On-Site Wastewater Assessment

Proposed rezoning of 70 Manifold Rd, North Casino (Lot 21 DP601461)

CLIENT	Jestermond Pty Ltd (Simon Dougherty)
REPORT	2310-04 Rev 4
DATE	23 October 2024

NORTH COAST WASTEWATER SOLUTIONS

EXECUTIVE SUMMARY

North Coast Wastewater Solutions (NCWS) was engaged by the property owner to investigate and undertake an on-site wastewater feasibility assessment for a proposed rezoning of 70 Manifold Rd, North Casino (Lot 21 DP601461) to R5 Large Lot Residential.

The purpose of this report is to assess site and soil constraints and provide a land capability assessment of the subject property to determine whether the land is suitable for onsite wastewater management for future dwellings in accordance with Richmond Valley Council's Onsite Sewage and Wastewater Management Strategy 2018.

Modelling to determine required future effluent disposal areas was undertaken on a standard 4-bedroom dwelling with 5 persons in accordance with the RVC OSSM Strategy 2018, with passive low tech wastewater treatment systems adopted where possible.

The proposed minimum lot size for the land subject to rezoning proposal is 7500m^2 for the land to be rezoned to R5.

Site Constraints

A site and soil evaluation was undertaken by NCWS on 30 October 2023. The site was assessed to identify constraints to on-site wastewater management in accordance with AS1547:2012 and Richmond Valley Council OSSM Strategy 2018.

The key limitations on this site that were addressed in the assessment were landform and drainage gullies. Site photos are included in Appendix A.

Site Constraints	Description	Comment/Management Response
Landform	The landform across the site is generally a hill crest or side slope. There is a general depression running north-south through the property which has potential to concentrate stormwater runoff however the land from widens back out spreading any drainage water.	Areas of potential concentrated stormwater flow are generally not suitable for effluent land application. The general drainage depression has been considered as a site limitation in the rezoning assessment, however the depression has the steeper slopes and tree vegetation so is unlikely to be used for future effluent land application areas. Future subdivision earthworks and road and drainage construction will alter the path of stormwater flows.
Watercourses and Drainage Lines	Watercourse – there are no watercourses within 100m of the subject property Gullies – a drainage gully and farm dam were identified on the neighbouring property to the south.	Future land application areas will be required to be located minimum 40m setback distance to the gully and dam. This has been adopted as a site limitation in the rezoning assessment.

Soil Constraints

The soil types are consistent across the subject property and are generally sandy loam topsoils overlying clay loam/light clays. The most limiting soil layer in the boreholes for wastewater disposal is a **moderately structured Light Clay (Category 5)** subsoil which occurs from 500mm below natural ground surface.

This most limiting soil type has a Design Loading Rate (DLR) of 5mm/day for primary treated effluent and 10mm for secondary treated effluent. This limiting soil type has been adopted for further modelling of the land application area requirements for rezoning assessment purposes.

There were some coarse fragments present in the soils but not in sufficient quantity or size to impede the flow of water into the soil. The pH is below the desired range for effluent disposal in some areas and secondary treatment may be required to reduce nutrient loading of the treated effluent. The soils are not dispersive. Groundwater is assumed to be at least 5m below surface. Bedrock is assumed to be 3m deep.

Design of future OSSM systems for each lot will require soil tests from within each lot to determine the required level of treatment and size of the OSSM system components.

Land Application Area Modelling

Preliminary modelling to determine land application areas for future residential lots was undertaken on a standard 4-bedroom dwelling with rainwater supply equivalent to 600L/day wastewater generation.

Both primary and secondary treatment systems have been modelled to determine the maximum land application areas required and ensure the widest range of options are maintained through this development stage.

The land application area (LAA) required for effluent disposal was determined using a water and nutrient balance model and results are shown in the table below for different treatment and land application systems. Wastewater model results are provided in Appendix C.

Treatment/Land Application System	Example	Hydraulic Area (m^2)	Nitrogen Area (m^2)	Phosphorus Area (m^2)	Reed Bed Area (m^2)
Primary treatment with trenches (**passive**)	Septic tank + ETA beds	155.6	169.0	61.9	-
Secondary treatment with trenches (**passive**)	Septic tank, reed bed + ETA Beds	73.6	0.0	61.9	19.5

Secondary treatment with trenches	AWTS + ETA Beds	68.4	1.0	61.9	-
Secondary treatment with subsurface irrigation	AWTS + subsurface irrigation	279.3	1.0	61.9	-

For the purposes of rezoning assessment, and to maintain the most available options for wastewater management at this stage of the development, it is recommended an area of 300m^2 is required for effluent disposal. A duplicate 300m^2 is required to provide a reserve area for future replacement, upgrade or expansion of the wastewater management system.

The lots are also suitable for future dual occupancy developments which can be accommodated within the 300m^2 effluent disposal envelopes by adopting secondary treatment systems.

In addition to providing adequate areas of land for disposal of the hydraulic and nutrient loads, the following minimum requirements for siting of land application areas must be considered in future lot layouts.

- Allow gravity fall from proposed dwelling envelope to land application area
- 40m setback to gully/dam
- 250m to domestic groundwater wells
- 6m up-gradient of property boundaries, swimming pools, driveways and buildings
- 3m down-gradient of property boundaries, swimming pools, driveways and buildings
- 12m up-gradient of property boundaries for ETA beds (though 6m for swimming pools, driveways and buildings)
- 6m down-gradient of property boundaries for ETA beds (though 3m for swimming pools, driveways and buildings)
- 10m from telegraph poles and powerlines

The proposed minimum lot size of 7500m^2 is considered sufficient to accommodate future OSSM systems with suitable setback distances alongside future building envelopes and other land improvements, without adversely impacting the existing environment.

Conclusion

Investigation of the site and soil characteristics across the subject property and preliminary OSSM system design has identified the property has suitable characteristics for on-site wastewater disposal for future residential purposes. The topography and soils found across the site are suitable for passive low-tech wastewater management systems.

Adopting the proposed 7500m^2 minimum lot size will ensure sufficient land is available on each future lot for on-site wastewater management and adverse impacts to existing environmental conditions at the site are not expected.

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Version Control

Revision	Description	Author	Issue Date
1	ISSUED TO CLIENT	Samuel Curran	2/12/2023
2	UPDATED PER NDC COMMENTS	Samuel Curran	3/04/2024
3	UPDATED CONCEPT LOT LAYOUT. INCLUDED REFERENCE TO DUAL OCCS	Samuel Curran	27/07/2024
4	UPDATED REFERENCE TO LOT SIZING	Samuel Curran	23/10/2024

Table of Contents

1. INTRODUCTION

North Coast Wastewater Solutions (NCWS) was engaged by the property owner to investigate and undertake an on-site wastewater feasibility assessment for a proposed rezoning of 70 Manifold Rd, North Casino (Lot 21 DP601461) to R5 Large Lot Residential. Figure 1 on the following page shows the location of the subject property.

The purpose of this report is to assess site and soil constraints and provide a land capability assessment of the subject property to determine whether the land is suitable for onsite wastewater management for future dwellings in accordance with Richmond Valley Council's Onsite Sewage and Wastewater Management Strategy 2018.

Modelling to determine required future effluent disposal areas was undertaken on a standard 4-bedroom dwelling with 5 persons in accordance with the RVC OSSM Strategy 2018, with passive low tech wastewater treatment systems adopted where possible.

The investigations included desktop studies, site and soil assessment, soil analysis and preliminary design of required on-site sewage management (OSSM) systems to service future residential dwellings on the subject property. A site inspection was carried out on the 30 October 2023 by Samuel Curran of NCWS.

The wastewater feasibility assessment has been undertaken in accordance with the Richmond Valley Council On-Site Sewage and Wastewater Management Strategy (2018), Australian Standard AS1547-2012 On-Site Domestic Wastewater Management and the NSW Government guidelines On-Site Sewage Management for Single Households (1998) ("Silver Book").

