Whitehead & Associates
Environmental Consultants

Richard Beardshall and Jen Clarke
c/- Prudence Bowe
Re: 36 Cockatoo Ridge,
Aberglasslyn, NSW 2320
(via email)

Ref: 3486_WMR_001

13 July 2023

On-site Wastewater Management Report for proposed development at 36 Cockatoo Ridge, Aberglasslyn NSW

Whitehead & Associates Environmental Consultants Pty Ltd ("W&A") were engaged by Richard Beardshall and Jen Clarke (the "Owners") to prepare an On-site Wastewater Management Report (WMR) for a proposed development at 36 Cockatoo Ridge, Aberglasslyn NSW (the "Site"). The Site, identified as Lot 3 in DP1124849, is approximately 8.215ha in area and is zoned C3 (environmental management) under the Maitland LEP (2011), with a minor area of R1 (general residential) zoned land identified within the access driveway.

Existing improvements at the Site consists of a three (3) bedroom dwelling and metal garage within the western portion. The dwelling is serviced by an on-site sewage management (OSSM) system consisting of two (2) septic tanks, with effluent disposal via two (2) absorption beds.

It is understood that the Owners propose to submit a Development Application (DA) to Maitland City Council ("Council") for the construction of a new three (3) bedroom dwelling and two (2) separate 1-bedroom 'Bed & Breakfast' ("B&B") units within the centre of the Site, and a standalone shed within the southeast of the property. An area has been set aside to the south of the proposed dwelling for a tennis court that is to be constructed at a later date. There are no alterations proposed to the existing dwelling. Potable water is provided by tank (roof) water supply. There is a reticulated sewer service available within the southern region of the Site; however, the closest connection point is >230m from the proposed development location.

The Site is bound by the Hunter River to the north and private property on all other boundaries. The property is extensively cleared and consists of open pasture with isolated mature trees and dense riparian vegetation adjacent the Hunter River. The property is flood-prone within a 20m zone south of the Hunter River, with this area also containing identified Biodiversity Values (biodiverse riparian land).

A dam is identified within the west of the Site, along with an intermittent drainage channel in the northeast draining into the Hunter River. Maitland LEP mapping indicates that Acid Sulphate Soils (ASS) may occur at depth (Class 5). The property is identified as bushfire-prone, with vegetation category 3 and buffer mapped throughout. No other major limitations to OSSM are noted.

This WMR presents the results of a detailed site and soil assessment that considers the inherent conditions and constraints of the Site with regard to OSSM to ensure compliance with the relevant standards and guidelines currently enforced by Council, as follows:

- Maitland City Council (2020), *On-site Sewage Management Policy*;
- NSW Ministry of Health (2016), *Sewage Management Facility Vessel Accreditation Guideline* (NSW Health, 2016);
- Standards Australia / Standards New Zealand (2012), *On-site Domestic Wastewater Management* (*AS/NZS 1547:2012*); and
- NSW Department of Local Government (1998), *Environmental & Health Protection Guidelines: On-site Sewage Management for Single Households* (NSW DLG, 1998).

1 Author Statement

This WMR was prepared by Connor Morton. Connor is an Environmental Consultant with W&A, holding a B. EnvSc. and Mgmt. from the University of Newcastle (2019). Connor has completed the On-site Wastewater Management professional short-course with the Centre for Environmental Training (CET) and has completed many WMRs across the Port Stephens, Hunter, Central Coast, and MidCoast regions.

2 Introduction

The following table summarises information relating to the property investigated.

Feature	Description
Site Address	36 Cockatoo Ridge, Aberglasslyn NSW 2320
Lot / DP	Lot 3 in DP1124849
Local Government Area	Maitland City Council
Land Zoning	C3 (environmental management); and R1 (general residential).
Lot Size (ha)	~8.215
Sewer Connection Available	Yes, >230m from development location
Potable Water Supply	Tank (roof) water supply

3 Site and Soil Assessment

The Site investigation was undertaken by Connor Morton of W&A on 10 May 2023. The following tables present the results of the Site and soil investigations for the property.

A description of the Site physical constraints and the degree of limitation they pose to OSSM is provided in the following table. Reference is made to the rating scale in Table 4 of NSW DLG (1998).

SITE ASSESSMENT			
Parameter	**Data/ Observation**	**Reference**	**Classification/ Outcome**
Climate	Temperate climate with median annual rainfall of 955.8mm; minimum of 31.7mm (July) and a maximum of 113.2mm (March).	Paterson (Tocal AWS) [061250]	Minor limitation
	Mean annual evaporation of 1,549.6mm. Rainfall does not exceed potential evaporation for any month of the year.		
Sizing			
Hydraulic sizing attached:	Yes	As per *AS/NZS 1547:2012*, and NSW DLG (1998) procedures (refer Appendix C)	
Nutrient balance (annual) attached:	Yes		
Land application area (LAA) sizing attached:	Yes		
Wet weather storage requirement:	N/A	N/A	
Flooding			
LAA above 5% AEP flood level:	Yes	Flood impact limited to northern boundary (LEP, 2011)	Minor limitation
LAA above 1% AEP flood level:	Yes		
Electrical components above 1% AEP flood level:	Yes		
Exposure	The available effluent management area (EMA) consists of open pasture, providing high wind and sun exposure.	Minor limitation	
Slope and Aspect	Slopes of 5% – 10% within the available EMA, with a northerly aspect.	Minor limitation	
Landform	Linear planar to linear divergent within the available EMA.	Minor limitation	
Run-on and Seepage	No run-on or up-slope seepage observed in the available EMA at time of the Site investigation; however, potential for run-on from upslope areas possible due to slope position. Stormwater from upslope areas must be directed away from the proposed LAA (refer Section 7.1).	Minor limitation	
Erosion Potential	No erosion evident within the available EMA during the Site investigation. Address potential concerns using erosion and sediment controls during construction and revegetation of LAA using turf or other suitable groundcover as appropriate (refer Section 7.2).	Minor limitation	
Site Drainage	Moderately well drained soils with no signs of surface saturation.	Minor limitation	

SITE ASSESSMENT			
Parameter	**Data/ Observation**	**Reference**	**Classification/ Outcome**
Fill	None observed during the Site and soil investigation.	Minor limitation	
Groundwater	No shallow groundwater (GW) encountered during the soil survey. NSW Office of Water GW bore registry indicates that there no registered bores located within 250m of the Site.	Minor limitation	
Surface Water Features	The Hunter River forms the northern Site boundary and a small (intermittent) drainage channel is identified in the west of the Site.	Minor limitation	
Buffers Applicable (NSW DLG, 1998)			
Domestic GW bores (250m):		N/A	
Permanent rivers and creeks (100m):		Yes	Achievable
Intermittent waterways and other waters (40m):		Yes	Achievable
Lot boundaries, buildings, and swimming pools (3m if EMA downslope-6m if EMA upslope):		Yes	Achievable
Limiting horizon (GW, bedrock etc.) (>0.6m):		Yes	Achievable
Other sensitive receptors:		Yes	Identified 'Biodiversity Values' outside of available EMA.
Surface Rock / Outcrop	Surface rock / outcrops identified throughout the northern region of the property; however, none identified within the available EMA.	Minor limitation	
Available EMA	Approximately <u>16,810m^2</u> of available EMA identified at the Site.	Minor limitation	
Concluding Remarks There are minimal site limitations in regards to OSSM. The available EMA complies with all standard NSW DLG (1998) buffers / setbacks.			

SOIL ASSESSMENT (physical)			
Parameter	**Data/ Observation**	**Reference**	**Classification/ Outcome**
Soil Depth	650mm – 750mm	Moderate limitation	
Soil Profile	**<u>BH1-3:</u>** A: 0mm – 200mm, moderately structured, very dark greyish brown silty clay loam (Cat 4).		

