Whitehead & Associates
Environmental Consultants

Caitlin O'Brien
Brown Commercial Building
PO Box 596
East Maitland
NSW 2323

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On-site Wastewater Management Report for a proposed farm shed at 2411 The Bucketts Way, Wards River NSW

Whitehead & Environmental Consultants Pty Ltd (W&A) were engaged by Caitlin O'Brien (the Client) to prepare an On-site Wastewater Management Report (WMR) for a proposed warehouse at 2411 The Buckets Way, Wards River NSW (the "Site"). The Site, identified as Lot 1 in DP1166147, totals 714.5ha in area and is zoned RU2 (Rural Landscape) under the Great Lakes LEP (2014).

Existing improvements at the Site include a detached storage shed and water tanks in the east. The property is serviced by on-site (tank) water supply and no reticulated sewer service is available (or anticipated).

It is understood that the Client proposes to submit a Development Application (DA) with MidCoast Council (MCC or Council) for the construction of a new warehouse (the "farm shed") at the Site. External landscaping and other minor improvements are also proposed within the DA. The farm shed is proposed to be ~800m^2 in size and will be located within a cleared area adjacent the northern property boundary. The farm shed will include a warehouse floor, storeroom, two (2) office spaces, reception area, meeting area and bathroom facilities (including shower).

The Site consists of cleared areas in the east with remnant forest in the west. The Site is identified as extensively bushfire prone (vegetation category 1 and 3) and includes biodiversity features (biodiverse riparian land and identified rainforest). Multiple waterways and dams are identified at the Site.

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 On-site Sewage Management (OSSM) to ensure compliance with the relevant standards and guidelines currently enforced by Council, as follows.

- NSW Department of Local Government (1998), *Environment & Health Protection Guidelines: On-site Sewage Management for Single Households* (NSW DLG, 1998);
- The NSW Ministry of Health (2001), *Septic Tank and Collection Well Accreditation Guideline* (NSW Health, 2001);
- The 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* (*AZ/NZS 1547:2012*); and
- MidCoast Council (2020), *On-site Sewage Development Assessment Framework* DAF. Final Version, dated 13 October 2020 (MCC DAF, 2020).

1 Author Statement

This WMR was prepared by Sophie Grossenbacher. Sophie is a Graduate Environmental Consultant with W&A, holding a Bachelor of Science (Earth Science) from the University of Newcastle (2023). Sophie has completed the On-site Wastewater Management professional short-course with the Centre for Environmental Training (CET).

2 Introduction

The following table summarises information of the property investigated.

Feature	Description
Site Address	2411 The Bucketts Way, Wards River NSW
Lot / DP	Lot 1 in DP1166147
Local Government Area	MidCoast Council
Land Zoning	RU2 (Rural Landscape)
Lot Size	714.5ha
Proposed Development	Farm shed
Sewer Connection Available	No
Potable Water Supply	On-site (tank) water supply

3 Site and Soil Assessment

A Site investigation was undertaken by Sophie Grossenbacher of W&A on 15 April 2025. The following tables present the results of the site and soil investigation.

A description of the physical constraints within the available Effluent Management Area (EMA), with the degree of limitation they pose to OSSM 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 1,093mm; minimum of 24.4mm (August) and maximum of 119.6mm (March).	Craven (Longview) [060042]	Moderate limitation
	Mean annual evaporation of 1,371.3mm; rainfall exceeds potential evaporation approximately two (2) months of the year (March and June).	SILO Point Data (-32.20, 151.95)	
Land Application Area (LAA) Sizing			

SITE ASSESSMENT				
Parameter	**Data / Observation**		**Reference**	**Classification / Outcome**
Hydraulic sizing (monthly) attached:		Yes	As per *AS/NZS 1547:2012* and NSW DLG (1998) procedures	
Nutrient balance (annual) attached:		Yes		
LAA sizing attached:		Yes		
Wet weather storage requirement:		N/A	N/A	
Flooding				
LAA above 5% AEP flood level:		Yes	MCC Intramaps	Minor limitation
LAA above 1% AEP flood level:		Yes		
Electrical components above 1% AEP flood level:		Yes		
Flooding	It is noted that areas in proximity to surface water features are identified as being flood prone; however, no flood prone land identified within the available EMA.			
Vegetation	The Site is cleared of vegetation in the east and contains dense forest in the west. Areas of dense vegetation are considered unsuitable for effluent reuse and have been discounted from the available EMA. The available EMA consists of managed pasture with minimal shading from adjacent mature vegetation.		Minor limitation	
Exposure	High exposure to sun and prevailing wind.		Minor limitation	
Aspect	North-easterly within proposed LAA.		Minor limitation	
Slope	Slopes of 6% – 14% throughout the Site, with slopes of 10% within the proposed LAA.		Minor to Moderate limitation	
Landform	Linear planar within proposed LAA.		Minor limitation	
Run-on & Seepage	No run-on or up-slope seepage observed at time of the site investigation; however, high potential for run-on and up-slope seepage due to the mid-slope position of the proposed LAA. Stormwater from upslope areas must be directed away from the proposed LAA (refer Section 7.2).		Moderate limitation	
Erosion Potential	No erosion evident during the site investigation. Address potential concerns using erosion and sediment controls during construction and revegetation of the LAA using turf or other		Minor limitation	

SITE ASSESSMENT			
Parameter	**Data / Observation**	**Reference**	**Classification / Outcome**
	suitable groundcover as appropriate (refer Section 7.3).		
Site Drainage	Moderately well drained with no signs of surface saturation throughout. Minor mottling observed in subsoils, indicating restricted vertical drainage during periods of extended wet weather.	Moderate limitation	
Fill	None observed.	Minor limitation	
Surface Water	Multiple intermittent waterways drain throughout the Site. Multiple dams are located to the east with two (2) permanent waterways located to the west of the Site. All standard (NSW DLG, 1998) buffers to surface water features can be achieved at the Site.	Minor limitation	
Groundwater	No shallow groundwater (GW) encountered during the soil investigation. The WaterNSW GW bore registry indicates there are no GW bores within 250m of the Site (refer Figure 1, Appendix A).	Minor limitation	
Buffers Applicable			
Domestic GW bores (250m):	Yes	Achievable	
Permanent waterways (100m):	Yes	Achievable	
Intermittent waterways and other waters (40m):	Yes	Achievable	
Buildings, driveways and swimming pools (3m if EMA downslope – 6m if EMA upslope):	Yes	Achievable	
Lot boundaries (6m if EMA downslope – 12m if EMA upslope):	Yes	Achievable	
Limiting horizon (GW, bedrock, etc.) (>0.6m):	Yes	Achievable, with mitigation (refer Section 7.1.1)	
Other sensitive receptors:	N/A		
Surface Rock	None observed.	Minor limitation	
Available EMA	Approximately 28.4ha of available EMA is identified at the Site.	Minor limitation	
Concluding Remarks Climate, slope, run-on potential and restricted vertical drainage pose moderate constraints to OSSM.			