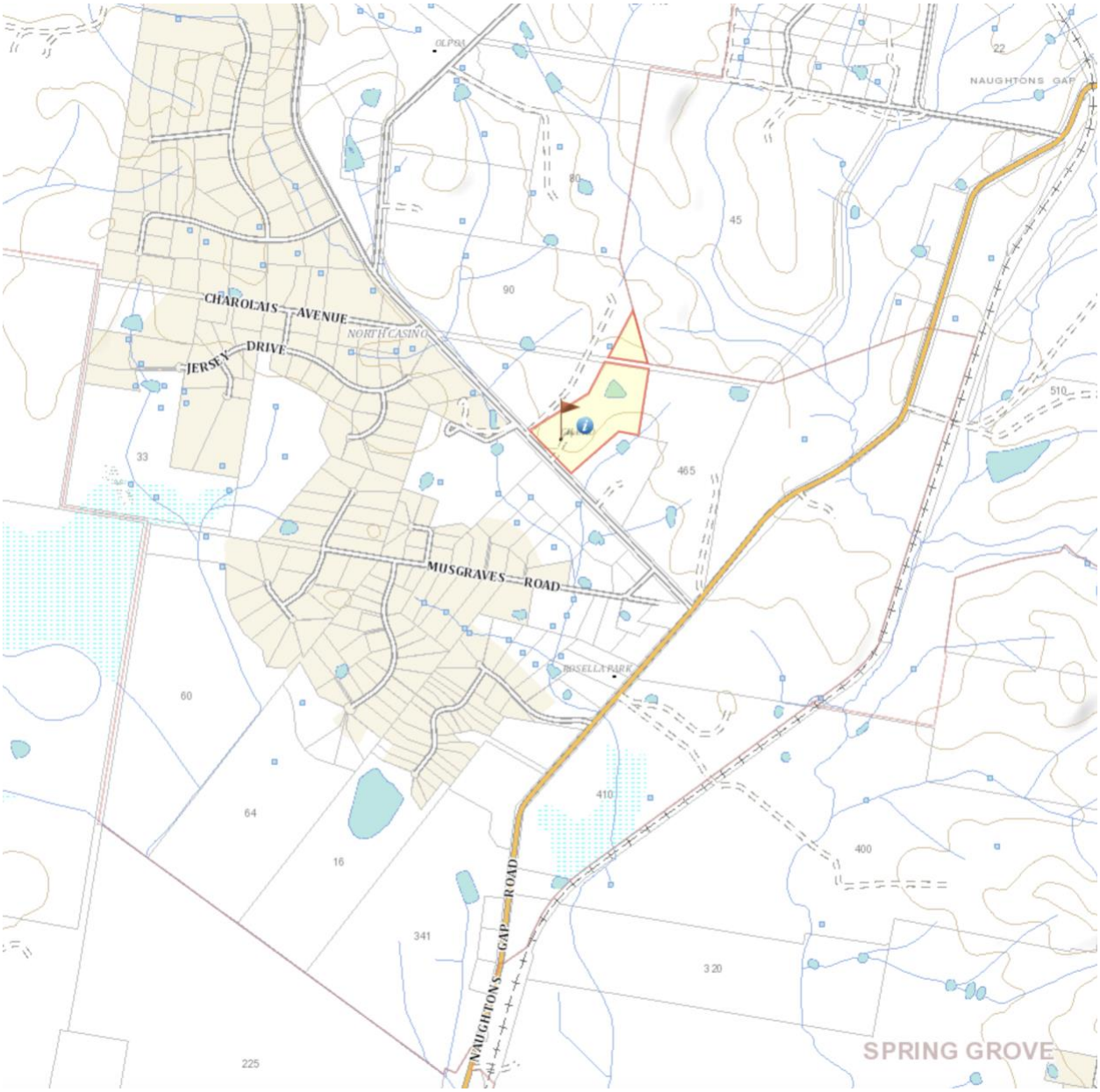


Figure 1 - Location Map (source: SIX MAPS)

1.1. Proposed development

The proposed development is to:

- Rezone the subject land from RU1 – Primary Production to R5 – Large Lot Residential in accordance with the provisions of the Richmond Valley Local Environmental Plan 2012;
- Amend the minimum lot size for subdivision to enable a minimum lot size of 7,500m^2 for the land to be rezoned to R5.

A concept subdivision layout provided in Figure 2 on the following page.

At this stage of the development process, there are no proposed lots or dwellings being created, with subdivision and subsequent construction of dwellings subject to further development planning processes and approvals.

The wastewater feasibility assessment was undertaken across the whole of the proposed R5 Large Lot Residential zoning area on the subject property.

1.2. Site Description

The property is extensively cleared open pasture characterised by gently sloping undulated terrain with slopes generally up to 10% draining towards the south or southeast. A wide depression runs through the northern half of the property. The land is currently used for livestock grazing and residential purposes.

An existing dwelling is located on the subject property with access from Manifold Rd. The dwelling is serviced by a septic system with further details and assessment of this system included in Section 2 of this report.

1.3. Connection to reticulated sewer

The closest sewage treatment plant is the Casino STP located on Spring Grove Rd approximately 4.2km south of the subject property.

Connection to reticulated sewer may be possible, however the distance from the development to the STP is significant and connection is expected to be uneconomical and has not been considered further in this report.

Provision of on-site sewage management systems for the future lots would be consistent with existing rural residential lots in North Casino.

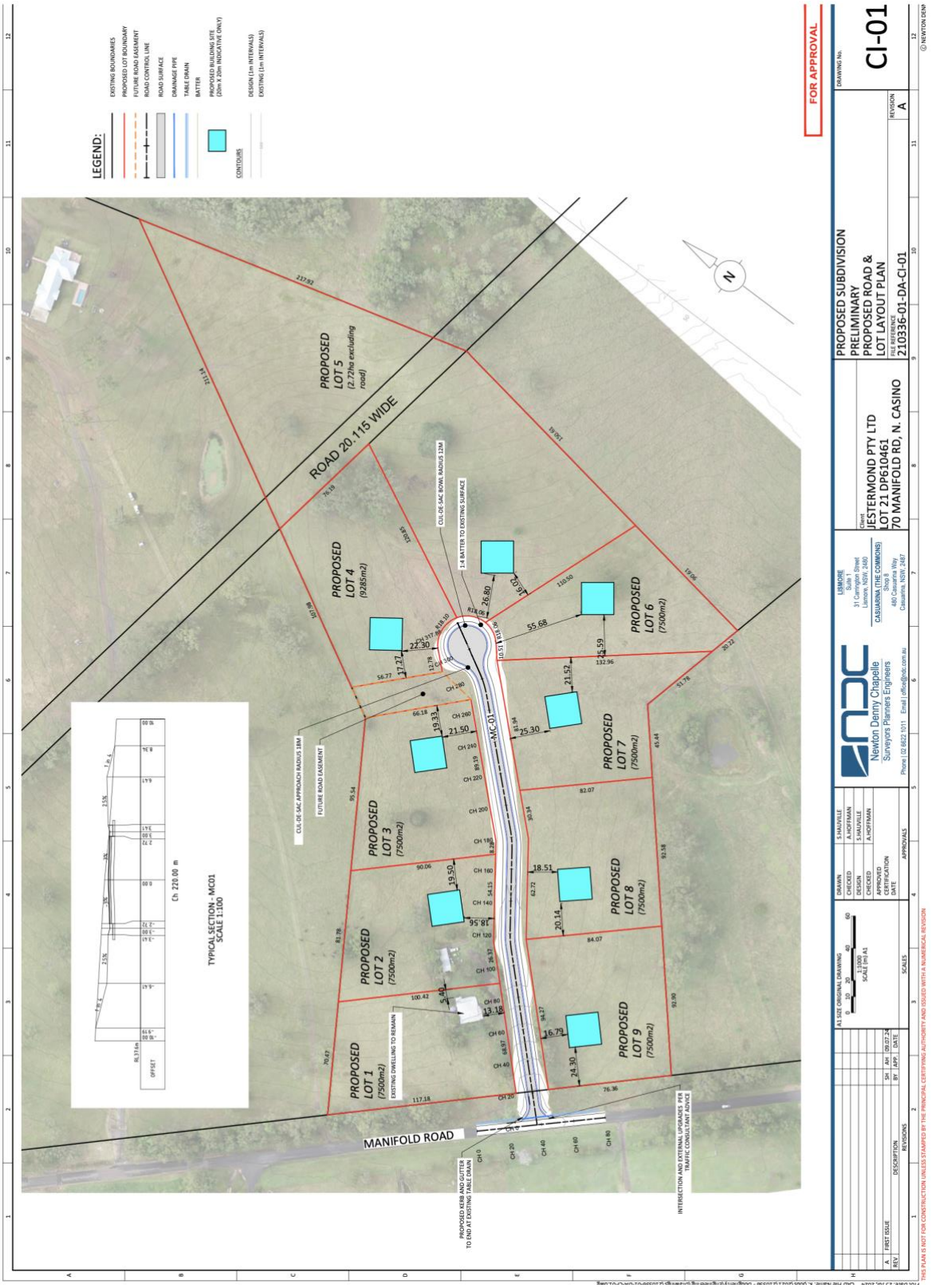


Figure 2 – Concept future lot layout and extent of rezoning (Source: Newton Denny Chapelle)

Figure 3 – Subject property boundary and location of existing septic system (Source: NCWS 30.10.23)

2. ASSESSMENT OF EXISTING OSSM SYSTEM

2.1. Details of Existing OSSM System

The OSSM system servicing the existing dwelling at 70 Manifold Rd, North Casino was inspected by NCWS on 30 October 2023.

The OSSM system comprises of a concrete septic tank and separate greywater discharge. Both disposal areas for the septic tank and greywater had failed, with observed wastewater on ground surface below the septic tank and at the front of the dwelling.

The existing septic system is failing and presents risks to public health and the environment. The OSSM system will need to be upgraded or replaced to ensure compliance with the RVC OSSM Strategy 2018.

An approximate layout of the existing septic system is shown below in Figure 4. Photos of the existing system are shown on the following page.

Figure 4 – Diagram of existing OSSM system (aerial image: NCWS 30.10.2023)

Figure 5 – Existing septic tank

Figure 6 – Discharge point 1

Figure 7 – Discharge point 2

3. SITE ASSESSMENT

3.1. Site Characteristics

A desktop study and site assessment of the property was undertaken to assess constraints and other environmental factors relating to on-site wastewater treatment and disposal. Table 1 below provides a summary of the desktop study and site assessment and highlights specific limitations. Further discussion and review of specific limitations follows. Site photos are included in Appendix A.