SOIL ASSESSMENT (physical)			
Parameter	**Data/ Observation**	**Reference**	**Classification/ Outcome**
	B: 200mm – 650/700mm, moderate to massive structure, brown medium clay (Cat 6). All boreholes discontinued on shale layer. Borehole locations shown in Figures 1 – 3, Appendix A. Soil borelogs presented in Appendix B.		
Depth to Water Table	Shallow (episodic) water table not encountered. Mottling observed in subsoils (~200mm - >500mm) indicating restricted vertical drainage within soils during periods of high rainfall and extended wet weather.	Moderate limitation	
Coarse Fragments (%)	Topsoil: <2% (<60mm). Subsoil: <20% (<60mm).	Minor limitation	
Soil Permeability	<0.06m/day (inferred).	Massive medium clay (Cat 6)	Major limitation
Emerson Aggregate Class (EAT)	Topsoil: 8 (negligible). Subsoil: 2(1-3) (moderate to very high).	Major limitation	
Soil Landscape	The available EMA is located on the Bolwarra Heights (bh) soil landscape. Topography consists of rolling low hills with slopes from 5% – 20%, local relief generally 50m. Soils generally consist of gravelly loam / sandy clay loam, underlain by pedal light to medium clay with mottling at depth. Limitations include moderate foundation hazard, water erosion hazard, high run-on (localised), seasonal waterlogging (localised), steep slopes (localised), and mass movement hazard.	Soil Landscapes of the Newcastle 1:100 000 Sheet (L.E. Matthei, 1995)	

Concluding Remarks

Available soil depth, restricted vertical drainage, soil permeability, and soil stability (EAT) present moderate to major constraints to OSSM at the Site.

Available soil depth, restricted vertical drainage, and low soil permeability will be mitigated through conservative treatment / LAA selection, location, design, and installation (refer Sections 6.2 and 6.3).

Soil stability limitations can be mitigated through soil improvement recommendations (refer Section 7.3).

SOIL ASSESSMENT (chemical)				
Parameter	**Data/ Observation**		**Reference**	**Classification / Outcome**
pH	4.59 – 5.73	Moderately to very strongly acidic	Moderate limitation	
EC (EC_e)	0.46 – 1.91	Non-saline	Minor limitation	
ESP (%)	3	Non-sodic	'bh3' Soil Landscapes of the Newcastle 1:100 000 Sheet (L.E. Matthei, 1995)	Minor limitation
CEC (me/100g)	17.7	Moderate fertility		Minor limitation
P-sorption (mg/kg)	464 (~6,960kg/ha)	High		Minor limitation
Concluding Remarks The pH of Site soils poses a moderate constraint to OSSM; however, this did not appear to impact groundcover growth during the Site investigation. If necessary, soil improvement measures may be employed to mitigate future concerns (refer Section 7.3). General notes on the soil chemistry parameters above are attached as Appendix D.				

4 Wastewater Generation

The existing three (3) bedroom dwelling and standalone garage will be retained with no alterations proposed. No wastewater generating fixtures are installed within the garage.

The proposal will construct a new three (3) bedroom dwelling; two (2) 1-bedroom B&B units, and a detached shed. The proposed dwelling and B&B units will each contain full amenities (WC, basin, bath, shower, kitchen, and laundry) for residents and guests. The proposed shed will contain limited amenities (WC, basin, and kitchenette).

4.1 Wastewater Quantity

Wastewater generation at the Site is expected to be from kitchen, shower, bath, laundry, and toilet facilities within Site buildings, with potable water provided by tank (roof) water supply.

For design, wastewater generation from the shed is assumed to be accounted for within the dwelling. A higher reticulated (mains) flow allowance has been adopted exclusively for the B&B component to account for typically higher (tourist) water use in the short-term accommodation units. The following table summarises the assumed hydraulic load from each development component.

Parameter	Value	Comment/Source
Existing Dwelling		
No. Bedrooms	3	As per plans provided
Occupancy Rate (persons per bedroom)	2 equivalent population (EP) for first 2 bedrooms, 1EP each bedroom thereafter	*AS/NZS 1547:2012*

Parameter	Value	Comment/Source
Equivalent Population (EP)	5	(2-bedroom x 2EP) + (1-bedroom x 1EP)
Flow Allowance (L/person/day)	120	Table H1 of *AS/NZS 1547:2012* for 'residential premises with tank water supply'
Design Hydraulic Load (L/day)	600	5EP x 120L/person/day
Proposed Dwelling		
No. Bedrooms	3	As per plans provided
Occupancy Rate (persons per bedroom)	2EP for first 2 bedrooms, 1EP each bedroom thereafter	*AS/NZS 1547:2012*
EP	5	(2-bedroom x 2EP) + (1-bedroom x 1EP)
Flow Allowance (L/person/day)	120	Table H1 of *AS/NZS 1547:2012* for 'residential premises with tank water supply'
Design Hydraulic Load (L/day)	600	5EP x 120L/person/day
Proposed B&B units		
No. Bedrooms	2	As per plans provided
Occupancy Rate (persons per bedroom)	2	Conservative occupancy rate for commercial accommodation units
EP	4	2-bedroom x 2EP
Flow Allowance (L/person/day)	150	Table H1 of *AS/NZS 1547:2012* for 'residential premises with reticulated water supply'
Design Hydraulic Load (L/day)	600	4EP x 150L/person/day

The design hydraulic load from the existing dwelling is 600L/day.

Due to the proximity of the proposed development components, it is recommended that the combined hydraulic load of 1,200L/day (600L/day + 600L/day) is managed within a common treatment system.

4.2 Wastewater Quality

The contaminants in sanitary wastewater have the potential to create undesirable public health concerns and pollute waterways unless managed appropriately. As a result, wastewater must be treated to remove the majority of pollutants and enable attenuation of the remaining pollutants through soil processes and plant uptake.

Wastewater generated at the Site is expected to be of 'typical' domestic nature, with combined wastewater; blackwater (toilet) and greywater (kitchen, laundry, and shower) streams. As such, untreated wastewater is expected to have characteristics similar to that described in the following table; which incorporates information taken from NSW DLG (1998).

Parameter	Loading	Greywater %	Blackwater %
Biochemical Oxygen Demand	200-300mg/L	35	65
Suspended Solids	200-300mg/L	40	60
Total Nitrogen	20-100mg/L	20-40	60-80
Total Phosphorus	10-25mg/L	50-70	30-50
Faecal Coliforms	10^3-10^{10}cfu/100ml	Medium-High	High

5 Existing OSSM System

The OSSM system servicing the existing dwelling is described in the following sections and is presented as Figure 2 of Appendix A.

5.1 Treatment System

Wastewater generated within the existing dwelling undergoes primary treatment within two (2) concrete septic tanks connected in series directly north of the dwelling. Greywater from the laundry and kitchen is pre-treated within an 80L (RELN poly) grease trap, prior to entering the septic tank system.

Both septic tanks were found to be in good structural condition, with a diameter of 1.5m and standing water level of ~1m, providing an approximate 'effective' volume of ~1,750L in each (3,500L total). No baffles were observed in either tank, with healthy scum and sludge layers present in both tanks. Inlet and outlet T-junctions were observed within both tanks (with minor damage noted).

NSW Health (2016) requires septic tank capacities to be sized to provide (minimum) 24-hours of settling volume and an allowance for accumulation of sludge. The guideline requires a minimum sludge accumulation allowance of 1,550L for a five (5) EP development, with an assumed de-sludge frequency of four (4) years, as per the following calculation.

Sludge Allowance + Daily Flow = Tank Capacity

Based on the combined septic tank volume of ~3,500L, the available treatment capacity of the septic tanks is ~1,900L (3,500L – 1,550L, rounded), which is considered more than sufficient to provide the minimum 24-hour settling volume required for the design hydraulic load (600L/day) based on a four (4) year desludge frequency.

5.2 Effluent Management

Primary effluent is gravity dosed to two (2) subsoil absorption beds installed north-west of the septic tanks. At the time inspection, the bed LAA was observed to be operating effectively with no evidence of compromise or surface saturation.

