Broadcrest Consulting Pty Ltd

44A Mayfair Road, Mulgoa NSW

On-Site Wastewater Report

Proposed Residence

June 2019

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Document controls

Approval and Authorisation

Title	44A Mayfair Road, Mulgoa NSW On-Site Wastewater Report
Authored on behalf of Broadcrest Consulting Pty Ltd by:	Rhys Starkey Civil Engineer
Signed:	
Dated:	6/06/2019

Document Status

Date	Internal Reference	Document Status	Prepared by	Reviewed by
6/06/2019	0333-WW-A-01	Issue for release	R. Starkey	C. Hudson

Contents

1 INTRODUCTION

1.1 Foreword

An On-Site Wastewater Report is a technical document which specifies how the sewage produced on-site will be managed, treated, and then disposed. An On-Site Wastewater Report carefully considers the environment, health, cost, and long-term management options for the on-site management of sewage.

1.2 Background

Broadcrest Pty. Ltd. was engaged by Mr. T. & Mrs. V. Delipetar to produce an On-Site Wastewater Management Report at 44A Mayfair Road, Mulgoa NSW (the site). The report will accompany plans for a proposed residential development.

A site inspection was carried out on the 5th June 2019 which involved a visual assessment of the site and soil sampling. The assessment of the results, system design and recommendations are detailed in this report.

1.3 Objectives

The performance objectives of the On-Site Wastewater Assessment are to:

- Protect human health
- Protect ground and surface water
- Maintain and enhance the quality of the land and vegetation
- Maintain and enhance community amenity
- Ensure maximum re-use of resources
- Promote an ecologically sustainable development.

1.4 Scope of Works

The scope of works included the following:

- A site inspection
- Soil sampling and analysis
- Wastewater management assessment
- Drafting of the proposed system
- Reporting in accordance with the associated legislations and guidelines.

1.5 Compliance

This report has been produced in accordance with the following guiding documents:

- *On-Site Sewerage Management and Greywater Reuse* (Penrith City Council DCP, 2014)
- DLG 1998, *On-site Sewerage Management for Single Households*
- SCA 2012, *Designing and Installing On-Site Wastewater Systems*
- Australian Standard AS 1289.3.8.1:2006 *Methods for testing soils for engineering purposes*
- Australian Standard AS 1546.1-3:2008 *On-site domestic wastewater treatment units*
- Australian Standard AS 1547:2012 *On-site domestic wastewater management*

2 SITE INFORMATION

TITLE

Address / Locality	44A Mayfair Road, Mulgoa NSW
Lot Area:	4.515 Ha
Council / LGA:	Penrith City Council
Zoning:	E3 – Environmental Management
Intended Water Supply:	Tank Water
Design Wastewater Loading: (litres / day)	• Proposed Residence, five (5) potential bedroom(s): 7 Person Equivalent Population[1] 120 L / day / Person Design Loading: 840 L / day

1. 'One person per bedroom and two for a master bedroom' (PCC 2014, *On-Site Sewerage Management and Greywater Reuse,* Table 2 Notes).

INSPECTION

Date	Evaluator(s)
05/06/2019	C. Hudson

3 SITE ASSESSMENT & INVESTIGATION

3.1 General

The site occupies approximately ~4.515ha E3 – Environmental Management zoned land within Penrith City Council LGA. At the time of inspection, the site was undeveloped and vegetated with an open woodland with an underlying dense grassland.

The development is understood to include a proposed 5-bedroom residence and shed in the west of the site and a 100kL in-ground concrete rainwater tank to the east of the residence. An open grassland area suitable for effluent disposal was identified east of the proposed residence (see Appendix A and Figure 3.1 below).

Figure 3.1: Photograph of open woodland and grassland consistent with proposed EDA (Taken from building envelope, facing East)

3.2 Assessment Methodology

The assessment methodology of this report follows that prescribed in DLG (1998), whereby the restriction imposed by a site/soil features are categorised by severity, and their impact forms the basis for subsequent system selection, design and recommendations (Table 3.1).

Table 3.1 – Site / soil limitation assigned per DLG (1998)

Limitation	Description
Minor	This feature has been assessed and deemed to pose no obstacle to OSSM, given the recommended system and measures are implemented.
Moderate	This feature requires consideration. It may typically be overcome by site modifications or by appropriate selection, design and sizing of treatment / application systems.
Major	This feature precludes the use of a given treatment, land application method, or Effluent Management Area (EMA). Particular Major Limitations may prevent OSSM entirely, require an off-site management approach, or re-evaluation of the development scope.

3.3 Site Assessment Summary

In order to evaluate the suitability of the site for On-Site Sewerage Management (OSSM) for the development, information was gathered and assessed during a desktop and site investigation. The summary of these investigations is detailed in Table 3.2 below.

Table 3.2 – Assessment summary of site features

Factor Assessed	Description	Limitation
Climate	Monthly evaporation exceeds rainfall throughout year (on average).	Minor
Temperature	Annual mean daytime maximum > 15°C.	Minor
Flood Potential	No data available. Flat landform, upstream catchment minimal.	Minor
Exposure	Excellent sun and wind which will maximise evapotranspiration.	Minor
Slope	Approximately 8% (Gently inclined) for EDA.	Minor
Landform	Linear Divergent slope.	Minor
Run-on and Seepage	Minimal catchment (divergent up-slope topography); very-dense ground cover adequate to address run-on.	Minor
Site-drainage	There are no signs of surface moisture or ponding.	Minor
Erosion Potential	There are no signs of erosion at this well vegetated site.	Minor
Site and Soil Disturbances	No site or soil disturbances identified.	Minor
Buffer Distances & Available land area	All buffer distances achieved.	Minor
Groundwater Bores	There are no bores used for potable water within 250 m of the proposed EMA.	Minor
Rock Outcropping	No rock outcropping observed within EMAs.	Minor
Geology / Regolith	NIL geological discontinuities, fractures or highly porous regolith.	Minor

3.4 Climate

Mulgoa has a temperate climate, with warm to hot wet summers, and cool drier winters. Median annual rainfall is 872 mm and evaporation 1,467 mm. Average monthly evaporation is greater than median rainfall for all of the year (*Minor Limitation)*.

Average daytime maximum temperatures range from 31.2°C to 17.9°C in January to July respectively. The mean annual daytime maximum of 23.7°C proves suitable for biological wastewater treatment systems (i.e. AWTS) (*Minor Limitation*).

3.5 Flood potential

A flood investigation has not been completed as part of this Assessment. However, the proposed effluent management area is positioned on a linear planar mid-slope and unlikely to be prone to flooding (*Minor Limitation*).