Table 1 – Desktop study/site assessment

Property Details				
Address	70 Manifold Rd, North Casino			
Title	Lot 21 DP601461			
Lot size	9.68ha			
Current zoning	RU1 Primary Production			
Date of site assessment	30/10/2023			
Recent weather conditions	30mm rain in previous week. Dry/sunny at time of inspection			
Site Feature	**Limitation Guideline**		**Description**	**Comment/Management Response**
	No limitation	**Limitation**		
Upstream and receiving environment	Upstream or downstream environment same as subject site or less sensitive	Sensitive upstream or downstream environment	Upstream – agricultural land used for livestock grazing. Downstream – agricultural land used for livestock grazing. Gullies and watercourses present to be addressed separately.	Upstream and downstream environments are not considered sensitive environments and do not present limitation to on site wastewater management.
Slope	<15%	>15%	The majority of the land across the subject property has mild slopes less than 15%. There are some minor areas around	No limitation

			the previous dam site with slopes greater than 15% but these are isolated and not significant enough in size to affect future lots.	
Landform	Divergent (drainage-spreading) land shape e.g. hill crests	Convergent (drainage-concentrating) land shape	The landform across the site is generally a hill crest or side slope. There is a general depression running north-south through the property which has potential to concentrate stormwater runoff however the land from widens back out spreading any drainage water.	Areas of potential concentrated stormwater flow are generally not suitable for effluent land application. The general drainage depression has been considered as a site limitation in the rezoning assessment, however the depression has the steeper slopes and tree vegetation so is unlikely to be used for future effluent land application areas. Future subdivision earthworks and road and drainage construction will alter the path of stormwater flows.
Exposure/Aspect	Facing within NW or NE quadrant, and high sunwind exposure	Facing within SW or SE quadrant, and sheltered from sun-wind	Generally south-eastern aspect with high sun and wind exposure.	No limitation. Exposure limitations on individual lots would be considered at later stages of development. Low exposure can be addressed by providing higher level treatment or conservative sizing of the effluent land application areas.
Watercourses and Drainage Lines	>100m to perennial and intermittent watercourse >40m to gullies	<100m to perennial and intermittent watercourse <40m to gullies	Watercourse – there are no watercourses within 100m of the subject property Gullies – a drainage gully and farm dam were identified on the neighbouring property to the south.	Future land application areas will be required to be located minimum 40m setback distance to the gully and dam. This has been adopted as a site limitation in the rezoning assessment.
Groundwater	>250m to domestic groundwater wells	<520m to domestic groundwater wells	Search of the NSW Real Time Water Database identified no	No limitation

Bores/Wells			bores within 250m of the subject property.	
Setback Distances	In the case of SDI, spray or dripper under mulch >6m if up-gradient and >3m if down-gradient of property boundaries, swimming pools, driveways and buildings. (In the case of ETA beds: >12m if up-gradient and >6m if down-gradient of property boundaries, but 6m/3m as above for pools, dwellings etc)	In the case of SDI, spray or dripper under mulch <6m if up-gradient and <3m if down-gradient of property boundaries, swimming pools, driveways and buildings. (In the case of ETA beds: <12m if up-gradient and <6m if down-gradient of property boundaries, but 6m/3m as above for pools, dwellings etc)	A preliminary lot layout has been identified and indicative building envelopes shown in Figure 2.	Proposed lot size will be minimum 7500m^2 which is adequate to accommodate required setback distances to future property boundaries, buildings, pools and driveways. Setback distances will be further addressed in the subdivision assessment and individual OSSM system design.
Run-on/upslope seepage	Minor	Major, where diversion not practical	Minor potential for run-on across future land application areas. No evidence of seepage water.	No limitation for rezoning. Minor diversion drain/bunds are required to be installed upslope of individual OSSM systems as standard.
Flooding Potential	Disposal system above 1 in 20 year flood contour Treatment system above 1 in 100 year flood contour	Disposal system below 1 in 20 year flood contour Treatment system below 1 in 100 year flood contour	Property not subject to flooding	No limitation
Site Drainage	No visible signs of surface dampness	Signs of surface dampness	No signs of dampness	No limitation
Vegetation indicating waterlogging	Absence of sedges etc that indicate waterlogged soil	Presence of sedges etc that indicate waterlogged soil	No signs of vegetation indicating waterlogging	No limitation
Surface Condition	No bare ground or cracking	Bare ground or cracking	Subject property was generally well grassed with some areas of bare ground from recent clearing and demolition of chicken coop structures.	No limitation
Fill	Disposal area not on fill	Disposal area contains fill	No fill material observed on subject property.	No limitation
Erosion/mass movement	No sign of rills, slips	Rills, slips	No erosion, slips or rills observed	No limitation
Boulders/floaters/rock	No exposed rock or rocks on ground	Areas of exposed or rock or rocks on ground	No exposed rock or rocks on	No limitation

outcrops			ground	
Coastal Wetland	Not within Coastal Management SEPP area or proximity area	Within Coastal Management SEPP area or proximity area	Not within Coastal Management SEPP area or proximity area	No limitation
Oyster Aquaculture	Not within zone of influence	Zone of influence - within 100m of the riverbank or tributary and within 10km upstream or downstream (measured along the river) to the nearest Priority Oyster Aquaculture	Not within zone of influence	No limitation
Acid Sulfate Soils	No acid sulfate soils present	Acid sulfate soils present (class 1-5)	Not mapped as acid sulfate soils. No signs of acid sulfate soils present on site	No limitation

3.2. Review of Site Limitations

3.2.1. Landform

The landform is characterised generally by hill crest or side slope with slopes <15%. A drainage depression was identified on the northern half of the property running north-south as shown in Figure 8 below with photos shown in Figure 9 and Figure 10. This area has increased ground slope and the channel shape would be unsuitable for effluent disposal due to the possibility of concentrated stormwater flows. It is recommended this area be excluded from consideration for future effluent disposal areas.

Figure 8 – Drainage depression landform on the subject property (NCWS Drone 30.10.23)

Figure 9 – Drainage depression – looking north

Figure 10 – Drainage depression – looking south

3.2.2. Watercourses and drainage lines

A drainage gully and farm dam were located on the neighbouring property to the south as shown in Figure 11 below. For the purposes of rezoning assessment, future effluent land application areas will be required to maintain 40m setback distance to gully/dam.

The dam that was previously located on the subject property has been removed and the ground reshaped to spread stormwater flows. This drainage depression feature is not considered a drainage gully.

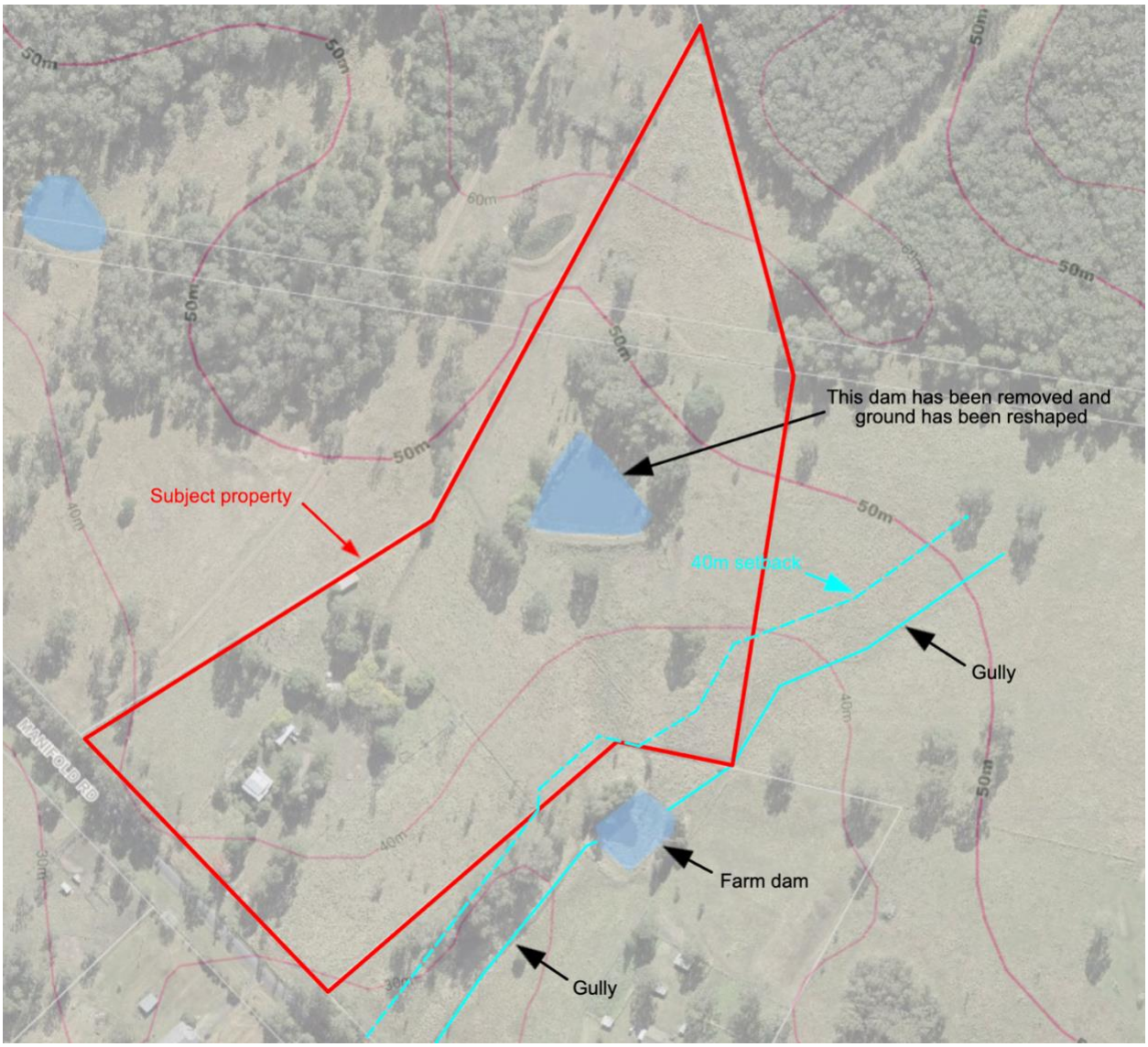


Figure 11 – Drainage gully/dams in relation to subject property (Aerial image: RVC Intramaps)

4. SOIL ASSESSMENT

4.1. Soil Landscape

A desktop review of soil landscape was undertaken using the NSW Soil Landscapes Web Portal.