SITE ASSESSMENT			
Parameter	**Data / Observation**	**Reference**	**Classification / Outcome**
Climate, slope and restricted vertical drainage limitations can be mitigated through conservative OSSM location, design and installation (refer Sections 5 and 6). Run-on potential can be mitigated by stormwater management measures (refer Section 7.2). To ensure that the *AS/NZS 1547:2012* horizontal setback (0.6m) to the limiting horizon (weathered parent material) is achieved, it is recommended that good quality topsoil material is imported to the LAA footprint (refer Section 7.1.1).			

A description of the soil physical and chemical constraints, and the degree of limitation they pose to OSSM is provided in the following tables. Reference is made to the rating scale in Table 6 of NSW DLG (1998).

SOIL ASSESSMENT (physical)			
Parameter	**Data / Observation**	**Reference**	**Classification / Outcome**
Soil Depth	500mm – 700mm.	Moderate limitation	
Soil Profile	**BH1&3:** A: 0mm – 200/250mm, weakly structured, clay loam (Cat 4). B_1: 200/250mm – 500mm, moderately structured, medium clay (Cat 6). B_2: 500mm – 600/700mm, weak to moderately structured, light clay (Cat 5). **BH2:** A_1: 0mm – 250mm, moderately structured, very dark grey loam (Cat 3). A_2: 250mm – 400mm, weakly structured, brown sandy clay loam (Cat 4). B: 400mm – 600mm, moderately structured, light yellowish-brown medium clay (Cat 6). **BH4**: A: 0mm – 200mm, moderately structured, very dark grey silty loam (Cat 3). B: 200mm – 500mm, moderately structured, light brownish grey medium clay (Cat 6). **BH5**: A: 0mm – 200mm, moderately structured, very dark grey loam (Cat 3). B: 200mm – 500mm, moderately structured, brown sandy clay loam (Cat 4). All boreholes terminated on parent material / hardpan layer.		

SOIL ASSESSMENT (physical)			
Parameter	**Data / Observation**	**Reference**	**Classification / Outcome**
	Borehole locations shown in Figure 2 of Appendix A, with borelogs and laboratory results presented as Appendix B.		
Depth to Water Table	No shallow water table encountered during the soil investigation.	Minor limitation	
Coarse Fragments	<20% (20-60mm).	Minor limitation	
Soil Permeability	<0.06m/day (indicative).	Moderately structured Cat 6 subsoil	Major limitation
Modified Emerson Aggregate Class (EAT)	2(1) – 3(2) (slightly to highly unstable/dispersive).	Moderate to Major limitation	
Soil Landscape	**Wards River (wd):** Rolling low hills on sediments of the Gloucester Coal Measures in the Stroud-Gloucester Basin region. Slopes generally <25%, local relief between 30-100m and elevation 100-240m. Cleared tall open-forest. Localised limitations include shallow, strongly acid, highly erodible and low fertility soils; high gully erosion risk; high sheet erosion risk; high run-on and seasonal water logging; and steep slopes.	Soil Landscapes of the Dungog 1:100,000 Sheet (Henderson L.E., 2000)	

Concluding Remarks

Site soils are generally characterised by loam (Cat 3) topsoils to 200/400mm, underlain by medium clay (Cat 6) subsoil to 500/700mm. Soil is typically moderately to weakly structured.

Available soil depth, soil permeability and soil dispersion/stability (EAT) present moderate to major limitations to OSSM.

Soil permeability limitations will be mitigated through conservative OSSM system sizing and design (refer Sections 5 and 6). Available soil depth limitations will be mitigated by the importation of topsoil material (refer Sections 6.4.3 and 7.1.1), with soil stability limitations mitigated through soil improvement measures (refer Section 7.1.2).

SOIL ASSESSMENT (chemical)				
Parameter	**Data / Observation**		**Reference**	**Classification/ Outcome**
pH	7.1 – 8.1	Neutral to moderately alkaline	Minor limitation	

SOIL ASSESSMENT (chemical)				
Parameter	**Data / Observation**		**Reference**	**Classification/ Outcome**
EC (EC_e)	0.12 – 1.01	Non-saline	Minor limitation	
ESP (%)	8.2	Sodic	eSpade Technical Report (WEL/96/143/150(1) on wd soil landscape (refer Appendix B)	Moderate limitation
CEC (me/100g)	12.2	Medium fertility		Moderate limitation
P-sorption (mg/kg)	344 (~2,890kg/ha)	Moderate to high		Moderate limitation

Concluding Remarks

The sodicity (ESP), fertility (CEC) and p-sorption capacity of the Site soils pose moderate constraints to OSSM.

Sodicity and fertility can be mitigated through soil improvement measures (refer Section 7.1.2). Limitations associated with p-sorption capacity can be mitigated through the implementation of a nutrient buffer (refer Section 6.3).

Soil laboratory results are presented within Appendix B, with general notes on the soil chemistry parameters attached as Appendix D.

4 Wastewater Generation

4.1 Wastewater Quantity

As per the provided plans, the proposed farm shed is to contain a WC, basin, shower and kitchen facilities.

As per information provided by the Client, approximately four (4) private contractors are anticipated to use the facilities within the farm shed once a week, with the two (2) property owners intermittently using the farm shed on weekends for property use and maintenance. The farm shed will not be utilised for living / accommodation purposes. Potable water is to be provided by on-site (tank) supply.

A flow allowance of 43L/person/day has been applied for staff using the farm shed facilities, based on Annexure 3 of NSW Health (2001) for ‘factories and offices with WC, urinal, basin, shower and kitchen facilities.

The design hydraulic load associated with the proposed farm shed is presented in the following table.

Parameter	Value	Comment / Source
Site Attendance	4	Maximum number of people using the facilities on site per day.
Flow Allowance (L/EP/day)	43	Factories and offices with WC, urinal, basin, shower and kitchen facilities (NSW Health, 2001)
Design Hydraulic Load (L/day)	172	4EP x 43L/EP/day

4.2 Wastewater Quality

The contaminants in 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 by the proposed farm shed is expected to be of 'typical' domestic nature, with combined wastewater; blackwater (toilet), and greywater (kitchen 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 %
Daily Flow	N/A	65	35
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 Proposed Wastewater Treatment

Based on the site and soil constraints, specifically shallow and slowly permeable soils, 'primary' treatment systems (i.e. septic tanks) are not typically recommended.

However, given the low-level and infrequent usage anticipated from the proposed farm shed, W&A support the use of a 'primary' treatment system if combined with storage and pressurised effluent distribution methods.

5.1 Recommended Treatment System

Primary treatment systems (i.e. septic tanks) are suitable for low-flow situations as they rely on anaerobic processes to treat generated wastewater to a 'primary' standard.

NSW Health provides accreditation for domestic primary treatment systems in NSW. The selected system must hold such an accreditation. A detailed list of NSW Health accredited primary treatment systems can be found at:

Septic tanks and collection wells - Single domestic waste water management (nsw.gov.au)

Final system selection will be responsibility of the Client. The selected treatment system must be installed by a certified plumber having experience with OSSM systems and be inspected at the recommended intervals and pumped out as necessary.