3.6 Exposure

Densely shaded areas have been avoided for effluent management purposes. The proposed effluent management area is well exposed to sun and wind with a south-eastern aspect (*Minor Limitation*).

Landform Feature	Aspect	Solar Exposure	Wind Exposure	Limitation
A	SE	Excellent	Excellent	Minor

3.7 Slope

Slope has the potential to become a restrictive landform feature for OSSM with increased slope increasing the risk of run-off and/or erosion (Table 4, p.63, OSM guide). Slope within the proposed effluent management area was identified as listed below:

Landform Feature	Approximate Slope Tangent (%)	Slope Classification
EDA	8	Gently Inclined

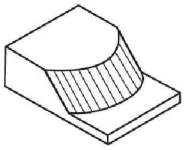
Table 3.3. - Percentage Slope and Land Application Limitations

Slope Range [%]	Slope Classification	Limitation				
		Surface Irrigation (Spray & Drip)	Absorption Systems	Mounds	Conventional Trenches & LPEDs	Sub-surface Irrigation
0 – 1	Level	Minor	Minor	Minor	Minor	Minor
1 – 3	Very Gently Inclined	Minor	Minor	Minor	Minor	Minor
3 – 10	Gently Inclined	Minor	Minor	Minor	Minor	Minor
10 – 15	Moderately Inclined	Major	Major	Moderate	Moderate	Minor
15 – 20		Major	Major	Major	Moderate[2]	Minor
> 20		Major	Major	Major	Moderate[3]	Moderate[1]

[1] 30% maximum slope without specific design (AS 1547, p.133)
[2] >15% slope increase difficulty in construction (AS 1547:2012, Table K1)
[3] >25% slope creates difficulty in trenching, risk of erosion during construction (AS 1547:2012, Table K1)

3.8 Landform

The landform describes the surface shape and topographic position at and ~40m surrounding the proposed EMA. Typical landform descriptors per AS1547:2012 are detailed below.

Landform Feature	Morphological Type	Slope Configuration	Limitation	
EDA	Mid-Slope	Linear Divergent	Minor	

3.9 Surface Water and Seepage

Surface water and seepage flow is determined by the catchment preceding the EMA, the prevailing landform features, as well as the interaction of soil and site features. General assessment of the likely surface water interaction with the landform and EMA has been provided.

Landform Feature	Catchment		Surface Flow		Soil Moisture	Seepage Potential	Limitation
	Size	Surface Coverage	Run-on	Run-off			
A	Limited	Dense Grass	Slow	Slow	Dry	Minimal	Minor

3.10 Site drainage

The proposed effluent management area appeared to be free draining with no signs of soil saturation, surface ponding, or noted presence of macrophytes (i.e. sedges, ferns, juncus) *(Minor Limitation).*

3.11 Erosion potential

Erosion and surface soil movement results from the interaction of the existing landform, surface flows and surface coverage. The following existing erosion conditions were identified and assessed in proposing additional hydraulic loading in the form of effluent.

Landform Feature	Surface Flow Type	Erosion Hazard		Limitation
		Surface Flow	Wind	
A	unconcentrated	Slow	Slight	Minor

The surface water assessment (Section 3.9), existing surface coverage, and soil landscape where evaluated for the susceptibility of the topsoil to the prevailing agents of erosion. Given the future land management for OSSM, the anticipate erodibility and hazard categories are as follows:

Landform Feature	Existing Erosion		Surface Cover	Coverage (%)	Limitation
	State	Type			
A	NIL - stable	-	Vegetated - grassland	75~100	Minor

3.12 Site & Soil Disturbances

No site or soil disturbances were identified within the proposed EMAs during inspection.

During construction, vegetation and top soil is likely to be removed. This will not impact the effluent disposal area. All works should be conducted in accordance with a suitable sediment and erosion control plan *(Minor Limitation).*

3.13 Domestic Bore

No groundwater bores were identified within 250m of the site.

3.14 Buffer Distances & Available Land Area

Minimum buffer zones / offset distances are designated by local approval authorities within their guiding documents to ensure the ongoing protection of community health, sensitive ecosystems, and the maintenance of community amenity. Where LGA guidance on a constraint is not available, appropriate offsets have been nominated in accordance with Appendix R, AS1547:2012 and Table 5 DLG (1998).

The site-specific constraints for the proposed EMA and land application method have been assessed as follows:

Table 3.4 – Minimum buffer distances from sensitive site features (EDA – Surface Spray)

Site Feature	Minimum Setback		Proposed Setback	Limitation
	If EMA is upslope of feature	If EMA is downslope / level with feature		
Dwellings	15m		>15m	Minor
Property Boundaries	6m	3m	>6m	Minor
Driveways	6m	3m	>6m	Minor
Paths & Walkways	3m		>3m	Minor
Pools	6m		>6m	Minor
Watercourses	100m		NA	-
Domestic Bore / Well	250m from high water level		NA	-
Dam / Drainage Depression	40m from high water level		>100m	Minor

3.15 Rock Outcropping

Surface of EMA free was free of outcropping. *Minor Limitation*.

3.16 Geology / Regolith

Site inspection and landscape mapping did not identify any geological discontinuities, fractures, or highly porous regolith which may introduce 'short-circuit' pathways of wastewater into the water table.

4 SOIL ASSESSMENT

4.1 Soil Assessment Summary

Investigation of the site for suitability for OSSM was accompanied by multiple Direct Push tube samples within the proposed EMA. The soil characteristics where assessed per AS 1547:2012, AS 1289.3.8.1:2006, and NSW DLWC (2001) methodologies. The summary of the soil investigation is presented in Table 4.1.

Table 4.1 – Assessment summary of site features

Factor Assessed	Description	Limitation
Depth to bedrock / hardpan	1.1m within proposed EMA	Minor
Depth to high water table	NIL free water or waterlogging characteristics. No local bore data to confirm SWL.	Minor
Soil Permeability Category	Cat. 3 – Highly Structured Clay Loam	Minor
Coarse Fragments	5-10% across all strata; weathered shale.	Minor
Bulk Density	N.A – Single lot	-
pH	Around 6 - 6.5 across all samples.	Minor
Electrical Conductivity (EC)	< 4 dS/m across all samples.	Minor
Sodicity (ESP)	N.A – Single lot	-
Cation exchange capacity (CEC)	N.A – Single lot	-
Phosphorous sorption	N.A – Single lot, not suspected	-
Dispersiveness	Class 2 (Slaking - some dispersion)	Minor

4.2 Soil Landscape Map

1:100,000 Soil Landscape Mapping indicates the site occurs on Luddenham Soil Landscape. Site inspection by C. Hudson from Broadcrest confirms mapping is consistent with the site investigative and geotechnical findings.

