On-site effluent management study

Lot 6 in the proposed subdivision of 6 Flirtation Hill Lane Gulgong NSW

Ref: R14644e1
Date: 01 August 2022

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Client	Lee Cunningham 6 Flirtation Hill Lane Gulgong NSW 2852				
Rev	**Report number**	**Date**	**Prepared by**	**Checked by**	**Revision details/status**
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1. Summary

Proposed development and situation	A rural-residential lot requires evaluation for suitability of on-site application of effluent from a new proposed dwelling. This report describes the assessment and recommends a suitable effluent treatment and application system.
Investigation	A site assessment and soil assessment were undertaken using the Australian Standard 1547, *On-site domestic wastewater management*, and the Environment and Health Protection Guidelines, *On-site sewage management for single households* (1998), Department of Urban Affairs and Planning, as guidelines. Suitable wastewater application systems, sizing and location for the site are recommended. The evaluation is based on a dwelling with four potential bedrooms.
Type of land application and **treatment** systems considered best suited to the site	The recommended systems are: **Option 1** • **Absorption or evapotranspiration absorption trench with a length of 54 metres**. The recommended trench width is 1.0m, with a maximum depth of 0.6m, covered by 0.15m of topsoil. Effluent water needs to be evenly distributed across the trench length by use of a distribution box directing water to trench segments. The trench segments should be 1m apart. • **Septic treatment system** (AS 1546) with a minimum capacity of 3,000 liters. **Option 2** • **Surface or sub-surface irrigation with an irrigation area of 444 square meters.** Gypsum should be applied to the application area during construction. • **Secondary wastewater treatment system** accredited by NSW Health
Location	The location of the effluent application area is identified in Appendix 1.
Notes	Construction of the treatment and application systems should be according to AS1547. Geotextile shall be laid over the distribution aggregate and arching to prevent ingress by the cover material for trench systems. Gypsum should be applied to the application area during construction and annually to maintain permeability. Secondary treatment systems require regular maintenance to ensure effective operation. Maintenance scheduling should be undertaken in accordance with manufacturers and NSW Health guidelines. The water balance is calculated using full water saving devices such as dual flush toilets (6/3 liters water closets), water reduction cycles on dishwashers, aerator faucets fitted to taps, front loader washing machines and water reducing shower heads.

2. Introduction

A rural residential lot requires evaluation for on-site application of effluent from a proposed new residential dwelling. A site and soil assessment were undertaken on 14 July 2022 and soil samples analysed. This report describes the site and soil investigation and recommends a suitable effluent treatment and application system.

3. Scope

A site assessment and soil assessment were undertaken using the Australian Standard 1547, *On-site domestic wastewater management*, Sydney Catchment Authority guidelines, *Designing and Installing On-site Wastewater Systems* (2012) and the Environment and Health Protection Guidelines, *On-site sewage management for single households* (1998), Department of Urban Affairs and Planning, as guidelines. Suitable wastewater application systems, sizing and location for the site are recommended.

4. Site information

Address of site	Lot 6 in the proposed subdivision of 6 Flirtation Hill Lane Gulgong NSW
Local Government	Mid-Western Regional Council
Client	Lee Cunningham
Size	6000m^2
Location, shape, layout	A plan of the relevant areas of the site and proposed effluent application area is described in Appendix 1.
Photograph(s) attached	Yes
Intended water supply	Rainwater Reticulated water supply Bore/Groundwater
Development	New residential dwelling
Expected wastewater flows	Number of potential bedrooms – 4 Number of persons – 5 Flows per person – 120 litres/person **Total** expected wastewater flow is 600 litres/day Flows are calculated using full water saving devices such as dual flush toilets (6/3 litre water closets), water reduction cycles on dishwashers, aerator faucets fitted to taps, front loader washing machines and water reducing shower heads. Re-calculation of the hydraulic balance and application area is required for dwellings containing a differing number of potential bedrooms.

Local experience of on-site management systems nearby	All systems are known to work satisfactorily in the locality providing they are adequately designed and maintained.
Setting	This lot is in a rural residential setting where the average dwelling density is less than 0.5 dwelling per 2 ha and therefore less than the 1 per 0.4 hectares required for groundwater protection (Geary & Gardner 1996, Land Management for Urban Development, Australian Society of Soil Sciences, Qld).
Current land-use	Grazing
Climate	Summers are warm to hot, and winters are cool to cold with little or no effective evaporation. Rainfall is distributed evenly throughout the year with an average annual rainfall of 629mm and pan evaporation of 1755mm (Bureau of Meteorology, Mudgee NSW).

