Graeme Payten

Wastewater Land Capability Assessment: Lot 711, DP1128593, South Pambula, NSW

martens consulting engineers

ENVIRONMENTAL

WATER

WASTEWATER

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PROJECT MANAGEMENT

P1404330JR02V02
February 2022

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All enquiries regarding this project are to be directed to the Project Manager.

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1 Overview

1.1 Background

Martens & Associates has prepared this wastewater assessment to support a rezoning application and development application to enable a future subdivision at Lot 711, DP 1128593, South Pambula, NSW. This report documents feasible onsite wastewater options for the proposed subdivision.

1.2 Development Proposal

The proposal seeks to rezone the site to allow the development of a rural subdivision.

1.3 Reference Guidelines

The assessment is prepared in accordance with the following guidelines:

- Australian/ New Zealand Standard 1547 (2012) - *On site Domestic Wastewater Management.*
- Bega Valley Shire Council (2013) – *Bega Valley Development Control Plan* (Revised 2019).
- Department of Local Government, NSW Environment Protection Authority, NSW Health Department, NSW Department of Land and Water Conservation and the NSW Department of Urban Affairs and Planning (1998) - *Environment and Health Protection Guidelines - On-site Sewage Management for Single Households.* [referred to as DLG et al. (1998)].

2 Site Description

2.1 Summary

Site description is provided in Table 1 with a site plan provided in Map 01 (Attachment A).

Table 1: Site description summary.

Element	Description/Detail
Site Area	Approximately 40.2ha
Lot/DP	Lot 711, DP1128593
Existing site development	Single storey dwelling and associated sheds and cottage in northern portion of site.
Aspect	East
Typical slopes	Variable - 6 - 32%
Existing vegetation	Generally cleared, dense vegetation to the north west and south west.
Neighbouring environment	The site is surrounded by rural properties to the north and east and bushland to the west and south. Yowaka River borders the southern boundary.
Local Government Area (LGA)	Bega Valley Shire Council.
Easements	None based on provided survey.
Drainage	Drainage via sheet flow to natural intermittent drainage channel running generally west to north east between site ridge lines draining to the Yowaka River.
Groundwater	No groundwater was encountered in boreholes during the site investigation.
Geology	The Bega & Mallacoota 1:250,000 Geological Sheet Series Sheet SJ/55-4 describes the geology at the site as Boyd Volcanic Complex consisting of undifferentiated acid volcanics, basalts, quartz porphyrites and minor sediments.

2.2 Field Investigations

A site inspection was undertaken on the September 23, 2014 and included:

- Walkover inspection to assess existing conditions, topography, geology, soil characteristics, hydrology and vegetation.
- Excavation of nine boreholes (BH) with a hydraulic auger to allow for characterisation of underlying soils.
- Collection of representative soil samples from boreholes for future reference.

Borehole testing locations are shown in Map 01 (Attachment A) and borehole logs are provided in Attachment B.

2.3 Subsurface Conditions

Borehole locations were selection to allow characterisation of existing soil landscapes. Observed subsurface conditions are summarised in Table 2 and soil characteristics for observed soil are summarised in Table 3.

Table 2: Observed subsurface conditions.

Landscape	Borehole	Material and Depth (m)		
		Sandy Clay Loam	Clay Loam	Weathered Basalt
Crest	BH101	0.0 – 0.1	0.1 – 0.8	>1.4
	BH109	0.0 – 0.2	0.2 – 1.1	>1.1
	BH106	0.0 – 0.1	0.1 – 1.7	>1.7
Mid crest	BH103	0.0 – 0.1	0.1 – 1.5	>1.5
	BH107	0.0 – 0.1	0.1 – 1.2	>1.2
	BH105	0.0 – 0.1	0.1 – 1.4	>1.4
Low lying	BH104	0.0 – 0.3	0.3 -1.8	>1.8
	BH108	0.0 – 0.1	0.1 – 0.8	>0.8
	BH102	0.0 – 0.8	0.8 – 2.5	>2.5

Notes

[1.] Material depths vary across the site.

Table 3: Summary of typical soil horizon characteristics.

Layer	Agricultural Classification	Soil Permeability Category [1]
Sandy Clay Loam	SCL	4b
Clay Loam	CL	4a

Notes

[1.] In accordance with Table 8 of NSW Department of Local Government et al. (NSW DLG et al., 1998).

2.4 Climate Data

The nearest rainfall station with adequate data is the Pambula Post Office (station number 069024, 1909 - 2012) and evaporation data was taken from the Bureau of Meteorology monthly evaporation maps (based on records from 1975 - 2005). These stations are considered representative of the site. A comparison of median rainfall and evaporation is provided in Table 4.

Table 4: Comparison of monthly rainfall and evaporation data for the site.

Month	Average Monthly Rainfall (mm)	Average Monthly Evaporation (mm)
January	81.6	180
February	84.1	150
March	88.8	125
April	79.2	70
May	66.0	50
June	77.3	40
July	53.6	40
August	48.6	60
September	53.9	80
October	66.2	120
November	78.3	165
December	76.0	170
Annual	**853.6**	**1250**

2.5 Hydrogeology

Review of WaterNSW Real-time Water Database, indicated one groundwater bore with available information within 500 m of the site, with the groundwater bore summarised in Table 5. The location of the groundwater bore is shown on Map 01 (Attachment A), and the groundwater bore log is presented in Attachment C.

Table 5: Available hydrogeological information.

Bore Identification	Record Date	Intended Use	Standing Water Level (mbgl)	First Water Bearing Zone (mbgl) and Substrate	Distance and Direction from Site
GW110974.1.1	2009	Stock / Domestic	14.9	19.8 – 33.5 Rhyolite	70 m southeast

3 Wastewater Assessment

3.1 Wastewater Treatment Options

Treatment system requirement are dictated by the selected method for effluent disposal. Primary and secondary treatment options may include (but are not limited to):

Primary options:

- Septic tank.
- Composting and Hybrid toilet system with greywater treatment systems.

Secondary options:

- Aerated wastewater treatment system (AWTS).

Typical primary and secondary treatment standards are provided in Table 6. This information is also used for the nutrient balance assessment.

Table 6: Assumed primary and secondary treatment standards.

Parameter	Primary Standard	Secondary Standard
BOD_5 (mg/L)	150	30
Suspended solids (mg/L)	50	30
Faecal coliforms (CFU/100mL)	10^5-10^7	30
Total phosphorus (mg/L)	15	12
Total nitrogen (mg/L)	50	27

3.2 Wastewater Disposal Options

Disposal options considered on the site include surface irrigation, subsurface irrigation and absorption systems. Secondary treatment is required for surface irrigation system and primary or secondary treatment is acceptable for subsurface irrigation or absorption based system.

3.3 Soil Chemical Capability Assessment

A summary of soil chemical properties is provided in Table 7.

Table 7: Summary of soil assessment.

