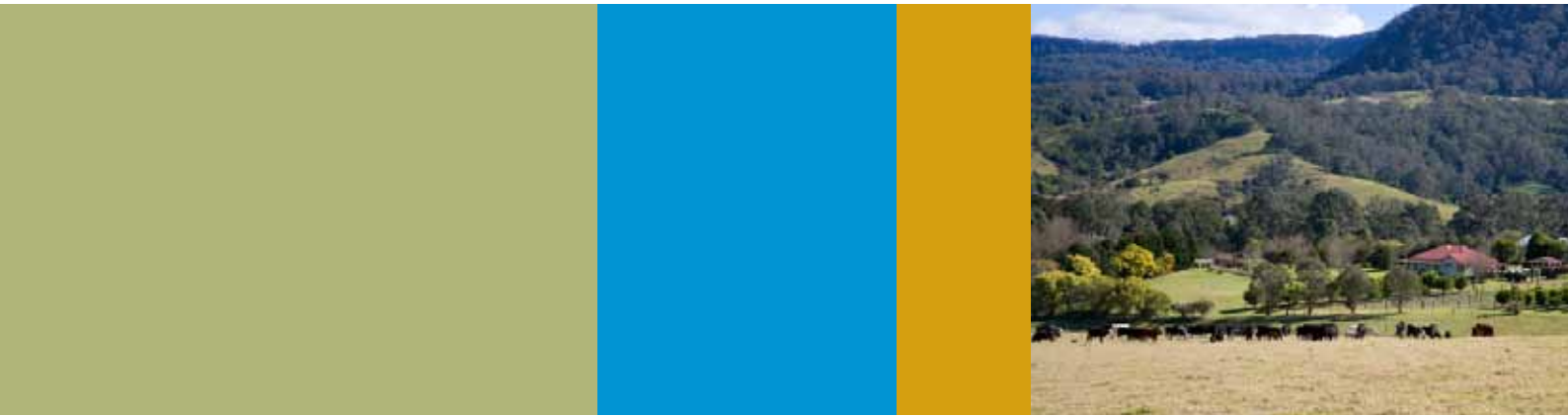




Designing and Installing On-Site Wastewater Systems

A Sydney Catchment Authority
Current Recommended Practice



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Document Control

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Disclaimer

This Manual provides technical information to help design, install, inspect and assess on-site hydraulic effluent management systems in the Sydney drinking water catchment. The information contained in the Manual is current, accurate and complete at the time of publication.

The Sydney Catchment Authority does not make or give any representation or warranty that complying with the recommended practices in the Manual will produce an effective hydraulic effluent management system and will not be liable in negligence, breach of contract or statutory duty for failure of the system or the consequences of that failure.

Reference to any particular product or service in this Manual does not imply any endorsement by the Sydney Catchment Authority.

The information in this Manual is based on independent research by Whitehead & Associates Environmental Consultants Pty Ltd. Recommendations are based on an honest appraisal of available information, subject to the limited scope and resources available for this project, and follow relevant best practice standards and guidelines where applicable.

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Table of Contents

1. Introduction	2
1.1 This Manual	3
1.2 Using this Manual with other guidelines, standards and tools	4
1.3 Technical issues and problems with effluent management	4
1.4 Designer and installer – improving practice and communication	5
1.5 How to use this Manual.....	6
2. Wastewater Site Assessment and System Selection	9
2.1 Assessing the wastewater site.....	9
2.2 Wastewater standards and SCA requirements.....	10
2.3 Selecting a system	17
2.4 System location.....	20
2.4 Case study	26
3. Septic Tanks	27
4. Aerated Wastewater Treatment Systems	43
5. Biological Filter System	62
6. Composting Toilets	77
7. Greywater Treatment Systems	86
8. Amended Soil Mounds	95
9. Sand Mounds	107
10. Absorption Trenches and Beds	119
11. Evapotranspiration / Absorption Beds	142
12. Surface Irrigation	155
13. Subsurface Irrigation	171
14. Emerging Technology	192
15. Acronyms	198
16. Glossary	199
17. References	204
Appendix 1	207
Appendix 2	209
Appendix 3	212
Appendix 4	217

DESIGNING AND INSTALLING ON-SITE WASTEWATER SYSTEMS

Many on-site wastewater systems installed in the Sydney drinking water catchment have failed from the day they began operating. The Sydney Catchment Authority (SCA) recognises the common failure of systems in the drinking water catchment is partly due to the lack of readily available technical information about installations. This Manual provides technical installation details not included in other guidelines or documents on domestic wastewater management. It brings together detailed design aspects of a variety of common effluent disposal systems and emerging technology. It provides checklists and standard drawings for approving authorities, system installers and owners. All information in the Manual relates to the SCA's drinking water catchment, but may have a wider benefit elsewhere in NSW.

1. Introduction

The Sydney drinking water catchment covers approximately 16,000 square kilometres and supplies drinking water to around four and a half million people in Sydney, the Blue Mountains, the Illawarra and the Southern Highlands (Figure 1.1).

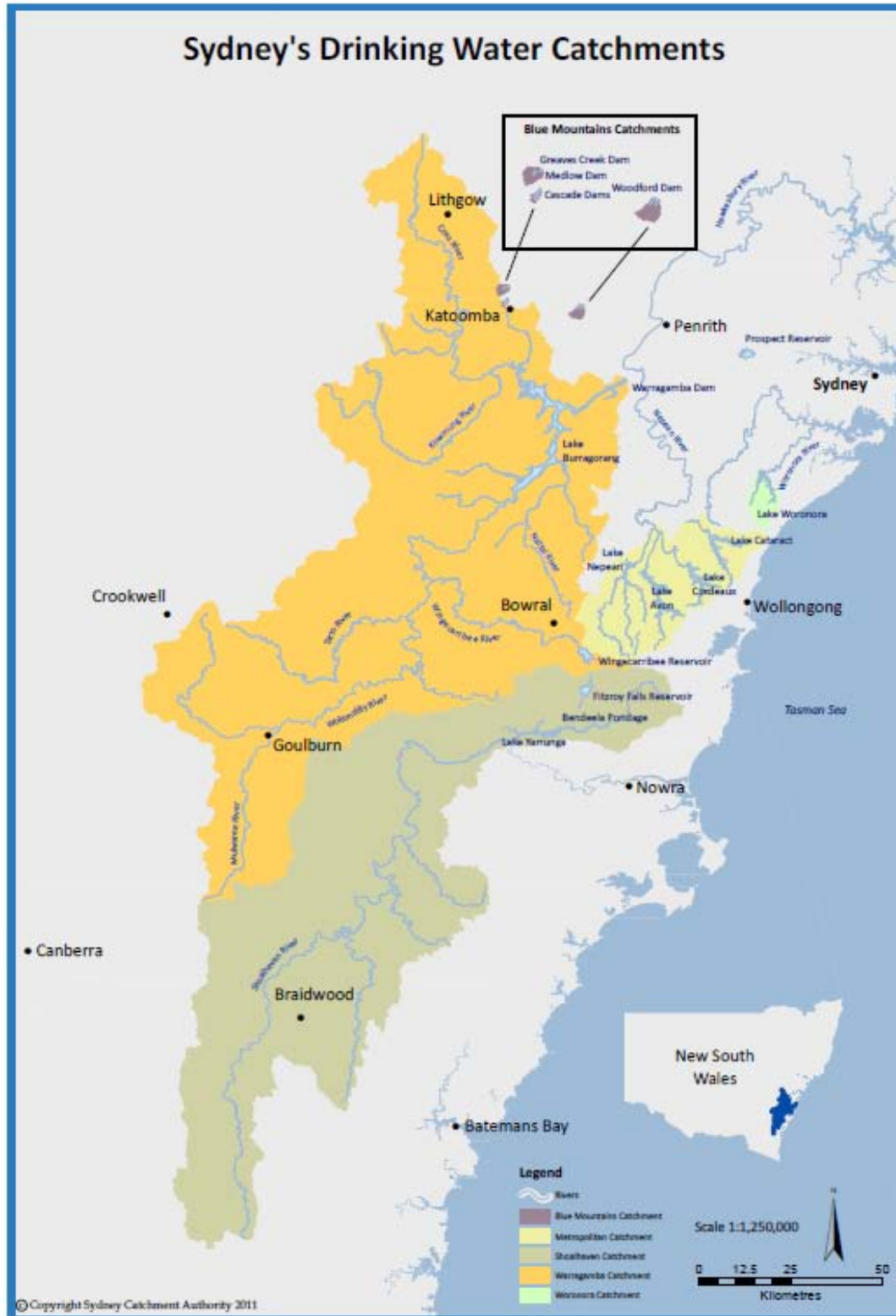


Figure 1.1 Map of the drinking water catchment

There are approximately 15,000 on-site wastewater systems in the catchment across 15 local government areas. A range of common technical and design faults encountered when installing on-site wastewater systems in the catchment can lead to health and water quality risks. Under the State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011 (the SEPP), any development in the catchment that requires consent from council, including any on-site wastewater system¹, must show a neutral or beneficial effect on water quality (NorBE). This Manual will help meet the requirements of the SEPP as they apply to on-site wastewater systems.

On-site wastewater systems are designed according to 'AS/NZS 1547:2012 On-site Domestic Wastewater Management' and the Department of Local Government's 'Environment & Health Protection Guidelines: On-site Sewage Management for Single Households' (the 'Silver Book', Department of Local Government, 1998). However, these publications do not provide detailed and complete advice about properly installing on-site systems. As a result, designs are often inadequate and/or their objectives fail due to poor installation. When these systems fail they present a risk to water quality and human health.

1.1 This Manual

This Manual will help system installers, design consultants, property owners, council officers, Sydney Catchment Authority officers, plumbers and contractors to ensure best practice methods are used to design and install on-site wastewater systems in Sydney's drinking water catchment. It is a technical manual for design and construction that brings together and builds on existing documents about on-site wastewater and plumbing.

The Manual gives practical and appropriate solutions for specific site constraints for the more common types of systems found in the catchment, and some innovative systems likely to become more common. Illustrated case studies and examples demonstrate common issues and suggest mitigation measures to minimise the risk of failure. There are annotated Standard Drawings, numerous tables, and checklists to design, install, construct and assess various systems, emphasising sound hydraulic design.

The Manual does not extensively cover choosing the size or type of system. This choice must be made according to 'AS/NZS 1547:2012 On-site Domestic Wastewater Management' and the Department of Local Government's 'Environment & Health Protection Guidelines: On-site Sewage Management for Single Households' (the 'Silver Book'). Section 2 of the Manual does describe how to interpret these documents together with the Sydney Catchment Authority's requirements.

The Manual provides recommendations to design, install, test, operate and inspect the following systems:

- septic tanks
- aerated wastewater treatment systems
- biological filter systems
- composting toilets
- amended soil mounds
- Wisconsin sand mounds
- greywater treatment systems

¹ Note: Notwithstanding that modifications to existing or installation of a new on-site wastewater system under section 68 of the *Local Government Act 1993* not requiring consent are not required to have a neutral or beneficial effect on water quality, councils and consultants should ensure that all modifications and installations are consistent with the intent of the SEPP and this manual.

- absorption trenches and beds
- evapotranspiration absorption beds
- surface irrigation systems
- subsurface irrigation systems.

The Manual identifies and describes practical approaches and solutions to key issues. Detailed, annotated Standard Drawings are provided to help design, install and inspect pump wells and various land application options. Checklists are also provided to help designers, installers and regulators check that necessary information is collated and key tasks are completed at different stages. The checklists are extensive and may include items not relevant to a particular installation. They can be modified to suit individual needs.

1.2 Using this Manual with other guidelines, standards and tools

This Manual supplements other existing guidelines and standards for on-site wastewater management.

The Manual is a current recommended practice (CRP) for on-site wastewater management according to the 'Neutral or Beneficial Effect on Water Quality Assessment Guideline 2011' (the NorBE Guideline, Sydney Catchment Authority, 2011). The NorBE Guideline helps regulatory authorities decide if a proposed development has a neutral or beneficial effect on water quality (NorBE). Under the SEPP, new developments should incorporate CRPs or performance standards endorsed by the Sydney Catchment Authority as best practice to help achieve NorBE. AS/NZS 1547:2012 and the 'Silver Book' (Department of Local Government, 1998) are both CRPs for on-site wastewater management. The brochure 'Developments in Sydney's Drinking Water Catchment – Water Quality Information Requirements' (available at www.sca.nsw.gov.au) is a performance standard developed by the Sydney Catchment Authority. This Manual is also a CRP for the design, installation, operation and inspection of on-site wastewater systems in Sydney's drinking water catchment. It should be read together with AS/NZS 1547:2012, the 'Silver Book' and the water quality information requirements brochure.

The Wastewater Effluent Model (WEM) is a GIS-based, effluent plume generation modelling tool used by local councils and the Sydney Catchment Authority to evaluate on-site wastewater systems designed using the above documents. The model is used to help decide whether NorBE is satisfied for developments where on-site wastewater management is required. It allows a visual interpretation and assessment of the potential impact of an on-site wastewater system on water quality. It considers site and soil characteristics such as soil depth, permeability, sorption capacity, slope and the proposed effluent management area. If the WEM shows the effluent plume reaches a watercourse, waterbody or drainage depression, or shows it leaving the boundaries of the site, then the proposal will be judged as not demonstrating NorBE (Sydney Catchment Authority, 2011). Using this Manual should help ensure that an on-site wastewater system that has been designed to achieve NorBE is installed correctly and maintained to continue to achieve NorBE throughout the system's life.

1.3 Technical issues and problems with effluent management

A wide range of technical issues and problems have been identified for on-site effluent management. They range from simple installation mistakes, such as not securing a tank into the ground, to larger design issues, such as having insufficient pump head capacity to adequately irrigate a large effluent application area. These issues are identified in the section for each system, however, some are common to a range of systems.

All systems should be installed according to NSW Workplace Safety requirements and 'AS/NZS 3500 (Set):2003 Plumbing and Drainage Set'.

1.4 Designer and installer – improving practice and communication

This Manual requires system designers to accept more accountability for the design, and improved communication between the designer and installer. More accountability for the design is achieved through a Design Producer Statement, in which the designer warrants the design. Better communication between the designer and installer is achieved by the designer preparing a System Design that communicates critical details of the proposed system to the installer. It describes and quantifies the design, and illustrates the appropriate layout and configuration of the system with appropriate plans and sketches, as well as a hydraulic design. For example, it should include a construction drawing to specify the location(s) of the effluent disposal field(s). Appendices 2 and 3 include examples of a Design Producer Statement and System Design.

The last stage of this process includes submitting an Installation Certificate provided by the installer. This certifies that the system was installed according to the System Design. Appendix 4 includes an example of an Installation Certificate. A copy of the Installation Certificate(s) must be provided to council and the system designer. The council certifier will make a final inspection before the system is approved for use.

NOTES

- The treatment system and application system **must** be installed by a contractor(s) licensed by NSW Fair Trading. That could be a licensed plumber or a licensed irrigation contractor (or both), each with at least three years experience in effluent disposal.
- The designer **must** have appropriate professional indemnity insurance for the system design.

Figure 1.2 shows the design and communication process. These documents clearly allocate the responsibility for the design and installation to the designer and licensed contractor(s) respectively. They provide a higher level of confidence for homeowners and regulators that the standards of design and installation are appropriately high.

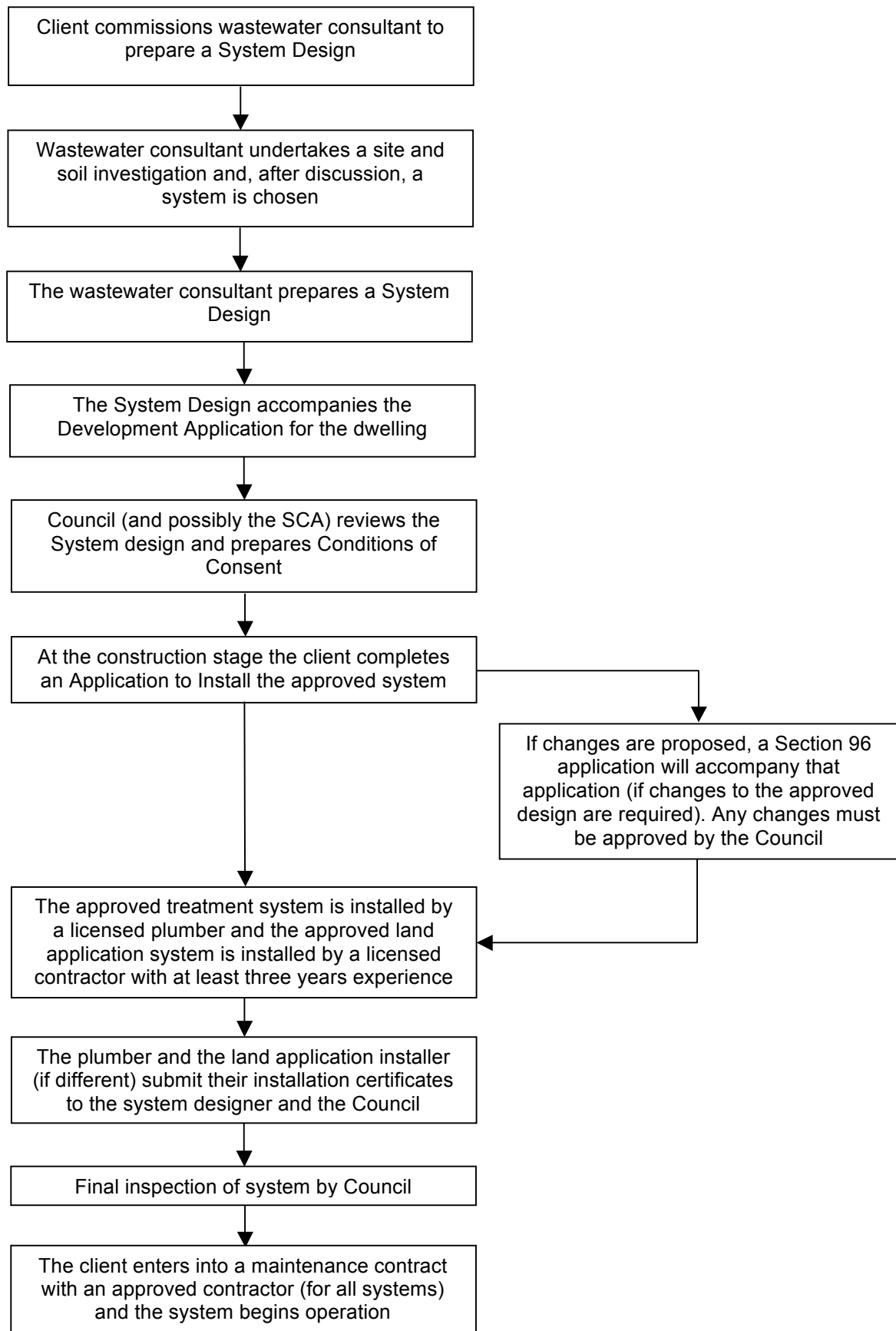


Figure 1.2 Flowchart to design and install an on-site wastewater system

1.5 How to use this Manual

For all systems, designers, installers and regulators should first consider the information in Section 2 of this Manual that outlines the land capability assessment that must be completed for each site. When the assessment is finished and a suitable system is chosen, Sections 3 to 7 and Section 14 are used to produce the treatment system design. Each system type has various design elements to consider when installing, commissioning and operating the system. They should be used, where appropriate, to prevent common technical problems that can cause the system to fail.

Table 1.1 lists each treatment system and land application option in this Manual. Users can select these from the directory and then refer to the appropriate colour-coded pages for detailed guidance on installing, testing, operating and inspecting the system.

Each section includes:

- information about constructing and installing treatment systems and land application methods
- case studies
- annotated Standard Drawings
- checklists for installers and regulators.

Table 1.1 Quick reference table based on treatment system and land application system types

Select Treatment System Type	System Checklist No.s	Select Effluent Management Method	Checklist No.s	Refer to Standard Drawing No.s
Section 3 Septic Tanks (including pump wells)	3.1 3.2	Section 8 Amended Soil Mounds	8.1	8A
		Section 9 Sand Mounds	9.1, 9.2	9A, 9B
		Section 10 Absorption Trenches and Beds (gravity and pressure dosed)	10.1, 10.2	10A, 10B, 10C, 10D
		Section 11 Evapotranspiration Absorption Beds	11.1, 11.2	11A, 11B
Section 4 Aerated Wastewater Treatment Systems (AWTS)	4.1 4.2	Section 8 Amended Soil Mounds	8.1	8A
		Section 9 Sand Mounds	9.1, 9.2	9A, 9B
		Section 10 Absorption Trenches and Beds (gravity and pressure dosed)	10.1, 10.2	10A, 10B, 10C, 10D
		Section 11 Evapotranspiration Absorption Beds	11.1, 11.2	11A, 11B
		Section 12 Surface Irrigation	12.1, 12.2, 12.3	12A, 12B, 12C
		Section 13 Subsurface Irrigation	13.1, 13.2	13A, 13B, 13C
Section 5 Biological Filter Systems (including wet composting systems)	5.1 5.2	Section 8 Amended Soil Mounds	7.1	7A
		Section 9 Sand Mounds	9.1, 9.2	9A, 9B
		Section 10 Absorption Trenches and Beds (gravity and pressure dosed)	10.1, 10.2	10A, 10B, 10C, 10D
		Section 11 Evapotranspiration Absorption Beds	11.1, 11.2	11A, 11B
		Section 13 Subsurface Irrigation	13.1, 13.2	13A, 13B, 13C
Section 6 Dry Composting Systems / Toilets	6.1 6.2	Section 10 Absorption Trenches and Beds (gravity and pressure dosed)	10.1, 10.2	10A, 10B, 10C, 10D
		Section 11 Evapotranspiration Absorption Beds	11.1, 11.2	11A, 11B
Section 7 Greywater Treatment Systems	7.1 7.2	Section 10 Absorption Trenches and Beds (gravity and pressure dosed)	10.1, 10.2	10A, 10B, 10C, 10D
		Section 11 Evapotranspiration Absorption Beds	11.1, 11.2	11A, 11B
		Section 13 Subsurface Irrigation	13.1, 13.2	13A, 13B, 13C
Section 14 Emerging Technologies	-	Various technologies to assist in effluent disposal	-	-

Section 2: Wastewater Site Assessment and Systems

2. Wastewater Site Assessment and System Selection

2.1 Assessing the wastewater site

An experienced and appropriately qualified consultant must complete a wastewater site assessment describing the results of a site and soil assessment. The SCA's document 'Using a Consultant to Prepare Your Water Cycle Management Study' contains information about using and choosing a consultant to help prepare a water cycle management study, which includes a wastewater report. The wastewater report will identify the capability of the site to sustainably manage treated wastewater. After discussion with the property owner the assessment must recommend a particular combination of a treatment system and land application method. This information must be provided in an on-site wastewater report and submitted as part of the development application.

The wastewater report must include:

- specific details of the proposed wastewater treatment and effluent disposal system applied for, including the proposed site of the effluent management area - the wastewater report must recommend a specific system and effluent management area, not a range of options
- a description of how appropriate the proposed system is for the frequency of use, available power, slope, soils, wastewater load and other site constraints as specified below
- a site map showing site constraints and the location of the proposed wastewater treatment system and effluent management area relative to key constraints and buffers
- consideration of the physical practicality of a proposed gravity-fed system given the site slope and grade and whether a pump well is required.

Appendix 2 of the 'Environment & Health Protection Guidelines: On-site Sewage Management for Single Households' (the 'Silver Book', Department of Local Government, 1998) includes a template for wastewater reports. The report should also refer to current references and standards including 'AS/NZS 1547:2012 On-site Domestic Wastewater Management' and the Sydney Catchment Authority's 'Developments in Sydney's Drinking Water Catchment – Water Quality Information Requirements'.

In most cases this manual provides the standard for design and installation of on-site wastewater and effluent management systems. The Sydney Catchment Authority's 'Developments in Sydney's Drinking Water Catchment – Water Quality Information Requirements' document indicates which other current recommended practice or performance standard to use where appropriate.

Site constraints map

The wastewater report must include a site map identifying all surface constraints, including:

- the drainage network, including named rivers, watercourses, drainage depressions and dams, roadside and other open drains (that are treated the same as drainage depressions) – in unsewered village areas this may need to be discussed with the Sydney Catchment Authority and council
- vegetation and shading/exposure
- orientation
- any poor drainage/wet seepage areas and springs

- river flats/ floodplains or flood planning level
- any groundwater bores located within 100 m of the effluent management area and their use
- existing wastewater management structures and effluent management areas
- slope (percentage or degrees)
- general landform
- areas of run-on
- rock outcrop and geology
- stormwater management structures
- all existing and proposed structures including buildings, access ways or roads, livestock yards
- buffer distances (see later)
- exposed soil/erosion potential/fill.

Soil information

The wastewater report must include soil profiles of up to at least one metre (where possible) taken at the specific locations of the proposed effluent management areas, consistent with AS/NZS 1547:2012. The report must describe:

- soil texture and structure with depth using standard soil descriptions as per AS/NZS 1547:2012 - weathered and decomposing rock of the C Horizon is not considered part of the soil profile when considering effluent disposal
- dispersibility (soil with an Emerson aggregate test class 1 are not generally suitable for effluent disposal (Van de Graff and Patterson, 2001))
- other relevant chemical or physical characteristics that could impact on sustainable effluent disposal – eg impeded drainage, as identified in the ‘Silver Book’ or AS/NZS 1547:2012.

The report should also include:

- electrical conductivity/salinity (soil with more than 8 dS/m are not suitable for effluent disposal unless the soil is treated)
- sodicity (soils with more than 10% exchangeable sodium percentage are not suitable for effluent disposal unless the soil is treated)
- weighted phosphorus sorption values for the soil profile, but only where effluent irrigation is proposed
- monthly rainfall and evaporation data.

Published soil data is broad scale and must be confirmed with site specific soil testing.

Climate information

Rainfall and evaporation data for the site and its implications for the nature and size of the effluent management area must be considered. This information is available on the Sydney Catchment Authority’s website at www.sca.nsw.gov.au.

Where relevant, the impact of severe and prolonged frost should also be considered when choosing an effluent disposal system eg surface irrigation may not be suitable during winter.

2.2 Wastewater standards and Sydney Catchment Authority requirements

On-site wastewater systems should be designed according to AS/NZS 1547:2012 and the ‘Silver Book’. These documents include appropriate specifications to design and manage on-site wastewater systems. However, they must be applied together with the Sydney Catchment Authority’s specific requirements for nutrient and water balances, wastewater design loading rates and buffer distances.

Nutrient and hydraulic balances

Nutrient and hydraulic balances must be used for effluent management area sizing and wet weather storage to ensure a sound design for on-site effluent management. Rainfall and evaporation rates vary widely in the Sydney drinking water catchment. An important part of system design is ensuring that rainfall and effluent loads do not exceed the evapotranspiration rate and absorptive capacity of the soil, and ensuring that the soil can readily assimilate the nutrients in the treated wastewater.

Hydraulic balances for effluent irrigation should be calculated as per Appendix 6 of the 'Silver Book' using design irrigation rate data for the soil from Table M1 of AS/NZS 1547:2012. The Sydney Catchment Authority can provide rainfall and evaporation data for various geographic zones (Figure 2.1) to help calculate the hydraulic balance.