Luddenham Soil Landscape is characterised as rolling low hills on the Wianamatta Group shales, often associated with Minchinbury Sandston. Local relief 50-80m, slopes 5-20%. Narrow ridges, hillcrests and valleys. Extensively cleared tall open forest (wet sclerophyll forest). Soils are generally shallow (<100cm) dark podzolic soils or massive earth clays on crests; moderately deep (70-150cm) red podzolic soils on upper slopes; moderately deep (<150cm) yellow podzolic soils and prairie soils on lower slopes and drainage lines.

4.3 Depth to Bedrock / Hardpan

Two (2) test pits were sampled on site via a direct push tube. Both boreholes, located as specified in Appendix A, achieved sampling depth of 1.1m. Depth to bedrock is estimated at 1.1m across the proposed EMA (*Minor Limitation).*

4.4 Depth to High Water Table

Site soil sampling identified bright, uniform soil colouration indicative of well drained and aerated soils (see Soil Profiles below). No visible free water or saturation was encounter within the sampling depth. No grey, bleached, or heavily mottled soils where identified in sampling; characteristics indicative of seasonal or continuous soil saturation (*Minor Limitation).*

4.5 Soil Permeability Category

Soil permeability as a result of test pit and soil landscape mapping has been assigned (Table 4.1) per Table L1 of AS1547:2012.

Table 4.1 – Soil permeability and Design Loading Rate

Bore Hole	Depth (mm)	Texture	Structure	Indicative Permeability	Design Irrigation Rate (DIR-Secondary Eff.)
BH#1	250	Loam	High	1.5 – 3.0 m / day	4 mm / day
	1100	Clay Loam	High	0.5 – 1.5 m / day	3.5 m / day
BH#2	225	Loam	High	1.5 – 3.0 m / day	4 mm / day
	1100	Clay Loam	High	0.5 – 1.5 m / day	3.5 m / day

Whilst the sampled soil profiles feature high permeability at upper loam strata, the lower clay loam stratum (category 3 soil) is considered the most restrictive layer to infiltration up to 600mm below the application area. A conservative Design Irrigation Rate (DIR) of 3.5 mm/day is adopted for this report.

4.6 Soil Profiles

Table 4.3 – BH #1

Excavation #	BH-01	Inspection Method:	Direct push tube	Sample size:	Ø 50	[mm]	Date sampled:	05-06-2019
Depth of Investigation:	1100	[mm]	Comment:	Bedrock (shale hardpan) encountered, no free water encountered				

Layer	Horizon	Lower Depth [mm]	Moisture	Colour	Field Texture	Coarse Fragment	Structure	Modified Emerson
1	A1	250	Dry	Dark Brown	Loam	5-10% (~5mm)	High	No change
2	B1	1100	Dry	Yellow-Brown	Clay Loam	10-15% (~5mm)	High	Slaking; some dispersion.

Figure 4.1 – BH #1 soil profile

Table 4.4 – BH #2

Excavation #	BH-02	Inspection Method:	Direct push tube	Sample size:	Ø 50	[mm]	Date sampled:	05-06-2019
Depth of Investigation:	1100	[mm]	Comment:	Bedrock (shale hardpan) encountered, no free water encountered				

Layer	Horizon	Lower Depth [mm]	Moisture	Colour	Field Texture	Coarse Fragment	Structure	Modified Emerson
1	A1	225	Dry	Dark Brown	Loam	5-10% (~5mm)	High	No change
2	B1	1100	Dry	Yellow-Brown	Clay Loam	10-15% (~5mm)	High	Slaking; some dispersion.

4.7 Soil Chemistry

One sample from each horizon of test pit #2 within the proposed EMA was tested for pH and EC by Broadcrest Consulting. The results are as follows:

Depth (mm)	Test	Result	Limitation	Recommendations
BH #2				
225	pH	5.8 (Slightly Acidic)	Minor	-
	EC (µS/cm)	81 (Non-Saline)	Minor	-
1100	pH	6.0 (Slightly Acidic)	Minor	-
	EC (µS/cm)	102 (Non-Saline)	Minor	-

5 NOMINATED WASTEWATER MANAGEMENT

5.1 OSSM Summary

Site and soil conditions and constraints where evaluated in selection of appropriate treatment and Effluent management method. Summary of the recommended OSSM system and application sizing is presented below.

Treatment		EMA	Effluent Management
AWTS + disinfection (or equiv.)	→ (Pumped dosing)	Effluent Disposal Area (EDA)	778m² surface fixed / semi-fixed spray irrigation

5.2 Wastewater Treatment

It is proposed to treat all wastewater generated by the existing residence (with proposed editions) to a secondary standard via an aerated wastewater treatment system (AWTS) or equivalent. The nominated units must be capable of sustainably treating the calculated daily wastewater load. One treatment system will be required for each of the proposed residences.

Justification of the proposed treatment method is as follows:

- Accidental or deliberate discharges are less detrimental to the environment and have less potential to adversely impact on health
- Higher quality effluent produced
- High commercial availability

Table 5.1 – Proposed Onsite Treatment

Treatment Level	Treatment Method	Minimum Treatment Capacity [L/day]
Secondary	AWTS + disinfection (Continued use)	840

Table 5.2 - Secondary Treatment Targets (per DLG 1998)

Biochemical Oxygen Demand (BOD^5)	Suspended Solids (TSS)	Total Nitrogen (TN)	Total Phosphorus (TP)	Faecal coliforms		Dissolved Oxygen (DO)
				Non-disinfected effluent	Disinfected effluent	
< 20 mg/L	< 30 mg/L	25 - 50 mg/L	10 - 15 mg/L	Up to 10^4 cfu/100 mL	< 30 cfu/100 mL	> 2 mg/L

A list of accredited AWTS systems and suppliers is available on the NSW Health website:
http://www.health.nsw.gov.au/environment/domesticwastewater/Pages/awts.aspx

5.3 Effluent Management

Given the development and site and soil conditions encountered, it is proposed to dispose of effluent from the treatment system via **Surface semi-fixed spray irrigation**. Sizing of the application method was undertaken via a site nutrient and water balanced as detailed in Appendix B with the results listed in Table 5.3.1 below:

Table 5.3.1 – Minimum Irrigation Area Requirement

Balance	Area Required (m^2)
Water	274
Nitrogen	778
Phosphorus	526
Minimum Irrigation Area	778

The following alternative irrigation methods may be installed with a minimum irrigation area as specified in Table 5.3.1:

- Surface Fixed Irrigation
- Subsurface Drip Irrigation

Justification of the proposed effluent management method is as follows:

- Sufficient setbacks and area have been attained to justify the surface spray application of secondary treated effluent (with disinfection);
- No waterways or environmental assets are present within proximity of the EMA;
- Surface irrigation maximises potential evapotranspiration due to the large surface area; reducing seepage volume and likelihood of effluent run-off;
- Application over a great footprint will reduce groundwater & resurfacing hazards; and
- Application method suitable for slope constraint in the EMA (*Minor Limitation*).