Parameter	Value	Limitations[1]
pH (1:5)	4.5 – 5.8	Moderate
ECe (dS/m)	<0.1	Minor
CEC (cmol(+)/kg)	16.40 – 21.70	Minor
P-sorption (mg/kg)	359 - 590	Minor

Notes
[1]-DLG et al. (1998).

Values are obtained from NSW Land and Water Conservation (1997) Soil Landscapes of Bega-Goalen Point 1:100,000 Sheet, Appendix 7.2.7 and 7.2.10 for the Bald Hills soil landscapes as found on the site (BH1 & BH3).

Site observations indicated no restriction to vegetation growth as a result of naturally acidic soil pH. The 'limitation' assessed by comparison to DLG et al. (1998) is therefore not considered to warrant any mitigation or to pose any significant limitation to onsite wastewater disposal.

3.4 Land Capability Assessment for Effluent Reuse

Site and soil suitability for effluent reuse have been determined according to Tables 4 and 6 of NSW DLG et al. (1998) and are summarised in Table 8.

Table 8: Site and soil suitability in accordance with NSW DLG et al. (1998).

Soil Feature	Potential Irrigation Areas	Limitation Rating
Flood potential	NA	Minor
Sun and wind exposure	High	Minor
Slope (%)	6– 32%	Minor - Moderate[2]
Landform	Convex side slopes	Minor
Erosion potential	Little present	Minor
Site drainage	Generally, well drained	Minor
Fill	None observed	Minor
Rock outcrops	< 10%	Minor
Geology	No major discontinuities	Minor
Depth to bedrock (m)	> 1	Minor
Depth to water table (m)	> 1	Minor
Soil permeability category	Category 4a and 4b	Minor
Coarse fragments (%)	0 – 20%	Minor

Notes

1. All proposed effluent management areas (EMAs) to be located above 1 in 100 year flood level.
2. Slope areas within proposed EMAs will be less than 20%, therefore minor to moderate limitation depending on application system selected.

Land capability assessment indicates a moderate slope limitation. The area for major slope limitations (i.e. > 20%) for both irrigation and absorption is shown in Map 02 (Attachment A). All other soil features indicate minor limitations. A plan detailing appropriate effluent management areas (EMA)s for the proposed lots is shown in Map 03 (Attachment A).

To address variable slope the following system selection is recommended for areas of each slope 'category':

- < 6 % - any application system.
- 6 – 10% - no surface irrigation; absorption or subsurface irrigation (including LPED) application only.
- 10 – 20% - no surface irrigation; subsurface irrigation (including LPED) application rate reduced by 20%. Site specific risk assessment for absorption system.

- 20 – 30% - no surface irrigation or absorption systems; subsurface irrigation (including LPED) application rate reduced by 50%. Site specific risk assessment for absorption system.

- > 30% - generally unsuitable for effluent application system.

3.5 Pathogen Modelling

A Beavers Gardner model has been completed to assess the risks posed to the existing groundwater supply bore by pathogens in applied effluent. This model determines the time taken to achieve the required magnitude of pathogen reduction in soil and the distance travelled by the effluent in that time to determine minimum buffer distances to effluent application systems. The following two equations are used:

1. Time taken to achieve pathogen reduction:

$$t = \frac{\ln\left(\frac{M_t}{M_0}\right)}{-k}$$

Where:

t = time to achieve required pathogen reduction (days);

$\frac{M_t}{M_0}$ = magnitude of reduction required; and,

-k = decay rate coefficient = $ln\left(10^{(-0.181+0.0214\ x\ groundwater\ temperature)}\right)$

2. Distance travelled by effluent:

$$\frac{(tKi)}{\eta_e}$$

Where:

t = time to achieve required pathogen reduction (Equation 1);

K = saturated hydraulic conductivity of soil in effluent disposal field (m/day);

i = hydraulic gradient of groundwater between effluent disposal field and observation point (m^{-1}); and,

η_e = effective porosity of aquifer between effluent disposal field and observation point (dimensionless).

Model inputs and assumptions are provided in Table 9 with the model results provided in Attachment D.

Table 9: Summary of modelling inputs and assumptions used in pathogen transport modelling.

Model Parameter	Assumed value
Initial concentration of pathogen (CFU / 100 mL)[1]	1 x 10^7
Required magnitude of reduction (log_{10})	7
Minimum groundwater temperature (°C)	12
Maximum groundwater temperature (°C)	22
Saturated hydraulic conductivity of soil (m/day)	1
Hydraulic gradient[2] (m^{-1})	0.16
Effective aquifer porosity	0.2

Notes

[1.] Typical concentration of faecal coliforms following primary treatment by a septic tank (NSW DLG., 1998).

[2.] Assumed based on surface gradients.

Results of the modelling show that for a groundwater temperature of 12 °C and a log-7 reduction of pathogens, a buffer of approximately 74 m would be required between effluent disposal fields and the existing groundwater bore at the site. Modelling calculations are presented in Attachment D.

3.6 Buffer Setbacks for Effluent Reuse Area

EMAs are to be located with setbacks in accordance with NSW DLG et al. (1998), Bega Valley Shire Council Development Control Plan 2019 (BDCP, 2019) and site specific pathogen modelling, with recommended setbacks summarised in Table 10. Buffers are applied to the site in Map 02 and 03 (Attachment A).

Table 10: Adopted buffer setbacks in accordance with NSW DLG et al. (1998).

Feature[1]	Buffer Distance (m)		
	Surface and Subsurface Irrigation	Spray Irrigation	Absorption
Yowaka River[2]	150	150	150
Groundwater Bore[3]	74	74	74
Dams and Waterways	40	40	40
Dwellings	6 / 3[4]	15	6 / 3[4]
Swimming Pools	6 / 3[4]	6	6 / 3[4]
Driveways	6 / 3[4]	6 / 3[4]	6 / 3[4]
Property Boundaries	6 / 3[4]	6 / 3[4]	12/ 6[4]

Notes

[1] In accordance with NSW DLG et al. (1998) except where otherwise noted.

[2] BDCP (2019) required a 150m setback from the Yowaka River.

[3] 74 m buffer based on pathogen modelling in section 3.5.

[4] x / y = downslope / upslope of effluent management area.

3.7 Hydraulic Load Estimations

Council's BDCP (2019) requires new onsite wastewater management systems to be designed based on an assumed future hydraulic load of 1,000 L/day.

3.8 Effluent Application Rates

3.8.1 Design Irrigation Rates

Recommended design irrigation rates (DIRs) according to AS/NZS 1547 (2012) are given in Table 11 for subsurface irrigation of secondary effluent and for subsurface LPED irrigation of primary treated effluent. For spray irrigation top soil rates are applicable, for subsurface irrigation, subsoil rates apply.

Table 11: Design irrigation rates for the site.