5.1.1 Septic Tank Sizing

Annexure 2 of NSW Health (2016) requires septic tanks to be sized to provide 24-hours of settling volume and an allowance for accumulation of sludge. The guideline required a minimum septic tank sludge accumulation allowance of 1,550L.

Based on the design hydraulic load, the proposed farm shed has an Equivalent Population of ~1EP (172L/day / 150L/EP/day, rounded). A sludge accumulation rate of 80L/EP/year has been assumed, as per NSW Health (2016), resulting in an annual sludge accumulation of 80L/year (1EP x 80L/EP/year).

Based on a 19 year desludge frequency (1,550L / 80L/year) and design hydraulic load of 172L/day, a minimum septic tank volume of 1,800L is recommended to service the proposed farm shed (1,550L + 172L/day, rounded).

An effluent filter must be installed within the outlet of the septic tank to minimise solids transfer to subsequent OSSM components. The effluent filter must be inspected every three (3) months and cleaned as required.

Final system selection will be the responsibility of the Client; however, selection and installation of the system must follow Council requirements and consistently achieve the prescribed minimum primary effluent quality standard (refer Section 5.1.2).

5.1.2 Treated Effluent Quality

The expected effluent quality of an appropriately operated and managed primary (septic) treatment system is provided in the following table, based on NSW DLG (1998).

Parameter	Loading
Biochemical Oxygen Demand	150mg/L
Suspended Solids	50mg/L
Faecal Coliforms	10^5 – 10^7 cfu/100mL
Total Nitrogen	≤60mg/L
Total Phosphorus	≤15mg/L

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

5.2 System Siting

The exact positioning of the proposed treatment system components 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. All plumbing and drainage works must be completed in accordance with the Plumbing Code of Australia (2022) and *AS/NZS 3500.2*.

5.3 System Operation and Management

Successful performance of the treatment system relies on periodic monitoring and maintenance, which will be the responsibility of the Client. In accordance with *AS/NZS 1547:2012*, the proposed septic tank will require de-sludging every 19-years.

6 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 5, primary treatment is considered the most appropriate wastewater treatment option for the proposed farm shed.

6.1 LAA Options

W&A have considered the suitability of various land application systems for the proposed farm shed. In determining the suitability of the various options, W&A have assessed the site and soil 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 primary treatment system (septic tank).

Land Application Option	Suitable	Reasoning
Absorption Trenches / Beds	No	Not supported due to shallow and slowly permeable soils (*AS/NZS 1547:2012*; Table L1).
ETA Beds		Considered unsuitable for primary effluent in Cat 6 soils
Mounds	Possible	Considered suitable; however, discounted due to substantial cost and availability of more suitable alternatives.
Low-pressure Effluent Distribution Irrigation	Yes	Considered suitable for primary effluent quality with effluent storage and pressurised distribution, based on the site and soil conditions
Surface Irrigation	No	Considered unsuitable for primary effluent
Subsurface Irrigation		

Based on the analysis, Low-pressure Effluent Distribution irrigation (LPED) is considered the most appropriate effluent management method for the Site. A description of the proposed LAA is provided in the following sections.

6.2 Pump Well

Primary effluent is to drain from the septic tank into a pump well to allow for pressure dosing of effluent to the proposed LAA.

Annexure 2 of NSW Health (2016) recommends a single-pump installation where the available pump well volume can achieve a minimum of two (2) days of effluent storage. Based on best practice, one (1) day of emergency effluent storage should also be provided. Therefore, a minimum pump well volume of 520L is required (172L/day x 3-days, rounded).

The pump well is to be fitted with an audible / visual high-water alarm and float operated submersible effluent pump to transfer effluent to the proposed LAA. It is important to ensure that the pump installed in the pump well is capable of managing 'duty' requirements. A standard drawing of a pump well is provided in Figure 3 of Appendix A

6.3 Buffers

Buffer distances are recommended to provide a form of mitigation against unidentified hazards and reduce potential pathways of human and environmental exposure. The following environmental buffers are required for primary LPED LAAs, based on Table 5 of NSW DLG (1998) and Table 37 of MCC DAF (2020):

- 250m from domestic GW bores;
- 100m from permanent waterways;

- 40m from intermittent waterways and other waters;
- 12m if area up-gradient and 6m if area down-gradient of property boundaries;
- 6m if area up-gradient and 3m if area down-gradient of driveways, swimming pools and buildings; and
- 0.6m vertical separation from hardpan or bedrock.

All of the recommended buffers can be achieved at the Site except for the 0.6m vertical setback from hardpan / bedrock. This buffer can be achieved with the importation of topsoil material (refer Section 7.1.1).

6.4 LAA Sizing

Water and nutrient balance modelling was undertaken to determine the sustainable application rate for the Site soils and to estimate the necessary size of the LAA required to manage the assumed hydraulic and nutrient loads from the proposed farm shed. The procedures for this generally follow 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 determined the 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 LAA required to ensure nutrients (nitrogen and phosphorus) are removed from the effluent via assimilation within the soil strata and uptake by the overlying crop. The nutrient balance used here is based on the simplistic NSW DLG (1998) methodology 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 Hydraulic Load	L/day	172	Refer Section 4.1
Precipitation	mm/month	Median monthly	Craven (Longview) [060042]
Pan Evaporation	mm/month	Mean monthly	SILO Point Data (-32.20, 151.95)
Retained Rainfall	Unitless	0.80	Conservative assumption that 80% of rainfall remains on-site and infiltrates the soil
Crop Factor	Unitless	0.6 – 0.8	Conservative annual value for grasses (adjusted for seasons)
Design Loading Rate	mm/day	2	Table M1 of *AS/NZS 1547:2012* for irrigation systems in Cat 6 soils

Parameter	Units	Value	Comments
Effluent Total Nitrogen Concentration	mg/L	60	Refer Section 5.1.2
Effluent Total Phosphorus Concentration	mg/L	15	
Nitrogen Lost to Soil Processes	annual percentage	20	Geary and Gardner (1996)
Soil Phosphorus Sorption Capacity	mg/kg	344	eSpade Technical Report (WEL/96/143/150(1)) on wd soil landscape (refer Appendix B)
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 (nutrient management)	Years	50	Reasonable service Life for system (NSW DLG 1998)
Results			
Hydraulic balance (m²)	146		
Nitrogen balance (m²)	116		
Phosphorus balance (m²)	160		

Based on the hydraulic and nutrient modelling outcomes, the nutrient load is the limiting factor for sizing the required LAA.

W&A recommend that the proposed LAA be sized on the minimum hydraulic requirements as there is sufficient area to allow for a nutrient buffer from the proposed LAA to any sensitive features. Therefore, a minimum LAA of <u>150m^2</u> (rounded) is recommended to service the proposed farm shed.

Modelling results indicate that a (minimum) nutrient buffer of 10m^2 is required (160m^2 – 150m^2). This area should be maintained in the adjacent and downslope area of the LAA footprint to assimilate excess nutrients within the surrounding soils and pasture. The required nutrient buffer is shown on Figure 2, Appendix A

6.5 LAA Design and Construction

A detailed land application system and design is beyond the scope of this WMR; however, this should be prepared upon receipt of development approval and before installation of the OSSM system. The detailed design should be undertaken by a specialist Contractor experienced with wastewater applications.

