Name	VZ total area (Ha)	Vegetation Zone Description	Patch Size Class
3433 - Hunter Coast Foothills Spotted Gum-Ironbark Grassy Forest	VZ 1: Intact Under-Scrubbed	10	PCT 3433 has been classed as intact-Under-scrubbed, this is due to intact canopy stratum with large mature trees consisting of multiple hollow bearing trees, along with a ground cover stratum consisting of a high abundance of native species, it is noted that this PCT currently has cattle grazing occurring within.	101
	VZ 2: Derived Grassland	10.1	This vegetation zone has been classified as derived grassland as it is lacking in a canopy and mid stratum, this veg zone predominantly consists of exotic and native grasses.	101
3444 - Lower Hunter Spotted Gum-Ironbark Forest	VZ1: Disturbed	1.59	PCT 3444 has been classed as disturbed due to having few trees and a high abundance of exotic ground cover species, this PCT is also used for cattle grazing purposes.	101
	VZ 2: Derived Grassland	6.25	This vegetation zone has been classified as derived grassland as it is lacking in a canopy and mid stratum, this veg zone predominantly consists of exotic and native grasses.	101
4036 - Hunter Coast Lake Flats Apple Forest	VZ1: Intact	2.65	PCT 4036 has been classed as intact respectively, this is due to intact canopy stratum with large mature trees consisting of hollow bearing trees, along with ground cover stratums consisting of high abundance of native species, it is noted that this PCT currently has cattle grazing occurring within.	101

4.5 Vegetation integrity (vegetation condition)

4.5.1 Vegetation integrity survey plots

Each vegetation zone identified on the site has been surveyed to obtain a quantitative measure for each zone, of the composition, structure and function attributes listed in Table 3 of the BAM. These attributes are listed below:

• Growth form groups used to assess composition and structure:

- Tree
- Shrub
- Grass and grass like
- Forb
- Fern
- Other

• Attributes used to assess function:

- Number of large trees
- Tree regeneration
- Tree stem size class
- Total length of fallen logs
- Litter cover
- High threat exotic vegetation cover
- Hollow-bearing trees

Plot-based surveys were conducted, in accordance with s.5.3.4 of the BAM, by one ecologist on 22nd February 2021 and April 1st 2021. Survey plots were established around a central 50m transect and included:

- One 400 m² (20 m x 20 m) plot to assess the composition and structure attributes listed above.
- One 1000 m² (20 m x 50 m) plot to assess the function attributes: number of large trees, stem size class, tree regeneration and length of logs.
- Five 1 m² sub-plots to assess average litter cover (and other optional groundcover components).

See previous Figure 6 for plot locations. Plot data is provided in Appendix E. Table 4-4 details the Vegetation Integrity Score.

4.5.2 Scores

Table 4-4 Vegetation Integrity Score

PCT	Vegetation Zone (VZ)	Composition Score	Structure Condition Score	Function Condition Score	Vegetation Integrity Score
3433 - Hunter Coast Foothills Spotted Gum-Ironbark Grassy Forest	VZ 1: Intact Under-Scrubbed	55.9	71.5	28.8	48.6
	VZ 2: Derived – Grassland	51.3	41.5	15	31.7
3444 - Lower Hunter Spotted Gum-Ironbark Forest	VZ1: Disturbed	33.4	57.3	19.8	33.6
	VZ 2: Derived – Grassland	29.1	40.7	1.3	11.5

4.5.3 Use of benchmark data

Table 4-5: Zone Composition Benchmark Data:

PCT or vegetation class	Vegetation Zone	Tree	Shrub	Grass & Grass like	Forb	Fern	Other
3433 - Hunter Coast Foothills Spotted Gum-Ironbark Grassy Forest	VZ 1: Intact Under-Scrubbed	5	12	11	11	2	5
	VZ 2: Derived – Grassland	5	12	11	11	2	5
3444 - Lower Hunter Spotted Gum-Ironbark Forest	VZ1: Disturbed	5	12	11	11	2	5
	VZ 2: Derived – Grassland	5	12	11	11	2	5

Table 4-6: Zone Structure Benchmark Data:

PCT or vegetation class	Vegetation Zone	Tree	Shrub	Grass & Grass like	Forb	Fern	Other
3433 - Hunter Coast	VZ 1: Intact Under-Scrubbed	55	34	66	8	1	4

Foothills Spotted Gum-Ironbark Grassy Forest	VZ 2: Derived – Grassland	55	34	66	8	1	4
3444 - Lower Hunter Spotted Gum-Ironbark Forest	VZ1: Disturbed	55	34	66	8	1	4
	VZ 2: Derived – Grassland	55	34	66	8	1	4

Table 4-7: Zone Function Benchmark Data:

PCT or vegetation class	Vegetation Zone	Number of Large Trees	Litter Cover	Length of Fallen Logs	Stem size class	Tree regeneration <5cm diameter	High Threat Weed Cover
3433 - Hunter Coast Foothills Spotted Gum-Ironbark Grassy Forest	VZ 1: Intact Under-Scrubbed	3	65	45	4	Present	0
	VZ 2: Derived – Grassland	3	65	45	4	Present	0
3444 - Lower Hunter Spotted Gum-Ironbark Forest	VZ1: Disturbed	3	65	45	4	Present	0
	VZ 2: Derived – Grassland	3	65	45	4	Present	0

Hollow bearing Trees occur onsite however the proposal has been designed to avoid the removal of any hollow bearing trees on site.

5. Habitat suitability for threatened species

5.1 Identifying Threatened Species for Assessment

Threatened species that require assessment are initially identified based upon the following criteria:

• the distribution of the species includes the IBRA subregion in which the subject land occurs

• the study area is within any geographic constraints of the distribution of the species within the IBRA subregion.

• the species is associated with any of the PCTs identified within the study area

• the native vegetation cover within an assessment area including a 1500m buffer around the study area is equal to or greater than the minimum required for the species.

• the patch size that each vegetation zone is part of is equal to or greater than the minimum required for that species.

• the species is identified as an ecosystem or species credit species in the Threatened Biodiversity Data Collection.

The process for identifying threatened species which meet the above criteria is completed through the BAM Calculator. The PCTs identified within the study area, patch sizes and native vegetation cover, as outlined in Section 3, were entered into the BAM Calculator and a preliminary list of threatened species were identified.

5.2 Identification of threatened species for assessment

Table 5-1 Predicted ecosystem credit species

Ecosystem Credit Species	Habitat Constraints	Veg Zone - Confirmed Predicted Species	Justification when not confirmed for a Veg Zone	BC Act listing	EPBC Act listing
Anthochaera phrygia Regent Honeyeater (Foraging)	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	CE	CE
Artamus cyanopterus cyanopterus Dusky Woodswallow		PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes		V	-

Botaurus poiciloptilus Australasian Bittern	• Waterbodies = yes • Brackish or freshwater wetlands = no • East of Cessnock = yes	PCT 4036 VZ1 = Yes	N/A	E	E
Callocephalon fimbriatum Gang-gang Cockatoo (Foraging)	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	V	E
Calyptorhynchus lathami Glossy Black-Cockatoo (Foraging)	• Presence of Allocasuarina and casuarina species = no	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	No Allocasuarina and casuarina species present in this PCT (Double Check this)	V	V
Chthonicola sagittata Speckled Warbler	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	V	-
Circus assimilis Spotted Harrier	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	V	-
Climacteris picumnus victoriae Brown Treecreeper (eastern subspecies)	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	V	-
Daphoenositta chrysoptera Varied Sittella	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	V	-
Dasyurus maculatus Spotted-tailed Quoll	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	V	E
Ephippiorhynchus asiaticus Black-necked Stork	• Shallow, open freshwater or saline wetlands or	PCT 3433 VZ1 = No PCT 3444 VZ1 = No	The sites dam's only occur as small artificial dams – the dams would not be considered as an open freshwater wetland.	E	-

	shallow edges of deeper wetlands within 300m of these swamps. • Waterbodies, Shallow lakes, lake margins and estuaries within 300m of these waterbodies				
Falco subniger Black Falcon	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	V	-
Falsistrellus tasmaniensis Eastern False Pipistrelle	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	V	-
Glossopsitta pusilla Little Lorikeet	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	V	-
Haliaeetus leucogaster White-bellied Sea Eagle (Foraging)	• Within 1km of a rivers, lakes, large dams or creeks, wetlands and coastlines	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	The site is not within 1 km of rivers, lakes, large dams or creeks, wetlands and coastlines. Although there are dams in the local area, these are small farm dams only.	V	-
Hieraaetus morphnoides Little Eagle (Foraging)	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	V	-
Hirundapus caudacutus White-throated Needletail	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	-	V
Ixobrychus flavicollis	• Land within 40 m of freshwater and	PCT 3433 VZ1 = No	The site is not within freshwater and estuarine wetlands, in areas of	V	-

Black Bittern	estuarine wetlands, in areas of permanent water and dense vegetation	PCT 3444 VZ1 = No	permanent water and dense vegetation. The sites Dams do not contain dense vegetation suitable to this species.		
Lathamus discolor Swift Parrot (Foraging)	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	E	CE
Limicola falcinellus Broad-billed Sandpiper (Foraging)	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	The site is not within a mapped area for this species	V	-
Lophoictinia isura Square-tailed Kite (Foraging)	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	V	-
Melithreptus gularis gularis Black-chinned Honeyeater (eastern subspecies)	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	V	-
Micronomus norfolkensis Eastern Coastal Free-tailed Bat	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	V	-
Miniopterus australis Little Bentwing-bat (Foraging)	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	V	-
Miniopterus** orianae **oceanensis Large Bentwing-bat (Foraging)	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	V	-
Neophema pulchella Turquoise Parrot	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	V	-

Ninox connivens Barking Owl (Foraging)	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	V	-
Ninox strenua Powerful Owl (Foraging)	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	V	-
Nyctophilus corbeni Corben's Long-eared Bat	-	PCT 3433 VZ1 = Yes	N/A	V	-
Pandion cristatus Eastern Osprey (Foraging)	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	V	-
Petaurus australis Yellow-bellied Glider	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	V	V
Petroica boodang Scarlet Robin	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	V	-
Petroica phoenicea Flame Robin	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	V	-
Pomatostomus temporalis temporalis Grey-crowned Babbler (Eastern subspecies)	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	V	-
Pseudomys novaehollandiae New Holland Mouse	-				
Pteropus poliocephalus Grey-headed Flying-fox (Foraging)	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	V	V
Saccolaimus flaviventris	-	PCT 3433 VZ1 = Yes	N/A	V	-

Yellow-bellied Sheathtail-bat		PCT 3444 VZ1 = Yes			
Scoteanax rueppellii Greater Broad-nosed Bat	-	PCT 3433 VZ1 = Yes	N/A	V	-
Stagonopleura guttata Diamond Firetail	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	V	-
Tyto longimembris Eastern Grass Owl	-	PCT 3433 VZ1 = Yes	N/A	V	-
Tyto novaehollandiae Masked Owl (Foraging)	-	PCT 3433 VZ1 = Yes PCT 3444 VZ1 = Yes	N/A	V	-

5.1.2 Species credit species

Species credit species (or candidate species) are those where the likelihood of occurrence of the species or elements of suitable habitat for the species, cannot be confidently predicted by vegetation surrogates and landscape features and can be reliably detected by survey. The TBDC has identified several candidate species as requiring assessment, for the proposal; these are listed in Table 5-2. Table 5-3 also provides an assessment of habitat suitability for candidate species, in accordance with s.6.4 of the BAM.

Table 5-2: Predicted Flora species credit species

Species Credit Species	Sensitivity to Gain	Habitat Constraints / Geographic Limitations	Confirmed Candidate Species for Further Assessment	Justification
Acacia bynoeana Bynoe's Wattle	High Sensitivity to Gain	Nil	Yes	N/A
Angophora inopina Charmhaven Apple	High Sensitivity to Gain	Nil	Yes	N/A

Callistemon linearifolius Netted Bottle Brush	Moderate Sensitivity to Gain	Nil	Yes	N/A
Corybas dowlingii Red Helmet Orchid	Moderate Sensitivity to Gain	• East of Morpeth	No	**Geographic limitation not present:** The Site is located to the West of Morpeth
Diuris tricolor Pine Donkey Orchid	Moderate Sensitivity to Gain	• Muswellbrook LGA	No	**Geographic limitation not present:** The site is located within the Maitland City Council LGA
Eucalyptus Glaucina Salty Red Gum	High Sensitivity to Gain	Nil	Yes	N/A
Eucalyptus parramattensis subsp. Decadens Eucalyptus parramattensis subsp. Decadens	High Sensitivity to Gain	Nil	Yes	N/A
Eucalyptus pumila Pokolbin Mallee	High Sensitivity to Gain	Nil	Yes	N/A
Grevillea parviflora subsp. Small-flower grevillea	High Sensitivity to Gain	Nil	Yes	N/A
Persoonia pauciflora North Rothbury Persoonia	High Sensitivity to Gain	• Within 10km of North Rothbury	No	**Habitat constraints not present:** The study area is not within 10km of North Rothbury
Pomaderris queenslandica Scant Pomaderris	High Sensitivity to Gain	Nil	Yes	N/A
Prasophyllum sp. Wybong Prasophyllum sp. Wybong	Moderate Sensitivity to Gain	Nil	Yes	N/A
Prostanthera cineolifera Singleton Mint Bush	High Sensitivity to Gain	Nil	Yes	N/A
Pterostylis chaetophora Pterostylis chaeterophora	Moderate Sensitivity to Gain	Nil	Yes	N/A

Rutidosis heterogams Heath Wrinklewort	High Sensitivity to Gain	Nil	Yes	N/A
Spyridium burragorang - endangered population Spyridium burragorang in the Cessnock local government area	High Sensitivity to Gain	Nil	Yes	N/A
Syzygium paniculatum Magenta Lilly Pilly	High Sensitivity to Gain	Nil	Yes	N/A
Tetratheca juncea Black-eyed Susan	High Sensitivity to Gain	Nil	Yes	N/A

Table 5-3: Predicted Fauna species credit species

Species Credit Species	Sensitivity to Gain	Habitat Constraints / Geographic Limitations	Confirmed Candidate Species for Further Assessment	Justification
Anthochaera phrygia Regent Honeyeater (Breeding)	High Sensitivity to Gain	• As per Important Habitat map	No	**Habitat constraints not present:** The study area is not within or near a mapped area of important habitat for this species.
Burhinus grallarius Bush Stone-curlew	High Sensitivity to Gain	• Fallen/standing dead timber including logs	Yes	**Habitat constraints present:** This study area has Fallen/standing dead timber present.

Callocephalon fimbriatum Gang-gang Cockatoo (Breeding)	High Sensitivity to Gain	• Hollow bearing trees • Eucalypt tree species with hollows greater than 9 cm in diameter	Yes	**Habitat constraints present:** This study area has Hollow bearing trees and eucalypt tree species with hollows greater than 9 cm in diameter present.
Calyptorhynchus lathami Glossy Black-Cockatoo (Breeding)	High Sensitivity to Gain	• Hollow bearing trees • Living or dead tree with hollows greater than 15 cm diameter and greater than 5m above the ground	Yes	**Habitat constraints present:** This study area has hollow bearing trees and living or dead trees with hollows greater than 15 cm in diameter and greater than 5m above the ground present
Cercartetus nanus Eastern Pygmy-possum	High Sensitivity to Gain	Nil	Yes	
Chalinolobus dwyeri Large-eared Pied Bat	Very High Sensitivity to Gain	• Cliffs • Within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, or crevices, or within two kilometres of old mines or tunnels	No	**Habitat constraints not present**: This study area is not within or near cliffs or within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, or crevices, or within two kilometres of old mines or tunnels.
Crinia tinnula Wallum Froglet	Moderate Sensitivity to Gain	Nil	No	**Habitat constraint not present:** although the site has water features, these on-site dams and gullies do not consist of the needed acidic ephemeral nature that this species utilises when breeding, therefore it is highly unlikely that this species would occur on site.

Delmar impar Striped Legless Lizard	Moderate Sensitivity to Gain	Nil	Yes	
Dromaius novaehollandiae - endangered population Emu population in the New South Wales North Coast Bioregion and Port Stephens local government area	Moderate Sensitivity to Gain	• Port Stephens LGA	No	**Habitat constraints not present:** The site is not located within the LGA of Port Stephens.
Haliaeetus leucogaster White-bellied Sea Eagle (Breeding)	High Sensitivity to Gain	• Living or dead mature trees within suitable vegetation within 1km of a rivers, lakes, large dams or creeks, wetlands and coastlines	No	**Habitat constraints present:** This study area contains Living or dead mature trees within suitable vegetation within 1km of a rivers, lakes, large dams or creeks, wetlands and coastlines.
Hieraaetus morphnoides Little Eagle (Breeding)	Moderate Sensitivity to Gain	• Nest trees - live (occasionally dead) large old trees within vegetation)	No	**Habitat constraints present:** This study area does contain Nest trees - live (occasionally dead) large old trees within vegetation)
Hoplocephalus stephensii Stephens' Banded Snake	High Sensitivity to Gain	• Hollow bearing trees • Within 500m of arboreal vines, tangles, fallen/standing dead timber including logs	Yes	**Habitat constraints present:** The site contains hollow bearing trees as well as having fallen/standing dead timber including logs.
Lathamus discolor Swift Parrot (Breeding)	Moderate Sensitivity to Gain	• As per Important Habitat Map	No	**Habitat constraints not present:** The study area is not within or near a mapped area of important habitat for this species.

Limicola Falcinellus Broad-billed Sandpiper (Breeding)	High Sensitivity to Gain	• As per Important Habitat Map	No	**Habitat constraints not present:** The study area is not within or near a mapped area of important habitat for this species.
Litoria aurea Green and Golden Bell Frog	Moderate Sensitivity to Gain	• Semi-permanent/ephemeral wet areas • Within 1km of wet areas|Swamps • Within 1km of swamp Waterbodies • Within 1km of waterbody	Yes	**Habitat constraints present:** The study area is within 1km of a waterbody / wet area / swamp/semi-permanent/ephemeral wet areas.
Litoria brevipalmata Green-thighed Frog	Moderate Sensitivity to Gain	• Semi-permanent/ephemeral wet areas swamps/waterbodies	Yes	**Habitat constraints present:** The study area contains Semi-permanent/ephemeral wet areas swamps/waterbodies.
Lophoictinia isura Square-tailed Kite (Breeding)	Moderate Sensitivity to Gain	• Nest trees	No	**Habitat constraints present:** This study area contains nest trees.
Miniopterus australis Little Bentwing-bat (Breeding)	Very High Sensitivity to Gain	• Caves • Cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding including species records in BioNet with microhabitat code 'IC – in cave' • observation type code 'E nest-roost' • with numbers of individuals >500 • or from the scientific literature	No	**Habitat constraints not present:** This study area does not contain cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding including species records in BioNet with microhabitat code 'IC – in cave'. No observation type code 'E nest-roost'.
Miniopterus orianae oceanensis Large Bent-winged Bat (Breeding)	Very High Sensitivity to Gain	• Caves • Cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding including species records in	No	**Habitat constraints not present:** This study area does not contain cave, tunnel, mine, culvert or other structure

		BioNet with microhabitat code 'IC – in cave' • observation type code 'E nest-roost' • with numbers of individuals >500		known or suspected to be used for breeding including species records in BioNet with microhabitat code 'IC – in cave'. No observation type code 'E nest-roost'.
Myotis macropus Southern Myotis	High Sensitivity to Gain	• Hollow bearing trees • Within 200 m of riparian zone • Bridges, caves or artificial structures within 200 m of riparian zone • This includes rivers, creeks, billabongs, lagoons, dams and other waterbodies on or within 200m of the site	Yes	**Habitat constraints present:** The study area is within 200 m of a riparian zone and contains hollows, Bridges, caves or artificial structures within 200 m of riparian zone and This includes rivers, creeks, billabongs, lagoons, dams and other waterbodies on or within 200m of the site.
Ninox connivens Barking Owl (Breeding)	High Sensitivity to Gain	• Hollow Bearing trees • 'Living or dead trees with hollows greater than 20cm diameter and greater than 4m above the ground.	Yes	**Habitat constraints present:** The site contains hollow bearing trees with hollows greater than 20cm diameter and that occur 4m above the ground.
Ninox strenua Powerful Owl (Breeding)	High Sensitivity to Gain	• Hollow bearing trees • Living or dead trees with hollow greater than 20cm diameter	Yes	**Habitat constraints present:** The site contains hollow bearing trees with hollows greater than 20cm diameter and that occur 4m above the ground.
Pandion cristatus Eastern Osprey (Breeding)	Moderate Sensitivity to Gain	• Presence of stick-nests in living and dead trees (>15m) or artificial structures within 100m of a floodplain for nesting)	No	**Habitat constraints not present:** The study area does not contain stick nests.