Depth (m) [1]	Texture	Structure	Indicative Permeability (K_{sat}) (m/d)	Design Irrigation Rate (DIR) (mm/day) [2]	
				Primary Effluent [3]	Secondary Effluent [4]
0.0 – 0.1 (surface)	Sandy Clay Loam	Weakly Structured	0.12 – 0.5	3.0	3.5
0.1 - >1.0 (subsurface)	Clay Loam	Moderately Structured	0.5 – 1.5	3.0	3.5
Design				**3.0**	**3.5**

Notes

[1] Depths of soil horizons varies across the site.

[2] Subject to DIR reductions in section 3.4 in response to slope.

[3] Primary effluent to LPED irrigation area.

[4.] Secondary effluent to subsurface irrigation area.

For a design hydraulic load of 1,000 L/day, secondary treated effluent irrigation fields are to be 285 m^2, for primary treated irrigation fields an area of 335 m^2 is required. In accordance with AS/NZS 1547 (2012), an area of 335 m^2 is to be provided as a reserve area for LPED irrigation giving a total required area of 670 m^2 per dwelling. Clause 5.5.3.4 of AS/NSZ 1547 (2012) notes that reserve areas are not required for secondary treated effluent applied to irrigation areas.

3.8.2 Design Loading Rates

Recommended design loading rates (DLRs) for absorption system according to AS/NZS 1547 (2012) are given in Table 12. As absorption systems apply to subsoil, the DLR for 0.5 – 1.0 m is applicable to design.

Table 12: Design loading rates for the site.

Depth (m) [1]	Texture	Structure	Indicative Permeability (K_{sat}) (m/d)	Design Loading Rate (DLR) (mm/day)[2]	
				Primary Effluent	Secondary Effluent
0.0 – 0.1	Sandy Clay Loam	Weakly Structured	0.12 – 0.5	6	10
0.1 - >1.0	Clay Loam	Moderately Structured	0.5 – 1.5	10	15
Design				**10**	**15**

Notes

[1.] Depths of soil horizons varies across the site.

[2.] Subject to DLR reductions in section 3.4 in response to slope.

For a design hydraulic load of 1,000 L/day an absorption area of 100 m^2 is required for primary effluent and 67 m^2 for secondary effluent. This may be provided as trench(s) or absorption bed(s).

3.9 Nutrient Modelling Summary

Assessment of nutrient balance has been undertaken in accordance with DLG et al. (1998). Modelling completed assesses the required areas for the assimilation of applied nutrient.

Detailed modelling outputs are provided in Attachment C of this report. Sustainable disposal area for primary and secondary effluent are summarised in Table 13. Primary and secondary treatment results in differing nutrient content in effluent and therefore differing areas to achieve nutrient uptake. Assessment of required areas has been completed.

Table 13: Area required for sustainable effluent application.

	Area Required (m^2)	
	Primary Treatment	**Secondary Treatment**
Nitrogen uptake	950	430
Phosphorus saturation	620	490

4 Recommendations

Recommendations are provided for primary or secondary treated effluent management systems. System design provided for sustainable hydraulic and nutrient loading rates.

4.1 Irrigation Requirements

The irrigation field is to be constructed in accordance with AS/NZS 1547 (2012) and the following minimum specifications.

4.1.1 All Irrigation Systems – General Requirements

- All effluent distribution and irrigation lines are to be fixed in place by burial to a depth of no less than 100 mm.
- The irrigation area cannot be used for growing fruit, vegetables or other edible plants.
- Effluent shall be pumped from the treatment system through an appropriately sized (25 mm minimum diameter) poly main line to the top of the disposal field(s). The main is to be fitted with suitable non return valves.
- Distribution mains and irrigation laterals are to be installed by a suitably qualified individual to meet the standards of AS/NZS 1547 (2012).
- The effluent dispersal pump and delivery mains are to be sized to provide adequate flow through the proposed irrigation system.
- Based on nutrient and hydraulic modelling and AS/NZS 1547 (2012) a minimum irrigation field area of 490 m^2 (secondary treatment) and 950 m^2 (primary treatment) per dwelling is required based on the limiting design criteria being nutrient assimilation.

4.1.2 Spray Irrigation (up to 6% slopes)

- Effluent is to be reticulated to a series of low through, coarse droplet sprinklers located across the irrigation field giving even effluent distribution.
- Irrigation field to be fenced to prevent casual pedestrian access.

- Spray irrigation only to be used in conjunction with secondary effluent treatment.

4.1.3 Shallow Subsurface Irrigation (up to 30% slopes)

- Effluent is to be distributed into a series of lateral irrigation lines parallel to site contours.
- Effluent is to be distributed using a pressure compensating subsurface irrigation line such as *"Netafim", "Amiad PC"* or *"Wasteflow"*. These products have been specifically designed for the distribution of secondary effluent and allow for the even distribution of flows along and between irrigation lines.
- Irrigation lines are to be spaced 1.0 m apart (centres) across the irrigation field.
- The irrigation field irrigation lines are to be installed directly into soil at a depth of 150 mm.
- A (minimum 25 mm) manifold is to be installed along the side of the field with distribution lateral lines running from it.
- A 25 mm reticulated flushing main with shut off valve is to be constructed for system flushing. Main is to discharge to inlet of treatment system.
- Where slopes in the irrigation field are 20 % - 30 % the minimum irrigation area is to be increased to 570 m^2.

4.2 Absorption Trench Requirements

Trenches are to be constructed with self supporting arches with trench backfilled with 20 – 40 mm aggregate prior to placement of geotextile and 150 mm topsoil cover. Recommended typical trench dimensions are provided Table 14.

Table 14: Approximate absorption trench dimensions.

Design Loading Rate (DLR) (mm/day)	Hydraulic Load (L/Day)	Required trench base (m^2)	Trench dimensions		
			Width (m)	Depth (m)	Length (m)
10[1]	1,000	100	0.6	0.6	167
15[2]	1,000	67	0.6	0.6	112

Notes

[1.] Primary treated effluent.

[2.] Secondary treated effluent.

Absorption bed may be used where sufficient level land is available. The total required trench/absorption bed surface area may be provided as multiple trenches/beds fed by a distribution box to ensure even flow to each trench. Distribution boxes should be checked as part of performance monitoring inspection to confirm that an even flow of effluent is being directed to each distribution line.

Trench design based on soil hydraulics (Table 14) does not consider nutrient assimilation. Sustainable assimilation of nutrients requires a minimum disposal area of 490 m^2 (secondary effluent) to 950 m^2 (primary effluent) which are too large for feasible absorption trench design and even effluent application.

5 Conclusion

The completed wastewater assessment concludes that appropriate onsite effluent management system is able to be accommodated on each of new allotment in the proposed subdivision. Review of capability mapping indicates that a suitable area is available for each lot for effluent management subject to the effluent treatment standard and disposal system which as summarised in Table 15.