Each bed is of self-supporting arch construction and has an approximate basal area of 36m^2 (~18m x ~2m), and a depth of 0.8m (0.2m topsoil, 0.6m void/gravel) based on a ground probe investigation, providing a combined basal area of 72m^2.

The absorption bed LAA complies with all required environmental buffers as shown in Figures 1 and 2 of Appendix A.

6 Proposed OSSM System

6.1 Existing Dwelling

The existing septic tanks are confirmed in good working order and have sufficient treatment capacity to manage the design hydraulic load from the existing dwelling (≤600L/day). Similarly, the existing absorption bed LAA is appropriately sized and appears to be operating effectively.

As there are no alterations proposed for the existing dwelling, continued use of the existing OSSM system is considered appropriate.

6.1.1 Recommendation

Minor damage to the inlet and outlet T-junctions was noted at the time of inspection. It is recommended that new T-junctions are fitted within both septic tanks to limit the carryover of solids between the two (2) tanks and the absorption bed LAA, prolonging the overall life of the system.

6.2 Dwelling and B&B Units

Given the identified Site constraints, specifically available soil depth and slow permeability subsoils, the number of treatment and land application system options considered suitable are limited. Primary treatment systems (i.e. septic tanks) are not recommended for the 'common system' proposal as they significantly limit effluent disposal and reuse options and pose a higher risk to human and environmental health compared to secondary or tertiary treatment systems.

Therefore, a minimum effluent quality standard of 'secondary treatment' (with disinfection) is recommended for the (combined) dwelling and B&B unit proposal.

6.2.1 Proposed Wastewater Treatment

Secondary treatment is aimed at the removal of dissolved and suspended organic material by a combination of physical and biological methods, usually incorporating both aerobic and anaerobic phases. Secondary treatment presents a significantly lower risk to human health and the environment when compared to conventional primary (septic tank) systems.

The NSW Ministry of Health (NSW Health) provides accreditation for domestic secondary treatment systems in NSW. The system selected must hold such an accreditation. Appropriate secondary treatment technologies include (but are not limited to) the following:

- Aerated wastewater treatment systems (AWTS) (accredited);
- Aerobic sand filters (accredited or site-specific design required);
- Reed bed systems (site-specific design required); and
- Media / textile filter systems (site-specific design required).

A detailed list of suitable NSW Health accredited systems can be found at:

http://www.health.nsw.gov.au/environment/domesticwastewater/Pages/default.aspx

Disinfection units are typically installed as a standard component of proprietary secondary treatment systems, or can be installed as an add-on by the system supplier. A disinfection unit must be installed with the chosen system. Domestic systems typically use one or a combination of the following disinfection methods:

- Ultra violet (UV) irradiation; and / or

- Chlorination.

Final system selection will be the responsibility of the Owner; however, selection and installation of the system must follow Council requirements and the recommendations provided within this WMR.

6.2.1.1 Treated Effluent Quality

Table 14 of NSW DLG (1998) describes the minimum effluent quality standard for secondary treatment systems, and have been reproduced in the following table.

Parameter	Loading
Biochemical Oxygen Demand	≤20mg/L
Suspended Solids	≤30mg/L
Faecal Coliforms	≤30cfu/100mL
Total Nitrogen	≤30mg/L
Total Phosphorus	≤10mg/L

The listed phosphorus and nitrogen concentration values are targets (only) and have been adopted for nutrient balance modelling.

6.2.2 System Siting

The exact positioning of the new treatment system will depend on the local gradient and level controls and can be determined in consultation with a licensed plumber and Council prior to obtaining consent for system installation.

As the proposed shed will contain wastewater generating facilities (including WC), it is recommended that the treatment system is located in close proximity to all proposed development components. A nominal location is presented in Figure 3 of Appendix A.

All plumbing and drainage works must be completed in accordance with the National Construction Code (NCC), which incorporates the Plumbing Code of Australia (2011).

6.2.3 System Operation and Management

Successful performance of wastewater treatment systems relies on periodic monitoring and maintenance, which will be the responsibility of the Owners. The selected treatment system should be serviced by a suitably qualified technician at the prescribed intervals.

6.3 Proposed Effluent Management

This section describes the Site's capability for effluent management and provides design details, including sizing of the required LAA. As detailed in Section 6.2.1, secondary treatment (with disinfection) is considered the most appropriate wastewater treatment option.

6.3.1 LAA Options

W&A have considered the suitability of various land application systems in relation to the identified Site and soil limitations. In determining the suitability of the various options, we have assessed the Site constraints and the relative environmental and public health risks associated with each.

The following table provides a summary analysis of the range of effluent land application options considered and presents recommendation for the preferred approach to be used in conjunction with the proposed secondary treatment system.

Land Application Option	Suitable	Reasoning
Absorption Trenches/Beds	No	Not supported for Cat 6 soils due to low permeability (*AS/NZS 1547:2012*).
ETA Beds	Possible	Considered suitable, but have been discounted due to substantial construction cost and availability of more appropriate alternatives.
Mounds		
Surface Irrigation	Yes	Considered suitable as effluent is able to be applied at sustainable loading rates on the soil surface (*AS/NZS 1547:2012*: Section M4).
Subsurface Irrigation	Yes	Considered suitable as effluent is able to be applied high in the soil profile, maximising evapotranspiration and vegetation uptake.

Surface irrigation and subsurface irrigation systems are considered the most suitable effluent management methods for the Site. Given the slope of the available EMA (5% – 10%); downslope sensitivity (Hunter River) and increased human contact risk associated with surface irrigation, subsurface irrigation (SSI) is the preferred land application approach to service the proposal.

A description of the proposed SSI LAA, required setbacks, and sizing are presented in the following sections.

6.3.2 Buffers

Buffer or setback distances are recommended to provide a form of mitigation against unidentified hazards and reduce potential pathways of human and environmental exposure. The following (minimum) environmental buffers are required for SSI land application systems, based on Table 5 of NSW DLG (1998):

- 250m from domestic GW bores;
- 100m from permanent watercourses;
- 40m from intermittent watercourses and dams;
- 6m if area up-gradient and 3m if area down-gradient of driveways, swimming pools, property boundaries, and buildings; and
- 0.6m vertical separation from hardpan or bedrock.

All of the required buffers can be achieved at the Site (refer Figure 1, Appendix A).

6.3.3 LAA Sizing

Water and nutrient balance modelling were undertaken to determine the necessary size of the LAA required to manage the proposed hydraulic and nutrient loads from the proposal. The procedures for this generally follow the NSW DLG (1998) guidelines.

The water balance used is a monthly model adapted from the “Nominated Area Method” described in NSW DLG (1998). These calculations determine minimum LAA size for the given effluent load for each month of the year. The water balance can be expressed by the following equation:

Precipitation + Effluent Applied = Evapotranspiration + Percolation + Storage

A conservative (annual) nutrient balance was also undertaken, which calculates the minimum application area requirements to enable nutrients to be assimilated by the soils and vegetation. The nutrient balance used generally follows the NSW DLG (1998) procedure, but improves this by more accurately accounting for natural nutrient cycles and processes.

The inputs and results of the analyses are presented in the following table. Full water and nutrient balance results are presented in Appendix C.

