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On-Site Wastewater Management Report for Eco Tourist facility at 851 Wang Wauk Rd, Wang Wauk NSW

Whitehead & Associates Environmental Consultants Pty Ltd ("W&A") were engaged by Adam Eckersley (the "Client" or "Owner") to prepare an On-site Wastewater Management Report (WMR) for a proposed Eco Tourist facility at 851 Wang Wauk Rd, Wang Wauk NSW (the "Site"). The Site, identified as Lot 43 DP263785, is approximately 40ha in area and is zoned RU1 (primary production) under the Greater Taree LEP (2010).

The Site is bound by private rural properties to the north and west, Wang Wauk Road to the east and Stevens Close to the south. Site usage is mixed residential/tourism with existing improvements including a shed used for residential purposes, a shed used for the eco-tourism component and 20 short-term accommodation units. The Site is predominantly cleared with native vegetation present in steeper areas and along intermittent drainage channels and Bulby Creek, which traverses through the Site. The Site is moderately bushfire prone and includes a number of dams connected by intermittent drainage channels draining to Bulby Creek. No flood data is available for the Site however, as per Client, large rain events cause relative surging of Bulby Creek and as such, the Site is taken as marginally flood-impacted.

Two (2) separate on-site sewage management (OSSM) systems are installed at the Site. The 'upper' system (hereafter OSSM1) services the residential shed and future dwelling. The 'lower' system (hereafter OSSM2) services the eco-tourism installation. Both systems were installed by a local plumbing contractor (Aquatech P/L). OSSM1 has an approval to operate (OSSM009464), expiring December 2024.

We understand MidCoast Council ("Council") require the preparation of a WMR to assess the sustainability of both OSSM systems installed at the Site under existing and proposed development conditions. 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, including:

- 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 Introduction

The following table summarises information of the Site investigated.

Feature	Description
Site Address	851 Wang Wauk Rd, Wang Wauk NSW
Lot / DP	Lot 43 DP263785
Local Government Area	MidCoast Council (Manning Region)
Land Zoning	RU1 (primary production)
Lot Size	~40ha
Sewer Connection Available	No
Potable Water Supply	Roof (tank) water supply

2 Development Context

Site improvements include both residential and eco-tourism components, described as follows.

2.1 Residential Buildings

In June 2019 development consent (448/2019/DA) was received for the construction of a residential dwelling on the property. To support the build the Owner constructed a machinery shed which included a bathroom and WC. It is understood the Owner has been living in the 'residential shed' while the approved dwelling is being constructed. OSSM1 was constructed to accept wastewater generated from the shed.

Plans provided (dwg: DACC 06, Mar 2019) show the proposed dwelling will have 4-bedrooms and will be constructed immediately downslope of the residential shed, with gravity drainage achievable to OSSM1.

We are advised that the residential shed will be repurposed as a 'Managers Residence'. Plans provided (Job no. 2023-023, Apr 2024) show a 3-bedroom dwelling which will be occupied by a live-in Manager who will attend to operations of the Eco Tourist facility.

2.2 Eco Tourist Facility

The Owner currently operates an eco-tourism business at the Site (described as 'Hang at The Wang' (HATW) which provides public guests an overnight experience including live music; food and basic accommodation. For assessment purposes, the HATW experience is described as a limited-attendance 'function'. The Client advises up to 20 functions per year, occurring exclusively from Saturday afternoon to Sunday noon. The annual function period is predominantly over winter months beginning in May (May – October).

During each function, live music is performed throughout the evening. Function activities take place in a lower terrace area of the property, as shown in plans (Job no. 2023-023, Sheets 1-2, Apr 2024), comprising an eco-tourism shed; accommodation huts and recreation area.

Accommodation for up to 40 guests is provided in 20 huts. The huts are basic in form, with no power or reticulated (water or sewer) services connected. Each hut can accommodate two (2) guests in either a queen bed (14 huts) or two king-single (6 huts) arrangement. This equates to a peak attendance of 40 guests (20 huts x 2 EP) per function.

Guest meals are provided by a contract catering service, with all food prepared off-site. Meals are presented on-site and distributed to guests via a waiter. Function guests have access to a communal amenity block located near the eco-tourism shed, comprising three (3) WCs, one (1) shower and one (1) PWD toilet/shower.

Five (5) staff are also present during each function, comprising two (2) musicians; food waiter; caterer and a sound person.

All existing and proposed improvements are shown in Figures 2 and 3 at Appendix A.

3 Wastewater Generation

3.1 Wastewater Quantity

3.1.1 *Residential Buildings*

Wastewater generated from the residential buildings (dwelling and Manager's Residence) will be derived from full kitchen, bath, laundry and toilet facilities. As described, all wastewater from residential buildings will be managed via OSSM1, installed in the upper portion of the property. Potable water is provided by on-site (tank) water supply.

The following table summarises the expected hydraulic load to OSSM1.

Parameter	Value	Comment / Source
Number of Bedrooms	7 (total)	3-bedroom Managers Residence and 4-bedroom dwelling.
Occupancy Rate (persons per bedroom)	2 Equivalent Population (EP) for first two bedrooms, 1EP thereafter for each building	As per Council procedure
Design Occupancy (EP)	11EP	5EP + 6EP [(2-bed x 2EP + 1-bed x 1EP) + (2-bed x 2EP + 2-bed x 1EP)]
Flow Allowance (L/person/day)	120	Table H1; AS/NZS 1547:2012 for tank supply
Design Hydraulic Load (L/day)	**1,320**	11EP x 120L/person/day

The design hydraulic load expected from residential buildings to OSSM1 is 1,320L/day. This value is conservative and assumes that the dwelling will be fully occupied and the Managers Residence could potentially be occupied by up to 5 persons during peak periods.

3.1.2 *Eco Tourist Facility*

Wastewater generated from function use is expected to be from toilet and shower facilities only. As described, all wastewater from the communal amenity block is managed via OSSM2, installed in the lower terrace of the property.

Potable water is to be provided by on-site (tank) water supply. The following table summarises the expected hydraulic load from each function with reference to Section 2.2.

Parameter	Value	Comment / Source
Number of Attendees	40	Section 2.2
Flow Allowance (L/person/day)	54	Function attendees, based on 'Camping Grounds and/or Caravan Parks – WC, urinal, basin & shower' from Annexure 3 of NSW Health, 2001
Design Hydraulic Load (L/day)	2160	40 people x 54L/person/day
Number of Staff	5	Section 2.2
Flow Allowance (L/person/day)	30	Function staff, based on 'non-resident staff – Hotels/Motels' from Table H4 AS/NZS 1547:2012
Design Hydraulic Load (L/day)	150	5 staff x 30L/person/day
Total Design Hydraulic Load per function Saturday (L/day)	**2,310**	2,160L/day + 150L/day

3.2 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 Eco-tourism Facility is expected to be of 'typical' domestic nature, with combined wastewater; blackwater (toilet) and greywater (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		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

4 Site and Soil Assessment

A site and soil assessment was undertaken by Ben Colautti and Sophie Grossenbacher of W&A on 8 March 2024. The following tables present the results of the investigation.

A description of the Site 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 Tables 4 and 6 of NSW DLG (1998).

<table>
<tr><th colspan="5">SITE ASSESSMENT</th></tr>
<tr><th>Parameter</th><th colspan="2">Data / Observation</th><th>Reference</th><th>Classification / Outcome</th></tr>
<tr><td rowspan="2">Climate</td><td colspan="2">Temperate climate with median annual rainfall of 1016.6mm; minimum of 29.8mm (July) and a maximum of 137.8mm (March).</td><td>SILO Data - 32.15, 152.25</td><td rowspan="2">Minor limitation</td></tr>
<tr><td colspan="2">Mean annual evaporation of 1,405.9mm; rainfall exceeds potential evaporation for two (2) months of the year (June and March).</td><td>BOM Station: 060030</td></tr>
<tr><td colspan="3">Sizing</td><td colspan="2" rowspan="5">As per AS/NZS 1547:2012 and NSW DLG (1998) procedures</td></tr>
<tr><td colspan="2">Hydraulic sizing attached:</td><td>Yes</td></tr>
<tr><td colspan="2">Nutrient balance (annual) attached:</td><td>Yes</td></tr>
<tr><td colspan="2">Land application area (LAA) sizing attached:</td><td>Yes</td></tr>
<tr><td colspan="2">Wet weather storage requirement:</td><td>No</td></tr>
<tr><td colspan="3">Flooding</td><td rowspan="4">No flood data available, however PMF unlikely to infiltrate available EMA</td><td rowspan="4">Minor limitation</td></tr>
<tr><td colspan="2">LAA above 5% AEP flood level:</td><td>Unknown</td></tr>
<tr><td colspan="2">LAA above 1% AEP flood level:</td><td>Unknown</td></tr>
<tr><td colspan="2">Electrical components above 1% AEP flood level:</td><td>Unknown</td></tr>
<tr><td>Exposure</td><td colspan="2">The available effluent management area (EMA) is cleared of vegetation, providing high wind and sun exposure.</td><td colspan="2">Minor limitation</td></tr>
<tr><td>Slope and Aspect</td><td colspan="2">Slopes are generally south west to south-east facing ranging from 5 - 7% within available EMA.</td><td colspan="2">Minor limitation</td></tr>
<tr><td>Landform</td><td colspan="2">Linear planar to linear divergent within available EMA.</td><td colspan="2">Minor limitation</td></tr>
<tr><td>Run-on & Seepage</td><td colspan="2">No observed up-slope seepage observed during Site investigation. Moderate stormwater run-on onto available EMA expected.</td><td colspan="2">Minor limitation</td></tr>
</table>

SITE ASSESSMENT			
Parameter	**Data / Observation**	**Reference**	**Classification / Outcome**
	A constructed stormwater diversion drain is recommended (refer Section 9.3).		
Erosion Potential	No erosion evident during the Site investigation, within Available EMA, however, soil landscape data indicates widespread erosion hazard. Address potential erosion risk by using erosion and sediment controls during construction and revegetation of the LAA using turf (refer Section 9.2).	Minor limitation	
Site Drainage	Minimal redoximorphic features observed indicating moderately to well-drained within available EMA.	Minor limitation	
Fill	None observed or apparent.	Minor limitation	
Groundwater	No shallow groundwater (GW) encountered during soil investigation. NSW Office of Water GW bore registry indicates a monitoring bore (GW080977) ~90m north of the Site. *GW report provided in Appendix B.*	Minor limitation	
Buffers Applicable			
Permanent rivers and creeks (100m):	No	Not achievable, mitigation required (see Section 8.1)	
Intermittent drainage channels and other waters (40m):	No	Not achievable, mitigation required (see Section 8.1)	
Domestic GW bores and wells (250m):	Yes	Achievable	
Buildings, lot boundaries, driveways and swimming pools (3m if EMA downslope, 6m if EMA upslope):	Yes	Achievable	
Limiting horizon (GW, bedrock, etc.) (>0.6m):	No	Not achievable, mitigation required (see Section 7.3.2)	
Constructed Swale (3m if EMA downslope, 6m if EMA upslope):	Yes	Achievable	
Surface Rock	None observed or present	Minor limitation	

SITE ASSESSMENT			
Parameter	**Data / Observation**	**Reference**	**Classification / Outcome**
Available EMA	With reduced buffers and the removal of unsuitable areas such as heavy vegetation and steep slopes (>15%). Large areas (>22ha) of ‘available EMA’ is identified at the Site. EMA is shown at Figures 2 and 3 in Appendix A.	Minor limitation	
Concluding Remarks Site conditions are generally good for OSSM within the available EMA.			