Table 15: Effluent treatment and disposal options

Lot ID	Suitable EMA Available (m^2)	Average Slope within Potential EMA (%)	Treatment Options		Disposal Options		
			Primary	Secondary	Irrigation		Absorption
					Spray	Surface / Subsurface	
1	> 1,000	13	✓	✓	X[1,2]	✓	✓
2	> 1,000	11	✓	✓	X[2]	✓	✓
3	> 1,000	10	✓	✓	X[2]	✓	X[3]
4	Existing System						
5	Existing System						
6	> 1,000	14	X	✓	X[1,2]	✓	X[3]
7	> 1,000	15	✓	✓	X[1]	✓	✓
8	600	8	X	✓	X[2]	✓	X[3]
9	> 1,000	14	✓	✓	X[1,2]	✓	✓
10	600	15	X	✓	X[1,2]	✓	X[3]
11	> 1,000	17	✓	✓	X[1,2]	✓	✓
12	> 1,000	17	✓	✓	X[1,2]	✓	✓
13	> 1,000	16	✓	✓	X[1]	✓	✓
14	> 1,000	13	X	✓	X[1,2]	✓	X[3]
15	> 1,000	11	✓	✓	X[1,2]	✓	✓

Notes

[1.] Spray irrigation not likely to be an acceptable disposal option due to average slope > 6% (DLG et al., 1998). Where sufficient land < 6% is identified spray irrigation may be possible.

[2.] Spray irrigation not a disposal option due to dwelling located within 15 m setback distance (DLG et al., 1998).

[3.] Absorption disposal not suitable due to setback distance less than 12 m from property boundary.

General requirements for onsite effluent disposal have been developed and are detailed in this report. Identified soil and land capability constraints have been assessed in accordance with relevant guidelines. Design of typical wastewater management solution have considered

nutrient and soil assessments. This assessment is considered preliminary and a more detailed wastewater management assessment would be required at the development application stage for residential dwellings and then again at the Local Government Act section 68 application stage for individual systems.

6 References

Australian/ New Zealand Standard 1547 (2012) - *On site Domestic Wastewater Management*

Bega Valley Shire Council (2013) – *Bega Valley Development Control Plan* (Revised 2019). [referred to as BDCP (2019)]

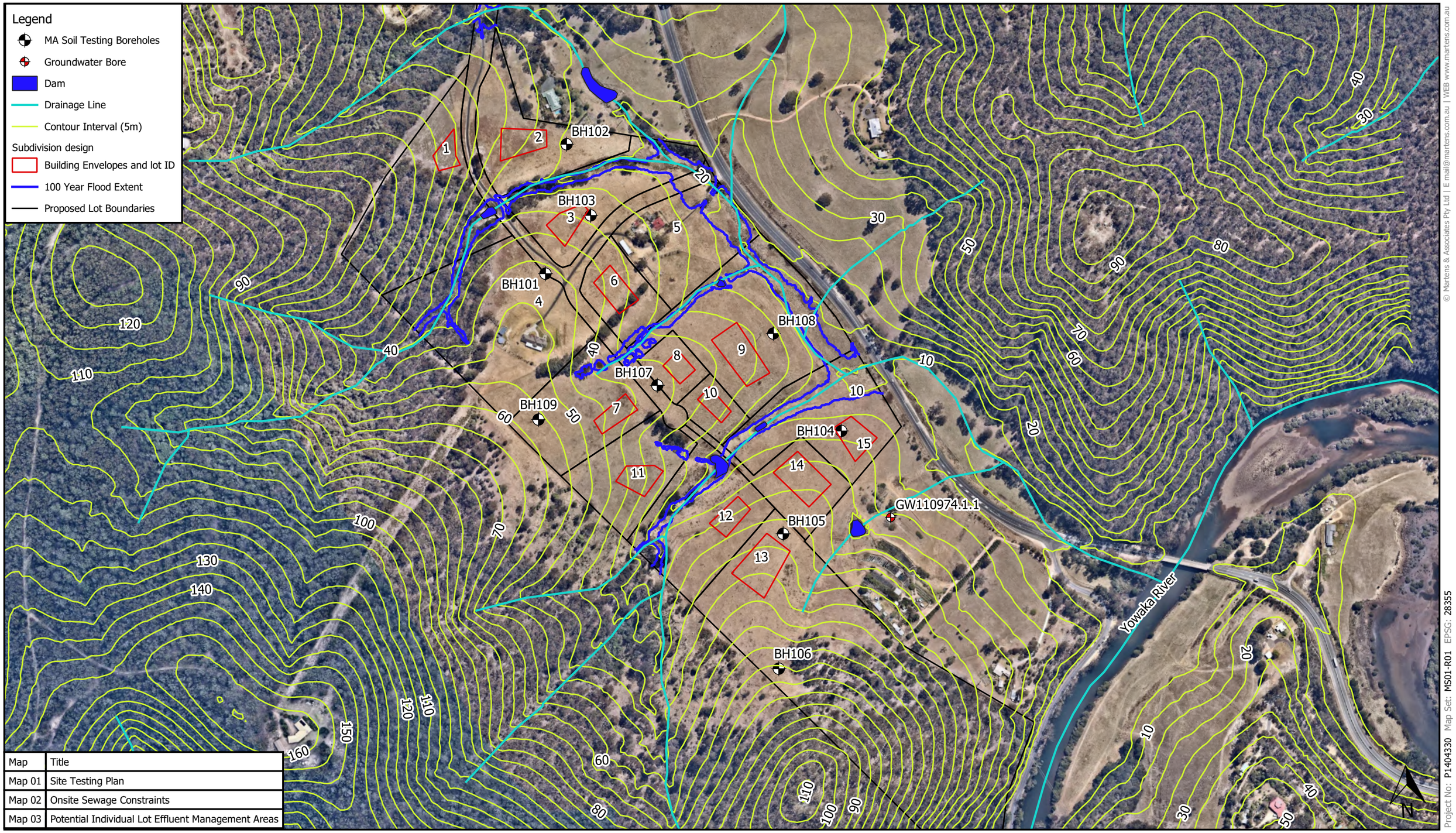
Department of Local Government, NSW Environment Protection Authority, NSW Health Department, NSW Department of Land and Water Conservation and the NSW Department of Urban Affairs and Planning (1998) - *Environment and Health Protection Guidelines - On-site Sewage Management for Single Households.*

Lewis P.C. and Glen R.A. (1995) Bega & Mallacoota 1:250,000 Geological Sheet Series Sheet SJ/55-4, SJ/55-8. (New South Wales Department of Mineral Resources).

OCRE (2021) General Arrangement: Lot 711, DP1128593, 3810 Princes Highway Griegs Flat.

Southeast (2021) Planning Proposal – Lot 711 DP 1128593: Flood Risk Assessment and Surface Water Assessment.

7 Attachment A – Figures



Map	Title
Map 01	Site Testing Plan
Map 02	Onsite Sewage Constraints
Map 03	Potential Individual Lot Effluent Management Areas

0 50 100 150 200 250 m

1:5000 @ A3

Sources:
Aerial Image Source: Nearmap (2021);
Flooding information from Southeast (2021) Planning Proposal Lot 711 DP1128593: Flood Risk Assessment and Surface Water Assessment;
Lot layout and building pads provided by OCRE (2021); Waterways from SixMaps; Contours from ELVIS Lidar.