Petauroides volans Southern Greater Glider	High Sensitivity to Gain	Nil	Yes	
Petaurus norfolcensis Squirrel Glider	High Sensitivity to Gain	Nil	Yes	
Petrogale penicillata Brush-tailed Rock-wallaby	Very High Sensitivity to Gain	• Land within 1km of rocky escarpments, gorges, steep slopes, boulder piles, rock outcrops or cliff lines.	No	**Habitat constraints not present:** The study site is not located within 1km of rocky escarpments, gorges, steep slopes, boulder piles, rock outcrops or cliff lines.
Phascogale tapoatafa Brush-tailed Phascogale	High Sensitivity to Gain	Nil	Yes	
Phascolarctos cinereus Koala (Breeding)	High Sensitivity to Gain	• Presence of Koala use trees – refer to Survey Comments field in TBDC	Yes	
Planigale maculata Common Planigale	High Sensitivity to Gain	Nil	No	This species is considered vagrant and therefore will not require further survey effort.
Pteropus poliocephalus Grey-headed Flying-fox (Breeding)	High Sensitivity to Gain	• Breeding camps	No	**Habitat constraints not present:** The study area does not contain any breeding camps.
Tyto novaehollandiae Masked Owl (Breeding)	High Sensitivity to Gain	• Hollow bearing trees • Living or dead trees with hollows greater than 20cm diameter	Yes	**Habitat constraints present:** The study area does contain hollow bearing trees, living or dead trees with hollows greater than 20cm diameter.
Uperoleia mahonyi Mahony's Toadlet	High Sensitivity to Gain	Nil	Yes	

Vespadelus troughtoni Eastern Cave Bat	Very High Sensitivity to Gain	• Caves • Within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, crevices or boulder piles, or within two kilometres of old mines, tunnels, old buildings or sheds.	No	**Habitat constraints not present:** The site does not contain Caves or is located Within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, crevices or boulder piles, or within two kilometres of old mines, tunnels, old buildings or sheds.

5.3 Presence of candidate species credit species

Table 5-4 Determining the presence of candidate flora species credit species on the subject land

Species Presence	Confirmed presence
Acacia bynoeana Bynoe's Wattle	No – surveyed
Angophora inopina Charmhaven Apple	No – surveyed
Callistemon linearifolius Netted Bottle Brush	No – surveyed
Cynanchum elegans *White-Flowered Wax Plant*	No – surveyed
Eucalyptus Glaucina Slaty Red Gum	No – surveyed
Eucalyptus parramattensis subsp. Decadens Eucalyptus parramattensis subsp. Decadens	No – surveyed
Eucalyptus pumila Pokolbin Mallee	No – surveyed
Grevillea parviflora subsp. Small-flower grevillea	No – surveyed
Pomaderris queenslandica Scant Pomaderris	No – surveyed
Prasophyllum sp. Wybong Prasophyllum sp. Wybong	No – surveyed
Prostanthera cineolifera Singleton Mint Bush	No – surveyed
Pterostylis chaetophora Pterostylis chaeterophora	No – surveyed
Rutidosis heterogams Heath Wrinklewort	No – surveyed
Spyridium burragorang - endangered population	No – surveyed
Syzygium paniculatum Magenta Lilly Pilly	No – surveyed
Tetratheca juncea Black-eyed Susan	No – surveyed

Table 5-5 Determining the presence of candidate fauna species credit species on the subject land

Species Presence	Confirmed presence
Burhinus grallarius Bush Stone-curlew **(Listed as E under BC Act)**	No – surveyed
Callocephalon fimbriatum Gang-gang Cockatoo	To be Surveyed at a later date in accordance with TBDC specified months.

Calyptorhynchus lathami Glossy Black-Cockatoo	To be Surveyed at a later date in accordance with TBDC specified months.
Cercartetus nanus Eastern Pygmy-possum	No – surveyed
Delmar impar Striped Legless Lizard	To be Surveyed at a later date in accordance with TBDC specified months.
Haliaeetus leucogaster White-bellied Sea-Eagle	To be Surveyed at a later date in accordance with TBDC specified months.
Hieraaetus morphnoides Little Eagle	To be Surveyed at a later date in accordance with TBDC specified months.
Hoplocephalus stephensii Stephens' Banded Snake	To be Surveyed at a later date in accordance with TBDC specified months.
Litoria aurea Green and Golden Bell Frog	To be Surveyed at a later date in accordance with TBDC specified months.
Litoria brevipalmata Green-thighed Frog	To be Surveyed at a later date in accordance with TBDC specified months.
Lophoictinia isura Square-tailed Kite	To be Surveyed at a later date in accordance with TBDC specified months.
Myotis macropus Southern Myotis	To be Surveyed at a later date in accordance with TBDC specified months.
Ninox connivens Barking Owl	No – surveyed
Ninox strenua Powerful Owl	No – surveyed
Ninox connivens Barking Owl	No – surveyed
Petauroides volans Southern Greater Glider	No – surveyed
Petaurus norfolcensis Squirrel Glider	No – surveyed
Phascogale tapoatafa Brush-tailed Phascogale	No – surveyed
Phascolarctos cinereus Koala	No – surveyed
Tyto novaehollandiae Masked Owl	No – surveyed
Uperoleia mahonyi Mahony's Toadlet	To be Surveyed at a later date in accordance with TBDC specified months.

5.4 Threatened species surveys

Table 5-6 Threatened species surveys for candidate flora species credit species on the subject land

Common name	**Scientific name**	**Threatened flora species surveys**				**Present**	**Further assessment required (BAM Subsections 5.2.5 and 5.2.6)**
		Survey method (transects or grids)	**Timing of survey – within recommended period?** (BAM-C / TBDC)		**Effort** (hours & no. people)		
Bynoe's Wattle	***Acacia bynoeana***	Parallel field-transverse method	☒ Yes 21/06/2023	☐ No <Dates & times>	2 hours, 2 People	No	No
Charmhaven Apple	***Angophora inopina***	Parallel field-transverse method	☒ Yes 21/06/2023	☐ No <Dates & times>	2 hours, 2 People	No	No
Netted Bottle Brush	***Callistemon linearifolius***	Parallel field-transverse method	☒ Yes 21/06/2023	☐ No <Dates & times>	2 hours, 2 People	No	No
White-Flowered Wax Plant	***Cynanchum elegans***	Parallel field-transverse method	☒ Yes 28/06/2023	☐ No <Dates & times>	2 hours, 2 People	No	No
Slaty Red Gum	***Eucalyptus Glaucina***	Parallel field-transverse method	☒ Yes 21/06/2023	☐ No <Dates & times>	2 hours, 2 People	No	No
Eucalyptus parramattensis subsp. Decadens	***Eucalyptus parramattensis subsp. Decadens***	Parallel field-transverse method	☒ Yes 21/06/2023	☐ No <Dates & times>	2 hours, 2 People	Yes (Not Within clearing aera)	No
Pokolbin Mallee	***Eucalyptus pumila***	Parallel field-transver	☐ Yes 21/06/2023	☐ No <Dates & times>	2 hours, 2 People	No	No

		se method					
Small-flower grevillea	***Grevillea parviflora subsp.***	Parallel field-transverse method	☒ Yes To Be surveyed	☐ No <Dates & times>	2 hours, 2 People	No	No
Scant Pomaderris	***Pomaderris queenslandica***	Parallel field-transverse method	☒ Yes 28/06/2023	☐ No <Dates & times>	2 hours, 2 People	No	No
Prasophyllum sp. Wybong	***Prasophyllum sp. Wybong***	Parallel field-transverse method	☐ Yes To Be surveyed	☐ No <Dates & times>	2 hours, 2 People	No	No
Singleton Mint Bush	***Prostanthera cineolifera***	Parallel field-transverse method	☐ Yes To Be surveyed	☐ No <Dates & times>	2 hours, 2 People	No	No
Pterostylis chaeterophora	***Pterostylis chaetophora***	Parallel field-transverse method	☐ Yes To Be surveyed	☐ No <Dates & times>	2 hours, 2 People	No	No
Heath Wrinklewort	***Rutidosis heterogams***	Parallel field-transverse method	☒ Yes 28/06/2023	☐ No <Dates & times>	2 hours, 2 People	No	No
Spyridium burragorang - endangered population	***Spyridium burragorang - endangered population***	Parallel field-transverse method	☒ Yes 28/06/2023	☐ No <Dates & times>	2 hours, 2 People	No	No
Magenta Lilly Pilly	***Syzygium paniculatum***	Parallel field-transverse method	☒ Yes 28/06/2023	☐ No <Dates & times>	2 hours, 2 People	No	No
Black-eyed Susan	***Tetratheca juncea***	Parallel field-transverse method	☐ Yes To Be surveyed	☐ No <Dates & times>	2 hours, 2 People	No	No

Refer to Section 2.4.3 for detailed survey effort.

Table 5-7: Threatened species surveys for candidate fauna species credit species on the subject land

Common name	Scientific name	Threatened fauna species surveys				Present	Further assessment required (BAM Subsections 5.2.5 and 5.2.6)
		Survey method (e.g., harp trap, Elliott trap, bioacoustics, etc.)	**Timing of survey – within recommended period?** (BAM-C / TBDC)		**Effort** (hours & no. people)		
Bush Stone-curlew	***Burhinus grallarius***	Transect surveys	☒ Yes 21/06/2023 28/06/2023	☐ No <Dates & times>		No	No
Gang-gang Cockatoo	***Callocephalon fimbriatum***	Bird Watching/ Watching hollows during dusk	☐ Yes To Be surveyed	☐ No <Dates & times>		No	No
Glossy Black-Cockatoo	***Calyptorhynchus lathami***	Bird Watching/ Watching hollows during dusk	☐ Yes To Be surveyed	☐ No <Dates & times>		No	No
Eastern Pygmy-possum	***Cercartetus nanus***	Elliot trapping	☐ Yes	☐ No <Dates & times>		No	No
Striped Legless Lizard	***Delma impar***	Transect surveys, targeting loose timber	☐ Yes To Be surveyed	☐ No <Dates & times>		No	No
White-bellied Sea-Eagle	***Haliaeetus leucogaster***	Bird watching/ listening for calls	☐ Yes To Be surveyed	☐ No <Dates & times>		No	No
Little Eagle	***Hieraaetus morphnoides***	Bird watching/ listening for calls	☐ Yes To Be surveyed	☐ No <Dates & times>		No	No
Stephens' Banded Snake	***Hoplocephalus stephensii***	Transect surveys, targeting loose timber, hollow surveys	☐ Yes To Be surveyed	☐ No <Dates & times>		No	No
Green and Golden Bell Frog	***Litoria aurea***	Frog surveys/ call playback/ listening	☐ Yes To Be surveyed	☐ No <Dates & times>		No	No

Green-thighed Frog	***Litoria brevipalmata***	Frog surveys/ call playback/ listening	☐ Yes To Be surveyed	☐ No <Dates & times>		No	No
Square-tailed Kite	***Lophoictinia isura***	Bird watching/ listening for calls	☐ Yes To Be surveyed	☐ No <Dates & times>		No	No
Southern Myotis	***Myotis macropus***	ANABAT Surveys	☐ Yes To Be surveyed	☐ No <Dates & times>		No	No
Barking Owl	***Ninox connivens***	Call playback surveys/ nocturnal transect surveys	☒ Yes 25/05/2023 29/05/2023 30/05/2023 28/06/2023	☐ No <Dates & times>		No	No
Powerful Owl	***Ninox strenua***	Call playback surveys/ spotlighting	☐ Yes 25/05/2023 29/05/2023 30/05/2023 28/06/2023	☐ No <Dates & times>		No	No
Southern Greater Glider	***Petauroides volans***	Spotlighting/ Stag watching/ Camera traps	☐ Yes Spotlighting 25/05/2023 29/05/2023 30/05/2023 28/06/2023Camera 14/04/2023 - 28/05/2023	☐ No <Dates & times>		No	No
Squirrel Glider	***Petaurus norfolcensis***	Spotlighting/ Stag watching/ Camera traps	☐ Yes Spotlighting 25/05/2023 29/05/2023 30/05/2023 28/06/2023 Camera 14/04/2023 - 28/05/2023	☐ No <Dates & times>		No	No
Brush-tailed Phascogale	***Phascogale tapoatafa***	Spotlighting/ Stag watching/ Camera traps	☐ Yes Spotlighting 25/05/2023 29/05/2023 30/05/2023	☐ No <Dates & times>		Yes	No

			28/06/2023 Camera 14/04/2023 - 28/05/2023				
Masked Owl	***Tyto novaehollandiae***	Call playback surveys/ spotlighting	☐ Yes 25/05/2023 29/05/2023 30/05/2023 28/06/2023	☐ No <Dates & times>		No	No
Mahony's Toadlet	***Uperoleia mahonyi***	Frog surveys/ call playback/ listening	☐ Yes To Be surveyed	☐ No <Dates & times>		No	No

Refer to Section 2.4.3 for detailed survey effort.

5.5 Expert reports

N/A

5.6 More appropriate local data (where relevant)

N/A

Table 5-8 Use of more appropriate local data for habitat suitability

Species	Amendments to species data	Local data source/s
N/A		

5.6 Area or count, and location of suitable habitat for a species credit species (a species polygon)

N/A No threatened species were found on site that will require offset.

Table 5-9 Results for present species (recorded within the subject land)

Common name	**Scientific name**	**Biodiversity risk weighting** (BAM-C & TBDC*)	**SAII entity**** (BAM-C & TBDC)	**Habitat constraints / microhabitats present on the subject land / vegetation zone**	**Abundance – No. individual plants present on subject land** (Flora with unit of measure of count)	**Extent (ha) of suitable habitat present on site** (flora or fauna with unit of measure of area)	**TBDC species specific recommendations e.g. buffers, general comments** (Where relevant)	**Habitat condition** (vegetation integrity score for each vegetation zone in the polygon – area species only)

Table 5-10 Results for EPBC Act listed species present (recorded within the subject land)

Common name	**Scientific name**	**Abundance – No. individual plants present on subject land** (Flora with unit of measure as count)	**Extent (ha) of suitable habitat present on site (**flora or fauna with unit of measure as area)

6. Identifying prescribed impacts

Table 6-1: Prescribed impacts identified

Feature	Present	Description of feature characteristics and location	Threatened entities that use, are likely to use, or are part of the habitat feature. Where relevant, threatened species or fauna that are part of a TEC or EC, that are at risk of vehicle strike
Example: Karst, caves, crevices, cliffs, rocks or other geological features of significance	☐Yes / ☒No	No krast's, caves, crevices, cliffs, rocks are present within or near the site, as such the proposed development would not impact these features.	N/A
Example: Vehicle strikes	☐Yes / ☒No	N/A	N/A
Human-made structures	☒Yes / ☐No	Two existing dwellings occur on site currently, they will not be impacted by the development.	N/A
Non-native vegetation	☒Yes / ☐No	The site consists of a mixture of native and non-native grasses.	N/A
Habitat connectivity	☒Yes / ☐No	Site is connected to larger intact portions of native vegetation. However, the majority if the sites intact native vegetation will be retained. As such habitat connectivity will not be affected by the Proposed development.	N/A
Waterbodies, water quality and hydrological processes	☒Yes / ☐No	Five ephemeral gullies occur within the site as well as one 2nd order ephemeral gully.	Threatened frog species are likely to use these geographical features found within the site as breeding/foraging habitat, however no threatened frog species have been identified as using the features. Threatened micro bat species Myotis macropus (Southern Myotis) is likely to use waterbodies located on site as foraging habitat due to the close proximity of hollow bearing trees to these features.

Feature	Present	Description of feature characteristics and location	Threatened entities that use, are likely to use, or are part of the habitat feature. Where relevant, threatened species or fauna that are part of a TEC or EC, that are at risk of vehicle strike
Wind turbine strikes (wind farm development only)	☐Yes / ☒No	N/A	N/A

Stage 2: Impact assessment (biodiversity values and prescribed impacts)

7. Avoid and minimise impacts

7.1 Avoid and minimise direct and indirect impacts

7.1.1 Project location

The site is ~32 ha in size and is located in the eastern periphery of the residential portion of Farley. The majority of the site is zoned as RU2 Rural Landscape, with the north-eastern corner of the site zoned as R1 General Residential. The northern western half of the site is covered predominantly in native and exotic grasses with Spotted Gum and Ironbark tree species scattered throughout. Spotted Gum – Ironbark Forest vegetation occurs over the majority of the south eastern half of the site. Forest adjoins the site from the west, south and east. A residential subdivision is being developed in the adjoining property to the north-east. Medium and large rural lots occur to the north across Wollombi Road. There are five ephemeral gullies which occur within the site. One 2nd order gully (in accordance with the Strahler stream ordering system in Appendix 3 of the BAM)

7.1.2 Project design

The proposal includes a Torrens title subdivision (2 lots into 207 manufactured homes as well as 47 multi-dwelling sites) of 303 Wollombi Road, Farley 2320 (Lot 4 DP 810894) to provide development space for the construction of 207 dwellings as well as associated infrastructure such as site access, services and asset protection zones (APZ).

The development footprint has largely been located in the northern portion of the site, which is predominately covered by a mixture of native and exotic grasses and weeds.

The proposed development footprint is indicated in Figure 1-2. It totals an area of 12.66 ha of land/vegetation and encompasses the following areas:

oThe designated area for residential lots, building envelopes and site access (12.66 ha)

• The proposed operational footprint would include the same areas as the construction footprint indicated in Figure 1; that being the developed areas for the residential lots and site access and the APZs.

The study area is the area of land within the site that has been assessed in this report, which is the area of vegetation within the site that is relevant to this BDAR i.e., the area of vegetation within or potentially impacted by the construction and operational footprint. Land within the site that is not considered to be impacted by the proposal (either directly or indirectly) is considered to be outside the study area. In this case however, the entire site was surveyed.

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7.2 Avoid and minimise prescribed impacts

The following sections 7.4 to 8.4 describe efforts undertaken to avoid and minimise impacts on biodiversity values in accordance with Chapter 7 of the BAM.