SOIL ASSESSMENT (physical)			
Parameter	**Data / Observation**	**Reference**	**Classification / Outcome**
Soil Depth	600mm – 700mm	Moderate limitation	
Soil Profile	**<u>BH1</u>** A: 0mm - 150mm, moderately structured, dark brown, clay loam (Cat 4) B_1: 150mm - 400mm, weakly structured, light olive brown, light clay (Cat 5) B_2: 400mm - 600mm, weakly structured, light olive brown, light clay (Cat 5) Refusal on stiff parent material **<u>BH2</u>** A: 0mm - 400mm, moderately structured, black, silty loam (Cat 3) B: 400mm - 700mm, moderately structured, olive brown, silty clay (Cat 5) refusal on parent material (weathered) **<u>BH3</u>** A: 0mm - 450mm, weakly structured, very dark greyish brown, silty clay (Cat 5) B: 450mm - 700mm, massive, very dark greyish brown, medium clay (Cat 6) Borehole terminated at 700mm *Borehole locations shown in Figure 2, Appendix A.* *Soil borelogs and laboratory results are presented as Appendix B.*	Major limitation	
Depth to Water Table	No shallow water table encountered during soil survey.	Minor limitation	

<table>
<tr><th colspan="4">SOIL ASSESSMENT (physical)</th></tr>
<tr><th>Parameter</th><th>Data / Observation</th><th>Reference</th><th>Classification / Outcome</th></tr>
<tr><td>Coarse Fragments</td><td><2%</td><td colspan="2">Minor limitation</td></tr>
<tr><td>Soil Permeability</td><td>< 0.06m/day (indicative).</td><td>Massive medium clay (Cat 6)</td><td>Major limitation</td></tr>
<tr><td>Modified Emerson Aggregate Class (EAT)</td><td>Topsoil: 5 - 3(2) (slightly dispersive)
Subsoil: 5 - 3(3) (slightly to moderately dispersive)</td><td colspan="2">Moderate limitation</td></tr>
<tr><td>Soil Landscape</td><td>Available EMA occurs on the Burraduc (‘brj’) soil landscape:
<u>Landscape</u> - Gently undulating rises to rolling low hills on Carboniferous sandstones and siltstones in the central east of the Hunter Region. Slopes 0 - 30%, local relief 10 - 90 m, elevation 10 - 200 m. Partially cleared tall-open forest.
<u>Soils</u> - Moderately deep (50 - <100 cm), moderately permeable well-drained Leptic Tenosols (Lithosols) occur in areas with no subsoil which can occur on crests and upper slopes. Very deep (150 - 500 cm), moderately permeable well-drained Red and Brown Kurosols (Red and Brown Podzolic Soils and Soloths) occur on siltstone/mudstones slopes. Moderately deep (50 - <100 cm), moderately permeable, well-drained Aeric Eutrophic Brown Kandosols (Yellow Earths) are found on sandstone upper slopes. On sandstone lower slopes occur deep (100 - <150 cm), slowly permeable imperfectly drained Bleached-Sodic Natric Brown Kurosols (Soloths and Solods).
<u>Limitations</u> - localised shallow soils, localised poor moisture availability, localised foundation hazard, localised recharge zone, localised discharge zone, localised gully erosion hazard, widespread sheet erosion hazard, localised streambank erosion hazard, localised high run-on, localised poor drainage, localised permanent waterlogging.</td><td colspan="2">Soil and Land Resources of the Hunter Region</td></tr>
<tr><td colspan="4">Concluding Remarks
Soil permeability poses a major constraint to OSSM, while soil depth and stability (EAT) pose a moderate constraint. Permeability and soil depth limitations can be mitigated or avoided through conservative LAA location, design and installation. Soil stability limitations can be mitigated by soil improvement techniques outlined in Section 9.1.
Site soils are characterised by silty loam to clay loam (Cat 3/5) topsoils to 150-400mm, underlain by a light to medium clay (Cat 5/6) subsoil to 600-700mm. Soil structure is typically moderate to weak.</td></tr>
</table>

SOIL ASSESSMENT (physical)			
Parameter	**Data / Observation**	**Reference**	**Classification / Outcome**
Targeted filling is observed within both installed LAA locations at the Site. Select VENM fill has been used to raise the point-of-application for both systems, such that they are able to achieve 600mm of free draining soil before the limiting layer, being silty clay (Cat 5). Based on the identified soil characteristics a (maximum) design loading rate (DLR) of 5mm/day is recommended for (primary) absorption systems for OSSM1 and OSSM2, with reference to Table L1 AS/NZS 1547:2012 for weakly structured Cat 5 soils.			

SOIL ASSESSMENT (chemical)				
Parameter	**Data / Observation**		**Reference**	**Classification / Outcome**
pH	Topsoil: 5.6 - 5.65 Subsoil: 5.41 - 6.02	slightly acid to strongly acid	Moderate limitation	
EC (EC_e) **(dS/m)**	Topsoil: 0.14 - 0.32 Subsoil: 0.11 - 0.28	Non-saline	Minor limitation	
ESP (%)	19.3	Strongly sodic	SALIS Technical Report on Burraduc (‘brj’) soil landscape WEL/95/37/400(1) See appendix B	Moderate limitation
CEC (me/100g)	17.5	Moderate fertility		Minor limitation
P-sorption (mg/kg)	534	Very high		Minor limitation
Concluding Remarks Soil acidity (pH) and sodicity (ESP) pose moderate constraint to OSSM; potential negative impacts can be mitigated through soil improvement recommendations (see Section 9.1). General notes on the soil chemistry parameters above are attached as Appendix F.				

5 Existing OSSM

An audit of the existing OSSM system components at the Site was undertaken to determine their capacity to service operational needs under the proposed loading scenarios.

The audit considers the wastewater generation patterns at the Site as well as design assessment criteria and expected performance outcomes in accordance with relevant guidelines and standards. The findings of the OSSM audit are presented below.

5.1 Description

OSSM1 comprises a 6,050L (Ø2.32m) dual-chambered concrete septic tank. With an operating depth of 1.43m, the septic tank has an effective treatment volume of ~6,050L. Treated effluent is pressure-dosed to a 95m^2 (20.2m long x 4.7m wide) ‘raised’ (absorption) bed land application area (LAA).

OSSM2 comprises a 6,350L (Ø2.32m) dual-chambered concrete septic tank. With an operating depth of 1.48m, the septic tank has an effective treatment volume of ~6,350L.

Treated effluent is pressure-dosed to a 145m^2 (23.0m long x 6.3m wide) 'raised' (absorption) bed LAA to the rear of the eco-tourism shed.

OSSM1 and OSSM2 were installed in 2020 and 2022 respectively. Both Septic tanks were in good condition, OSSM1 tank had thick scum and sludge while OSSM2 tank had minimal scum and sludge. Both OSSM1 and OSSM2 tanks were chambered 2 to 1 first chamber to second chamber. As such, chamber volumes for OSSM1 is 4.10m^3 and 2.05m^3 and for OSSM2 is 4.25m^3 and 2.10m^3. Both tanks utilise the 2nd chamber for irrigation consisting a pump triggered by float switch, the first chamber providing 'primary' treatment. As such, OSSM1 and OSSM2 tanks have a primary treatment operating capacity of 4,100L and 4,250L respectively.

Both LAAs have been raised 450mm (OSSM1) and 900mm (OSSM2) above the natural surface and finished with a ~3:1 H:V batter on all sides. Neither LAA showed signs of failure (surcharge) with both having good structural condition. Vegetative (crop) cover on the OSSM1 LAA was poor, with dead/dying grass cover. The OSSM2 LAA had <u>no</u> overlying crop (exposed soil).

It is understood both existing OSSM systems were installed by the same contractor, Lloyd Aquilina of Aquatech P/L (the 'plumber'). All OSSM components currently installed at the Site are shown in Figure 2, Appendix A.

5.2 Performance Analysis

5.2.1 *OSSM1 Treatment*

AS/NZS 1547:2012 (Table J1) recommends a minimum septic tank size of 4,500L for hydraulic loads up to 10EP. This is required to achieve the minimum 24-hour hydraulic retention time (HRT) to sufficiently treat wastewater to a primary standard, with an assumed 5-year de-sludge interval.

For larger loads, NSW Health (2016) provides guidance for sizing septic tank capacities to accommodate the (minimum) 24-hours of settling volume and an appropriate allowance for accumulation of sludge. The guideline requires analysis based on the following calculation.

Sludge Allowance + Daily Flow = Tank Capacity

To achieve the minimum 24-hour HRT, a liquid operating capacity of 1,320L is required based on the daily hydraulic load to the system. Therefore, the existing septic tank can provide a maximum sludge allowance of 4,730L (6,050L – 1,320L) before treatment performance may be impacted. Sludge generation is calculated at 880L/year, based on the maximum occupancy of 11EP and an 80L/EP/yr sludge accumulation rate (*AS/NZS1547:2012*).

De-sludge rates for septics are typically 3-5 years (*AS/NZS1547:2012*). Based on the available sludge storage allowance, the existing septic tank has an expected desludge frequency >5 years. This is considered acceptable for ongoing use at the Site.

5.2.2 *OSSM2 Treatment*

To achieve the minimum 24-hour HRT, a liquid operating capacity of 2,310L is required based on the 'peak' daily hydraulic load to the system. Therefore, the existing septic tank can provide a maximum sludge allowance of 4,040L (6,350L – 2,310L) before treatment performance may be impacted. Sludge generation is calculated at <100L/year, based on the intermittent use of the (Eco Tourist Facility) Site.

Based on the available sludge storage allowance, the existing septic tank has an expected desludge frequency >10 years. This is considered acceptable for ongoing use at the Site.

5.2.3 *LAAs*

Preliminary water balance analysis (per *AS/NZS1547:2012)* indicates that, based on future loading conditions for the development, both LAA systems are undersized.

OSSM2 LAA is also located within standard (DLG, 1998) setbacks.

5.2.4 *Recommendation*

Both septic tanks are in good operational order and are suitably sized to service the proposed development scenario, continued use is supported.

To address existing LAA sizing constraints, recommended upgrades and improvements are provided for OSSM1 (see Section 7) and OSSM2 (see Section 6.2).

To address the proximity risk associated with the OSSM2 LAA, a risk analysis has been completed (see Section 8.1).

6 Proposed Wastewater Treatment

As discussed, continued use of both septic tanks installed is supported. Based on the analysis the available treatment volumes in both septic tanks is sufficient to achieve (minimum) primary effluent quality standard under the expected loading conditions.

6.1 Treated Effluent Quality

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

Parameter	Expected Effluent Quality
Biochemical Oxygen Demand	~150mg/L
Suspended Solids	~50mg/L
Faecal Coliforms	>10,000cfu/100mL
Total Phosphorus	≤15mg/L
Total Nitrogen	≤60mg/L

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

6.2 Flow Balancing

Expected wastewater generation patterns at the Eco Tourist Facility are variable (refer Section 2.2). In such situations, it is common to introduce 'flow balancing' to manage diurnal (daily) and weekly fluctuations to avoid overloading the existing LAA during peak periods.

Flow balancing will be achieved through storing excess generated effluent in the 2nd chamber of the OSSM2 septic tank. This will hold excess effluent during peak generation periods and allow incremental dispersal upon entering lower generation periods.

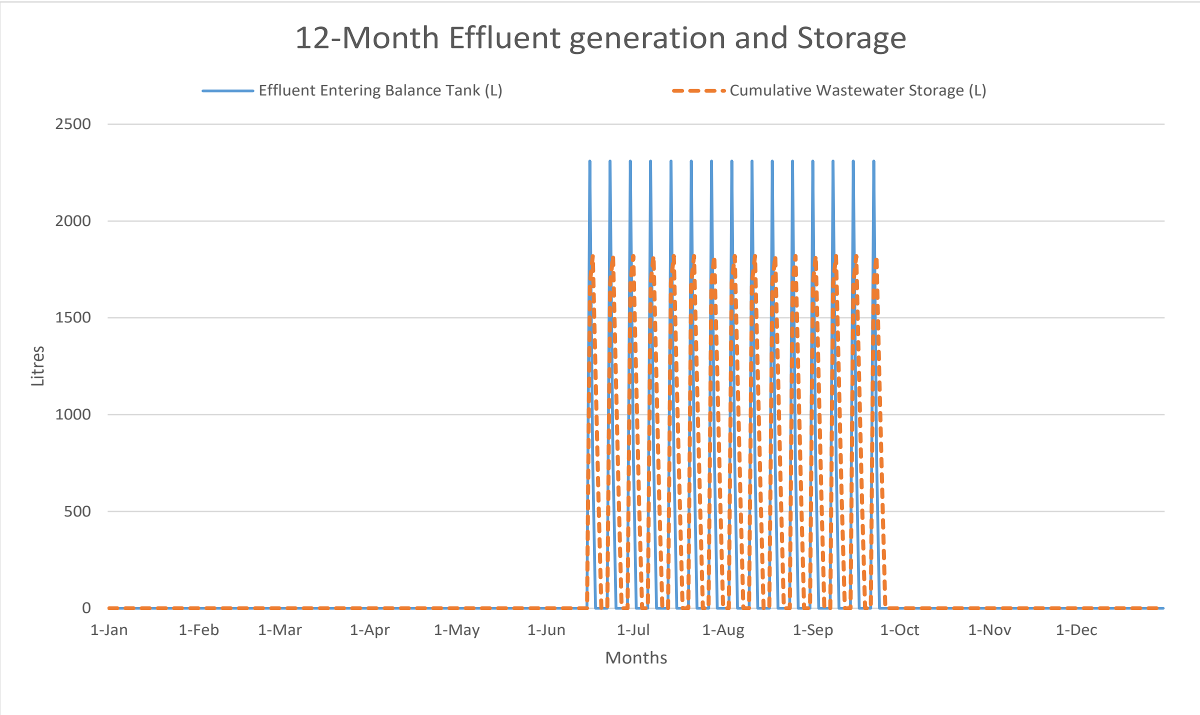
To determine the required size of effluent storage volume necessary to adequately balance the expected hydraulic loads from the Eco Tourist operation, a 12-month flow balancing analysis was prepared (copy attached at Appendix C). The analysis is used iteratively to determine the minimum effluent storage volume required to ensure the assimilation capacity of the LAA is not exceeded at any time throughout the design year.