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Map Title / Figure:
Site Testing Plan

Map 01	Map
Lot 711, DP 1128593 South Pambula, NSW	Site
Wastewater land capability assessment	Project
	Sub-Project
Mr. Graeme Payten	Client
24/02/2022	Date

Project No: P1404330 Map Set: MS01-R01 EPSG: 28355

Legend

- MA Soil Testing Boreholes
- Groundwater Bore Pathogen Transport Modelled Buffer
- Groundwater Bore
- Dam 40 m Buffer
- Dam
- Drainage Line 40m buffer
- Drainage Line
- Contour Interval (5m)
- Council nominated waterway 150 m buffer

Subdivision design

- Building Envelopes and lot ID
- 100 Year Flood Extent
- Proposed Lot Boundaries

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Subsurface Slope Analysis (%)

- > 20

BH101 BH102 BH103 BH104 BH105 BH106 BH107 BH108 BH109 GW110974.1.1

Yowaka River

0 50 100 150 200 250 m

1:5000 @ A3

Sources:
Aerial Image Source: Nearmap (2021);
Flooding information from: Southeast (2021) Planning Proposal Lot 711 DP1128593: Flood Risk Assessment and Surface Water Assessment;
Lot layout and building pads provided by OCRE (2021); Waterways from SIxMaps; Contours from ELVIS Lidar.

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Map Title / Figure:

Onsite Sewage Constraints

Map 02	Map
Lot 711, DP 1128593 South Pambula, NSW	Site
Wastewater land capability assessment	Project
	Sub-Project
Mr. Graeme Payten	Client
24/02/2022	Date

Project No: P1404330 Map Set: MS01-R01 EPSG: 28355

Legend

- MA Soil Testing Boreholes
- Groundwater Bore Pathogen Transport Modelled Buffer
- Groundwater Bore
- Dam 40 m Buffer
- Dam
- Drainage Line 40m buffer
- Drainage Line
- Contour Interval (5m)
- Council nominated waterway 150 m buffer

Subdivision design

- Building Envelopes and lot ID
- 6m House Buffer
- 100 Year Flood Extent
- Proposed Lot Boundaries
- 3m Lot Boundary Buffer
- Suitable Effluent Management Area (600 sqm)
- Suitable Effluent Management Area (1000 sqm)

LiDar

Subsurface Slope Analysis (%)

- > 20

BH101 BH102 BH103 BH104 BH105 BH106 BH107 BH108 BH109 GW110974.1.1

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Yowaka River

0 50 100 150 200 250 m

1:5000 @ A3

Sources:
Aerial Image Source: Nearmap (2021);
Flooding information from: Southeast (2021) Planning Proposal Lot 711 DP1128593: Flood Risk Assessment and Surface Water Assessment;
Lot layout provided by OCRE; Waterways from SixMaps; Contours from ELVIS lidar.

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Map Title / Figure:

Potential Individual Lot Effluent Management Areas

Map 03

Lot 711, DP 1128593 South Pambula, NSW	Site
Wastewater land capability assessment	Project
	Sub-Project
Mr. Graeme Payten	Client
24/02/2022	Date

Map

Project No: P1404330 Map Set: MS01-R01 EPSG: 28355

8 Attachment B – Borehole Logs

CLIENT	Caddey Searl & Jarman Pty Ltd	**COMMENCED**	23.09.14	**COMPLETED**	23.09.14	**REF**	**BH101**
PROJECT	Wastewater Assessment	**LOGGED**	AB	**CHECKED**	AN	**Sheet**	1 of 1
SITE	Lot 711, DP 1128593 South Pambula NSW	**GEOLOGY**	Basalt	**VEGETATION**	Grass	**PROJECT NO.**	P1404330
EQUIPMENT	Hydraulic Auger	**EASTING**	-	**RL SURFACE**	-		
EXCAVATION DIMENSIONS	Ø95mm X 3.0m depth	**NORTHING**	-	**ASPECT**	North East	**SLOPE**	10-15°

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	DRILLING RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	MATERIAL DESCRIPTION SOIL NAME, plasticity or particle characteristics, colour, secondary and minor components, moisture condition, consistency/relative density, ROCK NAME, grain size, texture/fabric, colour strength, weathering.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
V	Nil	N	M	0.1			SCL	Sandy Clay Loam - Dark brown, weakly structured, organic.					
V	Nil	N	M	0.8			CL	Clay Loam - Brown, moderately structured.			B	0.5-0.75	4330/101/ 0.5-0.75 - V Bit refusal at 0.8m.
TC	Nil	N	D	1.0 1.4				BASALT - Pale grey/white, inferred very low strength, distinctly to slightly weathered.					1.0
TC	Nil	N	D	2.0 3.0				BASALT - Pale grey/white, inferred low strength, slightly weathered.					2.0 3.0
				4.0 4.5				Borehole terminated at target depth of 3.0m on inferred low strength basalt.					4.0 4.5

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
HA Hand auger
S Spade
CC Concrete Corer
V V-Bit
TC Tungsten Carbide Bit
PT Push tube

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

DRILLING RESISTANCE
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
N USCS
Y Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

CLIENT	Caddey Searl & Jarman Pty Ltd	**COMMENCED**	23.09.14	**COMPLETED**	23.09.14	**REF**	**BH102**
PROJECT	Wastewater Assessment	**LOGGED**	AB	**CHECKED**	AN	**Sheet**	1 of 1
SITE	Lot 711, DP 1128593 South Pambula NSW	**GEOLOGY**	Basalt	**VEGETATION**	Grass	**PROJECT NO.**	P1404330
EQUIPMENT	Hydraulic Auger	**EASTING**	-	**RL SURFACE**	-		
EXCAVATION DIMENSIONS	Ø95mm X 2.5m depth	**NORTHING**	-	**ASPECT**	North East	**SLOPE**	5-10°

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	DRILLING RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	MATERIAL DESCRIPTION SOIL NAME, plasticity or particle characteristics, colour, secondary and minor components, moisture condition, consistency/relative density, ROCK NAME, grain size, texture/fabric, colour strength, weathering.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS	
V	Nil	N	M	0.8			SCL	Sandy Clay Loam - Dark brown, weakly structured, organic.			B B	0.1-0.3 0.5-0.75	4330/102/ 0.1-0.3 4330/102/ 0.5-0.75	
V	Nil	N	M	1.0 2.0 2.5			CL	Clay Loam - Brown, moderately structured.			B B	1.0-1.2 2.0-2.25	4330/102/ 1.0-1.2 4330/102/ 2.0-2.25	1.0 2.0
				3.0 4.0 4.5				V bit refusal at 2.5m on weathered basalt.						3.0 4.0 4.5

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
HA Hand auger
S Spade
CC Concrete Corer
V V-Bit
TC Tungsten Carbide Bit
PT Push tube

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

DRILLING RESISTANCE
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
N USCS
Y Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