7.3 Other measures considered

N/A

7.4 Summary of measures to avoid and minimise impacts

Table 7-1: Avoidance and minimisation measures for direct, indirect and prescribed impacts

Locating a Project to Avoid and Minimise Impacts on Native Vegetation and Habitat	
Objectives/Requirements	**Compliance**
Project location decisions should be informed by knowledge of biodiversity values. The biodiversity values set out in Stage 1 of the BAM may be used to provide early consideration in planning the route or location of a proposal.	Under the Maitland Local Environment Plan 2011 (the LEP), The proposed development has been designed to avoid the PCTs with the higher VIS and located the development in the lower VIS PCTs, which is mainly grassland with scattered Eucalyptus.
Final selection of project location may be an iterative process. Location decisions may need to be revisited when all field surveys have been completed. Direct impacts on clearing of native vegetation and habitat can be avoided and minimised by: (a) locating the development outside of biodiversity values (b) locating the project in areas where the native vegetation or threatened species habitat is in the poorest condition (i.e. areas that have a lower vegetation integrity score) (c) locating the project in areas that avoid habitat for species that have a high biodiversity risk weighting or land mapped on the important habitat map, or native vegetation that is a TEC or highly cleared PCT. (d) locating the project so its outside of the buffer area around breeding habitat features such as nest trees or caves	The site has been subject to previous disturbance by existing use as Rural Land. a) As reflected in the Biodiversity Values Map, the Subject Land does not contain any areas containing biodiversity values. b) The Subject DA Footprint has been located within the RU2 Rural Landscape zone. The majority of the development footprint is to occur within the grassland present on site, this grassland is currently used for grazing by cattle and has been selected as to avoid the removal of habitat features such as hollow bearing trees and to retain the higher VIS PCT's. c) The Subject DA Footprint will impact upon TEC Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions within PCT (3433 and 3444) The development footprint as stated has been designed to avoid the higher VIS PCT's and aims to avoided habitat features that will impact upon species that may use these

	features, such as hollow bearing trees, established nests, gully lines and associated buffers as well as high risk weighting species such as the 4 *Eucalyptus parramattensis* which will be avoided by clearing, d) All hollow bearing trees located within the site are to be retained as to not disturb possible breeding habitat of threatened species that may occur on site, however 2 water bodies located on site are planned to be removed as part of the development, in order to offset potential impacts to species using the feature currently the water bodies will be drained in the presence of an ecologist to preserve and relocate any potential species found during the process.
Justifications for the decisions in determining the final location must be based on consideration of (a) an analysis of alternative modes or technologies that would avoid or minimise impacts on biodiversity values (b) an analysis of alternative routes that would avoid or minimise impacts on biodiversity values (c) an analysis of alternative sites that within a property on which the project is proposed that would avoid or minimise impacts on biodiversity values	The removal of vegetation will occur within the RU2 Rural Landscape as well as the North-Eastern portion of the site zoned as R1 General Residential. a) b) The route that has been selected has aimed to minimise the impacts to the biodiversity of the site. c) An analysis of the site has shown that the location chosen for the proposed subdivision has been chosen to minimise and avoid impacts on biodiversity values.
The proposal may also list and map constraints, such as: (a) Bushfire protection requirements, including clearing for asset protection zones (b) Flood planning levels (c) Servicing constraints	Bushfire mitigation measures including Asset Protection Zones has been implemented within the proposed lots.
Design the proposal to avoid or minimise direct and indirect impacts on native vegetation, threatened species, threatened ecological communities and their habitat	
Justifications for the decisions in determining the final location must be based on consideration of (a) reducing the clearing footprint of the project	a) The proposed development will avoid the majority of higher quality habitat within Zone 1, with only removal of 0.28ha. The proposed development has a low impact on biodiversity values, native

<table>
<tr><td>(b) locating ancillary facilities in areas where there are no biodiversity values
(c) locating ancillary facilities in areas where the native vegetation or threatened species habitat is in the poorest condition (i.e. areas that have a lower vegetation integrity score)
(d) locating ancillary facilities in areas that avoid habitat for species and vegetation in high threat status categories (e.g. an EEC or CEEC or entity at risk of SAII)
(e) Actions and activities that provide for rehabilitation, ecological restoration, rehabilitation and/or ongoing maintenance of retained native vegetation, threatened species, threatened ecological communities and their habitat on the development site</td><td>vegetation, connectivity routes and fauna movements whilst retaining the better-quality habitat within the site.</td></tr>
<tr><th colspan="2">Avoid or Minimise Prescribed Impacts when planning the proposal</th></tr>
<tr><td>Prescribed impacts may occur on habitat features that are not native vegetation e.g., caves, rocky outcrops, and flyways. Because these types of features cannot readily replace or offset, it is important that measures to avoid minimise impacts are undertaken and are clearly documented</td><td>No prescribed impacts were identified for the development footprint. The existing dwelling and manmade structures will be retained as part of the proposal.</td></tr>
<tr><th colspan="2">Locating a Project to Avoid and Minimise Prescribed Biodiversity Impacts</th></tr>
<tr><td>Prescribed biodiversity impacts can be avoided and minimised by:
(a) locating surface works to avoid direct impacts on the habitat features
identified in Chapter 6
(b) locating of sub-surface works, both in the horizontal and vertical plane, to avoid and minimise operations beneath the habitat features identified in Chapter 6 e.g., locating longwall panels away from geological features of significance or water dependent plant communities and their supporting aquifers
(c) locating the project to avoid severing or interfering with corridors connecting different</td><td>Surface works will avoid habitat features such as hollow bearing trees, the proposals design will impact habitat features such as watercourses and water bodies, as two waterbodies on site are to be removed for the building of a proposed club house.
a) The project is located to predominantly affect open grassland, with most of the sites mature canopy vegetation to be retained this in turn will aim to avoid severing or interfering with corridors.
b) Project layout is designed to minimise impacts to threatened species areas containing habitat features such as hollows which may</td></tr>
</table>

areas of habitat, migratory flight paths to important habitat or local movement pathways (d) optimising project layout to minimise interactions with threatened species and ecological communities, e.g. designing turbine layout to allow buffers around features that attract and support aerial species, such as forest edges, riparian corridors and wetlands, ridgetops and gullies (e) locating the project to avoid direct impacts on water bodies or hydrological processes	be utilised by threatened species are to be retained, the project has been designed to avoid impacts/ interactions with *Eucalyptus parramattensis* found on site. c) 2 farm dams are located on site are planned to be removed as part of the development, in order to offset potential impacts to species using the feature currently the water bodies will be drained in the presence of an ecologist to relocate any potential species found during the process.
When locating a proposal, the following need to be analysed and justification should be provided for each alternative selected: (a) alternative modes or technologies that would avoid or minimise prescribed impacts (b) alternative routes that would avoid or minimise prescribed impacts (c) alternative locations that would avoid or minimise prescribed impacts (d) alternative sites within a property on which the project is proposed that would avoid or minimise prescribed impacts	The location of the proposal has been designed to avoid the better-quality habitat within the site i.e., hollow bearing trees and the PCT with the higher VIS. The location of the development occurs already in a disturbed are of the site that is comprised of grassland and scattered trees.
Justifications for project location decisions should identify any other site constraints that the proponent has considered in determining the location and design of the project, e.g., bushfire protection requirements including clearing for asset protection zones, flood planning levels, servicing constraints.	Bushfire mitigation measures including Asset Protection Zones has been implemented within the proposed lot layout to occur within the site.
Design the proposal to avoid or minimise prescribed impacts	
Design measures that can avoid or minimise prescribed impacts include: (a) engineering solutions, such as proven techniques to: i. minimise fracturing of bedrock underlying features of geological significance, or groundwater-dependent communities and their supporting aquifers ii. restore connectivity and movement corridors (b) design elements that minimise interactions with threatened entities, such as: i. designing	Water Sensitive Urban Design (WSUD) will be implemented to ensure that water quality and runoff are appropriately like existing conditions on site and minimise prescribed impacts on biodiversity values.

turbines to dissuade perching and minimise the diameter of the rotor swept area ii. designing fencing to prevent animal entry to transport corridors iii. providing vegetated buffers rehabilitated with native species (c) maintaining environmental processes that are critical to the formation and persistence of habitat features not associated with native vegetation (d) maintaining hydrological processes that sustain threatened entities (e) controlling the quality of water released from the site, to avoid or minimise downstream impacts on threatened entities.	

8. Impact Assessment

8.1 Direct Impacts

The following describes direct impacts on native vegetation, including impacts on TECs and threatened species through the removal of potential habitat. Direct impacts of the development are detailed in the following Tables 8-1 to 8-3.

Table 8-1: Summary of residual direct impacts

PCT	BC Act Name / Listing Status	EPBC Act Name / Listing Status	Vegetation Zone (VZ) Name	Direct Impact
PCT 3433- Hunter Coast Foothills Spotted Gum-Ironbark Grassy Forest	Endangered Ecological Community	Not Listed	56.3	
PCT 3444 - Lower Hunter Spotted Gum-Ironbark Forest	Endangered Ecological Community	Not Listed	30.1	
PCT 4036 - Hunter Coast Lake Flats Apple Forest	Not listed	Not listed	60.6	

Table 8-2: Impacts to Vegetation Integrity (VI) Scores

PCT	Vegetation Zone (VZ)	Management Zone / Area Impacted	Current VI Score	Future VI Score	Change in VI Score	Total Change in VI Score
3433 - Hunter Coast Foothills Spotted Gum-Ironbark Grassy Forest	VZ1	0.28	48.6	0	-48.6	-48.6
	VZ2	1.9	31.7	0	- 31.7	- 31.7
3444 - Lower Hunter Spotted Gum-Ironbark Forest	VZ1	1.18	30.1	0	-30.1	-30.1
	VZ2	1.9	11.5	0	- 11.5	- 11.5

8.1.1 Residual direct impacts

Table 8-1: Summary of residual direct impacts.

Direct impact (Describe the impact on PCT/TEC/EC or threatened species and their habitat)	**BC Act status**	**EPBC Act status**	**SAII entity**	**Project phase/timing of impact** (e.g. construction, operation, rehabilitation)	**Extent** (ha, number of individuals)
Removal of 0.11ha of native vegetation **3433** - Hunter Coast Foothills Spotted Gum-Ironbark Grassy Forest (Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions)	Endangered Ecological Community	Not Listed	No	Pre-construction	0.11ha
Removal of 1.2ha of native vegetation **3444** - Lower Hunter Spotted Gum-Ironbark Forest (Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions)	Endangered Ecological Community	Not Listed	No	Pre-construction	1.2ha
Remoival of 0.11ha of native vegetation **4036** - Hunter Coast Lake Flats Apple Forest	Not listed (Not a TEC)	Not Listed	No	Pre-construction	0.11ha

8.1.2 Assessment of Direct Impacts on Confirmed Ecosystem Credit Species

As indicated in previous Table 2-7, several predicted ecosystem credit species have been confirmed for the site. The following provides an assessment of direct impacts on the confirmed ecosystem credit species, which have been grouped into guilds.

Open Forest / Woodland Birds – *Anthochaera phrygia* (Regent Honeyeater (Foraging)), *Artamus cyanopterus* (Dusky Woodswallow), *Chthonicola sagittata* (Speckled Warbler), *Climacteris picumnus victoriae* (Brown Treecreeper (eastern subspecies)), *Daphoenositta chrysoptera* (Varied Sittella), and *Glossopsitta pusilla* (Little Lorikeet).

These are highly mobile species that are able to footage over large ranges. There is potential for any of these species to occur in the site (although some more than others). The area of habitat within the site that these species would most likely prefer is PCT 3433 - vegetation zone 1, which has largely been avoided by the proposal.

Overall, it is considered that the avoided habitat described in previous section 3.2.1, as well as the recommended mitigation measures described in previous section 3.1.2 would minimise the impacts on these wide-ranging species.

Birds of Prey – *Lophoictinia isura* (Square-tailed Kite (Foraging)), *Circus assimilis* (Spotted Harrier), *H. morphnoides* (Little Eagle) (Foraging) and *Pandion cristatus* (Eastern Osprey) (Foraging) *Falco subniger* (Black Falcon).

P. cristatus (Eastern Osprey) generally hunt over large areas of open water. The study area and nearby surrounding areas do not provide open water for foraging, as such it is considered unlikely that this species would occur within the site. However, the study area may serve as a brief resting area for. *P. cristatus* (Eastern Osprey).

H. morphnoides (Little Eagle), *Lophoictinia isura* (Square-tailed Kite) and *Circus assimilis* (Spotted Harrier) are highly mobile species that are able to hunt/travel over large ranges. There is potential for any of these species to occur in the site (although some more than others). The area of habitat within the site that these species would most likely prefer is PCT 3433 - vegetation zone 1, which has largely been avoided by the proposal.

Overall, it is considered that the avoided habitat described in previous section 3.2.1, as well as the recommended mitigation measures described in previous section 3.1.2 would minimise the impacts on these wide-ranging species.

Forest Owls – Ninox connivens (Barking Owl (Foraging)), Ninox strenua (Powerful Owl (Foraging)) & Tyto novaehollandiae (Masked Owl (Foraging))

These species were not recorded on the site during the targeted surveys undertaken. The site contains potential hunting habitat for these owls; although arboreal mammal activity was observed to be low for the site, with low sightings of prey species during spotlighting surveys. Nevertheless, it must be assumed that prey species may nest and forage within the site.

These are highly mobile species that can travel over large ranges. There is potential for any of these species to occur in the site (although some more than others). The area of habitat within the site that these species would most likely prefer is PCT 3433 - vegetation zone 1, which has largely been avoided by the proposal
All the hollow-bearing trees and most of the ground hollows within vegetation zone 1 (PCT 3433) have been avoided. As such, the proposal has avoided impacts to nesting habitat for hollow-dependant prey species.

Overall, it is considered that the avoided habitat described in previous section 3.2.1, as well as the recommended mitigation measures described in previous section 3.1.2 would minimise the impacts on these wide-ranging species.

Microbats – Microbats – *Falsistrellus tasmaniensis* (Eastern-False pipistrelle), *Micronomus norfolkensis* (Eastern Coastal Freetail-bat), *Miniopterus australis* (Little Bentwing-bat) (Foraging), *Miniopterus orianae oceanensis* (Large Bentwing-bat) (Foraging), *Myotis Macropus* (Southern Myotis), *Nyctophilus corbeni* (Corben's Long-Eared Bat), S*accolaimus flaviventris* (Yellow Bellied Shea tail-bat), *Scoteanax rueppellii* (Greater Broad-Nosed Bat)

These species are highly mobile and are known to travel large distances to forage. They generally forage in structurally open and associated edge habitat and roost in trees containing hollows, or (in the case of *Miniopterus australis* (Little Bentwing-bat) and *Miniopterus orianae oceanensis* (Large Bentwing-bat), caves or similar structures)..

All the hollow-bearing trees have been avoided. As such, the proposal has avoided significant impacts to nesting habitat for these hollow-dependant species.

***Dasyurus maculatus* (Spotted-tailed Quoll)**
D. maculatus (Spotted-tailed Quoll) is known to favour extensive tracts of undisturbed bushland away from human development, the chances of it occurring within the site is very small. Nevertheless, its presence must be assumed.

Overall, it is considered that the recommended mitigation measures would minimise the direct impacts and allow the directly impacted areas of the site to retain some of its habitat values for these species.

Phascolarctos cinereus (Koala) (Foraging)

A development proposal must be assessed under the development assessment process under the SEPP in LGAs where no approved Koala Plan of Management is in place. The includes all land:

with an area of at least 1 hectare, including adjoining land (meaning land the next cadastre over) within the same ownership, and

that is within an LGA to which the SEPP applies

The site is greater than 1 hectare and Farley occurs within the Maitland LGA which lies within the Central Coast Koala Management Area. There is no Koala Plan of Management for the Maitland LGA and so this development proposal must be assessed under the development assessment process under the Koala Habitat Protection SEPP 2021.

The definition of core koala habitat under the Koala SEPP 2021 includes a reference to highly suitable habitat. Highly suitable habitat is where 15% or greater of the total number of trees within any Plant Community Type (PCT) are the regionally relevant species of those listed in Schedule 2 of the SEPP.

An area of land is defined as – including both the development footprint and the surrounding area that may have indirect impacts from the development (that is contained within the subject lot and adjoining land within the same ownership). The Koala SEPP 2021 applies to both direct and indirect impacts to habitat on the site area, therefore all habitat on the landholding should be considered even if no vegetation is to be cleared, however this does not mean all habitat must be surveyed – see below.

• For development applications, to determine the size of the surrounding area that needs to be surveyed, the suitably qualified person needs to consider the extent of potential indirect impacts from the development, such as vehicle strikes, drowning in pools, increased risk of fire, disturbance, and impediments to movement. It is not always necessary to survey the entire landholding

• Historical koala occupation of the site area is determined by considering koala records within the last 18 years, within the following maximum distances from the external boundary of the site area: o 2.5 kilometres of the site (for North Coast, Central Coast, Central Southern Tablelands, South Coast KMAs).

The field survey undertaken found no evidence of P. cinereus (Koala) occurring in the site. A review of the OEH Atlas of NSW Wildlife indicated no historical records of Koala within the last 18 years.

The isolated nature of the site, lack of scats and no recordings of Koala's suggest that the site would not constitute 'Core Koala Habitat' as defined by SEPP. No further provisions of the Koala Habitat Protection SEPP apply.

Megabats - *Pteropus poliocephalus* (Grey-headed Flying-fox) (Foraging)
These species were not recorded within the site during any of the spotlighting surveys undertaken in May 2023.

This species is highly mobile and are known to travel large distances to forage. The development footprint potential foraging habitat, however the majority of native vegetation within the site will be retained. Large areas of suitable habitat for these species also occurs within the wider Maitland locality, ensuring that any local scale impacts from vegetation removal would be unlikely to impact on populations of these wide-ranging species.

Overall, it is considered that the recommended mitigation measures would minimise the direct impacts and allow the directly impacted areas of the site to retain some of its habitat values for these species.

8.2 Indirect impacts

Table 8-3: Summary of residual indirect impacts

Indirect impact (Describe impact, e.g., transport of weeds and pathogens form the site to adjacent vegetation)	**Impacted entities** (PCT/threatened entity and their habitats and where relevant, EPBC Act listing)	**Extent** (ha or zone reference)	**Frequency**	**Duration** (long-term/ short-term/ medium-term)	**Project phase/ timing of impact** (e.g., construction, operation, rehabilitation)	**Likelihood and consequences**
Inadvertent impacts on adjacent habitat or vegetation	?	Adjacent vegetation	Daily during construction	Potentially long-term	During construction	Medium
Sedimentation and contaminated and/or nutrient rich run-off	?	Into downstream areas	During heavy rainfall or storm events	Potentially long-term	During rainfall events	Medium
Noise, dust or light spill	?	Adjacent vegetation	Daily during construction and sporadically during operation	Short-term impacts during construction phase, long-term impacts	Daily during construction and sporadically during operation	Medium
Transport of weeds and pathogens from the site to adjacent vegetation	?	Potential to spread into nearby habitat	During construction and operation	Potentially long-term impacts	Ongoing for the life of the development	Medium
Rubbish Dumping	?	Potential for rubbish to spread into areas outside the development footprint.	Anytime during construction and operation	Ongoing for the life of the development	Ongoing for the life of the development	Low

Wood collection	?	Potential habitat to be removed from areas outside of the development footprint	Anytime during construction and operation.	Ongoing for the life of the development	Ongoing for the life of the development	Low
Bush rock removal and disturbance	?	Potential habitat to be removed from areas outside of the development footprint	Anytime during construction and operation	Ongoing for the life of the development	Ongoing for the life of the development	Low
Vehicle strike	?	Within access roads and within development footprint	Daily, during construction and operational phases	Potential long-term impacts.	Potential long-term impacts	Low
Increased risk of fire	?	Adjacent vegetation	Anytime during construction and operation	Anytime during construction and operation	Anytime during construction and operation	Low

8.3 Prescribed impacts

No prescribed biodiversity impacts are anticipated from the proposed development. The proposal would not severe or significantly interfere with a habitat corridor.

8.3.1 Minimisation of impacts

Mitigation measures are proposed to minimise potential impacts to the site's biodiversity values: these are summarised in Table 8-4. These include measures to be implemented in the pre-construction, construction and post-construction phases. It is considered that these measures would serve to minimise any potential direct or indirect impacts.

8.4 Mitigating residual impacts – management measures and implementation

Table 8-4 Summary of proposed mitigation and management measures for residual impacts (direct, indirect and prescribed)

Action	Responsibility	Timing
Pre-construction Phase Measures		
The area of endangered ecological community PCT 3433 and 3444 (Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions) that occurs within the site but outside of the construction and operational development footprint is to be fenced off.	Landowner	Covenant to be established prior to commencement of any excavation or clearing works.
The proposed APZs are to be managed to the standards of an APZ as defined in *Planning for Bushfire Protection 2019*. No exotic trees or shrubs are to be planted within the proposed APZs. It is recommended that this should be protected in perpetuity through a positive / restrictive covenant, registered on title, under Section 88B or 88E of the Conveyancing Act 1919.	Landowner	Covenant to be established prior to commencement of any excavation or clearing works.
The boundaries of the development footprint will be delineated in the field using bunting / flagging tape to ensure inadvertent clearing / disturbance of the adjacent vegetation does not occur.	Project manager.	Prior to commencement of any excavation or clearing works.
Any site workers / contractors are to be inducted on the ecological sensitivities of the site, including, but not limited to, the importance of avoiding disturbance to the vegetation / habitat external to the development footprint.	Project manager in consultation with the project ecologist.	Prior to commencement of any excavation or clearing works.
Erosion and sediment control measures (e.g. silt fences, straw bales wrapped in geotextile etc) must be established before excavation or vegetation clearance begins and are to remain in place until all surfaces have been fully restored and stabilised.	Project manager.	Prior to commencement of any excavation or clearing works.
A pre-clearing survey will be conducted by a qualified ecologist and will include the following;	Project Ecologist	Prior to commencement of any excavation or clearing works.