Distribution pipes for the LPED LAA are to be laid in shallow (200mm x 200mm) trenches at maximum 1m centres. The recommended length of distribution laterals serviced by pressure (pump) distribution is ~25m.

The proposed LPED LAA shall comprise six (6) distribution laterals of 25m length and 30mm diameter. The LPED trenches should be installed 200mm below the existing ground surface and covered with a mounded topsoil capping layer to finish (~100mm).

A minimum depth of 600mm of soil is to exist from the point of effluent application (LPED laterals) to the limiting layer (weathered parent material). As this separation cannot be achieved at the Site, the addition of topsoil material to the proposed LAA footprint is recommended (refer Section 7.1.1).

Each distribution lateral should be sleeved with 100mm slotted PVC pipe or ag pipe with manual flush valves (in valve boxes) fitted to the terminal end to allow for manual flushing of each line. A standard design feature and construction notes for LPED systems is provided in Figure M3 of *AS/NZS 1547:2012* and reproduced as Figure 4 in Appendix A.

6.6 Effluent Distribution

AS/NZS 1547:2012 recommends 'special' distribution techniques be employed in clay soils to ensure even distribution of effluent over the full design surface of the LAA.

Pressure dosing optimises LAA performance by maximising effluent distribution and resting time between doses. Distribution between individual laterals should be achieved by a hydraulic indexing valve (or similar) to sequentially direct effluent to two (2) LPED lines during each pump cycle. Manual flush valves (in a valve box) must be fitted to the terminal end of each distribution manifold to ensure fouling of the laterals does not occur.

All pipework must be buried at a minimum depth of 300mm under the ground surface, increasing to 500mm under trafficable surfaces to ensure pipework is not damaged.

6.7 Reserve LAA

As per Council requirements, the provision of a 100% reserve LAA is achievable within the available EMA (refer Figure 2, Appendix A).

6.8 LAA Positioning

Available areas for effluent application are shown in Figure 2 of Appendix A as 'Available EMA'. These areas exclude minimum buffer distances as detailed in Section 6.3. A nominal proposed LAA location has been presented in Figure 2 of Appendix A.

7 Mitigation Measures

7.1 Soil Improvement

7.1.1 Soil Depth

Shallow soil profiles are identified throughout the available EMA. To ensure the minimum 600mm vertical separation from the limiting layer (weathered parent material), it is recommended the 300mm of good quality topsoil material (sandy loam or clay loam) is applied throughout the LAA footprint prior to installation. Locally won or imported clean topsoil material should be used and blended appropriately with the natural LAA soils.

The following installation procedure is recommended.

- Scarify (lightly till) the proposed LAA footprint;
  - Incorporate proposed soil amendments (refer Section 7.1.2);
- Add 200mm of good quality topsoil material to the LAA footprint;
- Install LPED system within the imported soil material;
- Cover with ~100mm of good quality topsoil material;
- Finish perimeter of 'raised' LAA with a 3 (horizontal): 1 (vertical) batter slope; and
- Vegetate with a suitable groundcover species (refer Section 7.3).

This will ensure that the LPED LAA meets the required 600mm setback to the limiting layer.

7.1.2 Soil Chemistry

Given that Site soils are unstable, dispersive and potentially sodic with low fertility, there is a potential risk of impaired vegetation growth and soil permeability. These properties can combined to reduce the soils capacity to sustainably manage wastewater. Prolonged application of sodium rich wastewater can exacerbate the situation.

Application of calcium mineral is a recognised way of reducing the previously mentioned limitations. It does this by supplying calcium to the affected soil and thereby elevating calcium concentrations with respect to sodium. Added calcium will improve the soil CEC and Ca/Mg ration, improving fertility, while reducing the potential for soil structural degradation. Gypsum is the preferred soil amendment for improving soil fertility via raising calcium levels.

Gypsum is 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 during construction of the land application system. This can be done by shallowing ripping of the natural soil and applying the gypsum. A suitable gypsum application rate of approximately $0.2 kg/m^2$ is recommended.

7.2 Stormwater Management

The performance of treatment systems and LAAs 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 treatment system and absorption bed LAA. The structure(s) 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.

7.3 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.

8 Conclusions and Recommendations

This completes our assessment of the Site's capability for sustainable OSSM in relation to the proposed farm shed at 2411 The Bucketts Way, Wards River NSW. Specifically, W&A recommend the following:

- Generated wastewater from the proposed farm shed (172L/day) will be treated to a primary standard in a (minimum) 1,800L NSW Health accredited septic tank, fitted with an effluent outlet filter;
- Primary effluent will drain into a (minimum) 520L pump well fitted with an audible / visual high-water alarm and float operated submersible (vortex) effluent pump;
- Primary treated effluent is to be reused on-site via a 'raised' LPED LAA with a minimum area of $150m^2$;
    - The proposed LPED LAA shall comprise six (6) distribution laterals of 25m;
    - A hydraulic indexing valve (or similar) is to be implemented;
    - A $10m^2$ nutrient buffer is to be maintained adjacent and downslope of the proposed LAA ro assimilate excess nutrients;
    - The proposed LAA footprint must include the importation of 300mm of good quality topsoil material with a 3 (horizontal): 1 (vertical) batter slope around the raised LAA;
- The LAA should be designed and installed by an experienced professional, considering the expected flows and other recommendations contained within this report;
- The proposed LAA must be located within the available EMA specified to comply with adopted setbacks;
- A suitable diversion device should be installed upslope of the LAA to divert stormwater away from the LAA;
- A suitable gypsum application rate of approximately $0.2kg/m^2$ is advised to be applied at the base of the absorption system prior to LAA installation;
- Suitable vegetation such as turf must be established over the LAA immediately after installation; and
- Vehicles and grazing animals must be prevented from entering the designated LAA.

Yours Sincerely,

Sophie Grossenbacher

Graduate Environmental Consultant
Whitehead and Associates Environmental Consultants Pty Ltd