As previously described (Section 2.2), HATW functions will only occur May to October, with up to 20 functions (1 per week) assumed during that period annually. Functions will occur over the weekend only, with attendees typically arriving during Saturday afternoon and required to leave the Site by Sunday noon. During that period, attendees are expected to make full use of the amenities available.

For modelling purposes, we assume that the design hydraulic load (2,310L/day) will be generated on the Saturday of each event, with an additional 33% of the design load (770L/day) generated on the Sunday morning as attendees prepare to leave the Site.

With the maximum interval between functions expected to be 1 week (Section 2.2), stored effluent would be 'dosed' to the LAA over the following 4-5 days following each function. The analysis shows that, with the provision of **1,820L** of effluent storage volume, the maximum loading rate to the LAA can be maintained **≤630L/day**. This volume can be achieved within the existing OSSM2 treatment tank.

The maximum expected effluent storage volume throughout a 12-month period are shown within the 'cumulative wastewater storage' column of the Effluent Flow Balancing sheet in Appendix C and are summarised graphically (below).



6.2.1 *Flow Balance Configuration*

To use the 2nd chamber of the existing OSSM2 septic tank for effluent balancing, the existing pump arrangement should be fitted with an appropriate time-dosing mechanism (run timer or similar) to evenly transfer effluent to the LAA throughout the day up to the maximum design load (630L). The pump arrangement should also include visual/audible high-water alarm and emergency-level float for overflow.

The re-purposed balance chamber is shown on Figure 3, Appendix A.

7 Proposed Effluent Management

This section examines the Site's capability for effluent management and provides design details, including sizing of the required LAAs. Site conditions allow for sustainable application of primary treated effluent within an appropriately located and designed LAA. As such, primary treatment systems (i.e. septic tanks) are considered appropriate for ongoing treatment at the Site.

7.1 Buffers

Buffer or setback distances are recommended to provide a form of mitigation against unidentified constraints and reduce potential pathways of human and environmental exposure. The following environmental buffers have been adopted based on Table 5 of NSW DLG (1998) for 'primary' subsurface land application systems:

- 250m to domestic groundwater bores;
- 100m to permanent watercourses;
- 40m from intermittent watercourses and dams;
- 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 buildings, swimming pools, and driveways; and
- Above 1 in 20-year flood levels.

With the exception of the setback between the OSSM2 LAA and surface waters, all applicable buffer distances are achievable, as shown on the Site Plan (Figure 2, Appendix A).

To support a reduction in the applied buffer to intermittent and permanent waterways and the OSSM2 LAA, a risk analysis is presented (see Section 8.1).

7.2 LAA Sizing

Water and nutrient balance modelling was undertaken to determine if the available LAAs are appropriately sized to accommodate the expected hydraulic and nutrient loads from the residential dwellings (OSSM1) and the Eco Tourist Facility (OSSM2). 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 determine 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 application area requirements to enable nutrients to be assimilated by the soils and vegetation. 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 modelling are presented in the tables below for each LAA. Full water and nutrient balance results are presented in Appendix D.

Parameter		Units	Value	Comments
Design hydraulic load	**OSSM1**	L/day	1,320	Section 3.1
	OSSM2		630	Section 6.2
Precipitation		mm/month	Median monthly	SILO Data: -32.15, 152.25
Pan evaporation		mm/month	Mean monthly	BOM Station: 060030
Retained rainfall		Unitless	0.8	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	5	Table L1 AS/NZS 1547:2012 for weakly structured Cat 5 soils
Effluent total nitrogen concentration		mg/L	≤60	Section 6.1
Nitrogen lost to soil processes		annual percentage	20	Geary & Gardner (1996)
Effluent total phosphorus concentration		mg/L	≤15	Section 6.1
Soil phosphorus sorption capacity		mg/kg	534	Previous laboratory analysis on the 'brj' soil landscape
Nitrogen uptake rate by plants		kg/ha/yr	260	A 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		years	50	DLG (1998) guidelines recommended design life

Results		
	OSSM1	**OSSM2**
Hydraulic balance (m^2)	285	138
Nitrogen balance (m^2)	849	404
Phosphorus balance (m^2)	838	399

As shown, the minimum area required to manage the expected 'design' hydraulic load for the developments using the existing absorption bed LAAs are: OSSM1 = 285m^2 and OSSM2 =

145m^2, based on the most limiting climate month of the year (i.e. June). A minimal (in-bed) effluent storage allowance of 21mm is assumed for OSSM1.

7.2.1 *Nutrient Management*

Nutrient buffers are a useful tool for LAA design where the hydraulic area requirement is substantially smaller than the nutrient balance requirement. This is particularly relevant in areas where evapotranspiration is the dominant water balance component. Research suggests where effluent remains subsurface, nutrients are transported in a subsurface plume, the nature and extent of which is dependent on the level of treatment, subsurface conditions and the attenuation and assimilation under and away from the LAA location.

The nutrient buffer is an area set aside around, and downslope, of the LAA system that allows for further nutrient reduction to background levels before reaching any sensitive receptors. Vegetation cover must be maintained within nutrient buffers and they should be protected from any future development or disturbance. Modelling indicates that a (minimum) area of 890m^2 (rounded) is required for OSSM1 and 430m^2 (rounded) for OSSM2.

Based on this, nutrient buffers no less than 605m^2 (890m^2 - 285m^2) and 285m^2 (430m^2 - 145m^2) should be maintained for OSSM1 and OSSM2 respectively, in the adjacent and downslope area of the LAA footprint to assimilate excess nutrients (N+P) within the surrounding soils and pasture.

The required nutrient buffers are shown on the Site Plan (Figure 3, Appendix A).

7.3 OSSM1 Absorption Bed - Detail

To upgrade OSSM1, two (2) additional beds are proposed. For simplicity, it is recommended that these be duplicates of the existing bed installed (20.2m length and 4.7m width), raised to a similar elevation (500mm) above the ground surface (see Section 7.3.1).

The bed should be constructed in accordance with standard drawing 10D of 'Sydney Catchment Authority – Design & Installation of On-Site Wastewater Systems' and the construction diagram presented as Figure 4 of Appendix A. The land application system should be installed by a plumber experienced in wastewater, ensuring that effluent is distributed evenly across the entire area serviced.

Raised pressure-dosed absorption beds should be constructed with a maximum batter slope ratio of 1 (vertical): 3 (horizontal) to minimise any risk of erosion and allow the LAA to be easily mown.

7.3.1 *Effluent Distribution*

To optimise LAA performance, a dedicated distribution manifold will be installed within the new beds. Distribution will be achieved by drilled 25-32mm PVC pipe (per LPED installation), and must be sleeved with 90mm slotted PVC pipe and with manual flush valves (in valve box) fitted to the terminal end of the distribution manifold on the bed. Three (3) distribution laterals installed at 1.5m spacing within the bed are recommended.

It is important to ensure that the irrigation pump is capable of managing 'duty' requirements for the LAA distribution system (installer to confirm). The details of the selected pump will be provided to Council with the application.

A 3-port indexing valve (or similar) will be installed at the septic tank outlet to sequentially dose the daily hydraulic load equally between the three (3) beds.

7.3.2 *Soil Depth*

Due to limited available depth identified within the preferred LAA location, the addition of 500mm of good quality 'VENM' topsoil (clay loam) is recommended throughout the LAA footprint, prior to the installation of the raised bed. Typical installation procedure is as follows:

- scarify (lightly till) the proposed LAA footprint;
- add good quality topsoil (clay loam) to a height of 500mm within the proposed LAA, finishing the perimeter of 'raised' LAA with a 3 (horizontal): 1 (vertical) batter slope;
- excavate and construct the (20.2m x 4.7m) distribution beds to 300mm depth and backfill with aggregate;
- install a pressure dosing manifold (refer Section 7.3.1) within each bed;
- overlay the distribution (aggregate) bed with geotextile cloth;
- cover with 100mm good quality imported topsoil and landscape with maximum 1:2 batter; and
- cover with suitable vegetation (turf).

7.4 LAA Positioning

Available areas for effluent application are shown in Figure 2 and 3 of Appendix A as 'Available EMA'. These areas exclude the required setback distances as detailed in Section 7.1. The required additional LAA can be located anywhere within the available EMA.

A nominal LAA location is shown in Figure 3 of Appendix A.

7.5 Reserve LAA

A reserve LAA is achievable within available EMA at the Site.

8 Risk Analysis

To support a reduction in the applied buffer to intermittent and permanent waterways and the OSSM2 LAA, a risk analysis was undertaken.

8.1 Buffer Risk Assessment

A buffer risk assessment was undertaken to support an appropriate reduction in the buffers to surface waters. The risk assessment procedure is outlined in Appendix R of *AS/NZS1547:2012*.

AS/NZS1547:2012 recommends that if a high level of constraint is identified for any Site feature, the maximum setback values should be considered. However, in practice the overall setback distance should be "based on an evaluation of the [relevant] constraint items and corresponding sensitive features and how these interact to provide a pathway or barrier for wastewater movement" to the Site feature.

The following assumptions are used to assess the OSSM2 LAA location to support a reduction in the recommended buffer distances:

- Slope ≤1% within LAA;
- Subsurface application method (absorption);
- 900mm raised system with >1.2m soil depth below base of bed;

- Intermittent (balanced) LAA dosing, with low average loads; and
- LAA not subject to flooding.

AS/NZS 1547:2012 recommends a setback distance range of 15-100m for surface waters.

Based on this analysis, the reduction in the required setbacks to the identified intermittent drainage channels from 40m to **15m** and the permanent waterway from 100m to **50m** is supported. Appendix E provides additional information on the analysis method and full results.

8.2 Viral Die-Off

To address any residual concern regarding the transport of pathogens away from the LAA towards sensitive receptors, we have considered the movement of viruses away from the LAA using an established 1-dimensional viral die-off model developed by Beavers and Gardner (1993) and refined by Cromer *et al*. (2001). Details of the methodology can be found in Cromer *et al*. (2001).

The model considers the movement of viruses away from the LAA using an established 1-dimensional viral die-off model developed by Beavers and Gardner (1993) and refined by Cromer *et al.* (2001). Details of the methodology can be found in Cromer *et al.* (2001).

The model generally applies to wastewater moving in saturated soils, i.e. in shallow GW beneath a LAA. These conditions are considered most conducive to pathogen transport. In unsaturated (vadose zone) soils, the travel distances will be substantially less. As such, the method is considered very conservative when applied to sites with drained topsoils and deep water tables. Some key assumptions used in the modelling are provided below:

- Bacteria have lesser die-off times than viruses and can therefore be assumed to be eliminated within a shorter distance than viruses (Cromer *et al.* 2001);
- Viral reduction has been set at six (6) orders of magnitude for primary treatment (Cromer *et al.* 2001); and
- Cooler temperatures allow viruses to reside longer in the soil and hence provide potentially greater travel distances. Groundwater temperatures based on the assumption of 12.0°C (BOM Station 060030 [Taree – Patanga Cl]) mean minimum temperature.

Modelling inputs and predicted maximum viral transport distances are provided in the following table. Appendix E provides additional information on the modelling methodology and full results.

Parameter	Value
Groundwater temperature (ºC)	12.0
Days for Viral Die-off	80
Porosity of soil (decimal)	0.52
K_{sat} (m/day)	0.06
Groundwater gradient (%)	10
Depth to groundwater (m)	1.20
Horizontal distance travelled in groundwater (m)	**0.8**

Viral die-off modelling demonstrates that with primary treatment, 100% pathogen reduction within the soil is expected to occur within **0.8m** from the installed LAA boundaries, reducing contaminants to background levels well within available setbacks and before reaching the surrounding sensitive receptors. Therefore, the reduced buffer distances from sensitive receptors are justified.

9 Mitigation Measures

9.1 Soil Improvement

Given that Site soils are identified as strongly sodic, moderately dispersive and strongly acidic, there is a risk of structural decline and dispersion leading to crusting and impeded effluent infiltration. To mitigate against the impacts of instability, gypsum application is recommended. Gypsum application adds calcium to the soil to improve the soil CEC and Ca/Mg ratio, improving fertility, while reducing the potential for soil structural degradation.

Typically, gypsum would be the preferred soil amendment; however, given the identified soil acidity 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 during construction of the land application system.

A suitable gypsum/lime application rate of approximately 0.4kg/m^2 is recommended.

9.2 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 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 in 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.

9.3 Stormwater Management

The performance of LAA (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 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 as Figure 5, 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.