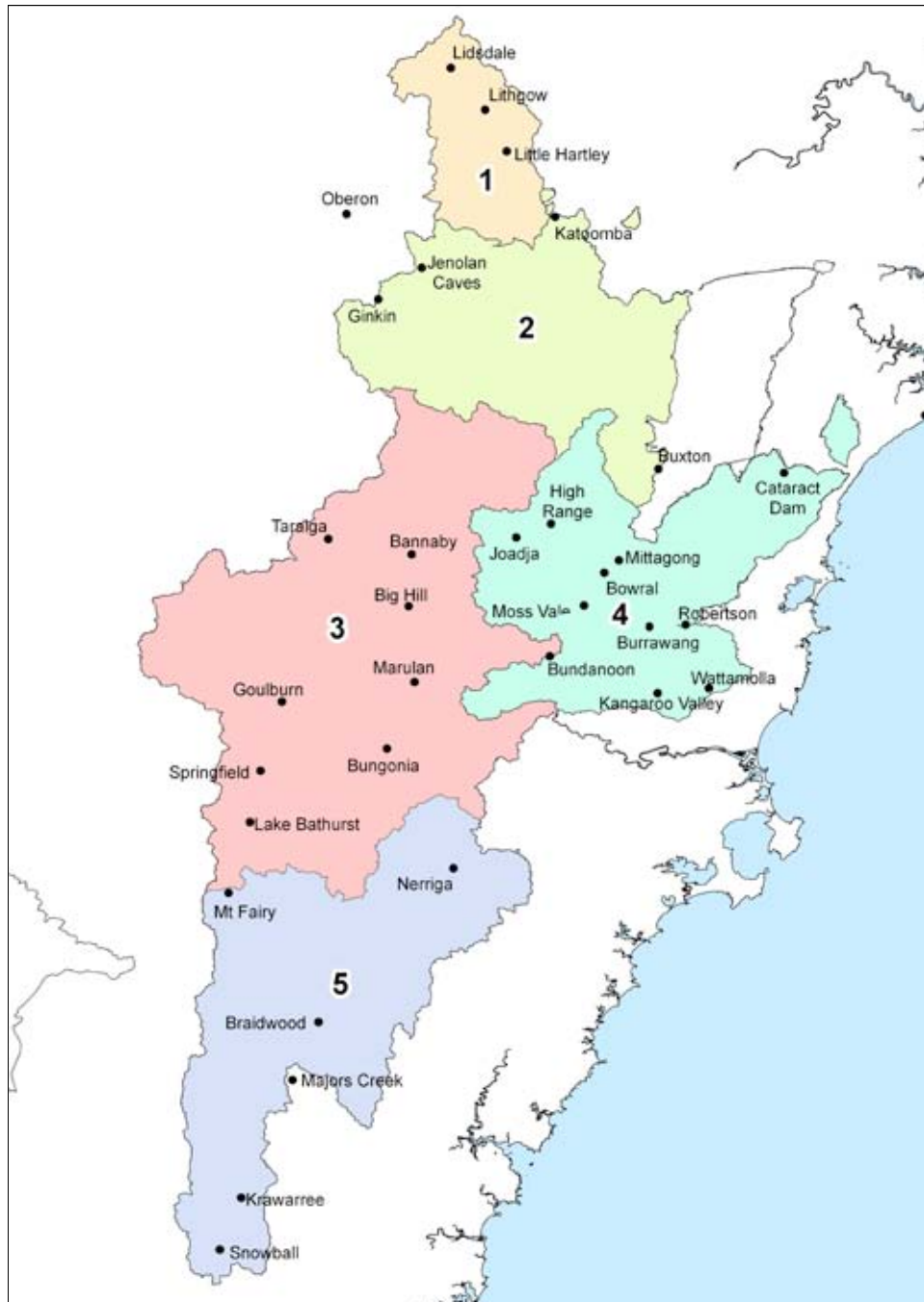


Figure 2.1 Map of catchment evaporation zones and rainfall stations

Zone	Evaporation (mm/month) (Source: BOM)												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1	211	164	140	87	53	33	37	56	84	124	156	202	1345
2	153	129	102	82	62	38	46	65	92	129	111	148	1157
3	149	105	95	71	57	35	42	62	83	108	95	139	1270
4	195	150	127	78	50	33	37	59	84	121	147	189	1041
5	143	107	93	63	40	27	31	53	78	105	117	143	1000

Station	Rainfall (mm/month) (Source BOM)												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Lidsdale	85.8	76.9	61.8	42.6	51.3	48.4	51.6	66.3	53.7	70	72.4	72.9	766
Lithgow	84	80.3	72.9	58	52.9	73.2	62	58.5	56.9	63.5	62.7	78	786
Little Hartley	95.6	91.8	77.1	54	51.7	56.5	47.7	58.2	48	64.2	69.5	67	792
Katoomba	161.5	175.6	165.2	121.8	102.9	118.2	84.3	79.2	72.5	92.3	107.3	123.3	1402
Jenolan Caves	93.6	92.9	77.6	72.5	65.2	87.2	83	83.8	67.5	78.8	78.2	87	972
Ginkin	94.2	84.4	93.8	64.6	78.4	84.4	76.2	88.8	71.6	87.1	83.6	74.6	1007
Buxton	88	127.9	76.6	73.2	55.9	57.7	37.6	49.8	46.3	68	92.7	77.6	855
Taralga	72.7	68.1	65.4	58.9	59.8	74.7	67.3	66.9	61.8	70.9	68	66.5	801
Bannaby	85.1	85.8	71.6	59.5	54.1	61.1	45.5	50.3	48.1	71.2	73	69.3	791
Big Hill	70.7	78.1	65.8	54	47.5	60.1	39.6	46.6	44.1	62.3	63.8	61.5	709
Marulan	67.4	68.2	68.7	52	56.2	60.4	51.7	45.9	48.1	62.7	59.8	61.2	707
Goulburn	57.9	52.6	53.8	45.1	46.5	50.4	47.1	50.2	50.1	58.3	57.1	58.3	631
Springfield	63.7	61.6	55.8	48.9	48.3	52.3	47.7	51.4	49.6	65.1	63.5	59.8	673
Bungonia	64.9	63.3	63.7	52	49.5	59.1	43.1	44.8	46.4	56	58.2	59.4	661
Lake Bathurst	66.8	60.8	58.5	51.1	47.9	53.7	45.9	51.5	52.6	68.3	65.7	60.7	685
Cataract Dam	92.9	115.7	108.8	99.2	96	112.5	75.8	70.4	55.4	77.6	78.6	77.6	1064
High Range	88.3	62.4	81.1	69.1	62.6	68.4	48.1	48.7	47.1	64.9	73.5	74.4	817
Joadja	79.3	77.3	78.8	64.3	56.0	65.4	41.5	55.8	49.6	67.4	81.8	63.9	788
Mittagong	85.3	90.2	91.7	74.7	76	88.1	68.3	55.2	52.7	64.9	70	75.3	891
Bowral	82.2	95.5	90.7	76.8	71.9	82.6	46.8	60.2	56.7	73.7	94.6	46.3	907
Moss Vale	88.9	95.6	90.1	80.6	84.8	99.9	76	63.6	60.1	74.7	73.5	77	964
Bundanoon	110.2	121.2	117.2	94.1	101.1	110.4	80	71.6	69.1	91.1	83.2	93.7	1157
Burrangong	112.3	119.9	124.1	129.9	134.1	161	139.4	91.1	83.5	91	83.8	101.4	1375
Robertson	149.5	165.9	188.3	151.1	143.7	182.9	127.9	106.4	92.3	120.4	110.7	120.7	1675
Wattamolla	131.5	187.3	170	133.8	128.2	156	85.6	103.5	91.6	109.7	126.9	97.8	1528
Kangaroo Valley	110.6	131.9	126.2	113.3	115.7	148.7	84.7	84.3	80.6	101.4	87.7	94.7	1294
Mt Fairy	63.8	59.1	61.2	51.7	55.9	63.1	55.3	50.7	55.8	63.7	65.4	62.5	719
Nerriga	68.4	65.8	73.9	56.5	60.8	71.4	61.9	56.5	53	62.9	65.2	65.3	762
Braidwood	69.2	67	68.2	55.2	57.7	65.2	46.8	47.7	50.4	62.5	63.1	64.5	719
Majors Creek	89	104.1	105.8	67.8	65.9	87.2	65.8	58.8	63.6	79.9	77	73.7	944
Krawarree	78.4	80.4	82.2	62.4	59.5	64.4	51.3	46.4	50.6	67.9	72.7	70.5	798
Snowball	91.7	81.5	87.9	66.9	54.5	73.8	74.9	62.8	97.2	71.5	81	91.1	914

It is more important to include wet weather storage in hydraulic balance designs in wet areas where the average annual rainfall is more than 1,000 millimetres. Where a proposed effluent irrigation area has separate locations and/or different elevations, the wastewater report must identify specific hydraulic design requirements to ensure the system will work effectively. All evapotranspiration absorption beds should be designed according to AS/NZS 1547:2012 to ensure appropriate bed size.

Nutrient balances must be calculated for irrigation. Inputs should include design hydraulic loading, soil depth, soil bulk density, effluent quality, uptake and phosphorus sorption rates. Managed lawn and slashed paddocks have different uptake values and must be treated differently. Data provided by the Sydney Catchment Authority (Appendix 1) is useful for indicative phosphorus sorption values and nutrient uptake rates, however site-specific information is required where an irrigation system is proposed.

The land application area that is determined by a nutrient balance is often substantially bigger than the area required hydraulically, however the whole nutrient assimilation area must be irrigated. In this case, the subsurface irrigation pipes can be spread further apart, although this may result in a striped lawn effect (depending on the slope of the site).

Sizing the effluent management area

- The size of the absorption trenches and beds, and evapotranspiration absorption beds, **must** be based on the design wastewater load and site and soil characteristics as per AS/NZS 1547:2012. The conservative design loading rate must be used for primary treated effluent.
- The size of sand mounds should be based on Converse and Tyler, 2000 and design loading rates in Table N1 of the AS/NZS 1547:2012.
- The irrigation area for surface and subsurface effluent irrigation must be the largest area for the design wastewater load and site soil characteristics determined by hydraulic, nitrogen and phosphorus loadings as per AS/NZS 1547:2012 and the 'Silver Book'.
- Phosphorus sorption values in the phosphorus loading example in the 'Silver Book' are not typical of most locations in the drinking water catchment. Site specific weighted phosphorus sorption values must be used to determine the size of the effluent irrigation area based on nutrient balances. The phosphorus sorption values in Appendix 1 are indicative only.
- Phosphorus sorption data in milligrams per kilogram (mg/kg) is converted to kilograms per hectare (kg/ha) using the following equation (see Appendix 1 for indicative bulk density values):

$$0.01 \times \text{soil depth (m)} \times \text{bulk density (kg/m}^3\text{)} \times \text{Psorp (mg/kg)}$$

- For amended soil mounds, decide the size using the design wastewater load and the design loading rate for the lowest depth soil at the upslope side of the bench of the mound.

Wastewater design loading

When choosing a system, the capacity of the system to manage the daily wastewater load and without overloading the system must be considered. For example, some aerated wastewater treatment systems struggle to effectively accommodate variable loads from holiday homes where the system may not be used at all on weekdays, but a whole family or larger group may use it on weekends and holidays for successive days. Bacteria needed to treat the wastewater can die off when there is no or low

inflow and take time to regenerate once higher flows restart. This can result in poor or ineffective treatment in the meantime.

For a proposed dwelling (including dual occupancies) the design wastewater loading must be determined using the 'Neutral or Beneficial Effect on Water Quality Assessment Guideline 2011' (Sydney Catchment Authority, 2011) based on:

- the number of potential bedrooms (which can't change, unlike the number of occupants)
- the nature of the water supply ie whether the dwelling uses town or bore water, or tank water
- the wastewater loading per bedroom based on the nature of the water supply.

Table 2.1 should be used to calculate the daily wastewater load for a dwelling together with any specific requirements of the relevant local council. For other developments (non-dwelling) involving wastewater, refer to the 'Septic Tank and Collection Well Accreditation Guideline', (NSW Health, 2001) or other reference source approved by the Sydney Catchment Authority.

Table 2.1 – Design wastewater loading calculations (for a dwelling)

Design wastewater loading for each potential bedroom	Reticulated / bore water	Tank water
1-2 potential bedrooms	600L/d	400 L/d
3 potential bedrooms	900L/d	600L/d
4 potential bedrooms	1200L/d	800L/d
More than 4 potential bedrooms	1200L/d plus 150L for each additional bedroom	800L/d plus 100L/d for each additional bedroom

Source: NorBE Assessment Guideline (Sydney Catchment Authority, 2011). Note: the Sydney Catchment Authority adopts a conservative approach for wastewater design calculations. Water saving fixtures should be standard in all new dwellings.

Determine the effluent design loading rates or design irrigation rates using the values for the identified soil description (texture and structure) in Tables L1, M1 and N1 of AS/NZS 1547:2012. Use the conservative design loading rates for septic tanks, absorption trenches and beds.

Septic tanks for residential developments must be at least 3,000 litres. Larger tank capacities must be based on design wastewater loads detailed in Table J1 in AS/NZS 1547:2012. If a spa bath is proposed as part of a development, the minimum septic tank size must be increased by 500 litres.

For greywater-only systems, use a value of 65% of the design wastewater load calculated above. Otherwise greywater systems are treated exactly the same as other wastewater systems.

Linear loading rate for beds, trenches, sand and amended soil mounds

The hydraulic linear loading rate is the amount of effluent that the soil around an effluent infiltration system can carry far enough away from the infiltration surface for it to no longer influence the infiltration of additional effluent (Tyler, 2001). It must be used in conjunction with the effluent design loading rates (DLR) from AS/NZS 1547:2012. DLRs assume there is no hydraulically limiting layer beneath the base of the disposal area; the linear loading rate is designed to ensure that the effluent cannot return to the surface as it travels downslope due to the presence of a hydraulically limiting layer.

So that soil absorption components deliver no more than the receiving soil can carry away from the site, maximum linear loading rates should be calculated based on the soil depth, soil morphology and the gradient of the slope. The linear loading rate is a critical design element for on-site wastewater systems whenever the vertical movement of water in the soil is restricted.

Since the hydraulic linear loading rate does not depend on the quality of the effluent applied, the linear loading rate values are the same for all application infiltration rates. The linear loading rates for residential strength effluent are listed in Table 2.2 below.

Minimum separation requirements

To ensure unsaturated flow conditions and to better filter effluent, the treatment system design must include **minimum** separation distances from the bottom of the beds, trench or mound to the limiting layer (eg bedrock or groundwater). This distance varies from 300 to 600 millimetres for all systems.

Table 2.2 Linear loading rates for residential strength wastewater

(Based on 'Sewerage System Standard Practice Manual', Ministry of Health Population Health and Wellness Health Protection, British Colombia, September 2006)

Soil characteristics		Linear loading rates (litres/metre/day)										
		Slope					Slope					
		0-4 %					5-9 %					>10 %
Texture	Structure	Depth of natural, unsaturated soil (cm)										
		20 – 30	31 - 60	> 61	20 – 30	31 - 60	> 61	20 – 30	31 - 60	> 61	20 – 30	31 - 60
Gravels and medium-coarse sands	Massive	40	49	60	49	60	70	60	70	60	70	79
	Massive	34	45	55	40	49	60	49	60	49	60	70
Sandy loam	Massive	30	34	40	36	40	45	49	60	49	60	70
	Weak	34	45	55	40	49	60	49	60	49	60	70
Loam	Massive	19	22	25	24	27	30	27	30	27	31	37
	Weak	24	27	30	27	30	33	30	33	30	34	40
	Moderate - strong	27	30	33	30	34	40	33	40	33	37	43
Clay loam	Massive	19	22	30	22	27	31	24	27	24	28	34
	Weak	19	22	30	22	27	31	24	27	24	28	34
	Moderate - strong	24	28	34	27	30	33	30	33	30	34	40
Clay	Massive	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Weak	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Moderate - strong	19	22	30	22	27	31	24	27	24	28	34

2.3 Selecting a system

After confirming that the site can accommodate an on-site wastewater system a specific system can be chosen. The chosen system should suit the range of site and soil constraints and the owner's needs. Consider the following items when choosing the system:

Regulatory requirements

All domestic wastewater and greywater systems installed in NSW must be accredited by NSW Health. A regulatory authority cannot approve the installation of a non-accredited wastewater system, except where the system is specifically and individually designed for the site and adequate supporting information is provided with the design. Accredited systems are listed on the NSW Health website www.health.nsw.gov.au/publichealth/environment/water/waste_water.asp.

System location

The location of a system on a site can greatly affect its long term performance. For drainage, using gravity instead of pressured delivery by pump or siphon can constrain the land application system performance. Wastewater must reach the tank or treatment system, and effluent must also be evenly distributed throughout the effluent management area.

Owner requirements

Choosing a system that suits the owner's interests can help ensure that they properly manage and maintain it. If a property owner has a system that does not suit their needs or expectations, they are less likely to maintain it. In areas with water restrictions, property owners often want a system that can supply treated effluent to reuse. Where this type of system is suitable for the site, it would be best to install a system that meets the owner's expectations.

Site and use considerations

Electricity

Many treatment systems that need pumps, timers, aerators, ultraviolet treatment or any other automated process are not suitable for sites with no mains power, or solar power only. Many aerated wastewater treatment systems need a continuous electricity supply to power the aerator and intermittent supply to power the pump.

A limited number of systems are suitable for these cases, including septic tanks, waterless composting toilets, and some worm farms that only need intermittent power. The Sydney Catchment Authority may, in exceptional circumstances, accept solar power for systems where power is only needed periodically to empty an effluent sump. A detailed analysis would need to be supplied of the power consumption of the pump in relation to a proposed power source and storage. These will only be considered on a case-by-case basis.

Intermittent loads

Systems for sites that only receive intermittent loads, such as holiday houses, include septic tanks, some worm farms and waterless composting toilets. Some systems, including aerated wastewater treatment systems, struggle to effectively manage variable loads from holiday homes, where the system may not be used at all on weekdays, but large loads are contributed for several days on weekends and in holiday periods. The bacteria needed to treat the wastewater can die off when there is

no or low inflow and can take time to regenerate once higher flows restart, resulting in poor or ineffective treatment in the meantime.

Frosts

Where sites are subject to prolonged or severe frosts, surface irrigation is generally not acceptable, although a summer surface / winter subsurface hybrid system may be acceptable.

Approved disposal methods

Not all system types are approved for the same disposal methods. Generally all aerated wastewater treatment systems with disinfection are approved by NSW Health for surface or subsurface irrigation. However, NSW Health would only approve a secondary treatment system without disinfection for subsoil disposal (more than 300 millimetres depth). These include worm farms. Although not commonly practised, applying secondary treated effluent from an aerated wastewater treatment system to an absorption trench or evapotranspiration bed on a constrained site is a viable alternative where there is not enough area for irrigation.

The system designer must ensure the proposed effluent management method will meet regulatory requirements. Guidance on approved effluent management methods can be found in the NSW Health Advisory Note 4 – April 2008 'Sewage Management Facility Accreditation Criteria Based on the Final Application of Treated Effluent and Risk of Disease Transmission'.

When considering installing surface irrigation effluent disposal, the following factors must be considered on a case-by-case basis:

- whether the site experiences severe and prolonged frosts (a summer surface / winter-subsurface hybrid system may be acceptable)
- proximity of neighbours
- proximity of the proposed irrigation area to the dwelling
- annual average rainfall (should be less than 1,200 millimetres)
- slope of the effluent irrigation area (should be less than seven percent (four degrees))
- whether council requires subsurface irrigation.

If these factors are not addressed, the Sydney Catchment Authority will require subsurface irrigation using either a capillary system, wick-based system, or pressure compensating drip emitters with root barriers.

Where surface irrigation is proposed, the Sydney Catchment Authority does not allow the use of moveable hoses, including semi-fixed systems. Developments need fixed sprinkler points using pop-up sprinklers (except for lawns or gardens close to the dwelling), or quick coupling valves or similar. Sprinklers must be rotated throughout the effluent irrigation area or employ an auto-sequencing valve. Sprays must not generate aerosols and must have a suitable throw and plume height for the site. This will vary depending on proximity to buildings, recreation areas and other sensitive environments. Ongoing maintenance and grass mowing must also be considered.

The sprinkler kits and hoses supplied by most aerated wastewater treatment system manufacturers are **not** suitable or acceptable, as the supplied hoses are generally soft and not suitable for burial, and the number of sprinklers generally supplied is insufficient for the required (fixed) coverage.

Special considerations

The Sydney Catchment Authority will require all effluent management areas to be fenced off from livestock or vehicles. Where the effluent management area is on a house block that livestock cannot access, it must still be protected from vehicles but may not need to be fenced.

The Sydney Catchment Authority will not accept:

- absorption systems where the soil is medium or heavy clay
- absorption systems where there is less than 0.75 metres of soil
- a trench system with a total length of more than 200 metres (lineal)
- trenches more than 20 metres long, except where they are made of two separate inline trenches with a central feeder, or where trenches are pressure dosed from a pump well (in these cases, the applicant should consider absorption beds)
- amended soil mounds on slopes of more than seven percent (four degrees) - the Sydney Catchment Authority may, in exceptional circumstances, consider amended soil mounds for slopes that are more than 7-10.5% (4-6 degrees) if the mound bench is built up with consolidated topsoil and is not cut into the slope
- reed bed systems to treat and dispose of effluent except in exceptional circumstances (reed bed systems will only be considered on a case-by-case basis. Where the design is based on peak loads, the calculated size of the reed beds would be too large for sustainable vegetation growth in the drier parts of the drinking water catchment. The nutrient uptake of the vegetation is less in colder climates, and in high rainfall areas system overflows can be a problem)
- pump-out systems for domestic situations, except where a location will probably be sewerred in the near future. Pump out systems are not sustainable and are often the worst performing on-site systems due to misuse and poor practices. They may be considered in exceptional circumstances, on a case-by-case basis, where effluent disposal on a heavily constrained site, such as a manned pumping station on the steep banks of a river, is not practical. They may also be considered where council does not allow on-site effluent disposal below a certain lot size, or the area is not and will not be serviced by a reticulated sewerage system. Where pump-out systems are approved they must be:
 - large enough for the development (minimum tank size for domestic systems/ residential purposes of 4,500 litres) – collection wells for an effluent pump-out system that relies on total water harvesting must be sized according to Table 2.3
 - appropriately designed and/or anchored eg tank and lid have an appropriate weight to ensure no tank buoyancy problems
 - equipped with an indicator for wastewater level and an alarm for excess wastewater levels
 - equipped with a readily accessible pump-out stand with a Kamlock (or similar) cover
 - equipped with a small spillage well with a valve for the pump-out pipe
 - pumped out regularly by a pump-out contractor.

Applicants should also be aware of council requirements for wastewater disposal.

Table 2.3: Collection well sizes (based on fortnightly pump-outs)

Number of bedrooms	Collection well size (litres)	
	Tank water	Reticulated / bore water
3	10,000	16,000
4	14,000	21,000
5	16,000	24,000
6	18,000	26,000

Existing wastewater treatment systems must be decommissioned according to the NSW Health Advisory Note No 3 (dated 3 May 2006) for 'Destruction, Removal or Reuse of Septic Tanks, Collection Wells, Aerated Wastewater Treatment Systems and Other Sewage Management Facility Vessels'.

2.4 System location

The location of a system on the site can greatly affect its long term performance. The site plan in the wastewater report that must be submitted with the development application must clearly show the location of the proposed effluent management areas. It must show their position in relation to buffer distances to drainage features, any nearby groundwater bores on the site or nearby adjoining properties, and setback distance to property boundaries, buildings and other infrastructure (existing and proposed). The drainage features are not simply the blue lines shown on contour maps, but should be mapped for the site. Open roadside drains should be treated as drainage depressions. In unsewered village areas this may need to be discussed with the Sydney Catchment Authority.

The site plan must also show the location of any existing wastewater system tanks, piping and effluent management areas that will be augmented or decommissioned, or where these systems are located close to a new on-site wastewater system. The site plan must be clear enough for an assessor to accurately locate the proposed effluent management area.

Buffer distances

The Division of Local Government and the Sydney Catchment Authority have buffer setbacks that apply to on-site wastewater systems to protect public health and the environment. The location of a system must comply with the buffer setbacks outlined in Table 2.4 below.

Table 2.4 – Buffer distances (after Table 5.5 ‘Silver Book’ (DLG, in draft))

Feature	Level of effluent treatment	Effluent application method	Buffer distance	Achievable
Buildings, boundaries, paths and walkways, retaining walls,	Primary	Subsoil	2.0 m downslope and where flat, or 4.0 m upslope	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
	Secondary (disinfected)	Subsurface and surface (including drip or trickle) irrigation	6.0 m	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
Premises boundaries, paths and walkways, recreation areas, in ground swimming pools	Primary	Subsoil	3.0 m downslope and where flat, or 6.0 m upslope	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
	Secondary (disinfected)	Subsurface irrigation	2.0 m downslope and where flat, or 4.0 m upslope	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
		Surface irrigation	6.0 m up- or downslope	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
In ground potable water tanks	Primary	Subsoil	15.0 m	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
	Secondary (disinfected)	Subsurface and surface irrigation	15.0 m - should not be located upslope of feature	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
Permanent and intermittent watercourses	Primary	Subsoil	100 m from the high water level; 150 m to a SCA named river*	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
	Secondary (disinfected)	Subsurface and surface irrigation	100 m from the high water level; 150 m to a SCA named river*	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
Bore or well used for domestic [^] consumption	Primary	Subsoil	100 m from the high water level	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
	Secondary (disinfected)	Subsurface and surface irrigation	100 m from the high water level	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
Dam and drainage depression	Primary	Subsoil	40 m from the high water level	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
	Secondary (disinfected)	Subsurface and surface irrigation	40 m from the high water level	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
<p>* SCA named rivers include: Wingecarribee, Nattai, Nepean, Coxs, Wollondilly, Kangaroo, Shoalhaven, Mongarlowe and Tarlo for the full length as defined on the topographical maps, and the Mulwaree River upstream as far as the Braidwood Road Crossing. Reference must be made to the SCA NorBE Assessment Guideline (SCA, 2011).</p> <p>[^] If within 100 metres of a bore or well used for domestic consumption, a draw-down analysis done using an appropriate methodology, such as Cromer, Gardner and Beavers, 2001 ‘An improved viral die-off method to estimate setback distances’ is required.</p>				

Drainage

Using gravity for drainage instead of pressured delivery by pump or siphon can limit the land application system performance. This must be considered when choosing a system. Wastewater must reach the tank or treatment system and then be evenly distributed from the tank. All drainage and plumbing work must be completed according to 'AS/NZS 3500.2:2003 Plumbing and Drainage Part 2 Sanitary Plumbing and Drainage'. The standard should also be used to decide the position of the system to ensure adequate drainage from internal fixtures to the system.

Pipe selection and grade

The grade or fall from the tank must be considered when locating a system. Pipe size should also be decided based on the minimum grade needed for adequate drainage. Table 2.5 can be used to select pipe size based on the minimum grade ratio. Where a sewer carrying untreated wastewater to a treatment system is longer than 60 metres, the minimum grade should be doubled and inspection ports should be installed at least every 30 metres or at an angle or change of grade.

Table 2.5 – Minimum pipe diameter calculations

Nominal pipe size (DN)	Minimum grade %	Minimum grade ratio
65	2.5	1:40
80	1.65	1:60
100	1.65	1:60
125	1.25	1:80
150	1.00	1:100

Source: 'AS/NZS 3500.2:2003 Plumbing and Drainage Part 2 Sanitary Plumbing and Drainage' Table 3.2. NB: pipe grades are expressed as a percentage of vertical to horizontal distances.

Minimum depth of drainage pipes

When considering system location, associated pipe work must be able to be buried according to 'AS/NZS 3500(Set):2003 Plumbing and Drainage Set'. Table 2.6 outlines the minimum pipe depth for trafficable areas. Use Table 2.6 for irrigation mains that may cross under driveways or through trafficable areas.

The effluent distribution pipe from the tank to the effluent disposal area must be buried at the applicable depth and in a manner that provides protection against mechanical damage or deformation.

Table 2.6 – Minimum pipe depth for trafficable areas

Location	Minimum depth of cover, millimetres (mm) for all materials other than cast iron
Where subject to heavy vehicular traffic	500
Where subject to light vehicular traffic	450
Elsewhere	300

Source: 'AS/NZS 3500:2003 Table 3.4 Minimum Cover for Buried Piping'

Construction work

For all installations, excavating and disturbing the ground surface will require erosion and sediment controls. These controls must be according to Landcom's 'Managing Urban Stormwater: Soils and Construction Vol 1 4th ed.' (Landcom, 2004; the 'Blue Book' Vol.1).

Checklist 2.1 Wastewater consultant - system selection and location	
System Selection	
What does the owner expect from the system?	
Is mains electricity available?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Will the owner pay for ongoing servicing and maintenance?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Will the owner be careful about what goes into the system?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
Will the owner actively maintain the management areas?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is the system for a permanently occupied dwelling or a holiday cottage?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
What is the predicted daily wastewater load on the system (Refer Table 2.1)?	L
Is the selected system the right size for the predicted daily wastewater load?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Has a water and nutrient balance been calculated for the site?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is the effluent management method approved for use with a system type suitable for the site and its constraints?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Does the area experience high rainfall (ie more than 1,200 mm a year)?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Does the area experience severe winter frost?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is the proposed effluent management method suitable for winter frosts?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
Is there sufficient grade from the house to tank? (Refer Table 2.5 – Minimum pipe diameter calculations)	<input type="checkbox"/> Yes <input type="checkbox"/> No
Vertical distance _____m	
Horizontal distance _____m	
Is there sufficient grade ¹ from the tank to the effluent management area? (Refer Table 2.5 – Minimum pipe diameter calculations)	<input type="checkbox"/> Yes <input type="checkbox"/> No
Vertical distance _____m	
Horizontal distance _____m	
If not, will a tank riser be needed?	<input type="checkbox"/> Yes <input type="checkbox"/> No
What size riser is needed to give sufficient grade?	mm
Will treated effluent need a pump or siphon to distribute it?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
If so, what size and other pump characteristics are needed?	
Is there enough area available to apply effluent as needed for hydraulic /nutrient assimilation?	<input type="checkbox"/> Yes <input type="checkbox"/> No

Does the proposed effluent management area meet the NSW Division of Local Government and Sydney Catchment Authority's requirements ² for buffer distance setbacks? (Refer Table 2.4)	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Does stormwater and upslope runoff need to be diverted away from the effluent irrigation area ² ?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Will the sewer pipe and the effluent distribution pipe be affected by any paths or driveways that will influence minimum burial depth? (Refer Table 2.6)	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Type, model name and number of chosen system (including pump details if non-standard)		
Based on the above questions does the chosen system meet the above needs and site constraints?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Comments ³ :		

¹ For passive systems only. For systems on a site with no grade, a pump will be required.

² All run-on and stormwater collected from roofs and other hard surface areas must be diverted away from the effluent management area eg via a stabilised berm or drain that allows energy dissipation at the outlet to prevent scouring or erosion.

³ Where a response to the above Checklist needs more information or action, specify the action plan and/or the process to fix the problem, or specify the alternative being offered.

2.4 Case study

An aerated wastewater treatment system was installed on a constrained site and a number of effluent irrigation areas were dedicated for effluent management. When installing the irrigation lines the contractor ran the main distribution pipe under a driveway to reach the effluent irrigation area (Figure 2.2). Several days after commissioning the system, a delivery truck drove onto the driveway, and within days of the truck movements, effluent began surfacing in the driveway area.

Problem

When the contractor returned to investigate the problem, he found the pipe below the driveway was cracked and effluent was leaking from the pipe and not reaching the effluent irrigation area. The pipe was buried so that it was only covered by about 50 millimetres of gravel.

Solution

When running irrigation pipe under traffic areas, the pipework should be protected the same as a sewer or stormwater pipe would be protected according to 'AS/NZS 3500.1:2003 Plumbing and Drainage Part 1: Water Services'. The Standard recommends that pipes under a driveway with heavy traffic should be buried at least 500 millimetres underground and in a manner that provides protection against mechanical damage or deformation, unless the product specification states otherwise (see Table 2.6).



Figure 2.2 Main irrigation line buried at only 50 mm under gravel driveway – 500 mm is the minimum required depth.

Section 3: Septic Tanks

3. Septic Tanks

3.1	Design	28
3.2	Installation	29
3.3	Testing	37
3.4	Inspection	37
3.5	Operation	37
3.6	Common technical issues	41
3.7	Case study	41

A septic tank provides the primary treatment of wastewater from a dwelling. It is often used together with other treatment measures such as in an aerated wastewater treatment system or with a pump well that pumps the clarified primary treated effluent for disposal. Primary treatment in a septic tank involves the following mainly physical (but also some chemical and biological) processes, which are further described below:

- sedimentation (solids)
- flotation (scum)
- clarification
- anaerobic digestion (organic material).

A septic tank must be able to retain the maximum 24 hour design flow to optimise settling and moderate peak flows. A correctly sized septic tank can remove approximately 25 to 35% of the Biochemical Oxygen Demand (BOD₅) load and more than 60% of the suspended solids load from raw wastewater. Solids are stored in the base of the primary tank and liquids are discharged for further treatment and/or disposal. Floating material (scum) typically accumulates on the surface providing an airtight seal creating anaerobic conditions. Figure 3.1 shows a typical cross section of a septic tank.

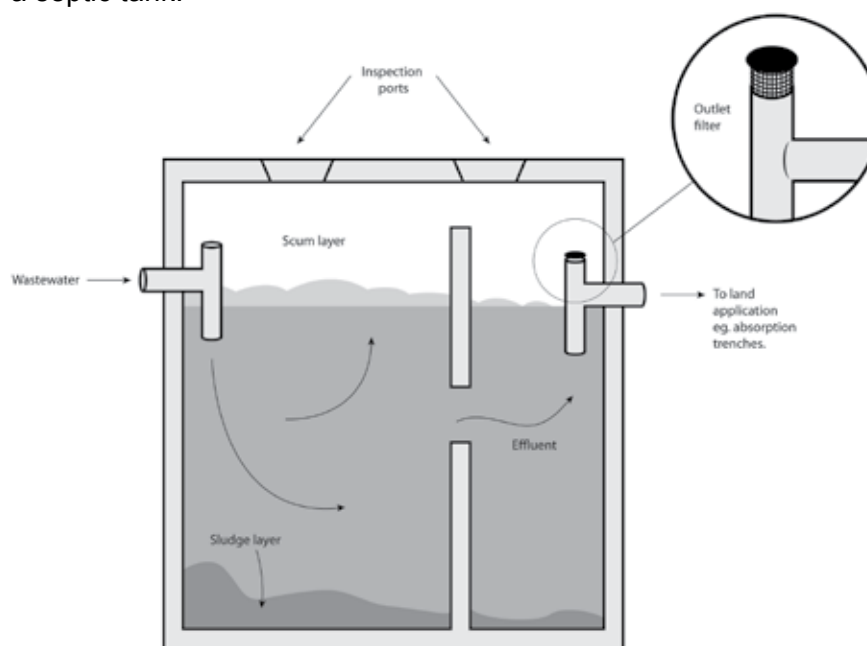


Figure 3.1 Cross section of a typical septic tank

Sedimentation

Sedimentation is achieved by settling in the still tank conditions, and is helped by the flocculation of suspended particles into larger aggregates. Sludge collects at the base of the tank. Whilst a long flow path in the tank from inlet to outlet helps with sedimentation, tanks with shorter flow paths may be baffled. The baffles will help keep the settled solids upstream of the baffle and create a still zone downstream to further help with settling before discharge. It is better for inflow to the tank to be gentle to avoid disturbing already settled solids. This is achieved by avoiding surge flows, having steep gradients from the source to the tank, and by fitting an inlet tee to moderate flow at the entry to the tank.