Appendix A

Figures

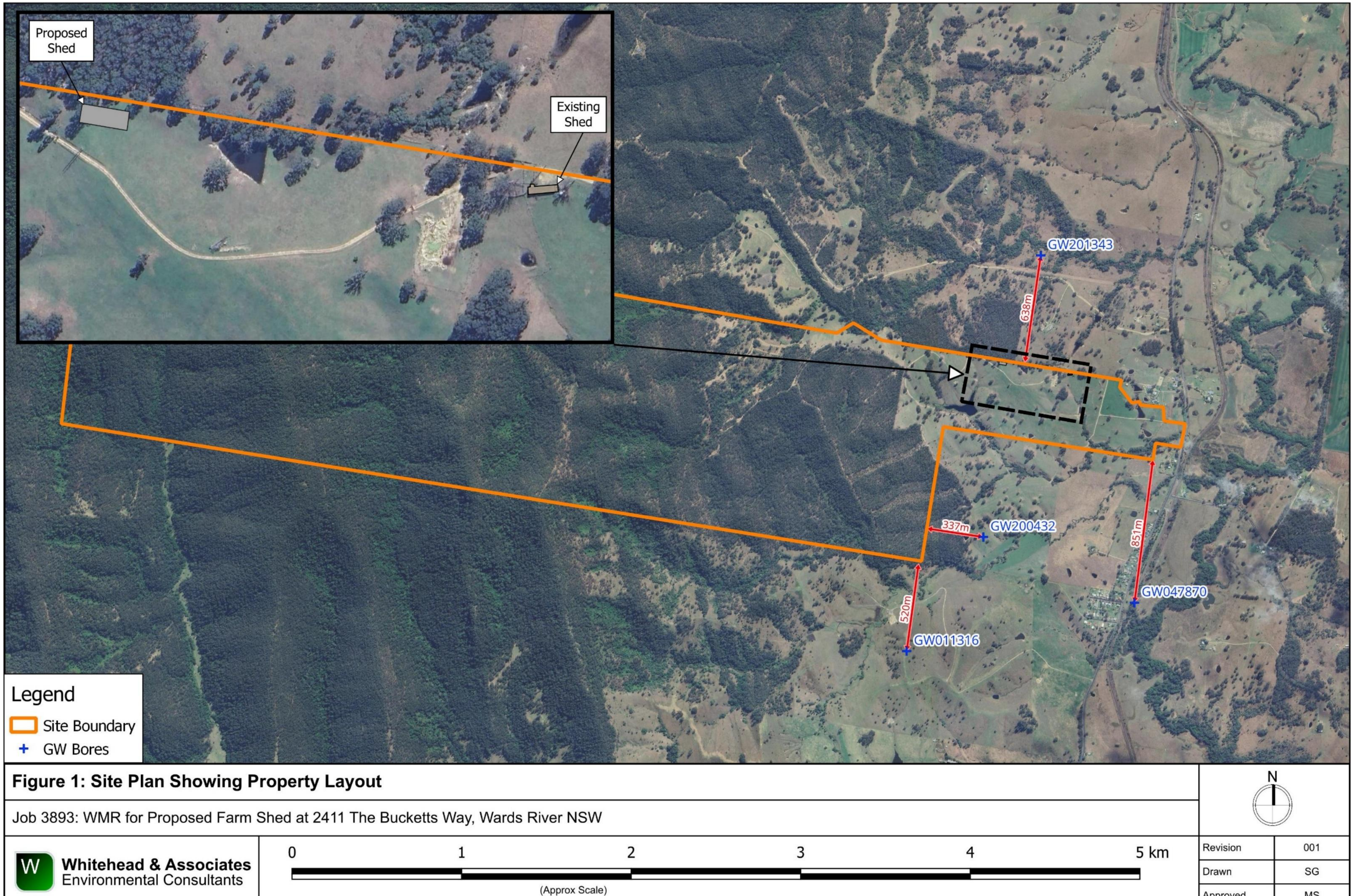

Figure 1: Site Plan Showing Property Layout

Job 3893: WMR for Proposed Farm Shed at 2411 The Bucketts Way, Wards River NSW

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Revision	001
Drawn	SG
Approved	MS

Figure 2: Site Plan Showing Proposed OSSM

Job 3893: WMR for Proposed Farm Shed at 2411 The Bucketts Way, Wards Rivers NSW

N

Whitehead & Associates Environmental Consultants

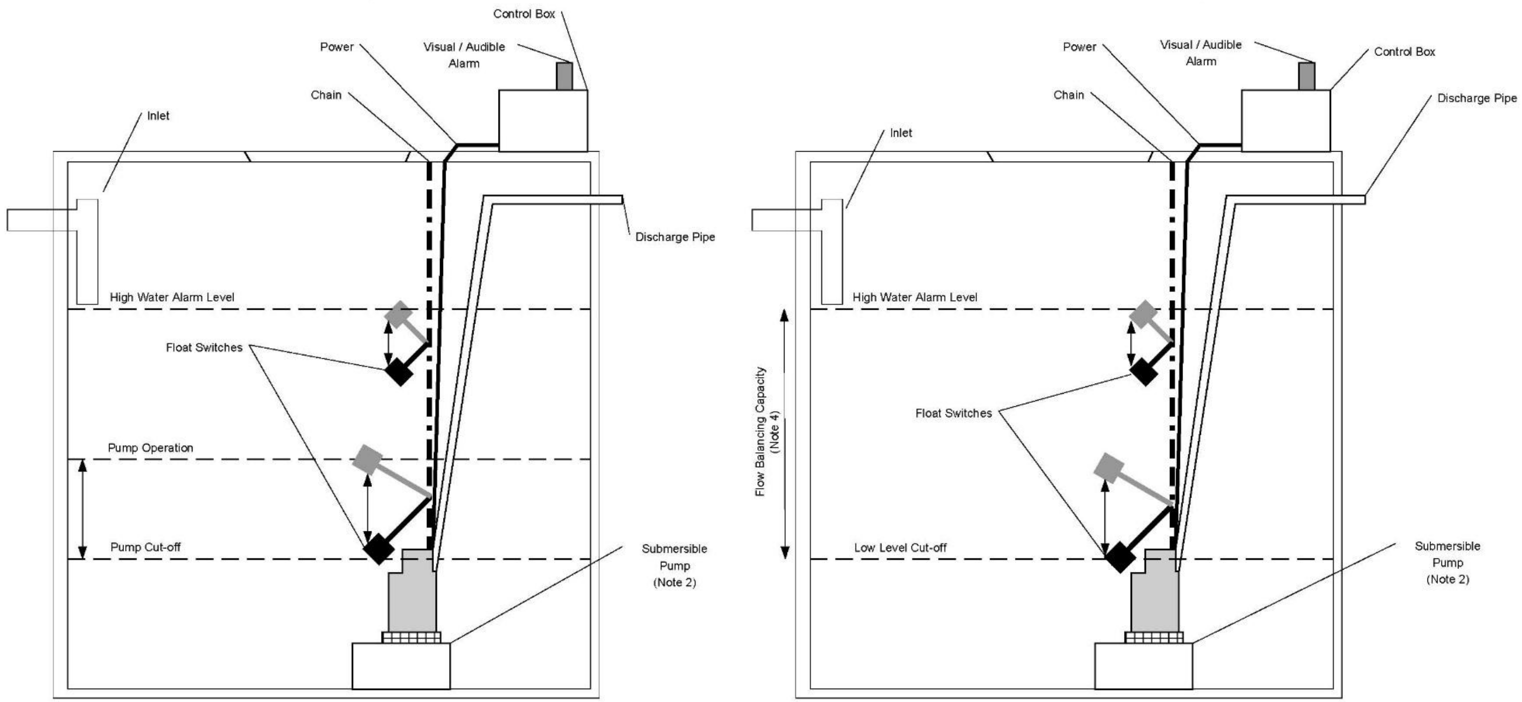
0 40 80 120 160 m

(Approx Scale)

Revision	001
Drawn	SG
Approved	MS

Demand Dose Pumpwell

Timed Dose Pumpwell



Notes

1. The depth of effluent pumped within each cycle of the float switch (i.e. the depth between Pump Cut-off and operation) is calculated by:
   Depth of pumped effluent (m) x tank area (m^2) x 1,000 = discharge volume (L per pump cycle)