Table 2 – Soil Landscape

Soil Landscape	Namoona (eSPADE, 2023).
Description	Dominant soils: na1-dark brown loamy sand. Massive to weak. pH 5.0-5.5 na2-brown sandy clay loam. Weak. pH 4.5-5.0 na3-reddish brown clay. Moderate to Strong. pH 4.0-5.0 na4-sandy clay. Massive. pH 8.0-8.5
Typical Limitations	Strongly acid Erodibility Low fertility Low water holding capacity

4.2. Soil Tests

Field soil testing has been undertaken to determine key soil parameters for water and nutrient balance modelling to determine the land required for future effluent disposal areas.

Five soil test boreholes were excavated in representative sites across the subject property. The borehole locations were selected to ensure coverage of the various slope/terrain combinations and spaced relatively evenly to detect changes in spatial variability of the soil. The borehole locations are shown in Figure 12 on the following page. Site and soil test photos are included in Appendix A.

The boreholes were sampled on the 30 October 2023. No rock was encountered in the boreholes. Material was dry to very slightly moist throughout all profiles. There was no evidence of springs or groundwater.

Bedrock is assumed to be at least 3m deep generally across the property. Groundwater is assumed to be at least 5m below surface. The soils found at the location of the proposed disposal area are generally consistent with the description of Morand (1994).

The following data was recorded for each soil borehole profile:

- **Depth** of each soil horizon
- **Soil texture** – determined by ribbon test and classified as per AS1547 Table 5.2 (sands, sandy loams, loams, clay loams, light clays, medium to heavy clays)
- **Soil structure** – determined by visual assessment of peds (massive, weak, moderate strong)
- **Colour** – determined by visual assessment
- **Soil category** – classified as per AS1547 Table 5.2
- **Coarse Fragments** – determined by visual assessment
- **Soil pH** – determined by pH testing of representative soil samples

- **Dispersiveness** – determined by Modified Emerson Aggregate test (Class 1: No change to aggregate, therefore non-dispersive, Class 2: Aggregates slake - smaller aggregates/particles fall off the original aggregate, Class 3: Aggregates disperse (cloud solution), Class 4: Worked bolus material disperses.)

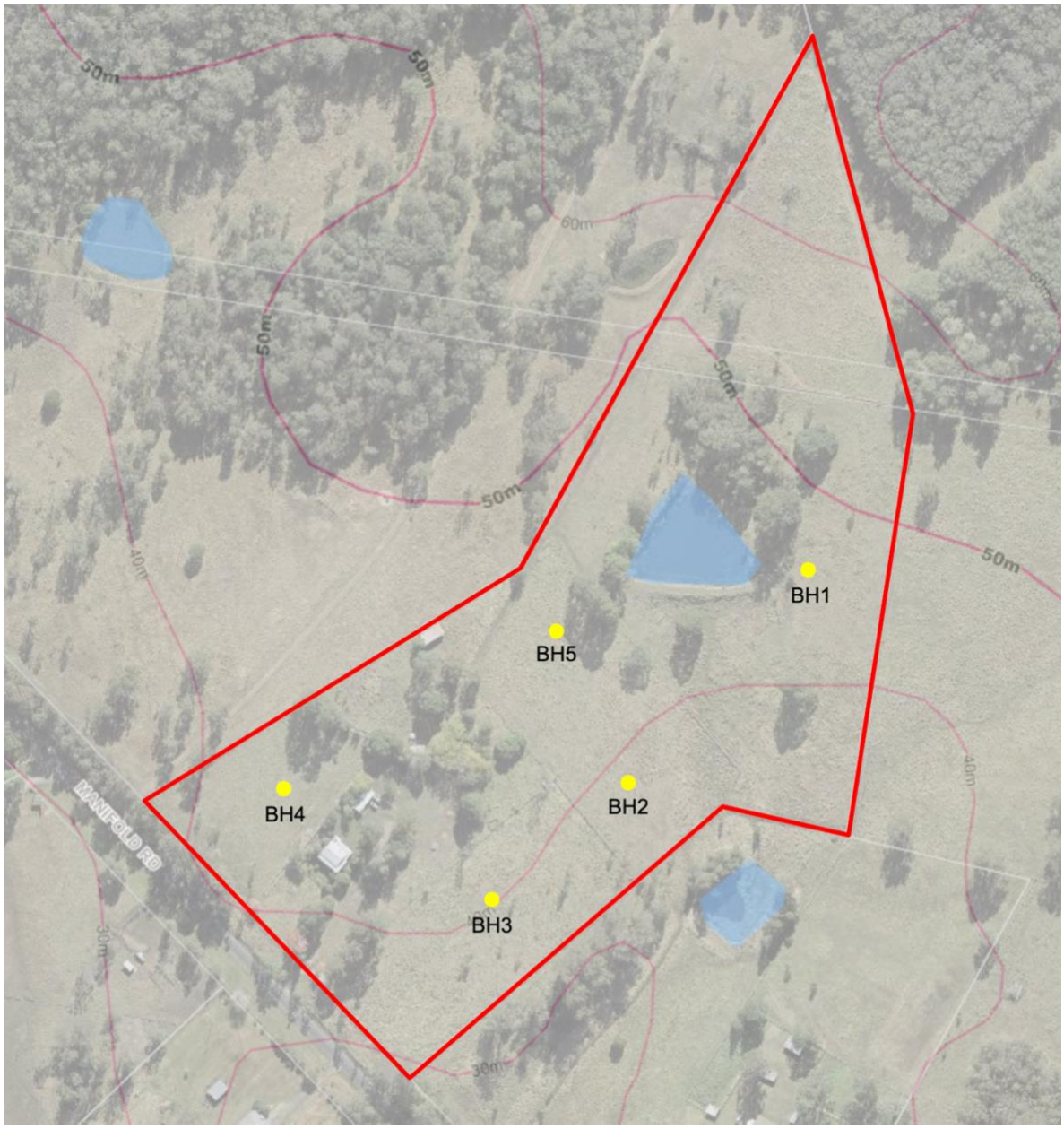


Figure 12 – Soil Test Borehole Map (aerial: RVC Intramaps)

Table 3 below presents the soil borehole profiles and test results. A summary of the soil limitations is presented on the following page in Table 4.

Table 3 – Soil Test Borehole Results

Bore hole	Horizon	Depth (mm)	Texture (ribbon length mm)	Structure	Colour	Soil Category	Coarse Fragments	pH	Dispersive Class
BH1	A	0-400	Sandy clay Loam (35mm)	Moderate	Dark brown	3	Nil	5.5	Class 1
	B	400-1000	Clay loam (40mm)	Strong	Brown	4	5% up to 10mm	6.0	Class 2
	C	600-1000	Light clay (50mm)	Strong	Red brown	5	Nil	5.0	Class 2
BH2	A	0-400	Sandy clay Loam (35mm)	Moderate	Dark brown	3	Nil	5.5	Class 1
	B	400-1000	Clay loam (40mm)	Strong	Brown	4	5% up to 10mm	6.0	Class 2
	C	600-1000	Light clay (50mm)	Strong	Red brown	5	Nil	5.0	Class 2
BH3	A	0-400	Sandy clay Loam (35mm)	Moderate	Dark brown	3	Nil	6.0	Class 1
	B	500-1000	Sandy light clay (50mm)	Moderate	Red brown	5	10% up to 20mm	5.5	Class 2
BH4	A	0-400	Sandy clay Loam (35mm)	Moderate	Dark brown	3	Nil	6.0	Class 1
	B	500-1000	Sandy light clay (50mm)	Moderate	Red brown	5	10% up to 20mm	5.0	Class 2
BH5	A	0-400	Sandy clay Loam (35mm)	Moderate	Dark brown	3	Nil	5.5	Class 1
	B	400-1000	Clay loam (40mm)	Strong	Brown	4	5% up to 10mm	6.0	Class 2
	C	600-1000	Light clay (50mm)	Strong	Red brown	5	Nil	5.0	Class 2

Table 4 - Soil Limitations

Soil Feature	Limitation Guideline		Description	Comment / Management Response
	No limitation	Limitation		
Soil Category	Receiving soils for primary treated effluent: Soil Categories 1-5 excluding mod. or weakly structured light clays. Receiving soils for secondary treated effluent: Soil Categories 1-5	Receiving soils for primary treated effluent: Soil Categories 5,6 excluding strongly structured light clays Receiving soils for secondary treated effluent: Soil Category 6 (as noted: dispersive or shrink-swell soils are to be considered as Soil Category 6 soils)	Ranges from Category 3: sandy clay loam to Category 5: Moderately structured light clay	Soils were generally consistent across the subject property. The most limiting soil type of a **moderately structured light clay** has been adopted for modelling of an indicative land application area for the rezoning proposal. Detailed design of future OSSM system for individual lots will require soil tests results from the proposed land application area.