10 Conclusions and Recommendations

This completes our assessment of Site's capability for sustainable OSSM at 851 Wang Wauk Rd, Wang Wauk NSW. To service the predicted wastewater loads generated from the new dwelling (OSSM1) and Eco Tourist Facility (OSSM2), we recommend the following:

- Both OSSM1 and OSSM2 systems are recommended for continued use, with upgrades to components and management described as follows:
  - Septic tanks should be regularly de-sludged. An indicate frequency of ≤3-years (OSSM 1) and ≤5-years (OSSM2) is suggested, and
  - The 2^{nd} chamber of OSSM2 will be modified to provide flow balance storage. To achieve this, the pump must be incorporated with an appropriate 'timer' mechanism (or similar) to evenly transfer **≤630L/day** of primary treated effluent to the associated LAA. Appropriate controls and alarms must be included.
- The addition of two (2) 'raised' **95m^2** beds to achieve a total LAA of 285m^2 for OSSM1, specifically the beds must be installed as follows:
  - The beds must be raised **≥500mm** above the natural surface with VENM soil from Site.
  - A distribution mechanism must be installed to equally proportion the design hydraulic load between each of the three (3) beds daily.
- The proposed LAA must be located within the available EMA specified to comply with adopted setbacks and must be designed and installed by an experienced professional, taking into account the expected flows and other recommendations contained within this WMR;
- Delivery lines must be buried at a minimum depth of 500mm under any trafficable surface to prevent damage from compaction;
- A suitable gypsum application rate of approximately 0.4kg/m^2 should be applied at the base of the land application system during installation;
- Vegetation must be established over the LAA immediately after installation;
- Vehicles and grazing animals must be prevented from entering the designated LAA;
- Stormwater run-on must be directed away from the proposed LAA; and
- Signage should be erected around OSSM2 LAA indicating the use of effluent;

Yours Sincerely,

B. Colautti

Ben Colautti

Environmental Consultant
Whitehead & Associates Environmental Consultants Pty Ltd

Appendix A
Figures

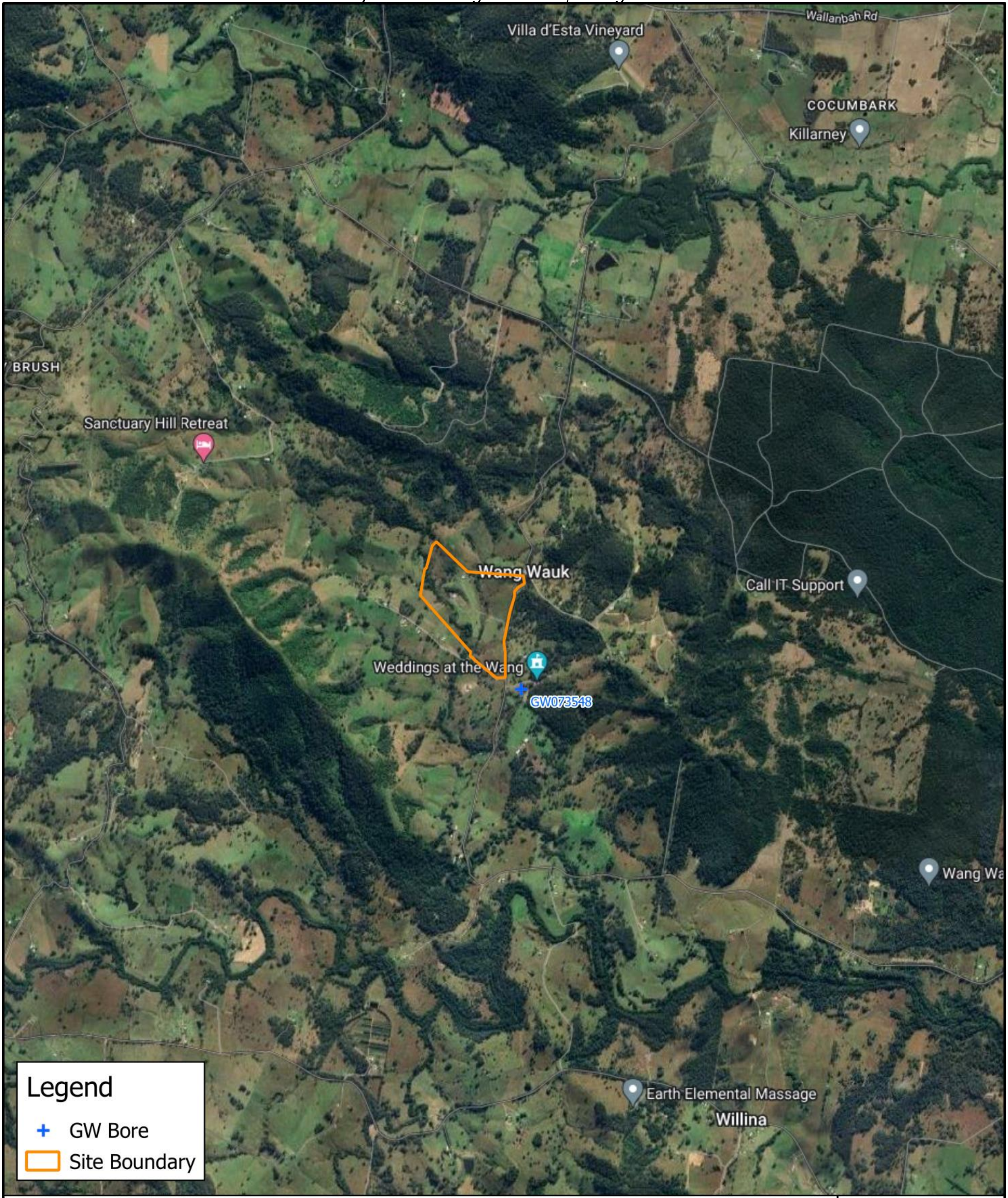


Figure 1 - Site Locality Plan

Job 3670: WMR at 851 Wang Wauk Rd, Wang Wauk NSW

N

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0 0.5 1 1.5 2 km

(Approx Scale)

Revision	001
Drawn	BC
Approved	MS

Figure 2: Site Plan Showing Existing OSSM and Available EMA

3670: WMR for Eco Tourist Facility at 851 Wang Wauk Rd, Wang Wauk NSW

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Environmental Consultants

Revision	001
Drawn	BC
Approved	MS

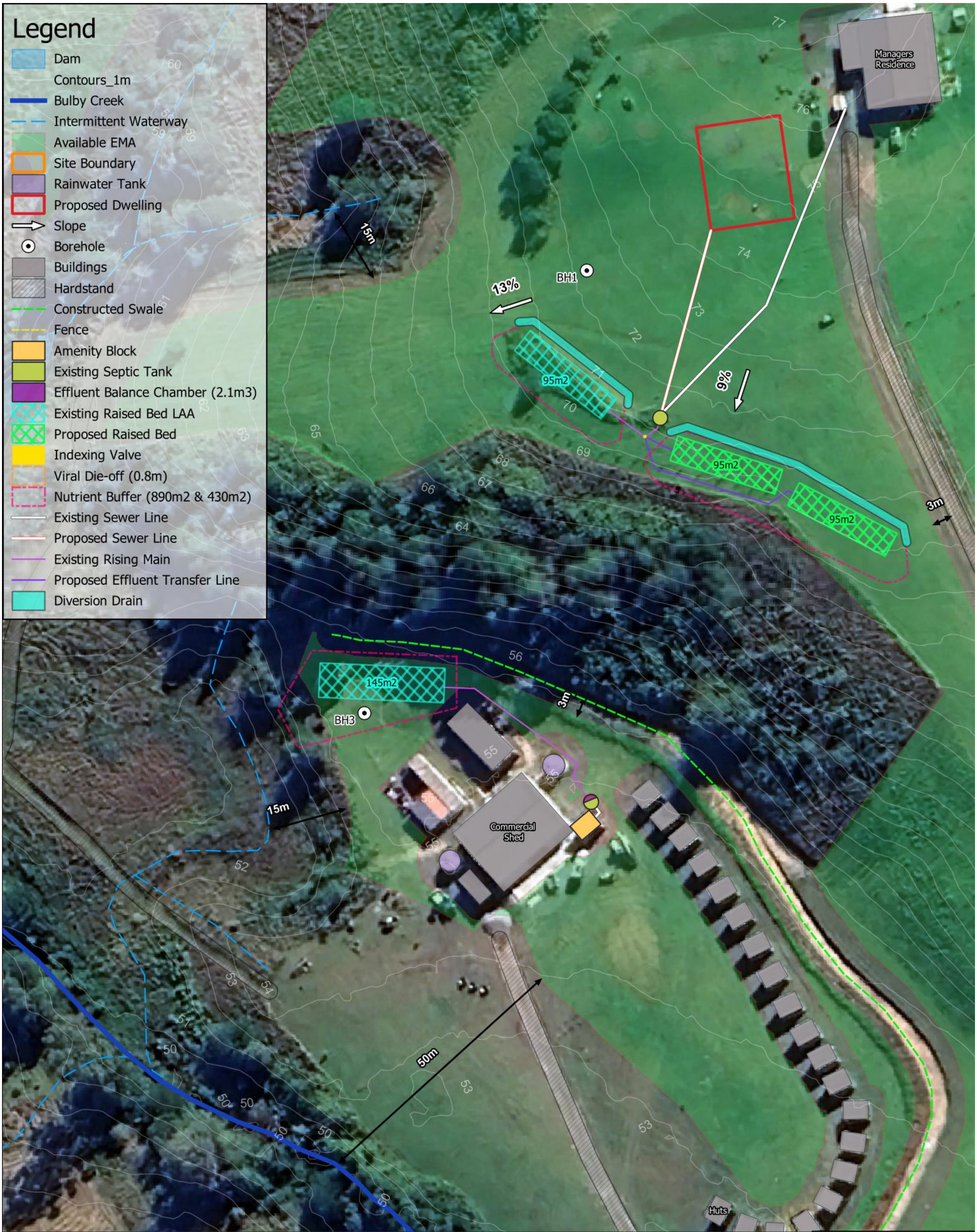

Figure 3: Site Plan Showing Proposed OSSM

3670: WMR for Eco Tourist Facility at 851 Wang Wauk Rd, Wang Wauk NSW

N

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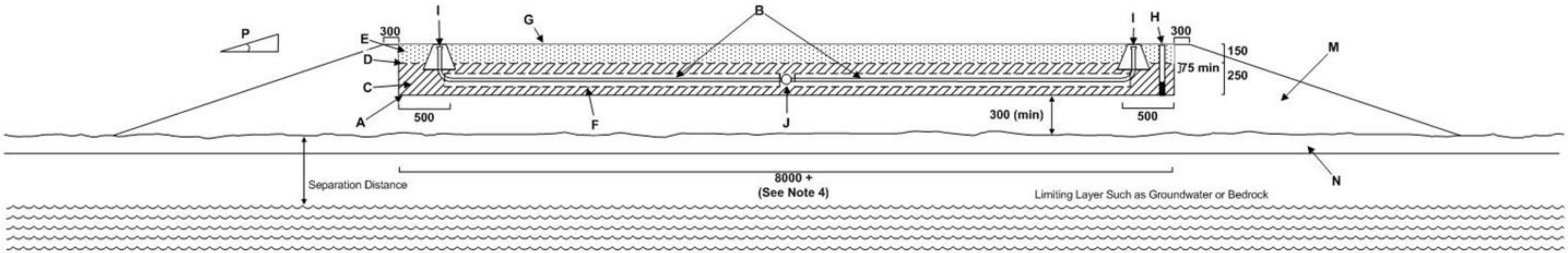
Environmental Consultants

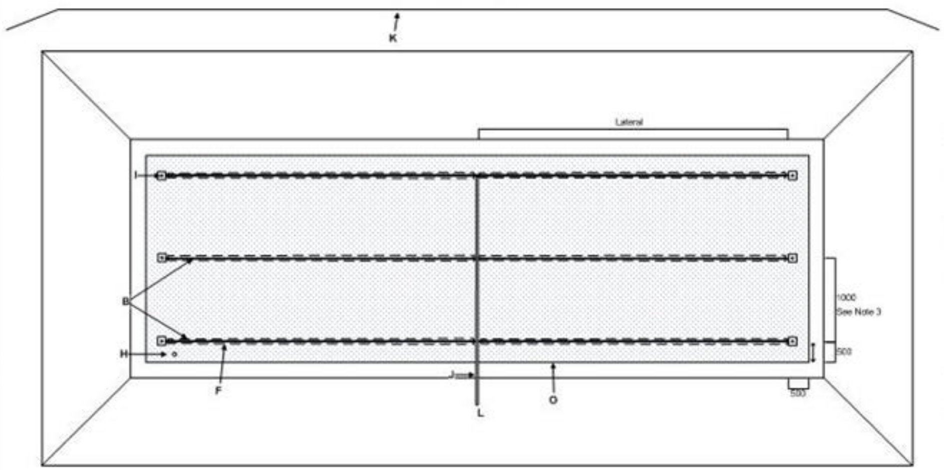
0 10 20 30 40 50 60 m
(Approx Scale)

Revision	001
Drawn	BC
Approved	MS

Cross Section View



Plan View



Raised Pressure Dosed Absorption Bed Construction

Note 1 The layout and dimensions used in this drawing are for general guidance only. The location, configuration and layout of individual beds will need to be determined on a site-specific basis. The purpose of this drawing is to illustrate a typical configuration and specify minimum system components.