5. Site assessment

Work undertaken	**Details**
Date	14 July 2022
Details	Site inspection, borehole construction, soil sampling
Weather on day and preceding week	Fine on day, >25mm rain in preceding week

Site feature	**Assessment**	**Limitation**
Vegetation	Grasses	Minor
Flood potential: 1 in 20 year 1 in 100 year	 Nil Nil	Minor
Exposure Site aspect Shelter belts Topographical feature or structure	High South Nil Nil	Minor
Slope	0-1% in application area	Minor
Landform	Mid-slope	Minor
Run-on and seepage	Run-on and sub-surface seepage is expected to be moderate. Diversion banks be required to divert the water from upper slope sources.	Moderate
Erosion potential: Erodibility Erosion hazard	 The topsoil and subsoil have a low erodibility. Erosion hazard is low and is reduced when vegetated.	Minor

Site drainage	Moderately drained. Heavy yellow mottles identified from a depth of 0.9m	Minor
Fill	Nil	Minor
Groundwater: Level of protection Bores and wells in the area and their purpose	 Low No groundwater bores are located within 100m of the recommended application area. One groundwater bore is located within 500m of the recommended application area. Bore is licensed for stock and domestic purposes. Standing water level is from32.0m and water bearing zone is from 40.0m to 41.0m. No impact on groundwater is expected from the application of effluent on the site.	Minor
Surface water: Permanent waters, streams, lakes *(Recommended buffer distance 100m)* Other waters, intermittent waterways *(Recommended buffer distance 40m)*	 Nil Nil	Minor
Buffer distances from recommended application area to: Boundary premises *(Recommended buffer distance 3-6m)* Swimming pools *(Recommended buffer distance 6m)* Buildings *(Recommended buffer distance 3-6m)*	 >6m Nil >6m	Minor
Area required for application system(s): Area available (including buffers):	54m^2 minimum area required for trench systems 444m^2 minimum area required for irrigation systems. Potential application area greater than 2,000m^2 in total available (Appendix 1).	Minor
Surface rocks, rock outcrops	Nil	Minor
Geology	This site is located within the Gulgong Soil Landscape. This soil comprises intergrades Red Podzolic Soils on crests and mid to upper slopes, Non-calcic Brown Soils and Red Earths on mid to lower slopes, Greybrown Podzolic Soils and Brown Podzolic-Solodic Soils on lower slopes and flats beside drainage lines. The geological unit is Tinja	Minor

	Formation, Burrunah Formation and undifferentiated. The parent rock are Shale, siltstone, chert, limestone, arkose, andesite, tuff and tuffaceous sandstone. The soil parent material is made up of in situ and alluvial-colluvial material derived from the parent rock (eSPADE v2.2).	
Environmental concerns: Native plants intolerant of phosphorous High water table Water way/wetland Community water storage	 Nil Nil None nearby	Minor
Site stability: Is expert assessment necessary	No, not expected to affect system performance	Minor

6. Soil assessment

Soil was assessed on site on 14 July 2022 by borehole construction to a depth of 1.5 metres or drill refusal with a truck mounted EVH auger drill.

The soil profile was described, and representative samples collected for the determination of physical and chemical properties. Soil physical property measurements undertaken included: dispersion description, texture, colour, pH, and salinity. The laboratory tests for physical properties were undertaken by Envirowest Testing Services and results are presented in the following table.

Depth (mm)	Description	Sampled (mm)	Texture group	Moisture	Emerson aggregate test*	pH (1:5 water)	ECe dS/m
Test hole 1							
0-200	Dark brown sandy clay loam	100	SCL	M	2	6.4	0.38
200-700	Dark yellowish brown silty clay with fine gravel	600	ZC	M	3	7.0	0.15
700-1500	Strong reddish brown light medium clay with gravel	1000	LMC	M	3	7.3	0.12
1500	End of hole at investigation depth						
Test hole 2							
0-200	Brown sandy clay loam	100	SCL	M	2	6.4	0.19
200-700	Reddish brown silty clay	600	ZC	M	3	7.0	0.15
700-1500	Brownish yellow light medium clay with heavy yellow mottles from 0.9m	1000	LMC	M	3	7.6	0.24
1500	End of hole at investigation depth						

M=Moist, D=Dry *1= highly dispersive (slakes, complete dispersion), 2= moderately dispersive (slakes, some dispersion), 3= slightly dispersive (slakes, some dispersion after remoulding), 4=M non-dispersive (slakes, carbonate or gypsum present), 5= non-dispersive (slakes, dispersion in shaken suspension) 6= non-dispersive (slakes, flocculates in shaken suspension), 7= non-dispersive (no slaking, swells in water), 8= non-dispersive (no slaking, does not swell in water).