Parameter	Units	Value	Comments
Design (daily) hydraulic load	L/day	1,200	Refer Section 4.1
Precipitation	mm/month	Median monthly	Paterson (Tocal AWS) [061250]
Pan evaporation	mm/month	Mean monthly	
Retained rainfall	Unitless	0.75	Conservative assumption that 75% of rainfall remains on-site and infiltrates the soil
Crop factor	Unitless	0.6-0.8	Annual value for grasses (adjusted for seasons)
Design loading rate	mm/day	2	Based on Table M1 *AS/NZS 1547:2012* for secondary effluent in Cat 6 soils
Effluent total nitrogen concentration	mg/L	≤30	Target effluent quality following secondary treatment, from Table 14 NSW DLG (1998)
Nitrogen lost to soil processes	annual percentage	20	Geary & Gardner (1996)
Effluent total phosphorus concentration	mg/L	≤10	Target effluent quality following secondary treatment, from Table 14 NSW DLG (1998)
Soil phosphorus sorption capacity	mg/kg	464	'bh3' Soil Landscapes of the Newcastle 1:100 000 Sheet (L.E. Matthei, 1995)
Nitrogen uptake rate by plants	kg/ha/yr	260	Conservative estimate based on published nutrient uptake rates in DECCW (2004) for grass (September-March)
Phosphorus uptake rate by plants	kg/ha/yr	30	
Design life of system (for nutrient management)	years	50	Recommended design life for system (NSW DLG, 1998)

Parameter	Units	Value	Comments
Results			
Hydraulic balance		657	
Nitrogen balance		404	
Phosphorus balance		610	

Based on the hydraulic sizing and nutrient modelling outcomes, the hydraulic load is the limiting factor for sizing the required SSI LAA. Therefore, a minimum LAA of 660m² (rounded) is recommended to service the proposal.

6.3.4 Subsurface Irrigation

SSI is suitable within lawn and landscaped areas and applies effluent within the root-zone of plants for optimum irrigation efficiency. It is an ideal option for ensuring even, widespread coverage of the proposed irrigation area. SSI installation does not require any bulk materials or heavy machinery; irrigation lines can be simply installed with a small trench digger or "ditch-witch".

Proprietary, pressure-compensating subsurface drip (PCSD) irrigation pipe designed for use with treated effluent should be used that will ensure distribution of effluent at uniform, controlled application rates. These products have been specifically designed for use with effluent and allow for the higher BOD_5, suspended solids, nutrient, and biological loads usually present in effluent compared to potable water. They contain specially designed emitters that reduce the risk of blockage, typically incorporating chemicals that provide protection against root intrusion and biofilm development (e.g. Trifluralin or copper). The dripper lines are coloured lilac to clearly identify that they are irrigating treated effluent.

6.3.4.1 Installation and Detail

A detailed irrigation design is beyond the scope of this WMR. The design should be prepared by the nominated irrigation installer for submission with the Section 68 application to Council and before installation of the irrigation system.

A critical element of the design process is hydraulic design, including selection of appropriate dripline, dosing and flush manifold pipe, lateral and emitter spacing, and pump performance. PCSD typically needs an operating pressure at the emitter of 10m – 40m (head) to maintain pressure compensation. As such, higher head low flow pumps are required to service drip irrigation systems that differ from pumps traditionally used in OSSM.

Lateral pipes should be spaced to provide good and even coverage of the area they service. Generally, they should be no more than 1m apart in clay soils and roughly parallel to prevent insufficient effluent distribution. SSI shall be installed at a depth of 100mm – 150mm in good quality topsoil as per *AS/NZS 1547:2012* (Note 2, Table M1).

General specifications for the proposed SSI LAA is as follows:

- Effluent must be applied evenly across the 660m^2 LAA;
  - This can be achieved by way of a hydraulic sequencing valve (indexing valve or similar) to appropriately sized dosing zones less than 400m^2, nominally two (2) zones of 330m^2 would be appropriate;

  - Care should be taken to ensure that the valve is installed at or above the maximum LAA elevation to prevent poor operation due to back-pressure;
- Driplines are to be buried within a minimum 100mm – 150mm depth below the ground surface;
- PCSD line specifically designed for effluent irrigation (e.g. Toro Drip-in, Netafim Bioline or Safe-T-Flo) shall be installed. 1.6 – 2.1 litres per hour emitters should be used;
- An in-line (nominally 120µm) disc filter must be installed to minimise the amount of solids entering the pipelines and emitters. This must be removed and cleaned regularly (at least at 3-monthly intervals);
- A flush main should be installed to periodically clean-out the irrigation lines to prevent soil particles being sucked into the lines at the end of pump cycles as pipelines depressurise and ensure effective long-term performance;
  - Either manual or automatic flush valves may be used, with flush water directed back to the treatment system or to a manual flush valve box installed at the terminal end of each zone. Valve boxes should installed with 50mm – 100mm pea gravel base and lilac lids level with ground surface;
- Air release valves will be installed at the high points in individual irrigation zones to ensure that any entrained air pockets are automatically released; and
- An 'as-built' layout of the OSSM system (treatment and LAA) shall be provided to Council and the system Owners upon completion.

Figure 4 in Appendix A provides a schematic representation of a SSI system. Specialist advice must be obtained for designing and installing the irrigation system.

6.3.5 LAA Positioning

Available areas for effluent application are shown in Figures 1 and 3 of Appendix A as 'Available EMA'. These areas exclude the required setback distances as detailed in Section 6.3.2. The required LAA can be located anywhere within the available EMA. A proposed location for the SSI LAA is shown in Figure 3 of Appendix A. This location is preferred due to better subsoil drainage conditions.

Access onto the LAA by vehicles and grazing animals can damage the soil conditions and irrigation infrastructure. Therefore, it is recommended that the LAA be appropriately fenced to restrict access, reducing the risk of damage.

7 Mitigation Measures

7.1 Stormwater Management

The performance of LAAs (and potentially treatment systems) can be adversely affected if stormwater is allowed to run onto these areas. A stormwater diversion device should be designed and constructed to collect, divert and dissipate collected run-on away from the proposed LAA. The structure should be designed and installed by a suitably qualified professional and be compliant with relevant guidelines and standards.

A diagram of a 'typical' stormwater diversion, which would be appropriate for this purpose, is provided in Figure 5 of Appendix A. The outlet must be stabilised and must discharge water in a safe location where it will not create an erosion hazard or impact on structures or neighbouring properties.

7.2 Vegetation Establishment

Vegetation that is suited to the application of effluent, preferably with high water and nutrient requirements (such as turf) should be established over the LAA following construction. A list of species can be found in Appendix 7 of NSW DLG (1998). A complete vegetation cover is important to reduce the erosion hazard and optimise water and nutrient uptake.

It is recommended to establish and maintain a vegetated buffer around the LAA. It should be planted with moisture-tolerant vegetation and remain well maintained to maximise moisture uptake. Plants must be selected that will not be so large as to shade the LAA once fully grown. It is important that the LAA receives maximum exposure to sun and wind to maximise evapotranspiration.

To maximise assimilation of effluent-borne nutrients within the LAA, vegetation clippings should be removed from the LAA and mulched elsewhere on-site for use on other landscaped areas that are not used for wastewater application. Mulching the clippings back onto the area from which they were cut is not recommended. An alternative is to dispose clippings in the general waste bin, or green waste bin collection service, if provided.

7.3 Soil Amelioration

Given that Site soils are identified as acidic and unstable; they may be susceptible to impaired vegetative growth and impaired permeability. These properties can combine to reduce the soils capacity to sustainably manage wastewater.

Prolonged application of sodium rich wastewater can exacerbate the situation. Application of calcium minerals is a recognised way of reducing the effects of soil instability. It does this by supplying calcium to the affected soil and thereby elevating calcium concentrations with respect to sodium.

Typically, gypsum would be the preferred soil amendment; however, given the identified acidity concern a 50:50 application of gypsum and lime may be more suitable for the Site. Both gypsum and lime are slowly soluble in water, so simply broadcasting at the surface can be of limited benefit as it can take a long time for the calcium to penetrate the soil and reach the deeper soil layers. Therefore, it is necessary to incorporate the amendment into the subsoil prior to construction of the land application system. This can be done by shallow ripping of the natural soil and applying the 50:50 gypsum/lime.

A suitable gypsum/lime application rate of approximately 0.2kg/m^2 is recommended.