Flotation

Residues (oils and grease, surfactants, other low density materials) rise to the surface of tank and form a scum layer. Scum is kept in the tank by the inverted outlet pipe or baffle. The scum layer helps create an anaerobic environment for organic solids to breakdown.

Clarification

Settled wastewater is kept in the middle layer of the tank. Tanks are appropriately sized to allow for maximum solids settling. Effluent is drawn from the clarified liquid between the sludge and scum layers for further treatment and/or disposal.

Anaerobic digestion

Anaerobic microbes break down the organic material kept at the base of the tank. Organic material is converted to stable compounds and gases (eg carbon dioxide, methane and hydrogen sulphide). The retained sludge is mainly ligneous (woody) material that is difficult to decompose and will continue to accumulate. It will need to be removed every three to five years.

3.1 Design

Septic tanks must be designed according to 'AS/NZS 1546.1:2008 On-site Domestic Wastewater Treatment Units – Septic Tanks'. In NSW any proprietary septic tank under 10,000 litres must be accredited by NSW Health. Larger tanks may be designed and produced on location but they must comply with AS/NZS 1546.1:2008. NSW Health requires all tanks more than 2,500 litres to be baffled. All septic tanks must include an outlet filter. Accredited tanks are listed on the NSW Health website www.health.nsw.gov.au/publichealth/environment/water/waste_water.asp.

Sizing

A septic tank must be able to deal with the peak daily hydraulic load for at least 24 hours plus an allowance for accumulated sludge. A tank that is too small could allow solids to pass on to the next treatment phase. The Sydney Catchment Authority requires at least a 3,000 litre tank in almost all circumstances. This may be increased according to the number of bedrooms in a proposed dwelling or where the dwelling includes a spa bath. For sizing, refer to AS/NZS 1547:2012.

Site considerations

When choosing the tank location you must consider the various site constraints such as slope, grade and stability. A septic tank must be positioned on a stable, level base. A septic tank on a sloping site may need a stormwater diversion drain to prevent

stormwater inundation. It may also need a pump well to pump effluent from the tank to an upslope effluent management area.

Tank location

The location of a tank should be decided in consultation with the licensed plumber. It will depend on the fall and drainage outlets needed from the dwelling. Some constrained sites may need to locate tanks under driveways and other structures, such as decks and patios. In these cases, the manufacturer can provide a maximum load rating for the tank and a structural engineer must be consulted to ensure the tank has the structural capacity to handle the anticipated vertical load.

Designer accountability

The designer must provide a Design Producer Statement, where the design is warranted by the designer, to ensure a high level of accountability. Appendix 2 includes an example of a Design Producer Statement.

3.2 Installation

Septic tank installation must comply with the manufacturer's recommendations, 'AS/NZS 3500.2:2003 Plumbing and Drainage Part 2 Sanitary Plumbing and Drainage' and Council requirements. Checklist 3.1 helps system installers and council inspectors ensure the septic tank has been correctly installed. The following extra steps provide details not included in the checklist.

Step 1 Transporting tanks

All proprietary tanks should be manufactured and transported to the installation site as one complete unit to preserve their structural integrity. Tank manufacturers can recommend suitable transport methods based on the tank type. Tanks should be kept upright and not laid on their side.

Step 2 Lifting and moving tanks

All tanks should only be lifted or moved using the lifting points shown on the outside of the tank. Tanks should not be lifted by the rim or lid/inspection holes. Do not use a forklift unless the lift arms reach completely underneath the tank to support the base.

Step 3 Excavating and preparing the hole for tanks

The depth of the hole for the tank depends on the fall of the pipe to the tank and the distance from the installed tank to the wastewater source. The tank should be installed so that the lid remains at least 100 millimetres above final ground level to stop stormwater entering the tank. The hole must be clear of roots and foreign matter. The excavation must allow space to fix tank anchors as per the manufacturer's recommendations, if required. The base of the hole must have a clean bed of compacted sand at least 50 millimetres deep. The sand surface must be flat and level.

Step 4 Installing tanks

Tanks should be carefully lowered into the hole and not dropped. Use lifting equipment to adjust the position of the tank. The tank inlet should be in line with the inlet pipes.

Step 5 Connecting pipes and fittings

Connect the tank inlet to the inlet pipe using a 100 millimetre rubber sleeve and secure it according to plumbing practices detailed in AS/NZS 3500:2003 and the

manufacturer's recommendations. Methods to secure pipe work into inlets and outlets vary with the different tanks, which may include concrete, fibreglass or polyethylene.

Step 6 Sealing pipes and lids

Tank lids and inlet and outlet connections should be sealed with an appropriate durable and flexible sealant to avoid stormwater entering the tank.

Step 7 Drainage

If stormwater or groundwater cannot adequately drain away from the tank hole, then the tank could move resulting in failed or broken pipes and connections and/or the tank lifting completely out of the ground. Infiltrated stormwater and/or groundwater should be drained from around the tank using agricultural (Ag) pipe (Figure 3.2) and a free draining backfill. If this is not possible because there is not enough fall for the water to exit the pipes, the tank may need to be anchored (Step 8).



Figure 3.2 Ag pipes around base of septic tank for drainage

On sloping sites and sites with high surface water flows, stormwater diversion devices may be needed to prevent ponding and pooling around the top of the installed tank. A surface drainage berm to divert surface water runoff from pooling around the tank can be built using mounded soil before vegetating (see Figure 3.3).

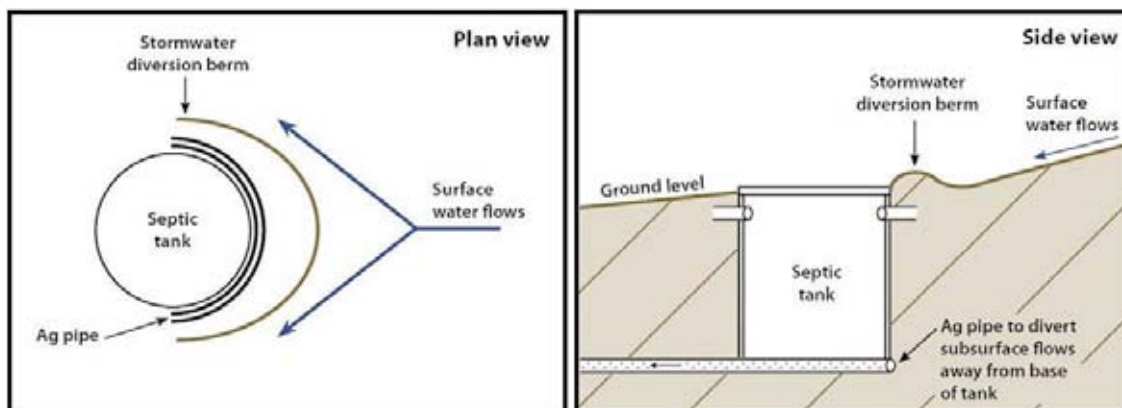


Figure 3.3 Tank stormwater drainage design

Step 8 Attaching ground anchors (if required)

If groundwater levels are high and/or drainage cannot be installed, ground anchors may be needed (Figure 3.4). The size and installation of ground anchors must comply with 'AS/NZS 1546:2008 3.2.2 Anchorage'.

Loops connecting the anchors to the tank must be fitted when the tank is installed. Each side of the tank must be anchored using a piece of filled pipe attached to the tank by durable ties made from stainless steel cable. These ties are fitted to the anchor points on the tank and have a loop in the other end at excavation base level.

Backfilling covers the anchors securing the tank in the ground. To prepare ground anchors you must:

- fill the ground anchors (100 millimetre uPVC sewer pipe) with sand and cap the ends. Attach at least two anchors to a tank, parallel to each other, on opposite sides of the tank. Use more anchors if the soil is prone to saturation. The anchors should be at least as long as the diameter of the tank
- secure the free end loops of cable around the ends of each ground anchor, with two cables to each anchor
- fit a stainless steel shackle in each cable through pre-drilled holes in vertical ribs of each tank and secure
- hang all ground anchors level beside the tank approximately 150 millimetres from the bottom of the excavation, with cables fully secured and all fastenings securely tightened. Sand filled anchors help tighten the cables and ensure maximum effect. Never run cables through the anchor pipes as they will cut when under loads.

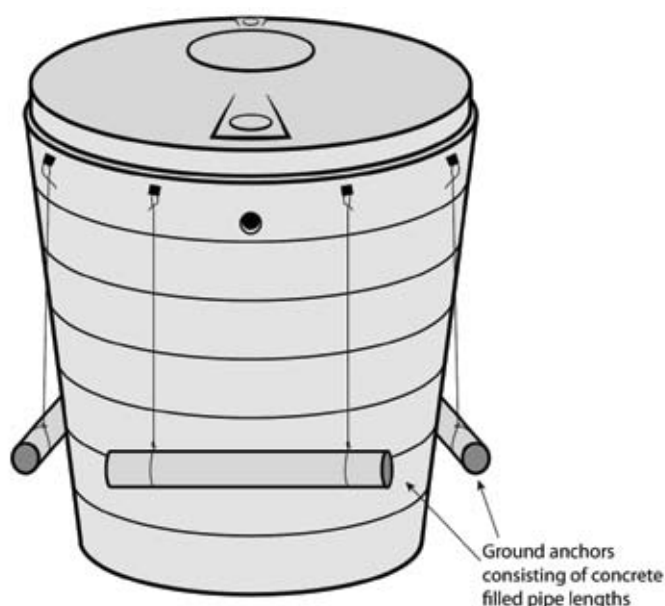


Figure 3.4 Ground anchors

Alternatively, a **hydrostatic flange and anchor collar** may be fitted. An 'L' shaped anchor collar section at least 65 millimetres wide and 6 millimetres thick should be built and fixed to the outside circumference of the tank with durable material protected from corrosion. The collar can be continuous around the circumference or in at least two sections each at least 600 millimetres long and fixed on opposite sides of the tank. For a vertical cylindrical tank, the flange is fixed less than 300 millimetres from the base. For a horizontal cylindrical tank the flange is situated along the line of the greatest horizontal perimeter.

Step 9 Backfill

Do not start backfilling until connections and anchoring are all complete. Some regulatory authorities require an inspection before backfilling.

Step 10 Vegetation

The area around the tanks should be suitably vegetated with non invasive plant species. Some plants can penetrate even a sealed tank and pipe work. Planting suitable species around a tank, particularly on sloping sites, is important to minimise soil erosion from the excavated area around the tanks.

Checklist 3.1 outlines a comprehensive range of items to inspect for new septic tank installations. Councils and installers can use the checklist as part of their installation report. Installation checklists for land application systems are in Sections 8 (Amended soil mounds), 9 (Sand mounds), 10 (Absorption trenches and beds), 11 (Evapotranspiration absorption beds), 12 (Surface irrigation) and 13 (Subsurface irrigation).

System Design

Better communication between the designer and installer is achieved by the designer preparing a System Design that explains critical details of the design to the installer. It describes and quantifies the design and shows the appropriate layout and configuration of the system with appropriate plans and sketches. Appendix 3 includes an example of a System Design.

Finally, the installer must provide an Installation Certificate that certifies that the installation is as described in the relevant sections of the System Design. Appendix 4 includes an example of an Installation Certificate.

Checklist 3.1 Septic tank installation inspection for installers and Council inspectors (Based on 'Consortium of Institutes for Decentralised Wastewater Treatment – Installation Checklists', Iowa State University, Midwest Plan Service, Ames, IA)			
Owners name:			
Address:			
Installation date:			
Type of tank (tick all applicable eg septic tank plus pump well. NB: where the system involves a septic tank and a pump well, the minimum NSW Health requirement is for the pump well to have a capacity of 2,000 L).			
<input type="checkbox"/> Septic tank	<input type="checkbox"/> Pump well	<input type="checkbox"/> Collection / holding well	<input type="checkbox"/> Other
Tank No.	Tank No.	Tank No.	
Manufacturer (Tank 1):		Model #:	
Material			
<input type="checkbox"/> Plastic/poly	<input type="checkbox"/> Concrete	<input type="checkbox"/> Fibreglass	<input type="checkbox"/> Other
			Comment:
Manufacturer (Tank 2):		Model #:	
<input type="checkbox"/> Plastic/poly	<input type="checkbox"/> Concrete	<input type="checkbox"/> Fibreglass	<input type="checkbox"/> Other
			Comment:
Specified or calculated tank capacity of each tank			
(1)	L	(2)	L
Tank dimensions (as provided on manufacturer's design specification sheet)			
	Tank (1)	Tank (2)	
Exterior dimensions (diameter & height)	mm	mm	
Interior dimensions	mm	mm	
Exterior height of inlet invert	mm	mm	
Exterior height of outlet invert	mm	mm	
Effective depth	mm	mm	
Tank seam			
Location	<input type="checkbox"/> N/A	<input type="checkbox"/> Mid	<input type="checkbox"/> Top
			Comment:
Has the tank been appropriately sealed?			
<input type="checkbox"/> Butylmastic	<input type="checkbox"/> Butyl tape wrap	<input type="checkbox"/> Two-part epoxy	<input type="checkbox"/> Two-part epoxy and stainless fasteners
			<input type="checkbox"/> Other
Tank structural integrity verified before setting			
		<input type="checkbox"/> Yes	<input type="checkbox"/> No
		<input type="checkbox"/> N/A	

Excavation / setting tanks			
Location of tanks:			
Verify required inlet / outlet elevations	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Groundwater present in excavation	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Dewatering performed	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Bottom of excavation			
Level	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Free of rock and debris	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Bedding material			
Description:			
Depth	cm		
Free of large rocks, debris	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Compacted	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Structural integrity of tanks verified			
Tank installed level	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Tank oriented correctly	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Free standing above ground			
Flat bed	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Compacted	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Verify required inlet and outlet elevations	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Flotation prevention			
Buoyancy calculations provided on design	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Anti-flotation implemented			
Tank collar	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Anchor weight	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Other / Comment			
Backfill			
Backfill material:			
Compacted	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Free of debris and large rocks	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A

Piping				
Piping in appropriate sequence (inlet/outlet)		<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Inlet	mm	Outlet / supply line	mm	
Pipe specifications (material and nominal diameter)				
Return line	mm	Electrical conduit	mm	
Joints in excavated area		<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Pipe sealing				
Pipes appropriately sealed (including electrical conduit for pump well)		<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Type of sealant	Inlet			
	Outlet / supply line			
	Return line (if installed)			
	Electrical conduit			
Recirculation device		<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Type of device				
Baffles / compartments				
Inlet baffle type				
Outlet baffle type				
Effluent screen model # and manufacturer:				
Types of baffles: <input type="checkbox"/> Poly/Plastic <input type="checkbox"/> Concrete <input type="checkbox"/> Fibreglass				
Installation by: <input type="checkbox"/> Manufacturer <input type="checkbox"/> Contractor				
Verify air passage		<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Tank access & venting				
Access location and size	Inlet		mm	
	Outlet		mm	
	Centre		mm	
Access risers required		<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Sealant used in tank / riser connections		<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Venting		<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Through plumbing stack		<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Tank vent (describe):				

Proprietary filter	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Filter manufacturer and model #:			
Tank water tightness testing	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
<p>Comments, actions or repairs required: (Where a response in the above Checklist needs extra information or action, specify the action plan and/or the process to fix the problem, or specify an alternative that is being offered)</p>			
<p>Service provider:</p>			
<p>Title:</p>			
<p>Contact number:</p>			
Signature:		Date:	

3.3 Testing

Pumps

Where pumps are used in a separate external pump well or an internal pump chamber, they should be clean water tested before commissioning to ensure they achieve the desired head for the proposed operation.

Water tightness

All joints should be sealed with flexible sealant according to the manufacturer's instructions to ensure water tightness. Secure the septic tank lid and inspection openings to provide a watertight seal.

3.4 Inspection

Council should inspect the tank and all associated pipe and drainage work before backfilling to ensure all components are correctly positioned and installed according to 'PCA 2004 Plumbing Code of Australia'. Council should make a final installation inspection to ensure the system complies with all consent conditions before issuing an approval to operate the system. Checklist 3.2 provides a list of items to inspect for operating septic systems that council inspectors and system owners can use to ensure their system continually operates as required.

3.5 Operation

Pumps

Different system designs can use different types of pumps. The most common are surface mounted pumps with an inlet in a separate pump well. These systems pump the clarified primary effluent, with minimal solids, to an effluent management area. Where a collection well is used with a pump-to-sewer system, there will be a grinder or macerator pump in the septic chamber of the tank. These pumps are designed to pump both liquid and solids to a secondary treatment system.

Do not use a macerator or grinder pump to transfer effluent directly from a septic tank to an effluent management area, as the latter will block and fail due to the solid content in the effluent.

Outlet filter

The outlet filter should be inspected every three months and cleaned when necessary. Clean the outlet filter by hosing it off (Figure 3.5), ideally, into a bucket or directly into the septic tank. It is important to only hose off gross solids and not the biofilm that accumulates on filter surfaces. The filter does not need to be completely clean.

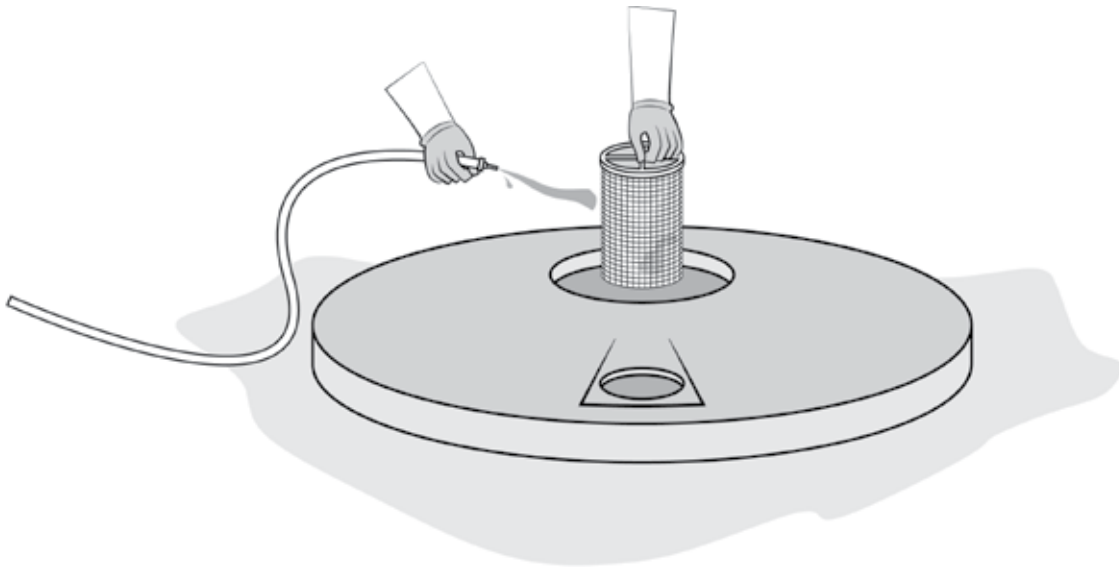


Figure 3.5 Cleaning the outlet filter

Desludging

Sludge levels in septic tanks should be inspected regularly as part of the maintenance schedule and the sludge depth measured with an appropriate device (eg 'Sludge Judge' (Figure 3.6) or 'Sonic Sludge Stick' (Figure 3.7)). AS/NZS 1547:2012 provides guidance about how often to remove sludge (roughly once every three to five years). A licensed contractor should remove the sludge. When sludge is removed from a septic tank, about 10% of the original contents should be kept in the tank to help an appropriate bacterial population regenerate for ongoing treatment.

Once pumped out, the tank should be refilled with water to its normal operating level to protect against undue upward pressure from high groundwater. If the groundwater level near the tank is known to be high, solids should be pumped from the tank at the same time as refilling it with clean water. Once pumped out, replace all inspection openings and seal the tank lid with flexible sealant.



Figure 3.6 'Sludge Judge'



Figure 3.7 'Sonic Sludge Stick'

Checklist 3.2 Operating septic system inspection for Council inspectors			
Slope	%	Tank diameter	mm
No. of bedrooms		Nearest watercourse	m
No. of residents		No. of tanks	
Water source	<input type="checkbox"/> Tank <input type="checkbox"/> Bore/reticulated	Tank volume(s)	L
System age		Nearest house	m
Is there vegetation present?		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is there native vegetation dieback?		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Do you need to remove vegetation around and in the tank to improve access for maintenance?		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is there weed infestation?		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is there localised flood potential?		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is there erosion potential?		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Tank			
Is there any indication of cracks, staining or leaks around the perimeter of the septic tank and/or pump well and/or holding tank?		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Are there any gaps between the tank and the lid?		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is the tank lid suitable for the tank?		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Does the tank have easily accessible inspection caps?		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Are the inspection caps present and unbroken?		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Has the primary septic tank been desludged in the last 5 years?		<input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Unknown
Does the tank need desludging (is the sludge level high or near the bottom of the inlet)?		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is any air vent attached to the septic tank / holding well in a functional state?		<input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> N/A
Is the tank in good condition (no cracks, leaks / damaged lids/ walls)?		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Do tanks need urgent repair / replacement due to major structural failure or undersizing?		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Does the tank have a scum or crust layer?		<input type="checkbox"/> Yes	<input type="checkbox"/> No

Has the outlet filter been cleaned recently?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Pumps			
Does the pump operate when needed? (trigger the float switches to check operation)	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Does the alarm work?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Has the pump been serviced in the last 12 months?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Pipes			
Are the pipes connecting the septic tank, pump well and/or holding well, or septic tank and trench, functioning and installed correctly?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
Are there any unsealed pipes that allow untreated wastewater to escape?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Unknown
<p>Comments, actions or repairs required: (Where a response in the above Checklist needs extra information or action, specify the action plan and/or the process to fix the problem, or specify an alternative that is being offered)</p>			
<p>Service provider:</p> <p>Title:</p> <p>Contact number:</p>			
Signature:		Date:	

3.6 Common technical issues

There are a number of common problems with septic tank installations including:

- tanks rising out of the ground after rainfall - this is most common for un-anchored plastic or fibreglass tanks
- baffles and inlet and outlet junctions removed, not installed (Figure 3.8), broken, or not connected to an effluent disposal system
- pumping from the septic tank rather a separate pump well
- high levels of sludge accumulating from inadequate maintenance (lack of desludging)
- undersized tanks relative to the hydraulic loads
- poor drainage around the tank due to run-on, or because it is installed too low into the ground.



Figure 3.8 Outlet pipe discharging directly onto open ground

3.7 Case study

A septic tank and pump well were installed on a site prone to high groundwater levels. After significant rain the property owner noticed that the pump well was sitting higher out of the ground than when installed. The owner put some fill around the tank and thought it would be alright. A month later a council officer inspected the tanks and noticed the same tank sitting high out of the ground with ponded effluent and soggy ground around it (Figure 3.9).



Figure 3.9 Tank that has *lifted due to high water table*

Problem

The tanks were installed without adequate drainage or ground anchors. During wet weather the pump well, which was almost empty, became buoyant and started to float. With the surrounding groundwater pressure the tank lifted from its original position in the hole. The tank movement caused the inlet and outlet pipes to crack and break resulting in continual discharge of effluent around the tanks. When the tanks were installed the installer did not follow the manufacturer's recommendation to install ground anchors and the tanks were not adequately secured in the ground. The tanks were also backfilled with clay material that did not allow enough drainage around the tank, and installed in a slight depression in the land that directed stormwater to the area around the tanks.

Solution

Dig out around the tank and install the ground anchors as recommended by the tank manufacturer. Repair the connections. Backfill around the tank with free draining soil or sand to ensure sufficient drainage. Install stormwater surface diversion drains around the top of the tanks. Alternatively, remove the tanks from the drainage depression and relocate them to a more suitable location on the property, again using ground anchors and free draining soil for backfilling.

Section 4: Aerated Wastewater Treatment Systems

4. Aerated Wastewater Treatment Systems

4.1	Design	44
4.2	Installation	45
4.3	Testing	54
4.4	Inspection	54
4.5	Operation	54
4.6	Common technical issues	56
4.7	Case study	61

An Aerated Wastewater Treatment System (AWTS) uses aerobic treatment to promote oxidation and microbiological consumption of organic matter by bacteria through facilitated biological processes. Given enough oxygen and time, aerobic microbes (eg bacteria, protozoa) break down organic matter through respiration. Figure 4.1 shows the schematic operation of an AWTS.

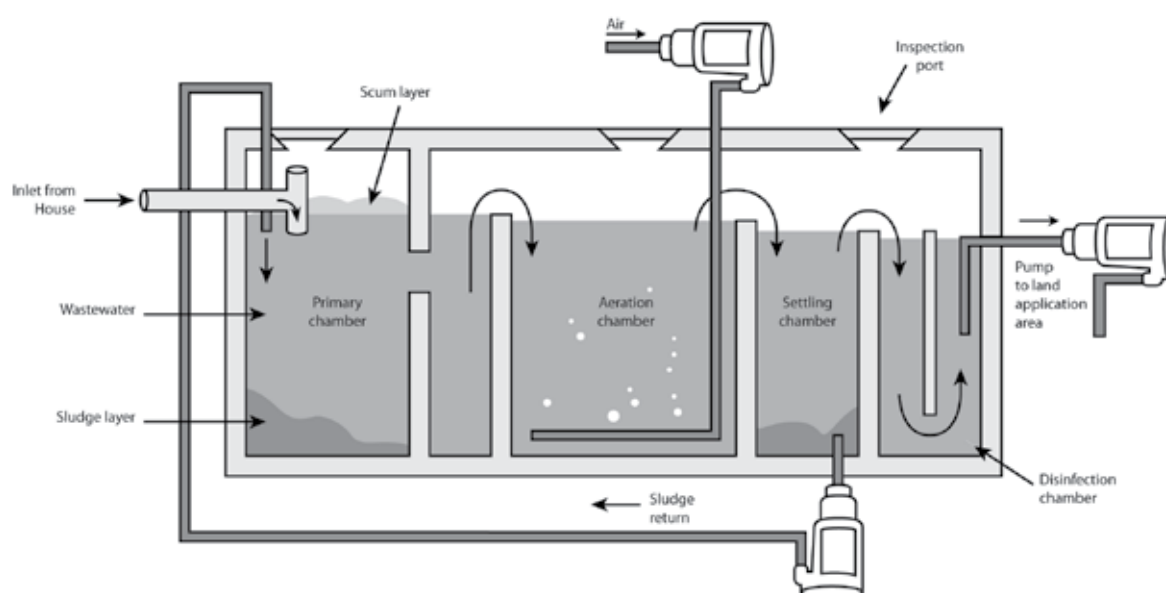


Figure 4.1 Typical schematic of an AWTS

Aeration and nitrogen

Aerobic processes encourage specific bacteria to convert organic nitrogen and ammonia to nitrate (nitrification). Oxygen is supplied to the aeration chamber by a pump (blower) and air diffusers, or mechanical mixing / movement of the effluent, or trickling effluent over porous material (passive). Aerobic chambers are sized to ensure endogenous respiration occurs, limiting the population and avoiding the need for larger aerobic chambers. Over time, dead cell mass and residuals will collect in the chamber and eventually need to be removed.

Aerobic treatment can be affected by variation in hydraulic and organic loads. Intermittent or low loads can affect the system performance. Air supply and sludge return systems need regular monitoring and adjustment to ensure best system

performance. Experience with AWTs shows that these factors constantly change and they cannot be left 'as installed'. Factors that will affect aerobic treatment are:

- volume / rate / timing of oxygen supply
- food / microorganism (F/M) ratio
- temperature
- pH
- sludge return ratios and wasting (sludge age).

Clarification

Clarification allows aerobically treated effluent and solids to settle by providing still conditions. Many clarification chambers use a funnel (Imhoff) design to concentrate settled sludge and minimise re-suspension. The collected sludge is either recirculated to the aeration chamber or wasted (pumped out). Wasted sludge is sent to the primary chamber but eventually some sludge must be removed from the aerobic chamber.

Disinfection

Disinfection removes disease-causing organisms from the wastewater stream. In NSW (and most states) you must have a disinfection system for AWTs if treated effluent will be irrigated on the surface or shallow subsurface. Disinfection usually involves either chlorination using chlorine tablets in an erosion feeder (most common), or ultraviolet (UV) irradiation (gaining acceptance).

Chlorine is harsh on metal components such as mechanical seals and impellers, and can very quickly degrade them. For treatment systems that use chlorine disinfection, the pump should be made from materials that will not be damaged by the corrosive chlorine.

4.1 Design

System selection

All domestic AWTs installed in NSW must be accredited by NSW Health. A regulatory authority cannot approve the installation of a non-accredited system. Accredited AWTs are listed on the NSW Health website www.health.nsw.gov.au/publichealth/environment/water/waste_water.asp.

You must select a system that is suitable for the proposed use. All systems have features that can be beneficial or problematic if installed on certain sites. Things to consider when selecting a system include:

- the daily wastewater load – AWTs can have various capabilities to accommodate different sized daily wastewater loads. The system chosen must consider these daily wastewater loads and not overload the system
- the system location – issues include distance from the house, gravity drainage, and proximity to other structures
- proximity to the effluent management area – this influences the pump size and where to run irrigation mains.

The irrigation hose and sprinklers provided with a new AWT are not acceptable for use in the Sydney drinking water catchment. Adequate supplementary hosing and sprinklers must be installed.

Membrane filter AWTs

Membrane filter AWTs use aeration, recycling and membrane filtration to produce a very high quality filtrate. Water is forced through a membrane with very small pores that separates suspended solids and microorganisms from treated water. Membranes

are cleaned by low flux operation, air scouring by bubbling, intermittent operation or backwashing.

Membrane filtration is a primary disinfection process. Membranes with an average pore size of 0.2 microns remove all faecal coliforms and some viruses. The purified wastewater is transported across the membranes under pressure by the filtrate pump and directed to the irrigation pump well (NSW Health, 2009).

Design flow chart

When choosing an AWTS, carefully consider daily wastewater loads and site and soil constraints to ensure sustainable effluent application with a neutral or beneficial effect on water quality. Figure 4.2 shows the minimum steps to take in AWTS design.

Designer accountability

The designer must provide a Design Producer Statement, including a warranty for the design, to ensure high level accountability. Appendix 2 includes an example of a Design Producer Statement.