6 ADDITIONAL INFORMATION

6.1 Pipework Detail

All associated plumbing / drainage work is to be in accordance with AS 3500.2:2015 *Sanitary Plumbing Drainage*. Positioning of the receiving treatment system is to ensure drainage from internal plumbing fixtures achieves the minimum grade and cover of the excerpts below.

Table 6.1 – Excerpts of AS3500.2:2015

(a) Table 3.4.1

Nominal Pipe Diameter (DN)	Minimum Grade	
(mm)	(%)	(Ratio)
65	2.50	1:40
80	1.65	1:60
100	1.65*****	1:60*****
125	1.25	1:80
150	1.00	1:100

*Drains from treatment plants may be 1.00% Min.

(b) Table 3.7.2

	Minimum depth of cover (mm)	
Location	Cast iron & Ductile iron	Other materials
Subject to vehicular loading	300	500
All other locations	NIL	300

6.2 Licensing

Operating a system of sewage management is a Prescribed Activity under the Local Government Act 1993 and clause 45 of the Local Government (Approvals) Regulation 1999. This means that an 'Approval to Operate' a system of sewage management must be obtained from Council.

7 CONCLUSION

7.1 System Recommendations

- The development is understood to include a proposed secondary dwelling with five (5) bedrooms on tank water supply. The anticipated wastewater loading is to be 840 L/day.
- It is proposed to secondary treat all wastewater generated by the proposed secondary dwelling with disinfection via an NSW Health accredited Aerated Wastewater Treatment System (AWTS). The nominated unit must be capable of sustainably treating the calculated daily wastewater load.
- Application of the secondary treated effluent is proposed via surface semi-fixed irrigation as detailed in Appendix A with a minimum effluent disposal area (EDA) of 778m².
- It is noted that an effluent distribution line, from the AWTS to the final quick-connect valve within the EDA, of approximately 185m will be required. An appropriate pump is to be fitted by the installer to ensure a sufficient operating pressure of 80-100kPa is achieved within the EDA.

7.2 General System Recommendations

- The EDAs are to be restricted from vehicles and livestock traffic. Signage indicating effluent reuse is to be posted around the EDA.
- The nominated systems have been determined to achieve all required buffer distances and site and soil constraints with the exception of the water bodies.
- Construction and maintenance of the EDAs are to ensure that well-maintained lawns are established to maximize performance of the systems.

APPENDIX A: SITE PLAN

PROPOSED AWTS SYSTEM
(TO SERVICE PROPOSED RESIDENCE)
APPROX. LOCATION ONLY; TO BE DETERMINED BY INSTALLER.

FLEXIBLE, DETACHABLE IRRIGATION LINE TO SPRINKLERS (LILAC)

EFFLUENT DISPOSAL AREA (EDA)
[SURFACE SEMI-FIXED SPRAY IRRIGATION]
AREA: 778m²; $SLOPE_{AVG}$: 8%

BURIED DISTRIBUTION
LINE TO TURF VALVES
[L_{APPROX}]: 185m; [Δh_{APPROX}]: −20.7m

Mayfair Road

DRIVEWAY

PROPOSED RESIDENCE

INGROUND RWT

BH1

BH2

1.745
29.925
26.000
2.220
2.500
26.000
29.925
1.585
13.000
13.000

VEGETATION DRIPLINE

QUICK-CONNECT VALVES
A.K.A. 'TURF-VALVES'

MIN. 3 HEAVY DROPLET ROTARY SPRINKLERS (LILAC)
THROW RADIUS: 2.000m
THROW HEIGHT: 0.400m
FLOWRATE: 0.05L/s
OPERATING PRESSURE: 80-100kPa

ALL DIMENSIONS ARE IN METERS UNLESS NOTED OTHERWISE.

THIS DRAWING MAY BE PREPARED IN COLOUR AND MAY BE MADE INCOMPLETE IF COPIED 50mm ON A3 SIZE ORIGINAL

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
A-01	05-06-19	RS	RS	CH	FOR RELEASE

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PROJECT	OSSM - PROPOSED RESIDENCE
PROJECT DESCRIPTION	AWTS + SURFACE SEMI-FIXED IRRIGATION
LOCATION	44A MAYFAIR ROAD, MULGOA NSW
CLIENT	MR. T. & MRS. V. DELIPETAR
LGA	PENRITH CITY COUNCIL
PROJECT NUMBER	0333
REVISION	01-A
DRAWING NUMBER	01
DATE	05.06.19
SCALE	1:500
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APPENDIX B: CLIMATE DATA

B1. - Climate Statistics

Table B1.1. Weather Stations

	Station No.	Station Name	Distance from site [km]
Temperature	67113	PENRITH LAKES AWS	9.59
Precipitation	67029	WALLACIA POST OFFICE	5.03
Evaporation	67068	BADGERYS CREEK MCMASTERS F.STN	9.59