➢ Any habitat trees (hollow-bearing trees or nest trees) within the clearing footprint shall be clearly marked (with flagging tape or fluoro spray-paint). Any salvageable habitat features (such as ground timber), identified during the pre-clearing survey, shall be redistributed in the site's retained area of vegetation.		
Construction Phase Management Actions		
During the clearing of native vegetation, and only if habitat trees occur within the development footprint, a suitably qualified and experienced ecologist must: a) Ensure no vegetation clearing occurs outside of the approved clearing footprint. b) Ensure soft felling techniques are utilised for felling of any habitat/hollow-bearing trees. c) Supervise all habitat/hollow-bearing tree removal to capture and/or relocate any dispersed fauna. d) Transport any injured wildlife to appropriate veterinary care or transfer the animal to a local volunteer wildlife carer group. e) Provide post-clearing reporting back to Council should any threatened species be captured or encountered by clearing operations.	Project ecologist	During clearing.
Appropriate weed control measures must be implemented, including for instance: • All weeds removed from the site must be transported in a sealed container or bag and disposed at a waste management facility licenced to accept green waste. • Vehicles, machinery and equipment must be free from weed material (including seeds) before entering the construction corridor.	Project manager.	During excavation, clearing and construction works.

Any spoil storage areas or stockpiles will have appropriate erosion control devices installed to control runoff and prevent sedimentation.	Project manager.	During excavation, clearing and construction works.
Materials, plant and equipment are not to be stored within the drip-lines of any retained trees at the site or near the site.	Project manager.	During excavation, clearing and construction works.
Topsoil is to be removed from newly cleared areas and then stockpiled for later use in the rehabilitation and/or landscaping works.	Project manager.	During excavation, clearing and construction works.
Cleared vegetation will be mulched and stockpiled for later use in any vegetation restoration/landscaping activities (provided that it doesn't contain weed material). Where possible, any felled trees may be cut into manageable sections and redistributed in the site.	Project manager.	During excavation, clearing and construction works.
Sediment and erosion control devices will be inspected regularly, maintained to ensure effectiveness over the entire duration of the project, and cleaned out before 30% capacity is reached.	Project manager.	During excavation, clearing and construction works.
Post-construction Phase Management Actions		
All temporary erosion and sediment control devices such as silt-stop fencing will be removed from the site at the completion of the works, but not until the site is fully revegetated/stabilised.	Project manager.	After construction, but not until the site is fully revegetated/stabilised.

8.5 Adaptive management strategy for uncertain impacts (where relevant)

Address the following considerations to outline an adaptive management plan for uncertain impacts (indirect or prescribed), or remaining impacts where mitigation measures have not been proposed:

- identify impacts where no mitigation measures are proposed
- describe the impacts (PCT/ threatened entity/ indirect/ prescribed)
- indicate the likelihood of impact and details of the extent, both spatially and temporally
- document the baseline data required and monitoring methods to measure uncertain impacts including frequency, timing and reporting; include published data sources where relevant
- assign performance indicators that trigger management intervention and determine when the action is completed
- evaluate the risk of failure
- management actions proposed to reduce or eliminate the impact, which may include additional biodiversity credits to offset (above the credit requirement generated by the BAM-C for direct impacts), other conservation measures and/or mitigation measures. Document the decision pathway and justification for the proposed actions
- where an adaptive management strategy is not required for the proposal or some impacts of the proposal, justify why adaptive management strategies have not been prepared. Include details on the size and nature of the impacts and reasons why the severity and consequence of direct and indirect impacts are easily predicted and well understood>

Adaptive management strategy is not required for the proposal due to the size and nature of the impacts have been avoided, minimised and offset

9. Serious and irreversible impacts

9.1 Assessment for serious and irreversible impacts on biodiversity values

No entities will be at risk of an SAII due to the proposal.

10. Impact summary

10.1 Determine an offset requirement for impacts o

10.1.1 Impacts on native vegetation and TECs or ECs (ecosystem credits)

Table 10-1: Impacts that do not require offset – ecosystem credits

Vegetation zone	PCT name	TEC	Impact area (ha)	TEC association	Entity at risk of an SAII?	Current VI score
					Choose an item.	

Table 10-2: Impacts that require an offset – ecosystem credits

Vegetation zone	PCT name	TEC	Impact area (ha)	Current VI score	Future VI score	Change in VI score	Biodiversity risk weighting	Number of ecosystem credits required
VZ 1	3433_Intact-under-scrubed	3433_Intact-under-scrubed	0.28	48.6	0	-48.6	2	7
VZ 2	3433_Derived-Grassland	3433_Intact-under-scrubed	1.9	31.7	0	-31.7	2	30
VZ 1	3444_Moderate	3433_Intact-under-scrubed	1.18	33.6	0	-33.6	2	20
VZ 2	3444_Derived-Grassland	3433_Intact-under-scrubed	1.9	11.5	0	-11.5	2	0

10.1.2 Impacts on threatened species and their habitat (species credits)

Table 10-3: Impacts that require an offset – species credits

Common name	**Scientific name**	**BC Act status**	**EPBC Act status**	**Loss of habitat** (ha) or individuals	**Biodiversity risk weighting**	**Number of species credits required**
					Total credits	

10 .1.3 Indirect and prescribed impacts

Table 10-4: Summary of proposed offsets for residual indirect and prescribed impacts

Residual indirect or prescribed impact (identified in Table 8-5 after mitigation)	**Proposed offset** (Additional biodiversity credit requirement and/or other conservation measures)
N/A	

10.2 Impacts that do not need further assessment

Table 10-5: Impacts that do not need further assessment for ecosystem credits

Impact	**Location within subject land**	**Justification why no further assessment is required**

11. Biodiversity credit report

Refer to Appendix G Credit reports

11.1 Ecosystem credits

Table 11-1 Ecosystem credit class and matching credit profile

Ecosystem credit	Attributes shared with matching credits						
	PCT name	**PCT vegetation class**	**PCT vegetation formation**	**Associated TEC or EC**	**Offset trading group** (BAM Section 10.2, Tables 4 & 5)	**Hollow bearing trees present?**	**IBRA subregion** (in which proposal is located)
37	Hunter Coast Foothills Spotted Gum-Ironbark Grassy Forest	Hunter-Macleay Dry Sclerophyll Forests	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Yes EC	Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions	No	Hunter
20	Lower Hunter Spotted Gum-Ironbark Forest	Hunter-Macleay Dry Sclerophyll Forests	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Yes EC	Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions	No	Hunter

11.2 Species credits

Table 11-2 Species credit class and matching credit profile

Species credit	Attributes shared with matching credits				
	Name of threatened species	**Kingdom**	**BC Act status**	**EPBC Act status**	**IBRA region**

12. References

Bladon, R.V., Dickman, C.R. and Hume, I.D. (2002). Effects of habitat fragmentation on the demography, movements and social organisation of the eastern pygmypossum (Cercartetus nanus) in northern New South Wales. Wildlife Research 29(1) 105 – 116.

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Meyer, E., Hero, J-M., Shoo, L. and Lewis, B. (2006). National recovery plan for the wallum sedgefrog and other wallum-dependent frog species. Report to Department of the Environment and Water Resources.

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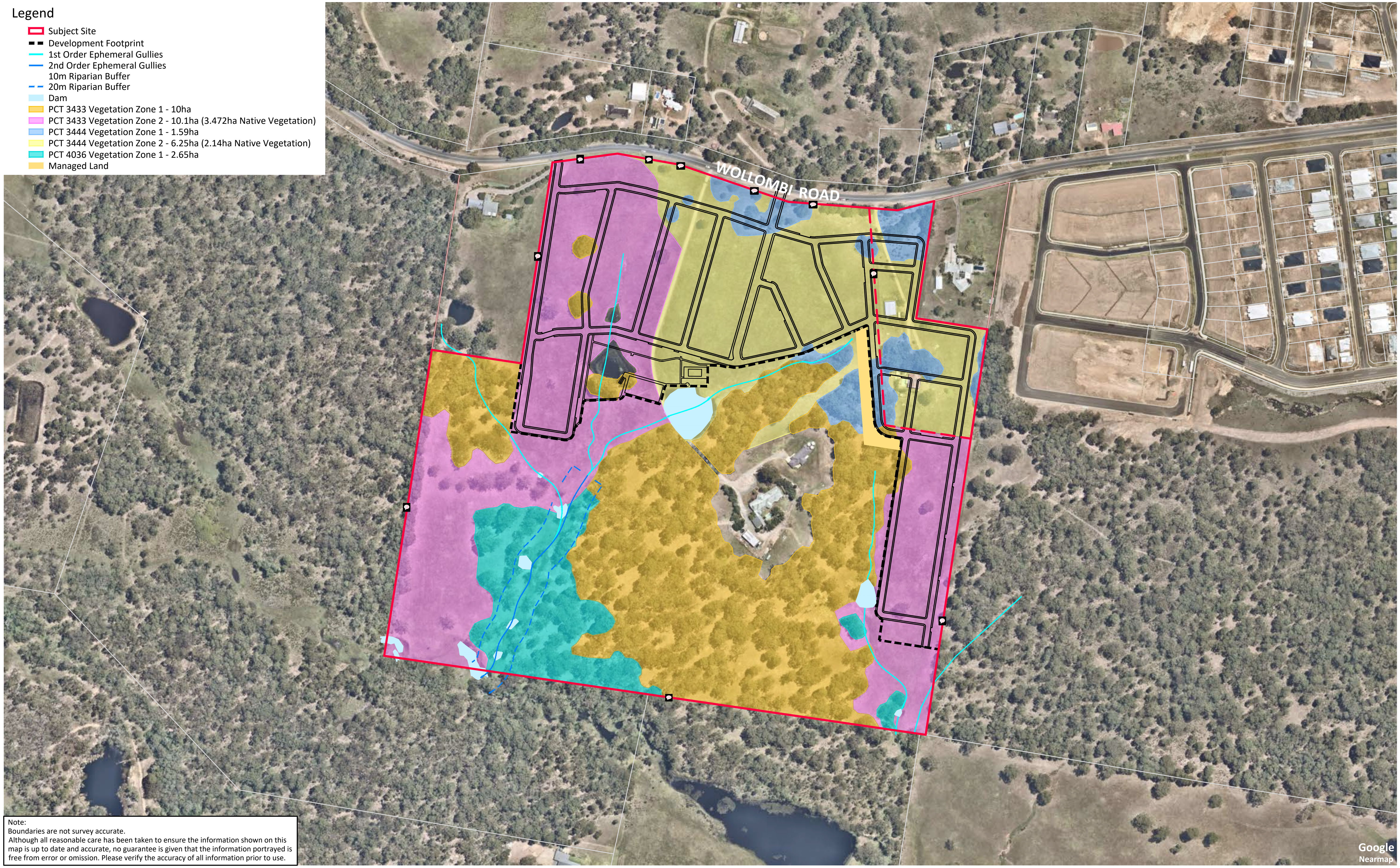
13. Figures

Figure 1 **Site Map**



Note:
Boundaries are not survey accurate.
Although all reasonable care has been taken to ensure the information shown on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Please verify the accuracy of all information prior to use.

FIGURE X-X: VEGETATION ZONES

Ref No 3215 F

CLIENT Client
SITE DETAILS Farley Lifestyle Village Wollombi Road Farley
DATE 23 August 2023

NORTH

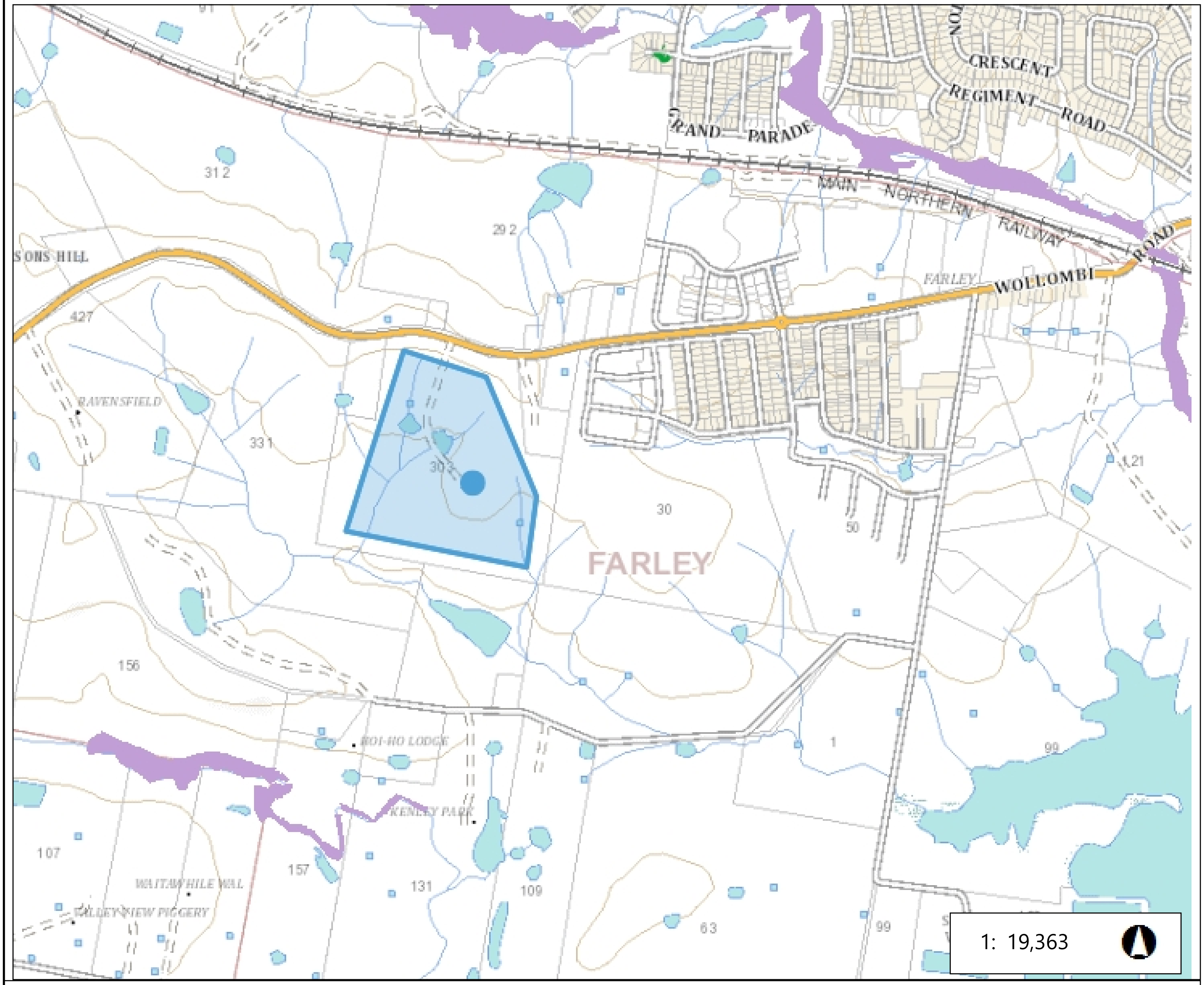
0 50 100 200
SCALE 4000 @ A3

PIXELDRAFTING

Firebird ecoSultants Pty Ltd
ABN - 16 105 985 993
Level 1, 146 Hunter Street, Newcastle NSW 2300
P O Box 354 Newcastle NSW 2300

firebird

Biodiversity Values Map



983.7 | 0 | 491.83 | 983.7 Metres

WGS_1984_Web_Mercator_Auxiliary_Sphere

This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.

THIS MAP IS NOT TO BE USED FOR NAVIGATION

Legend

- Biodiversity Values that have been mapped for more than 90 days
- Biodiversity Values added within last 90 days

Notes

Figure 5 Excluded impacts

N/A

FIGURE 2-3: FLORISTIC SURVEY PLOT

Ref No 3215 F

CLIENT	Client
SITE DETAILS	Farley Lifestyle Village Wollombi Road Farley
DATE	16 August 2023

NORTH

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SCALE 4000 @ A3

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FIGURE X-X: CAMERA TRAPS & ANABAT SURVEY

Ref No 3215 F

CLIENT	Client
SITE DETAILS	Farley Lifestyle Village Wollombi Road Farley
DATE	16 August 2023

NORTH

0 50 100 200

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Ref No 3215 F

FIGURE X-X: SQUIRREL GLIDER

CLIENT Client
SITE DETAILS Farley Lifestyle Village Wollombi Road Farley
DATE 16 August 2023

NORTH

0 50 100 200
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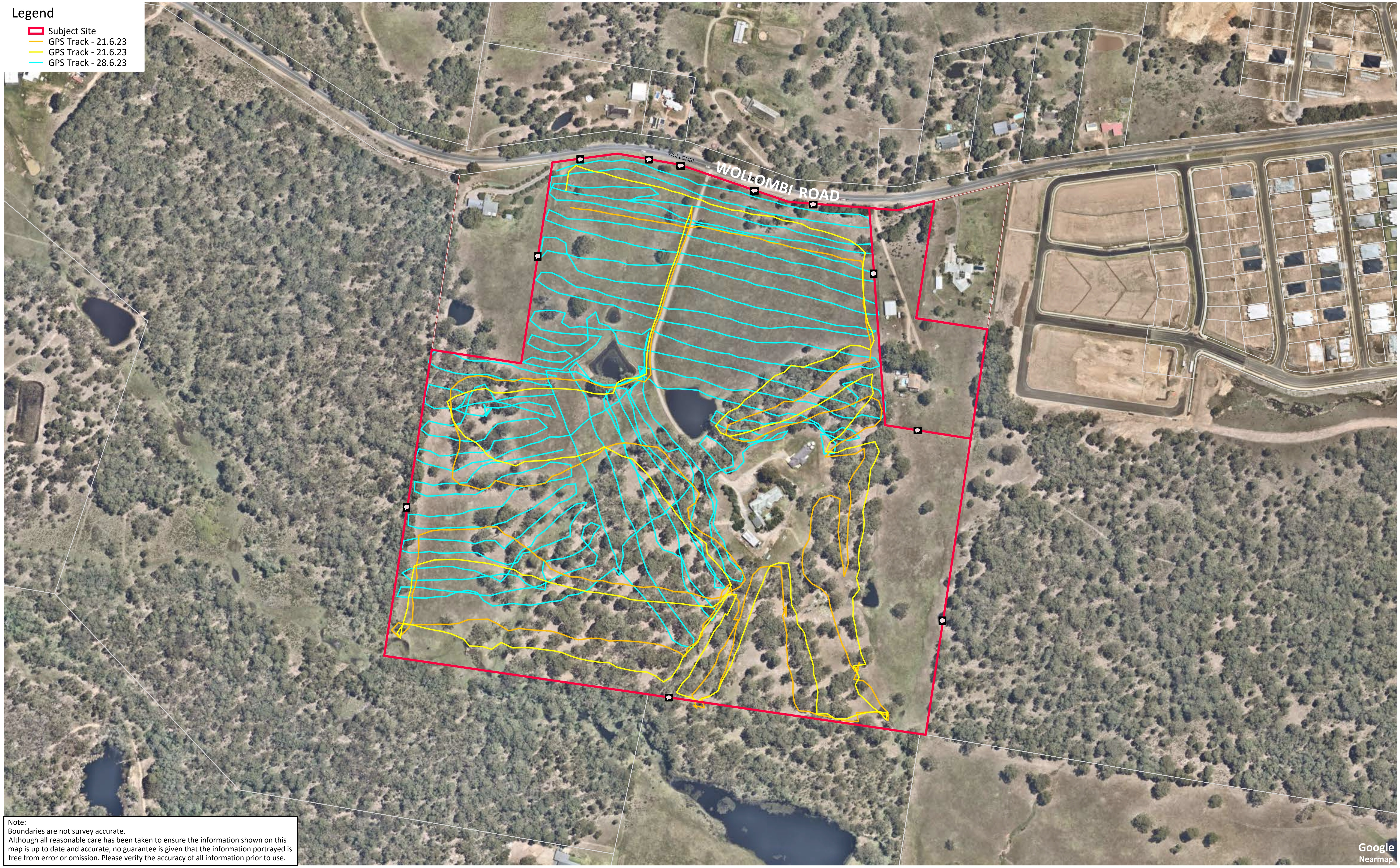