Site feature	Assessment	Limitation
Depth to bedrock	Greater than 1,500mm in recommended application area *(600mm below application base recommended)*	Minor
Depth to high water table	Greater than 900mm in recommended application area *(600mm below application base recommended)*	Moderate

Site feature	Assessment	Limitation
Coarse fragments	Fine gravel identified in subsoil profile	Minor
Bulk density	Good (estimated)	Minor
pH	Satisfactory *(4.5-8.5 optimum range)*	Minor
Salinity	Non-saline *(<4.0 dS/m desirable threshold)*	Minor
Phosphorus sorption capacity *(SCA, 2012)*	6,500 kg/ha estimated	Minor
Nutrient balance	Water is not expected to move off site, nutrients will be utilised by the vegetation and stored in the soil. The subsoil is a well-drained silty clay to moderately drained light medium clay that will immobilise moderate quantities of nitrogen (in ammonium and organic forms) as derived from primary treatment systems.	Minor
Cation exchange capacity	Moderate (estimated). Will provide adequate retention of nutrients for plant growth.	Minor
Dispersiveness (Emerson aggregate test)	Moderately dispersive sandy clay loam topsoil over slightly dispersive silty clay to light medium clay subsoil. Regular application of gypsum recommended at the rate of 1kg per square metre of application area.	Minor
Soil structure	Strongly structured	Minor
Soil texture and permeability category	Clay Loam CL (100mm) Light clay LC (600mm)	Minor

7. System selection

7.1 Estimation of land application areas from hydraulic loadings

Rainfall water balance and land application area calculations are presented in Appendix 3 and summarised in the following table. Design flow rates for the dwelling are 600L/day based on the use of water saving features. Wet weather storage areas included in the water balance utilise the storage capacity of the soil. The design application rate was determined from Tables L1, M1, N1 in AS1547 using the permeability classification of the subsoil.

Factors Affecting Design Loading and Sizing	Design application rate (AS1547) (mm/day)	Size required for effluent application
Hydraulic loading for different application systems - Absorption trench - Evapotranspiration / absorption trench - Surface/sub-surface irrigation	 8 8 3	 54m^2 54m^2 444m^2
Notes	The proposed loading will provide for leaching of salts out of the root zone and prevent the soil from becoming sodic. The proposed infiltration rates will protect the catchment against off-site nutrient movement.	

7.2 Centralised sewerage systems

Consideration of connection to a centralised sewerage system Approximate distance to nearest feasible connection: Potential for future connection to centralised sewerage: Potential for future connection to reticulated water:	 >2km high / medium / low / already connected high / medium / low / already connected

7.3 Suitability of application systems

Application system	Treatment system	Site limitations of the application system	Modifications to mitigate constraints	Suitability
Absorption system	Septic tank	Slightly dispersive subsoil	Regular application of gypsum	Yes
Evapotranspiration system	Septic tank	Slightly dispersive subsoil	Regular application of gypsum	Yes
Surface irrigation	Secondary	Moderately dispersive topsoil	Regular application of gypsum	Yes
Sub-surface irrigation	Secondary	Moderately dispersive topsoil	Regular application of gypsum	Yes

7.4 System recommendation

Type of land application and **treatment** systems considered best suited to the site	The recommended systems are: **<u>Option 1</u>** • **Absorption or evapotranspiration absorption trench with a length of 54 metres**. The recommended trench width is 1.0m, with a maximum depth of 0.6m, covered by 0.15m of topsoil. Effluent water needs to be evenly distributed across the trench length by use of a distribution box directing water to trench segments. The trench segments should be 1m apart. • **Septic treatment system** (AS 1546) with a minimum capacity of 3,000 liters. **<u>Option 2</u>** • **Surface or sub-surface irrigation with an irrigation area of 444 square meters.** Gypsum should be applied to the application area during construction. • **Secondary wastewater treatment system** accredited by NSW Health
Location	The location of the effluent application area is identified in Appendix 1.