Figure B.1 - Monthly Cimate Statistics

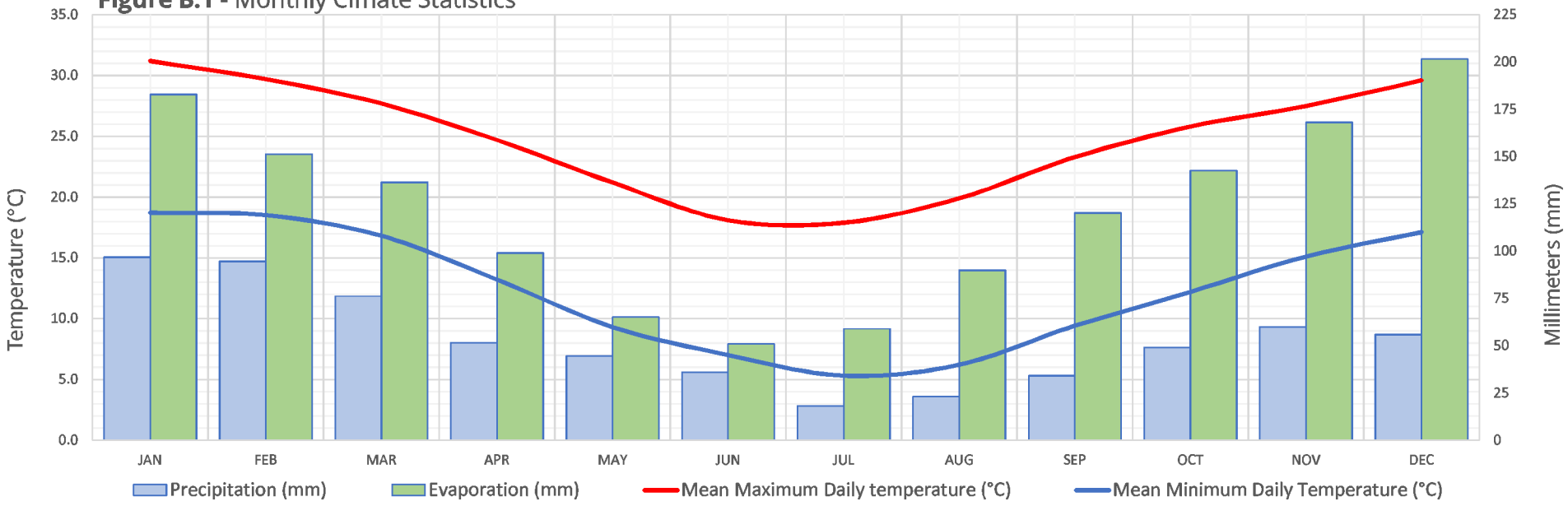

Table B1.2. Site Climate Statistics

Site Factors	Symbol	Units	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Mean Max. Temperature	[T]	[°C]	31.2	29.7	27.7	24.7	21.2	18.1	17.9	19.9	23.3	25.8	27.5	29.6	24.7
Mean Min. Temperature	[T]	[°C]	18.7	18.5	16.8	13.2	9.3	7.0	5.3	6.2	9.4	12.2	15.1	17.1	12.4
Days	[D]		31	28	31	30	31	30	31	31	30	31	30	31	365
Precipitation[1]	[P]	[mm/month]	96.8	94.5	76.2	51.5	44.6	36	18.2	23.2	34	49	60	55.8	872
Evaporation	[E]	[mm/day]	5.9	5.4	4.4	3.3	2.1	1.7	1.9	2.9	4.0	4.6	5.6	6.5	4.0
		[mm/month]	182.9	151.2	136.4	99	65.1	51	58.9	89.9	120	142.6	168	201.5	1467
Natural Site Balance[2]	[P-E]	[mm/month]	-86.1	-56.7	-60.2	-47.5	-20.5	-15	-40.7	-66.7	-86	-93.6	-108	-145.7	

[1] Median historic precipitation. Note: total is not equivalent to annual median.

[2] Negative value indicates monthly mean evaporation > precipitation

B2. - Water Balance

Table B2.1. Site & Soil Parameters

Parameter	Symbols	Values	Units
Design Wastewater Flowrate	Q	840	L/day
Soil Texture		Clay Loam	
Soil Structure		Moderate	
Indicative Permeability	K_{sat}	0.4 - 1.5	m/day
Design Irrigation Rate	DIR_{day}	3.5	mm/day

Table B2.2. Effluent water balance

Site Factors	Symbol	Units	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Days per Month	D	days	31	28	31	30	31	30	31	31	30	31	30	31	365
Crop Factor	C		0.7	0.7	0.7	0.6	0.5	0.45	0.4	0.45	0.55	0.65	0.7	0.7	0.7
Effluent Irrigation	(Q x D)	mm/month	26040	23520	26040	25200	26040	25200	26040	26040	25200	26040	25200	26040	306600
Evapotranspiration	(E xC)	mm/month	128.0	105.8	95.5	59.4	32.6	23.0	23.6	40.5	66.0	92.7	117.6	141.1	1026.6
Design Irrigation Rate	DIR_{Month}	mm/month	108.5	98	108.5	105	108.5	105	108.5	108.5	105	108.5	105	108.5	1277.5
Minmum Area Required	$A_{wb.min}$	m^2	186	215	204	223	270	**274**	229	207	184	171	155	134	214

Table B2.3. Water Balance Minimum Area Requirement

	Symbols	Area m^2
Minimum Area Required to Satisfy	A_{wb}	**274**

B3. - Nutrient Balance & Minimum irrigation area

Table B3.1. Nitrogen Balance

Parameter	Symbols	Values	Units
Design Wastewater Flowrate	Q	840	L/day
Effluent Total Nitrogen (TN) Concentration[1]	TN	25	mg/L
Critical TN Loading Rate[1]	$L_{n.sfc}$	27	$mg/m^2/day$
Minimum Application Area	$A_{n.sfc}$	778	m^2

[1] Nominal ATWS Loading Rates & Concerntrations (PCC 2014, *On-Site Sewage Management and Greywater Reuse*)

Table B3.2. Phosphorus Balance

Parameter	Symbols	Values	Units
Design Wastewater Flowrate	Q	840	L/day
Effluent Total Phosphorus (TP) Concentration[1]	TP	12	mg/L
Phosphorus Generated 50_{YR}	P_{gen}	183.96	kg
Soil Phosphorus Sorption Capacity[2]	P_{sorp}	6000	kg/Ha
Phosphorus Absorped 50_{YR}	P_{absorb}	0.200	kg/m^2
Critical TP Loading Rate[2]	$L_{p.sfc}$	8	$mg/m^2/day$
Phosphorus Uptake 50YR	$P_{uptake.sfc}$	0.150	kg/m^2
Minimum Application Area	$A_{p.sfc}$	526	m^2

[1] Nominal ATWS Loading Rates & Concerntrations (PCC 2014, *On-Site Sewage Management and Greywater Reuse*)

[2] Psorp Capacity - 600,000mg/m^2/depth for clay soil types or 400,000mg/m^2/depth for sandy soil types (PCC 2014, On-Site Sewage Management and Greywater Reuse)

B4. - Minimum Effluent Irrigation Areas

Table B4.1. Minimum Irrigation Area Requirement

Balance	Area Required (m^2)
Water	274
Nitrogen	778
Phosphorus	526
Minimum Irrigation Area	778

APPENDIX C: INFORMATION FOR THE PROPERTY OWNER

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ON-SITE SEWAGE MANAGEMENT SYSTEMS

If you live in or rent a house that is not connected to the main sewer then chances are that your yard contains an on-site sewage management system. If this is the case then you have a special responsibility to ensure that it is working as well as it can.

The aim of this pamphlet is to introduce you to some of the most popular types of on-site sewage management systems and provide some general information to help you maintain your system effectively. You should find out what type of system you have and how it works.

More information can be obtained from the pamphlets:

Your Septic System
Your Aerated Wastewater Treatment System
Your Composting Toilet
Your Land Application Area

You can get a copy of these pamphlets from your local council or the address marked on the back of this pamphlet.