8 Acid Sulfate Soils

Council mapping indicates the Site is located within a Class 5 acid sulphate soil (ASS) risk zone (LEP, 2011). Work carried out in this zone may require development consent, including an ASS Management Plan, under the following conditions:

> *Class 5 – Works within 500m of adjacent Class 1, 2, 3, or 4 land that is below 5m AHD and by which the watertable is likely to be lowered below 1m AHD on adjacent Class 1, 2, 3, or 4 land.*

All development will occur above 34m AHD at the Site (available DEM data). SSI laterals are to be buried approximately 0.1m – 0.15m below the ground surface, with the excavation depth required for the proposed secondary treatment system being approximately 1.8m – 2m.

Therefore, a maximum excavation elevation of ~32m AHD (34m AHD – 2m AHD) is expected. Encountering ASS or lowering of the water table below 1m AHD is considered unlikely. Based on preliminary investigation, it is assumed that ASS management measures are not likely required.

9 Conclusions and Recommendations

This completes our assessment of the Site capability for sustainable OSSM in relation to the proposed development at 36 Cockatoo Ridge, Aberglasslyn NSW. Specifically, W&A recommend the following:

- Wastewater generated within the existing dwelling will continue to be managed within the existing (approved) OSSM system;
  - It is recommended that new T-junctions are fitted to the inlet and outlet structures within both septic tanks to limit solids transfer between the tanks and absorption beds;
- Combined wastewater generated from the proposed dwelling, B&B units and shed will be treated to a 'secondary' standard within an appropriately sized, NSW Health accredited, secondary treatment system (with disinfection);
- Secondary treated effluent will be reused on-site via a 660m^2 SSI LAA;
  - The LAA should be split into separate zones no more than 400m^2, nominally two (2) zones of 330m^2 would be suitable;
- The LAA should be designed and installed by an experienced professional, taking into account the expected flows and other recommendations contained within this report;
- A suitable gypsum / lime application rate of approximately 0.2kg/m^2 should be applied at the base of the land application systems during installation;
- The proposed LAA must be located within the available EMA specified to comply with adopted setbacks;
- Suitable vegetation such as turf must be established over the LAA immediately after installation; and
- Livestock and vehicles must be prevented from entering the designated LAA.

Yours Sincerely,

Connor Morton

Environmental Consultant
Whitehead and Associates Environmental Consultants Pty Ltd

Appendix A

Figures

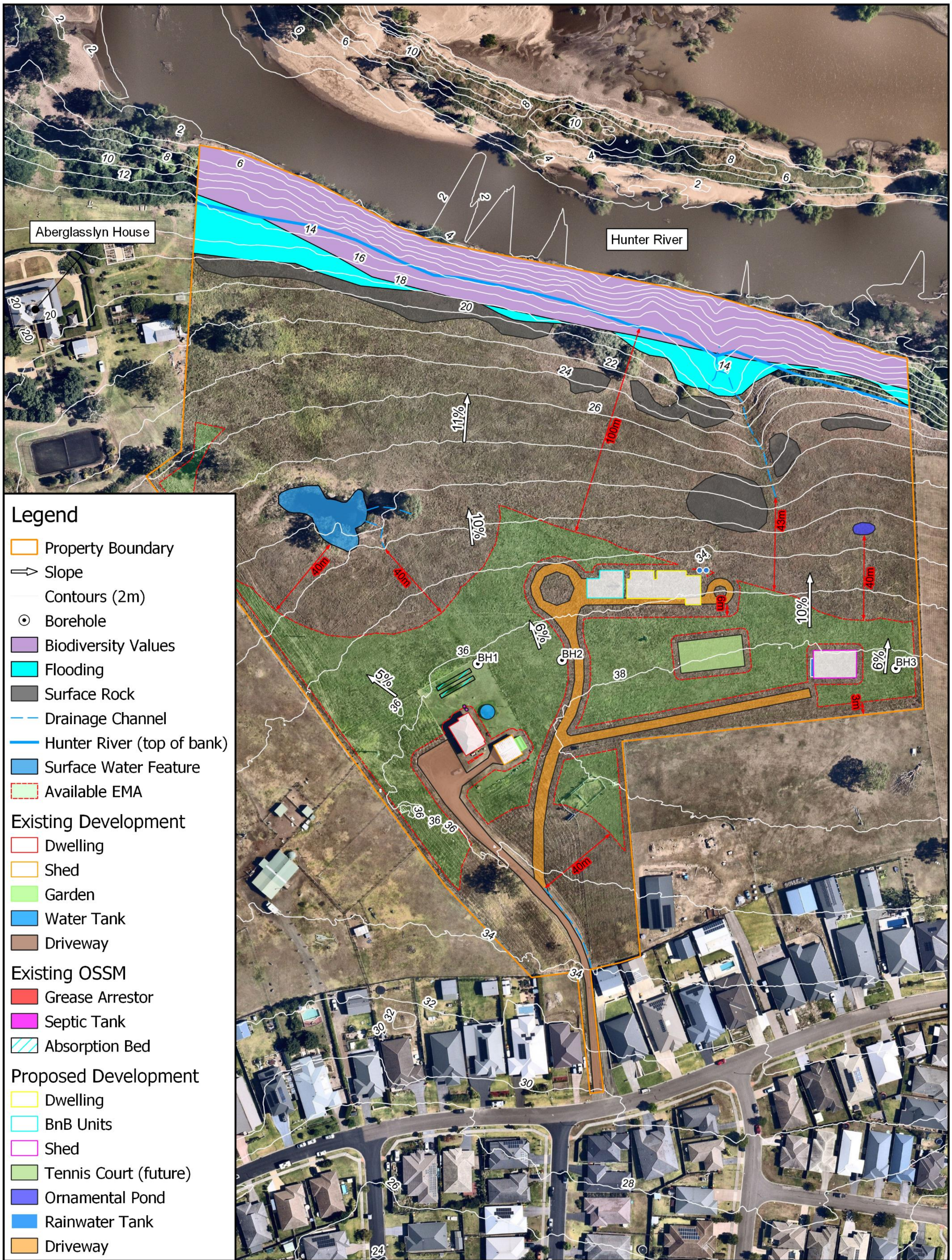

Figure 1: Site Plan Showing Proposed Development and Available EMA

3486: WMR for proposed development at 36 Cockatoo Ridge, Aberglasslyn

N

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0 50 100 150 m

(Approx Scale)

Revision	002
Drawn	CM
Approved	MS

Figure 2: Site Plan Showing Existing OSSM

3486: WMR for proposed development at 36 Cockatoo Ridge, Aberglasslyn

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0 10 20 30 m (Approx Scale)

N

Revision	001
Drawn	CM
Approved	MS

Figure 3: Site Plan Showing Proposed OSSM

3486: WMR for proposed development at 36 Cockatoo Ridge, Aberglasslyn

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0 | 25 | 50 | 75 | 100 | 125 m
(Approx Scale)

N

Revision	002
Drawn	CM
Approved	MS

NOTES

Design for long lateral runs on relatively uniform slope.

An earth bank diversion drain must be constructed upslope of each zone to divert stormwater run-on.