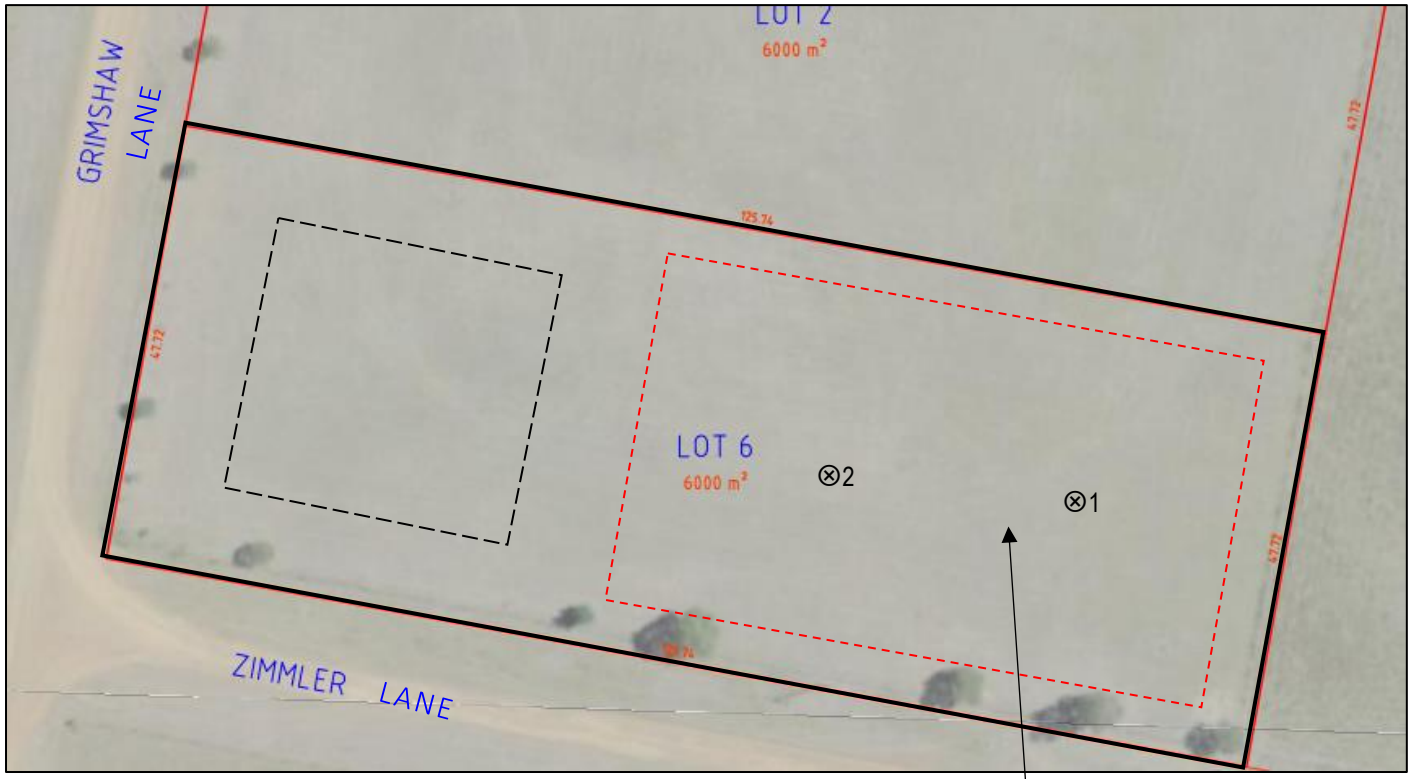
Notes	Construction of the treatment and application systems should be according to AS1547. Geotextile shall be laid over the distribution aggregate and arching to prevent ingress by the cover material for trench systems. Gypsum should be applied to the application area during construction and annually to maintain permeability. Secondary treatment systems require regular maintenance to ensure effective operation. Maintenance scheduling should be undertaken in accordance with manufacturers and NSW Health guidelines. The water balance is calculated using full water saving devices such as dual flush toilets (6/3 liters water closets), water reduction cycles on dishwashers, aerator faucets fitted to taps, front loader washing machines and water reducing shower heads.

8. General comments

Are there any specific environmental constraints?	Wastewater should be evenly applied over the application area.
Are there any specific health constraints?	Restrict access to people and stock as recommended in AS1547 and summarised in Appendix 4.
Any other comments?	The topsoil is capable of supporting plant growth that will optimise evapotranspiration and wastewater usage.