Limiting soil texture	Sands to strong/mod structured light clays	Weakly structured light clays, medium/heavy clays, shrink-swell & dispersive soils	Category 5 – Moderately structured light clay	This soil type has low permeability and generally requires secondary treatment systems to be adopted.
Coarse fragments	Occupies <20% of soil volume	Occupies >20% of soil Volume (Need to increase Soil Category by one class)	Coarse fragments occupy <20% of soil volume	No limitation.
Field pH	>5.5	<5.5	Soil pH ranges from 5.0-6.5	Low pH soils can reduce plant growth and affect evapotranspiration processes. Liming of the soil in the land application areas is recommended. Secondary treatment may be required to reduce the amount of nutrients being discharged to the environment.
Dispersiveness	Class 1 or 2	Class 3 or 4	Soils were either Class 2 (slake only) or Class 1 (water stable). No dispersiveness observed.	No limitation
Depth to groundwater	Soil depth of >1m before groundwater is encountered	Soil depth of <1m before groundwater is encountered	No groundwater encountered in 1000mm depth boreholes. Assumed groundwater is >5m	No limitation
Depth to bedrock	Soil depth of >1m before bedrock is encountered	Soil depth of <1m before bedrock is encountered	No bedrock encountered in 1000mm depth boreholes. Assumed bedrock is >3m	No limitation

4.3. Soil Laboratory Analysis

In accordance with Section 10.1 of the Richmond Valley OSSM Strategy, the following soil parameters were tested for a representative topsoil and subsoil sample from the subject property.

- Phosphorous sorption rates
- Sodicity (also known as dispersiveness)
- Electrical Conductivity
- Bulk Density
- Cation Exchange Capacity

The topsoil sample was collected at 300mm depth and the subsoil sample collected at 800mm depth from the centre of the Investigation area. The soil samples analysed were representative of the consistent soil types found across the subject property. The soil samples were analysed by EAL Labs at Southern Cross University. Full analysis results are included in Appendix B. Commentary on the analysis follows.

4.3.1. Phosphorus Sorption Capacity

Phosphorus is found in human excreta and household detergents. Excess phosphorus over a long period of time will lead to poor soil and stunted plant growth which can lead to early failure of the land application area. Land application areas must consider and be designed to cater for the expected phosphorus loading and the ability of the soil to uptake the phosphorus.

The *phosphorus sorption capacity* test measures the ability of the effluent to absorb phosphorus from the treated effluent. Test results are presented in Table 5 below.

Table 5 - Phosphorus Sorption Capacity

Soil Type	Phosphorus Sorption Capacity (kg/P sorption/ha/100cm depth)
Topsoil – 300mm depth Sandy Loam	6,082
Subsoil – 800mm depth Sandy clay loam	32,079

The phosphorus sorption capacity test results vary considerably between the topsoil and subsoil, however the average sorption capacity of approximately 19,000kg/ha.m is significantly higher than the adopted design value for sandy duplex soils of 8,000kg/ha.m used in the land application area modelling.

There will be variation in phosphorus sorption capacity across soils from different depths, different locations and from sampling at different times of year, however soils across the subject property were generally very consistent.

For future households, it is important that only low or nil phosphorus detergents and cleaning products are used.

4.3.2. Sodicity

Sodicity in soil is the presence of a high proportion of sodium ions relative to other cations. Highly sodic soils can affect the soil structure by causing wetted clay particles to disperse and clog the pores of the soil which reduces infiltration capacity of the soil.

Soils are considered sodic when the Exchangeable Sodium Percentage (ESP) is greater than 6. Both topsoil and subsoil had ESP of 1.5 or less and are not sodic.

Soils were also tested for dispersiveness using the Emerson Aggregate Stability Test and again all soils were tested as not dispersive (Class 3/6).

For future households, it is important that only low or nil sodium detergents and cleaning products are used.

4.3.3. Electrical Conductivity

Electrical conductivity is a simple way to measure salinity of the soil. Salines soils can impact plant growth and also cause waterlogging.

The analysed soils returned EC_e results of 0.138-0.392. Results less than 2 are considered non-saline. There was no evidence of saline soils at the site.

4.3.4. Bulk Density

The bulk density of the sampled soils is presented below in Table 6.

Table 6 – Bulk Density

Soil Type	Bulk Density ton/m^3
Topsoil – 300mm depth Sandy Loam	1.43
Subsoil – 800mm depth Sandy clay loam	1.08

4.3.5. Cation Exchange Capacity

Cation exchange capacity (CEC) measures the ability of soil to hold cations by electrical attraction which directly relates to the soils ability to hold and make nutrients available to plants. Soils with low CEC are susceptible to leaching of nutrients which can lead to poor plant growth, soil pH issues and associated aluminium toxicity potential and increased risk of dispersiveness. A figure above 10 cmol(+)/kg is preferred for plant production[1].

Test results are presented in Table 7 below.

Table 7 – Cation Exchange Capacity

Soil Type	Cation Exchange Capacity ($cmol_+/kg$)
Topsoil – 300mm depth Sandy Loam	6.3
Subsoil – 800mm depth Sandy clay loam	17.2

The sandy loam topsoil has lower than desired CEC which can affect the ability of the effluent land application area to effectively uptake and transfer nutrient to the plants.

Design of individual OSSM systems may need to consider measures to increase the CEC of the soils in the future effluent land application areas by considering addition of lime to increase pH or organic matter (mulches, manures). Secondary treatment can be adopted for low fertility soils to reduce the nutrients being discharged to the environment.

[1] NSW DPI, https://www.dpi.nsw.gov.au/agriculture/soils/guides/soil-nutrients-and-fertilisers/cec

4.4. Soil Assessment Summary

The soil types are consistent across the subject property and are generally sandy loam topsoils overlying clay loam/light clays. The most limiting soil layer in the boreholes for wastewater disposal is a **moderately structured Light Clay (Category 5)** subsoil which occurs from 500mm below natural ground surface.

This most limiting soil type has a Design Loading Rate (DLR) of 5mm/day for primary treated effluent and 10mm for secondary treated effluent. This limiting soil type has been adopted for further modelling of the land application area requirements for rezoning assessment purposes.

There were some coarse fragments present in the soils but not in sufficient quantity or size to impede the flow of water into the soil. The pH is below the desired range for effluent disposal in some areas and secondary treatment may be required to reduce nutrient loading of the treated effluent. The soils are not dispersive. Groundwater is assumed to be at least 5m below surface. Bedrock is assumed to be 3m deep.

Design of future OSSM systems for each lot will require soil tests from within each lot to determine the required level of treatment and size of the OSSM system components.

5. ON SITE SEWAGE MANAGEMENT SYSTEM

5.1. Introduction

For the purposes of land capability assessment and calculation of land application areas, preliminary OSSM system designs have been modelled based on the site and soil constraints.

Both primary and secondary treatment systems have been modelled to determine the maximum land application areas required and ensure the widest range of options are maintained through this development stage. It is noted that Council's preference is for passive low-tech treatment systems (such as septic system or reed bed treatment trains).

The guiding principles for the preliminary design of the OSSM system are:

- Protection of public health and the environment
- Maximise opportunity for nutrient and water re-use by vegetation uptake
- Efficient utilisation of resources

5.2. Land Application Area Calculations

The design effluent volume for the future residential lots is assessed using a standard 4-bedroom dwelling with rainwater supply. The number of equivalent persons (EP) in the dwelling for wastewater design purposes is taken to be 5, which is the number of bedrooms + 1. Proposed future dwellings will be required to have efficient water saving devices installed to meet BASIX requirements.

A wastewater allowance of 120L/person/day has been adopted which is in accordance with Table H1 of AS1547:2012. Therefore, the design effluent volume is as follows:

Table 8 – Design Effluent Volume

Dwelling	Bedrooms	EP	Effluent Volume (L/day)
4 bedroom	4	5	600

The following Design Irrigation/Loading Rates (DIR/DLR) have been used in the modelling based on AS1547:2012 Table 5.2 soil category 5, being moderately structured light clay.

Table 9 – Design Irrigation/Loading Rates

Treatment/Land Application System	Examples	DIR/DLR (mm/day)
Primary treatment with trenches	Septic tank + ETA beds	5
Secondary treatment with trenches	Septic tank, reed bed + ETA Beds, or AWTS + ETA Beds	10
Secondary treatment with subsurface irrigation	AWTS + subsurface irrigation	4.125

To ascertain the size of the land application area required on future lots, the Richmond Valley Council On-Site Wastewater Model (single rural households) was used. This model determines the required land application area (LAA) for the nitrogen, phosphorous and hydraulic loadings.