Note:
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Ref No 3215 F

FIGURE X-X: FLORA SURVEY

CLIENT	Client
SITE DETAILS	Farley Lifestyle Village Wollombi Road Farley
DATE	16 August 2023

Firebird ecoSultants Pty Ltd
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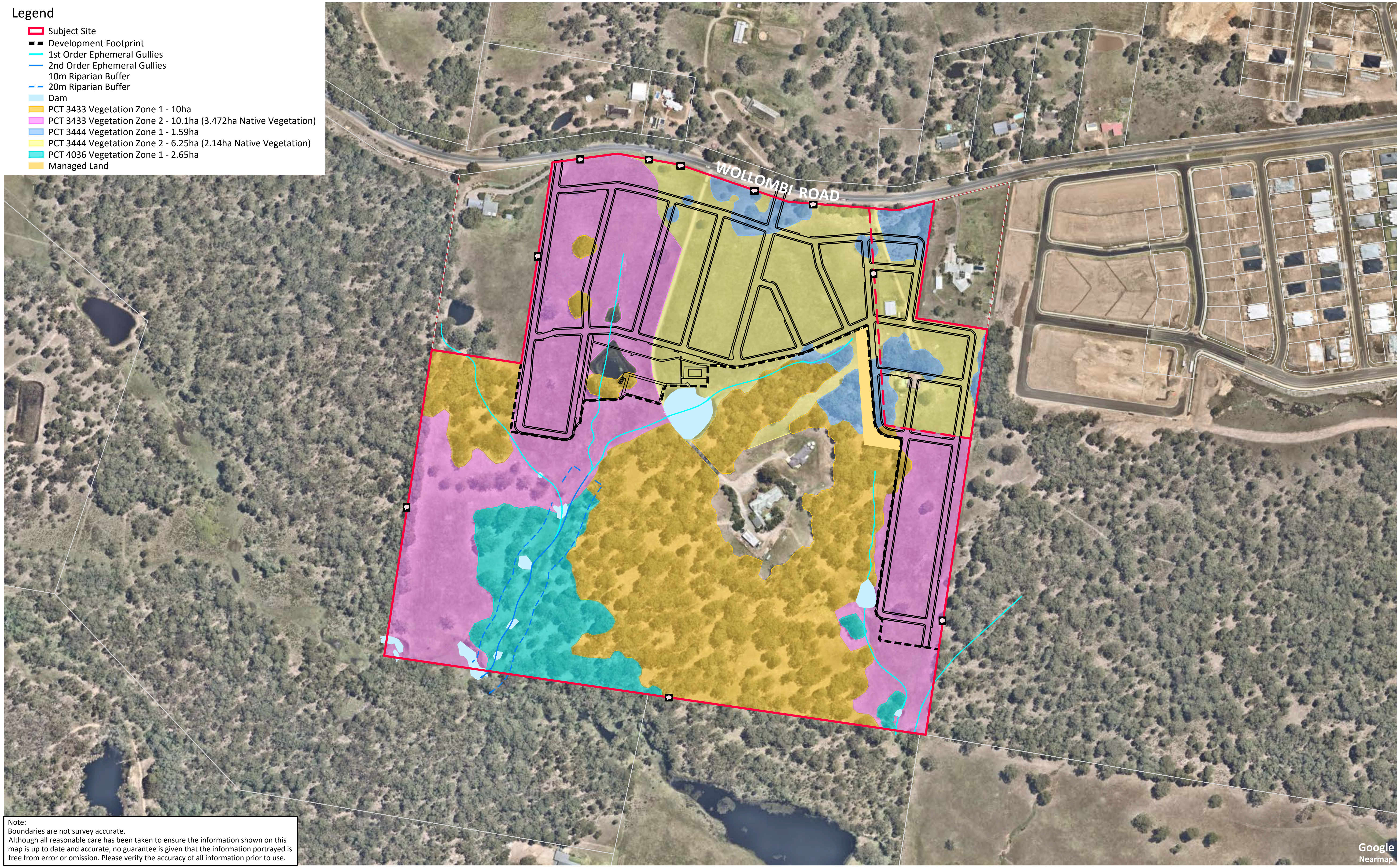
Figure 7 Native vegetation extent



Ref No 3215 F

F I G U R E X - X : PLANT COMMUNTIY TYPES

CLIENT	Client
SITE DETAILS	Farley Lifestyle Village Wollombi Road Farley
DATE	23 August 2023

NORTH

0 50 100 200

SCALE 4000 @ A3

PIXELDRAFTING

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Level 1, 146 Hunter Street, Newcastle NSW 2300
P O Box 354 Newcastle NSW 2300

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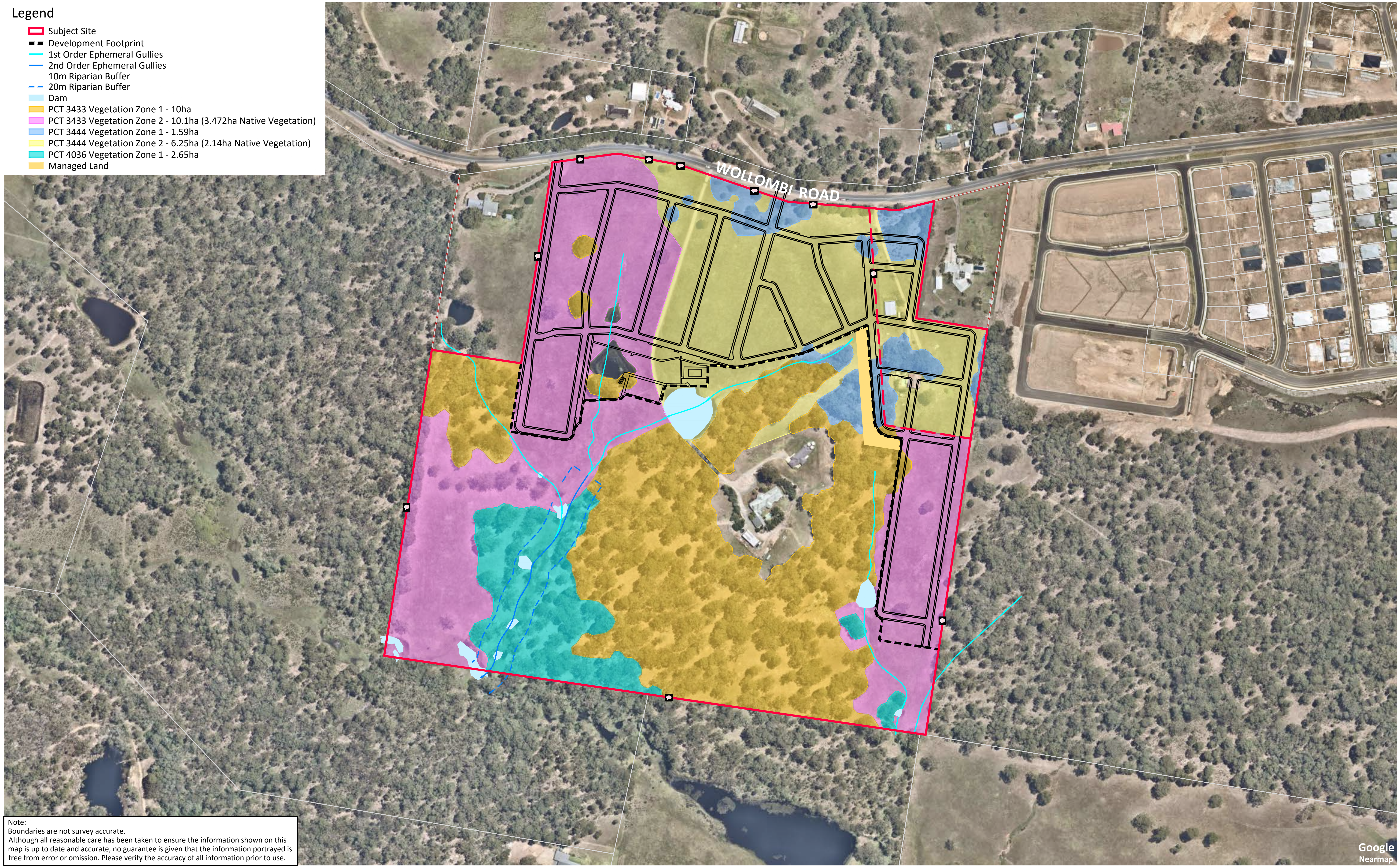
Figure 9 Threatened ecological communities and ecological communities

N/A



Note:
Boundaries are not survey accurate.
Although all reasonable care has been taken to ensure the information shown on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Please verify the accuracy of all information prior to use.

Ref No 3215 F

FIGURE X-X: VEGETATION ZONES

CLIENT Client
SITE DETAILS Farley Lifestyle Village Wollombi Road Farley
DATE 23 August 2023

NORTH

0 50 100 200
SCALE 4000 @ A3

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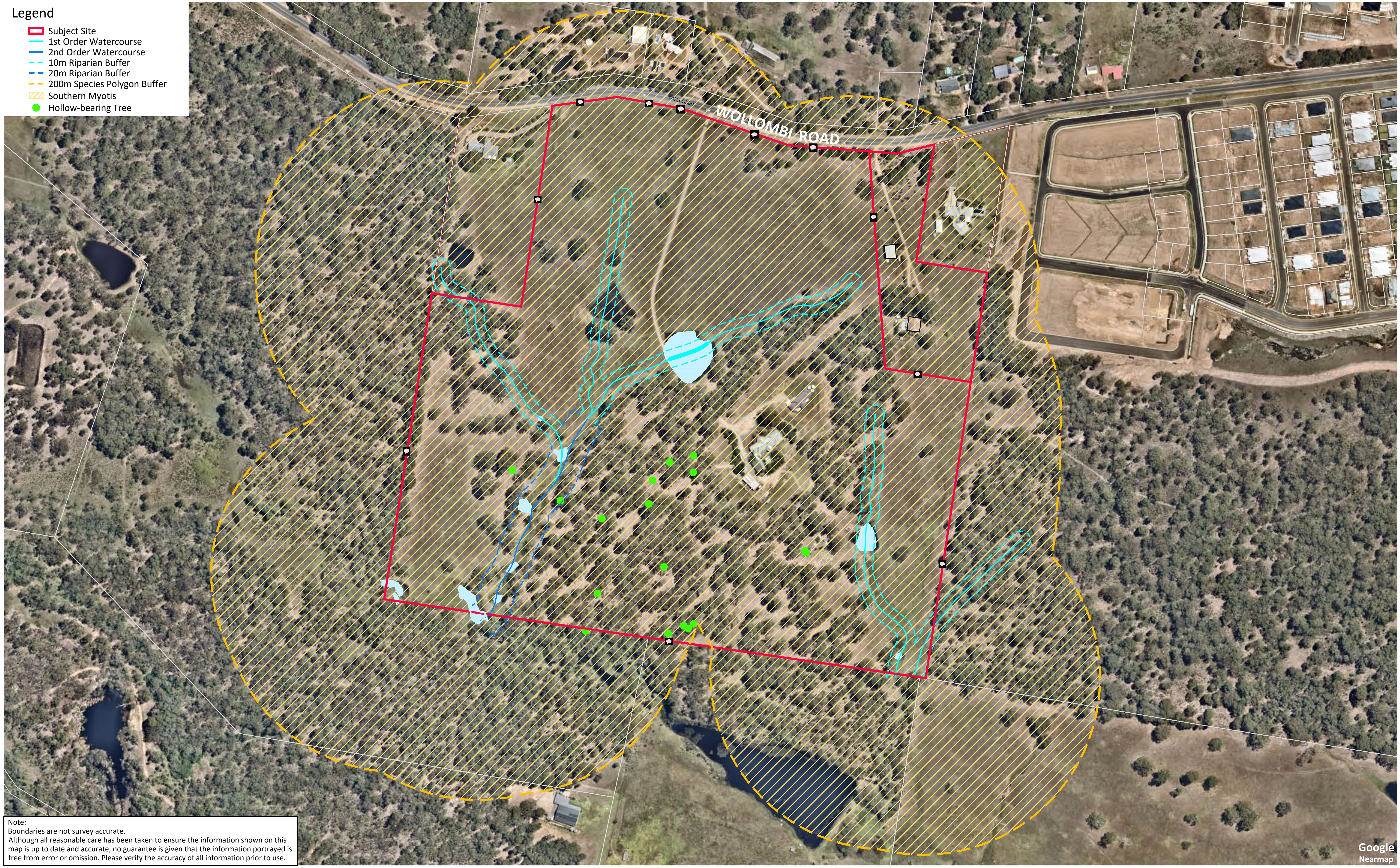

FIGURE X-X: SPECIES POLYGON MAP - SOUTHERN MYOTIS

Ref No 3215 F

CLIENT	Client
SITE DETAILS	Farley Lifestyle Village Wollombi Road Farley
DATE	16 August 2023

NORTH

0 50 100 200

SCALE 4000 @ A3

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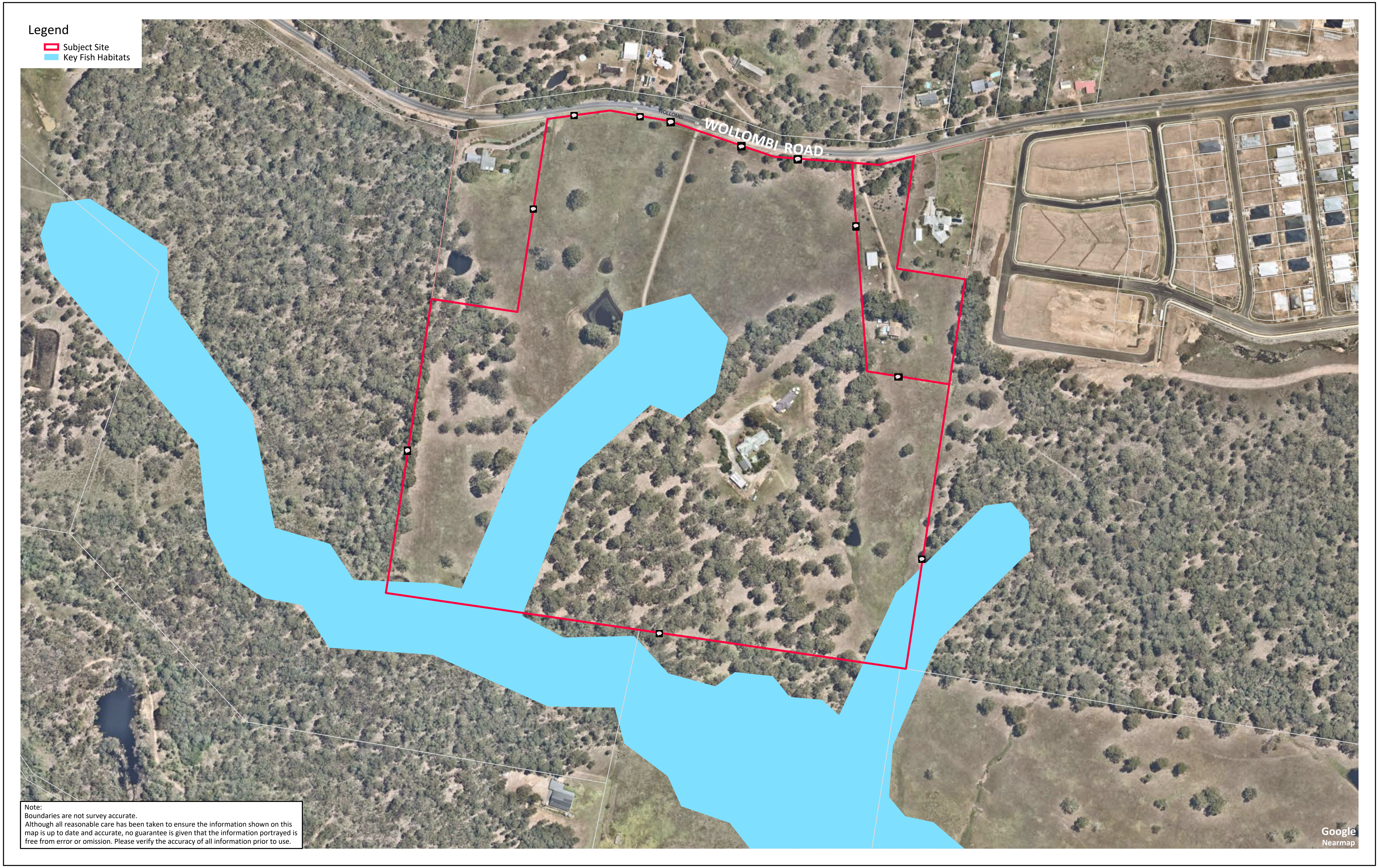

FIGURE X-X: KEY FISH HABITATS

Ref No 3215 F

CLIENT Client
SITE DETAILS Farley Lifestyle Village Wollombi Road Farley
DATE 16 August 2023

PIXELDRAFTING

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P O Box 354 Newcastle NSW 2300

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Figure 12 **Wind turbine disturbance zone**

N/A

Figure 13 Serious and irreversible impacts

N/A

Appendix A: BDAR requirements compliance

Table 41 Assessment of compliance with BDAR minimum information requirements

BDAR section	BAM ref.	BAM requirement	Page reference(s) in the BDAR
Introduction	Chapters 2 and 3	Information	
		Introduction to the biodiversity assessment including:	–
		☒ brief description of the proposal	10
		☒ identification of subject land boundary, including:	10
		☒ operational footprint	
		☒ construction footprint indicating clearing associated with temporary/ancillary construction facilities and infrastructure	
		☒ general description of the subject land	10
		☒ sources of information used in the assessment, including reports and spatial data	12
		☒ identification and justification for entering the BOS	11
		Maps and tables	
		☐ Map of the subject land boundary showing the final proposal footprint, including the construction footprint for any clearing associated with temporary/ancillary construction facilities and infrastructure	<**Error! Reference source not found.**>
Landscape	Sections 3.1 and 3.2, Appendix E	Information	

BDAR section	BAM ref.	BAM requirement	Page reference(s) in the BDAR
		Identification of site context components and landscape features, including:	–
		☒ general description of subject land topographic and hydrological setting, geology and soils	35
		☒ per cent native vegetation cover in the assessment area (as described in BAM Section 3.2)	36
		☒ IBRA bioregions and subregions (as described in BAM Subsection 3.1.3(2.))	35
		☒ rivers and streams classified according to stream order (as described in BAM Subsection 3.1.3(3.) and Appendix E)	35
		☒ wetlands within, adjacent to and downstream of the site (as described in BAM Subsection 3.1.3(3.))	35
		☒ connectivity of different areas of habitat (as described in BAM Subsection 3.1.3(5–6.))	35
		☒ karst, caves, crevices, cliffs, rocks and other geological features of significance and for vegetation clearing proposals, soil hazard features (as described in BAM Subsections 3.1.3(7.) and 3.1.3(12.))	35
		☒ areas of outstanding biodiversity value occurring on the subject land and assessment area (as described in BAM Subsection 3.1.3(8–9.))	35
		☒ any additional landscape features identified in any SEARs for the proposal	36
		☒ NSW (Mitchell) landscape on which the subject land occurs	36
		☐ details of field reconnaissance undertaken to confirm the extent and condition of landscape features and native vegetation cover (as described in Operational Manual Stage 1 Section 2.4)	N/A
		Maps and tables	
		☐ Site Map	**<Error! Reference source not found.>**
		☐ Property boundary	
		☐ Boundary of subject land	

BDAR section	BAM ref.	BAM requirement	Page reference(s) in the BDAR
		☐ Cadastre of subject land (including labelling of Lot and DP or section plan if relevant) ☐ Landscape features identified in BAM Subsection 3.1.3	
		☐ Location Map	**<Error! Reference source not found.>**
		☐ Digital aerial photography at 1:1,000 scale or finer	
		☐ Boundary of subject land	
		☐ Assessment area (i.e. the subject land and either 1500 m buffer area or 500 m buffer for linear development)	
		☐ Landscape features identified in BAM Subsection 3.1.3	
		☐ Additional detail (e.g. local government area boundaries) relevant at this scale	
		Landscape features identified in BAM Subsection 3.1.3 and to be shown on the Site Map and/or Location Map include:	–
		☐ IBRA bioregions and subregions	**<Error! Reference source not found. & Error! Reference source not found.>**
		☐ rivers, streams and estuaries	
		☐ wetlands and important wetlands	
		☐ connectivity of different areas of habitat	
		☐ karst, caves, crevices, cliffs, rocks and other geological features of significance and if required, soil hazard features	
		☐ areas of outstanding biodiversity value occurring on the subject land and assessment area	
		☐ any additional landscape features identified in any SEARs for the proposal	
		☐ NSW (Mitchell) landscape on which the subject land occurs	
		Data	
		☐ All report maps as separate jpeg files	–