9. Report limitations and intellectual property

This report has been prepared for the use of the client to achieve the objectives given the clients requirements. The Australian Standard 1547, *On-site domestic wastewater management*, and the Environment and Health Protection Guidelines, *On-site sewage management for single households* (1998) Department of Urban Affairs and Planning, have been used as guidelines in this report. Where system limitations or uncertainties are known, they are identified in the report. No liability can be accepted for failure to identify conditions or issues which arise in the future and which could not reasonably have been predicted using the scope of the investigation and the information obtained. No guarantee can be made that the wastewater system will achieve all performance criteria because of operational factors and the inherent variable and unpredictable nature of the soil. All components of the wastewater system have a limited life.



Disposal system to be located in recommended application area (Greater than 2,000m² available)

Legend

- Lot boundary
- ⊗ Borehole location
- Approximate building envelope
- slope
- Recommended application areas (Greater than 2,000m² available)

Approximate Scale 1: 800

0 8 16 32m

Appendix 1. Site plan and borehole location		
Lot 6 in the proposed subdivision of 6 Flirtation Hill Lane, Gulgong NSW		
	Envirowest Consulting Pty Ltd	
Job: R14644e1	Drawn by: HT	Date: 27/07/2022

Appendix 2. Photograph of the recommended application area

Looking east over the recommended the application area

Appendix 3. Monthly water balance determines the wastewater application area required
(Irrigation systems)

Design wastewater flow	Q	L/day	600	120	L/person/day	5	persons
Design percolation rate	R	mm/wk	21	3	mm/day		
Land area	L	m2	98				
Effective precipitation	EP		0.9	(10% runoff)			

Parameter	**Symbol**	**Formula**	**Units**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**total**
days in month	D		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Precipitation	P		mm/month	70	72	46	32	36	41	42	36	49	56	78	72	629
Evaporation	E		mm/month	272.8	221.2	195.3	126	77.5	48	52.7	74.4	102	158.1	207	220	1755
Crop factor	C		-	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	10.8
Inputs																
Effective Precipitation	EP		mm/month	62.73	64.62	41.4	28.98	32.13	37.17	37.62	32.22	43.83	50.4	70.2	64.8	566
Effluent irrigation	W	QXD/L	mm/month	189.8	171.4	189.8	183.7	189.8	183.7	189.8	189.8	183.7	189.8	183.7	189.8	2235
Inputs		P+W	mm/month	252.5	236.0	231.2	212.7	221.9	220.8	227.4	222.0	227.5	240.2	253.9	254.6	2801
Outputs																
Evaportranspiration	ET	ExC	mm/month	245.52	199.1	175.8	113.4	69.8	43.2	47.4	67.0	91.8	142.3	186.3	198.0	1580
Percolation	B	R/7xD	mm/month	93.0	84.0	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0	1095
Outputs		ET+B	mm/month	338.5	283.1	268.8	203.4	162.8	133.2	140.4	160.0	181.8	235.3	276.3	291.0	2675
Storage	S	(EP+W)-(ET+B)	mm/month	-86.0	-47.0	-37.6	9.3	59.2	87.6	87.0	62.1	45.7	4.9	-22.4	-36.4	
Cumulative storage	M		mm	0.0	0.0	0.0	9.3	68.4	156.1	243.1	305.1	350.8	355.7	333.3	296.9	

Storage	V	largest M	mm	355.7
		Soil storage	mm	372.0
		Storage required	mm	-16.3
		VxL/1000	m^3	**-1.6**
Irrigation area			m^2	**98**

	water holding capacity	depth (mm)	Totals(mm)
Topsoil	34%	200	68
Subsoil	38%	800	304
			372

Appendix 3b. Monthly water balance to determine the wastewater application area required (trench systems)

Design wastewater flow	Q	L/day	600	120	L/person/day	5 persons
Design percolation rate	R	mm/wk	56	8	mm/day	
Land area	L	m^2	54			
Effective precipitation	EP		0.9	(10% runoff)		