The model performs an iterative water balance to determine the LAA required to adequately dispose of the hydraulic load. The water balance considers the allowable infiltration rate of the soil and local rainfall and evapotranspiration rates. The nutrient balance considers the vegetative and soil uptake of nutrients and allowable annual export of nutrients

The land application areas (LAA) required for effluent disposal are shown below in Table 10 for different treatment and land application systems. Model results are provided in Appendix C.

Table 10 – Land application areas

Treatment/Land Application System	Example	Hydraulic Area (m^2)	Nitrogen Area (m^2)	Phosphorus Area (m^2)	Reed Bed Area (m^2)
Primary treatment with trenches (**passive**)	Septic tank + ETA beds	155.6	169.0	61.9	-
Secondary treatment with trenches (**passive**)	Septic tank, reed bed + ETA Beds	73.6	0.0	61.9	19.5
Secondary treatment with trenches	AWTS + ETA Beds	68.4	1.0	61.9	-
Secondary treatment with subsurface irrigation	AWTS + subsurface irrigation	279.3	1.0	61.9	-

For the purposes of rezoning assessment, and to maintain the most available options for wastewater management at this stage of the development, it is recommended an area of 300m^2 is required for effluent disposal. A duplicate 300m^2 is required to provide a reserve area for future replacement, upgrade or expansion of the wastewater management system.

The 300m^2 area is for subsurface irrigation effluent disposal method. However, it is noted there are several other options for wastewater management for future dwellings which can be installed within a lesser footprint. Design of individual systems is not considered further at this stage of the development.

The lots are also suitable for future dual occupancy developments which can be accommodated within the 300m^2 effluent disposal envelopes by adopting secondary treatment systems.

In addition to providing adequate areas of land for disposal of the hydraulic and nutrient loads, the following minimum requirements for siting of land application areas must be considered in future lot layouts.

- Allow gravity fall from proposed dwelling envelope to land application area
- 40m setback to gully/dam
- 250m to domestic groundwater wells
- 6m up-gradient of property boundaries, swimming pools, driveways and buildings
- 3m down-gradient of property boundaries, swimming pools, driveways and buildings
- 12m up-gradient of property boundaries for ETA beds (though 6m for swimming pools, driveways and buildings)
- 6m down-gradient of property boundaries for ETA beds (though 3m for swimming pools, driveways and buildings)
- 10m from telegraph poles and powerlines

The proposed lot size of 7500m^2 is considered sufficient to accommodate future OSSM systems with suitable setback distances alongside future building envelopes and other land improvements, without adversely impacting the existing environment.

Figure 13 on the following page presents example 7500m^2 residential lots showing there is adequate room to accommodate future building envelopes and effluent disposal envelopes whilst still meeting the required setback distances.

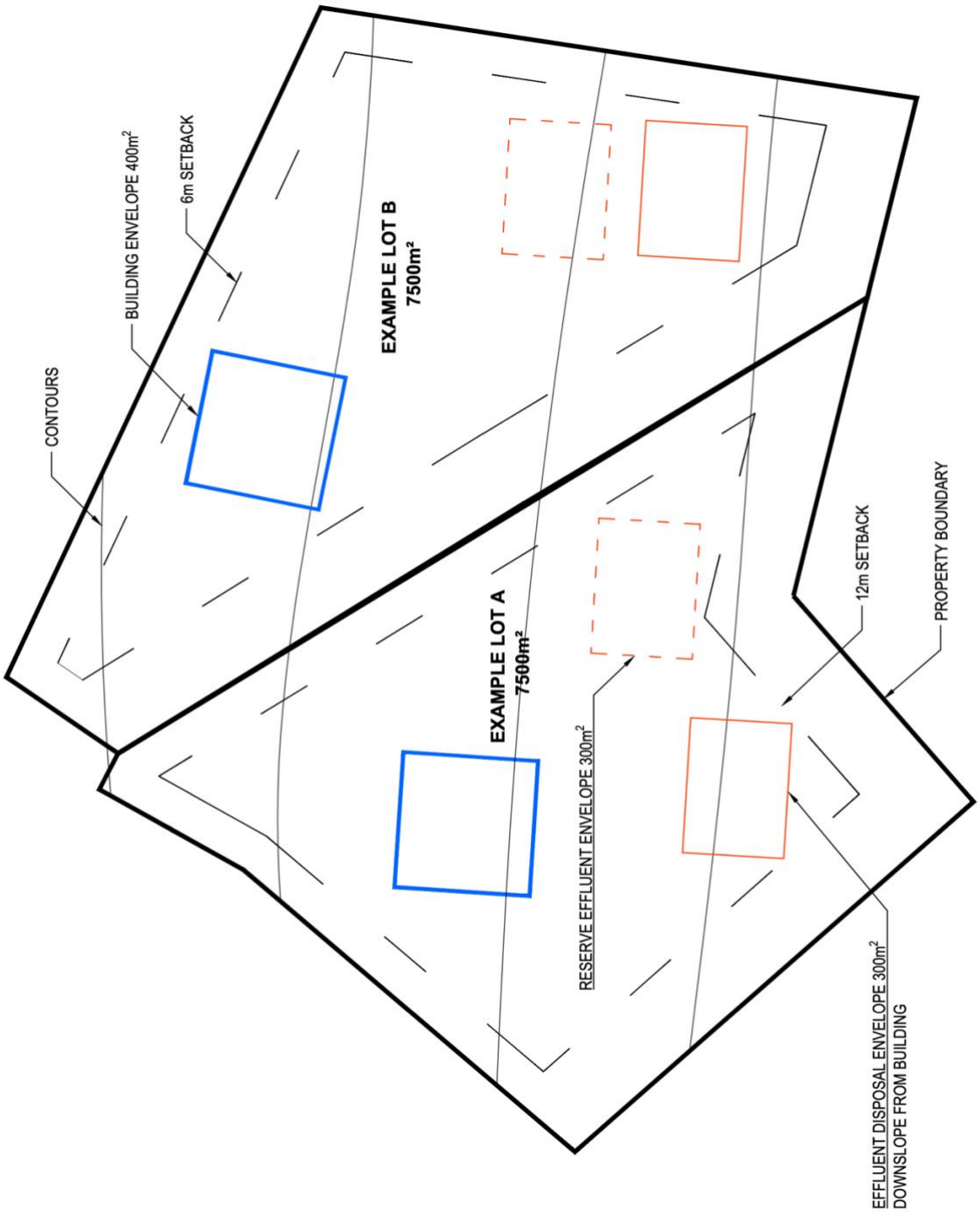


Figure 13 – Example 7500m² lots with building and effluent disposal envelopes

6. PRELIMINARY IMPACT ASSESSMENT

A preliminary impact assessment has been undertaken in relation to on-site wastewater management and any impacts on the environment, particularly surface and groundwater resources.

6.1. Existing Environment

The existing environment on the subject property is cleared land used for extensive livestock grazing. An existing dwelling and outbuildings were identified on the southern end of the property fronting Manifold Rd. There are no watercourses or gullies on the subject property. The closest gully and farm dam are located on neighbouring property to the south.

The dam was observed to have generally good water quality with no obvious signs of contamination. Existing pollutant sources include nutrient runoff from adjoining farmland.

There are no groundwater bores within 250m of the subject property. The closest bore GW305392, located approximately 500m to the west of the subject property, has a recorded drilled depth of 24m. Groundwater is expected to be relatively deep across the site.

6.2. Impact Assessment

Land application of treated effluent from future residential dwellings will increase the nutrient and pathogen loading into the environment with potential for contamination or pollution of water sources. A key objective of on-site wastewater management is to treat and dispose of the effluent with all nutrient and wastewater contained within each individual lot.

Water and nutrient balance calculations are included in Appendix C, which take into account expected hydraulic and nutrient loadings from residential dwellings, permeability of the soil and nutrient uptake rates of the soil and vegetation. Calculation of required land application areas using this method ensures effluent is managed with the boundaries of the lot including during high rainfall periods.

Land application areas for nitrogen uptake are based on 200kg/ha/year plant uptake and allowable percolation of nitrogen of up to 15kg/dwelling/year. The allowable percolation equates to 20kg/ha/year on a 7500m^2 residential lot. This is significantly less than typical nitrogen fertiliser rates for livestock grazing operations which are currently undertaken on the property. Agricultural nitrogen is typically applied at rates of 23-46kg/ha (typically as 50-100kg urea/ha) multiple times per year depending on the season and pasture being grown.

Land application areas required for phosphorus uptake are based on an allowable phosphorus sorption capacity of 8000kg/ha/m for sandy duplex soil, 20kg/ha/year plant uptake and a 50-year accumulation period. All phosphorus is therefore considered to be absorbed into plants or stored in the soil within the individual lot.

Pathogens in the effluent are reduced through the treatment processes however a proportion will pass to the land application area. Pathogen levels are higher in primary treatment effluent than secondary treated effluent. Soil processes will eliminate remaining pathogens as the effluent

disperses through the soil. Pathogen die-off modelling using method developed by Cromer, Gardner and Beavers is presented below for both primary (Figure 14) and secondary treated effluent (Figure 15).

Pathogen Die-Off Model

Address: 70 Manifold Rd, North Casino

Days required for viral reduction

Formula: $M_t / M_o = e^{-kt}$

M_t / M_o = is the dimensionless ratio between the viral concentration in the groundwater at any time t (M_t) and the viral concentration in the wastewater at the time of its application to the subsurface (M_o)

t = is the travel time (days) of the viruses in the groundwater

k = is the first order rate coefficient for the die-off rate of the organism and is the temperature-dependent variable (°C). Viruses do not replicate outside host organisms.