4.2 Installation

The manufacturer or their agent usually installs AWTS tanks in compliance with the manufacturer's recommendations, 'AS/NZS 3500.2:2003 Plumbing and Drainage Part 2 Sanitary Plumbing and Drainage' and Council requirements. System installers and Council inspectors can use Checklist 4.1 to ensure the AWTS has been installed correctly. The following extra steps provide details that are not included in the checklist.

Step 1 Transporting tanks

All proprietary tanks should be manufactured and transported to the installation site as one complete unit to preserve their structural integrity. Tank manufacturers can recommend suitable transport methods based on the tank type. Tanks should be kept upright and not laid on their side.

Step 2 Lifting and moving tanks

All tanks should only be lifted or moved using the lifting points shown on the outside of the tank. Tanks should not be lifted by the rim or lid/inspection holes. Do not use a forklift unless the lift arms reach completely underneath the tank to support the base.

Step 3 Excavating and preparing the hole for tanks

The depth of the hole for the tank depends on the fall of the pipe to the tank and the distance from the installed tank to the wastewater source. The tank should be installed so that the lid remains at least 100 millimetres above final ground level to avoid stormwater entering the tank. The hole must be clear of roots and foreign matter. The excavation must allow space to fix tank anchors as per the manufacturer's recommendations, if needed. The base of the hole must have a clean bed of compacted sand at least 50 millimetres deep. The sand surface must be flat and level.

Step 4 Installing tanks

Tanks should be carefully lowered into the hole and not dropped. Use lifting equipment to adjust the position of the tanks. The tank inlet should be in line with the inlet pipes.

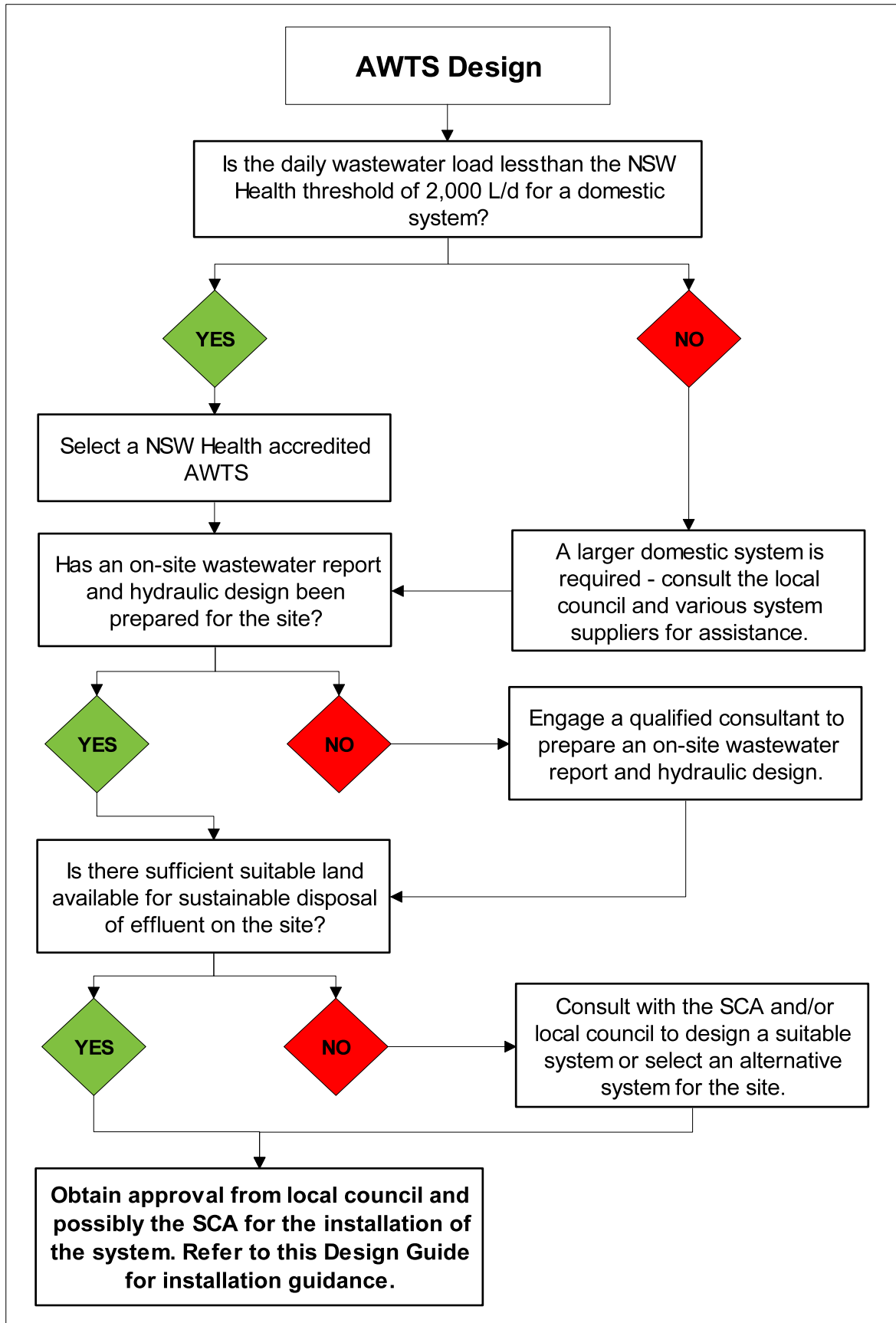


Figure 4.2 AWTS Design

Step 5 Connecting pipes and fittings

Connect the tank inlet to the inlet pipe using a 100 millimetre rubber sleeve and secure it according to plumbing practices detailed in AS/NZS 3500:2003 and the manufacturer's recommendations. Methods to secure pipe work into inlets and outlets vary with the different tanks, which may include concrete, fibreglass or polyethylene.

Step 6 Sealing pipes and lids

Seal tank lids and inlet and outlet connections with an appropriate durable and flexible sealant to stop stormwater entering the tank.

Step 7 Drainage

If stormwater or groundwater cannot adequately drain away from the tank hole, the tank could move resulting in failed or broken pipes and connections, and/or the tank could lift completely out of the ground. Infiltrated stormwater and/or groundwater should be drained from around the tank using agricultural (Ag) pipe (Figure 4.3) and a free draining backfill. This may not be possible if there is not enough fall for the water to leave the pipes. In this case the tank may need to be anchored (Step 8).

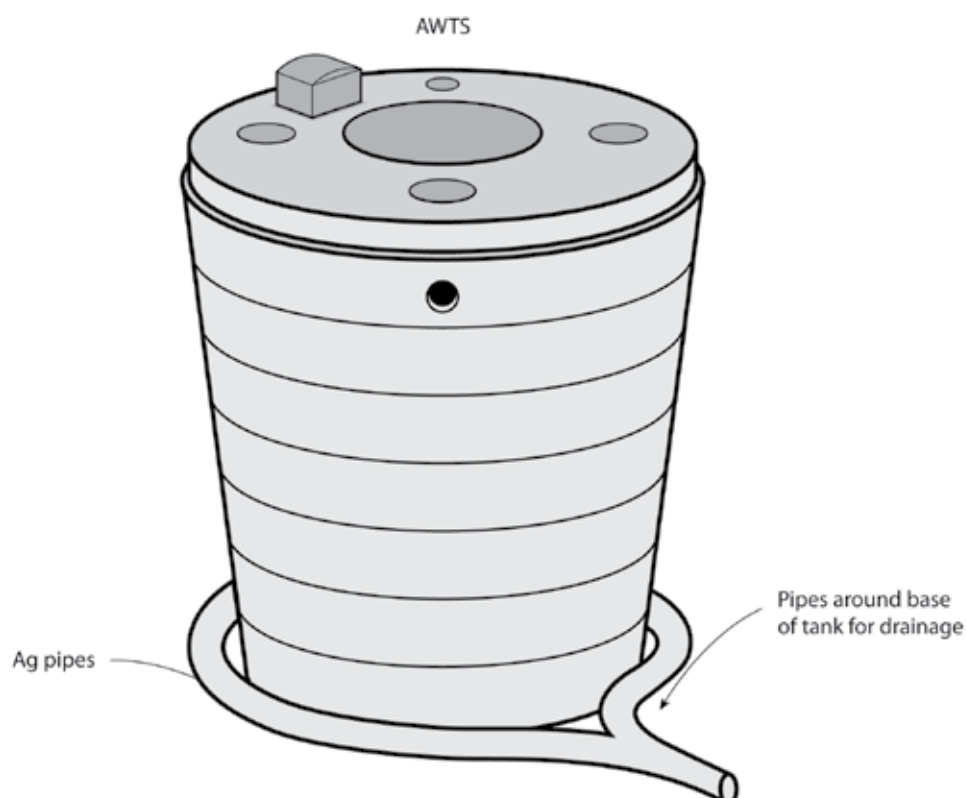


Figure 4.3 Ag pipes around base of tank for drainage

Sloping sites and sites with high surface water flows may need stormwater diversion devices to prevent ponding and pooling around the top of the installed tank. A surface drainage berm to divert surface water run off from pooling around the tank can be built using mounded soil before vegetating (see Figure 4.4).

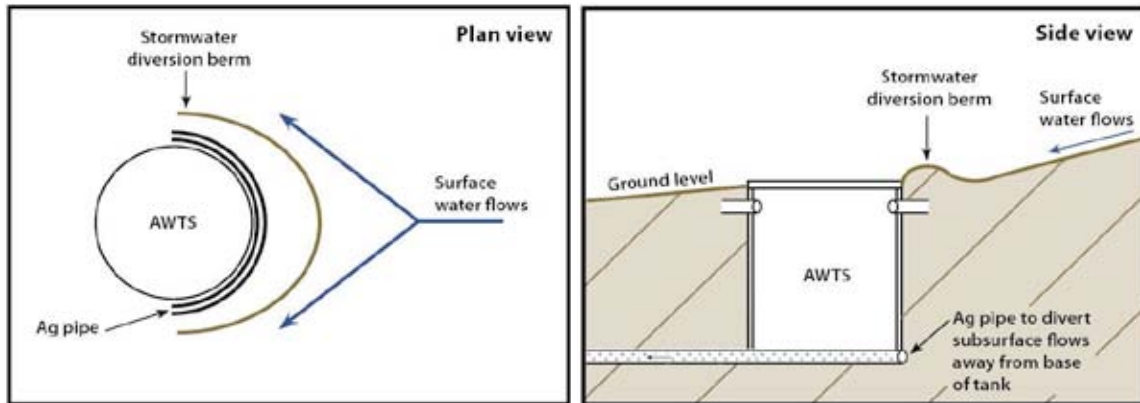


Figure 4.4 Tank stormwater drainage design

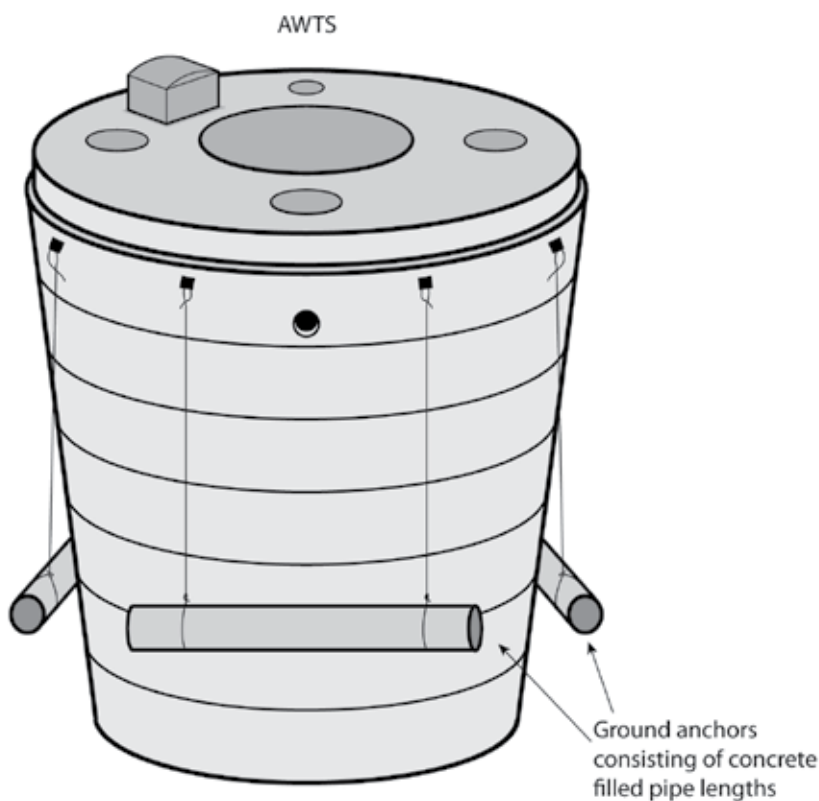


Figure 4.5 Ground anchors

Step 8 Attaching ground anchors (if needed)

If groundwater levels are high and/or drainage cannot be installed, ground anchors may be needed (Figure 3.4). The size and installation of ground anchors must comply with 'AS/NZS 1546:2008 3.2.2 Anchorage'.

Loops connecting the anchors to the tank must be fitted when the tank is installed. Each side of the tank must be anchored using a piece of filled pipe attached to the tank by durable ties made from stainless steel cable. These ties are fitted to the anchor points on the tank and have a loop in the other end at excavation base level. Backfilling covers the anchors securing the tank in the ground. To prepare ground anchors you must:

- fill the ground anchors (100 millimetres uPVC sewer pipe) with sand and cap the ends. Attach at least two anchors to a tank, parallel to each other, on opposite sides of the tank. Use more anchors if the soil is prone to saturation. The anchors should be at least as long as the diameter of the tank
- secure the free end loops of cable around the ends of each ground anchor, with two cables to each anchor
- fit a stainless steel shackle in each cable through pre-drilled holes in vertical ribs of each tank and secure
- hang all ground anchors level beside the tank approximately 150 millimetres from the bottom of the excavation, with cables fully secured and all fastenings securely tightened. Sand filled anchors help tighten the cables and ensure maximum effect. Do not run cables through the anchor pipes as they will cut when under loads.

Alternatively, a **hydrostatic flange and anchor collar** may be fitted. An 'L' shaped anchor collar section at least 65 millimetres wide and 6 millimetres thick should be constructed and fixed to the outside circumference of the tank with durable material protected from corrosion. The collar can be continuous around the circumference or in sections at least 600 millimetres long and fixed on opposite sides of the tank. For a vertical cylindrical tank the flange is fixed less than 300 millimetres from the base. For a horizontal cylindrical tank the flange is situated along the line of the greatest horizontal perimeter.

Step 9 Venting and air supply

AWTSS need an air supply for treatment processes. The volume of air delivered to the aeration chamber directly relates to the amount of organic matter the treatment plant can remove. The air that enters the treatment plant must be able to exit to complete the aeration cycle.

Substantial airflow is needed for proper aeration. The compressor and blower are positive pressure air supplies. The air supply into the treatment unit is protected by removing debris from the air with a filter, which must be installed in the air blower.

Where a blower or compressor is used for the air supply the correct diameter pipe must be used, and the number of fittings that change direction must be minimised to avoid excess friction loss in the air supply pipes. A blower needs a larger diameter pipe because of the volume of air being moved through the piping. The depth of the air discharge point will depend on the system design and can vary from one manufacturer to another. The compressor/air blower must be located on a stable foundation to prevent movement. It should also be located above the relevant council's flood planning level, and not in an area on the tank subjected to flooding.

Step 10 Sludge return lines

Solids that settle in the clarifier are known as sludge. A sludge return line directs the sludge from the clarifier back into the aeration chamber for further treatment. The sludge return pump is located at critical points where sludge settles, usually specified by the manufacturer of a proprietary system. The sludge return lines must be directed to either the aeration chamber or the septic (anoxic zone) as recommended by the system designer. Sludge return outlets should be located at the inlet junction of these zones, not directly into the tank as the discharge into a scum layer of a septic zone can break down the scum layer and cause odours (see Figure 4.1). The sludge return pump must be electrically wired to the system control panel for suitable operation.

Step 11 Control panel

The control panel must be water tight with all connections sealed to stop moisture or sewer gases from entering.

Step 12 Backfill

Do not start backfilling until connections and anchoring are all complete. Some regulatory authorities require an inspection before backfilling.

Step 13 Vegetation

The area around the tanks should be suitably vegetated with non-invasive plant species. Some plants can penetrate even a sealed tank and pipe work. Planting suitable species around a tank, particularly on sloping sites, is important to minimise soil erosion from the excavated area around the tanks.

Checklist 4.1 outlines a comprehensive range of inspection items for new AWTS tank installations. Councils and installers can use the checklist as part of their installation report. Installation checklists for land application systems are included in Sections 10 - Absorption trenches and beds, 11 - Evapotranspiration absorption beds, 12 - Surface irrigation and 13 - Subsurface irrigation.

Step 14 Manufacturer's instructions

Carefully follow manufacturer's instructions for the specific type of AWTS being installed.

The system installer or Council inspector can use Checklist 4.1 when installing and inspecting the installation of an AWTS.

System Design

Better communication between the designer and installer is achieved by the designer preparing a System Design. This report describes and quantifies the design and illustrates the appropriate layout and configuration of the system with appropriate plans and sketches. Appendix 3 includes an example of a System Design.

Finally, the installer provides an Installation Certificate. This certifies that the installation is as described in the relevant sections of the Design Producer Statement. Appendix 4 includes an example of an Installation Certificate.

Checklist 4.1 AWTS tank installation inspection for system installer and Council inspectors		
Owners name:		
Address:		
Installation date:		
Tank description:		
Type of AWTS		
Manufacturer:		Model #:
Material: <input type="checkbox"/> Plastic/poly <input type="checkbox"/> Concrete <input type="checkbox"/> Fibreglass <input type="checkbox"/> Other		
Manufacturer's load bearing rating:		
Multiple tanks <input type="checkbox"/> Yes <input type="checkbox"/> No		
Specified or calculated tank capacity of each tank		
(1)	L	(2) L
Total tank capacity		L
Tank dimensions and capacities (as provided on manufacturer's design specification sheet)		
	Tank (1)	Tank (2)
Exterior dimensions (diameter & height)	mm	mm
Interior dimensions (base to invert of outlet)	mm	mm
Exterior height of inlet invert	mm	mm
Exterior height of outlet invert	mm	mm
Effective depth	mm	mm
Capacities of each compartment		
Anaerobic (Septic)	L	Aeration L
Clarifier (sludge settling)	L	Pump well (chlorine contact) L
Other (describe)		
Excavation / setting tank		
Location of tanks (describe):		
Nature of installation: <input type="checkbox"/> Free Standing <input type="checkbox"/> Buried		
Verify required inlet / outlet elevations <input type="checkbox"/> Yes <input type="checkbox"/> No		
Groundwater present in excavation <input type="checkbox"/> Yes <input type="checkbox"/> No		
Dewatering performed <input type="checkbox"/> Yes <input type="checkbox"/> No		

Bottom of excavation			
Level		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Free of rock and debris		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Bedding material			
Description:			
Depth		cm	
Free of large rocks and debris		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Compacted		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Structural integrity of tank verified			
Tank installed level		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Tank oriented correctly		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Flotation prevention (for buried tanks only)			
Buoyancy calculation provided on design		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Tank collar installed		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Anchor weight installed		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Other (describe):			
Backfill			
Backfill material:			
Free of debris and large rocks		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Compacted		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Piping			
Piping in appropriate sequence (inlet/outlet)		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Inlet	mm	Outlet / supply line	mm
Pipe specifications (nominal diameter and material)			
Return line	mm	Electrical conduit	mm
Joints in excavated area		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Pipe sealing			
Pipes sealed (including electrical conduit)		<input type="checkbox"/> Yes	<input type="checkbox"/> No

Type of sealant	Inlet	
	Outlet / supply line	
	Return line	
	Electrical conduit	
Recirculation device	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Type of device		
Tank lids		
Venting	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Tank vent (describe):		
Tank water tightness testing	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Manufacturer testing	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Pumps operational	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Pump timing	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Alarm to indicate no irrigation / high water	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Service contract in place	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Service provider:		
Contact number:		
Comments, actions or repairs needed: (Where a response in the above Checklist needs extra information or action, specify the action plan and/or the process to fix the problem, or specify an alternative that is being offered)		
Name / title of inspector:		
Signature:	Date:	

4.3 Testing

Electrical components

All electrical components should be tested by an appropriately qualified technician.

Pumps

All pumps should be clean water tested before commissioning and pressure tested to ensure the desired pressure can be achieved for the pumps' specific purpose.

Water tightness

Seal all joints with flexible sealant according to the manufacturer's instructions so they are watertight. Secure the AWTS lid and inspection openings to provide a watertight seal.

Pre-commissioning checks

- Check pressure of air blower
- Check all air diffusers are working and adjust air valves to appropriate settings
- Check sludge and skimmer return lines are working
- Check float switch levels and pump activation levels
- Check alarms work
- Check the operation of the irrigation pump.

4.4 Inspection

A Council inspector should inspect the tank and all associated pipe and drainage work before backfilling, to ensure all components are correctly positioned and installed according to 'PCA 2004 Plumbing Code of Australia'. Council should make a final installation inspection to ensure compliance with all consent conditions, before issuing an approval to operate the system. Council inspectors can use Checklist 4.1 to ensure the system has been installed correctly.

4.5 Operation

The plant should be inspected quarterly by the designated service provider. This detailed maintenance inspection should include:

- checking that pumps, motors and blower assemblies are operating correctly. If the system includes a standby pump, motor or blower, it should be alternated with the operating piece from time to time to ensure that the work hours on both are approximately equal
- checking the sludge return lines and skimmers are working properly and excess scum does not accumulate in the clarification chamber
- a suitably qualified person servicing the pump and control system according to any schedule set by the manufacturer. Pump(s) should be serviced at least once a year
- checking the sludge depth – accumulated solids in the primary tank may need to be pumped out by an approved contractor
- inspecting the control system and ensuring that it is set to deliver appropriate volumes of effluent to specific irrigation fields according to the design hydraulics.

Council inspectors can use Checklist 4.2 to ensure the system is operating correctly.

Desludging

Sludge accumulation in septic tank chambers should be inspected regularly as part of the maintenance schedule and the sludge depth measured with an appropriate device (Figure 4.6). Guidance on the frequency of sludge removal is provided in AS/NZS 1547:2012. Sludge removal should be undertaken by an experienced and licensed contractor.

When sludge is removed from a septic tank chamber approximately 10% of the original contents should be retained in the tank to help regenerate an appropriate bacterial population for ongoing treatment. Once pumped out, the septic tank chamber should be refilled with water to its normal operating level to ensure that the tank is not subject to undue upward pressure from high groundwater. If the groundwater level in the vicinity of the tank is high, the tank should be pumped and simultaneously partially refilled with clean water. Once pumped out, replace all inspection openings and seal the tank lid with flexible sealant.



Figure 4.6 Testing sludge depth using a ‘Sonic Sludge Stick’

General maintenance

The system owner needs to complete a number of general maintenance and operational tasks, including:

- addressing maintenance issues identified by the service provider
- engaging a contractor to desludge the system when its recommended by the service provider or council
- ensuring all products used in the household are safe for an AWTS (bleaches, many household cleaning products, and certain medications are not safe as they can adversely affect the biological activity)
- managing the vegetation around the tank and effluent irrigation areas (including mowing and trimming back bushes for maximum exposure)

- ensuring a continuous power supply is provided to the system – power to the system should not be turned off when the house is unoccupied
- ensuring that the service provider is contacted as soon as practicable if an alarm activates.

Checklist 4.2 outlines items that should be checked at a three monthly maintenance inspection for an operational AWTS. Qualified service providers and council inspectors can use this checklist for compliance inspections of an AWTS. The land application section of the checklist can be used for the various effluent irrigation methods referred to in Sections 12 and 13.

4.6 Common technical issues

A number of common technical problems with AWTS installations have been observed by plumbers, property owners and regulatory authorities. These include:

- the sludge return line was not installed or not installed correctly
- tanks are not secured into the ground, which causes them to pop out or float and break/crack the pipes
- the pump size is too small for the hydraulic gradient of the effluent irrigation system, resulting in overloading and pump burn out
- the effluent management area is too small
- intermittent or low wastewater loads are resulting in a lower level of treatment
- pumps have burned out and the system has failed from disruption to the power supply
- stormwater in the tank because the location is too low and/or there is no runoff diversion (Figures 4.7 and 4.8)
- no valid service agreement with an appropriately qualified service provider for regular inspections
- a subsurface irrigation area flushing or return line was not installed.



Figure 4.7



Figure 4.8

Both figures – Low installation locations, no stormwater diversion berm / drain and inadequate sealing of lid to tank leading to stormwater inflows

Checklist 4.2 Operational AWTS inspection report for use by service providers and Council inspectors			
Owner's name:			
Address:		Council area:	
System brand and model:		<input type="checkbox"/> Domestic	<input type="checkbox"/> Commercial
Date of service:	Date of last service:	Next service due:	
General Comments			
General condition of tank		<input type="checkbox"/> Good	<input type="checkbox"/> Fair <input type="checkbox"/> Poor
Comments:			
Septic tank / chamber			
Crust <input type="checkbox"/> Yes <input type="checkbox"/> No		Odour <input type="checkbox"/> Yes <input type="checkbox"/> No	
		Sludge depth _____ m	
Desludge needed <input type="checkbox"/> Yes <input type="checkbox"/> No		Inlet/outlet junctions clear <input type="checkbox"/> Yes <input type="checkbox"/> No	
Good biological activity <input type="checkbox"/> Yes <input type="checkbox"/> No		Sludge return lines clear <input type="checkbox"/> Yes <input type="checkbox"/> No	
Treatment tank / chamber			
Aeration zone			
Odour <input type="checkbox"/> Yes <input type="checkbox"/> No		pH	Dissolved oxygen _____ mg/L
Activated sludge			
Activated sludge system <input type="checkbox"/> Yes <input type="checkbox"/> No		Diffusers operating <input type="checkbox"/> Yes <input type="checkbox"/> No	
Air blower working <input type="checkbox"/> Yes <input type="checkbox"/> No		Sufficient air supply <input type="checkbox"/> Yes <input type="checkbox"/> No	
Air blower noise <input type="checkbox"/> Yes <input type="checkbox"/> No		Biofilm build up <input type="checkbox"/> High <input type="checkbox"/> Normal	
Air blower pressure OK <input type="checkbox"/> Yes <input type="checkbox"/> No		Aeration timer / diffusers adjusted <input type="checkbox"/> Yes <input type="checkbox"/> No	
Air blower filter cleaned <input type="checkbox"/> Yes <input type="checkbox"/> No		Air blower filter replaced <input type="checkbox"/> Yes <input type="checkbox"/> No	
Colour of Effluent (tick one only)			
<input type="checkbox"/> Dark brown (good)		<input type="checkbox"/> Light brown (insufficient aeration times)	
<input type="checkbox"/> Dark grey (insufficient oxygen delivery)			
Suspended growth system		<input type="checkbox"/> Yes (conduct settleability test) <input type="checkbox"/> No	

Settleability test			
<input type="checkbox"/> Clear (good)	<input type="checkbox"/> Bulky (excess sludge accumulation)	<input type="checkbox"/> Turbid (short residence time and carry over)	
Trickling filter			
Recirculation pump operational	<input type="checkbox"/> Yes <input type="checkbox"/> No	Distribution plate biofilm good	<input type="checkbox"/> Yes <input type="checkbox"/> No
Rotating arm / sprayer operational	<input type="checkbox"/> Yes <input type="checkbox"/> No	Timer working correctly	<input type="checkbox"/> Yes <input type="checkbox"/> No
Clarification zone			
Sludge return operating	<input type="checkbox"/> Yes <input type="checkbox"/> No	Clarity	<input type="checkbox"/> Clear <input type="checkbox"/> Cloudy
Scum return operating	<input type="checkbox"/> Yes <input type="checkbox"/> No	Sludge depth	<input type="checkbox"/> High <input type="checkbox"/> Med
Disinfection			
Chlorine	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Turbidity	NTU		
Chlorinator intact & operating	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
No. tablets consumed:	No. tablets replaced:		
Free chlorine	mg/L		
Ultraviolet (UV)	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Turbidity	NTU		
Lamp cleaned	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Lamp replaced	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Irrigation Chamber			
Irrigation pump operational	<input type="checkbox"/> Yes <input type="checkbox"/> No	Float switches operational	<input type="checkbox"/> Yes <input type="checkbox"/> No
Presence of sludge	<input type="checkbox"/> Yes <input type="checkbox"/> No	Alarm operational	<input type="checkbox"/> Yes <input type="checkbox"/> No
Electrical components			
Alarms tested			
Water	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Air	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
General condition	<input type="checkbox"/> Good	<input type="checkbox"/> Fair	<input type="checkbox"/> Poor
Land Application Area			
Evidence of physical damage	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Comments:

Presence of surface ponding / runoff from the effluent irrigation area		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Excess weed growth in the area		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Effluent running into dam, stormwater drain or watercourse		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Subsurface Irrigation		Trench / Bed / Mound	
Operating pressure <input type="checkbox"/> Good <input type="checkbox"/> Poor		Check surface ponding / toe leaching <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
Lines back flushed <input type="checkbox"/> Yes <input type="checkbox"/> No		Comments:	
Filter checked and cleaned <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A			
<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A		<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
Sprinklers spraying in high risk area <input type="checkbox"/> Yes <input type="checkbox"/> No	Auto sequencing valves working <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Manual valves working <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
Sprinklers moved / manual valves switched to a different effluent irrigation / trench / mound area		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Comments, action or repairs needed: (Where a response in the above Checklist needs extra information or action, specify the action plan and/or the process to fix the problem, or specify an alternative that is being offered)			
Service provider:			
Contact number:			
Name / title of inspector:			
Signature:		Date:	

4.7 Case study

A builder engaged a contractor to supply and install an AWTS for a new dwelling in the Sydney drinking water catchment. The builder also obtained all approvals needed by council and installed the system before handing the new home over to the owner to occupy. Upon inspection council officers saw that the system had not been installed according to the approval. The owner did not have a copy of the approval and did not know the system was not ready to use.

Problem

The tanks were positioned in the correct location on-site but the lids were not sealed to prevent stormwater entering and the lid was level with the ground surface on the upslope side of the tank. A black poly hose was coiled over the top of the tank with two butterfly sprinklers left in the pump box on the top of the tank (Figure 4.9). The approved plans for the system indicated that there would be 400 square metres of surface spray irrigation installed according to buffer distances from the dwelling and a nearby intermittent drainage line.



Figure 4.9 New AWTS with irrigation hose coiled on top, no sprinklers and potential for stormwater inundation

Solution

- Install the AWTS and irrigation system as needed by the council approval (the installer of the wastewater and effluent disposal system must be provided with the relevant conditions of consent)
- install a surface water diversion drain around the top of the tank to divert all upslope surface water runoff away from the tank
- seal around the lid of the tank to ensure stormwater water cannot enter the system
- system installers should liaise with builders and property owners about outstanding work needed for the system to comply with council approvals.

Section 5:

Biological Filter Systems

5. Biological Filter System

5.1	Design	62
5.2	Installation	63
5.3	Inspection	68
5.4	Operation	72
5.5	Common technical issues	72
5.6	Case study	75

A biological filter system (BFS; Figure 5.1) relies on microorganisms, worms and beetles to break up the organic material in wastewater. They convert the organic material into humus and maintain drainage and air porosity.