CLIENT	**Caddey Searl & Jarman Pty Ltd**	**COMMENCED**	23.09.14	**COMPLETED**	23.09.14	**REF**	**BH103**
PROJECT	**Wastewater Assessment**	**LOGGED**	AB	**CHECKED**	AN	**Sheet**	**1 of 1**
SITE	**Lot 711, DP 1128593 South Pambula NSW**	**GEOLOGY**	Basalt	**VEGETATION**	Grass	**PROJECT NO.**	P1404330
EQUIPMENT	Hydraulic Auger	**EASTING**	-	**RL SURFACE**	-		
EXCAVATION DIMENSIONS	Ø95mm X 1.4m depth	**NORTHING**	-	**ASPECT**	North East	**SLOPE**	10-15°

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	DRILLING RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	MATERIAL DESCRIPTION SOIL NAME, plasticity or particle characteristics, colour, secondary and minor components, moisture condition, consistency/relative density, ROCK NAME, grain size, texture/fabric, colour strength, weathering.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
V	Nil	N	M	0.1			SCL	Sandy Clay Loam - Dark brown, weakly structured, organic.			B	0.1-0.3	4330/103/ 0.1-0.3
V	Nil	N	M	1.0			CL	Clay Loam - Brown, moderately structured.			B B	0.5-0.75 1.0-1.2	4330/103/ 0.5-0.75 4330/103/ 1.0-1.2
V	Nil	N	M	1.4			CL	Clay Loam - White, pale grey, moderately weathered.					
				2.0				V bit refusal at 1.4m on weathered basalt.					
				3.0									
				4.0									
				4.5									

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
HA Hand auger
S Spade
CC Concrete Corer
V V-Bit
TC Tungsten Carbide Bit
PT Push tube

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

DRILLING RESISTANCE
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
N USCS
Y Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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CLIENT	Caddey Searl & Jarman Pty Ltd	**COMMENCED**	23.09.14	**COMPLETED**	23.09.14	**REF**	**BH104**
PROJECT	Wastewater Assessment	**LOGGED**	AB	**CHECKED**	AN	**Sheet**	1 of 1
SITE	Lot 711, DP 1128593 South Pambula NSW	**GEOLOGY**	Basalt	**VEGETATION**	Grass	**PROJECT NO.**	P1404330
EQUIPMENT	Hydraulic Auger	**EASTING**	-	**RL SURFACE**	-		
EXCAVATION DIMENSIONS	Ø95mm X 1.8m depth	**NORTHING**	-	**ASPECT**	North East	**SLOPE**	5-10°

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	DRILLING RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	MATERIAL DESCRIPTION SOIL NAME, plasticity or particle characteristics, colour, secondary and minor components, moisture condition, consistency/relative density, ROCK NAME, grain size, texture/fabric, colour strength, weathering.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
V	Nil	N	M	0.3			SCL	Sandy Clay Loam - Dark brown, weakly structured, organic.			B	0.1-0.3	4330/104/ 0.1-0.3
V	Nil	N	M	1.0 1.4			CL	Clay Loam - Brown, moderately structured.			B	0.5-0.75	4330/104/ 0.5-0.75 1.0
V	Nil	N	M	1.8			CL	Clay Loam - White, pale grey, moderately weathered basalt.			B	1.5-1.7	4330/104/ 1.5-1.7
				2.0 3.0 4.0 4.5				V bit refusal at 1.8m on weathered basalt.					2.0 3.0 4.0 4.5

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
HA Hand auger
S Spade
CC Concrete Corer
V V-Bit
TC Tungsten Carbide Bit
PT Push tube

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

DRILLING RESISTANCE
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
N USCS
Y Agricultural

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CLIENT	Caddey Searl & Jarman Pty Ltd	**COMMENCED**	23.09.14	**COMPLETED**	23.09.14	**REF**	**BH105**
PROJECT	Wastewater Assessment	**LOGGED**	AB	**CHECKED**	AN	**Sheet**	1 of 1
SITE	Lot 711, DP 1128593 South Pambula NSW	**GEOLOGY**	Basalt	**VEGETATION**	Grass	**PROJECT NO.**	P1404330
EQUIPMENT	Hydraulic Auger	**EASTING**	-	**RL SURFACE**	-		
EXCAVATION DIMENSIONS	Ø95mm X 1.4m depth	**NORTHING**	-	**ASPECT**	North East	**SLOPE**	5-10°

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	DRILLING RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	MATERIAL DESCRIPTION SOIL NAME, plasticity or particle characteristics, colour, secondary and minor components, moisture condition, consistency/relative density, ROCK NAME, grain size, texture/fabric, colour strength, weathering.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
V	Nil	N	M	0.1			SCL	Sandy Clay Loam - Dark brown, weakly structured, organic.			B	0.1-0.3	4330/105/ 0.1-0.3
											B	0.5-0.75	4330/105/ 0.5-0.75
V	Nil	N	M	1.0			CL	Clay Loam - Brown, moderately structured.					
				1.4				V bit refusal at 1.4m on weathered basalt.					
				2.0									
				3.0									
				4.0									
				4.5									

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
HA Hand auger
S Spade
CC Concrete Corer
V V-Bit
TC Tungsten Carbide Bit
PT Push tube

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

DRILLING RESISTANCE
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
N USCS
Y Agricultural

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CLIENT	Caddey Searl & Jarman Pty Ltd	**COMMENCED**	23.09.14	**COMPLETED**	23.09.14	**REF**	**BH106**
PROJECT	Wastewater Assessment	**LOGGED**	AB	**CHECKED**	AN	**Sheet**	1 of 1
SITE	Lot 711, DP 1128593 South Pambula NSW	**GEOLOGY**	Basalt	**VEGETATION**	Grass	**PROJECT NO.**	P1404330
EQUIPMENT	Hydraulic Auger	**EASTING**	-	**RL SURFACE**	-		
EXCAVATION DIMENSIONS	Ø95mm X 1.7m depth	**NORTHING**	-	**ASPECT**	North East	**SLOPE**	15-20°

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	DRILLING RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	MATERIAL DESCRIPTION SOIL NAME, plasticity or particle characteristics, colour, secondary and minor components, moisture condition, consistency/relative density, ROCK NAME, grain size, texture/fabric, colour strength, weathering.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
V	Nil	N	M	0.1			SCL	Sandy Clay Loam - Dark brown, weakly structured, organic.			B	0.1-0.3	4330/106/ 0.1-0.3
											B	0.5-0.75	4330/106/ 0.5-0.75
V	Nil	N	M	1.0			CL	Clay Loam - Brown, moderately structured.					
				1.7				V bit refusal at 1.7m on weathered basalt.					
				2.0									
				3.0									
				4.0									
				4.5									

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
HA Hand auger
S Spade
CC Concrete Corer
V V-Bit
TC Tungsten Carbide Bit
PT Push tube

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

DRILLING RESISTANCE
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
N USCS
Y Agricultural