It is important to keep in mind that maintenance needs to be performed properly and regularly. Poorly maintained on-site sewage management systems can significantly affect you and your family's health as well as the local environment.

What is an on-site sewage management system?

A domestic on-site sewage management system is made up of various components which - if properly designed, installed and maintained - allow the treatment and utilisation of wastewater from a house, completely within the boundary of the property.

Wastewater may be blackwater (toilet waste), or greywater (water from showers, sinks, and washing machines), or a combination of both.

Partial on-site systems - eg. pump out and common effluent systems (CES) - also exist. These usually involve the preliminary on-site treatment of wastewater in a septic tank, followed by collection and transport of the treated wastewater to an off-site management facility. Pump out systems use road tankers to transport the effluent, and CES use a network of small diameter pipes.

How does an on-site sewage management system work?

For complete on-site systems there are two main processes:

1. treatment of wastewater to a certain standard
2. its application to a dedicated area of land.

The type of application permitted depends on the quality of treatment, although you should try to avoid contact with all treated and untreated wastewater, and thoroughly wash affected areas if contact does occur.

Treatment and application can be carried out using various methods:

Septic Tank
Septic tanks treat both greywater and blackwater, but they provide only limited treatment through the settling of solids and the flotation of fats and greases. Bacteria in the tank break down the solids over a period of time. Wastewater that has been treated in a septic tank can only be applied to land through a covered soil absorption system, as the effluent is still too contaminated for above ground or near surface irrigation.

AWTS
Aerated wastewater treatment systems (AWTS) treat all household wastewater and have several treatment compartments. The first is like a septic tank, but in the second compartment air is mixed with the wastewater to assist bacteria to break down solids. A third compartment allows settling of more solids and a final chlorination contact chamber allows disinfection. Some AWTS are constructed with all the compartments inside a single tank. The effluent produced may be surface or sub-surface irrigated in a dedicated area.

Composting Toilets
Composting toilets collect and treat toilet waste only. Water from the shower, sinks and the washing machine needs to be treated separately (for example in a septic tank or AWTS as above). The compost produced by a composting toilet has special requirements but is usually buried on-site.

These are just some of the treatment and application methods available, and there are many other types such as sand filter beds, wetlands, and amended earth mounds. Your local council or the NSW Department of Health have more information on these systems if you need it.

Regulations and recommendations

The NSW Department of Health determines the design and structural requirements for treatment systems for single households. Local councils are primarily responsible for approving the installation of smaller domestic septic tank systems, composting toilets and AWTSs in their area, and are also responsible for approving land application areas. The NSW Environment Protection Authority approves larger systems.

The design and installation of on-site sewage management systems, including plumbing and drainage, should only be carried out by suitably qualified or experienced people. Care is needed to ensure correct sizing of the treatment system and application area.

Heavy fines may be imposed under the Clean Waters Act if wastewater is not managed properly.

Keeping your on-site sewage management system operating well

What you put down your drains and toilets has a lot to do with how well your system performs. Maintenance of your sewage management system also needs to be done well and on-time. The following is a guide to the types of things you should and should not do with your system.

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DO

- ✓ Learn how your sewage management system works and its operational and maintenance requirements.
- ✓ Learn the location and layout of your sewage management system.
- ✓ Have your AWTS (if installed) inspected and serviced four times per year by an approved contractor. Other systems should be inspected at least once every year. Assessment should be applicable to the system design.
- ✓ Keep a record of desludgings, inspections, and other maintenance.
- ✓ Have your septic tank or AWTS desludged every three years to prevent sludge build up, which may 'clog' the pipes.
- ✓ Conserve water. Conservative water use around the house will reduce the amount of wastewater which is produced and needs to be treated.
- ✓ Discuss with your local council the adequacy of your existing sewage management system if you are considering house extensions for increased occupancy.

DON'T

- ✗ Don't let children or pets play on land application areas.
- ✗ Don't water fruit and vegetables with effluent.
- ✗ Don't extract untreated groundwater for cooking and drinking.
- ✗ Don't put large quantities of bleaches, disinfectants, whiteners, nappy soakers and spot removers into your system via the sink, washing machine or toilet.
- ✗ Don't allow any foreign materials such as nappies, sanitary napkins, condoms and other hygiene products to enter the system.
- ✗ Don't put fats and oils down the drain and keep food waste out of your system.
- ✗ Don't install or use a garbage grinder or spa bath if your system is not designed for it.

Reducing water usage

Reducing water usage will lessen the likelihood of problems such as overloading with your septic system. Overloading may result in wastewater backing up into your house, contamination of your yard with improperly treated effluent, and effluent from your system contaminating groundwater or a nearby waterway.

Your sewage management system is also unable to cope with large volumes of water such as several showers or loads of washing over a short period of time. You should try to avoid these 'shock loads' by ensuring water use is spread more evenly throughout the day and week.

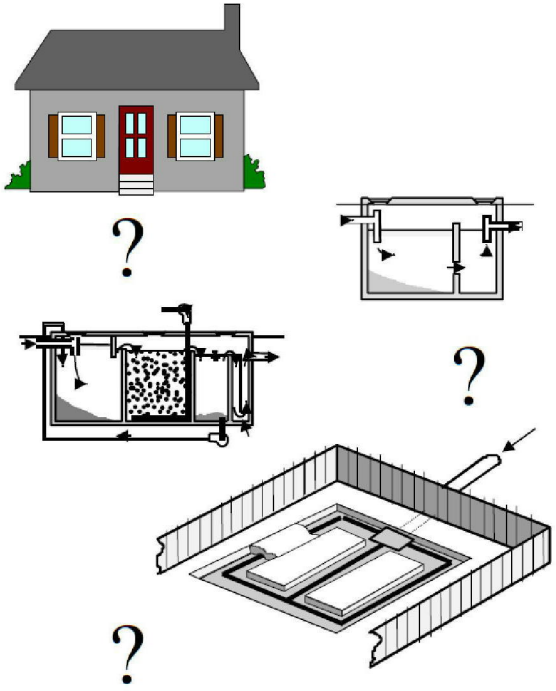
HELP PROTECT YOUR HEALTH AND THE ENVIRONMENT

Poorly maintained sewage management systems are a serious source of water pollution and may present health risks, cause odours and attract vermin and insects.

By looking after your management system you can do your part in helping to protect the environment and the health of you and your community.

For more information please contact:

Managing Wastewater In Your Backyard



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Aerated Wastewater Treatment Systems (AWTS)

In unsewered areas, the proper treatment and utilisation of household wastewater on-site is critical in preserving the health of the public and the environment. AWTS have been developed as a way of achieving this.

What is an AWTS?