Mt/Mo	0.0000001	for primary treatment
T	14	°c (conservative value for cooler weather)
k	0.275	
t	58.6	days

Calculate setback distance

The time required for groundwater (containing viruses) to move a given distance in saturated material is estimated by the formula below:

Formula: $d_g = (t - d_v.P/K)/(P/K.i)$

d_g = horizontal distance from effluent land application area to where virus die-off occurs (m)
d_v = vertical distance to groundwater (m)
t = travel time (days)
P = porosity soil (fraction eg 0.3) - clay 40-70%, silt 35-50%, sand 25-50%, gravel 25-40%
K = permeability (m/day)
i = groundwater gradient (fraction eg 0.02 if slope of groundwater 1:50).

d_v	20	m	Assumed based on topography/nearby bores
P	0.4		light clay
K	0.5	m/day	AS1547 2012
i	0.15		match ground slope
d_g	7.99	m	
FOS	2	Factor of safety	
Setback Distance	15.98	m	

Figure 14 - Pathogen Die off model - PRIMARY

Pathogen Die-Off Model

Address: 70 Manifold Rd, North Casino

Days required for viral reduction

Formula: $M_t / M_o = e^{-kt}$

M_t / M_o = is the dimensionless ratio between the viral concentration in the groundwater at any time t (M_t) and the viral concentration in the wastewater at the time of its application to the subsurface (M_o)

t = is the travel time (days) of the viruses in the groundwater

k = is the first order rate coefficient for the die-off rate of the organism and is the temperature-dependent variable (°C). Viruses do not replicate outside host organisms.

Mt/Mo	0.001	for secondary treatment
T	14	°C (conservative value for cooler weather)
k	0.275	
t	25.1	days

Calculate setback distance

The time required for groundwater (containing viruses) to move a given distance in saturated material is estimated by the formula below:

Formula: $d_g = (t - d_v.P/K)/(P/K.i)$

d_g = horizontal distance from effluent land application area to where virus die-off occurs (m)

d_v = vertical distance to groundwater (m)

t = travel time (days)

P = porosity soil (fraction eg 0.3) - clay 40-70%, silt 35-50%, sand 25-50%, gravel 25-40%

K = permeability (m/day)

i = groundwater gradient (fraction eg 0.02 if slope of groundwater 1:50).

d_v	20	m	Assumed based on topography/nearby bores
P	0.4		light clay
K	0.5	m/day	AS1547 2012
i	0.15		match ground slope
d_g	1.71	m	
FOS	2	Factor of safety	
Setback Distance	3.42	**m**	

Figure 15 - Pathogen Die off model - SECONDARY

The calculations show pathogen die-off can be achieved in at a distance of 15.98m for primary treated effluent and 3.42m for secondary treatment effluent from the effluent land application area. This includes suitable factors of safety. The adoption of appropriate setback distances in the design of individual wastewater management systems limits the potential for pathogens to be transferred outside the individual lots.

Where maximum setback distances are unable to be achieved secondary treatment systems and other mitigations should be adopted. All future OSSM systems will be individually designed to suit the specific site and soil constraints on each future lot by adopting appropriate treatment and setback distances as required to ensure effluent is managed within each lot with no impact on the receiving environment. Owners are required to undertake operation and maintenance activities to ensure the system is maintained in working order. OSSM systems are also subject to routine inspection by Council to ensure they are in working order.

7. CONCLUSION

An on-site wastewater assessment was undertaken to assess the feasibility of on-site wastewater management for a proposed rezoning of 70 Manifold Rd, North Casino (Lot 21 DP601461) to R5 Large Lot Residential.

Investigation of the site and soil characteristics across the subject property and preliminary OSSM system design has identified the property has suitable characteristics for on-site wastewater disposal for future residential purposes. The topography and soils found across the site are suitable for passive low-tech wastewater management systems.

A 40m setback for future effluent land application envelopes from the drainage gully and farm dams will need to be considered in the development of lot layouts at the subdivision stage of the development.

For the purposes of rezoning assessment, and to maintain the most available options for wastewater management at this stage of the development, it is recommended an area of 300m^2 is required effluent disposal. A further 300m^2 is required to provide a reserve area for future replacement, upgrade or expansion of the wastewater management system.

Adopting the proposed 7500m^2 minimum lot size will ensure sufficient land is available on each future lot for on-site wastewater management and adverse impacts to existing environmental conditions at the site are not expected.

8. REFERENCES

Australian Standard AS 1546.1 - 2008 *On-site domestic wastewater treatment units – Part 1: Septic Tanks*

Australian Standard AS 1546.3 - 2008 *On-site domestic wastewater treatment units – Part 3: Aerated wastewater treatment systems*

Australian Standard AS 1547 - 2012 *Disposal Systems for Effluent from Domestic Premises*

Bureau of Meteorology, *Australian Groundwater Explorer,* www.bom.gov.au/water/groundwater/explorer/map.shtml

Crites, R., & Tchobanoglous, G. (1998). *Small and decentralized wastewater management systems*. Boston: WCB/McGraw-Hill.

Environment Protection Authority, Dept. of Local Government, Department of Land & Water Conservation and NSW Department of Health (1998). *Environment and Health Protection Guidelines - On-Site Wastewater Management Systems for Domestic Households*.

Metcalf & Eddy, Inc. (2003). *Wastewater engineering: treatment and reuse*. Boston. McGraw-Hill

NSW Office of Environment and Heritage, eSPADE v2.0, *Soil Landscapes,* http://www.environment.nsw.gov.au/eSpade2Webapp

Richmond Valley Council (2018). *On-Site Sewage and Wastewater Management Strategy, Revised 2017 - Adopted by Council Feb 2018*.

9. APPENDICES

9.1. Appendix A – Site and Soil Test Photos

Subject property – looking north

Subject property – looking east

Subject property – looking north

Subject property – looking west

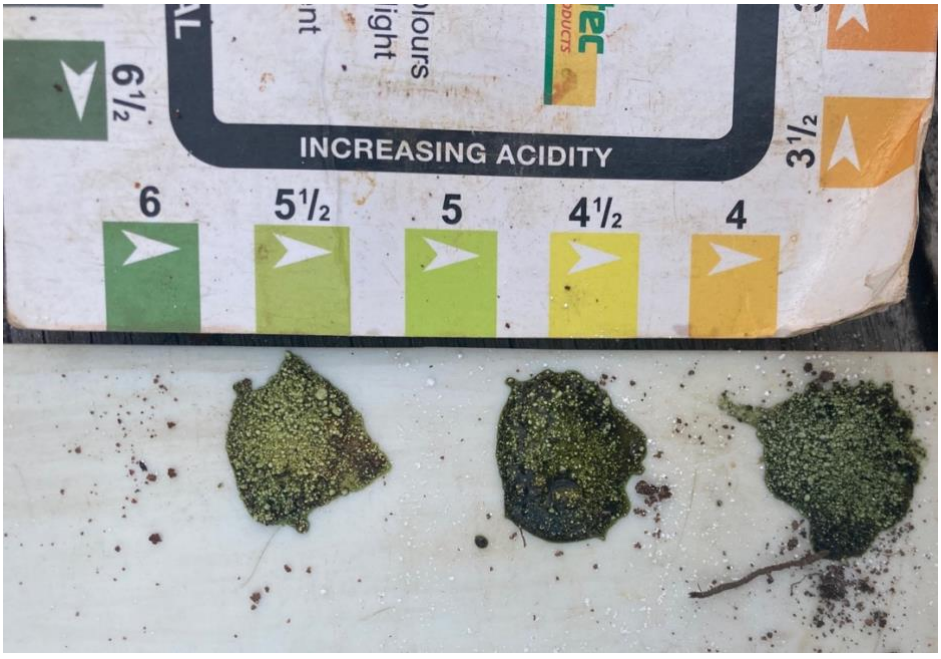
Subject property – looking south

Subject property – looking east towards gully/dam

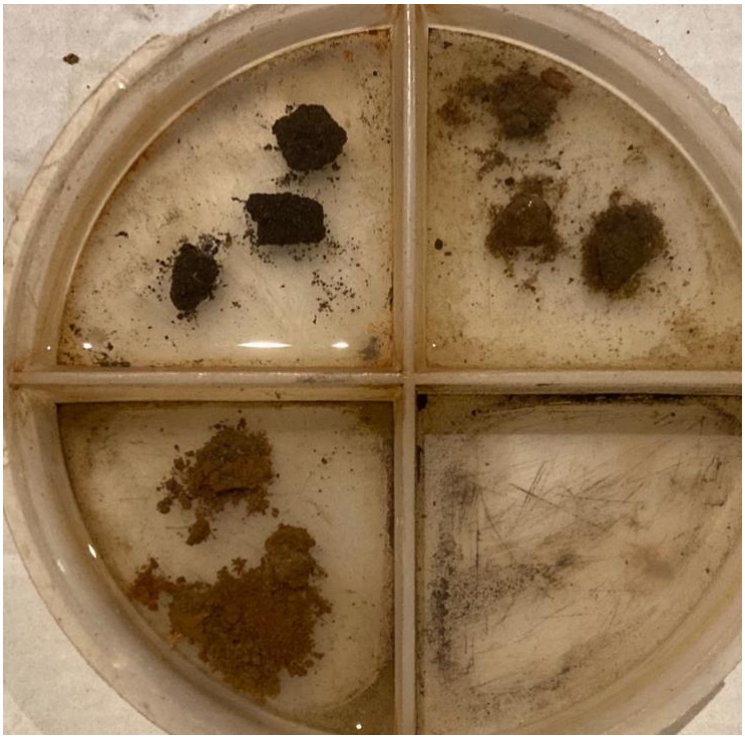
Ribbon Test **Borehole 1, 2 & 5** (Top: Horizon A, Middle: Horizon B, Bottom: Horizon C)