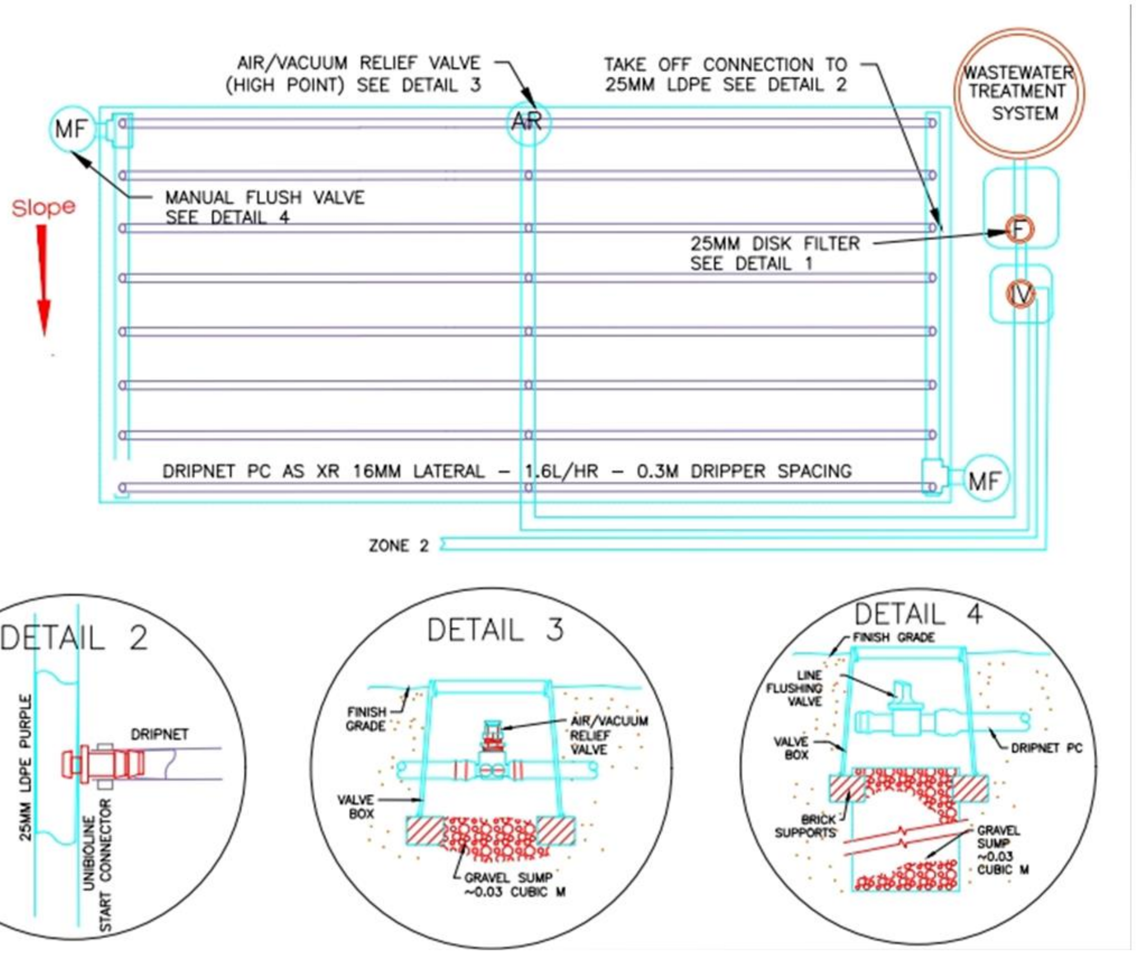
A Total application area = 852m2. Four zones of 213m2 each.

B Each zone is fed by a central distribution manifold with return flushing manifolds on the outer ends, each with a flush valve. An air/vacuum relief valve is located at the high point in each zone.

C Distribution and flushing return manifolds should be buried minimum 150mm below the ground surface.

D Pressure Compensating (PC) subsurface drip line with emitters at 0.3m spacing, with output 1.6L/hr, and laterals at 1000mm spacing and buried to a depth 150-200mm.

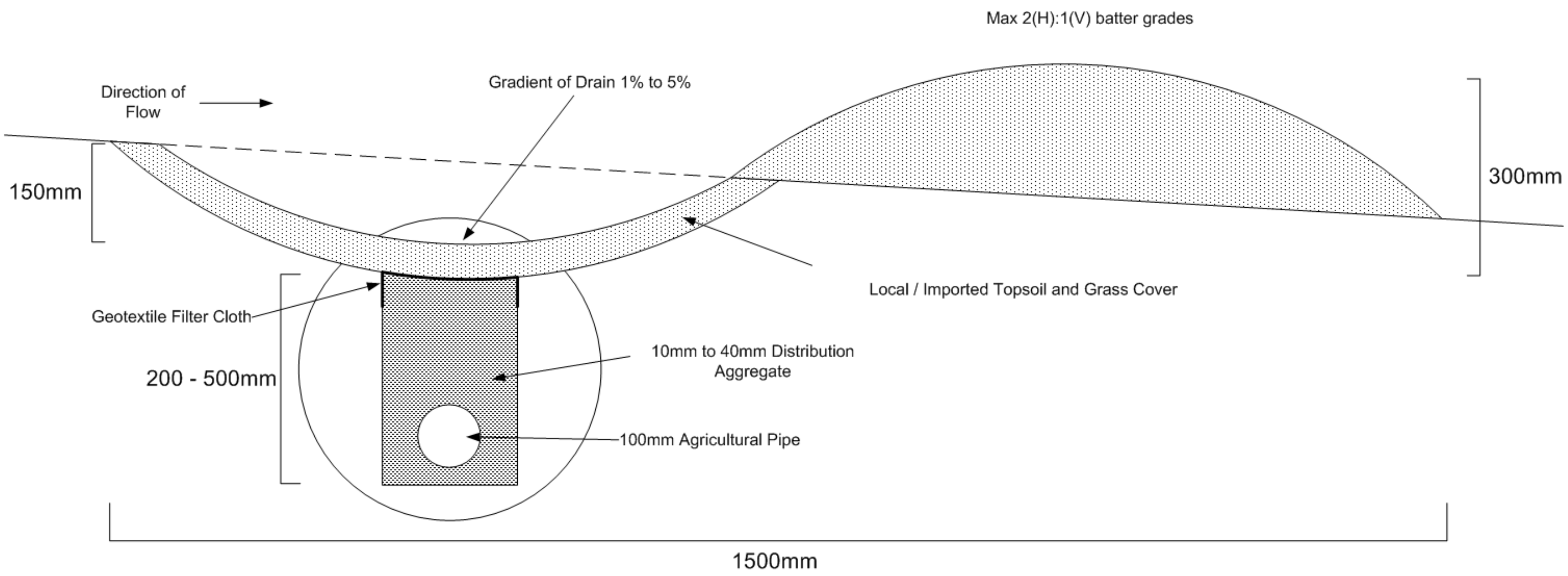
E Non-return valves to be installed on distribution and return flushing manifolds where fall is greater than 2m over the zone.



Courtesy: Netafim Australia Pty Ltd

Whitehead & Associates **Environmental Consultants**	*This standard design has been based on a generic area for irrigation based on typical conditions. It does not eliminate the need for a site and soil evaluation to be carried out or any additional consideration of site specific issues. It should be used as a generic guide only.*	**Figure 4: Standard Drawing, Subsurface Irrigation**

Cross Section: Upslope Diversion Drain



Whitehead & Associates Environmental Consultants	**FIGURE 5: STANDARD DRAWING OF AN UPSLOPE DIVERSION DRAIN**	Project: 3486 Drawn: CM Approved: MS Scale: NTS

Appendix B

Soil Borelogs and Laboratory Results

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Key to Soil Borelogs

Symbols

W	Watertable depth	●	Sample collected
X	Depth of refusal		

Moisture condition

D	Dry
SM	Slightly moist
M	Moist
VM	Very moist
W	Wet / saturated

Graphic Log and Textures

S - Sand
LS - Loamy sand
CS - Clayey sand

CL - Clay loam
SCL - Sandy clay loam
SiCL - Silty clay loam

Gravel (G)

SL - Sandy loam

LC - Light clay
SC - Sandy clay

Parent material (stiff)

L - Loam
LFS - Loam fine sandy
SiL - Silty loam

MC - Medium clay
HC - Heavy clay

Parent material (weathered)

SOIL BORE LOG

Whitehead & Associates
Environmental Consultants

Client:	Richard Beardshall	**Test Pit No:**	**BH1**
Site:	36 Cockatoo Ridge, Aberglasslyn	Excavated/logged by:	Connor Morton
Date:	10 May 2023	Excavation type:	Auger & crowbar
Notes:	- refer to site plan for position of test pit		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Size of Coarse Fragments	Moisture Condition	Comments
0.1		BH1/1	A	SiCL	Moderate	Very dark greyish brown	Nil	< 2%	20-60mm	SM	
0.2											
0.3		BH1/2	B1	MC	Moderate	Brown	Nil	10 - 20%	20-60mm	SM	
0.4											
0.5											
0.6		BH1/3	B2	MC	Massive	Brown	Orange (moderate)	10 - 20%	20-60mm	SM	
0.7	- stopped on shale										