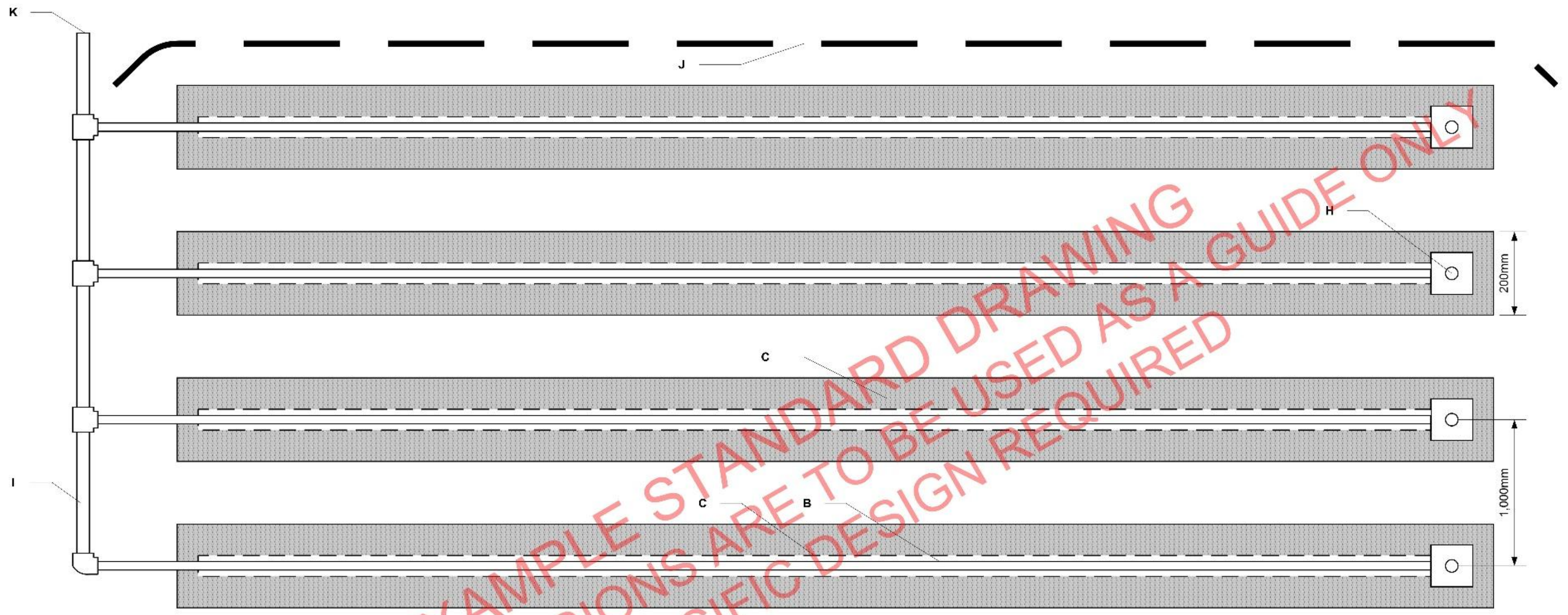
2. Submersible pump used as an example only. The pump will need to be selected based on the specific task. May be a centrifugal pump, vortex pump or grinder pump. The type of effluent being pumped and the hydraulic characteristics of the system. May sit on top of the tank and draw effluent from the tank.

3. Submersible pump must not be removed from a tank by their power cord. Heavier pumps may require the installation of a solid steel bar configuration in accordance with manufacturers specifications.

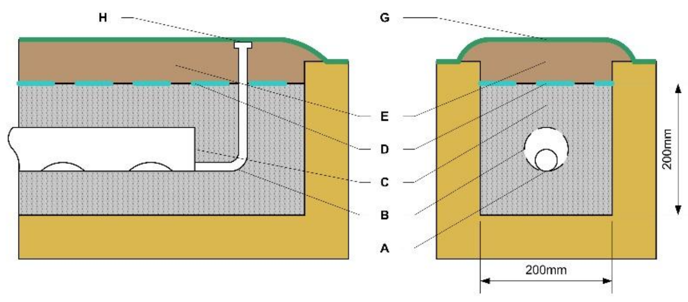
4. Tank must be large enough to buffer peak loads without levels exceeding the high level alarm. Tank is also to be sized to ensure that the volume of storage in the tank reaches the low-level cut-off at least once a every week

Whitehead & Associates Environmental Consultants	**Figure 3:** **Standard Drawing** **Pump Well**	Project: 3839 Drawn: SG Approved: MS Scale: NTS

Plan View



Cross Section



LPED Irrigation Construction

- **A** Pressurised dosing manifold consisting of 25-30mm PVC pipe with 3-5mm holes drilled (deburred) at 400-600mm centres facing upwards. The total number and length of laterals will be determined by the required irrigation area (m^2) and the lateral spacing's shown in this drawing.
- **B** 100mm slotted PVC or 90mm agricultural pipe over manifold laterals.
- **C** 20-40mm distribution aggregate.
- **D** Geotextile filter cloth.
- **E** Clean local or imported topsoil (sandy loam to clay loam).
- **G** Grass must be established across the construction area as soon as possible. Irrigation area surface should be slightly mounded.
- **H** Individual flush points for each lateral. May be a screw cap fitting on a 90 degree elbow level with the filter surface or a pressure controlled flush valve inside an irrigation control box. Manual flushing should be carried out annually.
- **I** 40mm PVC dosing manifold. Larger systems may require different pipe sizes and orifice reducers at lateral connection points.
- **J** Upslope stormwater diversion drain, subsoil drainage may be necessary on select sites.
- **K** Pressure dosed effluent from treatment system / pump well. The pump must be capable of delivering the total flow rate required for all laterals whilst providing a 1.5m residual head (i.e. squirt height) at the highest orifice (with no more than 15% variation in squirt height across the whole bed). For individual laterals less than 10m long, it is acceptable to adopt a flow rate of 3.5-4L/min/lineal metre. Total dynamic head (including friction loss) will need to be determined on a site-specific basis.