Note 4 Consideration should be given to ensuring all beds have a level base when determining an appropriate width. The distribution manifold must also be level. Beds longer than 30m will require specialist hydraulic design.

A The base of the trench must be level to ensure even distribution of effluent. Base levels should be checked with a dumpy / laser level.

B Pressurised dosing laterals consisting of 25mm PVC pipe with 3mm holes drilled (deburred) at 400mm centres facing upwards. The total number and length of laterals will be determined by the required bed size (m^2) and the lateral spacings shown in this drawing. It is essential that effluent is distributed evenly across the distribution bed. A residual head (or squirt height) of 1.5m should be achieved across the distribution laterals. The squirt height across the laterals must be tested prior to covering with agricultural / slotted pipe, with no more than 15% variation in height observed. Consideration must also be given to static head and friction loss when sizing pumps. A full hydraulic design must be carried out.

C 20-40mm distribution aggregate.

D Geotextile filter cloth.

E Clean local or imported topsoil (sandy loam to loam).

F 90mm slotted PVC or agricultural pipe over manifold laterals.

G Grass must be established across the construction area as soon as possible. The bed surface should be slightly mounded.

H Inspection port on downhill side of bed. Made from 50mm PVC pipe with perforations in the aggregate level of the bed.

I Individual flush points for each lateral. May be a screw cap fitting on a 90 degree elbow level with the bed surface or a pressure controlled flush valve (such as those used for subsurface irrigation systems) inside an irrigation control box. Manual flushing should be carried out at least every twelve months.

J PVC or polyethylene dosing manifold. Larger systems may require different pipe sizes and orifice reducers at lateral connection points.

K Upslope stormwater diversion drain. Subsoil drainage may be necessary on particular sites.

L Pump dosed effluent from treatment system (minimum secondary treatment).

M The base of the absorption bed is to be raised to a height of 500mm above the natural ground surface (total bed height 900mm). Compaction should be minimised when installing the bed. The fill must be a sandy loam to loam with minimal clay content.

N Prepare the site by clearing all shrubs, trees and boulders. Scarify the natural soils across the entire basal area to a minimum depth of 200mm taking care not to compact the basal area in the process. This should extend to at least 1 m beyond the perimeter.

O The bed dimensions shown are an example only. The basal area of the land application area must be determined based on the load and soil characteristics of the Site. A minimum bed length to width ratio of 3:1 must be adopted when developing individual designs and beds must be installed parallel to the Site contours. The location and orientation of the area should be based on a site by a suitably qualified person. The system may comprise a single bed or preferably multiple smaller beds.

P Batter slope 1(vertical):3 (horizontal) maximum.

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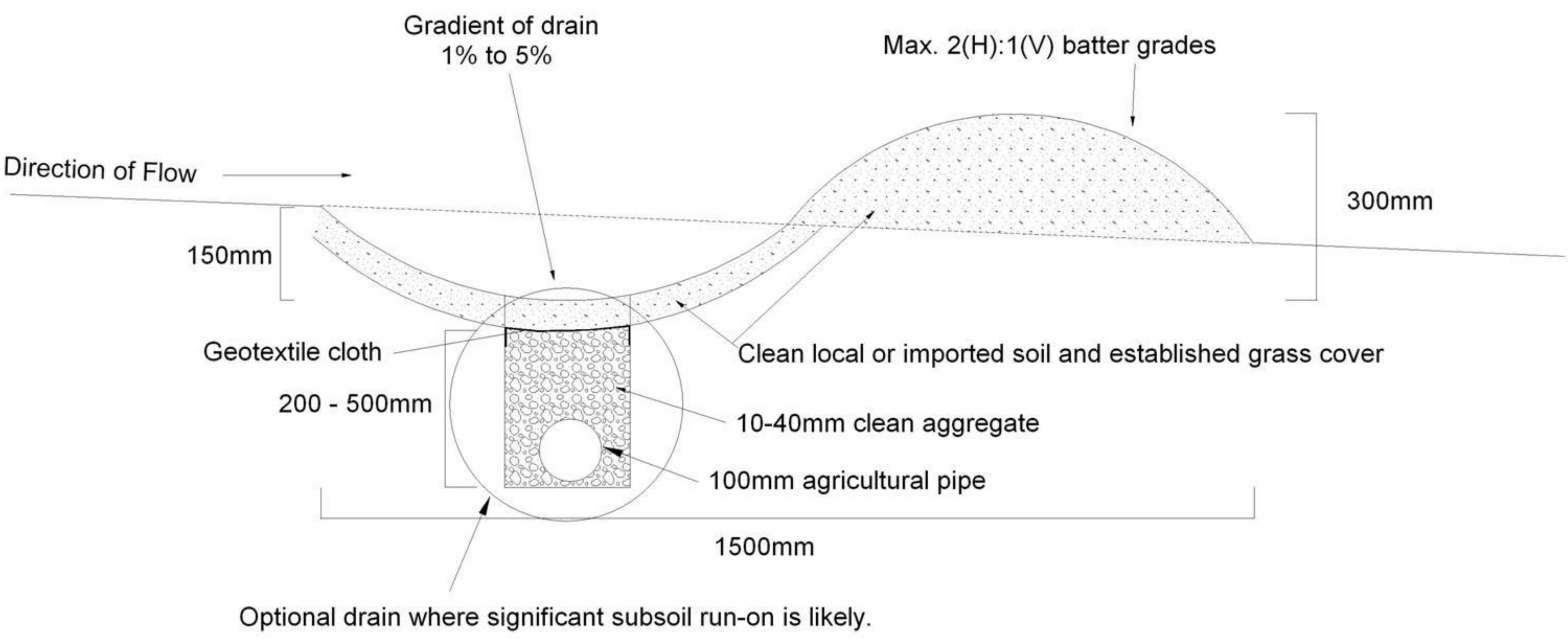
Figure: 4
Standard Drawing:
Raised Absorption Bed

Project: 3670
Drawn: BC
Approved: MS
Date: 16/04/2024
Scale: NTS

Cross Section: Upslope Diversion Drain



Whitehead & Associates Environmental Consultants	**FIGURE 5:** **UPSLOPE DIVERSION DRAIN**	**Project: 3670** **Scale: NTS** **Drawn: BC** **For visualisation purposes only, not for construction use**

Appendix B
Soil Borelogs, Laboratory Results
and GW Bore Report

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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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Client:	Adam Eckersley	**Borehole No:**	**BH1**
Site:	851 Wang Wauk Rd, Wang Wauk NSW	Excavated/logged by:	B.C, S.G, B.M
Date:	8th March 2024	Excavation type:	Auger, crowbar & shovel
Notes:	- refer to site plan for position of borehole		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles/ Gley	Coarse Fragments	Moisture Condition	Comments
0.1		BH1/1	A	CL	moderate	dark brown	N/A	<2%	SM	
0.2 0.3 0.4		BH1/2	B_1	LC	weak	light olive brown	N/A	<2%	SM	
0.5 0.6		BH1/3	B_2	LC	weak	light olive brown	N/A	<2%	SM	
0.7 0.8 0.9 1 1.1 1.2		refusal on parent material (stiff)								

SOIL BORE LOG

Whitehead & Associates
Environmental Consultants

Client:	Adam Eckersley	**Borehole No:**	**BH2**
Site:	851 Wang Wauk Rd, Wang Wauk NSW	Excavated/logged by:	B.C, S.G, B.M
Date:	8th March 2024	Excavation type:	Auger, crowbar & shovel
Notes:	- refer to site plan for position of borehole		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles/ Gley	Coarse Fragments	Moisture Condition	Comments
0.1–0.4		BH2/1	A	SiL	moderate	black	N/A	<2%	SM	
0.5–0.7		BH2/2	B	SiC	moderate	olive brown	N/A	<2%	D	
0.8–1.2		refusal on parent material (weathered)								

SOIL BORE LOG

Whitehead & Associates
Environmental Consultants

Client:	Adam Eckersley	**Borehole No:**	**BH3**
Site:	851 Wang Wauk Rd, Wang Wauk NSW	Excavated/logged by:	B.C, S.G, B.M
Date:	8th March 2024	Excavation type:	Auger, crowbar & shovel
Notes:	- refer to site plan for position of borehole		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles/ Gley	Coarse Fragments	Moisture Condition	Comments
0.1		BH3/1	A	SiC	weak	very dark greyish brown	N/A	<2%	SM	
0.2										
0.3										
0.4										
0.5		BH3/2	B	MC	massive	very dark greyish brown	N/A	<2%	SM	
0.6										
0.7										
0.8			Borehole terminated							
0.9										
1										
1.1										
1.2										

Project 3670: 851 Wang Wauk Rd, Wang Wauk 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	150	CL	5	Slight	n/a	5.65	moderately acid	37	0.32	non-saline	
	1/2	400	LC	3(2)	Slight	n/a	5.67	moderately acid	17	0.15	non-saline	
	1/3	600	LC	3(2)	Slight	n/a	5.41	strongly acid	33	0.28	non-saline	
BH2	2/1	400	SiL	5	Slight	n/a	5.60	moderately acid	15	0.14	non-saline	
	2/2	700	SiC	5	Slight	n/a	6.02	slightly acid	13	0.11	non-saline	
BH3	3/1	450	SiC	3(2)	Slight	n/a	5.65	moderately acid	23	0.20	non-saline	
	3/2	700	MC	3(3)	Moderate	n/a	5.7	moderately acid	35	0.26	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

Project 3670: 851 Wang Wauk Rd, Wang Wauk NSW

Sheet 2 - Results of External Laboratory Analysis

SALIS profile 232 Survey 1000386	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
	0.2 - 0.7	17.5	M	320	VL	804	H	483	VH	195	M	19.3	SS	534	H

Notes:- (also refer Interpretation Sheet 2)

Converting mg kg-1 to cmol (+) kg-1 from: Table D3–2, Vegetable SOILpak. D3. Chemical tests

n/t

NSW SOIL AND LAND INFORMATION SYSTEM

Soil Technical Report

SITE DETAILS:

Survey:	Soil Landscapes of the Bulahdelah 1:100 000 Sheet (1000386)
Profile:	282
Location:	WANG WAUK ROAD

PROFILE MAP DETAILS:

1:100,000 Mapsheet:	BULAHDELAH (9333)	Locational Accuracy:	1:25 000
MGA Easting:	432505	MGA Northing:	6441889
MGA Zone:	56		

PROFILE DETAILS:

Described by:	Mr Casey Murphy	Profile Date:	15 November, 1995
Nature of Exposure:	batter	Photo Taken:	
Base of observation:	bedrock reached	No of Layers:	5

SOIL AND MAP CODES:

Geology Map Code:	Cey	Soil Map Code:	br
Aust. Soil Classification:	Kurosol, Brown, Natric, Sodic, medium, gravelly, silty, clayey, moderate, All required data available		
Great Soil Group:	Soloth (Solod)	Northcote PPF:	Dy3.41
Soil Taxonomy:		Atlas(Northcote) Code:	
Atlas (A&M) Code:			
Soil Type:	Sodic Natric Brown Kurosol; medium, gravelly, silty, clayey, moderate (All required data available) (ASC 2nd Edition)		

TOPOGRAPHY:

Slope:	7% (measured)		
Elevation:	30.0 m	Aspect:	north east

LANDFORM:

Site Morphology:	mid-slope	Site Process:	residual
Slope Morphology:		Local Relief:	very low (9-30 m)
Landform Pattern:		Landform Element:	hillslope
Plan Curvature:			