A BFS generally consists of several layers of organisms on a finely structured humus, coco-peat and geotextile fabric. Aerobic processes occur in the system that produce very little or no odour. The mechanical components generally consist of a single-phase industrial strength pump and a small air pump. Effluent is commonly treated to close to a secondary standard. These systems generally do not include disinfection, so they can only be irrigated via subsoil irrigation (300 millimetres depth) or disposed of to absorption systems (a NSW Health requirement). These systems require some maintenance that varies with the different system types.

This Section can also be used for wet composting systems (dry composting systems are discussed in Section 6 of this Manual).

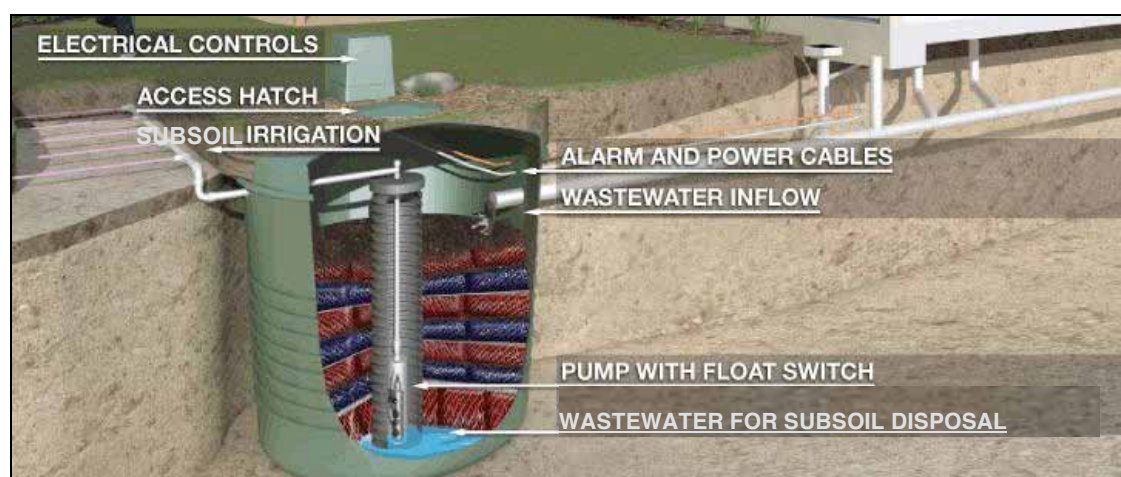


Figure 5.1 A Biological Filter System (after Biolytix, 2009)

5.1 Design

System selection

Any domestic BFS installed in NSW must be accredited by NSW Health (see the NSW Health website www.health.nsw.gov.au/publichealth/environment/water/waste_water.asp). A regulatory authority cannot approve the installation of a non-accredited system.

It is important to choose a system that is suitable for the proposed use as all systems have features that can be either beneficial or detrimental if installed on certain sites. Things to consider when choosing a system include:

- daily wastewater load, which influences the system size
- system location – distance from the house, gravity drainage, distance from other structures
- distance from the effluent management area – influences pump size and where to locate irrigation mains.

Design flow chart

When choosing a BFS carefully consider daily wastewater loads and site and soil constraints to ensure sustainable effluent application with a neutral or beneficial effect on water quality. Figure 5.2 shows the minimum steps involved in BFS design.

Designer accountability

A Design Producer Statement provides more accountability for the design as it is warranted by the designer. An example of a Design Producer Statement is included in Appendix 2.

5.2 Installation

The installation of all tanks must comply with the manufacturer's recommendations, 'AS/NZS 3500.2:2003 Plumbing and Drainage Part 2 Sanitary Plumbing and Drainage' and Council requirements. System installers and Council inspectors can use Checklist 5.1 to ensure the BFS is installed correctly. The following additional steps provide details not included in the checklist.

Step 1 Transporting tanks

All proprietary tanks should be manufactured and transported to the installation site as one complete unit to preserve their structural integrity. Tank manufacturers can recommend suitable transport methods based on the tank type. Tanks should be kept upright and not laid on their side.

Step 2 Lifting and moving tanks

All tanks should only be lifted or moved using the lifting points shown on the outside of the tank. Tanks should not be lifted by the rim or lid/inspection holes. Do not use a forklift unless the lift arms reach completely underneath the tank to support the base.

Step 3 Excavating and preparing the hole for tanks

The depth of the hole for the tank depends on the fall of the pipe to the tank and the distance from the installed tank to the wastewater source. The tank should be installed so that the lid remains at least 100 millimetres above final ground level to prevent stormwater entering the tank. The hole must be clear of roots and foreign matter. The excavation must allow space to fix tank anchors as per the manufacturer's recommendations, if needed. The base of the hole must have a clean bed of compacted sand at least 50 millimetres deep. The sand surface must be flat and level.

Step 4 Installing tanks

Tanks should be carefully lowered into the hole and not dropped. Use lifting equipment to adjust the position of the tanks. The tank inlet should be in line with the inlet pipes.

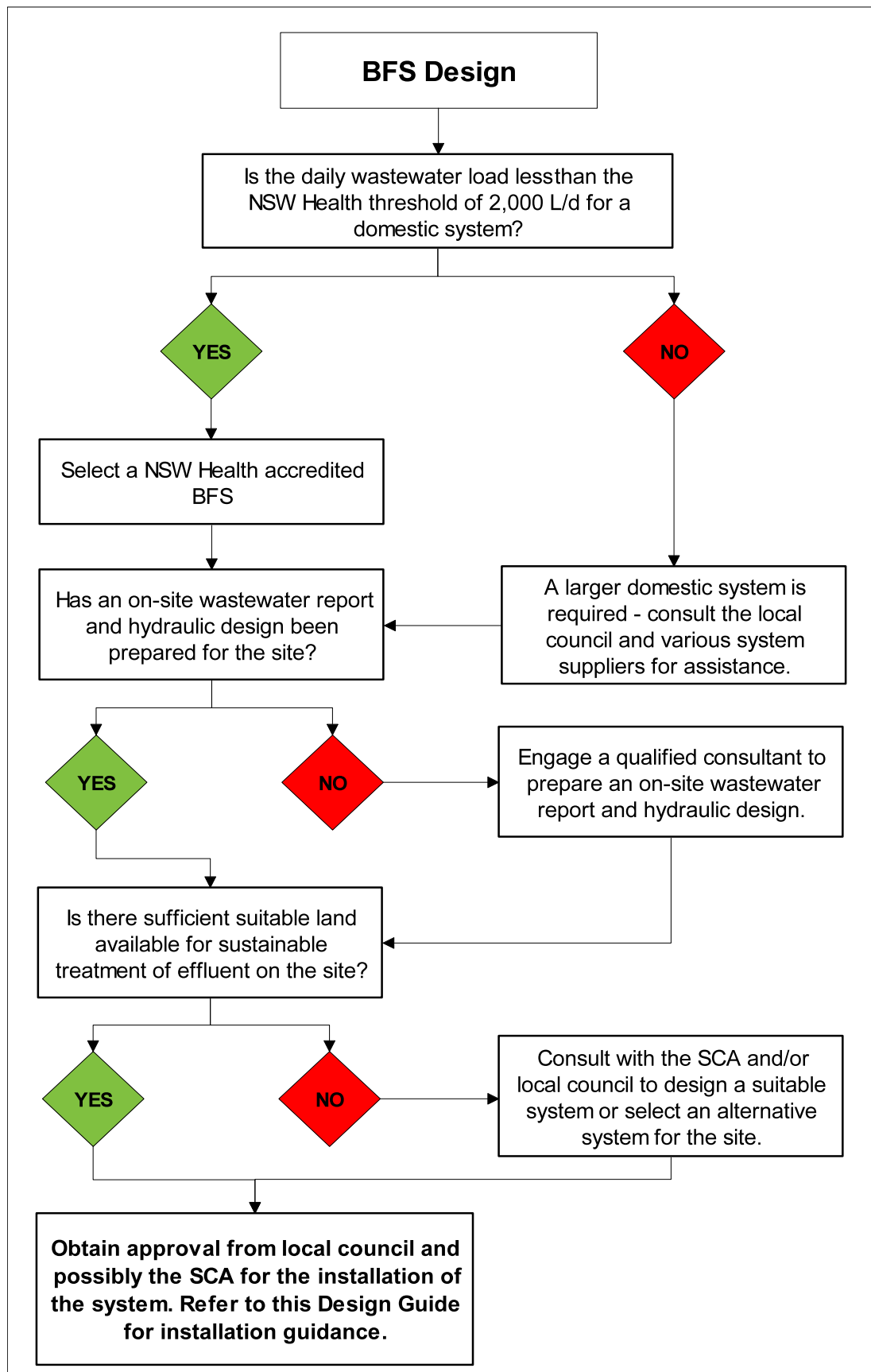


Figure 5.2 Biological filter system design

Step 5 Connecting pipes and fittings

Connect the tank inlet to the inlet pipe using a 100 millimetre rubber sleeve and secure it according to plumbing practices detailed in AS/NZS 3500:2003 and the manufacturer's recommendations. Methods to secure pipe work into inlets and outlets vary with the different tanks, which may include concrete, fibreglass or polyethylene.

Step 6 Sealing pipes and lids

Seal tank lids and inlet and outlet connections with an appropriate durable and flexible sealant.

Step 7 Drainage

If stormwater or groundwater cannot adequately drain away from the tank hole, the tank could move resulting in failed or broken pipes and connections and/or the tank lifting completely out of the ground. Infiltrated stormwater and/or groundwater should be drained from around the tank using agricultural (Ag) pipe (Figure 5.3) and a free draining backfill. If this is not possible because there is not enough fall for the water to exit the pipes, the tank may need to be anchored (Step 8).

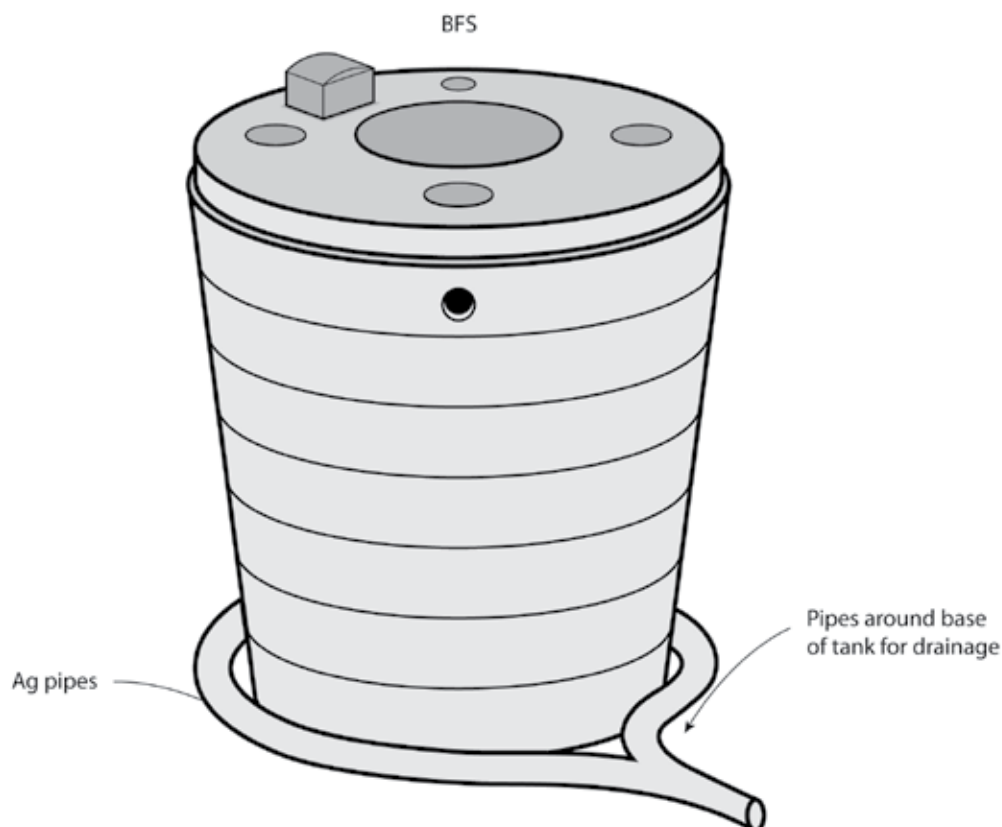


Figure 5.3 Ag pipes around base of tank for drainage

Sloping sites and sites with high surface water flows may need stormwater diversion devices to prevent ponding and pooling around the top of the installed tank. A surface drainage berm to divert surface water run off from pooling around the tank can be constructed using mounded soil before vegetating (see Figure 5.4).

It is also important to ensure that the tank lid is adequately sealed and protrudes at least 100 millimetres from final ground level to prevent stormwater inundation and flooding of the tank.

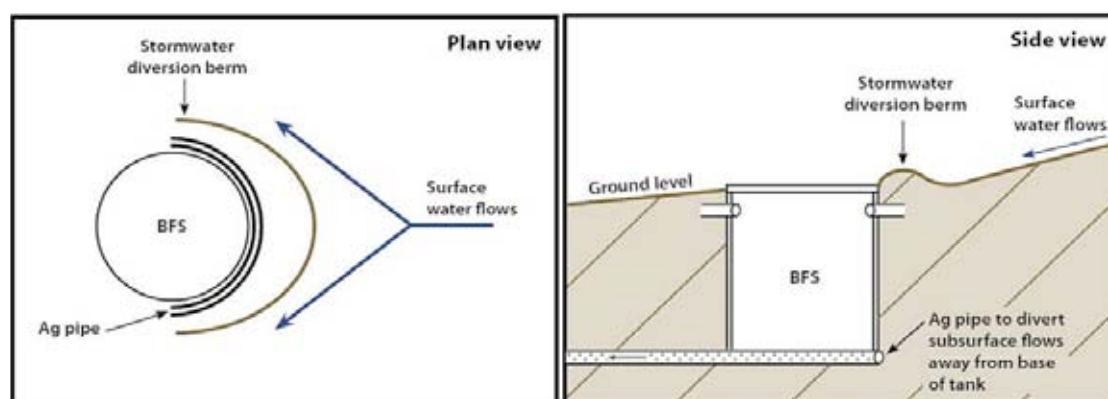


Figure 5.4 Tank stormwater drainage design

Step 8 Attaching ground anchors

Where tanks are made from polyethylene or fibreglass, there is high groundwater on the site, or drainage cannot be installed, ground anchors will need to be attached (Figure 5.5). If they are needed, the size and installation of ground anchors must comply with 'AS/NZS 1546:2008 3.2.2 Anchorage'.

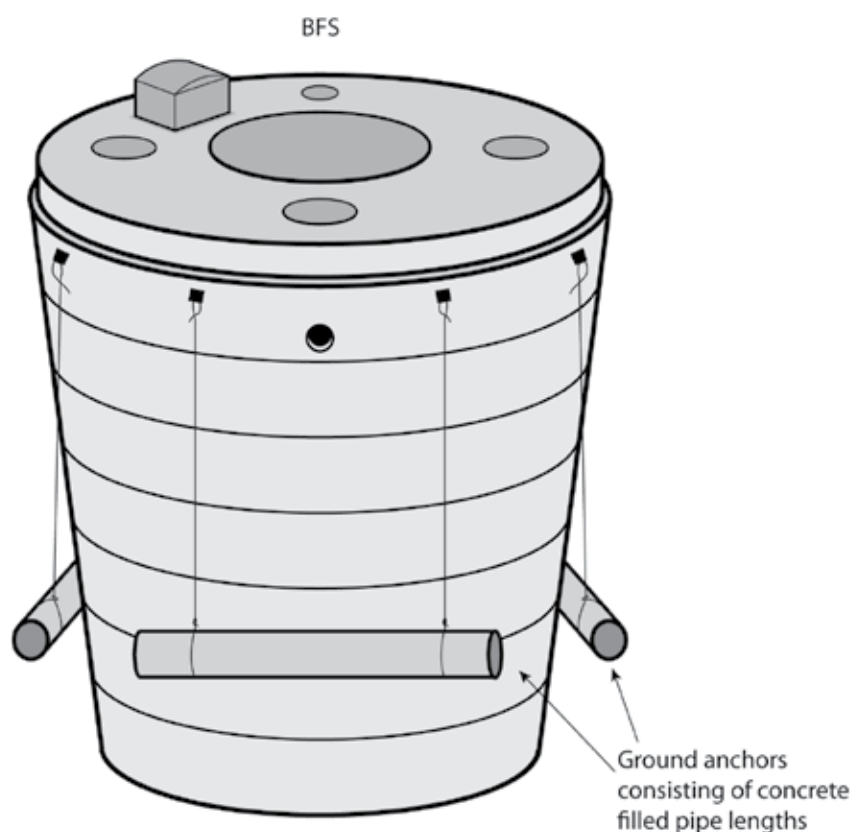


Figure 5.5 Ground anchors

When the tank is installed, loops must be fitted to connect the anchors to the tank. Each side of the tank must be anchored using a piece of filled pipe attached to the tank by durable ties made from stainless steel cable. These ties are fitted to the anchor points on the tank and have a loop in the other end at excavation base level. Backfilling covers the anchors and secures the tank in the ground. To prepare ground anchors you must:

- fill the ground anchors (100 millimetre uPVC sewer pipe), with sand and cap the ends. Attach at least two anchors to a tank, parallel to each other, on opposite sides of the tank. Use more anchors if the soil is prone to saturation. The anchors should be at least as long as the diameter of the tank
- secure the free end loops of cable around the ends of each ground anchor, with two cables to each anchor
- fit a stainless steel shackle in each cable through pre-drilled holes in vertical ribs of each tank and secure
- hang all ground anchors level beside the tank approximately 150 millimetres from the bottom of the excavation, with cables fully secured and all fastenings securely tightened. Sand filled anchors help tighten the cables and ensure maximum effect. Never run cables through the anchor pipes as they will cut when under loads.

Alternatively, a **hydrostatic flange and anchor collar** may be fitted. An 'L' shaped anchor collar section should be constructed. It needs to be at least 65 millimetres wide and 6 millimetres thick and fixed to the outside circumference of the tank with durable material protected from corrosion. The collar may be continuous around the circumference or in at least two sections each at least 600 millimetres long and fixed on opposite sides of the tank. For a vertical cylindrical tank, fix the flange no more than 300 millimetres from the base. For a horizontal cylindrical tank, fix the flange along the line of the greatest horizontal perimeter.

Step 9 Control panel

The control panel should be watertight with all connections sealed to prevent moisture or sewer gases from entering.

Step 10 Backfill

Do not start backfilling until connections and anchoring are all complete. Some regulatory authorities require an inspection before backfilling.

Step 11 Vegetation

The area around the tank should be suitably vegetated with non invasive plant species. Some plants can penetrate even a sealed tank and pipe work. Planting suitable species around a tank, particularly on sloping sites, is important to minimise soil erosion from the excavated area around the tanks.

Step 12 Manufacturer's instructions

It is important to carefully follow manufacturer's instructions for the specific type of BFS being installed. The system installer or Council inspector can use Checklist 5.1 when installing and inspecting the installation of a BFS.

Checklist 5.1 outlines a comprehensive range of items to inspect for new tank installations. Councils and installers can use the checklist as part of their installation report. Installation checklists for land application systems are also included in Sections 10 – Absorption trenches and beds, 11 – Evapotranspiration absorption beds, 12 – Surface irrigation and 13 – Subsurface irrigation.

System Design

Better communication between the designer and installer is achieved by the designer preparing a System Design. This report conveys critical details of the design to the installer. It describes and quantifies the design and illustrates the appropriate layout

and configuration of the system with appropriate plans and sketches. An example of a System Design is included in Appendix 3.

Finally, the installer must provide an Installation Certificate that certifies that the installation is as described in the relevant sections of the Design Producer Statement. An example of an Installation Certificate is included in Appendix 4.

5.3 Inspection

A Council inspector should inspect the tank and all associated pipe and drainage work before backfilling to ensure all components are correctly positioned and installed according to 'PCA 2004 Plumbing Code of Australia'. Council should make a final installation inspection to ensure compliance with all conditions of consent, before issuing an approval to operate the system.

Checklist 5.1 Biological filter system installation inspection for installers and councils			
Owners name:			
Address:			
Installation date:			
Type of BFS			
Tank description:			
Manufacturer:		Model #:	
Material (circle)			
<input type="checkbox"/> Plastic/poly <input type="checkbox"/> Concrete <input type="checkbox"/> Fibreglass <input type="checkbox"/> Other			
Manufacturer's load bearing rating:			
Tank dimensions and capacities (as provided on manufacturer's design specification sheet)			
Exterior dimensions (diameter & height)			mm
Interior dimensions			mm
Exterior height of inlet invert			mm
Exterior height of outlet invert			mm
Effective depth			mm
Total tank capacity			L
Capacities of each compartment			
Main chamber	L	Pump well	L
Excavation / setting tank			
Location of tanks (describe):			
Nature of installation:		<input type="checkbox"/> Free Standing <input type="checkbox"/> Buried	
Verify required inlet / outlet elevations		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Groundwater present in excavation		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Dewatering performed		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Bottom of excavation			
Level		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Free of rock and debris		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Bedding material			
Description:			

Depth	cm		
Free of large rocks and debris	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Compacted	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Structural integrity of tank verified			
Tank installed level	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Tank oriented correctly	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Flotation prevention (for buried tanks only)			
Buoyancy calculation provided on design	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Tank collar installed	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Anchor weight installed	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Other (describe):			
Backfill			
Backfill material:			
Free of debris and large rocks	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Compacted	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Piping			
Piping in appropriate sequence (inlet/outlet)	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Inlet	mm	Outlet / supply line	mm
Pipe specifications (nominal diameter and material)			
Return line	mm	Electrical conduit	mm
Joints in excavated area	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Pipe sealing			
Pipes sealed (including electrical conduit)	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Type of sealant	Inlet		
	Outlet / supply line		
	Return line		
	Electrical conduit		
Recirculation device	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Type of device			
Tank lids			

Venting	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Tank vent (describe):		
Tank water tightness testing	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Manufacturer testing	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Pumps operational	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Pump timing	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Alarm to indicate no irrigation / high water	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Service contract in place	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Service provider:		
Contact number:		
Comments, actions or repairs needed: (Where a response in the above Checklist needs extra information or action, specify the action plan and/or the process to fix the problem, or specify an alternative that is being offered)		
Name / title of inspector:		
Signature:		Date:

5.4 Operation

A designated service provider should inspect the system at the interval specified on the certificate of accreditation by NSW Health. This detailed maintenance inspection should include:

- checking that pumps and motor assemblies are operating correctly. If the system includes a standby pump, motor or blower, it should be alternated with the operating part from time to time to ensure that the work hours on both are approximately equal
- checking that the pump and control system are serviced by a suitably qualified person according to any schedule set by individual manufacturers. The pump(s) should be serviced at least every 12 months
- checking the control system is set to deliver appropriate volumes of effluent to specific irrigation fields / disposal areas according to the design hydraulics
- checking the effluent irrigation / disposal area.

General maintenance

The owner of the system also needs to complete a number of general maintenance and operational tasks, including:

- removing the composted humus after the minimum composting period has passed
- addressing any maintenance issues identified by the service provider
- ensuring all products used in the household are safe for a BFS (this excludes many household cleaning products)
- managing the vegetation around the tank and effluent irrigation / disposal areas (this includes mowing and trimming back bushes for maximum exposure)
- ensuring the system has a continuous power supply. Power to the system must not be turned off when the house is unoccupied
- contacting the service provider as soon as practicable if any alarm triggers.

Checklist 5.2 outlines the items that should be checked at an annual maintenance inspection for an operational BFS. This checklist can be used by the qualified service provider for the system and for also council compliance inspections. The land application section of the checklist can be used for the various disposal methods.

5.5 Common technical issues

A number of common problems with installing BFS have been identified by plumbers, property owners and regulatory authorities, including:

- tanks are not secured into the ground, which causes them to pop out or float and break/crack the pipes
- undersized pumps are used for the hydraulic gradient of the effluent irrigation system, resulting in overloading and pump burn out
- disruptions to power supply cause pump burn out and system failure
- undersized effluent management areas
- a subsoil irrigation area flushing or return line is not installed
- stormwater enters the tank because of a low location and/or runoff has not been diverted.

Checklist 5.2 Operational biological filter system inspection report for use by service providers and Council inspectors			
Owner's name:			
Address:		Council area:	
System brand and model:		<input type="checkbox"/> Domestic <input type="checkbox"/> Commercial	
Date of service:	Date of last service:	Next service due:	
General Comments			
General condition of tank		<input type="checkbox"/> Good <input type="checkbox"/> Fair <input type="checkbox"/> Poor	
Comments:			
Treatment Chamber			
Odour present	<input type="checkbox"/> Yes <input type="checkbox"/> No	Filter humus depth	<input type="checkbox"/> High <input type="checkbox"/> Med <input type="checkbox"/> Low
Inlet/outlet junctions clear	<input type="checkbox"/> Yes <input type="checkbox"/> No	Good biological activity	<input type="checkbox"/> Yes <input type="checkbox"/> No
pH	Dissolved oxygen mg/L		
Colour of Effluent (tick one only)			
<input type="checkbox"/> Dark brown (good)	<input type="checkbox"/> Light brown (insufficient aeration times)	<input type="checkbox"/> Dark grey (insufficient oxygen delivery)	<input type="checkbox"/> Turbid (short residence time and carry over)
Irrigation Chamber			
Irrigation pump operational	<input type="checkbox"/> Yes <input type="checkbox"/> No	Float switches operational	<input type="checkbox"/> Yes <input type="checkbox"/> No
Presence of sludge	<input type="checkbox"/> Yes <input type="checkbox"/> No	Alarm operational	<input type="checkbox"/> Yes <input type="checkbox"/> No
Electrical components			
Alarms tested			
Water	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Air	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Electrical compartment in good working order	<input type="checkbox"/> Yes <input type="checkbox"/> No		
General condition	<input type="checkbox"/> Good <input type="checkbox"/> Fair <input type="checkbox"/> Poor		
Land Application Area			
Evidence of physical damage	<input type="checkbox"/> Yes <input type="checkbox"/> No	Comments:	

Presence of surface ponding / runoff from the effluent irrigation area		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Excess weed growth in the area		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Effluent running into dam, stormwater drain or watercourse		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Subsoil Irrigation ⁽¹⁾		Trench / Bed / Mound	
Operating pressure <input type="checkbox"/> Good <input type="checkbox"/> Poor		Check surface ponding / toe leaching <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
Lines back flushed <input type="checkbox"/> Yes <input type="checkbox"/> No		Comments:	
Filter checked and cleaned <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A			
Sprinklers spraying in high risk area <input type="checkbox"/> Yes <input type="checkbox"/> No	Auto sequencing valves working <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Manual valves working <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
Sprinklers moved / manual valves switched to a different effluent irrigation / trench / mound area		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Comments, action or repairs needed: (Where a response in the above Checklist needs extra information or action, specify the action plan and/or the process to fix the problem, or specify an alternative that is being offered)			
Service provider:			
Contact number:			
Name / title of inspector:			
Signature:		Date:	

⁽¹⁾ Sub-soil irrigation: NSW Health requirement; if disinfected, subsurface disposal at 100-150 mm may apply.

5.6 Case study

A biological filter system (BFS) was installed below the relevant council's flood plain level (FPL) and appeared to be working properly for the first 12 months. The BFS used minimal electricity and allowed all wastewater to be treated on-site. A subsoil irrigation system limited the chance of surface runoff of effluent, including during flooding.

Problem

Following a severe storm/flood the owner noticed that the tank was completely full and the pumps did not appear to be working. He called the service provider who inspected the system and found that all of the electrical components in the system had become waterlogged and failed. The electrical components had been installed below the FPL (just on top of the tank) and had been flooded during the storm. This caused the system to short out and flood, as the irrigation pump no longer worked.



Figure 5.8 An electrical box that was flooded



Figure 5.9 A flooded system due to pump failure



Figure 5.10 A flooded system due to pump failure

Solution

Remove the tank and all electrical control components and place them at a control point that is well above the FPL, on the side of the house. During future floods the water can rise around the tank and not interfere with the electrical work as it will be located at a safe height. This solution required the service provider to engage a licensed electrician to move the electrical components as he did not have an electrical licence.

Section 6: Composting Toilets

6. Composting Toilets

6.1	Design	77
6.2	Installation	79
6.3	Inspection	83
6.4	Operation	83
6.5	Common technical issues	83
6.6	Case study	85

Composting toilets (Figure 6.1) rely on the action of microorganisms in an aerobic environment. Systems are usually dry (waterless); although some wet composting systems with vermiculture (worms) are available (see Section 5 Biological Filter Systems). Dry systems may be continuous flow or batch processing. Compost and any liquid waste generated require appropriate subsurface disposal. Compost needs to be buried at least 150 millimetres below ground. Liquid waste needs to be disposed of to an absorption trench.



Figure 6.1 A composting unit used in conjunction with a composting toilet

6.1 Design

Any domestic composting system installed in NSW must be accredited by NSW Health, and a regulatory authority cannot approve the installation of a non-accredited system. Accredited composting systems are listed on the NSW Health website, www.health.nsw.gov.au/publichealth/environment/water/waste_water.asp.

Climatic conditions

A composting toilet's performance can be significantly affected by the climatic conditions, particularly in cold climates where cold temperatures slow the composting process. In cool temperatures a larger system may be needed to allow for slower decomposition of the compost.

Other wastewater sources

Where composting toilets are used, design considerations must also be made for other wastewater sources in the home. Composting toilets are generally used together with a greywater treatment system to manage greywater. See Section 7 of this Manual for advice on greywater treatment systems.

If more than one toilet is needed in the dwelling and the toilets are not in adjoining rooms, two systems will be required, doubling the cost of the system.

Access

Most composting toilets are designed to sit under the dwelling, so these systems are not suited to slab on ground homes or raised homes where the toilet is in the middle of the dwelling, as regular access to the composting unit is needed to remove the humus.

Tank systems

Wet composting systems are more adaptable to various types of dwellings as the entire wastewater stream is generally collected into one tank that can be located away from the dwelling, unlike the dry compost toilet. These systems treat the whole wastewater load from the dwelling and do not require separate greywater management. These systems use installation techniques similar to the biological filter system (see Section 5).

Specialised plumbing requirements

Composting toilets require specialised plumbing fixtures and non standard toilets. The internal components of the toilet usually come as part of the whole system and normal cistern toilets cannot be used (Figure 6.2). The plumbing requirements of a composting toilet are significantly different to a standard toilet with a cistern. The composting toilet does not have a water supply for flushing and it does not have sewer drainage pipes the same as a standard toilet as all waste falls directly into the composting unit. Nevertheless, most composting toilets require a small absorption trench to deal with excess moisture.

Ventilation

A composting unit requires a ventilation system to manage odours and help the composting process. The ventilation system generally consists of a small electric fan in the vent pipe. A power supply is usually needed for the venting system.

Designer accountability

A Design Producer Statement, whereby the design is warranted by the designer provides more accountability. An example of a Design Producer Statement is included in Appendix 2.