BDAR section	BAM ref.	BAM requirement	Page reference(s) in the BDAR
		Individual digital shape files of:	–
		☐ subject land boundary	–
		☐ assessment area (i.e. subject land and 1500 m buffer area) boundary	–
		☐ cadastral boundary of subject land	–
		☐ areas of native vegetation cover	–
		☐ landscape features	–
Native vegetation	Chapter 4, Appendix A and Appendix H	Information	
		☒ Identify native vegetation extent within the subject land, including cleared areas and evidence to support differences between mapped vegetation extent and aerial imagery (as described in BAM Section 4.1(1–3.) and Subsection 4.1.1)	36
		☒ Provide justification for all parts of the subject land that do not contain native vegetation (as described in BAM Subsection 4.1.2)	37
		☒ Review of existing information on native vegetation including references to previous vegetation maps of the subject land and assessment area (described in BAM Section 4.1(3.) and Subsection 4.1.1)	37
		☒ Describe the systematic field-based floristic vegetation survey undertaken in accordance with BAM Section 4.2	13,14,15, 41
		☒ Where relevant, describe the use of more appropriate local data, provide reasons that support the use of more appropriate local data and include the written confirmation from the decision-	N/A

BDAR section	BAM ref.	BAM requirement	Page reference(s) in the BDAR
		maker that they support the use of more appropriate local data (as described in BAM Subsection 1.4.2 and Appendix A)	
		For each PCT within the subject land, describe:	–
		☒ PCT name and ID	37,38
		☒ vegetation class	37,38
		☐ extent (ha) within subject land	37,38
		☒ evidence used to identify a PCT including any analyses undertaken, references/sources, existing vegetation maps (BAM Section 4.2(1–3.))	38
		☒ plant species relied upon for identification of the PCT and relative abundance of each species	38
		☒ if relevant, TEC status including evidence used to determine vegetation is the TEC (BAM Subsection 4.2.2(1–2.))	39
		☒ estimate of per cent cleared value of PCT (BAM Subsection 4.2.1(5.))	37,38
		Describe the vegetation integrity assessment of the subject land, including:	–
		☒ identification and mapping of vegetation zones (as described in BAM Subsection 4.3.1)	40
		☒ description of vegetation zones within the subject land (as described in Operational Manual Stage 1 Table 2 and Subsection 3.3.2)	40
		☒ area (ha) of each vegetation zone	39
		☒ assessment of patch size (as described in BAM Subsection 4.3.2)	40
		☒ survey effort (i.e. number of vegetation integrity survey plots) as described in BAM Subsection 4.3.4(1–2.)	41
		☒ use of relevant benchmark data from BioNet Vegetation Classification (as described in BAM Subsection 4.3.3(5.))	42,43

BDAR section	BAM ref.	BAM requirement	Page reference(s) in the BDAR
		Where use of more appropriate local benchmark data is proposed (as described in BAM Subsection 1.4.2, BAM Subsection 4.3.3(5.) and BAM Appendix A):	–
		☒ identify the PCT or vegetation class for which local benchmark data will be applied	N/A
		☒ identify published sources of local benchmark data (if benchmarks obtained from published sources)	
		☒ describe methods of local benchmark data collection (if reference plots used to determine local benchmark data)	
		☒ provide justification for use of local data rather than BioNet Vegetation Classification benchmark values	N/A
		☒ provide written confirmation from the decision-maker that they support the use of local benchmark data	N/A
		Maps and tables	
		☐ Map of native vegetation extent within the subject land at scale not greater than 1:10,000 including identification of all areas of native vegetation including areas that are ground cover only, cleared areas (as described in BAM Section 4.1(1–3.)) and all parts of the subject land that do not contain native vegetation (BAM Subsection 4.1.2)	<**Error! Reference source not found.**>
		☐ Map of PCTs within the subject land (as described in BAM Section 4.2(1.))	<**Error! Reference source not found.**>
		☐ Map of vegetation zones within the subject land (as described in BAM Subsection 4.3.1)	<**Error! Reference source not found.**>
		☐ Map the location of floristic vegetation survey plots and vegetation integrity survey plots relative to PCT boundaries	<**Error! Reference**

BDAR section	BAM ref.	BAM requirement	Page reference(s) in the BDAR
			source not found.>
		☐ Map of TEC distribution on the subject land and table of TEC listing, status and area (ha)	**<Error! Reference source not found.** & **Error! Reference source not found.>**
		☐ Map of patch size locations for each native vegetation zone and table of patch size areas (as described in BAM Subsection 4.3.2)	**<Error! Reference source not found.** & **Error! Reference source not found.>**
		Table of current vegetation integrity scores for each vegetation zone within the site and including:	–
		☒ composition condition score	42
		☒ structure condition score	
		☒ function condition score	
		☒ presence of hollow bearing trees	
		Data	
		☐ All report maps as separate jpeg files	–
		☐ Plot field data (MS Excel format)	

BDAR section	BAM ref.	BAM requirement	Page reference(s) in the BDAR
		☐ Plot field datasheets	<Appendix F>
		Digital shape files of:	–
		☐ PCT boundaries within subject land	–
		☐ TEC boundaries within subject land	–
		☐ vegetation zone boundaries within subject land	–
		☐ floristic vegetation survey and vegetation integrity plot locations	–
Threatened species	Chapter 5	Information	
		Identify ecosystem credit species likely to occur on the subject land, including:	
		☒ list of ecosystem credit species derived from the BAM-C (as described in BAM Subsection 5.1.1 and Section 5.2(1.))	44,45,46,47,48,49,50
		☒ justification and supporting evidence for exclusion of any ecosystem credit species based on geographic limitations, habitat constraints or vagrancy (as described in BAM Subsections 5.2.1 and 5.2.2)	44,45,46,47,48,49,50
		☒ justification for addition of any ecosystem credit species to the list	N/A
		Identify species credit species likely to occur on the subject land, including:	–
		☒ list of species credit species derived from the BAM-C (as described in BAM Subsection 5.1.1)	50,51,52,53,54,55,56,57
		☒ justification and supporting evidence for exclusions based on geographic limitations, habitat constraints or vagrancy (as described in BAM Subsections 5.2.1 and 5.2.2)	50,51,52,53,54,55,56,57

BDAR section	BAM ref.	BAM requirement	Page reference(s) in the BDAR
		☒ justification and supporting evidence for exclusions based on degraded habitat constraints and/or microhabitats on which the species depends (as described in BAM Subsection 5.2.2)	50,51,52,53,54,55,56,57
		☒ justification for addition of any species credit species to the list	N/A
		From the list of candidate species credit species, identify:	–
		☒ species assumed present within the subject land (if relevant) (as described in BAM Subsection 5.2.4(2.a.)) ☒ species present within the subject land on the basis of being identified on an important habitat map for a species (as described in BAM Subsection 5.2.4(2.d.)) ☒ species for which targeted surveys are to be completed to determine species presence (BAM Subsection 5.2.4(2.b.)) ☒ species for which an expert report is to be used to determine species presence (BAM Subsection 5.2.4(2.c.))	58,59,60,61
		Present the outcomes of species credit species assessments from:	–
		☒ threatened species survey (as described in BAM Section 5.2.4)	62,63,64
		☒ expert reports (if relevant) including justification for presence of the species and information used to make this determination (as described in BAM Subsection 5.2.4, Section 5.3, Box 3)	64
		Where survey has been undertaken include detailed information on:	–
		☒ survey method and effort (as described in BAM Section 5.3)	62,63,64
		☒ justification of survey method and effort (e.g. citation of peer-reviewed literature) if approach differs from the department's taxa-specific survey guides or where no relevant guideline has been published	60,61
		☒ timing of survey in relation to requirements in the TBDC or the department's taxa-specific survey guides. Where survey was undertaken outside these guides include justification for the timing of surveys	60,61,62,63,64

BDAR section	BAM ref.	BAM requirement	Page reference(s) in the BDAR
		☒ survey personnel and relevant experience	60,61,62,63,64
		☒ describe any limitations to surveys and how these were addressed/overcome	60,61,62,63,64
		Where an expert report has been used in place of survey (as described in BAM Section 5.3, Box 3), include:	–
		☒ justification of the use of an expert report	N/A
		☒ identify the expert, provide evidence of their expert credentials and departmental approval of expert status	
		☒ all requirements of Box 3 have been addressed in the expert report	
		Where use of local data is proposed (BAM Subsection 1.4.2):	–
		☒ identify relevant species	N/A
		☒ identify data to be amended	
		☒ identify source of information for local data, e.g. published literature, additional survey data, etc.	
		☒ justify use of local data in preference to VIS Classification or TBDC data	
		☒ provide written confirmation from the decision-maker that they support the use of local data	N/A
		Species polygon completed for species credit species present within the subject land (assumed present or determined on the basis of survey, expert report or important habitat map) ensuring that:	–
		☐ the unit of measure for each species is documented	
		for species assessed by area:	
		☒ the polygon includes the extent of suitable habitat for the target species within the subject land (as described in BAM Subsection 5.2.5)	N/A

BDAR section	BAM ref.	BAM requirement	Page reference(s) in the BDAR
		☒ a description of, and evidence-based justification for, the habitat constraints, features or microhabitats used to map the species polygon including reference to information in the TBDC for that species and any buffers applied	N/A
		for species assessed by counts of individuals:	N/A
		☒ the number of individual plants present on the subject land (as described in BAM Subsection 5.2.5(3.))	N/A
		☒ the method used to derive this number (i.e. threatened species survey or expert report) and evidence-based justification for the approach taken	N/A
		☒ the polygon includes all individuals located on the subject land with a buffer of 30 m around the individuals or groups of individuals on the subject land	N/A
		☒ Identify the biodiversity risk weighting for each species credit species identified as present within the subject land (as described in BAM Section 5.4)	N/A
		Maps and tables	
		☒ Table showing ecosystem credit species in accordance with BAM Subsection 5.1.1, and identifying:	44,45,46,47 ,48,49,50
		☒ the ecosystem credit species removed from the list	52,53,54,55 ,56,57
		☒ the sensitivity to gain class of each species	52,53,54,55 ,56
		☒ Table detailing species credit species in accordance with BAM Section 5.2 and identifying:	58, 59
		☒ the species credit species removed from the list of species because the species is considered vagrant, out of geographic range or the habitat or microhabitat features are not present	58, 59
		☒ the candidate species credit species not recorded on the subject land as determined by targeted survey, expert report or important habitat map	58, 59

BDAR section	BAM ref.	BAM requirement	Page reference(s) in the BDAR
		☒ Table detailing species credit species recorded or assumed as present within the subject land, habitat constraints or microhabitats associated with the species, counts of individuals (flora)/extent of suitable habitat (flora and fauna) (as described in BAM Subsection 5.2.6) and biodiversity risk weighting (BAM Section 5.4)	60,61,62,63,64
		☐ Map indicating the GPS coordinates of all individuals of each species recorded within the subject land and the species polygon for each species (as described in BAM Subsection 5.2.5)	
		Data	
		☐ Digital shape files of suitable habitat identified for survey for each candidate species credit species	–
		☐ Survey locations including GPS coordinates of any plots, transects, grids	
		☐ Digital shape files of each species polygon including GPS coordinates of located individuals	–
		☐ Species polygon map in jpeg format	–
		☐ Expert reports and any supporting data used to support conclusions of the expert report	
		☐ Field datasheets detailing survey information including prevailing conditions, date, time, equipment used, etc.	
Prescribed impacts	Chapter 6	Information	
		Identify potential prescribed biodiversity impacts on threatened entities, including:	–
		☒ karst, caves, crevices, cliffs, rocks and other geological features of significance (as described in BAM Subsection 6.1.1) ☒ occurrences of human-made structures and non-native vegetation (as described in BAM Subsection 6.1.2) ☒ corridors or other areas of connectivity linking habitat for threatened entities (as described in BAM Subsection 6.1.3)	67,68

BDAR section	BAM ref.	BAM requirement	Page reference(s) in the BDAR
		☒ waterbodies or any hydrological processes that sustain threatened entities (as described in BAM Subsection 6.1.4)	
		☒ protected animals that may use the proposed wind farm development site as a flyway or migration route (as described in BAM Subsection 6.1.5)	67,68
		☒ where the proposed development may result in vehicle strike on threatened fauna or on animals that are part of a threatened ecological community (as described in BAM Subsection 6.1.6)	67,68
		☒ Identify a list of threatened entities that may be dependent upon or may use habitat features associated with any of the prescribed impacts	67,68
		☒ Describe the importance of habitat features to the species including, where relevant, impacts on life cycle or movement patterns (e.g. Subsection 6.1.3)	67,68
		Where the proposed development is for a wind farm:	
		☒ identify a candidate list of protected animals that may use the development site as a flyway or migration route, including: resident threatened aerial species, resident raptor species and nomadic and migratory species that are likely to fly over the proposal area (as described in BAM Subsection 6.1.5)	N/A
		☒ provide details of targeted survey for candidate species of wind farm developments undertaken in accordance with BAM Subsection 6.1.5(2–3.)	N/A
		☒ predict the habitual flight paths for nomadic and migratory species likely to fly over the subject land and map the likely habitat for resident threatened aerial and raptor species (BAM Subsection 6.1.5(4.))	N/A
		Where the proposal may result in vehicle strike:	–
		☒ identify a list of threatened fauna or protected fauna species that are part of a TEC and at risk of vehicle strike due to the proposal	N/A
		Maps and tables	

BDAR section	BAM ref.	BAM requirement	Page reference(s) in the BDAR
		☐ Map showing location of any prescribed impact features (i.e. karst, caves, crevices, cliffs, rocks, human-made structures, etc.)	<**Error! Reference source not found.** & **Error! Reference source not found.**>
		☐ Map showing location of potential vehicle strike locations	<**Error! Reference source not found.**>
		☐ Maps of habitual flight paths for nomadic and migratory species likely to fly over the site and maps of likely habitat for threatened aerial species resident on the site (for wind farm developments only)	<**Error! Reference source not found.** & **Error! Reference source not found.**>
		Data	
		☐ Digital shape files of prescribed impact feature locations	–
		☐ Prescribed impact features map in jpeg format	–
Avoid and minimise impacts	Chapter 7	Information	

BDAR section	BAM ref.	BAM requirement	Page reference(s) in the BDAR
		Demonstration of efforts to avoid and minimise impacts on biodiversity values (including prescribed impacts) associated with the proposal location in accordance with Chapter 7, including an analysis of alternative:	–
		☒ modes or technologies that would avoid or minimise impacts on biodiversity values and justification for selecting the proposed mode or technology	69,70,71,72 ,73,74
		☒ routes that would avoid or minimise impacts on biodiversity values and justification for selecting the proposed route	73
		☒ alternative locations that would avoid or minimise impacts on biodiversity values and justification for selecting the proposed location	73
		☒ alternative sites within a property on which the proposal is located that would avoid or minimise impacts on biodiversity values and justification for selecting the proposed site	73
		☒ Describe efforts to avoid and minimise impacts (including prescribed impacts) to biodiversity values through proposal design (as described in BAM Sections 7.1 and 7.2)	72,73
		☒ Identification of any other site constraints that the proponent has considered in determining the location and design of the proposal (as described in BAM Subsection 7.2.1(3.))	72,73
		☒ Detail measures or options considered but not implemented because they are not feasible and/or practical (e.g. due to site constraints)	N/A
		Maps and tables	
		☒ Table of measures to be implemented to avoid and minimise the impacts of the proposal, including action, outcome, timing and responsibility	81,82,83
		☐ Map of alternative footprints considered to avoid or minimise impacts on biodiversity values; and of the final proposal footprint, including construction and operation	**<Error! Reference source not found.>**
		☐ Maps demonstrating indirect impact zones where applicable	**<Error! Reference**

BDAR section	BAM ref.	BAM requirement	Page reference(s) in the BDAR
			source not found.>
		Data	
		Digital shape files of:	–
		☐ alternative and final proposal footprint	–
		☐ direct and indirect impact zones	–
		☐ Maps in jpeg format	–
Assessment of impacts	Chapter 8, Sections 8.1 and 8.2	Information	
		☒ Determine the impacts on native vegetation and threatened species habitat, including a description of direct impacts of clearing of native vegetation, threatened ecological communities and threatened species habitat (as described in BAM Section 8.1)	75
		Assessment of indirect impacts on vegetation and threatened species and their habitat including (as described in BAM Section 8.2):	–
		☒ description of the nature, extent, frequency, duration and timing of indirect impacts of the proposal	79,80
		☒ documenting the consequences to vegetation and threatened species and their habitat including evidence-based justifications	76,77,78
		☒ reporting any limitations or assumptions, etc. made during the assessment	76,77,78
		☒ identification of the threatened entities and their habitat likely to be affected	76,77,78
		Assessment of prescribed biodiversity impacts (as described in BAM Section 8.3) including:	–

BDAR section	BAM ref.	BAM requirement	Page reference(s) in the BDAR
		assessment of the nature, extent frequency, duration and timing of impacts on the habitat of threatened species or ecological communities associated with:	–
		☒ karst, caves, crevices, cliffs, rocks and other features of geological significance	N/A
		☒ human-made structures	N/A -80
		☒ non-native vegetation	N/A -80
		☒ connectivity of different areas of habitat of threatened species that facilitates the movement of those species across their range	N/A-80
		☒ movement of threatened species that maintains their life cycle	N/A-80
		☒ water quality, waterbodies and hydrological processes that sustain threatened species and threatened ecological communities	N/A-80
		☒ assessment of the impacts of wind turbine strikes on protected animals	N/A-80
		☒ assessment of the impacts of vehicle strikes on threatened species of animals or on animals that are part of a TEC	N/A-80
		☒ evaluate the consequences of prescribed impacts	N/A-80
		☒ describe impacts that are uncertain	N/A-80
		☒ document limitations to data, assumptions and predictions	N/A-80
		Maps and tables	
		☒ Table showing change in vegetation integrity score for each vegetation zone as a result of identified impacts	75
		Data	
		N/A	–
Mitigation and manage	Chapter 8, Sectio	Information	

BDAR section	BAM ref.	BAM requirement	Page reference(s) in the BDAR
ment of impacts	ns 8.4 and 8.5		
		Identification of measures to mitigate or manage impacts in accordance with the recommendations in BAM Sections 8.4 and 8.5 including:	–
		☒ techniques, timing, frequency and responsibility ☒ identify measures for which there is risk of failure ☒ evaluate the risk and consequence of any residual impacts	81,82,83
		☒ document any adaptive management strategy proposed	81,82,83
		Identification of measures for mitigating impacts related to:	
		☒ displacement of resident fauna (as described in BAM Subsection 8.4.1(2.)) ☒ indirect impacts on native vegetation and habitat (as described in BAM Subsection 8.4.1(3.)) ☒ mitigating prescribed biodiversity impacts (as described in BAM Subsection 8.4.2)	81,82,83
		☒ Details of the adaptive management strategy proposed to monitor and respond to impacts on biodiversity values that are uncertain (BAM Section 8.5)	84
		Maps and tables	
		☒ Table of measures to be implemented before, during and after construction to mitigate and manage impacts of the proposal, including action, outcome, timing and responsibility	81,82,83
		Data	
		N/A	–
Impact summar y	Chapt er 9	Information	