Parameter	**Symbol**	**Formula**	**Units**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**total**
days in month	D		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Precipitation	P		mm/month	70	72	46	32	36	41	42	36	49	56	78	72	629
Evaporation	E		mm/month	273	221	195	126	78	48	53	74	102	158	207	220	1755
Crop factor	C		-	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	11
Inputs																
Effective Precipitation	EP		mm/month	63	65	41	29	32	37	38	32	44	50	70	65	566
Effluent irrigation	W	QXD/L	mm/month	344	311	344	333	344	333	344	344	333	344	333	344	4056
Inputs		P+W	mm/month	407	376	386	362	377	371	382	377	377	395	404	409	4622
Outputs																
Evaportranspiration	ET	ExC	mm/month	246	199	176	113	70	43	47	67	92	142	186	198	1580
Percolation	B	R/7xD	mm/month	248	224	248	240	248	240	248	248	240	248	240	248	2920
Outputs		ET+B	mm/month	494	423	424	353	318	283	295	315	332	390	426	446	4500
Storage	S	(EP+W)-(ET+B)	mm/month	-86	-47	-38	9	59	87	87	62	45	5	-23	-37	
Cumulative storage	M		mm	0	0	0	9	68	155	242	303	349	353	331	294	

Storage	V	largest M	mm	353.3
		Soil storage	mm	372.0
		Storage required	mm	-18.7
		VxL/1000	m^3	**-1.0**
Application area			m^2	54
Trench length			m	**54.0**
Trench width			m	0.6

	water holding capacity	depth (mm)	Totals(mm)
Topsoil	34%	200	68
Subsoil	38%	800	304
			372

Appendix 3c. Estimation area requirement from organic matter and nutrient balances (irrigation systems)

Estimated effluent flow	(Q)	600	L/day
Soil depth		1.5	m

Organic matter balance

BOD (C)	20	mg/L
treated wastewater flow rate (Q)	600	L/day
critical loading rate of BOD (Lx)	3000	mg/m^2/day
land area required (A)	**4.0**	m^2

Nitrogen balance

nutrient concentration	37	mg/L
treated wastewater flow rate	600	L/day
critical loading rate of nutrient	50	mg/m^2/day
land area required (A)	**444**	m^2

Determination of nitrogen criitical loading rate

Nitrogen load (kg/year)	8.1	kg/year			
Loss 20% denitrification	6.5	kg/year			
Load to soil	146.0	kg/ha/year	assumed irr. area from table	444	m2
Vegetation usage	200.0	kg/ha/year			
Residual (potential leaching)	-54.0	kg/ha/year			

Typical nitrogen uptake (Myers et al. 1984)		
Pastures	300 kg/ha/year	82 mg/m2/day
Pine	350 kg/ha/year	96 mg/m2/day
Eucalypts	180 kg/ha/year	49 mg/m2/day

Phosphorus balance

Phosphorus sorption capacity per metre=			8,000	kg/ha
Phosphorus sorption capacity of profile=			12,000	kg/ha
Soil factor			0.33	
Critical loading=		3 mg/m^2/day		
P concentation*=		12	mg/L	
P adsorbed=	phosphorus sorption capacity x soil factor 3960			
	0.396	kg/m^2		
Puptake=	critical loading x days/year x 54750	50	years	
	0.0548	kg/m^2		
Pgenerated=	total phosphorus concentration x wastewater volume in 131400000			50 years
	131	kg		
	Pgenerated / (Padsorbed + Puptake)			
Land area required	**291.5**	**m^2**		

Appendix 4. Checklist for effective management of wastewater systems

Domestic wastewater system

DO

- Check household products for suitability of use with a septic tank.
- Conserve water, prolonged period of high water use can lead to application area failure. For optimum operation, avoid daily and weekly surges in water flows. Spas are not recommended.
- Scrape cooking dishes and plates prior to washing to reduce solid load.
- Maintain the system with regular servicing as per the manufacturer's instructions.

DON'T

- Dispose of excessive solid material, fats, lint or large water volumes into drains.

Land application area

- Construct and maintain diversion drains around the top-side of the application area to divert surface water.
- The application area should be a grassed area, which is maintained at 10-30cm height.
- The area around the perimeter can be planted with small shrubs to aid transpiration of the wastewater.
- Ensure run-off from the roof or driveway is directed away from the application area.
- Periodic application of gypsum may be necessary to maintain the absorptive capacity of the soil.
- **Don't** erect any structures or paths on the land application area.
- **Don't** graze animals on the land application area.
- **Don't** drive over the land application area.
- **Don't** plant large trees that shade the land application area thereby reducing transpiration of water.
- **Don't** let children or pets play on the land application area.
- **Don't** extract untreated groundwater for potable use.