Sample Code: WEL/95/37/400(1) Upper bound: 0.20 Lower bound: 0.70

Name	Value	Unit of measure
15F1_CA [Exchangeable Ca - 0.01M (AgTU)+, no pretreatment]	1.6	cmol/kg
15F1_K [Exchangeable K - 0.01M (AgTU)+, no pretreatment]	0.5	cmol/kg
15F1_MG [Exchangeable Mg - 0.01M (AgTU)+, no pretreatment]	6.7	cmol/kg
15F1_NA [Exchangeable Na - 0.01M (AgTU)+, no pretreatment]	2.1	cmol/kg
15F2_AL [Exchangeable Al - 0.01 M AgTU+]	4.1	cmol/kg
15F3_CEC [Cation exchange capacity - 0.01 M AgTU+]	17.5	cmol/kg
2B1 [As received moisture content]	3.7	%
3A1 [EC of 1:5 soil/water extract]	0.21	dS/m
4A1 [pH of 1:5 soil/water suspension]	5.1	pH
4B1 [pH of 1:5 soil/0.01M CaCl2 extract - direct, no stir]	4	pH
504.02_FC [Field Capacity, SWC pressure plate]	30.1	
504.02_PWP [Permanent Wilt Point, SWC pressure plate]	12.1	
513.98 [Emerson aggregate test SCS method]	3(2)	
514.99 [Dispersion percentage]	34	%
515.01 [Dry aggregate distribution]	95	
517.99_CL [PSA clay - hydrometer]	17	%
517.99_CS [PSA coarse sand - hydrometer]	6	%
517.99_FS [PSA fine sand - hydrometer]	21	%
517.99_GR [PSA gravel - hydrometer]	49	%
517.99_SI [PSA silt - hydrometer]	7	%
518.99 [Volume expansion]	5	
550.01 [Unified Soil Classification System (lab)]	GC	
6A1 [Organic carbon - Walkley & Black]	0.49	%
9E1 [Fluoride-extractable P (Bray 1-P) - manual colour]	3	mg/kg
9I1 [Phosphate sorption index]	534	

For information on laboratory test data and units of measure, please see: Soil survey standard test methods

Report generated on 06/03/2024 at 04:30 PM

To contact us, email: soils@environment.nsw.gov.au

Soil technical Report

WaterNSW
Work Summary

GW073548

Licence: 20WA214328

Licence Status: CURRENT

Authorised Purpose(s): STOCK
Intended Purpose(s): STOCK

Work Type: Bore
Work Status:
Construct.Method: Rotary Air
Owner Type: Private

Commenced Date:
Completion Date: 01/11/1994

Final Depth: 21.20 m
Drilled Depth: 21.20 m

Contractor Name: (None)
Driller: Leon Frederick Hook
Assistant Driller:

Property: N / A Wang Wauk Rd DYERS CROSSING 2429 NSW
GWMA: -
GW Zone: -

Standing Water Level (m):
Salinity Description: 1001-3000 ppm
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	GLOUCESTER	COOLONGOL	12 836779
Licensed:	GLOUCESTER	COOLONGOLOOK	Whole Lot 12//836779

Region: 20 - Hunter
River Basin: 209 - KARUAH RIVER
Area/District:

CMA Map:
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown

Northing: 6443639.000
Easting: 430501.000

Latitude: 32°08'29.5"S
Longitude: 152°15'47.1"E

GS Map: -
MGA Zone: 56
Coordinate Source: GD.,ACC.GIS

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	2.00	190			Rotary Air
1		Hole	Hole	2.00	21.20	165			Rotary Air
1	1	Casing	P.V.C.	-0.30	21.20	125			Seated on Bottom
1	1	Casing	Concrete	0.00	0.50				
1	1	Opening	Slots	6.00	21.20	125		1	Slotted In Hole, PVC Class 9, SL: 0.3mm, A: 2.50mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
7.50	7.60	0.10	Fractured			0.20			
17.50	17.60	0.10	Fractured			0.20			

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	1.00	1.00		Topsoil	
1.00	2.00	1.00	Yellow Shale	Shale	
2.00	21.20	19.20	Blue Shale	Shale	

Remarks

01/11/1994: TDS = 1400 ppm.

Appendix C

Flow Balancing

Effluent Balance

				Effluent Entering Balance Tank (L)	LAA Capacity (L/day)	Stored Wastewater (L)	Stored Wastewater from Previous Day (L)	Cumulative Wastewater Storage (L)	Cumulative Storage Managed by Pumpout (L)	Maximum Storage Requirement (L)	Average daily LAA dose rate (L)	
					630					1,820	169	
17-May	Thursday	Weekday	low	0	630	-630	0	0	0			
18-May	Friday	Weekday	low	0	630	-630	0	0	0			
19-May	Saturday	Weekend	low	0	630	-630	0	0	0			
20-May	Sunday	Weekend	low	0	630	-630	0	0	0			
21-May	Monday	Weekday	low	0	630	-630	0	0	0			
22-May	Tuesday	Weekday	low	0	630	-630	0	0	0			
23-May	Wednesday	Weekday	low	0	630	-630	0	0	0			
24-May	Thursday	Weekday	low	0	630	-630	0	0	0			
25-May	Friday	Weekday	low	0	630	-630	0	0	0			
26-May	Saturday	Weekend	low	2310	630	1,680	0	1,680	1,680			
27-May	Sunday	Weekend	low	770	630	140	1,680	1,820	1,820			
28-May	Monday	Weekday	low	0	630	-630	1,820	1,190	1,190			
29-May	Tuesday	Weekday	low	0	630	-630	1,190	560	560			
30-May	Wednesday	Weekday	low	0	630	-630	560	0	0			
31-May	Thursday	Weekday	low	0	630	-630	0	0	0			May
1-Jun	Friday	Weekday	low	0	630	-630	0	0	0			
2-Jun	Saturday	Weekend	low	2310	630	1,680	0	1,680	1,680			
3-Jun	Sunday	Weekend	low	770	630	140	1,680	1,820	1,820			
4-Jun	Monday	Weekday	low	0	630	-630	1,820	1,190	1,190			
5-Jun	Tuesday	Weekday	low	0	630	-630	1,190	560	560			
6-Jun	Wednesday	Weekday	low	0	630	-630	560	0	0			
7-Jun	Thursday	Weekday	low	0	630	-630	0	0	0			
8-Jun	Friday	Weekday	low	0	630	-630	0	0	0			
9-Jun	Saturday	Weekend	peak	2310	630	1,680	0	1,680	1,680			
10-Jun	Sunday	Weekend	low	770	630	140	1,680	1,820	1,820			
11-Jun	Monday	Weekday	low	0	630	-630	1,820	1,190	1,190			
12-Jun	Tuesday	Weekday	low	0	630	-630	1,190	560	560			
13-Jun	Wednesday	Weekday	low	0	630	-630	560	0	0			
14-Jun	Thursday	Weekday	low	0	630	-630	0	0	0			
15-Jun	Friday	Weekday	low	0	630	-630	0	0	0			
16-Jun	Saturday	Function	low	2310	630	1,680	0	1,680	1,680			
17-Jun	Sunday	Weekend	low	770	630	140	1,680	1,820	1,820			
18-Jun	Monday	Weekend	low	0	630	-630	1,820	1,190	1,190			
19-Jun	Tuesday	Weekend	low	0	630	-630	1,190	560	560			
20-Jun	Wednesday	Weekend	low	0	630	-630	560	0	0			
21-Jun	Thursday	Weekend	low	0	630	-630	0	0	0			
22-Jun	Friday	Weekend	low	0	630	-630	0	0	0			
23-Jun	Saturday	Function	low	2310	630	1,680	0	1,680	1,680			
24-Jun	Sunday	Weekend	low	770	630	140	1,680	1,820	1,820			
25-Jun	Monday	Weekend	low	0	630	-630	1,820	1,190	1,190			
26-Jun	Tuesday	Weekend	low	0	630	-630	1,190	560	560			
27-Jun	Wednesday	Weekend	low	0	630	-630	560	0	0			
28-Jun	Thursday	Weekend	low	0	630	-630	0	0	0			
29-Jun	Friday	Weekend	low	0	630	-630	0	0	0			
30-Jun	Saturday	Function	low	2310	630	1,680	0	1,680	1,680			June
1-Jul	Sunday	Weekend	low	770	630	140	1,680	1,820	1,820			
2-Jul	Monday	Weekend	low	0	630	-630	1,820	1,190	1,190			
3-Jul	Tuesday	Weekend	low	0	630	-630	1,190	560	560			
4-Jul	Wednesday	Weekend	low	0	630	-630	560	0	0			
5-Jul	Thursday	Weekend	low	0	630	-630	0	0	0			
6-Jul	Friday	Weekend	low	0	630	-630	0	0	0			
7-Jul	Saturday	Function	peak	2310	630	1,680	0	1,680	1,680			
8-Jul	Sunday	Weekend	low	770	630	140	1,680	1,820	1,820			
9-Jul	Monday	Weekend	low	0	630	-630	1,820	1,190	1,190			
10-Jul	Tuesday	Weekend	low	0	630	-630	1,190	560	560			
11-Jul	Wednesday	Weekend	low	0	630	-630	560	0	0			
12-Jul	Thursday	Weekend	low	0	630	-630	0	0	0			
13-Jul	Friday	Weekend	low	0	630	-630	0	0	0			
14-Jul	Saturday	Function	low	2310	630	1,680	0	1,680	1,680			
15-Jul	Sunday	Weekend	low	770	630	140	1,680	1,820	1,820			
16-Jul	Monday	Weekend	low	0	630	-630	1,820	1,190	1,190			
17-Jul	Tuesday	Weekend	low	0	630	-630	1,190	560	560			
18-Jul	Wednesday	Weekend	low	0	630	-630	560	0	0			
19-Jul	Thursday	Weekend	low	0	630	-630	0	0	0			
20-Jul	Friday	Weekend	low	0	630	-630	0	0	0			
21-Jul	Saturday	Function	low	2310	630	1,680	0	1,680	1,680			
22-Jul	Sunday	Weekend	low	770	630	140	1,680	1,820	1,820			
23-Jul	Monday	Weekend	low	0	630	-630	1,820	1,190	1,190			
24-Jul	Tuesday	Weekend	low	0	630	-630	1,190	560	560			
25-Jul	Wednesday	Weekend	low	0	630	-630	560	0	0			
26-Jul	Thursday	Weekend	low	0	630	-630	0	0	0			
27-Jul	Friday	Weekend	low	0	630	-630	0	0	0			
28-Jul	Saturday	Function	low	2310	630	1,680	0	1,680	1,680			
29-Jul	Sunday	Weekend	low	770	630	140	1,680	1,820	1,820			
30-Jul	Monday	Weekend	low	0	630	-630	1,820	1,190	1,190			
31-Jul	Tuesday	Weekend	low	0	630	-630	1,190	560	560			July
1-Aug	Wednesday	Weekend	low	0	630	-630	560	0	0			
2-Aug	Thursday	Weekend	low	0	630	-630	0	0	0			
3-Aug	Friday	Weekend	low	0	630	-630	0	0	0			
4-Aug	Saturday	Function	peak	2310	630	1,680	0	1,680	1,680			
5-Aug	Sunday	Weekend	low	770	630	140	1,680	1,820	1,820			
6-Aug	Monday	Weekend	low	0	630	-630	1,820	1,190	1,190			
7-Aug	Tuesday	Weekend	low	0	630	-630	1,190	560	560			
8-Aug	Wednesday	Weekend	low	0	630	-630	560	0	0			
9-Aug	Thursday	Weekend	low	0	630	-630	0	0	0			
10-Aug	Friday	Weekend	low	0	630	-630	0	0	0			
11-Aug	Saturday	Function	low	2310	630	1,680	0	1,680	1,680			
12-Aug	Sunday	Weekend	low	770	630	140	1,680	1,820	1,820			
13-Aug	Monday	Weekend	low	0	630	-630	1,820	1,190	1,190			
14-Aug	Tuesday	Weekend	low	0	630	-630	1,190	560	560			
15-Aug	Wednesday	Weekend	low	0	630	-630	560	0	0			
16-Aug	Thursday	Weekend	low	0	630	-630	0	0	0			
17-Aug	Friday	Weekend	low	0	630	-630	0	0	0			
18-Aug	Saturday	Function	low	2310	630	1,680	0	1,680	1,680			
19-Aug	Sunday	Weekend	low	770	630	140	1,680	1,820	1,820			
20-Aug	Monday	Weekend	low	0	630	-630	1,820	1,190	1,190			
21-Aug	Tuesday	Weekend	low	0	630	-630	1,190	560	560			
22-Aug	Wednesday	Weekend	low	0	630	-630	560	0	0			
23-Aug	Thursday	Weekend	low	0	630	-630	0	0	0			
24-Aug	Friday	Weekend	low	0	630	-630	0	0	0			
25-Aug	Saturday	Function	low	2310	630	1,680	0	1,680	1,680			
26-Aug	Sunday	Weekend	low	770	630	140	1,680	1,820	1,820			
27-Aug	Monday	Weekend	low	0	630	-630	1,820	1,190	1,190			
28-Aug	Tuesday	Weekend	low	0	630	-630	1,190	560	560			
29-Aug	Wednesday	Weekend	low	0	630	-630	560	0	0			
30-Aug	Thursday	Weekend	low	0	630	-630	0	0	0			
31-Aug	Friday	Weekend	low	0	630	-630	0	0	0			August
1-Sep	Saturday	Function	shoulder	2310	630	1,680	0	1,680	1,680			
2-Sep	Sunday	Weekend	shoulder	770	630	140	1,680	1,820	1,820			
3-Sep	Monday	Weekend	shoulder	0	630	-630	1,820	1,190	1,190			
4-Sep	Tuesday	Weekend	shoulder	0	630	-630	1,190	560	560			
5-Sep	Wednesday	Weekend	shoulder	0	630	-630	560	0	0			
6-Sep	Thursday	Weekend	shoulder	0	630	-630	0	0	0			
7-Sep	Friday	Weekend	shoulder	0	630	-630	0	0	0			
8-Sep	Saturday	Function	peak	2310	630	1,680	0	1,680	1,680			
9-Sep	Sunday	Weekend	shoulder	770	630	140	1,680	1,820	1,820			
10-Sep	Monday	Weekend	shoulder	0	630	-630	1,820	1,190	1,190			
11-Sep	Tuesday	Weekend	shoulder	0	630	-630	1,190	560	560			
12-Sep	Wednesday	Weekend	shoulder	0	630	-630	560	0	0			
13-Sep	Thursday	Weekend	shoulder	0	630	-630	0	0	0			
14-Sep	Friday	Weekend	shoulder	0	630	-630	0	0	0			
15-Sep	Saturday	Function	peak	2310	630	1,680	0	1,680	1,680			
16-Sep	Sunday	Weekend	shoulder	770	630	140	1,680	1,820	1,820			
17-Sep	Monday	Weekend	shoulder	0	630	-630	1,820	1,190	1,190			
18-Sep	Tuesday	Weekend	shoulder	0	630	-630	1,190	560	560			
19-Sep	Wednesday	Weekend	shoulder	0	630	-630	560	0	0			
20-Sep	Thursday	Weekend	shoulder	0	630	-630	0	0	0			
21-Sep	Friday	Weekend	shoulder	0	630	-630	0	0	0			
22-Sep	Saturday	Function	shoulder	2310	630	1,680	0	1,680	1,680			
23-Sep	Sunday	Weekend	shoulder	770	630	140	1,680	1,820	1,820			
24-Sep	Monday	Weekend	shoulder	0	630	-630	1,820	1,190	1,190			
25-Sep	Tuesday	Weekend	shoulder	0	630	-630	1,190	560	560			
26-Sep	Wednesday	Weekend	shoulder	0	630	-630	560	0	0			
27-Sep	Thursday	Weekend	shoulder	0	630	-630	0	0	0			
28-Sep	Friday	Weekend	shoulder	0	630	-630	0	0	0			
29-Sep	Saturday	Weekend	shoulder	2310	630	1,680	0	1,680	1,680			
30-Sep	Sunday	Weekend	shoulder	770	630	140	1,680	1,820	1,820			September
1-Oct	Monday	Weekend	shoulder	0	630	-630	1,820	1,190	1,190			
2-Oct	Tuesday	Weekend	shoulder	0	630	-630	1,190	560	560			
3-Oct	Wednesday	Weekend	shoulder	0	630	-630	560	0	0			
4-Oct	Thursday	Weekday	shoulder	0	630	-630	0	0	0			
5-Oct	Friday	Weekday	shoulder	0	630	-630	0	0	0			
6-Oct	Saturday	Weekend	peak	2310	630	1,680	0	1,680	1,680			
7-Oct	Sunday	Weekend	shoulder	770	630	140	1,680	1,820	1,820			
8-Oct	Monday	Weekday	shoulder	0	630	-630	1,820	1,190	1,190			
9-Oct	Tuesday	Weekday	shoulder	0	630	-630	1,190	560	560			
10-Oct	Wednesday	Weekday	shoulder	0	630	-630	560	0	0			
11-Oct	Thursday	Weekday	shoulder	0	630	-630	0	0	0			
12-Oct	Friday	Weekday	shoulder	0	630	-630	0	0	0			
13-Oct	Saturday	Weekend	peak	0	630	-630	0	0	0			
14-Oct	Sunday	Weekend	shoulder	0	630	-630	0	0	0			
15-Oct	Monday	Weekday	shoulder	0	630	-630	0	0	0			
16-Oct	Tuesday	Weekday	shoulder	0	630	-630	0	0	0			
17-Oct	Wednesday	Weekday	shoulder	0	630	-630	0	0	0			
18-Oct	Thursday	Weekday	shoulder	0	630	-630	0	0	0			
19-Oct	Friday	Weekday	shoulder	0	630	-630	0	0	0			
20-Oct	Saturday	Weekend	shoulder	0	630	-630	0	0	0			
21-Oct	Sunday	Weekend	shoulder	0	630	-630	0	0	0			
22-Oct	Monday	Weekday	shoulder	0	630	-630	0	0	0			
23-Oct	Tuesday	Weekday	shoulder	0	630	-630	0	0	0			
24-Oct	Wednesday	Weekday	shoulder	0	630	-630	0	0	0			
25-Oct	Thursday	Weekday	shoulder	0	630	-630	0	0	0			
26-Oct	Friday	Weekday	shoulder	0	630	-630	0	0	0			
27-Oct	Saturday	Weekend	shoulder	0	630	-630	0	0	0			
28-Oct	Sunday	Weekend	shoulder	0	630	-630	0	0	0			
29-Oct	Monday	Weekday	shoulder	0	630	-630	0	0	0			
30-Oct	Tuesday	Weekday	shoulder	0	630	-630	0	0	0			
31-Oct	Wednesday	Weekday	shoulder	0	630	-630	0	0	0			October