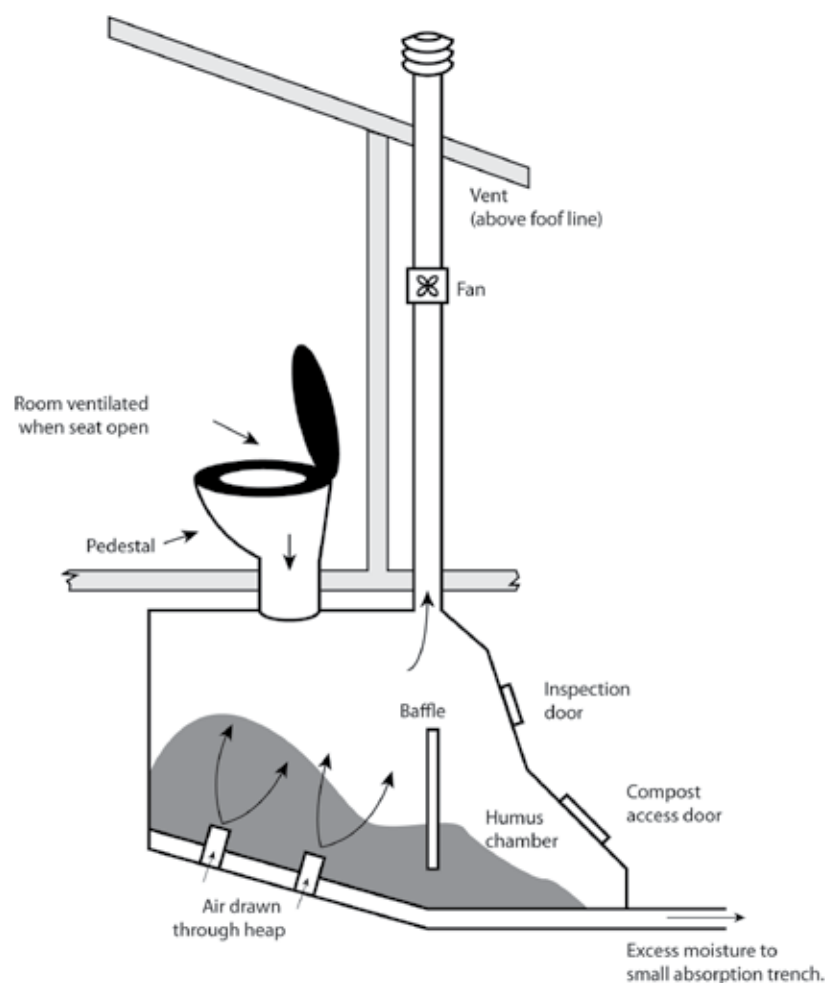


Figure 6.2 A composting toilet (after Department of Local Government, 1998)

6.2 Installation

The installation of all composting toilets must comply with the manufacturer's recommendations, 'AS/NZS 3500.2:2003 Plumbing and Drainage Part 2 Sanitary Plumbing and Drainage' and Council requirements. System installers and Council inspectors can use Checklist 6.1 to ensure the composting toilet has been correctly installed. The following additional steps provide details not included in the checklist.

Step 1 Transporting dry composting tank

All proprietary composting tanks should be manufactured and transported to the installation site so that the structural integrity of the tanks is not compromised. Manufacturers of tanks can recommend suitable transport methods based on the tank type.

Step 2 Lifting and moving composting tank

All tanks should only be lifted or moved using the lifting points shown on the outside of the tank. Tanks should not be lifted by the rim or lid/inspection holes. Do not use a forklift unless the lift arms reach completely underneath the tank to support the base.

Step 3 Installing composting tank

Lifting equipment may be used to adjust the position of the tank.

Step 4 Connection of pipes and fittings

Connect the system according to the plumbing practices detailed in AS/NZS 3500:2003 and the manufacturer's recommendations. Methods used to secure pipe work into outlets vary with the different composting units, which are typically polyethylene.

Step 5 Sealing pipes

Seal composting tank outlet connections with an appropriate durable and flexible sealant.

Step 6 Drainage

During installation, it is important to ensure good drainage of stormwater from around the composting unit. If stormwater or groundwater cannot properly drain away from or around the composting tank, the tank may move causing pipes to break. Stormwater should be diverted around the tank using agricultural (Ag) pipe and a free draining soil to minimise the chance of stormwater pooling around the composting tank and causing movement.

Step 7 Venting

Install the venting system supplied by the manufacturer according to the manufacturer's recommendations and AS/NZS 3500:2003.

Step 8 Internal fixtures

Install the internal fixtures (toilet pan and ancillary equipment) supplied by the manufacturer according to the manufacturer's recommendations and 'AS/NZS 3500(Set):2003 Plumbing and Drainage Set'.

Step 10 Manufacturer's instructions

Carefully follow manufacturer's instructions for the specific type of composting toilet being installed.

The system installer or Council inspector can use Checklist 6.1 when installing and inspecting the installation of a composting toilet. This includes the construction of an excess liquid absorption trench where needed. Installation checklists for land application systems are also included in Sections 10 – Absorption trenches and beds, 11 – Evapotranspiration absorption beds, 12 – Surface irrigation and 13 – Subsurface irrigation.

System Design

Better communication between the designer and installer is achieved by the designer preparing a System Design. This report conveys critical details of the design to the installer. It describes and quantifies the design and illustrates the appropriate layout and configuration of the system with appropriate plans and sketches. Appendix 3 includes an example of a System Design.

An Installation Certificate is provided by the installer. This certifies that the installation is as described in the relevant sections of the Design Producer Statement. Appendix 4 includes an example of an Installation Certificate.

Checklist 6.1 Dry composting toilet installation inspection for installers and councils			
Owners name:			
Address:			
Installation date:			
Tank description:			
Type of composting toilet			
Manufacturer:		Model #:	
Material:	<input type="checkbox"/> Plastic/Poly	<input type="checkbox"/> Concrete	<input type="checkbox"/> Fibreglass <input type="checkbox"/> Other
Composting tank dimensions and capacity			
Exterior dimensions	mm	Effective depth	mm
Total tank capacity	m ³		
Setting composting tank			
Location of composting tanks (describe):			
Nature of installation:	<input type="checkbox"/> Free Standing	<input type="checkbox"/> Buried	
Multiple systems	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Bottom of excavation			
Level	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Free of rock and debris	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Bedding material			
Description:			
Depth	cm		
Free of large rocks and debris	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Compacted	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Backfill			
Backfill material (describe):			
Free of debris and large rocks	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Compacted	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Structural integrity of tank verified			
Tank installed level	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Tank oriented correctly	<input type="checkbox"/> Yes	<input type="checkbox"/> No	

Free standing above ground		
Flat bed	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Compacted	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Verify required outlet elevations	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Venting		
Venting installed as per manufacturer's requirements	<input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> N/A
Pipe sealing		
Excess moisture pipe to absorption trench	Type of sealant (describe or N/A):	
Electrical conduit	Type of sealant (describe or N/A):	
Other	Type of sealant (describe or N/A):	
Service provider:		
Contact number:		
Comments or repairs needed: (Where a response in the above Checklist needs extra information or action, specify the action plan and/or the process to fix the problem, or specify an alternative that is being offered)		
Name / title of inspector:		
Signature:	Date:	

6.3 Inspection

A Council inspector should inspect the composting tank and all associated pipe and drainage work to ensure all components are correctly positioned and installed according to 'PCA 2004 Plumbing Code of Australia'. Council should make a final installation inspection to ensure compliance with all conditions of consent before issuing an approval to operate the system.

Appropriate items to check on installation of a composting toilet are outlined in Checklist 6.2.

6.4 Operation

Daily operation of some composting systems requires adding a supplementary carbon source. This often means adding sawdust to the compost pile. After each use of the system a small scoop of sawdust is poured down the toilet onto the compost pile. The fresh sawdust supply should be refilled at appropriate intervals depending on the use of the system. Composting systems need to be inspected periodically, and composted humus needs to be removed and buried. The compost bins in some batch composting systems need to be rotated by replacing a full bin with an empty one. Extra worms may need to be added. Homeowners need to be aware of, and willing to meet, the maintenance needs for these systems.

6.5 Common technical issues

Plumbers, property owners and regulatory authorities have observed a number of common problems with composting toilet installations, including:

- problems from an inappropriate load type ie composting systems need a sufficient amount of solid faecal matter to operate properly. When installed at locations where the load is mainly urine, for example at roadside stops, composting is less effective because the compost pile is saturated by the mainly liquid (urine) load
- failing to remove humus from the humus chamber at appropriate intervals can mean less airflow around the compost pile or clogging in the compost chamber
- odours from the compost pile due to ineffective composting or not enough ventilation
- absorption trenches that are too small to handle excessive moisture.

Checklist 6.2 Operational inspection of a composting toilet for use by councils		
Is an appropriate instruction notice fixed in place near the toilet to inform users of the nature and operation of the composting toilet?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is there adequate ventilation?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is the exhaust fan operational?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is there an available and appropriate supply of sawdust?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is there adequate access for the purposes of humus removal?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Has the biological activity in the composting chamber produced satisfactory quality humus (ie dry and friable)?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Has provision been made for periodic inspection of the compost chamber?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is there provision for humus removal and burial to a depth of 150 mm and further than 40 m from a drainage depression or waterbody (such as a farm dam), 100 m from a watercourse and 150 m from a named river*?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is humus buried on a flood plain or in an area likely to be flooded?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is there a compost tank available and being used for rotation?	<input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> N/A
Service provider:		
Contact number:		
Comments or repairs needed: (Where a response in the above Checklist needs extra information or action, specify the action plan and/or the process to fix the problem, or specify an alternative that is being offered)		
Name / title of inspector:		
Signature:	Date:	
* SCA named rivers include: Wingecarribee, Nattai, Nepean, Coxs, Wollondilly, Kangaroo, Shoalhaven, Mongarlowe and Tarlo for the full length as defined on the topographical maps, and the Mulwaree River upstream as far as the Braidwood Road Crossing. Reference must be made to the SCA NorBE Assessment Guideline (Sydney Catchment Authority, 2011).		

6.6 Case study

A composting toilet was installed on a small residential block in the Blue Mountains and greywater was managed in a greywater treatment system (see Section 8), as there was very little room for on-site effluent management. The composting unit was fitted underneath the floor of the bathroom, (Figure 6.3) with the composting toilet located directly above. Composted material (humus) needed to be removed every three to six months depending on accumulation rates, and the owner needed to regularly monitor the amount accumulated.



Figure 6.3 The installed composting unit, before installation of bathroom and steps



Figure 6.4 New steps blocking access to the composting unit

Problem

The composting unit was located under the floor of the dwelling and there was very limited space between the unit and the floor level. A set of steps was constructed from floor level to ground level that largely blocked access to the composting unit. (Figure 6.4) The owner could not regularly monitor the amount of composted material and the system became blocked.

Solution

Poor design has meant a major problem with access to the unit. The installer, builder and owner should have consulted before installation to decide where other features could be installed so that access would not be restricted. The toilet and associated composting unit could have been relocated away from the steps to provide easier access to the unit. The only solution in this case was to move the steps to allow that easy access to the unit.

Section 7: Greywater Treatment Systems

7. Greywater Treatment Systems

7.1	Design	88
7.2	Installation	88
7.3	Testing	90
7.4	Operation and maintenance	90
7.5	Common technical issues	90
7.6	Case study	94

Greywater treatment systems (GTS) collect, store and treat greywater to a quality that allows it to be reused for toilet flushing, clothes washing, or subsurface irrigation in gardens. Installing a greywater treatment system does not eliminate the need to deal with blackwater from the toilet and kitchen, which must be treated separately. Often the cost of installing both greywater and blackwater treatment systems can be more than the cost of one treatment system that would deal with both grey and blackwater.

The most common treatment process involves settling of solids, flotation of lighter materials, anaerobic digestion, aeration, clarification and disinfection. Disinfection to reduce pathogenic micro-organisms is the final process. It usually involves chlorinating clarified water.

There are a number of NSW Health accredited GTS available on the market using a range of treatment technologies (Figures 7.1 and 7.2). All GTSs installed in the drinking water catchment need to use fixed surface or subsurface disposal, and comply with all Sydney Catchment Authority requirements for buffer distances from waterbodies and drainage depressions (40 metres), watercourses (100 metres) and named rivers (150 metres - see Sydney Catchment Authority, 2011). All greywater treatment systems in unsewered areas need to be approved by Council before installation under the *Local Government Act 1993*.

This Manual does not cover greywater diversion devices. Diversion devices are specialised plumbing fixtures that divert untreated greywater to subsurface garden irrigation. For advice on greywater diversion devices consult local council and NSW Health guidelines.



Figure 7.1 Example of an Oasis GT600 Greywater Treatment System (Nubian Water Systems, 2009)

- | | | | |
|---------------------|------------------|--------------------|-------------------|
| 1 Solids separation | 2 Tank overflow | 3 Tank body | 4 Tank lid |
| 5 Tank base | 6 Greywater pump | 7 Treatment column | 8 UV disinfection |
| 9 Backwash tank | 10 Backwash pump | 11 Aeration blower | 12 Drain valve |
| 13 PCB controller | | | |

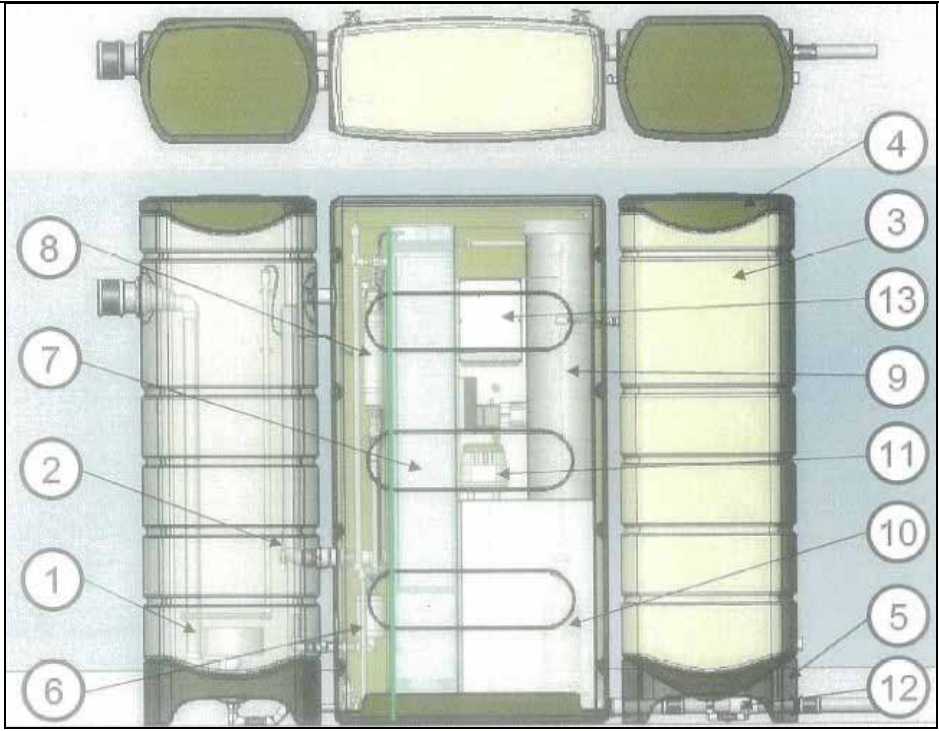


Figure 7.2 Schematic of an Oasis DGTS (NSW Health Certificate of Accreditation, 2008)

7.1 Design

Any domestic GTS installed in NSW must be accredited by NSW Health. A regulatory authority cannot approve the installation of a non-accredited system. Accredited greywater treatment systems are listed on the NSW Health website, www.health.nsw.gov.au/publichealth/environment/water/accreditations/gts.asp.

A GTS must be suitable for the desired reuse methods and daily wastewater loads. Some systems are accredited for internal reuse for toilet flushing and clothes washing, where others are only accredited for garden irrigation purposes.

GTSs use a number of treatment processes:

- bioreactors
- trickling filters
- biofilters
- media filters
- aerated treatment systems
- activated sludge systems
- membrane filters, or
- disinfection by chlorine or ultraviolet (UV).

Daily wastewater loads

When designing a GTS for a domestic dwelling it is important to consider the input and output loads when considering potential reuse options. If treated greywater is only used for toilet flushing then less input will be needed than if it is used for toilet flushing, clothes washing and garden irrigation. Calculate a hydraulic balance for the system design before choosing which system to install. The Sydney Catchment Authority does not allow treated greywater to be used for landscape watering except through fixed surface or subsurface irrigation systems. Only systems with disinfection can be used for surface or subsurface irrigation. GTSs with no disinfection must use subsoil irrigation at a depth of at least 300 millimetres.

Site assessment

Use section 2 of this Manual to decide if the site is suitable for greywater reuse.

Designer accountability

More accountability for the design is provided by a Design Producer Statement, where the design is warranted by the designer. An example of a Design Producer Statement is included in Appendix 2.

7.2 Installation

The NSW Health Certificate of Accreditation for each accredited GTS describes the requirements for installation and commissioning, maintenance and ongoing management. Installers and regulators need to refer to the requirements in the relevant Certificate of Accreditation.

Tanks must be installed in compliance with the manufacturer's recommendations, 'AS/NZS 3500:2003 Plumbing and Drainage Part 2 Sanitary Plumbing and Drainage' and Council requirements. For some GTSs, it is useful to refer to the information in this Manual on installing septic tanks and aerated wastewater treatment systems.

Checklist 7.1 is a generic checklist of items to check when inspecting the installation of a GTS.

Checklist 7.1 Installation inspection of a greywater treatment system for use by service providers and Council inspectors		
The installation of the system and construction requirements are consistent with the council's conditions of consent.	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Installation has been checked by manufacturer or manufacturer's agent.	<input type="checkbox"/> Yes	<input type="checkbox"/> No
The manufacturer or manufacturer's agent has certified that the installation is according to the Certificate of Accreditation.	<input type="checkbox"/> Yes	<input type="checkbox"/> No
All electrical work has been carried out by a licensed electrician according to 'AS/NZS 3000:2007 Electrical Installations (Wiring Rules)'.	<input type="checkbox"/> Yes	<input type="checkbox"/> No
The tank and all associated pipe and drainage work has been inspected by a Council inspector before backfilling, to ensure correct positioning of all components and that all components have been installed according to 'PCA 2004 Plumbing Code of Australia'.	<input type="checkbox"/> Yes	<input type="checkbox"/> No
The irrigation type and location are consistent with SCA's requirements and council's conditions of consent.	<input type="checkbox"/> Yes	<input type="checkbox"/> No
An Owner's manual has been provided and the details of operation explained to the homeowner.	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Service provider:		
Contact number:		
Comments, action or repairs needed: (Where a response in the above Checklist needs extra information or action, specify the action plan and/or the process to fix the problem, or specify an alternative that is being offered)		
Name / title of inspector:		
Signature:	Date:	

System design

The designer must prepare a System Design report to better communicate with the installer. This report provides critical details of the design to the installer, describes and quantifies the design, and illustrates the appropriate layout and configuration of the system with appropriate plans and sketches. Appendix 3 includes an example of a System Design. The installer must provide an Installation Certificate (Appendix 4) that certifies that the installation is as described in the relevant sections of the Design Producer Statement.

7.3 Testing

Electrical components

An appropriately qualified technician should test all electrical components.

Pumps

All pumps should be clean water tested before commissioning and pressure tested to ensure the desired pressure can be achieved for the pumps specific purpose.

Water tightness

Seal all joints with flexible sealant according to manufacturer's instructions to ensure they are water tight. Secure the GTS lid and inspection openings to provide a watertight seal.

Pre-commissioning checks

- Check alarms work.
- Check the operation of the irrigation pump, if applicable.

7.4 Operation and maintenance

A service contract should be in place to ensure the GTS is serviced at the appropriate interval specified in the Certificate of Accreditation. The periodic service should check and report on all electrical, mechanical and other functioning components of the system, the operation of the collection, treatment and reuse chambers and the effective means of disinfection. A service report should be provided to the homeowner and the council. Service providers and Council inspectors can use Checklist 7.2 to inspect an operational GTS.

7.5 Common technical issues

Plumbers, property owners and regulatory authorities have observed a number of common problems with GTS installations including:

- odours in the treatment system and stored treated greywater
- blocked filters
- not enough organic material for effective bacterial treatment processes in aerated and activated sludge systems
- accumulation of settled solids that need to be pumped out or back flushed to the sewer
- colour in recycled water limiting its reuse for laundry washing and staining toilet bowls
- not enough treated effluent supplies to toilets for reuse
- possible cross connections with potable water supply
- backflow prevention.

Checklist 7.2 Operational greywater treatment system inspection report for use by councils					
Owner's name:					
Address:			Council area:		
System brand and model:			<input type="checkbox"/> Domestic <input type="checkbox"/> Commercial		
Date of service:		Date of last service:		Next service due:	
General Comments					
General condition of tank <input type="checkbox"/> Good <input type="checkbox"/> Fair <input type="checkbox"/> Poor					
Comments:					
Primary Chamber					
Crust <input type="checkbox"/> Yes <input type="checkbox"/> No		Odour <input type="checkbox"/> Yes <input type="checkbox"/> No		Sludge depth <input type="checkbox"/> High <input type="checkbox"/> Med <input type="checkbox"/> Low	
Desludge needed <input type="checkbox"/> Yes <input type="checkbox"/> No		Inlet/outlet junctions clear <input type="checkbox"/> Yes <input type="checkbox"/> No			
Good biological activity <input type="checkbox"/> Yes <input type="checkbox"/> No		Sludge return lines clear <input type="checkbox"/> Yes <input type="checkbox"/> No			
Treatment tank / chamber					
Aeration zone					
Odour <input type="checkbox"/> Yes <input type="checkbox"/> No		pH		Dissolved oxygen mg/L	
Activated sludge					
Activated sludge system <input type="checkbox"/> Yes <input type="checkbox"/> No		Diffusers operating <input type="checkbox"/> Yes <input type="checkbox"/> No			
Air blower working <input type="checkbox"/> Yes <input type="checkbox"/> No		Sufficient air supply <input type="checkbox"/> Yes <input type="checkbox"/> No			
Air blower noise <input type="checkbox"/> Yes <input type="checkbox"/> No		Biofilm build up <input type="checkbox"/> High <input type="checkbox"/> Normal			
Air blower pressure OK <input type="checkbox"/> Yes <input type="checkbox"/> No		Aeration timer / diffusers adjusted <input type="checkbox"/> Yes <input type="checkbox"/> No			
Air blower filter cleaned <input type="checkbox"/> Yes <input type="checkbox"/> No		Air blower filter replaced <input type="checkbox"/> Yes <input type="checkbox"/> No			
Colour of Effluent (tick one only)					
<input type="checkbox"/> Dark brown (good)		<input type="checkbox"/> Light brown (insufficient aeration times)		<input type="checkbox"/> Dark grey (insufficient oxygen delivery)	
Suspended growth system <input type="checkbox"/> Yes (conduct settleability test) <input type="checkbox"/> No					

Settleability test		
<input type="checkbox"/> Clear (good)	<input type="checkbox"/> Bulky (excess sludge accumulation)	<input type="checkbox"/> Turbid (short residence time and carry over)
Irrigation Chamber		
Irrigation pump operational	<input type="checkbox"/> Yes <input type="checkbox"/> No	Float switches operational <input type="checkbox"/> Yes <input type="checkbox"/> No
Presence of sludge	<input type="checkbox"/> Yes <input type="checkbox"/> No	Alarm operational <input type="checkbox"/> Yes <input type="checkbox"/> No
Disinfection		
Chlorine	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Turbidity	NTU	
Chlorinator intact & operating	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> N/A
No. tablets consumed:	No. tablets replaced:	
Free chlorine	mg/L	
Ultraviolet (UV)	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Turbidity	NTU	
Lamp cleaned	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> N/A
Lamp replaced	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> N/A
Electrical components		
Alarms tested		
Water	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Air	<input type="checkbox"/> Yes	<input type="checkbox"/> No
General condition	<input type="checkbox"/> Good <input type="checkbox"/> Fair	<input type="checkbox"/> Poor
Land Application Area		
Evidence of physical damage	<input type="checkbox"/> Yes <input type="checkbox"/> No	Comments:
Presence of surface ponding / runoff from the effluent irrigation area	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Excess weed growth in the area	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Effluent running into dam, stormwater drain or watercourse	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Surface Irrigation	Subsurface Irrigation	Trench / Bed / Mound
Sprinkler heads fixed	Operating pressure	Check surface ponding / toe leaching
<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Good <input type="checkbox"/> Poor	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A

Sprinkler heads working <input type="checkbox"/> Yes <input type="checkbox"/> No	Lines back flushed <input type="checkbox"/> Yes <input type="checkbox"/> No	Comments:
Non-working sprinkler heads replaced <input type="checkbox"/> Yes <input type="checkbox"/> No	Filter checked and cleaned <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
Sprinklers spraying in high risk area <input type="checkbox"/> Yes <input type="checkbox"/> No	Auto sequencing valve working <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Manual valves working <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
Sprinklers heads moved / valves switched to a different effluent irrigation area / trench / mound area		<input type="checkbox"/> Yes <input type="checkbox"/> No
Check and clean filter		<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
Service provider:		
Contact number:		
Comments, action or repairs needed: (Where a response in the above Checklist needs extra information or action, specify the action plan and/or the process to fix the problem, or specify an alternative that is being offered)		
Name / title of inspector:		
Signature:		Date:

7.6 Case study

A greywater treatment system (Figure 7.3) was installed at a residence as part of an extensive sustainable water management project. The greywater storage tank created unpleasant odours and the treated greywater, once filtered through the worm bed filter and UV disinfected, was stored in a 1,000 litre tank for toilet flushing and laundry reuse. The treated greywater stained the toilet bowl brown and left an off-white colour in white clothing in the washing machine.

Problem

Storing greywater for any length of time can create unpleasant odours if it turns septic. Greywater should not be stored for more than 24 hours. However this does not guarantee that odours will not be created in a shorter time. The organic material in the worm bed filter adds tannin to the greywater as it filters through the beds. This colour can stain the toilet bowl and clothing in the washing machine. The lack of a coarse screen filter allowed gross contaminants such as hair and lint into the storage tank for greywater destined for treatment and reuse.



Figure 7.3 Organic media from the GTS

Solution

To avoid problems with odours, the greywater tank must be the right size and flows to the pre-treatment storage tanks must be regulated so that they are not collected and stored for enough time for odours to develop. Either some excess greywater should be diverted to a blackwater treatment system or sewer, or a treatment system that can better manage higher inflows should be chosen. The 1,000 litre pre-treatment storage tank is probably too large as it stores untreated greywater for too long.

To avoid staining from reuse of the treated greywater, consider an alternative non-staining filtration media, such as quartz sand. Greywater treated in a sand filter will usually be free of discolouration. The tannin in the greywater can make UV disinfection less effective, which has other health implications for human contact with the treated greywater. The greywater needs a higher level of treatment without discolouration to ensure the UV disinfection is effective.

The coarse screen filter should be replaced to effectively remove gross solids. The passage of gross solids to the greywater storage tank may have contributed to the poor water quality and odours. A sink strainer would offer a first line of defence to help remove solids.

Section 8: Amended Soil Mounds

8. Amended Soil Mounds

8.1	Design	95
8.2	Installation	96
8.3	Inspection	101
8.4	Operation	101
8.5	Common technical issues	105
8.6	Case study	105

An amended soil mound (Figure 8.1) is designed to treat and dispose of primary or secondary effluent and further remove phosphorus, nitrogen and micro-organisms from the effluent. The soil used in this type of mound often contains an industrial by-product, which is high in iron and aluminium sesquioxides that have a high phosphorus adsorption capacity. Amended soil mounds are suitable for sites where there is limited area available for on-site effluent or where there is a high groundwater table or a sensitive surrounding environment. Septic tanks are the most common treatment system type used with amended soil mounds, but they may also be combined with an aerated wastewater treatment system, biological filter system or composting toilet.



Figure 8.1 An amended soil mound in the Blue Mountains

8.1 Design

Early amended soil mounds constructed in NSW had a mounded profile using many proven successful hydraulic concepts, with highly phosphorus sorptive material used in the mound to remove phosphorus from the effluent. The soil used in amended soil mounds has been modified to achieve a very high level of nutrient reduction. These

mounds, constructed with an appropriately sized peripheral seepage trench have generally performed well in NSW.

More recently amended soil mounds have been constructed with a much flatter profile and a relatively thin sand bed beneath the amended soil bed. Figure 8.2 shows a cross section of such an amended soil mound. A number of the technical issues identified in Section 8.5 have been associated with the flatter profile mounds. Ensuring that upslope water is diverted and building the mound 'proud' of the natural ground surface addresses most of these issues.

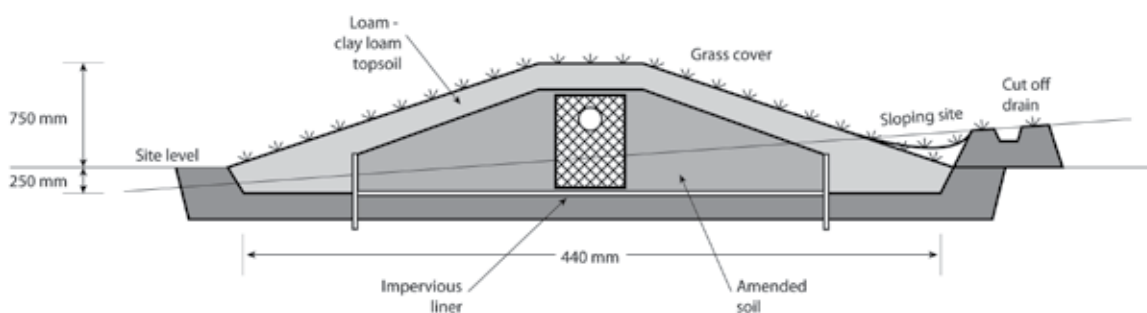


Figure 8.2 Cross section of an amended soil mound

Shallower or flatter mounds have less exposure to wind and consequently evapotranspiration is reduced. More hydraulic load must then be managed by seepage through the underlying sand bed that may on occasions become saturated due to insufficient intergranular pore storage. Hydraulic overloading is likely to cause toe seepage. Careful attention must be given to the linear loading rate. Longer and narrower amended soil mounds are more effective and less likely to suffer toe seepage.

The mound and basal seepage bed, or the peripheral absorption trenches, should be sized based on an appropriate hydraulic balance with careful consideration of the site and soil conditions and the available storage in the underlying sand bed or absorption trench. This is important to provide enough storage for wet periods when less effluent is taken up by evapotranspiration. When calculating the hydraulic loading rate for the hydraulic balance for a mound that is cut into sloping ground, consider the lower hydraulic conductivity of the deeper soil layers on the upslope side of the mound.

Cutting into the slope can also result in a very thin separation distance between the base of the bed and the limiting layer, especially where soil is already shallow. The system can fail due to poor understanding of the hydraulic effect of placing it on shallow soils. For this reason, the Sydney Catchment Authority generally only accepts amended soil mounds on sites where the slope is less than seven percent (four degrees). The Sydney Catchment Authority may, on a case-by-case basis, consider amended soil mounds for slopes that are 7 to 10.5% (4-6°) if the mound bench is built up with consolidated topsoil and not cut into the slope.