Whitehead & Associates Environmental Consultants	**Figure 4:** **Low-pressure Effluent Distribution Irrigation Standard Drawing**	**Project: 3893** **Drawn: SG** **Date: 05/05/2025** **Scale: Not to scale**

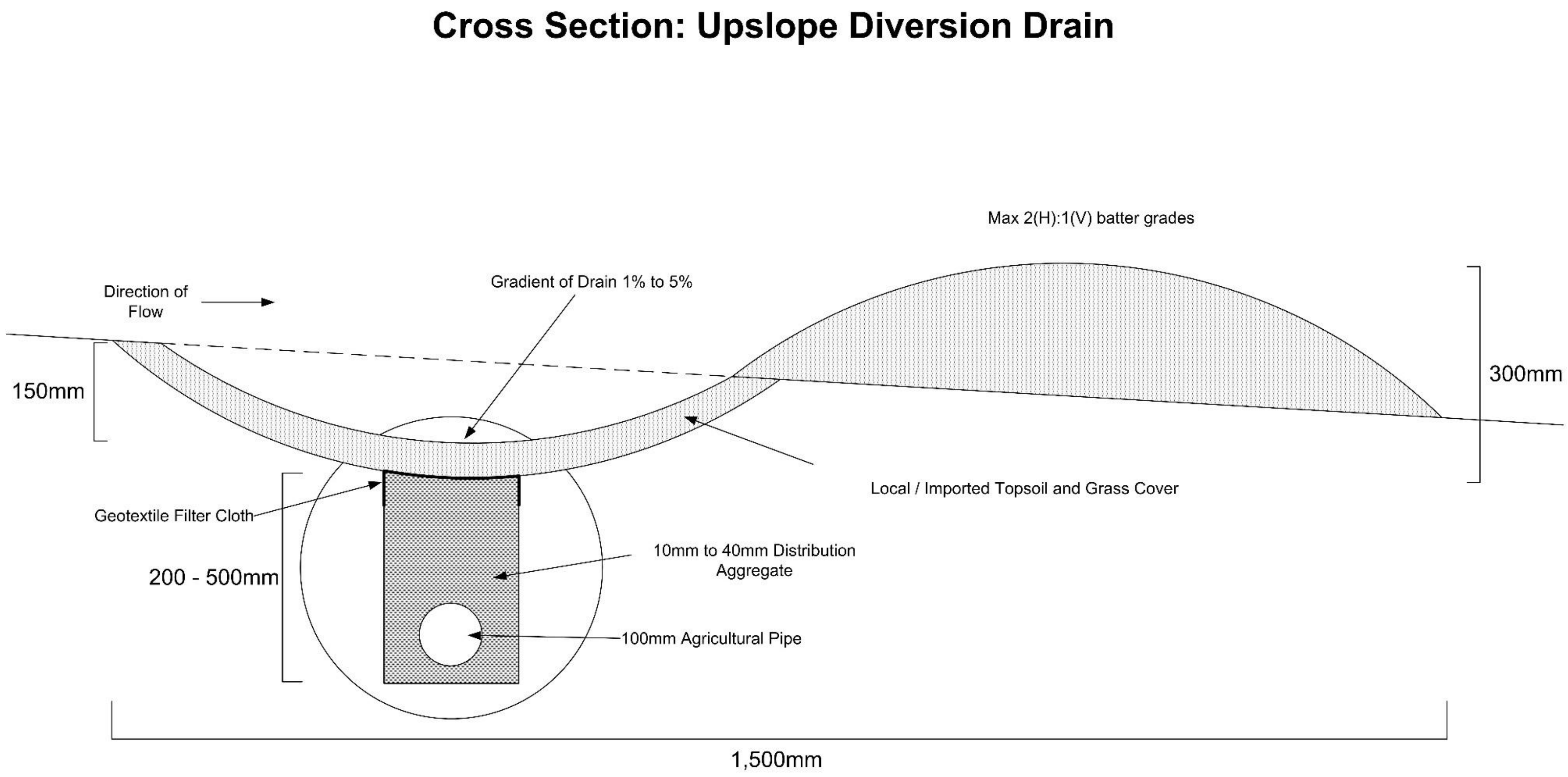


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Figure 5:
Standard Drawing of an Upslope Diversion Drain

Project: 3893
Drawn: SG
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

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Environmental Consultants

Client:	Caitlin O'Brien	**Test Pit No:**	**BH1**
Site:	2411 The Bucketts Way, Wards River NSW	Excavated/logged by:	SG
Date:	15 April 2025	Excavation type:	Auger & crowbar
Notes:	- refer to site plan for position of test pit - Burraduc Soil Landscape		

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	CL	Weak	Brown		< 2%		SM	
0.2											
0.3		BH1/2	B1	MC	Moderate	Light Brownish Grey	Orange	10 - 20%	20-60mm	SM	
0.4											
0.5											
0.6		BH1/3	B2	LC	Weak	Yellowish Brown		< 2%		D	
0.7	Borehole terminated on parent material										
0.8											
0.9											
1.0											
1.1											
1.2											
1.3											
1.5											

Soil Bore Log

Whitehead & Associates
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Client:	Caitlin O'Brien	**Test Pit No:**	**BH2**
Site:	2411 The Bucketts Way, Wards River NSW	Excavated/logged by:	SG
Date:	15 April 2025	Excavation type:	Auger & crowbar
Notes:	- refer to site plan for position of test pit - Burraduc Soil Landscape		

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	A1	L	Moderate	Very Dark Grey		10 - 20%	20-60mm	SM	
0.2											
0.3		BH2/2	A2	SCL	Weak	Brown		< 2%		D	
0.4											
0.5		BH2/3	B	MC	Moderate	Light Yellowish Brown	Orange	< 2%		D	
0.6											
0.7	Borehole terminated on parent material										
0.8											
0.9											
1.0											
1.1											
1.2											
1.3											
1.5											

Soil Bore Log

Whitehead & Associates
Environmental Consultants

Client:	Caitlin O'Brien	**Test Pit No:**	**BH3**
Site:	2411 The Bucketts Way, Wards River NSW	Excavated/logged by:	SG
Date:	15 April 2025	Excavation type:	Auger & crowbar
Notes:	- refer to site plan for position of test pit - Burraduc Soil Landscape		

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		BH3/1	A	CL	Weak	Very Dark Brown		2 - 10%	6-20mm	SM	
0.2											
0.3		BH3/2	B1	MC	Moderate	Light Yellowish Brown	Orange	< 2%		D	
0.4											
0.5											
0.6		BH3/3	B2	LC	Moderate	Light Yellowish Brown	Orange	< 2%		D	
0.7											
0.8	Borehole terminated on parent material										
0.9											
1.0											
1.1											
1.2											
1.3											
1.5											

SOIL BORE LOG

Whitehead & Associates
Environmental Consultants

Client:	Caitlin O'Brien	**Test Pit No:**	**BH4**
Site:	2411 The Bucketts Way, Wards River NSW	Excavated/logged by:	SG
Date:	15 April 2025	Excavation type:	Auger & crowbar
Notes:	- refer to site plan for position of test pit - Burraduc Soil Landscape		

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		BH4/1	A	SiL	Moderate	Very Dark Grey		< 2%		SM	
0.3 0.4 0.5		BH4/2	B	MC	Moderate	Light Brownish Grey	Orange	< 2%		SM	
0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.5	Borehole terminated on hardpan										

SOIL BORE LOG

Whitehead & Associates
Environmental Consultants

Client:	Caitlin O'Brien	**Test Pit No:**	**BH5**
Site:	2411 The Bucketts Way, Wards River NSW	Excavated/logged by:	SG
Date:	15 April 2025	Excavation type:	Auger & crowbar
Notes:	- refer to site plan for position of test pit - Burraduc Soil Landscape		

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		BH5/1	A	L	Moderate	Very Dark Grey		2 - 10%	20-60mm	SM	
0.2											
0.3		BH5/2	B	SCL	Moderate	Brown	Orange & Yellow	< 2%		SM	
0.4											
0.5											
0.6	Borehole terminated on hardpan										
0.7											
0.8											
0.9											
1.0											
1.1											
1.2											
1.3											
1.5											