Ribbon Test **Borehole 3 & 4** (Top: Horizon A, Bottom: Horizon B)

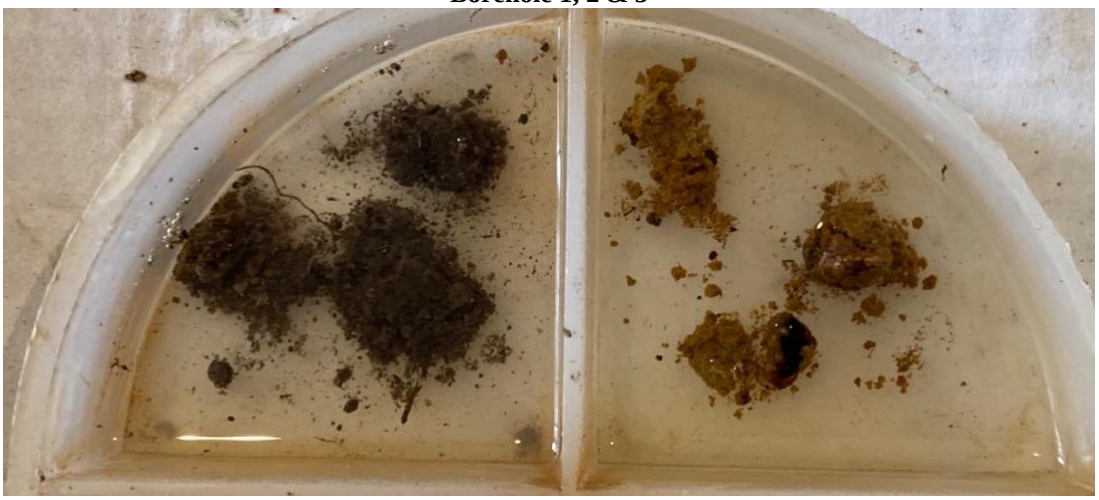
Soil test **Borehole 1**



pH Test **Borehole 1, 2 & 5**



Modified Emerson Aggregate Test (Top Left: Horizon A, Top Right: Horizon B, Bottom Left: Horizon C)
Borehole 1, 2 & 5



Modified Emerson Aggregate Test (Left: Horizon A, Right: Horizon B)
Borehole 3 & 4

9.2. Appendix B – Soil Sample Laboratory Analysis

9.3. Appendix C – Wastewater Model Results

PRIMARY TREATMENT – SEPTIC TANK AND ETA BEDS

	RVC On-site Wastewater Model (Single Rural Households) OSmodel170115.xls *Printed 23-11-2023*	Default	User-defined
Client	Jestermond Pty Ltd		
Address	70 Manifold Rd, North Casino		
Site	Block size (m2)		7500
	Buffer (m) from land application area to gully	>40	
	Water (L/p.d) from Roof water harvesting	120	
	Persons		5
	☐ Internal wastewater sources split? ☐ Multiple households? How many?		
Wastewater components/system	Toilet ☑		
	Bathroom ☑		
	Laundry ☑		
	Kitchen ☑		
	Total wastewater flow (L/d) [needs caution if user-defined]	600	
Treatment system	Primary only (e.g. septic)		
	Nitrogen removal %	0%	
	Maximum N allowed to go down from system (kg/yr)	15.00	
Land application	Land application type ETA beds		
	Depth of soil above gravel layer (= root zone) (mm)	200	
	Depth of gravel layer (mm)	200	
Soil information	Morand code (examples) Duplex Soils= ck		
	Phosphorus sorption (kg/ha.m)	8000	
	Depth to water table or bedrock (for P calcs) (m)		3
	Texture/structure Light clays - moderately structured		
	DLR (mm/d)	5	
Area calculations	Hydraulic area (m2)	155.6	
	Nitrogen area (m2) [allowing export of 13.42 kg/yr]	169.0	
	Phosphorus area (m2)	61.9	
	Required land application area (m2)	**169.0**	
			0.0%

SECONDARY TREATMENT – SEPTIC TANK, REED BEDS AND ETA BEDS

	RVC On-site Wastewater Model (Single Rural Households) OSmodel170115.xls *Printed 23-11-2023*	Default	User-defined
Client	Jestermond Pty Ltd		
Address	70 Manifold Rd, North Casino		
Site	Block size (m2)		7500
	Buffer (m) from land application area to gully	>40	
	Water (L/p.d) from Roof water harvesting	120	
	Persons		5
	☐ Internal wastewater sources split? ☐ Multiple households? How many?		
Wastewater components/system	Toilet ☑		
	Bathroom ☑		
	Laundry ☑		
	Kitchen ☑		
	Total wastewater flow (L/d) [needs caution if user-defined]	600	
Treatment system	Secondary: Reed bed - BOD 20mg/L		
	Nitrogen removal %	68%	
	Wetted depth of reed bed (m)	0.5	
	Maximum N allowed to go down from system (kg/yr)	15.00	
Land application	Land application type ETA beds		
	Depth of soil above gravel layer (= root zone) (mm)	200	
	Depth of gravel layer (mm)	200	
Soil information	Morand code (examples) Duplex Soils= ck		
	Phosphorus sorption (kg/ha.m)	8000	
	Depth to water table or bedrock (for P calcs) (m)		3
	Texture/structure Light clays - moderately structured		
	DLR (mm/d)	10	
Area calculations	Hydraulic area (m2)	73.6	
	Nitrogen area (m2) [allowing export of 13.42 kg/yr]	0.0	
	Phosphorus area (m2)	61.9	
	Required land application area (m2)	**73.6**	
	Reed bed area (m2) and HRT (d)	19.5	6.5
	Reed bed outlet BOD (mg/L and TN% removal	≤20.0	68.0%

SECONDARY TREATMENT – AWTS AND ETA BEDS

RVC On-site Wastewater Model (Single Rural Households) OSmodel170115.xls
Printed 23-11-2023

		Default	User-defined
Client	Jestermond Pty Ltd		
Address	70 Manifold Rd, North Casino		
Site	Block size (m2)		7500
	Buffer (m) from land application area to gully	>40	
	Water (L/p.d) from Roof water harvesting	120	
	Persons		5
	☐ Internal wastewater sources split? ☐ Multiple households? How many?		
Wastewater components/system	Toilet ☑		
	Bathroom ☑		
	Laundry ☑		
	Kitchen ☑		
	Total wastewater flow (L/d) [needs caution if user-defined]	600	
Treatment system	Secondary: AWTS		
	Nitrogen removal %	20%	
	Maximum N allowed to go down from system (kg/yr)	15.00	
Land application	Land application type ETA beds		
	Depth of soil above gravel layer (= root zone) (mm)	200	
	Depth of gravel layer (mm)	200	
Soil information	Morand code (examples) Duplex Soils= ck		
	Phosphorus sorption (kg/ha.m)	8000	
	Depth to water table or bedrock (for P calcs) (m)		3
	Texture/structure Light clays - moderately structured		
	DLR (mm/d)	10	
Area calculations	Hydraulic area (m2)	68.4	
	Nitrogen area (m2) [allowing export of 13.42 kg/yr]	1.0	
	Phosphorus area (m2)	61.9	
	Required land application area (m2)	**68.4**	
			20.0%

SECONDARY TREATMENT – AWTS AND SUBSURFACE IRRIGATION

RVC On-site Wastewater Model (Single Rural Households) OSmodel170115.xls
Printed 23-11-2023

		Default	User-defined
Client	Jestermond Pty Ltd		
Address	70 Manifold Rd, North Casino		
Site	Block size (m2)		7500
	Buffer (m) from land application area to gully	>40	
	Water (L/p.d) from Roof water harvesting	120	
	Persons		5
	☐ Internal wastewater sources split? ☐ Multiple households? How many?		
Wastewater components/system	Toilet ☑		
	Bathroom ☑		
	Laundry ☑		
	Kitchen ☑		
	Total wastewater flow (L/d) [needs caution if user-defined]	600	
Treatment system	Secondary: AWTS		
	Nitrogen removal %	20%	
	Maximum N allowed to go down from system (kg/yr)	15.00	
Land application	Land application type Subsurface drip irrigation		
	Design depth of root zone (mm)	300	
Soil information	Morand code (examples) Duplex Soils= ck		
	Phosphorus sorption (kg/ha.m)	8000	
	Depth to water table or bedrock (for P calcs) (m)		3
	Texture/structure Light clays - moderately structured		
	DIR (mm/d)	4.125	
Area calculations	Hydraulic area (m2) (or override with SSI industry estimate)	279.3	
	Nitrogen area (m2) [allowing export of 13.42 kg/yr]	1.0	
	Phosphorus area (m2)	61.9	
	Required land application area (m2)	**279.3**	
			20.0%