Designer accountability

More accountability for the design is provided by a Design Producer Statement, where the design is warranted by the designer. Appendix 2 includes an example of a Design Producer Statement.

8.2 Installation

A mound must be installed properly, as poor installation techniques often result in system failure. Experienced practitioners should design and construct the amended

soil mound. Following the steps below when installing a mound. System installers and Council inspectors can use Checklist 8.1 to check the amended soil system is correctly installed.

Step 1 Site selection

A suitable site must be chosen for an amended soil system. It should be adequate for construction of the mound without undue cutting into the existing slope. The site should allow any upslope drainage to be appropriately diverted around the amended soil mound to stop the treatment cell from becoming saturated with run-on stormwater. Diversion drains, as shown in Standard Drawing No. 8A, should be constructed to divert run-on water from upslope.

The treatment cell and underlying sand bed should not be cut into the slope to the extent that it intersects groundwater. This could allow groundwater to seep into the underlying sand bed and cause hydraulic overload, or penetrate the treatment cell liner and add to the hydraulic load being treated within.

By cutting the treatment cell and underlying sand bed into a slope, the upslope portion of the underlying sand bed will probably be on soil with a significantly lower hydraulic conductivity than that under the downslope side of the bed. This can cause uneven hydraulic loading of the soil beneath the underlying sand bed and can cause toe seepage from the overloaded downslope side of the mound.

Step 2 Site layout

Set out the base dimension of the mound on the ground and start to excavate the area (Figure 8.3). The liner of the treatment cell must be level and on homogenous soil to ensure that effluent passes evenly out through the treatment cell from the central leach drain. If the sand bed later experiences uneven settlement, the form of the liner could become uneven and cause effluent to pass preferentially through only part of the treatment cell. This has implications for detention time, phosphorus removal and overall treatment. It could concentrate the hydraulic load at one part of the mound and make hydraulic failure more likely. Amended soil mound systems should not be built on unconsolidated fill.



Figure 8.3 Excavation/preparation of base of mound (Figures 8.3-8.7 Ecomax, 2001)

Step 3 Construction

- Erect the cell boundary framework.
- Line the base of the mound with construction membrane to protect from root incursion or rocks, as shown in Figure 8.4.
- Line the base of the mound with an impervious liner, as shown in Figure 8.5, to contain the amended soil mixture.
- Position the effluent tunnel in the centre of the cell area and wrap in fabric to prevent ingress of soil.



Figure 8.4 Construction membrane



Figure 8.5 Lining with an impervious liner

Step 4 Backfilling

Spread amended soil over the liner and install a distribution tunnel, as shown in Figures 8.6 and 8.7. In more clay rich soils, ensure that there is enough granulated phosphorus sorbing material to increase the hydraulic conductivity of the soil in the treatment cell. This will help transmission and reduce the chance of waterlogging of the treatment cell and surcharging to the surface. Boundary areas are filled with crushed rock covered with fabric to prevent soil entering the area soil.



Figure 8.6 Backfilling with amended soil



Figure 8.7 Final shaping of cell mound

Step 5 Completion

Spread topsoil and turf over the mound ensuring that batter grades are as per the design, as shown in Figure 8.8. The mound must be capped with a soil of moderate permeability (eg loam to clay loam) to minimise rainfall infiltration and promote evapotranspiration. Construct the mound with reduced batter slopes, or a flat bed, to reduce the provision for diversion of incident rainfall from the top surface of the mound

and add to the hydraulic load on the treatment cell. The treatment cell should always be constructed with two capped, slotted inspection pipes inserted in the base of the cell, one on either side of the leach drain.

Fence off the mound area to protect it from livestock and other animals (eg dogs and rabbits) and vehicles.

Construct a stormwater diversion berm / drain before finishing the mound. Stormwater diversion should be constructed according to Standard Drawing 8A.

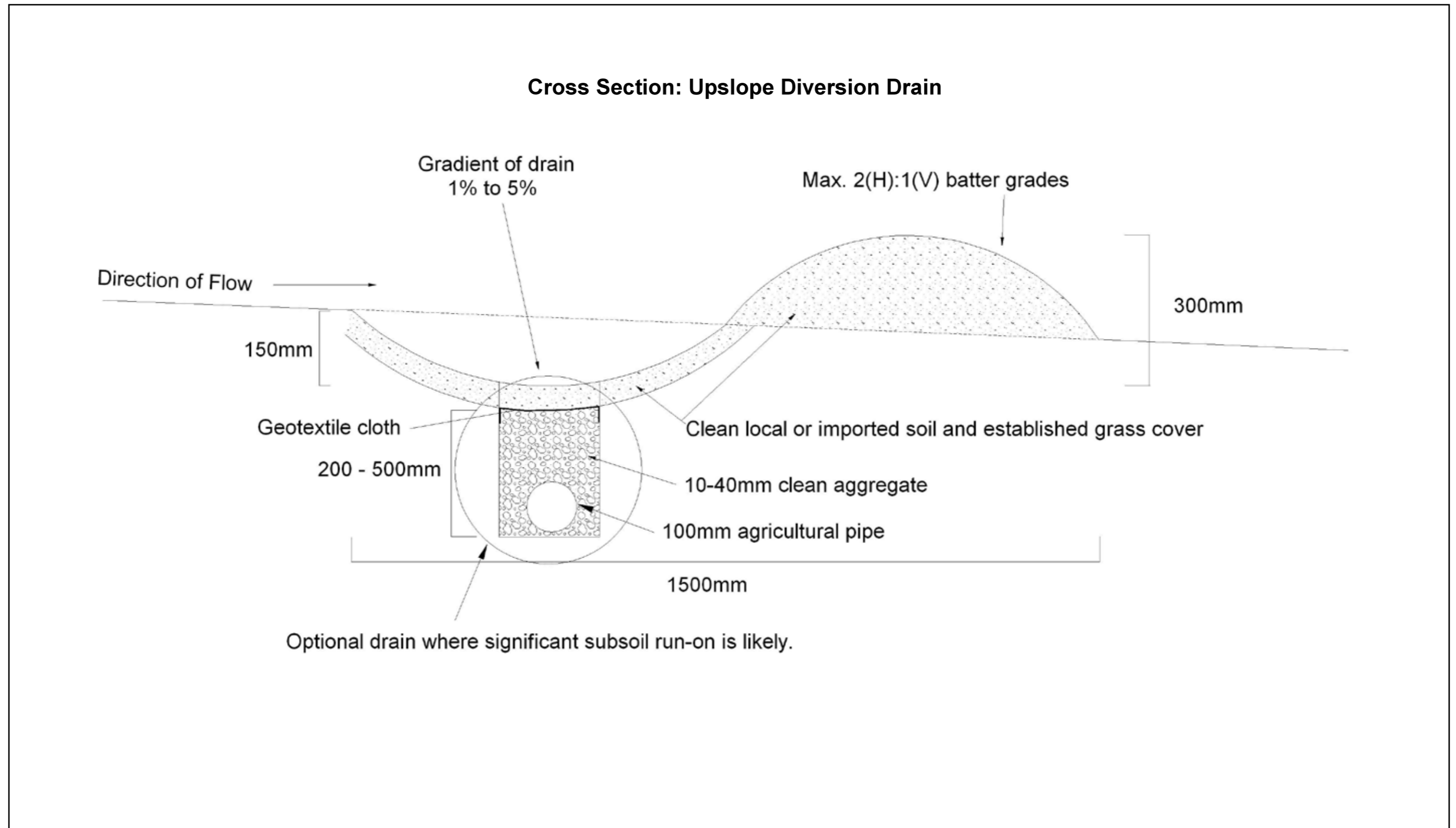


Figure 8.8 Finished amended soil mound

System Design

Better communication between the designer and installer is achieved by the designer preparing a System Design. This report provides critical details of the design to the installer. It describes and quantifies the design and illustrates the appropriate layout and configuration of the system with appropriate plans and sketches. The designer and installer are usually the same for amended soil mounds. Appendix 3 includes an example of a System Design.

The installer provides an Installation Certificate that certifies that the installation is as described in the relevant sections of the Design Producer Statement. Appendix 4 includes an example of an Installation Certificate.



Standard Drawing 8A - Upslope Diversion Drain
(not to scale)

8.3 Inspection

Council should inspect the tank and all associated pipe and drainage work before backfilling to ensure that all components are in the correct position and installed according to 'PCA 2004 Plumbing Code of Australia'. Council should inspect the final installation to ensure it complies with all conditions of consent before issuing an approval to operate the system.

8.4 Operation

The owner should inspect the mound regularly. This detailed maintenance inspection should include:

- switching treatment cells every six months
- checking any pumps are operating correctly. If the system includes a standby pump, it should be swapped with the operating pump regularly to ensure that the work hours on both are approximately equal
- checking the surrounds of the mound for signs of leakage
- checking the inspection ports of the mound for water level, to ensure the mound is not internally flooded.

The owner of the system also has general maintenance and operational tasks to carry out, including:

- ensuring all products used in the household are safe for the system (bleaches and many household cleaning products are not)
- managing the vegetation around the tank and mound (this includes mowing and trimming bushes for maximum exposure)
- for a septic tank, inspecting and cleaning the outlet filter every three months
- checking the septic tank sludge depth levels regularly
- contacting a plumber as soon as practicable if a pump well or other alarm activates
- continuing other maintenance requirements for an aerated wastewater treatment system or a biological filtration system where they are used together with an amended soil mound.

Checklist 8.2 lists items that should be checked during a regular maintenance inspection for an operational amended soil mound. The system owner and Council compliance inspectors can use this checklist.

Installation checklists for land application systems are also included in Sections 10 – Absorption trenches and beds, 11 – Evapotranspiration absorption beds, 12 – Surface irrigation and 13 – Subsurface irrigation.

Checklist 8.1 Installation of mound for use by plumbers and Council inspectors	
Owner's name:	
Address:	
Installation date:	
Is the mound positioned according to council and Sydney Catchment Authority requirements for buffer distances?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is the mound positioned according to Council and Sydney Catchment Authority design requirements for contours and slope?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Have at least two inspection ports been incorporated into the mound?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is the installed switching valve readily accessible?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is there an indication of poor drainage on or near the mound area?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Has a diversion berm / drain been installed above the mound?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Has the mound been protected to prevent mound damage (eg using fencing)?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Has a turfed cover been established over the mound surface?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Does the mound have good exposure to wind and sun?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Are the mound dimensions and construction requirements consistent with council's conditions of consent?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Mound length:	M
Mound width:	M
No. of cells:	
Does the mound include any non-standard elements in its design?	<input type="checkbox"/> Yes <input type="checkbox"/> No
If yes, describe:	
Note: the checklist for the septic tank and any pump well will also need to be completed	
Service provider:	
Contact number:	
Comments, action or repairs needed: (Where a response in the above Checklist needs extra information or action, specify the action plan and/or the process to fix the problem, or specify an alternative that is being offered)	
Name / title of inspector:	
Signature:	Date:

Checklist 8.2 Operational mound system inspection report for use by councils and system owners (Note: system includes septic tank and pump well plus mound)			
Owner's name:			
Address:		Council area:	
System brand and model:		<input type="checkbox"/> Domestic <input type="checkbox"/> Commercial	
Date of service:	Date of last service:	Next service due:	
General Comments			
General condition of tank <input type="checkbox"/> Good <input type="checkbox"/> Fair <input type="checkbox"/> Poor			
Comments:			
Septic Tank			
Crust <input type="checkbox"/> Yes <input type="checkbox"/> No		Odour <input type="checkbox"/> Yes <input type="checkbox"/> No	
Sludge depth <input type="checkbox"/> High <input type="checkbox"/> Med <input type="checkbox"/> Low		Desludge needed <input type="checkbox"/> Yes <input type="checkbox"/> No	
Inlet/outlet junctions clear <input type="checkbox"/> Yes <input type="checkbox"/> No		Good biological activity <input type="checkbox"/> Yes <input type="checkbox"/> No	
Pump well (where installed)			
Pump operational <input type="checkbox"/> Yes <input type="checkbox"/> No		Float switches operational and set at appropriate levels <input type="checkbox"/> Yes <input type="checkbox"/> No	
Presence of sludge <input type="checkbox"/> Yes <input type="checkbox"/> No		Standby pump switched (if relevant) <input type="checkbox"/> Yes <input type="checkbox"/> No	
Electrical components			
Alarm operational		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Electrical compartment in good working order		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Mound			
Evidence of physical damage (eg digging, erosion) <input type="checkbox"/> Yes <input type="checkbox"/> No		Comments:	
Presence of surface ponding / toe leaching / seepage		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Excess weed growth on mound and in the area		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Incomplete or inappropriate vegetation cover		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Valves working		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Have the cells been switched?		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Inspection port interiors clear (ie no standing water suggesting internal flooding) and in good condition		<input type="checkbox"/> Yes <input type="checkbox"/> No	

Service provider:	
Contact number:	
Comments, action or repairs needed: (Where a response in the above Checklist needs extra information or action, specify the action plan and/or the process to fix the problem, or specify an alternative that is being offered)	
Name / title of inspector:	
Signature:	Date:

8.5 Common technical issues

Plumbers, property owners and regulatory authorities have observed a number of common problems with amended soil mound installations, including:

- installing mounds on too steeply sloping sites, with the upslope side of the mound cut into low hydraulic conductivity subsoils
- intersection of groundwater flow by cutting into the slope to form a level base for the mound
- building the mound too flat, limiting the amount of rainfall that is shed from the mound
- building the mound too flat and relying too much on seepage and only limited evapotranspiration
- building the mound too short along the contour due to poor understanding of the linear loading rates
- uneven distribution across the mound
- mound toe leakage
- poor vegetation cover
- undersizing.

8.6 Case study

An amended soil mound was built on a sloping site with shallow soil (Figure 8.9). The mound was built into the hillside by cut and fill, so the upslope portion of the mound is possibly set on deep subsoils that probably have a lower hydraulic conductivity than soil near the surface. The upslope part of the mound is possibly on bedrock and the downslope part is on unconsolidated fill. As a result, the soil under the mound is of variable strength and hydraulic capacity. The lower hydraulic conductivity of the soil under the upslope portion of the mound will tend to force effluent downslope. Effluent will seep to the bottom of the mound where it is more likely to overload the soil beneath. The relatively high transmissivity of the fill, compared to the shallow natural soil beneath, can cause toe seepage. This hydraulic overload of the mound could be made worse by stormwater flowing onto the mound from upslope.

Problem

The problems are a lack of adequate stormwater diversion, excessive hydraulic load due to stormwater, uneven basal loading under mound, uneven settlement under mound, and toe seepage.

Solution

Build enough diversion drainage around the upslope margin of the amended soil mound (see Standard Drawing No. 8A). Where possible avoid excessive excavation into the hill slope to build the mound to reduce the chance of intersecting lower hydraulic conductivity soils. Form the basal soakage bed on soils of uniform characteristics (but not unconsolidated fill). Calculate the basal loading rate based on these sub-soils (ie use a lower value). If toe seepage is a concern, extend the mound out in the downslope direction and use an appropriately low linear loading rate for the mound.



Figure 8.9 Amended soil mound constructed on sloping site

Section 9: Sand Mounds

9. Sand Mounds

9.1	Design	107
9.2	Installation	108
9.3	Inspection	113
9.4	Operation	113
9.5	Common technical issues	117
9.6	Case study	117

The sand mound (often called a Wisconsin mound) is used to treat and dispose of domestic wastewater in areas that are unsuitable for conventional septic tank soil absorption systems due to shallowness, high water table, low permeability, or prior disturbance. They can also be used even where these constraints do not exist.

The Wisconsin sand mound system includes a septic tank, a dosing chamber, and a mound made of sand fill above the soil surface. It is essentially a combination of a single pass sand filter and dispersal unit (Converse and Tyler, 2000). Septic tank effluent is distributed in even and timed doses into the mound via a dosing chamber or pump well (Figure 9.1). Wastewater is treated as it moves through the sand mound, then further treated and disposed of in the soil underneath the mound.

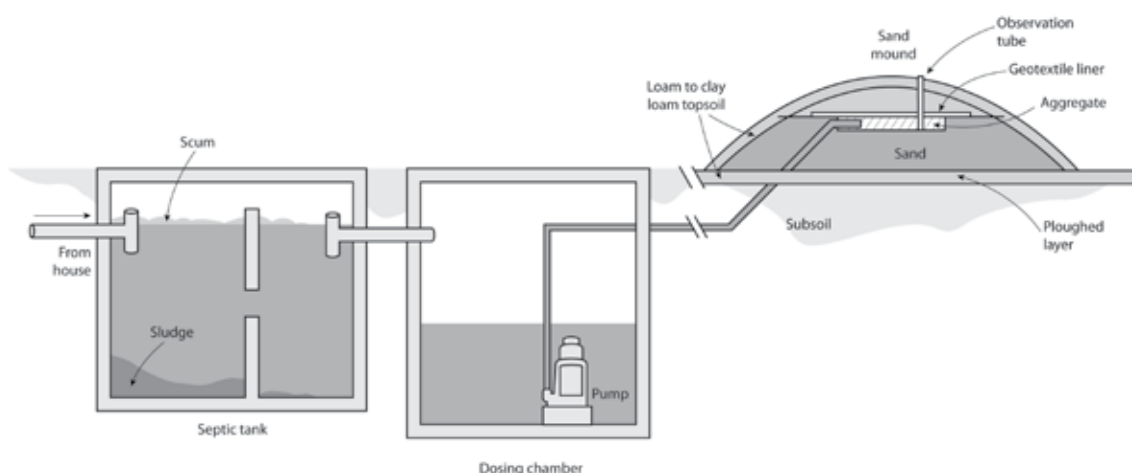


Figure 9.1 Components of a Wisconsin sand mound system

A level area is best for building Wisconsin sand mounds, but a gently sloping site will also work. On sloping sites, the mound is built along the contour of the land, and the width of the toe will increase with increasing slope.

9.1 Design

Many of the considerations for designing a sand mound described below are based on 'Wisconsin Mound Soil Absorption System: Siting Design and Construction Manual' (Converse and Tyler, 2000).

Successful mound performance depends on several design and location factors. There must be some type of screen (such as a septic tank outlet filter) to stop small particles from entering the sand mound. Small particles in the sand media can clog

the pore spaces and make the mound less effective. Sand quality also affects performance and the distribution of grain sizes (and hence the pore size) is an essential design factor. AS/NZS 1547:2012 sets out the grain size and uniformity coefficient for mounds. The size of sand mounds should be based on Converse and Tyler, 2000 and design loading rates in Table N1 of the AS/NZS 1547:2012.

The absorption mound is built in layers at different depths. The depths of these layers are determined by the depth of the limiting layer of the soil, which may be the depth to the groundwater table, depth to bedrock or a low permeability soil layer. The separation distance from the distribution cell to the base of the tilled or ripped layer must be at least 300 millimetres on flat ground, and up to 600 millimetres for the downslope side of the distribution bed on sloping ground (AS/NZS 1547:2012).

The distribution system normally consists of small diameter pipes that allow wastewater to be evenly applied under low pressure in the mound. A pressure distribution network is essential to distribute the septic tank effluent. Gravity flow is unacceptable as it will not distribute the effluent evenly over the infiltrative surface or along the length of the mound.

The two factors that determine the size and configuration of a mound are how the effluent moves away and the rate at which it moves into the subsurface and away from the sand mound. The calculation of the movement and the rate of movement are based on a soil and site evaluation by a licensed professional. The linear loading rate determines the length of the mound along the contour and controls the landscape hydraulic loading.

Dosing is important for effective function of the mound system. Short frequent doses of effluent (timed dosing) onto sand filters with closely spaced openings are preferred as they help improve effluent quality. Demand dosing, where large amounts of effluent are applied at once, causes effluent to pass more rapidly through the sand, and does not give the biota enough time to effectively clean the effluent.

Designer accountability

More accountability for the design is provided by a Design Producer Statement, where the design is warranted by the designer. Appendix 2 includes an example of a Design Producer Statement.

9.2 Installation

A Wisconsin sand mound must be installed properly, as poor installation techniques often cause these systems to fail. An experienced practitioner should design and build a Wisconsin sand mound. The following steps should be used to install a Wisconsin sand mound.

Step 1 Site selection and layout

Establish the contour of the lot and mound area. Stake out the mound so that the distribution cell runs parallel to the contour. Mounds must be on the contour to maintain constant mound height and ensure effluent is evenly distributed.

The site should be one where any upslope drainage can be appropriately diverted around the sand mound to stop it from becoming saturated with run-on stormwater. A diversion berm / drain, as shown in Standard Drawing 9A, should be built to divert run-on water from upslope. Consider where the effluent pipe from the pump well to the sand mound will be located.

Step 2 Construction

Create a trench and lay the effluent pipe from the pump well to the mound site according to 'PCA 2004 Plumbing Code of Australia'. Cut and cap the pipe 300 millimetres beneath the ground surface. Lay the pipe sloping evenly back to the pump well so that it drains after dosing. Backfill and compact the soil around the pipe to stop effluent seeping back along the pipe.

Prepare the mound site by clearing all shrubs, trees and boulders. Cut any trees to ground level and then grind the stump out to a depth of 300 millimetres and backfill with permeable material such as the natural topsoil or sand (not clay). Scarify the natural soils along the contour across the entire basal area to a minimum depth of 200 millimetres taking care not to compact the basal area in the process. This should extend at least one metre beyond the mound perimeter and two metres on the downhill side. This preparation is necessary to provide a cleared ground surface with a series of vertical furrows to enhance transfer of moisture from the sand mound to the original soil, while inhibiting lateral movement at the sand-soil interface. The vertical furrows will also help to stabilise the sand at the sand-soil interface.

If the soil is too wet, there will be smearing and compaction during site preparation, reducing the infiltration capacity of the soil and ultimately the mound's effectiveness. If the site is too wet, it is essential to wait until the soil has dried out sufficiently.

Once the site has been furrowed, place a layer of sand on the base. Perform all work from the upslope side to avoid compacting the downslope area, especially if effluent flows horizontally away from the mound (Converse and Tyler, 2000).

Decide where the distribution pipe from the pump chamber enters the mound. An upslope centre feed is better for long mounds. Lay the pipe with an even slope back to the chamber so that it drains after dosing.

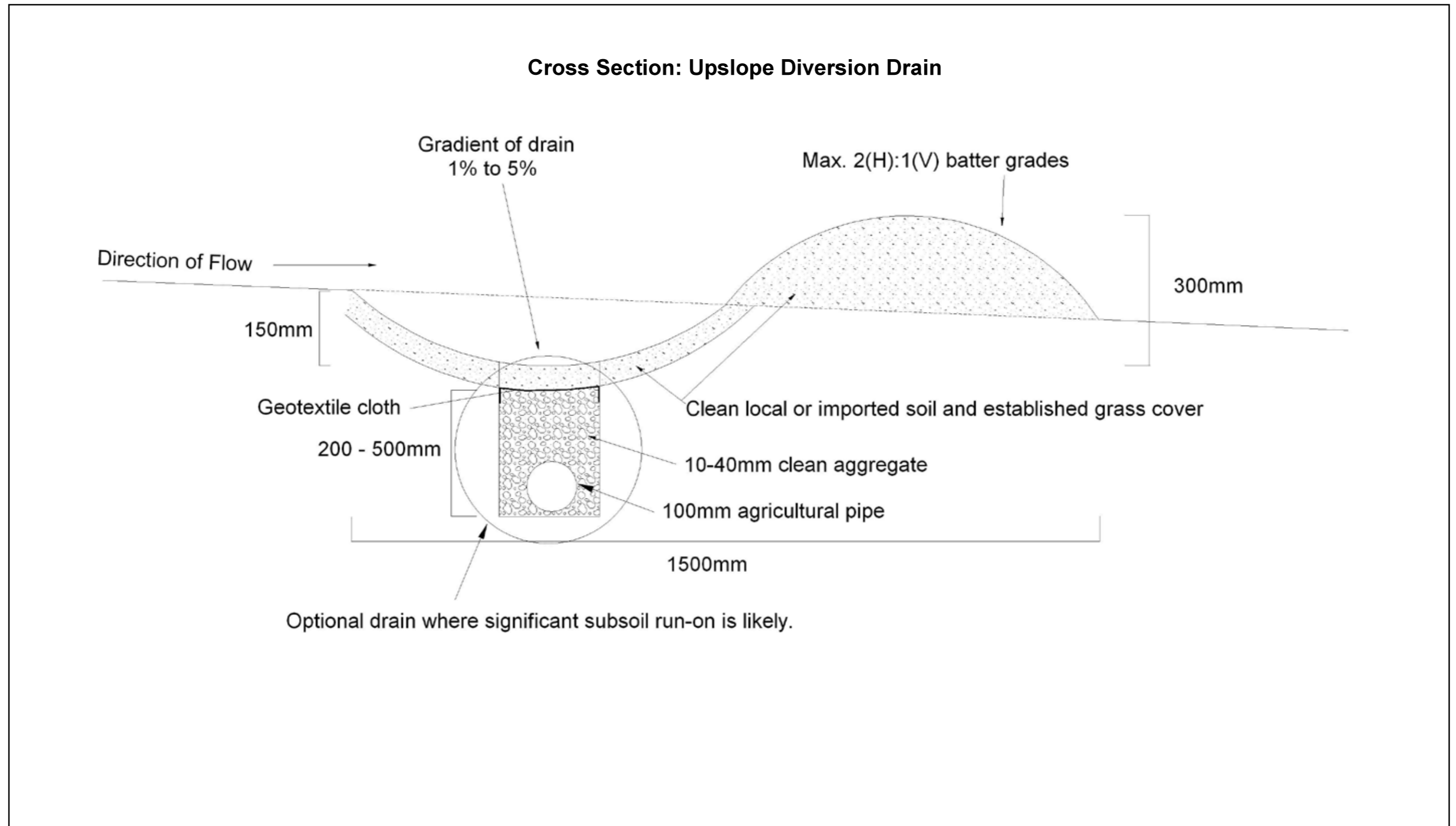
The mound must have observation tubes extending from the infiltrative surface to or above the ground surface to observe ponding at the infiltrative surface. Place the tubes at approximately $\frac{1}{4}$ and $\frac{3}{4}$ points along the length of the distribution cell.

- Place the proper depth of sand (compacted) then form the distribution area with the bottom area raked level
- Place washed, sound aggregate to a depth of approximately 150 millimetres
- Place the pressure distribution network with holes located downward and pressure test the system for uniformity of flow
- Cover the distribution network with approximately 150 millimetres of aggregate
- Cover the aggregate with geotextile synthetic fabric.

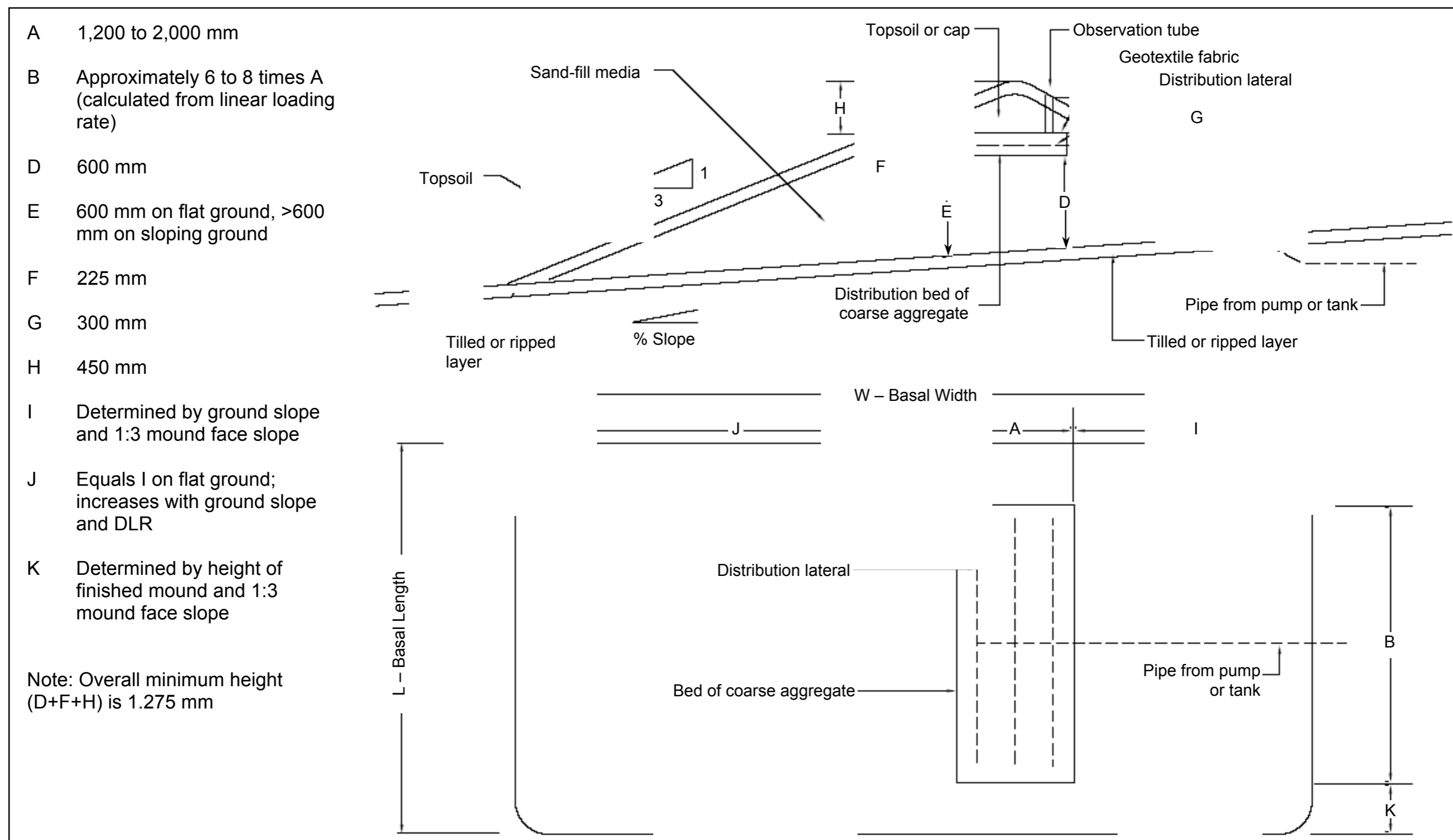
Step 3 Completion

- Cap the distribution cell with at least 300 millimetres of topsoil and shape to create the profile of the mound
- At least 150 millimetres of topsoil must be placed over the entire mound
- Cap the mound with moderately permeable soil (eg loam to clay loam) to minimise rainfall infiltration and promote evapotranspiration. The soil should be garden quality topsoil and free of coarse fragments. The mound must be able to breathe to allow oxygen to diffuse into and below the absorption area.
- Final grade the mound area so surface water moves away from and does not accumulate on the up slope side of the mound. The recommended side slopes ratio is 3:1 for mowing safety.