Job 3893: 2411 The Bucketts Way, Wards River NSW

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]
BH1	1/1	250	CL	2(1)	Mod-High	n/a	8.08	Moderately alkaline	14	0.12	Non-saline	
	1/2	500	MC	2(1)	Mod-High	n/a	7.39	Mildly alkaline	34	0.26	Non-saline	
	1/3	600	LC	2(1)	Mod-High	n/a	7.45	Mildly alkaline	32	0.28	Non-saline	
BH2	2/1	250	L	3(1)	Slight	n/a	7.12	Neutral	28	0.27	Non-saline	
	2/2	400	SL	2(1)	Mod-High	n/a	7.65	Mildly alkaline	19	0.27	Non-saline	
	2/3	600	MC	2(1)	Mod-High	n/a	7.21	Neutral	36	0.27	Non-saline	
BH3	3/1	200	CL	3(1)	Slight	n/a	7.57	Mildly alkaline	14	0.12	Non-saline	
	3/2	500	MC	2(1)	Mod-High	n/a	7.38	Mildly alkaline	49	0.37	Non-saline	
	3/3	700	LC	2(1)	Mod-High	n/a	7.28	Neutral	118	1.01	Non-saline	
BH4	4/1	200	SiL	3(2)	Slight	n/a	7.36	Mildly alkaline	28	0.27	Non-saline	
	4/2	500	MC	2(1)	Mod-High	n/a	7.39	Mildly alkaline	29	0.22	Non-saline	
BH5	5/1	200	L	3(2)	Slight	n/a	7.29	Neutral	25	0.24	Non-saline	
	5/2	500	SCL	2(1)	Mod-High	n/a	7.57	Mildly alkaline	23	0.20	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

WEL/96/143/150(1)

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
eSpade	0.2-0.5	12.2	M	80	VL	660	H	138	M	312	H	8.2	S	344	MH

Notes:- (also refer Interpretation Sheet 2)

n/a
n/t

Appendix C

Water and Nutrient Balance

Irrigation Area Water Balance & Storage Calculations

Whitehead & Associates
Environmental Consultants

Site Address: 3839: 209 Old Maitland Road, Mardi NSW

INPUT DATA

Design Wastewater Flow	Q	172	L/day	Total daily wastewater flow
Design Irrigation Rate	DIR	2.0	mm/day	Litres/m^2/day - based on Table M1 AS/NZS 1547:2012; Cat 6 soil and primary effluent
Available Land Application Area	L	150	m^2	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	0.8	unitless	Proportion of rainfall that remains onsite and infiltrates; function of slope/cover, allowing for any runoff
Rainfall Data		Craven (Longview) - 060042		Median Monthly data (64 years)
Evaporation Data		SILO Data -32.20, 151.95 -		Mean Daily Evaporation (60 years)

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	31	30	31	30	31	31	30	31	30	31	31	28	31	30	31	30	**546**
Rainfall	R		mm/month	102.3	112.6	119.6	56.6	50.0	70.9	27.0	24.4	39.0	60.2	82.0	87.1	102.3	112.6	119.6	56.6	50.0	70.9	**1093.0**
Evaporation	E		mm/month	172.0	135.7	119.5	86.8	64.8	53.3	61.8	86.8	115.5	143.1	153.4	178.6	172.0	135.7	119.5	86.8	64.8	53.3	**1371.3**
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	137.6	108.6	83.6	52.1	38.9	32.0	37.1	52.1	80.9	114.4	122.7	142.9	137.6	108.6	83.6	52.1	38.9	32.0	**1002.8**
Percolation	B	DIRxD	mm/month	62.0	56	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	**730.0**
Outputs		ET+B	mm/month	199.6	164.6	145.6	112.1	100.9	92.0	99.1	114.1	140.9	176.4	182.7	204.9	199.6	164.6	145.6	112.1	100.9	92.0	**1732.8**
INPUTS (GAINS)																						
Retained Rainfall	RR	RxRC	mm/month	81.8	90.1	95.7	45.3	40.0	56.7	21.6	19.5	31.2	48.2	65.6	69.7	81.84	90.08	95.68	45.28	40	56.72	**665.36**
Effluent Irrigation	W	(QxD)/L	mm/month	35.5	32.1	35.5	34.4	35.5	34.4	35.5	35.5	34.4	35.5	34.4	35.5	35.5	32.1	35.5	34.4	35.5	34.4	**418.5**
Inputs		RR+W	mm/month	117.4	122.2	131.2	79.7	75.5	91.1	57.1	55.1	65.6	83.7	100.0	105.2	117.4	122.2	131.2	79.7	75.5	91.1	**1083.9**
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	-82.2	-42.4	-14.4	-32.4	-25.3	-0.9	-41.9	-59.0	-75.3	-92.7	-82.7	-99.7	-82.2	-42.4	-14.4	-32.4	-25.3	-0.9	
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																		
Storage Volume required	V	(NxL)/1000	m^3	0																		
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	45	65	107	77	88	146	69	56	47	42	44	39	45	65	107	77	88	146	

MINIMUM AREA REQUIRED FOR ZERO STORAGE: 146 m^2

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

3839: 209 Old Maitland Road, Mardi NSW

Please read the attached notes before using this spreadsheet.

SUMMARY - LAND APPLICATION AREA REQUIRED BASED ON THE MOST LIMITING BALANCE = 160 m^2

INPUT DATA [1]

Wastewater Loading			Nutrient Crop Uptake					
Hydraulic Load	172	L/day	Crop N Uptake	260	kg/ha/yr	which equals	71.23	mg/m^2/day
Effluent N Concentration	60	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	2,064	mg/day	P-sorption result	344	mg/kg	which equals	2,890	kg/ha
Remaining N Load after soil loss	8,256	mg/day	Bulk Density	1.4	g/cm^3			
Effluent P Concentration	15	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			Determination of Buffer Zone Size for a Nominated Land Application Area (LAA)		
Nitrogen	116	m^2	Nominated LAA Size	150	m^2
Phosphorus	160	m^2	Predicted N Export from LAA	-0.89	kg/year
			Predicted P Export from LAA	0.06	kg/year
			Phosphorus Longevity for LAA	44	Years
			Minimum Buffer Required for excess nutrient	10	m^2

PHOSPHORUS BALANCE

STEP 1: Using the nominated LAA Size

Nominated LAA Size	**150**	m^2			
Daily P Load	0.00258	kg/day	→ Phosphorus generated over life of system	47.085	kg
Daily Uptake	0.0012329	kg/day	→ Phosphorus vegetative uptake for life of system	0.150	kg/m^2
Measured p-sorption capacity	0.28896	kg/m^2			
Assumed p-sorption capacity	0.144	kg/m^2	→ Phosphorus adsorbed in 50 years	0.144	kg/m^2
Site P-sorption capacity	21.67	kg	→ Desired Annual P Application Rate	0.883	kg/year
			which equals	0.00242	kg/day
P-load to be sorbed	0.49	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 Soil Chemistry 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.