BDAR section	BAM ref.	BAM requirement	Page reference(s) in the BDAR
		Identification and assessment of impacts on TECs and threatened species that are at risk of a serious and irreversible impacts (SAII, in accordance with BAM Section 9.1) including:	–
		☐ addressing all criteria in Subsection 9.1.1 for each TEC listed as at risk of an SAII present on the subject land	**<Error! Reference source not found.** & **Error! Reference source not found.>**
		☐ for each TEC, report the extent of the TEC in NSW	**<Error! Reference source not found.>**
		☐ addressing all criteria in Subsection 9.1.2 for each threatened species at risk of an SAII present on the subject land	**<Error! Reference source not found.** & **Error! Reference source not found.>**
		☐ for each threatened species, report the population size in NSW	**<Error! Reference source not found.>**
		☐ documenting assumptions made and/or limitations to information	**<Error! Reference source not found.–Error!**
		☐ documenting all sources of data, information, references used or consulted	
		☐ clearly justifying why any criteria could not be addressed	

BDAR section	BAM ref.	BAM requirement	Page reference(s) in the BDAR
			Reference source not found.>
		☐ Identification of impacts requiring offset in accordance with BAM Section 9.2	**<Error! Reference source not found. & Error! Reference source not found.>**
		☐ Identification of impacts not requiring offset in accordance with BAM Subsection 9.2.1(3.)	**<Error! Reference source not found.>**
		☐ Identification of areas not requiring assessment in accordance with BAM Section 9.3	**<Error! Reference source not found.>**
		Maps and tables	
		☐ Map showing the extent of TECs at risk of an SAII within the subject land	**<Error! Reference source not found.>**
		☐ Map showing location of threatened species at risk of an SAII within the subject land	**<Error! Reference source not found.>**
		Map showing location of:	–

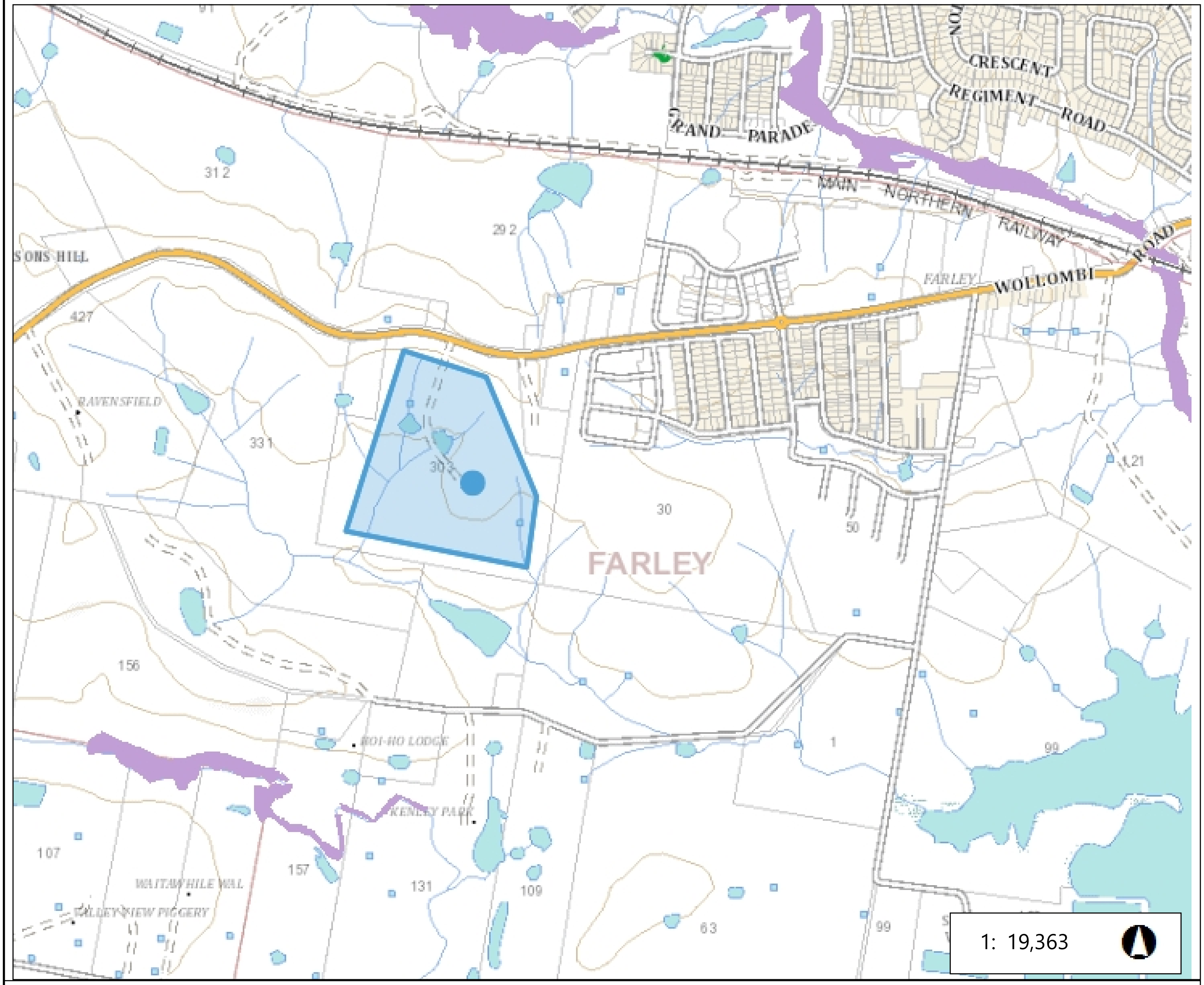
BDAR section	BAM ref.	BAM requirement	Page reference(s) in the BDAR
		☐ impacts requiring offset	<**Error! Reference source not found.**>
		☐ impacts not requiring offset	<**Error! Reference source not found.**>
		☐ areas not requiring assessment	<**Error! Reference source not found.**>
		Data	
		Digital shape files of:	–
		☐ extent of TECs at risk of an SAII within the subject land	–
		☐ location of threatened species at risk of an SAII within the subject land	–
		☐ boundary of impacts requiring offset	–
		☐ boundary of impacts not requiring offset	–
		☐ boundary of areas not requiring assessment	–
		☐ Maps in jpeg format	–
Impact summar y	Chapt er 10	Information	
		Ecosystem credits and species credits that measure the impact of the development on biodiversity values, including:	–

BDAR section	BAM ref.	BAM requirement	Page reference(s) in the BDAR
		☐ future vegetation integrity score for each vegetation zone within the subject land (Equation 25 and Equation 26 in BAM Appendix H) ☐ change in vegetation integrity score (BAM Subsection 8.1.1) ☐ number of required ecosystem credits for the direct impacts of the proposal on each vegetation zone within the subject land (BAM Subsection 10.1.2)	<**Error! Reference source not found.**>
		☐ biodiversity risk weighting for each	<**Error! Reference source not found.** & **Error! Reference source not found.**>
		☐ number of required species credits for each candidate threatened species that is directly impacted on by the proposal (BAM Subsection 10.1.3)	<**Error! Reference source not found.**>
		Maps and tables	
		☐ Table of PCTs requiring offset and the number of ecosystem credits required	<**Error! Reference source not found.**>
		☐ Table of threatened species requiring offset and the number of species credits required	<**Error! Reference source not found.**>
		Data	
		☐ Submitted proposal in the BAM Calculator	–

BDAR section	BAM ref.	BAM requirement	Page reference(s) in the BDAR
Biodiversity credit report	Chapter 10	Information	
		☐ Description of credit classes for ecosystem credits and species credits at the development or clearing site or land to be biodiversity certified (BAM Section 10.2)	<**Error! Reference source not found.** & **Error! Reference source not found.**>
		☐ BAM credit report in pdf format	<Appendix H>
		Maps and tables	
		☐ Table of credit class and matching credit profile	<**Error! Reference source not found.**>
		Data	
		☐ BAM credit report in pdf format	<Appendix H>

Appendix B: Biodiversity Values Map and Threshold tool report

Biodiversity Values Map



983.7 0 491.83 983.7 Metres

WGS_1984_Web_Mercator_Auxiliary_Sphere

This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.

THIS MAP IS NOT TO BE USED FOR NAVIGATION

Legend

- Biodiversity Values that have been mapped for more than 90 days
- Biodiversity Values added within last 90 days

Notes

Biodiversity Values Map and Threshold Report

Results Summary

Date of Calculation	06/03/2023 12:09 PM	**BDAR Required***
Total Digitised Area	192,937.4 sqm	
Minimum Lot Size Method	LEP	
Minimum Lot Size 10,000sqm = 1ha	400,000 sqm	
Area Clearing Threshold 10,000sqm = 1ha	10,000 sqm	
Area clearing trigger Area of native vegetation cleared	Unknown #	Unknown #
Biodiversity values map trigger Impact on biodiversity values map(not including values added within the last 90 days)?	no	no
Date of the 90 day Expiry	N/A	

*If BDAR required has:

- at least one 'Yes': you have exceeded the BOS threshold. You are now required to submit a Biodiversity Development Assessment Report with your development application. Go to https://customer.lmbc.nsw.gov.au/assessment/AccreditedAssessor to access a list of assessors who are accredited to apply the Biodiversity Assessment Method and write a Biodiversity Development Assessment Report
- 'No': you have not exceeded the BOS threshold. You may still require a permit from local council. Review the development control plan and consult with council. You may still be required to assess whether the development is '"likely to significantly affect threatened species' as determined under the test in s. 7.3 of the Biodiversity Conservation Act 2016. You may still be required to review the area where no vegetation mapping is available.

Where the area of impact occurs on land with no vegetation mapping available, the tool cannot determine the area of native vegetation cleared and if this exceeds the Area Threshold. You will need to work out the area of native vegetation cleared - refer to the BMAT user guide for how to do this.

On and after the 90 day expiry date a BDAR will be required.

Disclaimer

This results summary and map can be used as guidance material only. This results summary and map is not guaranteed to be free from error or omission. The State of NSW and Department of Planning and Environment and its employees disclaim liability for any act done on the information in the results summary or map and any consequences of such acts or omissions. It remains the responsibility of the proponent to ensure that their development application complies will all aspects of the *Biodiversity Conservation Act 2016.*

The mapping provided in this tool has been done with the best available mapping and knowledge of species habitat requirements. This map is valid for a period of 30 days from the date of calculation (above).

Acknowledgement

I as the applicant for this development, submit that I have correctly depicted the area that will be impacted or likely to be impacted as a result of the proposed development.

Signature______________________ Date: 06/03/2023 12:09 PM

Appendix C: Determination of excluded impacts

N/A

Appendix D: Matters of national environmental significance

N/A

Appendix E: Vegetation survey data

Table 42 Vegetation survey data and locations

plot	pct		area	patchsize	condition class	zone	easting	northing	bearing	compTree	compShrub	compGrass	compForbs	compFerns	compOther	strucTree	strucShrub	strucGrass	strucForbs	strucFerns	strucOther	funLargeTrees	funHollowtrees	funLitterCover	funLenFallenLogs	funTreeStem5to9	funTreeStem10to19	funTreeStem20to29	funTreeStem30to49	funTreeStem50to79	funTreeRegen	funHighThreatExotic	Plot-based vegetation survey?	Vegetation integrity survey?
																																	☐ Yes ☐ No	☐ Yes ☐ No
																																	☐ Yes ☐ No	☐ Yes ☐ No

Scientific Name	Common Name	BC Act	EPBC Act	GrowthForm	N or E	HTE	Cover	Abundance
Eucalyptus gunnii	Cider Gum	Not Listed	Not Listed	Tree (TG)	Not Known from NSW		0.1	1
Eucalyptus siderophloia	Grey Ironbark	Not Listed	Not Listed	Tree (TG)	Alive in NSW, Native		25	2
Aristida vagans	Threeawn Speargrass	Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		0.1	10
Haloragis heterophylla	Variable Raspwort	Not Listed	Not Listed	Forb (FG)	Alive in NSW, Native		0.1	10
Murdannia graminea		Not Listed	Not Listed	Forb (FG)	Alive in NSW, Native		0.1	1
Cynodon dactylon	Common Couch	Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		3	100
Themeda australis	Kangaroo Grass	Not Listed	Not Listed	0	Alive in NSW, Native		8	500
Echinopogon caespitosus	Bushy Hedgehog-grass	Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		1	200
Eragrostis brownii	Brown's Lovegrass	Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		15	1000
Aristida ramosa	Purple Wiregrass	Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		1	200
Paspalidium distans		Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		2	400
Microlaena stipoides	Weeping Grass	Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		10	1000
Sporobolus creber	Slender Rat's Tail Grass	Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		4	400
Fimbristylis dichotoma	Common Fringe-sedge	Not Listed	Not Listed	FALSE	Alive in NSW, Native		0.1	20
Glycine tabacina	Variable Glycine	Not Listed	Not Listed	Other (OG)	Alive in NSW, Native		2	400
Dichondra repens							0.2	100
Pratia purpurascens							0.2	100
Glycine microphylla							3	500
Axonopus compressus	Broad-leaved Carpet Grass	Not Listed	Not Listed	0	Introduced		1	200
Modiola caroliniana	Red-flowered Mallow	Not Listed	Not Listed	0	Introduced		0.1	1
Paspalum dilatatum	Paspalum	Not Listed	Not Listed	0	Introduced		0.5	100
Digitaria didactyla	Queensland Blue Couch	Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		55	2000
Sida rhombifolia	Paddy's Lucerne	Not Listed	Not Listed		Introduced		0.2	20
Senecio madagascariensis	Fireweed	Not Listed	Not Listed	0	Introduced		0.3	30
Juncus cognatus		Not Listed	Not Listed	0	Introduced		0.1	20
Trifolium repens	White Clover	Not Listed	Not Listed	0	Introduced		0.2	50
Stellaria media	Common Chickweed	Not Listed	Not Listed	0	Introduced		0.1	5
Plantago lanceolata	Lamb's Tongues	Not Listed	Not Listed	0	Introduced		0.2	100
Hypochoeris radicata	Catsear	Not Listed	Not Listed	0	Introduced		0.1	10
Paronychia brasiliana	Chilean Whitlow Wort, Brazilian Whitlo	Not Listed	Not Listed	0	Introduced		0.3	200
Cyperus brevifolius		Not Listed	Not Listed	0	Introduced		0.2	100
Desmodium varians							0.1	5
Cyperus polystachyos							0.1	10
Laxmannia gracilis	Slender Wire Lily	Not Listed	Not Listed	Forb (FG)	Alive in NSW, Native		0.1	1
Poa sieberiana	Snowgrass	Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		0.1	3
Echinopogon ovatus	Forest Hedgehog Grass	Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		0.1	2
Cenchrus clandestinus	Kikuyu Grass	Not Listed	Not Listed	0	Introduced		0.1	1

Scientific Name	Common Name	BC Act	EPBC Act	GrowthForm	N or E	HTE	Cover	Abundance
Eucalyptus globoidea	White Stringybark	Not Listed	Not Listed	Tree (TG)	Alive in NSW, Native		0.1	1
Eucalyptus tereticornis	Forest Red Gum	Not Listed	Not Listed	Tree (TG)	Alive in NSW, Native		15	51
Glycine microphylla	Small-leaf Glycine	Not Listed	Not Listed	Other (OG)	Alive in NSW, Native		0.3	150
Digitaria didactyla	Queensland Blue Couch	Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		70	200
Microlaena stipoides	Weeping Grass	Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		8	600
Eragrostis brownii	Brown's Lovegrass	Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		10	700
Cyperus polystachyos		Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		0.1	10
Haloragis heterophylla	Variable Raspwort	Not Listed	Not Listed	Forb (FG)	Alive in NSW, Native		0.5	200
Oxalis perennans		Not Listed	Not Listed	Forb (FG)	Alive in NSW, Native		0.1	10
Juncus remotiflorus		Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		0.4	10
Glycine tabacina complex		Not Listed	Not Listed	0	Alive in NSW, Native		0.2	100
Desmodium varians	Slender Tick-trefoil	Not Listed	Not Listed	Other (OG)	Alive in NSW, Native		0.1	10
Leucopogon juniperinus	Prickly Beard-heath	Not Listed	Not Listed	Shrub (SG)	Alive in NSW, Native		0.2	1
Hydrocotyle sibthorpioides		Not Listed	Not Listed	Forb (FG)	Alive in NSW, Native		0.1	200
Hibbertia obtusifolia	Hoary Guinea Flower	Not Listed	Not Listed	Shrub (SG)	Alive in NSW, Native		0.1	3
Fimbristylis dichotoma	Common Fringe-sedge	Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		0.1	10
Goodenia paniculata							0.5	200
Centella asiatica	Indian Pennywort	Not Listed	Not Listed	Forb (FG)	Alive in NSW, Native		0.5	100
Scleranthus sieberi							0.1	20
Pratia purpurascens	Whiteroot	Not Listed	Not Listed	Forb (FG)	Alive in NSW, Native		0.1	10
Glycine clandestina	Twining glycine	Not Listed	Not Listed	Other (OG)	Alive in NSW, Native		0.1	2
Tricoryne elatior	Yellow Autumn-lily	Not Listed	Not Listed	Forb (FG)	Alive in NSW, Native		0.1	1
Themeda australis	Kangaroo Grass	Not Listed	Not Listed	0	Alive in NSW, Native		0.2	10
Romulea rosea		Not Listed	Not Listed	0	Introduced		0.1	10
Juncus cognatus		Not Listed	Not Listed	0	Introduced		0.2	50
Trifolium repens	White Clover	Not Listed	Not Listed	0	Introduced		0.1	10
Senecio madagascariensis	Fireweed	Not Listed	Not Listed	0	Introduced		0.2	5
Hypochoeris radicata	Catsear	Not Listed	Not Listed	0	Introduced		0.2	100
Cyperus brevifolius		Not Listed	Not Listed	0	Introduced		0.2	80
Axonopus compressus	Broad-leaved Carpet Grass	Not Listed	Not Listed	0	Introduced		6	800
Richardia brasiliensis	Mexican Clover	Not Listed	Not Listed	0	Introduced		0.2	20
Cynodon dactylon	Common Couch	Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		0.2	10
Drosera peltata		Not Listed	Not Listed	Forb (FG)	Alive in NSW, Native		0.1	1

Scientific Name	Common Name	BC Act	EPBC Act	GrowthForm	N or E	HTE	Cover	Abundance
Corymbia maculata	Spotted Gum	Not Listed	Not Listed	Tree (TG)	Alive in NSW, Native		35	14
Eucalyptus siderophloia	Grey Ironbark	Not Listed	Not Listed	Tree (TG)	Alive in NSW, Native		6	1
Goodenia rotundifolia		Not Listed	Not Listed	Forb (FG)	Alive in NSW, Native		0.4	50
Pratia purpurascens	Whiteroot	Not Listed	Not Listed	Forb (FG)	Alive in NSW, Native		2	400
Opercularia hispida	Hairy Stinkweed	Not Listed	Not Listed	Forb (FG)	Alive in NSW, Native		0.1	2
Brunoniella australis	Blue Trumpet	Not Listed	Not Listed	Forb (FG)	Alive in NSW, Native		0.1	10
Lomandra multiflora	Many-flowered Mat-rush	Not Listed	Not Listed	0	Alive in NSW, Native		0.1	10
Cyperus polystachyos		Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		0.1	2
Fimbristylis dichotoma	Common Fringe-sedge	Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		0.1	5
Entolasia stricta	Wiry Panic	Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		15	800
Echinopogon caespitosus	Bushy Hedgehog-grass	Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		10	500
Panicum simile	Two-colour Panic	Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		15	700
Aristida vagans	Threeawn Speargrass	Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		4	200
Eragrostis brownii	Brown's Lovegrass	Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		10	600
Microlaena stipoides	Weeping Grass	Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		25	1000
Echinopogon ovatus							0.1	1
Paspalidium distans		Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		7	500
Digitaria ramularis	Finger Panic Grass	Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		0.2	30
Glycine microphylla	Small-leaf Glycine	Not Listed	Not Listed	Other (OG)	Alive in NSW, Native		0.1	10
Digitaria didactyla	Queensland Blue Couch	Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		1	50
Pseuderanthemum variabile	Pastel Flower	Not Listed	Not Listed	Forb (FG)	Alive in NSW, Native		0.1	10
Chrysocephalum apiculatum	Common Everlasting	Not Listed	Not Listed	Forb (FG)	Alive in NSW, Native		0.1	3
Opercularia diphylla	Stinkweed	Not Listed	Not Listed	Forb (FG)	Alive in NSW, Native		0.1	2
Epaltes australis	Spreading Nut-heads	Not Listed	Not Listed	Forb (FG)	Alive in NSW, Native		0.2	50
Hypoxis graminea/ Hypoxis hygromet							0.1	1
Cheilanthes sieberi	Rock Fern	Not Listed	Not Listed	Fern (EG)	Alive in NSW, Native		0.1	10
Arthropodium milleflorum	Pale Vanilla-lily	Not Listed	Not Listed	Forb (FG)	Alive in NSW, Native		0.1	5
Panicum effusum	Hairy Panic	Not Listed	Not Listed	Grass & grasslike (GG)	Alive in NSW, Native		0.1	10
Axonopus compressus	Broad-leaved Carpet Grass	Not Listed	Not Listed	0	Introduced		0.5	50
Juncus cognatus		Not Listed	Not Listed	0	Introduced		0.1	10
Hypochoeris radicata	Catsear	Not Listed	Not Listed	0	Introduced		0.1	10
Dichondra repens	Kidney Weed	Not Listed	Not Listed	Forb (FG)	Alive in NSW, Native		0.1	2
Murdannia graminea		Not Listed	Not Listed	Forb (FG)	Alive in NSW, Native		0.1	1
Breynia oblongifolia	Coffee Bush	Not Listed	Not Listed	Shrub (SG)	Alive in NSW, Native		0.1	1
Cyperus brevifolius		Not Listed	Not Listed	0	Introduced		0.1	5