An AWTS is a purpose built system used for the treatment of sewage and liquid wastes from a single household or multiple dwellings.

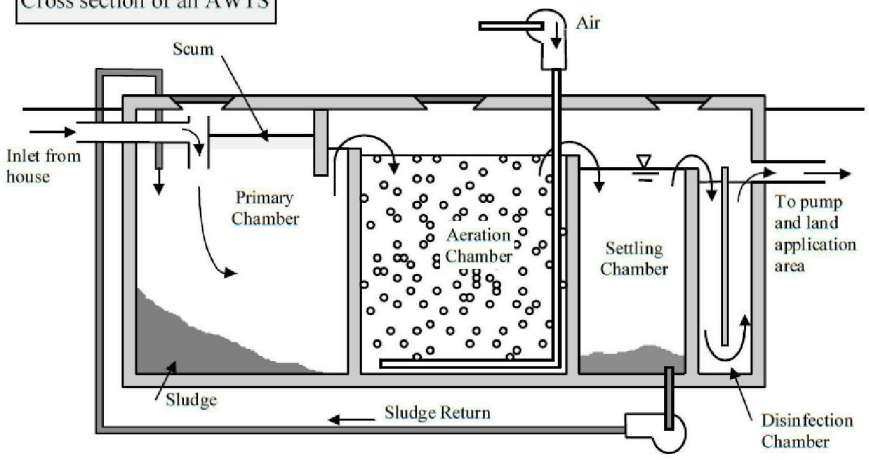
It consists of a series of treatment chambers combined with an irrigation system. An AWTS enables people living in unsewered areas to treat and utilise their wastewater.

How does an AWTS work?

Wastewater from a household is treated in stages in several separate chambers. The first chamber is similar to a conventional septic tank. The wastewater enters the chamber where the solids settle to the bottom and are retained in the tank forming a sludge layer. Scum collects at the top, and the partially clarified wastewater flows into a second chamber. Here the wastewater is mixed with air to assist bacteria to further treat it. A third chamber allows additional clarification through the settling of solids, which are returned for further treatment to either the septic chamber (as shown) or to the aeration chamber. The clarified effluent is disinfected in another chamber (usually by chlorination) before irrigation can take place.

Bacteria in the first chamber break down the solid matter in the sludge and scum layers. Material that cannot be fully broken down gradually builds up in the chamber and must be pumped out periodically.

Cross section of an AWTS



Regulations and recommendations

Local councils are primarily responsible for approving the smaller, domestic AWTSs in their area. The Environment Protection Authority (EPA) approves larger units, whilst the NSW Department of Health determines the design and structural requirements for all AWTSs.

At present AWTSs need to be serviced quarterly by an approved contractor at a cost to the owner. Local councils should also maintain a register of the servicing of each system within their area.

AWTSs should be fitted with an alarm having visual and audible components to indicate mechanical and electrical equipment malfunctions. The alarm should provide a signal adjacent to the alarm and at a relevant position inside the house. The alarm should incorporate a warning lamp which may only be reset by the service agent.

Maintaining your AWTS

The effectiveness of the system will, in part, depend on how it is used and maintained. The following is a guide on good maintenance procedures that you should follow:

DO

- ✓ Have your AWTS inspected and serviced four times per year by an approved contractor. Assessment should be applicable to the system design.
- ✓ Have your system service include assessment of sludge and scum levels in all tanks, and performance of irrigation areas.
- ✓ Have all your tanks desludged at least every three years.
- ✓ Have your disinfection chamber inspected and tested quarterly to ensure correct disinfectant levels.
- ✓ Have your grease trap (if installed) cleaned out at least every two months.
- ✓ Keep a record of pumping, inspections, and other maintenance.
- ✓ Learn the location and layout of your AWTS and land application area.
- ✓ Use biodegradable liquid detergents such as concentrates with low sodium and phosphorous levels.
- ✓ Conserve water.

DON'T

- ✗ Don't put bleaches, disinfectants, whiteners, nappy soakers and spot removers in large quantities into your AWTS via the sink, washing machine or toilet.
- ✗ Don't allow any foreign materials such as nappies, sanitary napkins, condoms and other hygiene products to enter the system.
- ✗ Don't use more than the recommended amounts of detergents.
- ✗ Don't put fats and oils down the drain and keep food waste out of your system.
- ✗ Don't switch off power to the AWTS, even if you are going on holidays

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Reducing water usage

Reducing water usage will lessen the likelihood of problems such as overloading with your AWTS. Overloading may result in wastewater backing up into your house, contamination of your yard with improperly treated effluent, and effluent from your system entering a nearby river, creek or dam.

Conservative water use around the house will reduce the amount of wastewater which is produced and needs to be treated.

Your AWTS is also unable to cope with large volumes of water such as several showers or loads of washing over a short period of time. You should try to avoid these 'shock loads' by ensuring water use is spread more evenly throughout the day and week.

Warning signs

You can look out for a few warning signs that signal to you that there are troubles with your AWTS. Ensure that these problems are attended to immediately to protect your health and the environment.

Look out for the following warning signs:

- Water that drains too slowly.
- Drain pipes that gurgle or make noises when air bubbles are forced back through the system.
- Sewage smells, this indicates a serious problem.
- Water backing up into your sink which may indicate that your system is already failing.
- Wastewater pooling over the land application area.
- Black coloured effluent in the aerated tank.
- Excess noise from the blower or pumping equipment
- Poor vegetation growth in irrigated area.

Odour problems from a vent on the AWTS can be a result of slow or inadequate breakdown of solids. Call a technician to service the system.

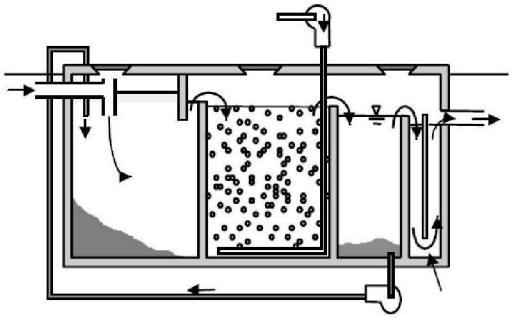
HELP PROTECT YOUR HEALTH AND THE ENVIRONMENT

Poorly maintained AWTSs are a serious source of water pollution and may present health risks, cause odours and attract vermin and insects.

By looking after your treatment system you can do your part in helping to protect the environment and the health of you and your family.

If you would like more information please contact:

Your Aerated Wastewater Treatment System



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LAND APPLICATION AREAS

The reuse of domestic wastewater on-site can be an economical and environmentally sound use of resources.

What are land application areas?

These are areas that allow treated domestic wastewater to be managed entirely on-site.