Appendix D

Water and Nutrient Balance

Water Balance & Storage Calculations - Bed Design

Site Address: 3670: 851 Wang Wauk Rd, Wang Wauk NSW

Whitehead & Associates
Environmental Consultants

INPUT DATA

Design Wastewater Flow	Q	1,320	L/day	Peak wastewater generation day (7-bedrooms)
Design Loading Rate	DLR	5.0	mm/day	Litres/m^2/day - based on Table L1 AS/NZS 1547:2012; weakly structured light clay & primary treatment
Nominated Land Application Area	L	285.00	m^2	Existing Bed area
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
Void Space Ratio	V	0.4	unitless	Proportion of bed/trench that is available for storage (assumes aggregate)
Rainfall Data		SILO Data -32.15, 152.25		Median Monthly data (60 years)
Evaporation Data		TAREE (PATANGA CL) - 060030		Mean Daily Evaporation (142 years)

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	**365**
Rainfall	R		mm/month	99.5	100.2	137.8	60.4	49.2	67.2	29.8	30.5	33.7	58.3	89.7	74.6	99.5	100.2	137.8	60.4	49.2	67.2	**1016.6**
Evaporation			mm/day	5.7	5.1	4.2	3.2	2.1	1.9	1.9	2.6	3.7	4.6	5.3	6	5.7	5.1	4.2	3.2	2.1	1.9	
Evaporation	E		mm/month	176.7	142.8	130.2	96.0	65.1	57.0	58.9	80.6	111.0	142.6	159.0	186.0	176.7	142.8	130.2	96.0	65.1	57.0	**1,405.9**
Crop Factor	C			0.80	0.80	0.70	0.70	0.60	0.60	0.60	0.70	0.70	0.80	0.80	0.80	0.80	0.80	0.70	0.70	0.60	0.60	
OUTPUTS (LOSSES)																						
Evapotranspiration	ET	ExC	mm/month	141.4	114.2	91.1	67.2	39.1	34.2	35.3	56.4	77.7	114.1	127.2	148.8	141.4	114.2	91.1	67.2	39.1	34.2	**1,046.7**
Percolation	B	DLRxD	mm/month	155.0	140.0	155.0	150.0	155.0	150.0	155.0	155.0	150.0	155.0	150.0	155.0	155.0	140.0	155.0	150.0	155.0	150.0	**1,825.0**
Outputs		ET+B	mm/month	296.4	254.2	246.1	217.2	194.1	184.2	190.3	211.4	227.7	269.1	277.2	303.8	296.4	254.2	246.1	217.2	194.1	184.2	**2,871.7**
INPUTS (GAINS)																						
Retained Rainfall	RR	RxRC	mm/month	79.6	80.2	110.2	48.3	39.4	53.8	23.8	24.4	27.0	46.6	71.8	59.7	79.6	80.2	110.2	48.3	39.4	53.8	**664.7**
Applied Effluent	W	(QxD)/L	mm/month	143.6	129.7	143.6	138.9	143.6	138.9	143.6	143.6	138.9	143.6	138.9	143.6	143.6	129.7	143.6	138.9	143.6	138.9	**1,690.5**
Inputs		RR+W	mm/month	223.2	209.8	253.8	187.3	182.9	192.7	167.4	168.0	165.9	190.2	210.7	203.3	223.2	209.8	253.8	187.3	182.9	192.7	**2,355.2**
STORAGE CALCULATION (Δ)																						
Storage remaining from previous month			mm/month	0.0	0.0	0.0	19.2	0.0	0.0	21.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.2	0.0	0.0	
Storage for the month	S	((RR+W)-(ET+B))/V	mm/month	-183.0	-111.0	19.2	-74.8	-27.8	21.3	-57.3	-108.6	-154.5	-197.2	-166.2	-251.4	-183.0	-111.0	19.2	-74.8	-27.8	21.3	
Cumulative Storage	M		mm	0.0	0.0	19.2	0.0	0.0	21.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.2	0.0	0.0	21.3	
Maximum Storage Depth for Nominated Area	N		mm	21																		
Maximum Storage Vol. for Nominated Area	V	(NxL)/1000	m^3	6																		
BOTTOM AREA REQUIRED FOR ZERO STORAGE			m^2	189	212	301	234	265	304	246	219	197	184	193	168	189	212	301	234	265	304	

MINIMUM BOTTOM AREA REQUIRED FOR ZERO STORAGE: 304 m^2

Value is based on the worst month of the year, so the balance overestimates the storage requirement for all other months. Assumes zero effluent depth (storage) in trench/bed. Model is run for 18-months to ensure trench/bed empties at least once per cycle.

Bed Dimensions (m)	**Width =**	4.7	**Depth =**	0.3	**No. of Trenches/Beds**		3.0	
Required Bed Length (m) =		60.64			**Interval spacing (m)**	**(m) =**	1	Minimum spacing is 1 metre
Design Bed Length (m) =		20.20	(Max) recommended trench/bed length is 20m (primary)		**Total EMA Area**	**(m^2) =**	325	Total area includes spacing between beds plus boundary buffer of 1.5 metres

Water Balance & Storage Calculations - Bed Design

Site Address: 3670: 851 Wang Wauk Rd, Wang Wauk NSW

Whitehead & Associates
Environmental Consultants

INPUT DATA

Design Wastewater Flow	Q	630	L/day	Peak wastewater generation day
Design Loading Rate	DLR	5.0	mm/day	Litres/m^2/day - based on Table L1 AS/NZS 1547:2012; weakly structured silty clay topsoil & primary treatment
Nominated Land Application Area	L	145.00	m^2	Existing Bed area
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
Void Space Ratio	V	0.5	unitless	Proportion of bed/trench that is available for storage (assumes aggregate)
Rainfall Data		SILO Data -32.15, 152.25		Median Monthly data (60 years)
Evaporation Data		TAREE (PATANGA CL) - 060030		Mean Daily Evaporation (142 years)