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Engineering Log - Borehole

CLIENT	Caddey Searl & Jarman Pty Ltd	**COMMENCED**	23.09.14	**COMPLETED**	23.09.14	**REF**	**BH107**
PROJECT	Wastewater Assessment	**LOGGED**	AB	**CHECKED**	AN	**Sheet**	1 of 1
SITE	Lot 711, DP 1128593 South Pambula NSW	**GEOLOGY**	Basalt	**VEGETATION**	Grass	**PROJECT NO.**	P1404330
EQUIPMENT	Hydraulic Auger	**EASTING**	-	**RL SURFACE**	-		
EXCAVATION DIMENSIONS	Ø95mm X 1.2m depth	**NORTHING**	-	**ASPECT**	North East	**SLOPE**	5-10°

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	DRILLING RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	MATERIAL DESCRIPTION SOIL NAME, plasticity or particle characteristics, colour, secondary and minor components, moisture condition, consistency/relative density, ROCK NAME, grain size, texture/fabric, colour strength, weathering.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
V	Nil	N	M	0.1			SCL	Sandy Clay Loam - Dark brown, weakly structured, organic.			B	0.1-0.3	4330/107/ 0.1-0.3
											B	0.5-0.7	4330/107/ 0.5-0.7
V	Nil	N	M	1.0			CL	Clay Loam - Brown, moderately structured.					
				1.2				V bit refusal at 1.2m on weathered basalt.					
				2.0									
				3.0									
				4.0									
				4.5									

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
HA Hand auger
S Spade
CC Concrete Corer
V V-Bit
TC Tungsten Carbide Bit
PT Push tube

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

DRILLING RESISTANCE
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
N USCS
Y Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

CLIENT	Caddey Searl & Jarman Pty Ltd	**COMMENCED**	23.09.14	**COMPLETED**	23.09.14	**REF**	**BH108**
PROJECT	Wastewater Assessment	**LOGGED**	AB	**CHECKED**	AN	**Sheet**	1 of 1
SITE	Lot 711, DP 1128593 South Pambula NSW	**GEOLOGY**	Basalt	**VEGETATION**	Grass	**PROJECT NO.**	P1404330
EQUIPMENT	Hydraulic Auger	**EASTING**	-	**RL SURFACE**	-		
EXCAVATION DIMENSIONS	Ø95mm X 0.8m depth	**NORTHING**	-	**ASPECT**	North East	**SLOPE**	2-5°

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	DRILLING RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	MATERIAL DESCRIPTION SOIL NAME, plasticity or particle characteristics, colour, secondary and minor components, moisture condition, consistency/relative density, ROCK NAME, grain size, texture/fabric, colour strength, weathering.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
V	Nil	N	M	0.1			SCL	Sandy Clay Loam - Dark brown, weakly structured, organic.			B	0.1-0.3	4330/108/ 0.1-0.3
V	Nil	N	M	0.8			CL	Clay Loam - Brown, moderately structured.			B	0.5-0.75	4330/108/ 0.5-0.75
				1.0				V bit refusal at 0.8m on weathered basalt.					
				2.0									
				3.0									
				4.0									
				4.5									

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
HA Hand auger
S Spade
CC Concrete Corer
V V-Bit
TC Tungsten Carbide Bit
PT Push tube

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

DRILLING RESISTANCE
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
N USCS
Y Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

Quality Sheet No. 4

martens

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Engineering Log - Borehole

CLIENT	Caddey Searl & Jarman Pty Ltd	**COMMENCED**	23.09.14	**COMPLETED**	23.09.14	**REF**	**BH109**
PROJECT	Wastewater Assessment	**LOGGED**	AB	**CHECKED**	AN	**Sheet**	1 of 1
SITE	Lot 711, DP 1128593 South Pambula NSW	**GEOLOGY**	Basalt	**VEGETATION**	Grass	**PROJECT NO.**	P1404330
EQUIPMENT	Hydraulic Auger	**EASTING**	-	**RL SURFACE**	-		
EXCAVATION DIMENSIONS	Ø95mm X 1.6m depth	**NORTHING**	-	**ASPECT**	North East	**SLOPE**	15-20°

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	DRILLING RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	MATERIAL DESCRIPTION SOIL NAME, plasticity or particle characteristics, colour, secondary and minor components, moisture condition, consistency/relative density, ROCK NAME, grain size, texture/fabric, colour strength, weathering.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
V	Nil	N	M	0.1			SCL	Sandy Clay Loam - Dark brown, weakly structured, organic.					
V	Nil	N	M	1.0			CL	Clay Loam - Brown, moderately structured.			B	0.5-0.75	4330/109/ 0.5-0.75
V	Nil	N	M	1.6			CL	Clay Loam - Brown, moderately structured.			B	1.2-1.4	4330/109/ 1.2-1.4
				2.0				V bit refusal at 1.6m on weathered basalt.					
				3.0									
				4.0									
				4.5									

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
HA Hand auger
S Spade
CC Concrete Corer
V V-Bit
TC Tungsten Carbide Bit
PT Push tube

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

DRILLING RESISTANCE
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
N USCS
Y Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

9 Attachment C – Groundwater Bore Log

WaterNSW
Work Summary

GW110974

Licence: | Licence Status:

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

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

Commenced Date:
Completion Date: 20/03/2009

Final Depth: 55.80 m
Drilled Depth: 55.80 m

Contractor Name: Gordon Noel BRIGGS
Driller: Gordon Noel Briggs
Assistant Driller:

Property:
GWMA:
GW Zone:

Standing Water Level (m): 14.900
Salinity Description:
Yield (L/s): 0.120

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	AUCKLAND	YOWAKA	5//262002
Licensed:			

Region: 10 - Sydney South Coast
River Basin: - Unknown
Area/District:

CMA Map:
Grid Zone:
Scale:

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

Northing: 5905879.000
Easting: 755260.000

Latitude: 36°57'30.9"S
Longitude: 149°52'01.1"E

GS Map: -

MGA Zone: 55

Coordinate Source: Unknown

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	2.70	185			Rotary Air
1		Hole	Hole	2.70	55.80	182			Down Hole Hammer
1	1	Casing	Pvc Class 9	-0.30	55.80	140			Seated on Bottom, Glued
1	1	Opening	Slots - Vertical	18.00	55.00	140		0	Casing - Machine Slotted, PVC, SL: 80.0mm, A: 2.00mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth	Duration (hr)	Salinity (mg/L)

Construction

egative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure emented; 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	2.70	185			Rotary Air
1		Hole	Hole	2.70	55.80	182			Down Hole Hammer
1	1	Casing	Pvc Class 9	-0.30	55.80	140			Seated on Bottom, Glued
1	1	Opening	Slots - Vertical	18.00	55.00	140		0	Casing - Machine Slotted, PVC, SL: 80.0mm, A: 2.00mm

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)
19.80	33.50	13.70	Unknown	14.90		0.12		02:00:00	