Appendix F: Decision-maker authorisation to use more appropriate local data

N/A

Appendix G: Credit reports

Appendix H: Bat Call Analysis

Appendix I: Photos

Appendix I

Stormwater Concept Sketch – Northrop Consulting Engineers (2023)

NORTHROP CONSULTING ENGINEERS
NL230521
STORMWATER CONCEPT SKETCH
3.07.2023 GW

BIMcloud: SDASERVER02 - BIMcloud Basic for Archicad 25/2023-029 _Farley Lifestyle Resort_SK

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ISSUE	DESCRIPTION	BY	CHK	DATE
A	FOR INFORMATION	DF	DF	31/05/2023
B	REVISED FOR INFORMATION	DF	DF	21/06/2023

PROJECT
FARLEY LIFESTYLE RESORT

LOCATION
303 Wollombi Rd, FARLEY NSW 2320 Australia

CLIENT
VIVACITY

DRAWING
MASTERPLAN 1:2000

PROJECT NO.	SCALE
2023-029	1:1500@A1
DRAWING NO.	**ISSUE NO.**
DD100	B

SDA
SPACE·DESIGN·ARCHITECTURE

NOMINATED ARCHITECTS Leigh Richardson NSW 8340 NT AR1209 QLD 4955, Daniel Bush NSW 9694, James Clarence NSW 7927 TAS 933

Appendix J

Peer Review of Mound System Design and Construction (2023)

Onsite Sewage Treatment Program
Water Resources Center
University of Minnesota
Extension Service

Room 173 McNeal Hall
1985 Buford Avenue
St. Paul, MN 55108

800-322-8642
Fax: 612-624-6434
http://septic.umn.edu

Care of Mr. James Mahoney
TrueWater Australia
PO Box 351
Maclean, NSW 2464

31 May 2023

RE: Mound System Design and Construction

Dear Mr. Mahoney,

Thank you for the opportunity to review your general mound design Since 1999 I have been working at the University of Minnesota in the Onsite Sewage Treatment Program (OSTP). Mound systems as we know them today were developed at the University of Wisconsin and at University of Minnesota in the late 1970s and early 1980s as a solution to many difficult soil conditions in the upper Midwest of the United States including high water tables, fast percolating soils (coarse sands/gravels), slow percolating soils (clays), and small lots near waterbodies. Over the last 40 years we have enhanced our design and installation rules and guidelines and now have over 50,000 mound systems in Minnesota serving both residential and commercial systems. I am a lead author on the following related publications:

1. 2021 Manual for Septic System Professionals – Authored numerous chapter including Chapters 10, 11 and 12 on the design, installation, operation and maintenance, troubleshooting of pretreatment systems, distribution, and soil treatment systems including mound systems.
2. 2009 Installation of Wastewater Treatment Systems – United States national manual on installation of decentralized wastewater treatment systems where I authored the section on installation of soil treatment systems including mound systems.

One of my roles in the OSTP is training septic system professionals including designers/ engineers/soil scientists, installers, inspectors, and service providers. I provided this training not only in Minnesota but across the United States. My other primary role is conducting research, serving as the principle investigator on several projects, overseeing graduate and undergraduate students and integrating new results into our training programs.

In my role at the University of Minnesota, I also serve on the NSF International committee on Wastewater Technology which develops standards and list products for use in septic systems.

This is just a limited summary of my work and I have included my curriculum vitae for more information on my career as it relates to the peer review of this project.

I have been asked to review the refinements that TrueWater has made to the traditional mound system developed in the United States as published by Converse and Tyler. Attached is my brief report. Upon review of my report if you have any questions feel free to reach out to me by email at sheger@umn.edu.

Sincerely,

Sara F. Heger

Dr. Sara Heger
Instructor, Research Associate and Adjunct Assistant Professor

Peer Review of General Design and Construction

of TrueWater Mound Systems

Dr. Sara Heger

University of Minnesota

May 2023

Author Note: Funding was provided by TrueWater Australia for this report.

Overview

A mound system is a two-stage process involving both effluent treatment and dispersal. The physical characteristics of the influent wastewater, influent loading rate, temperature, and the nature of the receiving fill material and in situ soil affect these processes. Mound systems provide critical unsaturated conditions with reactive sand to achieve final treatment through physical entrapment, increased retention time, and conversion of pollutants.

The mound system was primarily developed in Minnesota and Wisconsin to deal with high water table conditions by elevating the infiltration bed to achieve the needed vertical separation. By using uniform distribution and adequate vertical separation in the selected sand media, vertical unsaturated flow is maintained, thus ensuring the maximum treatment permitted by this technology. On sites with highly permeable soils, the mound system helps assure a known level of effluent treatment before the effluent is discharged into the native soil. They were also designed to treat and disperse the effluent below grade in a climate with many months of temperatures below freezing with no evapotranspiration.

Since mound systems were first developed there have been many enhancements and improvements to design and installation across the United States based on local site conditions, material availability, climatic conditions, and regulatory requirements. Since mound systems are used in many countries these modifications are international as well. On sites with slowly or rapidly permeable soils, the mound system helps assure a known level of effluent treatment before the effluent is discharged to the native soil. Slow permeability soils are subject to severe damage from smearing and compaction, especially during the construction of conventional systems, which drastically reduces the permeability of the soil by destroying water-moving pores and channels.

TrueWater requested I evaluate some of the design and construction modifications they have made to their mound design based on their experience in Australia as outlined below.

1. **Leveling of the basal area**

   The mound systems in Australia are installed in a much drier climate than the Midwest and therefore much of the effluent is leaving the system via evapotranspiration. The remaining effluent with the level design of the mound will flow equally in both directions away from the rock bed, as opposed to a sloping mound where the effluent will only move downgradient. This change is also simpler from a construction standpoint as the pipes must be level for uniform distribution or changes to design made to account for unlevel distribution of effluent. It is wise to always install the mound with the longest dimension (the length) following the natural contours of the site as this typically predicts the subsurface flow of effluent away from the system.

In summary, the TrueWater design on a level basal maximizes absorption in both directions away from the system and ensures level grade along both the length and width.

2. **Excavation of native soils (Category 4,5,6) beneath the mound and backfilling with mound sand**

   Many locations in the Midwest have very shallow appropriate soil before a limiting condition such as a water table or bedrock. Therefore, we typically do not remove the existing topsoil but do roughen it with the goal of an easy transition from the mound sand to the existing soil. In some instances, if the topsoil has been damaged we do recommend it be removed and backfilled with mound sand. Having additional sand beneath the system is not a concern and will provide additional treatment prior to the movement of the effluent into the underlying soil.

   In summary, the TrueWater design increases the sand media depth providing additional known treatment before reaching the natural soil.

3. **Extension of mound width**

   The overall mound width of 7 – 9 meters is not wider than typical residential mounds installed in the Midwest where some of our systems are as wide as 12 meters or more. This width is essential to assure sufficient area exists for acceptance of the effluent and to prevent wetness at the toe of the mound.

   In summary, the TrueWater mound design has a suitable absorption width.

4. **Flush box**

   When mound systems were first designed and installed cleanout for the pressure distribution systems were not required. Now both Minnesota and Wisconsin require pressure distribution pipe cleanouts to check the system for proper operation and to clean debris out of the pipes or perforation. Cleanouts are placed at the distal end of pressurized laterals to also allow flushing of the system prior to startup, measurement of operating pressure and regular flushing of solids when dosed with septic tank effluent.

   The pipe configuration of the cleanout varies, but the most basic and convenient cleanout consists of a 90-degree turn up. Two 45-degree elbows or one sweep 90-degree elbow may be used. Using these allows the service provider to use a pressure washer or bottle brush for cleaning purposes because the gentle turn allows easy insertion of the pressure line. These cleanouts must be accessible from grade therefore locating them in landscaping boxes is commonly done to provide access, to prevent them from being hit by a lawnmower, and to make the system more visually appealing.

In summary, the TrueWater flush box design modification is a needed enhancement to allow for regular operation and maintenance of the pressure distribution system.

5. Capping soil is recessed 2 inches into the native soil

The final cover/capping soil stabilizes the completed installation, supports vegetative growth, and sheds runoff. Extending this soil 2 inches (~50mm) into the native soil could potentially help limit surface runoff from influencing the mound system. It is also recommended that the top of the mound be peaked at the center with a gradual slope away across the top to assure most of the rainfall runs off the system.

In summary, the TrueWater capping soil extension will assist in diverting surface water away from the system which is very beneficial.

6. Mound is turfed

To ensure a properly functioning mound system a suitable vegetative cover must be established. The right vegetative cover prevents erosion and lets the mound system function at its best by removing moisture and nutrients from the system. Generally, we recommend turf grasses that have fibrous root systems that hold soil in place, require maintenance like a lawn, and are available in numerous varieties. Turf grasses can be either seeded or sodded (turfed). Sodding has several advantages over seeding including:

- a rapid establishment and weed-free growth from the beginning,
- prevents erosion immediately, and
- can be laid anytime during the growing season.

The typical concern with sodding is the additional cost, therefore it is extremely uncommon in the United States. Care should also be taken to not overwater the sod during establishment.

In summary, with the TrueWater design including turfing of the system the positive impacts to the system out way the cost and watering concerns.

7. Conclusion

In general, the enhancements made by TrueWater to their mound system design in Australia are in line with many recommendations and newer requirements in the United States and should only improve the treatment and performance of their systems.

Since the effluent to the mound has undergone advanced pretreatment having a BOD/TSS of 20/5 mg/L and very low peak loading of 19 $mm/m^2/day$ the mound design is very conservative. This will result in increased longevity.

Dr. Sara Heger
University of Minnesota, Water Resources Center
Onsite Sewage Treatment Program
http://septic.umn.edu
Email: sfheger@gmail.com, Phone: 612-239-8198

Education

Ph.D. Water Resource Science, University of Minnesota, St. Paul, MN — 2015
Dissertation: Treatment of High-Strength Wastewater from Milk House Wastewater

M.S. Water Resource Science, University of Minnesota, St. Paul, MN — 2001
Thesis: Recirculating Sand Filters for Decentralized Wastewater Treatment

B.S. Biosystems and Agricultural Engineering, University of Minnesota, St. Paul, MN — 1998
Emphasis: Environment and Water Quality

Employment and Certifications

1999 – Present **University of Minnesota**, Researcher and Instructor and Adjunct Assistant Professor. Water Resource Center, Onsite Sewage Treatment Program and Bioproducts and Biosystems Engineering.

2011 – Present **National Onsite Wastewater Recycling Association**, Contract Trainer and Developer of Education Curriculum for in-person and online training.

Certifications: MPCA Advanced Designer, Advanced Inspector and Service Provider, UMN Equity and Diversity Certificate, University of Minnesota Supervisory Development Certificate
Graduate students current: Alycia Overbo, Elizabeth Boor, Matthew Belanger
Past graduate students: Jack Distel (2019), Taylor Nelson (2019), Michael Szmorlo (2017), Michael Waak (2014)

Professional Experience

Research - Lead numerous field-based research projects at the UMN with the role of Principle Investigator developing novel research approaches related to septic systems, chlorides, and management of systems.

- Develop, implement, and manage grants to improve understanding of septic system performance:
  - MN Department of Transportation grant evaluating high strength wastewater, groundwater mounding, chemicals of emerging concern research, septic tank performance, water use and septage management.
  - MnDrive biochar and iron-enhanced sand for improving septic system performance.
  - MPCA Grant evaluating chemicals of emerging concern.
  - MnDOT wastewater reuse evaluation and implementation.
  - LCCMR grant evaluating impacts of chloride from water conditioning and the recommended best management practices to reduce this impact.
  - LCCMR grant on septic tanks for evaluation of nutrient recuperation, bioenergy generation, and environmental protection by the implementation of a bio-electrochemical system.

- BWSR grant to develop a septic system and milkhouse wastewater estimator for BWSR under a LCCMR grant.
    - LCCMR Project: On-Site Sewage Treatment Alternatives: Performance, Outreach & Demonstration
    - 319 Milkhouse Wastewater Treatment and Demonstration
- Develop, implement, and manage grants to improve educational resources:
    - MPCA Type V Operator Training Curriculum Development Project
    - MN Department of Health educational grant relating to chemicals of emerging concern.
    - NIFA Community Septic System Owner's Guide project

Teaching – Provide education to a wide range of diverse audiences form property owners to engineering students on wastewater management principles, applications, solutions, and management.

- Direct, develop and teach technical related training opportunities for septic professionals (over 1,500 professionals trained per year) in Minnesota including engineers, soil scientists, designers, installers, service providers, and maintainers/pumpers.
- Invited speaker to over 30 states in the US to keynote and educate on various topics regarding onsite wastewater treatment.
- Coordinate with partners at the University of Minnesota, state and local agencies and the private sector to develop and deliver septic system related training.
- Developed homeowner/realtor education materials linking well and septic system related educational content.
- Strengthen technical septic system expertise by involvement in septic system design, septic system troubleshooting and research.
- Develop and teach Bioproducts and Biosystem 4533 – Sustainable Wastewater Management Engineering

Technical Expertise – Serve on numerous committees, authored hundreds of articles on technical aspects of decentralized wastewater treatment and serve as a technical resource across Minnesota, the US and Internationally.

- Serve on several national and local related committees:
    - NSF International Wastewater Committee (since 2016)
    - MPCA Technical Evaluation Panel (since 2008)
    - Chair of MN SSTS Advisory Committee (since 2015)
    - Minnesota Onsite Wastewater Association board of directors (2 terms over last 15 yrs.)
    - National Onsite Wastewater Association Past President (current)
- Technical advisor to the Department of Natural Resources and small communities on septic system related projects
- Serve as an author on numerous septic system related publications
    - UMN OSTP Professional Manual
    - National CIDWT Installer Manual
- Author of monthly articles for the Onsite Installer and Pumper Magazine
- General technical support and education
    - Provide technical assistance to county employees, designers, installers, inspectors, and maintainers of decentralized septic systems.
    - Troubleshooting potential and existing onsite systems offering expert options to designers and regulatory authorities.
    - Serve as an expert reviewer/witness on projects related to Amish case law and application of advanced treatment systems.

Grants

- MnDOT Evaluating Treatment and Options for Wastewater Treatment at Rest Areas and Truck Stations, 2022 – 2023
- EnviroStep Literature Review on Effectiveness of Distribution Methods, 2023
- MPCA Type V, 2019 – 2022 and 2022-2024
- Earthbuster Evaluation of Remediation, 2022-2205
- MnDrive Biochar and Iron Enhanced Sand for Improved Septic System Performance, 2021-2023
- MnDOT Groundwater Mounding and Chemicals of Emerging Concern Research and Education, 2018-2022
- MPCA CEC Grant, 2020-2021
- MDH CEC Education Grant, 2017-2021
- MnDOT Wastewater Reuse Grant, 2017-2019
- LCCMR Project - Understanding Impacts of Salt Usage on Minnesota Lakes, Rivers, and Groundwater, 2016 - 2019
- MnDOT Rest Stop Septic System Evaluation Grant, 2013-2019
- LCCMR Project - Septic Tank Evaluation: Greenhouse Gas Collection and Nutrient Removal, 2014 - 2017
- MPCA Online Training Evaluation and Advanced Inspector Educational Assistance Grant, 2014-2015
- USDA NIFA Community Septic System Owner's Guide Grant, 2013-2016
- Waterloo Phosphorus Removal Study, 2013-2015
- LCCMR BWSR Septic System and Milkhouse Wastewater Estimator Development, 2012-2014
- Chisago County Adult Care Facility Evaluation, 2013
- Laboratory Development of High Strength Wastewater, 2012-2013
- USEPA and Texas A&M Installation Training Manual Development Grant, 2007 – 2009
- Colorado School of Mines Residential Water Use Survey Grant, 2007-2008
- Large Septic Tank Evaluation Grant, 2006-2008
- On-Site Sewage Treatment Alternatives: Performance, Outreach & Demonstration 1995-2002
- 319 Milkhouse Waste Treatment Project: Milkhouse Wastewater Treatment Research and Demonstration, 2001-2007
- Minnesota Pollution Control Agency Grant to Update Professional Training Manual, 2005-2008
- Infiltrator Field Evaluation, 2005-2006

Professional Honors and Awards

- Teaching Award 2020
- Education and Public Service Award, 2019 – The Board of Directors of The Universities Council on Water Resources – UM Onsite Sewage Treatment Program
- 2013-2018 NOWRA Education Committee Chair Appreciate Award.
- 2003, 2006, 2010 Minnesota Onsite Wastewater Association Outstanding Service Award.
- 2006 and 2007 Meritorious Service Award from the National Onsite Wastewater Recycling Association for chairperson of the education and training committee.

Professional Organizations

- Consortium of Institutes for Decentralized Wastewater Treatment
- Minnesota Onsite Wastewater Association, past board member and current education chair
- National Onsite Wastewater Recycling Association, Current Past President

Publications

Peer Reviewed

1. Overbo, A., Heger. S., and Gulliver, J. 2020. Evaluation of Chloride Contributions from Major Point and Nonpoint Sources in a Norther U.S. State. Science of the Total Environment 764 (144179).
2. Heger, S.F., D.R. Schmidt and K.A. Janni. 2010. Aerobic and Media Filter Treatment Systems for Milk House Wastewater on Small Dairy Operations. Applied Engineering in Agr. 26(2): 319-327.
3. Janni, K. A., S. H. Christopherson (Heger) and D. R. Schmidt. 2009. Milkhouse Wastewater Flows and Characteristics for Small Dairy Operations. Applied Engineering in Agr. 25(3): 417-423.
4. Christopherson (Heger), S., Wheeler, D., Wittwer, J and T. Haeg. 2008. Field Evaluation of Rock versus Chamber Trench Systems. J. Hydrol. Eng., 13(6): 671-680.

Other Publications

1. Heger, S. and J. Buchanan. 2023. Septic System User Manual. National Onsite Wastewater Association and Rural Community Assistance Program.
2. Brown, L., S. Heger, D. Gustafson, B. Liukkonen, N. Haig, D. Malchow, K. Olson, V. Prax, D. Wheeler, and J. Wittwer, 2022. Septic System Owner's Guide. Water Resources Center ISBN: 281000008407B
3. Heger, S. 2022. Wastewater Characteristic Analysis of Distilled Spirits. UMN Water Resources available online.
4. Heger, S. et al. 2022. Onsite Wastewater Manual. University of Minnesota On-Site Training Program. University of Minnesota, St. Paul, MN
5. Koski, B. and S. Heger. 2021. Evaluation of MnDOT Truck Wash Water Reuse for Brine Production. Water Resources Center available online.
6. Larson, S. and S. Heger. 2020. Wastewater Characteristics Analysis of Coffee and Soda Products. Water Resource Center available online at: https://septic.umn.edu/sites/septic.umn.edu/files/coffee_soda_report_final.pdf
7. Overbo, A. and S. Heger. 2020. Chloride in Minnesota Waters. Water Resources Center available online.
8. Larson, S. and S. Heger. 2020. Analysis of Recreation Vehicle Holding Tank Treatment Products. 2020. Water Resources Center available online.
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