The area must be able to utilise the wastewater and treat any organic matter and wastes it may contain. The wastewater is rich in nutrients, and can provide excellent nourishment for flower gardens, lawns, certain shrubs and trees. The vegetation should be suitably tolerant of high water and nutrient loads.

How does a land application area work?

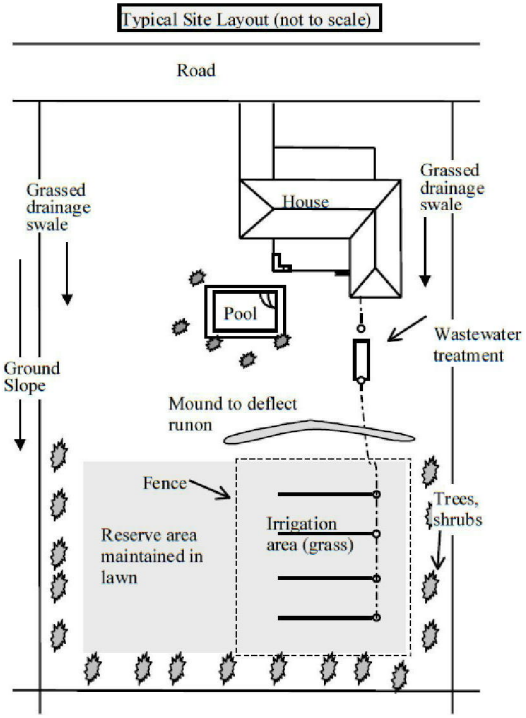
Treated wastewater applied to a land application area may be utilised or simply disposed, depending on the type of application system that is used. The application of the wastewater can be through a soil absorption system (based on disposal) or through an irrigation system (based on utilisation).

Soil absorption systems do not require highly treated effluent, and wastewater treated by a septic tank is reasonable as the solids content in the effluent has been reduced. Absorption systems release the effluent into the soil at a depth that cannot be reached by the roots of most small shrubs and grasses. They rely mainly on the processes of soil treatment and then transmission to the water table, with minimal evaporation and up-take by plants. **These systems are not recommended in sensitive areas as they may lead to contamination of surface water and groundwater.**

Irrigation systems may be classed as either subsurface or surface irrigation. If an irrigation system is to be used, wastewater needs to be pre-treated to at least the quality produced by an aerated wastewater treatment system (AWTS).

Subsurface irrigation requires highly treated effluent that is introduced into the soil close to the surface. The effluent is utilised mainly by plants and evaporation.

Surface irrigation requires highly treated effluent that has undergone aeration and disinfection treatments, so as to reduce the possibility of bacteria and virus contamination.



The effluent is then applied to the land area through a series of drip, trickle, or spray points which are designed to eliminate airborne drift and run-off into neighbouring properties.

There are some public health and environmental concerns about surface irrigation. There is the risk of contact with treated effluent and the potential for surface run-off. Given these problems, subsurface irrigation is arguably the safest, most efficient and effective method of effluent utilisation.

Regulations and recommendations

The design and installation of land application areas should only be carried out by suitably qualified or experienced people, and only after a site and soil evaluation is done by a soil scientist. Care should be taken to ensure correct buffer distances are left between the application area and bores, waterways, buildings, and neighbouring properties.

Heavy fines may be imposed under the Clean Waters Act if effluent is managed improperly.

At least two warning signs should be installed along the boundary of a land application area. The signs should comprise of 20mm high Series C lettering in black or white on a green background with the words:

RECLAIMED EFFLUENT
NOT FOR DRINKING
AVOID CONTACT

Depending on the requirements of your local council, wet weather storage and soil moisture sensors may need to be installed to ensure that effluent is only irrigated when the soil is not saturated.

Regular checks should be undertaken of any mechanical equipment to ensure that it is operating correctly. Local councils may require periodic analysis of soil or groundwater characteristics

Humans and animals should be excluded from land application areas during and immediately after the application of treated wastewater. The longer the period of exclusion from an area, the lower the risk to public health.

The householder is required to enter into a service contract with the installation company, its agent or the manufacturer of their sewage management system, this will ensure that the system operates efficiently.

Location of the application area

Treated wastewater has the potential to have negative impacts on public health and the environment. For this reason the application area must be located in accordance with the results of a site evaluation, and approved landscaping must be completed prior to occupation of the building. Sandy soil and clayey soils may present special problems.

The system must allow even distribution of treated wastewater over the land application area.

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Maintaining your land application area

The effectiveness of the application area is governed by the activities of the owner.

DO

- ✓ Construct and maintain diversion drains around the top side of the application area to divert surface water.
- ✓ Ensure that your application area is kept level by filling any depressions with good quality top soil (not clay).
- ✓ Keep the grass regularly mowed and plant small trees around the perimeter to aid absorption and transpiration of the effluent.
- ✓ Ensure that any run off from the roof, driveway and other impermeable surfaces is directed away from the application area.
- ✓ Fence irrigation areas.
- ✓ Ensure appropriate warning signs are visible at all times in the vicinity of a spray irrigation area.
- ✓ Have your irrigation system checked by the service agent when they are carrying out service on the treatment system.

DON'T

- ✗ Don't erect any structures, construct paths, graze animals or drive over the land application area.
- ✗ Don't plant large trees that shade the land application area, as the area needs sunlight to aid in the evaporation and transpiration of the effluent.
- ✗ Don't plant trees or shrubs near or on house drains.
- ✗ Don't alter stormwater lines to discharge into or near the land application area.
- ✗ Don't flood the land application area through the use of hoses or sprinklers.
- ✗ Don't let children or pets play on land application areas.
- ✗ Don't water fruit and vegetables with the effluent.
- ✗ Don't extract untreated groundwater for potable use.

Warning signs

Regular visual checking of the system will ensure that problems are located and fixed early.

The visual signs of system failure include:

- surface ponding and run-off of treated wastewater
- soil quality deterioration
- poor vegetation growth
- unusual odours

Volume of water

Land application areas and systems for on-site application are designed and constructed in anticipation of the volume of waste to be discharged. Uncontrolled use of water may lead to poorly treated effluent being released from the system.

If the land application area is waterlogged and soggy the following are possible reasons:

- Overloading the treatment system with wastewater.
- The clogging of the trench with solids not trapped by the septic tank. The tank may require desludging.
- The application area has been poorly designed.
- Stormwater is running onto the area.

HELP PROTECT YOUR HEALTH AND THE ENVIRONMENT

Poorly maintained land application areas are a serious source of water pollution and may present health risks, cause odours and attract vermin and insects.

By looking after your sewage management system you can do your part in helping to protect the environment and the health of you and your family.

For more information please contact:

Your Land Application Area