SOIL BORE LOG

Whitehead & Associates
Environmental Consultants

Client:	Richard Beardshall	**Test Pit No:**	**BH2**
Site:	36 Cockatoo Ridge, Aberglasslyn	Excavated/logged by:	Connor Morton
Date:	10 May 2023	Excavation type:	Auger & crowbar
Notes:	- refer to site plan for position of test pit		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Size of Coarse Fragments	Moisture Condition	Comments
0.1		BH2/1	A	SiCL	Moderate	Very dark greyish brown	Nil	< 2%	20-60mm	SM	
0.2											
0.3		BH2/2	B	MC	Massive	Brown	Nil	10 - 20%	20-60mm	SM	
0.4											
0.5											
0.6											
0.7											
	- stopped on shale										

SOIL BORE LOG

Whitehead & Associates
Environmental Consultants

Client:	Richard Beardshall	**Test Pit No:**	**BH3**
Site:	36 Cockatoo Ridge, Aberglasslyn	Excavated/logged by:	Connor Morton
Date:	10 May 2023	Excavation type:	Auger & crowbar
Notes:	- refer to site plan for position of test pit		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Size of Coarse Fragments	Moisture Condition	Comments
0.1 0.2		BH3/1	A	SiCL	Moderate	Very dark greyish brown	Nil	< 2%	20-60mm	SM	
0.3 0.4 0.5		BH3/2	B1	MC	Massive	Brown	Orange (moderate)	10 - 20%	20-60mm	SM	
0.6 0.7		BH3/3	B2	MC	Moderate	Brown	Orange (moderate)	10 - 20%	20-60mm	D	
	- stopped on shale										

Project 3486: 36 Cockatoos Ridge, Aberglasslyn

Sheet 1 - Soil Sampling Schedule and Results of pH, EC and Emerson Aggregate Test Analysis

Site	Sample Name	Sample Depth (mm)	Texture Class	EAT [1]	Rating [2]	pH f [3]	pH 1:5 [4]	Rating	EC 1:5 (µS/cm)	ECe (dS/m) [5]	Rating	Other analysis [6]
3486	BH1/1	200	SiCL	8	Negligible	n/a	5.73	Moderately acid	53	0.46	Non-saline	
3486	BH1/2	500	MC	2(3)	Very High	n/a	5.41	Strongly acid	92	0.69	Non-saline	
3486	BH1/3	650	MC	2(1)	Mod-High	n/a	5.08	Strongly acid	159	1.19	Non-saline	
3486	BH2/1	200	SiCL	8	Negligible	n/a	4.99	Very strongly acid	60	0.52	Non-saline	
3486	BH2/2	700	MC	2(1)	Mod-High	n/a	4.68	Very strongly acid	97	0.73	Non-saline	
3486	BH3/1	200	SiCL	8	Negligible	n/a	4.59	Very strongly acid	65	0.56	Non-saline	
3486	BH3/2	550	MC	2(3)	Very High	n/a	4.81	Very strongly acid	131	0.98	Non-saline	
3486	BH3/3	700	MC	2(1)	Mod-High	n/a	5.41	Strongly acid	254	1.91	Non-saline	

Notes:- (also refer Interpretation Sheet 1)

n/a not available
n/t not tested
[1] The modified Emerson Aggregate Test (EAT) provides an indication of soil susceptibility to dispersion.
[2] Ratings describe the likely hazard associated with land application of treated wastewater.
[3] pH measured in the field using Raupac Indicator.
[4] pH measured on 1:5 soil:water suspensions using a *Hanna Combo* hand-held pH/EC/temp meter.
[5] Electrical conductivity of the saturated extract (Ece) = $EC_{1:5}$(µS/cm) x MF / 1000. Units are dS/m. MF is a soil texture multiplication factor.
[6] External laboratories used for the following analyses, if indicated:

- CEC (Cation exchange capacity)
- Psorb (Phosphorus sorption capacity)
- Bray Phosphorus
- Organic carbon
- Total nitrogen

Soil Landscapes of the Newcastle 1:100 000 Sheet

Sheet 2 - Results of External Laboratory Analysis

Name	Depth (m)	CEC (me/100g)	Rating	Ca (mg/kg)	Rating	Mg (mg/kg)	Rating	Na (mg/kg)	Rating	K (mg/kg)	Rating	ESP (%)	Rating	P-sorp. (mg/kg)	Rating
bh3	0.3-0.5	17.7	M	240	VL	1056	VH	138	M	429	H	3.0	NS	464	H

Notes:- (also refer Interpretation Sheet 2)

n/a
n/t

Appendix C

Water and Nutrient Balance

Irrigation Area Water Balance & Storage Calculations

Project 3486: 36 Cockatoo Ridge, Aberglasslyn NSW

Whitehead & Associates
Environmental Consultants

INPUT DATA

Design Wastewater Flow	Q	1,200	L/day	Calculated/estimated daily flow (proposed dwelling + B&B)
Design Irrigation Rate	DIR	2.0	mm/day	Litres/sqm/day - based on Table M1 AS/NZS 1547:2012 for secondary effluent with Cat 6 soil
Available Land Application Area	L	660	m²	Used for iterative purposes to determine storage requirements for nominated areas
Crop Factor	C	0.6-0.8	unitless	Estimates evapotranspiration as a fraction of pan evaporation; varies with season and crop type
Runoff Coefficient	RC	0.75	unitless	Proportion of rainfall that remains onsite and infiltrates; function of slope/cover, allowing for any runoff
Rainfall Data	Paterson (Tocal AWS) (061250)			Median Monthly data 1967-2023
Evaporation Data	Paterson (Tocal AWS) (061250)			Mean Monthly data 1967-2023

Soil Category (AS1547:2012)	DIR	Units
Gravels and Sands (1)	5	mm/day
Sandy Loams (2)	5	mm/day
Loams (3)	4	mm/day
Clay Loams (4)	3.5	mm/day
Light Clays (5)	3	mm/day
Medium to Heavy Clays (6)	2	mm/day

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
Days in Month	D		days	31	28.25	31	30	31	30	31	31	30	31	30	31	31	28	31	30	31	30	**365**
Rainfall	R		mm/month	82.8	95.2	113.2	63.2	57.6	57.3	31.7	31.8	36.4	52.0	69.0	69.5	82.8	95.2	113.2	63.2	57.6	57.3	**955.8**
Evaporation	E		mm/month	189.1	148.4	130.2	96.0	74.4	63.0	74.4	102.3	132.0	161.2	174.0	204.6	189.1	148.4	130.2	96.0	74.4	63.0	**1549.6**
Crop Factor	C			0.80	0.80	0.70	0.60	0.60	0.60	0.60	0.60	0.70	0.80	0.80	0.80	0.80	0.80	0.70	0.60	0.60	0.60	
OUTPUTS (LOSSES)																						
Evapotranspiration	ET	ExC	mm/month	151.3	118.7	91.1	57.6	44.6	37.8	44.6	61.4	92.4	129.0	139.2	163.7	151.3	118.7	91.1	57.6	44.6	37.8	**1131.44**
Percolation	B	DIRxD	mm/month	62.0	56.5	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0	62.0	56.0	62.0	60.0	62.0	60.0	**730.5**
Outputs		ET+B	mm/month	213.3	175.2	153.1	117.6	106.6	97.8	106.6	123.4	152.4	191.0	199.2	225.7	213.3	174.72	153.1	117.6	106.6	97.8	**1861.9**
INPUTS (GAINS)																						
Retained Rainfall	RR	RxRC	mm/month	62.1	71.4	84.9	47.4	43.2	43.0	23.8	23.9	27.3	39.0	51.8	52.1	62.1	71.4	84.9	47.4	43.2	42.975	**569.775**
Effluent Irrigation	W	(QxD)/L	mm/month	56.4	51.4	56.4	54.5	56.4	54.5	56.4	56.4	54.5	56.4	54.5	56.4	56.4	50.9	56.4	54.5	56.4	54.5	**664.1**
Inputs		RR+W	mm/month	118.5	122.8	141.3	101.9	99.6	97.5	80.1	80.2	81.8	95.4	106.3	108.5	118.5	122.3	141.3	101.9	99.6	97.5	**1233.9**
STORAGE CALCULATION (Δ)																						
Storage Remaining from Previous Month			mm/month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Storage for the Month	S	(RR+W)-(ET+B)	mm/month	-94.8	-52.5	-11.9	-15.7	-7.1	-0.3	-26.5	-43.2	-70.6	-95.6	-92.9	-117.2	-94.8	-52.4	-11.9	-15.7	-7.1	-0.3	
Cumulative Storage	M		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Maximum Storage for Nominated Area	N		mm	0.0																		
Storage Volume required	V	(NxL)/1000	m³	0.0																		
LAND AREA REQUIRED FOR ZERO STORAGE			m²	246	327	545	513	586	657	449	374	288	245	244	214	246	325	545	513	586	657	