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	**365**
Rainfall	R		mm/month	99.5	100.2	137.8	60.4	49.2	67.2	29.8	30.5	33.7	58.3	89.7	74.6	99.5	100.2	137.8	60.4	49.2	67.2	**1016.6**
Evaporation			mm/day	5.7	5.1	4.2	3.2	2.1	1.9	1.9	2.6	3.7	4.6	5.3	6	5.7	5.1	4.2	3.2	2.1	1.9	
Evaporation	E		mm/month	176.7	142.8	130.2	96.0	65.1	57.0	58.9	80.6	111.0	142.6	159.0	186.0	176.7	142.8	130.2	96.0	65.1	57.0	**1,405.9**
Crop Factor	C			0.80	0.80	0.70	0.70	0.60	0.60	0.60	0.70	0.70	0.80	0.80	0.80	0.80	0.80	0.70	0.70	0.60	0.60	
OUTPUTS (LOSSES)																						
Evapotranspiration	ET	ExC	mm/month	141.4	114.2	91.1	67.2	39.1	34.2	35.3	56.4	77.7	114.1	127.2	148.8	141.4	114.2	91.1	67.2	39.1	34.2	**1,046.7**
Percolation	B	DLRxD	mm/month	155.0	140.0	155.0	150.0	155.0	150.0	155.0	155.0	150.0	155.0	150.0	155.0	155.0	140.0	155.0	150.0	155.0	150.0	**1,825.0**
Outputs		ET+B	mm/month	296.4	254.2	246.1	217.2	194.1	184.2	190.3	211.4	227.7	269.1	277.2	303.8	296.4	254.2	246.1	217.2	194.1	184.2	**2,871.7**
INPUTS (GAINS)																						
Retained Rainfall	RR	RxRC	mm/month	79.6	80.2	110.2	48.3	39.4	53.8	23.8	24.4	27.0	46.6	71.8	59.7	79.6	80.2	110.2	48.3	39.4	53.8	**664.7**
Applied Effluent	W	(QxD)/L	mm/month	134.7	121.7	134.7	130.3	134.7	130.3	134.7	134.7	130.3	134.7	130.3	134.7	134.7	121.7	134.7	130.3	134.7	130.3	**1,585.9**
Inputs		RR+W	mm/month	214.3	201.8	244.9	178.7	174.0	184.1	158.5	159.1	157.3	181.3	202.1	194.4	214.3	201.8	244.9	178.7	174.0	184.1	**2,250.6**
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))/V	mm/month	-164.1	-104.8	-2.4	-77.1	-40.0	-0.2	-63.6	-104.7	-140.8	-175.5	-150.2	-218.9	-164.1	-104.8	-2.4	-77.1	-40.0	-0.2	
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 Depth for Nominated Area	N		mm	0																		
Maximum Storage Vol. for Nominated Area	V	(NxL)/1000	m^3	0																		
BOTTOM AREA REQUIRED FOR ZERO STORAGE			m^2	90	101	144	112	126	145	117	104	94	88	92	80	90	101	144	112	126	145	

MINIMUM BOTTOM AREA REQUIRED FOR ZERO STORAGE: 145 m^2

Value is based on the worst month of the year, so the balance overestimates the storage requirement for all other months. Assumes zero effluent depth (storage) in trench/bed. Model is run for 18-months to ensure trench/bed empties at least once per cycle.

Bed Dimensions (m)	Width =	6.3	Depth =	0.3	**No. of Trenches/Beds**		1
Required Bed Length (m) =		23.02			**Interval spacing (m)**	(m) =	1 Minimum spacing is 1 metre
Design Bed Length (m) =		23.00	(Max) recommended trench/bed length is 20m (primary)		**Total EMA Area**	(m^2) =	145 Total area includes spacing between beds plus boundary buffer of 1.5 metres

Nutrient Balance

Whitehead & Associates
Environmental Consultants

3670: 851 Wang Wauk Rd, Wang Wauk NSW

Please read the attached notes before using this spreadsheet.

SUMMARY - LAND APPLICATION AREA REQUIRED BASED ON THE MOST LIMITING BALANCE = 889 m^2

INPUT DATA [1]

Wastewater Loading			Nutrient Crop Uptake					
Hydraulic Load	1,320	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	15,840	mg/day	P-sorption result	534	mg/kg	which equals	5,233	kg/ha
Remaining N Load after soil loss	63,360	mg/day	Bulk Density	1.4	g/cm^3			
Effluent P Concentration	15	mg/L	Depth of Soil	0.7	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	889	m^2	Nominated LAA Size	285	m^2
Phosphorus	878	m^2	Predicted N Export from LAA	15.72	kg/year
			Predicted P Export from LAA	4.88	kg/year
			Phosphorus Longevity for LAA	12	Years
			Minimum Buffer Required for excess nutrient	604	m^2

PHOSPHORUS BALANCE
STEP 1: Using the nominated LAA Size

Nominated LAA Size	**285**	m^2			
Daily P Load	0.0198	kg/day	→ Phosphorus generated over life of system	361.35	kg
Daily Uptake	0.0023425	kg/day	→ Phosphorus vegetative uptake for life of system	0.150	kg/m^2
Measured p-sorption capacity	0.52332	kg/m^2			
Assumed p-sorption capacity	0.262	kg/m^2	→ Phosphorus adsorbed in 50 years	0.262	kg/m^2
Site P-sorption capacity	74.57	kg	→ Desired Annual P Application Rate	2.346	kg/year
			which equals	0.00643	kg/day
P-load to be sorbed	6.37	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.

Nutrient Balance

Whitehead & Associates
Environmental Consultants

3670: 851 Wang Wauk Rd, Wang Wauk NSW

Please read the attached notes before using this spreadsheet.

SUMMARY - LAND APPLICATION AREA REQUIRED BASED ON THE MOST LIMITING BALANCE = 425 m^2

INPUT DATA [1]

Wastewater Loading			Nutrient Crop Uptake					
Hydraulic Load	630	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	7,560	mg/day	P-sorption result	534	mg/kg	which equals	5,233	kg/ha
Remaining N Load after soil loss	30,240	mg/day	Bulk Density	1.4	g/cm^3			
Effluent P Concentration	15	mg/L	Depth of Soil	0.7	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	425	m^2
Phosphorus	419	m^2

Determination of Buffer Zone Size for a Nominated Land Application Area (LAA)		
Nominated LAA Size	145	m^2
Predicted N Export from LAA	7.27	kg/year
Predicted P Export from LAA	2.26	kg/year
Phosphorus Longevity for LAA	13	Years
Minimum Buffer Required for excess nutrient	280	m^2

PHOSPHORUS BALANCE

STEP 1: Using the nominated LAA Size

Nominated LAA Size	**145**	m^2			
Daily P Load	0.00945	kg/day	→ Phosphorus generated over life of system	172.4625	kg
Daily Uptake	0.0011918	kg/day	→ Phosphorus vegetative uptake for life of system	0.150	kg/m^2
Measured p-sorption capacity	0.52332	kg/m^2			
Assumed p-sorption capacity	0.262	kg/m^2	→ Phosphorus adsorbed in 50 years	0.262	kg/m^2
Site P-sorption capacity	37.94	kg	→ Desired Annual P Application Rate	1.194	kg/year
			which equals	0.00327	kg/day
P-load to be sorbed	3.01	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 E
Buffer Risk Assessment Matrix and Viral Die-off

Project	3670 - 851 Wang Wauk Rd, Wang Wauk NSW				AS1547:2012 Table R1 and R2 Buffer Distance Justification																	
		Constraint Scale			Risk Assessment									Revised Risk Assessment							Adopted Buffer Distance	
Site Feature	Site Constraint Items of Concern	Low Constraint	High Constraint	Applicable Constraint	Risk Assessment	Low (1)		Moderate (2)		High (3)		Risk Rating	Mitigation Measures	Low (1)		Moderate (2)		High (3)		Revised Risk Rating	Standard DLG Buffer (m)	Minimum Acceptable Buffer (m)
Surface Water 15m (low) - 100m (high)	Microbial Quality of Effluent	Secondary treated effluent (with disinfection) and Contractual Service Agreement	Primary treated effluent (no disinfection)	Primary treated effluent (no disinfection)	**High**		**0**		**0**	✓	**3**	**Moderate (<15)**			**0**		**0**	✓	**3**	**Low (<10)**	40m to intermittent watercourses as per AS/NZS 1547:2012	**15-30**
	Surface Water	Category 1 to 3 soils no surface water down gradient within 100m; low rainfall area	Category 4 to 6 soils permanent surface water <50m down gradient; high rainfall; high resource / environmental value	Category 5 soils permanent surface water 70m down gradient; moderate rainfall	**Moderate**		**0**	✓	**2**		**0**		Flow balancing of irrigation chamber allowing for low loading rate and mitigating surcharge potential	✓	**1**		**0**		**0**			
	Slope	0-6% (surface effluent application), 0 -10% (subsurface effluent application)	>10% (surface effluent application), >30% subsurface effluent application	1% slope with sub-surface application	**Low**	✓	**1**		**0**		**0**			✓	**1**		**0**		**0**			
	Position of Land Application Area in Landscape	Downgradient of surface water, property boundary, recreational area	Upgradient of surface water, property boundary, recreational area	15m upgradient of intermittent waterway and 70m upgradient of permanent waterway	**Moderate**		**0**	✓	**2**		**0**				**0**	✓	**2**		**0**			
	Drainage	Category 1 to 2 soils; gently sloping area	Category 6 soils; sites with visible seepage; moisture tolerant vegetation; low lying area	Category 5 soils; slight mottling, 1% slope, no water tolerant vegetation	**Low**	✓	**1**		**0**		**0**			✓	**1**		**0**		**0**			
	Flood Potential	Above 1 in 20 year flood contour	Below 1 in 20 year flood contour	Proposed LAA above 1 in 20 year flood contour	**Low**	✓	**1**		**0**		**0**			✓	**1**		**0**		**0**			
	Application Method	Drip irrigation or subsurface application of effluent	Surface / above ground application of effluent	Subsurface application	**Low**	✓	**1**		**0**		**0**			✓	**1**		**0**		**0**			

Beavers, Cromer, Gardner Viral Dieoff Model (refer Cromer *et al.*, 2001)

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Step 1 — Use Figure 1 in Cromer *et al.* (2001) (reproduced below) to determine days travel time using groundwater temperature* and a selected order of magnitude reduction.

* If mean groundwater temperature is unavailable, mean daily air temperature can be used in most cases.

Groundwater Temperature (^oC)	12	mean min temp. BOM: 060030 TAREE (PATANGA CL)
Order of magnitude reduction	6	
Days required for viral reduction	**80**	(from Figure 1, below)

Step 2 — Calculate the predicted travel distance using Equation 4 from Cromer *et al.* (2001).
Dg = (t-d_v.P/K)/(P/K.I)

Time in days	t =	80	days	See notes below for description of values
Effective porosity of soil (fraction)	P =	0.52		
Saturated hydraulic conductivity	K =	0.06	m/day	
Groundwater gradient (fraction)	I =	0.1		
Vertical drainage before entering groundwater	d_v =	1.2	m	

Setback Distance	**Distance travelled in groundwater**	**d_g =**	**0.8**	**m**

Notes:

Porosity (P):	Assume weakly structured medium clay 52% (Hazelton & Murphy
Ksat (K):	weakly structured silty clay, inferred Ksat of 0.06m/day (*AS/NZS 1547:2012*).
Groundwater gradient (I):	Assume max groundwater gradient of 10%
Vertical drainage (d_v):	Assume 1.2m of unsaturated flow before reaching groundwater

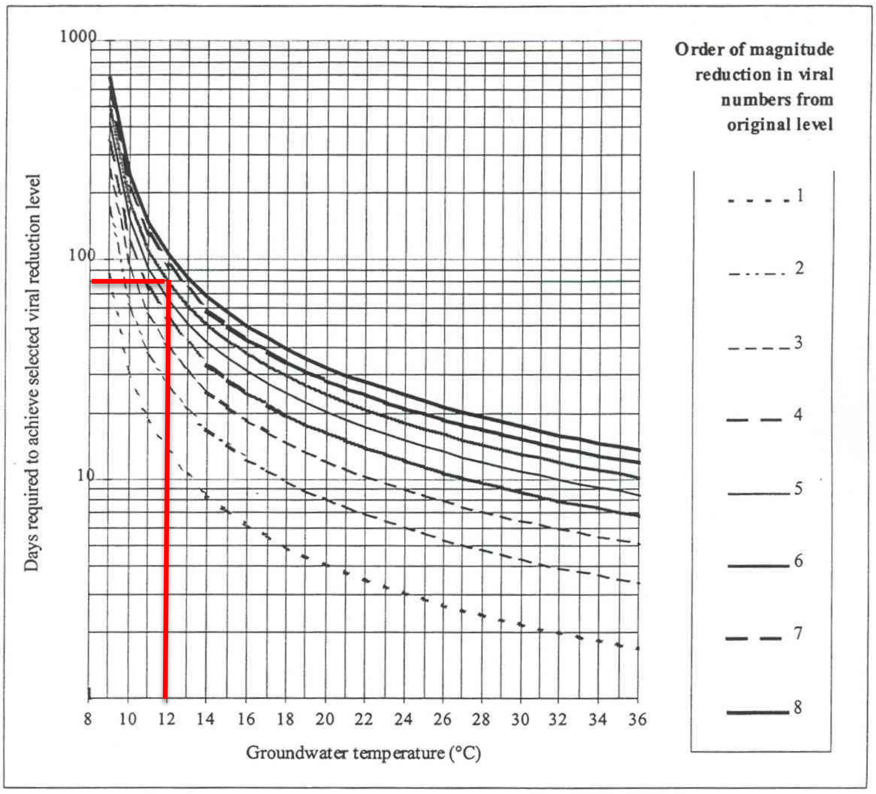

Figure 1. Relationship between Groundwater Temperature and Viral Die-Off Time for Various Order-of-Magnitude Reductions in Viral Numbers

(Figure 1 taken from Cromer et al., 2001)

Appendix F

General Notes on Soil Chemistry

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.