Drillers Log

From m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	0.60	0.60	TOPSOIL	Topsoil	
0.60	2.70	2.10	CLAY RED	Clay	
2.70	19.80	17.10	RHYOLITE RED	Rhyolite	
19.80	23.70	3.90	RHYOLITE RED, FOULTED ZONES	Rhyolite	
23.70	55.80	32.10	RHYOLITE BLUE	Rhyolite	

*** End of GW110974 ***

10 Attachment D – Pathogen Transport Modelling

Beavers Gardner - Virus Transport Assessment

Method ST-71 22.10.2020

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PROJECT DETAILS

Project	Proposed Development, Lot 711 DP 1128593, South Pambula, NSW			Ref. No.	P1404330JS05V01
Author	MD	Reviewed	GT	Date Created	14/12/2021

STEP 1 : CONTAMINANT BOUNDARY CONDITIONS

Initial Concentration of Viruses (viruses/L)	1.00E+07	(M_0)
Magnitude of Reduction	1.00E-07	$\left(\frac{M_t}{M_0}\right)$

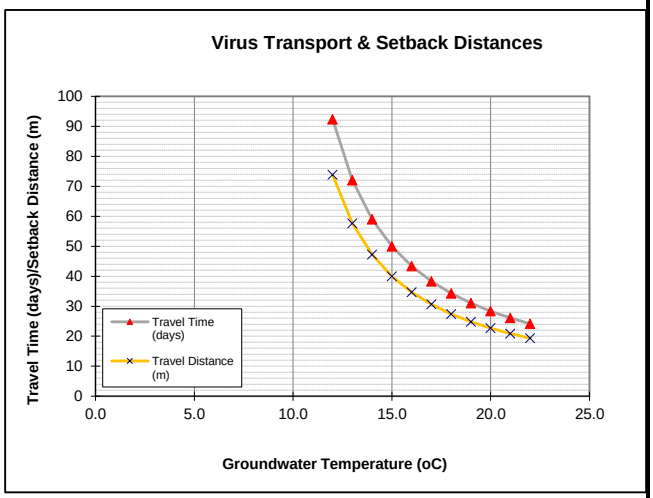
Aquifer Boundary Conditions

Minimum Groundwater Temperature (°C)	12	(T_l)
Maximum Groundwater Temperature (°C)	22	(T_h)
Saturated Hydraulic Conductivity (m/day)	1	(K)
Hydraulic Gradient (m^{-1})	0.16	(i)
Effective Porosity of the Aquifer	0.2	(η_e)

STEP 2 : ASSESSMENT

Modelled Predictors

Groundwater Temperature (°C)	Decay rate coefficient (k)	Travel Time (days)	Travel Distance (m)
12.0	0.17	92	73.9
13.0	0.22	72	57.6
14.0	0.27	59	47.2
15.0	0.32	50	40.0
16.0	0.37	43	34.7
17.0	0.42	38	30.6
18.0	0.47	34	27.4
19.0	0.52	31	24.8
20.0	0.57	28	22.7
21.0	0.62	26	20.9
22.0	0.67	24	19.3



11 Attachment E – Nutrient Modelling Calculations

Effluent Disposal Field - Annual Nutrient Balance Assessment

Method ST-14 Revised 20.3.2007

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PROJECT DETAILS

Project	Lot 711, DP1128593, South Pambula, NSW			Ref. No.	P1404330
Author	ML	Reviewed	ASN	Date Created	14/12/2021

STEP 1 : ENTER SITE AND FIELD CHARACTERISTICS

FACTOR	Enter Data	Unit	
Treatment System	Primary	-	
Effluent flow rate	1000	L/day	
Effluent N	60.0	mg/L	
Effluent P	15.0	mg/L	
Design soil depth	1.00	m	
Soil P-sorption	179.5	mg/kg	50% of estimated P-sorption capacity of 359 mg/kg used in calculations
Plant N uptake	230.0	kg/ha/year	
Plant P uptake	30.0	kg/ha/year	

STEP 2 : ASSESSMENT

NITROGEN BUDGET FOR RE-USE FIELD

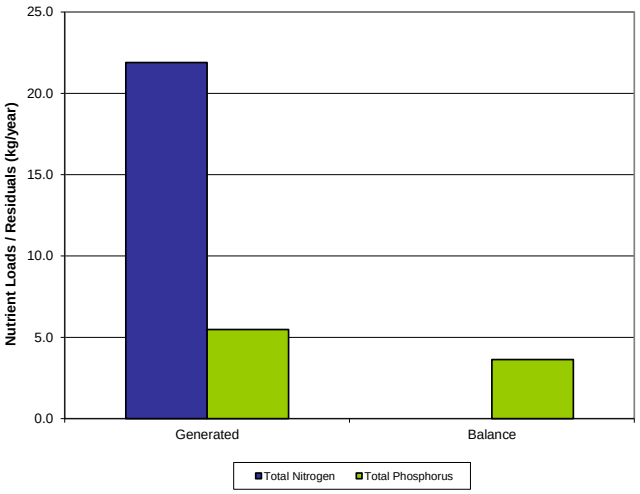
N generated	21.90	kg/year
N consumed	21.90	kg/year
N balance	0.00	kg/year
Min Area	952	m^2

PHOSPHORUS BUDGET FOR RE-USE FIELD

P generated	5.48	kg/year
P consumed	1.84	kg/year
P balance	3.63	kg/year
P sorption	181.7	kg P/design soil depth
Field life (for P)	50.0	Years
Min Area	614	m^2

MINIMUM NUTRIENT ASSIMILATION AREA

Minimum Area	**952**	m^2



Effluent Disposal Field - Annual Nutrient Balance Assessment

Method ST-14 Revised 20.3.2007

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PROJECT DETAILS

Project	Lot 711, DP1128593, South Pambula, NSW			Ref. No.	P1404330
Author	ML	Reviewed	ASN	Date Created	14/12/2021

STEP 1 : ENTER SITE AND FIELD CHARACTERISTICS

FACTOR	Enter Data	Unit	
Treatment System	Secondary	-	
Effluent flow rate	1000	L/day	
Effluent N	27.0	mg/L	
Effluent P	12.0	mg/L	
Design soil depth	1.00	m	
Soil P-sorption	179.5	mg/kg	50% of estimated P-sorption capacity of 359 mg/kg used in calculations
Plant N uptake	230.0	kg/ha/year	
Plant P uptake	30.0	kg/ha/year	

STEP 2 : ASSESSMENT

NITROGEN BUDGET FOR RE-USE FIELD

N generated	9.86	kg/year
N consumed	9.86	kg/year
N balance	0.00	kg/year
Min Area	428	m^2

PHOSPHORUS BUDGET FOR RE-USE FIELD

P generated	4.38	kg/year
P consumed	1.47	kg/year
P balance	2.91	kg/year
P sorption	145.4	kg P/design soil depth
Field life (for P)	50.0	Years
Min Area	491	m^2

MINIMUM NUTRIENT ASSIMILATION AREA

Minimum Area	**491**	m^2