MINIMUM AREA REQUIRED FOR ZERO STORAGE: 657 m²

This value is based on the worst month of the year, so the balance overestimates the area/storage requirements and is therefore conservative for all other months

Nutrient Balance

Whitehead & Associates Environmental Consultants

Project 3486: 36 Cockatoo Ridge, Aberglasslyn NSW

Please read the attached notes before using this spreadsheet.

SUMMARY - LAND APPLICATION AREA REQUIRED BASED ON THE MOST LIMITING BALANCE = 610 m^2

INPUT DATA [1]

Wastewater Loading			Nutrient Crop Uptake					
Hydraulic Load	1,200	L/day	Crop N Uptake	260	kg/ha/yr	which equals	71.23	mg/m^2/day
Effluent N Concentration	30	mg/L	Crop P Uptake	30	kg/ha/yr	which equals	8.22	mg/m^2/day
% Lost to Soil Processes (Geary & Gardner 1996)	0.2	Decimal	**Phosphorus Sorption**					
Total N Loss to Soil	7,200	mg/day	P-sorption result	464	mg/kg	which equals	4,176	kg/ha
Remaining N Load after soil loss	28,800	mg/day	Bulk Density	1.5	g/cm^3			
Effluent P Concentration	10	mg/L	Depth of Soil	0.6	m			
Design Life of System	50	yrs	% of Predicted P-sorp.[2]	0.5	Decimal			

METHOD 1: NUTRIENT BALANCE BASED ON ANNUAL CROP UPTAKE RATES

Minimum Area required with zero buffer

Nitrogen	404	m^2
Phosphorus	610	m^2

Determination of Buffer Zone Size for a Nominated Land Application Area (LAA)

Nominated LAA Size	630	m^2
Predicted N Export from LAA	-5.87	kg/year
Predicted P Export from LAA	-0.14	kg/year
Phosphorus Longevity for LAA	53	Years
Minimum Buffer Required for excess nutrient	0	m^2

PHOSPHORUS BALANCE

STEP 1: Using the nominated LAA Size

Nominated LAA Size	630	m^2			
Daily P Load	0.012	kg/day	→ Phosphorus generated over life of system	219	kg
Daily Uptake	0.0051781	kg/day	→ Phosphorus vegetative uptake for life of system	0.150	kg/m^2
Measured p-sorption capacity	0.4176	kg/m^2			
Assumed p-sorption capacity	0.209	kg/m^2	→ Phosphorus adsorbed in 50 years	0.209	kg/m^2
Site P-sorption capacity	131.54	kg	→ Desired Annual P Application Rate	4.521	kg/year
			which equals	0.01239	kg/day
P-load to be sorbed	2.49	kg/year			

NOTES

[1]. Model sensitivity to input parameters will affect the accuracy of the result obtained. Where possible site specific data should be used. Otherwise data should be obtained from a reliable source such as,

- *Environment and Health Protection Guidelines: Onsite Sewage Management for Single Households*
- *Appropriate Peer Reviewed Papers*
- *EPA Guidelines for Effluent Irrigation*
- *USEPA Onsite Systems Manual.*

[2]. A multiplier, normally between 0.25 and 0.75, is used to estimate actual P-sorption under field conditions which is assumed to be less than laboratory estimates.

Appendix D

General Notes

Soil Physical Properties/ Chemistry

pH

This test is used to determine the acidity or alkalinity of native soils. pH is measured on a scale of 0 to 14, with 7 being neutral. Results below 7 are considered acid, while those above 7 are alkaline. For land application of effluent, soil with a pH of 4.5 to 8.5 should typically pose no constraints. Soil pH affects the solubility and fixation of some nutrients; this in turn reduces soil fertility and plant growth. By correcting soil pH beneficial plant growth is improved, assisting in the assimilation of nutrient and improving evapotranspiration of effluent. Most Australian soils are naturally acidic.

Electrical Conductivity

Electrical conductivity (EC) is a measure of a soil or soil/water extracts ability to conduct an electrical current. It is used as an indirect measure of a soils accumulation of water soluble salts, mainly of sodium, with minor potassium, calcium and magnesium. High EC within a land application area reflects general soil salinity and is undesirable for vegetation growth. The tolerance of vegetation species to soil salinity varies among plant types. Typically EC readings of <4dS/m pose no constraints. There are a number of measures available to counter high soil EC values for land application of effluent; however, the most important measure relates to the conservative selection of application rates and appropriate application area sizing.

Emerson Aggregate Test

The Emerson Aggregate Test (EAT) is a measure of soil dispersibility and susceptibility to erosion and structural degradation. It assesses the physical changes that occur in a single ped of soil when immersed in water, specifically whether the soil slakes and falls apart or disperses and clouds the water. Dispersive soils pose limitations to on-site sewage management because of the potential loss of soil structure when effluent is applied. Soil pores can become smaller or completely blocked, causing a decrease in soil permeability, which can lead to system failure.

Cation Exchange Capacity

The cation exchange capacity (CEC) is the capacity of the soil to hold and exchange cations (positively charged molecules). Because some soils have a dominant negative charge, they can adsorb cations. Soils bind cations such as calcium, magnesium, potassium and sodium, preventing them from being leached from the soil profile and making them available as plant nutrients. CEC is a major controlling agent for soil structural stability, nutrient availability for plants and the soils’ reaction to fertilisers and other ameliorants. A CEC of greater than 15 cmol+/kg or me/100g is recommended for land application systems. Adding organic matter (compost/humus) to soil can greatly increase its CEC.

Exchangeable Sodium Percentage

The exchangeable sodium percentage (ESP) is an important indicator of soil sodicity, which affects soil structural stability and overall susceptibility to dispersion. Sodic soils tend to have a low infiltration capability, low hydraulic conductivity, and a high susceptibility to erosion. When sodium dominates the exchangeable cation complex, soil structural stability declines significantly. Soil ESP is considered acceptable for effluent application areas when it is below 5%, marginal between 5% – 10% and limiting >10%. The ESP of application area soils can be improved by the measured application of calcium (lime/gypsum).

Phosphorus Sorption Capacity

Phosphorus sorption (P-sorption) capacity is a direct measure of a soils ability to adsorb phosphorus. Phosphorus is an important plant nutrient and is the limiting available nutrient in many aquatic environments. Excess phosphorus can increase the production of nuisance vegetative growth such as algae. The P-sorption capacity of the soil in an effluent application area relates to its ability to assimilate the phosphorus in the wastewater for the design life of the application area. P-sorption values greater than 400mg/kg is considered acceptable for land application of effluent, while values below 150mg/kg present a constraint.