- The mound must be turfed immediately after finishing construction. Maintain a vegetated buffer around the area that extends two metres on the upslope side and four metres on the downslope side.
- The mound area must be appropriately fenced-off or protected from livestock, other animals (eg dogs and rabbits) and vehicles.



Standard Drawing 9A - Upslope Diversion Drain
(not to scale)



Standard Drawing 9B - Wisconsin Sand Mound
(not to scale)

System design

Better communication between the designer and installer is achieved by the designer preparing a System Design to convey critical details of the design to the installer. It describes and quantifies the design and shows the appropriate layout and configuration of the system with appropriate plans and sketches. Appendix 3 includes an example of a System Design.

Finally, the installer provides an Installation Certificate. This certifies that the installation is as described in the relevant sections of the Design Producer Statement. Appendix 4 includes an example of an Installation Certificate.

9.3 Inspection

A Council inspector should inspect the septic tank, pump well, mound distribution cell and all associated pipe and drainage work before backfilling, to ensure all components are correctly positioned and installed according to 'PCA 2004 Plumbing Code of Australia'. Council should make a final installation inspection to ensure compliance with all conditions of consent, before issuing an approval to operate the system.

9.4 Operation

The owner should inspect the mound regularly, including:

- checking any pumps are operating correctly. If the system includes a standby pump, it should be swapped with the working one regularly to ensure that the work hours on both are approximately equal
- checking the mound for signs of leakage (soggy spots or seepage on the top or side slopes or toe areas of the mound)
- checking the inspection ports of the mound for standing water, to ensure the mound is not internally flooded.

The owner should also perform a number of general maintenance tasks, including:

- minimising the use of products in the household that are unsafe for the system (bleaches and many household cleaning products are unsafe)
- managing the vegetation around the tank and mound (including mowing the grass)
- ensuring power is continuously available and switched on when the house is occupied
- ensuring that a plumber is contacted as soon as practicable if an alarm activates.

System installers and Council inspectors can use Checklist 9.1 to ensure the sand mound is correctly constructed.

Checklist 9.2 outlines items that should be checked during a regular maintenance inspection for an operational Wisconsin sand mound. This checklist can be used by the owner of the system and also for council compliance inspections.

Checklist 9.1 Installation of mound for use by plumbers and Council inspectors	
Owner's name:	
Address:	
Installation date:	
Is the mound positioned according to council and Sydney Catchment Authority requirements for buffer distances?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is the mound positioned according to Council and Sydney Catchment Authority design requirements for contours and slope?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Have at least two inspection ports been incorporated into the mound?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is the installed switching valve readily accessible?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is there an indication of poor drainage on or near the mound area?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Has a diversion berm / drain been installed above the mound?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Has the mound been protected to prevent mound damage (eg through fencing)?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Has a turfed cover been established over the mound surface?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Does the mound have good exposure to wind and sun?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Are the mound dimensions and construction requirements consistent with council's conditions of consent?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Mound length:	m
Mound width:	m
No. of cells:	
Does the mound include any non-standard elements in its design? If yes, describe:	<input type="checkbox"/> Yes <input type="checkbox"/> No
Note: the checklist for the septic tank and any pump well will also need to be completed	
Service provider:	
Contact number:	
Comments, action or repairs needed: (Where a response in the above Checklist needs extra information or action, specify the action plan and/or the process to fix the problem, or specify an alternative that is being offered)	
Name / title of inspector:	
Signature:	Date:

Checklist 9.2 Operational mound system inspection report for use by councils and system owners (Note: system includes septic tank and pump well plus mound)		
Owner's name:		
Address:		Council area:
System brand and model:		<input type="checkbox"/> Domestic <input type="checkbox"/> Commercial
Date of service:	Date of last service:	Next service due:
General Comments		
General condition of tank <input type="checkbox"/> Good <input type="checkbox"/> Fair <input type="checkbox"/> Poor		
Comments:		
Septic Tank		
Crust <input type="checkbox"/> Yes <input type="checkbox"/> No	Odour <input type="checkbox"/> Yes <input type="checkbox"/> No	
Sludge depth <input type="checkbox"/> High <input type="checkbox"/> Med <input type="checkbox"/> Low	Desludge needed <input type="checkbox"/> Yes <input type="checkbox"/> No	
Inlet/outlet junctions clear <input type="checkbox"/> Yes <input type="checkbox"/> No	Good biological activity <input type="checkbox"/> Yes <input type="checkbox"/> No	
Pump well (where installed)		
Pump operational <input type="checkbox"/> Yes <input type="checkbox"/> No	Float switches operational and set at appropriate levels <input type="checkbox"/> Yes <input type="checkbox"/> No	
Presence of sludge <input type="checkbox"/> Yes <input type="checkbox"/> No	Standby pump switched (if relevant) <input type="checkbox"/> Yes <input type="checkbox"/> No	
Electrical components		
Alarm operational		<input type="checkbox"/> Yes <input type="checkbox"/> No
Electrical compartment in good working order		<input type="checkbox"/> Yes <input type="checkbox"/> No
Mound		
Evidence of physical damage (eg digging, erosion) <input type="checkbox"/> Yes <input type="checkbox"/> No	Comments:	
Presence of surface ponding / toe leaching / seepage		<input type="checkbox"/> Yes <input type="checkbox"/> No
Excess weed growth on mound and in the area		<input type="checkbox"/> Yes <input type="checkbox"/> No
Incomplete or inappropriate vegetation cover		<input type="checkbox"/> Yes <input type="checkbox"/> No
Inspection port interiors clear (ie no standing water suggesting internal flooding) and in good condition		<input type="checkbox"/> Yes <input type="checkbox"/> No
Service provider:		
Contact number:		

Comments, action or repairs needed: (Where a response in the above Checklist needs extra information or action, specify the action plan and/or the process to fix the problem, or specify an alternative that is being offered)	
Name / title of inspector:	
Signature:	Date:

9.5 Common technical issues

Figure 9.2 shows a cross section of a Wisconsin sand mound highlighting potential problems and common technical issues including:

- installation on too steeply sloping sites, with the upslope side of the mound cut into low hydraulic conductivity subsoils
- intersection of groundwater flow by cutting into the slope to form a level base for the mound
- building the mound too flat, limiting the amount of incident rainfall that is shed from the system
- building the mound too short along the contour due to poor understanding of the linear loading rate
- uneven distribution across the mound
- water in the observation tubes caused by plugging of the soil distribution cell or excessive loading
- mound toe leakage caused by slowly permeable soil, compaction or soil damage during construction, or overloading of system, or downslope basal width too short
- seepage of raw sewage on side or top of mound caused by plugging of the soil absorption area, overloading the system or using too fine sand as fill
- choosing inappropriate materials
- undersizing.

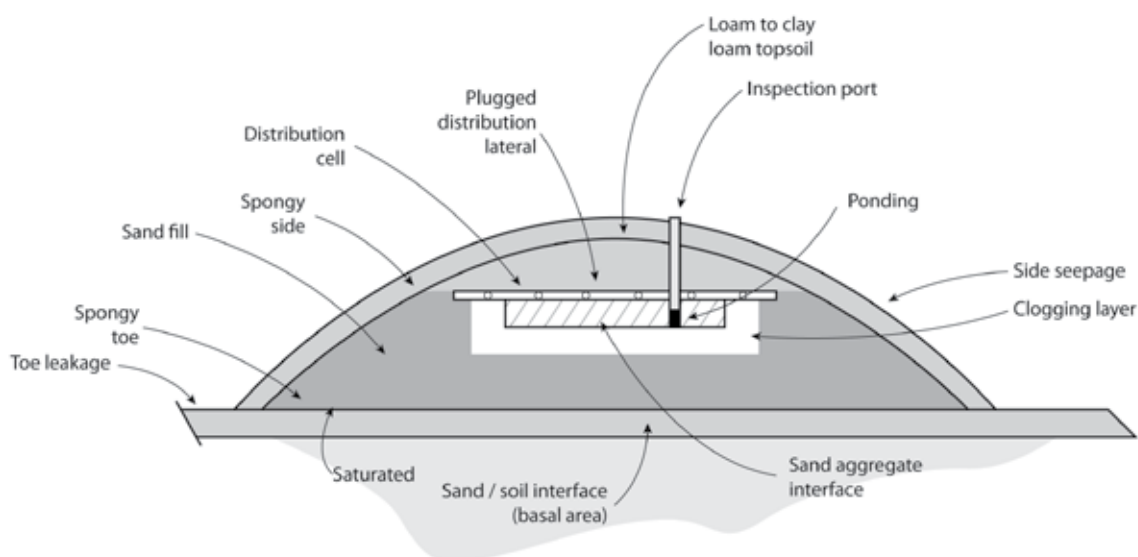


Figure 9.2 Cross section of a Wisconsin sand mound showing potential problems (after Converse and Tyler, 1987)

9.6 Case study

A Wisconsin sand mound was built on a sloping site with shallow soil. It was built into the hillside by cut and fill. During a routine maintenance inspection, high water levels were observed in the inspection ports indicating ponding at the sand / aggregate interface. The ponding remained after dosing and was therefore considered permanent ponding which can cause failure.

Permanent ponding can be caused by a clogging mat at the sand / aggregate interface due to excessive effluent hydraulic loads and/or sand fill that is too fine. There was also not enough stormwater diversion that caused saturation from run-on.

The solution was to first build adequate diversion drainage around the upslope margin of the sand mound (see Standard Drawing No. 9A). Where possible avoid excessive excavation into the hill slope for sand mound construction.

A water efficiency program was started for the dwelling, resulting in reduced hydraulic loads. If this was not enough to overcome the ponding problem, the mound may have needed to be resized and expanded. The mound cap should be removed and the aggregate in the absorption bed stripped out. The organic matter should be removed and the distribution laterals re-laid. The area downslope of the mound should be tilled or ripped, and additional fill added to enlarge the mound to the proper size. The absorption bed can then be rebuilt.

Alternatively, highly pre-treated effluent could be introduced to the mound by installing an aerobic unit or equivalent between the septic tank and the pump well (Converse and Tyler, 2000).

Soon after building the sand mound, the pump was running continuously with no apparent drop in the liquid level in the dose tank. The continuous pumping with no distribution of wastewater to the mound indicates clogging of the distribution laterals.

The solution was to fit an outlet filter to stop particulate material clogging the distribution cell and laterals. The end caps to the distribution laterals were removed and the solids flushed out using a high volume, high pressure pump. The laterals were recapped and water or air forced into the distribution system to unplug the holes.

Section 10: Absorption Trenches and Beds

10. Absorption Trenches and Beds

10.1	Design	119
10.2	Installation	122
10.3	Testing	125
10.4	Operation	125
10.5	Inspection	134
10.6	Common technical issues	134
10.7	Case study	136
10.8	'Wick' trenches	137

In a conventional septic tank and absorption system, wastewater is gravity-fed or pumped from the septic tank to the absorption area. Trenches or beds (hereafter 'trenches' refers to 'trenches and beds') are usually built below ground and can be media-filled or consist of a durable self supporting arch resting on gravel (or occasionally coarse sand). Trenches are usually relatively narrow and deep, while beds are wider and shallower. NSW Health requires non-disinfected effluent to be disposed of at a soil depth more than 300 millimetres for both trenches and beds (NSW Health, 2008). Trenches are usually 500 to 700 millimetres deep and up to around 600 millimetres wide. Beds are usually no deeper than 600 millimetres, but up to several metres wide and contain a number of distribution pipes or arches. The depth and overall basal area depend on soil type and anticipated wastewater volume, climate and site features.

In septic tank and absorption trench systems, household wastewater first flows into a primary septic tank where solids settle to bottom of the tank to form a sludge layer, and grease and fat float to the surface to form a scum layer. Clarified effluent then flows (or is pumped via a pump well) to the absorption trench or bed for treatment and disposal. The effluent is typically distributed along the length of the trench or bed through slotted or drilled 100 millimetre distribution pipes, and then filtered through the gravel and sand to the underlying soil. A clogging layer or biomat develops along the bottom and sides of the trench and acts as a further filter. This filtering process helps remove pathogens, toxins and other pollutants. Nutrients in the effluent are taken up by vegetation (normally grass) planted across the absorption trench area, incorporated in the biomat, and, in the case of phosphorus, adsorbed onto clay particles in the soil.

Absorption trenches and beds are typically used to manage primary treated effluent. They can also be used to manage secondary treated effluent, in which case higher loading rates are acceptable, as outlined in 'AS/NZS 1547:2012 On-site Domestic Wastewater Management'. Absorption trenches or beds used together with secondary treated effluent are small footprint systems. They are often used where there is limited space available for effluent disposal.

10.1 Design

The design of an absorption trench should consider the site and soil assessment outlined in Section 2. The absorption trench should be sized according to the recommendations of AS/NZS 1547:2012. Installing absorption trenches requires

council approval under the *Local Government Act 1993*. The trench must comply with council and Sydney Catchment Authority requirements for buffer distances and setbacks from significant site features. The following points should also be considered.

- Where more than one trench is needed, trench lengths should be equal and effluent should be distributed evenly via a splitter box (Figure 10.1) or sequencing valve (Figure 10.2).
- The maximum number of trenches for any one design is 10.
- Trench lengths should be designed to ensure that effluent is evenly distributed and reaches the far end of each trench. Individual trenches must be less than 20 metres for passive systems, or 25 metres for pressure dosed trenches.



Figure 10.1 Splitter box



Figure 10.2 Sequencing valve

- The linear loading rate is critical where soil is shallow (see Section 2 of this Manual).
- Distribution pipes and arches should be laid according to manufacturer's instructions.
- It is better for trenches or beds to be pressure dosed instead of allowing the effluent to trickle into the trench or bed. This provides better and more even distribution and use along the whole trench while prolonging the life of the trench. A suitable pump or siphon is needed to ensure that there is enough pressure to fully and evenly dose the trench or trenches.
- Inspection ports of 50 millimetre pipe, slotted at the trench base and capped at the top, should be inserted in each trench to allow inspection of the trenches once in operation.
- The Sydney Catchment Authority will not support any design where the absorption trenches or beds are added in series (ie end on end).
- If a siphon (Figure 10.3) or pump (Figure 10.4) is used or required to pressure-dose trenches then a separate pump or siphon well is needed. NSW Health requires the pump well to be at least 2,000 litres. The pump or siphon well can either be separate from the septic tank or a dedicated chamber in the septic tank (Figure 10.5). The pump and pump well, or siphon and dosing siphon well, should be designed to ensure that the trenches can be fully dosed for even distribution of the effluent.



**Figure 10.3 Dosing siphon
(Inwater, 2010)**



**Figure 10.4 A submersible pump.
(Davey Pty Ltd)**

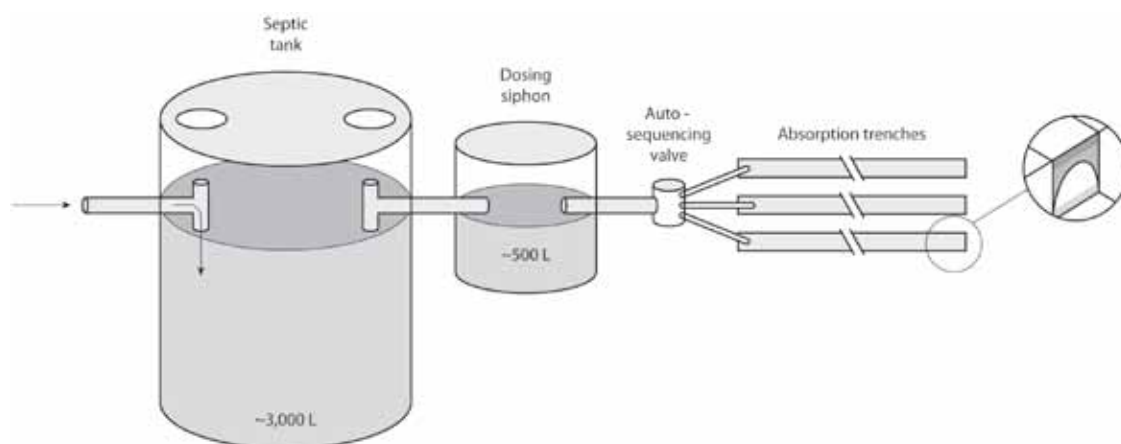


Figure 10.5 Septic tank, dosing siphon and trench set-up

- Trenches and beds must not be exposed to vehicle activity or grazing animals that can cause compaction and premature trench failure (Figure 10.6). Where vehicles and grazing animals can access the trench area, the owner must fence the area or plant a protective barrier of shrubs to prevent access.



Figure 10.6 A failing trench due to vehicular activity

Where a pump is used it should:

- be made from materials suitable for pumping septic tank effluent – it may be above ground or submersible
- have capacity to discharge the maximum daily flow against any physical or imposed head
- be able to be float switch controlled
- be statically mounted, protected from the elements and wired to operate automatically
- have all electrical work carried out according to the Supply Authority Service Rules and 'AS/NZS 3000:2007 Electrical Installations (Wiring Rules)'
- have all connection pipework made with approved material
- have an audible and visible alarm (the audible alarm should be mutable) in a highly visible place in the kitchen or laundry to warn of pump failure and high-water level.

A pump or siphon can be used together with a sequencing valve (Figure 10.2).

Designer accountability

A Designer Producer Statement, where the designer warrants the design, provides more accountability for the design. Appendix 2 includes an example of a Design Producer Statement.

10.2 Installation

A number of installation techniques should be used to ensure effective long term operation of an absorption trench or bed. Absorption trenches or beds often fail because of poor installation. Follow the steps below when installing an absorption trench or bed.

Step 1 Site preparation

Obtain a copy of the council approved plans and conditions of consent. Accurately locate trenches and beds as shown on the site plans and according to the specified and approved design and/or any covenant. Check the location of all constructed trenches and beds against the approved site plans. If there is any change in their position from the site plans, a Section 96 application (from the *Environmental Planning and Assessment Act 1979*) must be made to council to alter their position.

Step 2 Positioning

Build the trenches and beds along the contours and use laser levelling to ensure that the base is exactly level. If this does not happen, distribution will not be even and one part of the trench will be more heavily loaded. This could cause the most heavily loaded part of the trench to fail prematurely, with further creeping failure as the effluent is forced to more distant parts of the trench.

Always avoid cutting trenches through existing weakened ground (eg through the alignments of former underground pipes, cables or conduits) as they may provide preferential pathways for effluent to escape from the trench. If they cut downslope through the ground occupied by a series of trenches, effluent may preferentially flow to the lowest trench causing it to fail or surcharge. Where it is unavoidable to cut into an alignment or it happens accidentally, seal the weaknesses in the trench walls with cement or bentonite grout.

Step 3 Timing

Build trenches during fine weather. If it rains before trenches are completed, they should be covered to protect them from rain damage.

Once dug, complete the trenches promptly to avoid foreign material being washed into the open trench (Figure 10.7). In particular, avoid puddling, where clay settles out at the bottom of a water filled trench exposed to rain, as clay settling on the base of the trench will reduce trench performance.

Step 4 Excavation

- Carefully excavate the base of any trench and level it with a dumpy or laser level. The trench must be level along and across the line of the trench. If there is a slope across the base of the trench, the effluent will drain to and preferentially load the downslope side of the trench, which may then fail or overflow.
- Where trenches are dug along the contour on sloping ground by an excavator that does not have a pivoting bucket, the base of the trench will probably be cut parallel to the ground surface. In this case, the base of the trench will have a fall towards the downslope side. The trench should be further hand dug to level the base and stop excessive effluent accumulating against the downslope wall of the trench.
- Where trenches are dug by excavator in clayey soils, any smearing of the trench walls and floor must be fixed by scarifying the surface.

Step 5 Construction

- Do not dig trenches in dispersive soils. If the soil appears dispersive after the trenches are dug, add gypsum to the trench base at the rate of one kilogram per square metre. Absorption trenches should not be built in medium to heavy clay soils, and preferably not in light clay soils (see Section 2).
- Install a self supporting pipe or arch (reIn) that complies with AS/NZS1547:2012.
- Ensure that the sides of trenches are not damaged or caused to collapse when the trenches are filled with gravel or sand.

- Trenches can be filled with gravel (typically 20-40 millimetres or occasionally coarse sand), but it should not be compacted. Appropriate consideration should be given to trench storage capacity where trenches are filled with material other than gravel.
- Lay geotextile filter cloth over the gravel or sand in a trench and under the topsoil to ensure that the topsoil does not penetrate and block the trench.
- Test the trenches and beds with clean water before filling with gravel (or coarse sand) to ensure effective and even distribution of effluent.
- Apply 150 to 200 millimetres of topsoil to the top of the trench and leave it slightly mounded above ground level to allow it to settle and to encourage incident rainfall to be shed away from the top of the trench.



Figure 10.7 Unfinished trench

- The top of the absorption trench area should be turfed or grass planted to establish vegetation cover promptly after construction. This ensures the best uptake of effluent by evapotranspiration. Ensure that larger deep-rooting plants are not planted close to trenches to reduce the chance of root intrusion and clogging of the trenches.
- A stormwater diversion berm / drain should be built on sloping sites upslope of the absorption trenches or beds. Standard Drawing No. 10A provides detail about constructing a stormwater diversion drain.

Step 6 Dosing

- Trenches or beds may be gravity-fed or pressure-dosed using pumps or dosing siphons. Raised pressure-dosed absorption beds are a possible alternative where there are shallow limiting layers present (eg bedrock, clay or water table) and not enough separation distance (Section 2) from that layer. The linear loading rate must be addressed in these situations.
- The annotated Standard Drawing No. 10B describes the installation of gravity-fed trenches and beds. Annotated Standard Drawing No. 10C describes the installation of pressure-dosed trenches and beds. Annotated Standard Drawing No. 10D describes the installation of raised pressure-dosed absorption beds.
- Checklist 10.1 details matters that should be checked when trenches or beds are installed. Plumbers/installers and Council inspectors can use this checklist to ensure installation has been completed properly.

System Design

Better communication between the designer and installer is achieved by the designer preparing a System Design which conveys critical details of the design to the installer. It describes and quantifies the design and shows the appropriate layout and configuration of the system with plans and sketches. Appendix 3 includes an example of a System Design.

Finally, the installer provides an Installation Certificate to certify that the installation is as described in the relevant sections of the Design Producer Statement. Appendix 4 includes example of an Installation Certificate.

10.3 Testing

Test trenches and beds with clean water before filling with gravel (or coarse sand) to ensure even distribution. If pressure dosed, the trenches or beds should be pressure tested to ensure uniform squirt height at each orifice and to check that sequencing valves are operating properly.

10.4 Operation

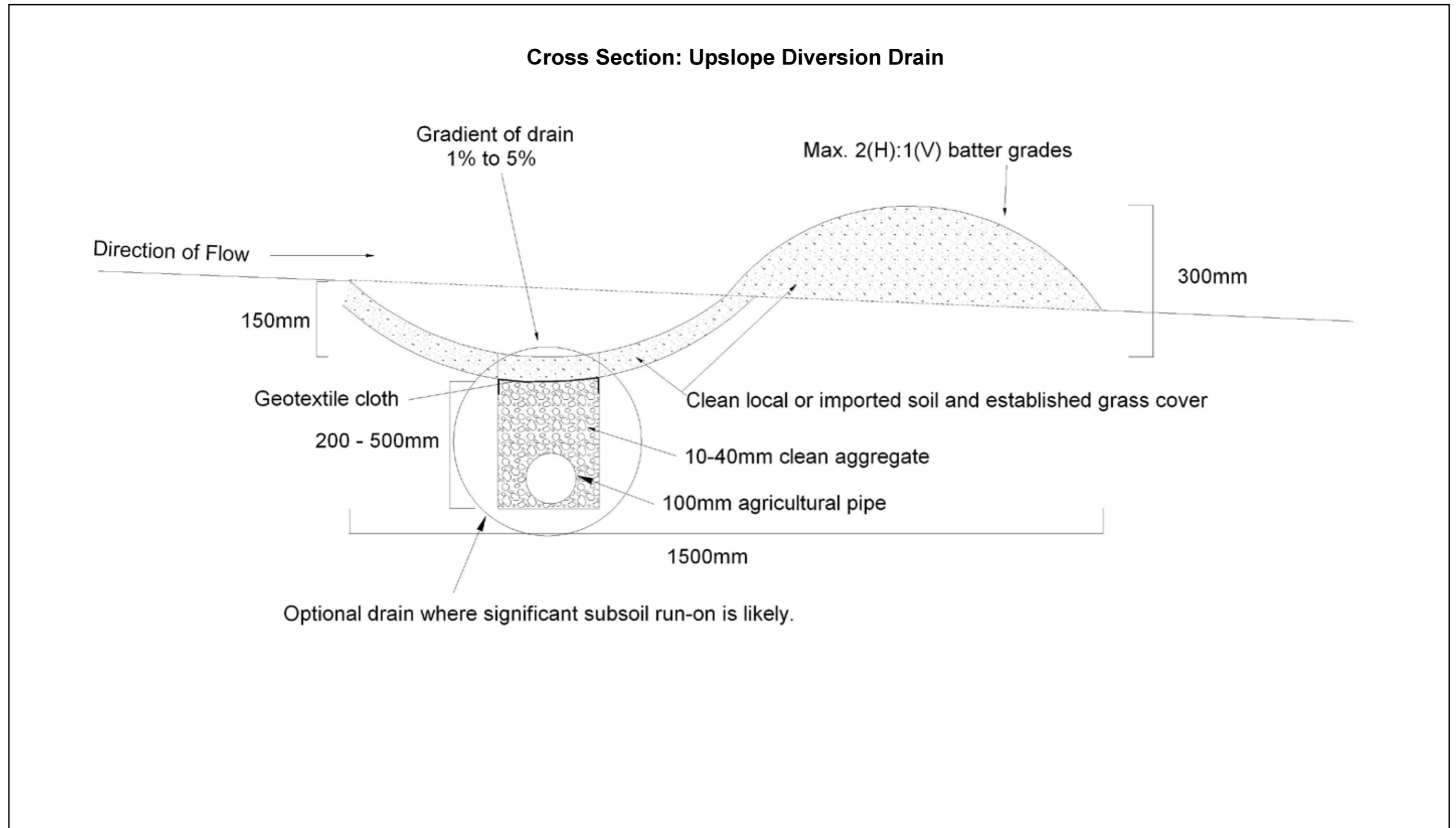
The owner must regularly inspect trenches and beds, together with the septic tank. This detailed maintenance inspection should include:

- checking around the trench for signs of leakage
- checking the water level at any inspection ports of the trench to ensure it is not flooded
- checking that the dosing siphon or splitter box is working properly and not blocked or clogged
- checking that any pump is operating correctly. If the system includes a standby pump, it should be regularly alternated with the operating pump to ensure that the work hours on both are approximately equal
- checking the control system and ensuring that it is set to deliver appropriate volumes of effluent to specific irrigation fields according to the hydraulic design
- checking that the tank is regularly desludged to limit the amount of solids carried over into the trench. Section 3 of this Manual includes details about desludging a septic tank
- inspecting the septic tank outlet filter every three months and hosing the filter off where necessary, ideally into a bucket or directly into the inlet 'T' of the septic tank. Cleaning should only remove gross solids and not the biofilm that accumulates on filter surfaces.

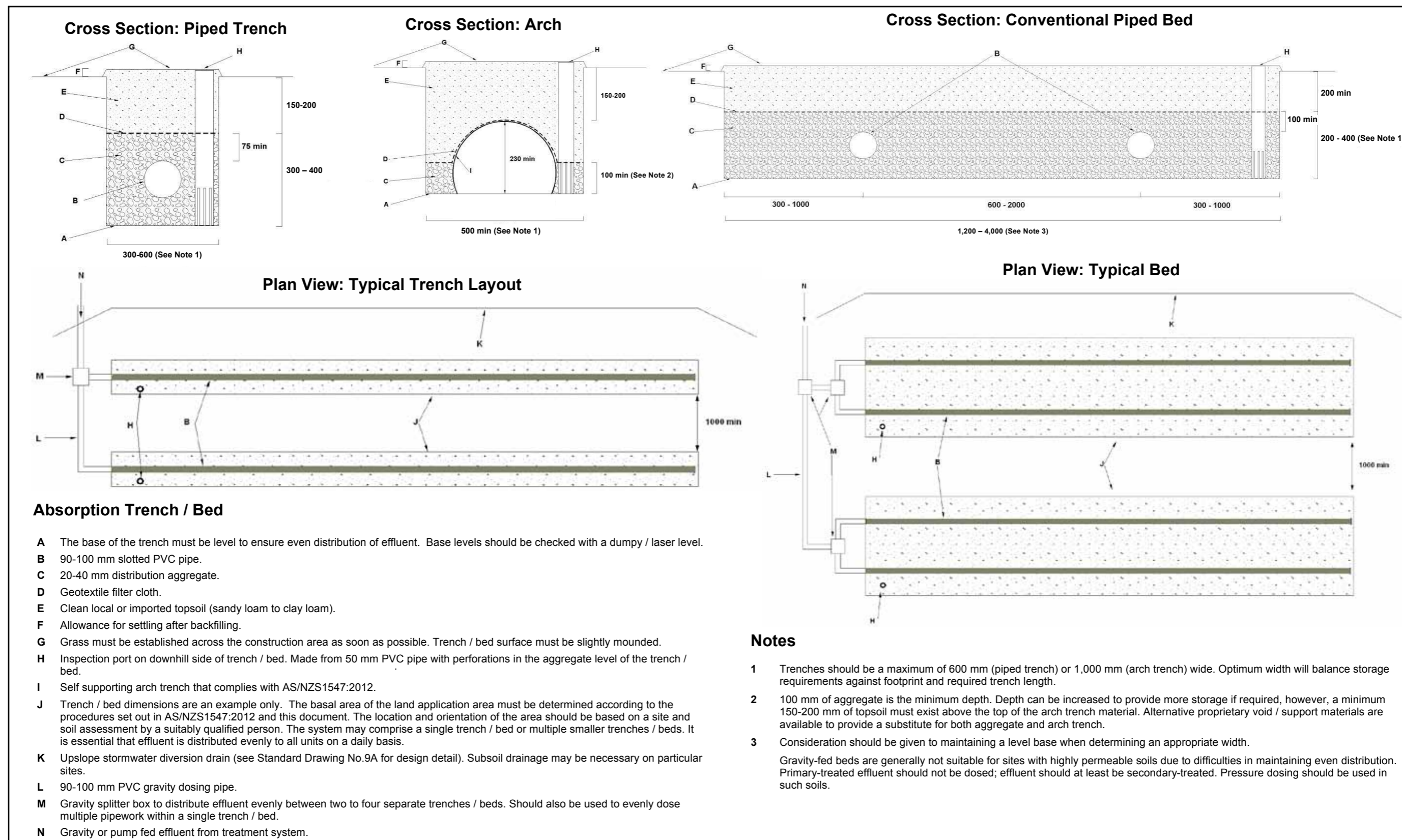
The owner should also perform a number of general maintenance and operational tasks, including:

- ensuring all products used in the household are safe for the system (bleaches and many household cleaning products are not)
- managing vegetation around the trench / bed and tank (including mowing grass around the trench area for maximum exposure)
- ensuring a continuous power supply to the system where a pump well is installed. The power to the system should not be turned off when the house is unoccupied.
- Calling a plumber as soon as practicable if a pump well alarm activates.

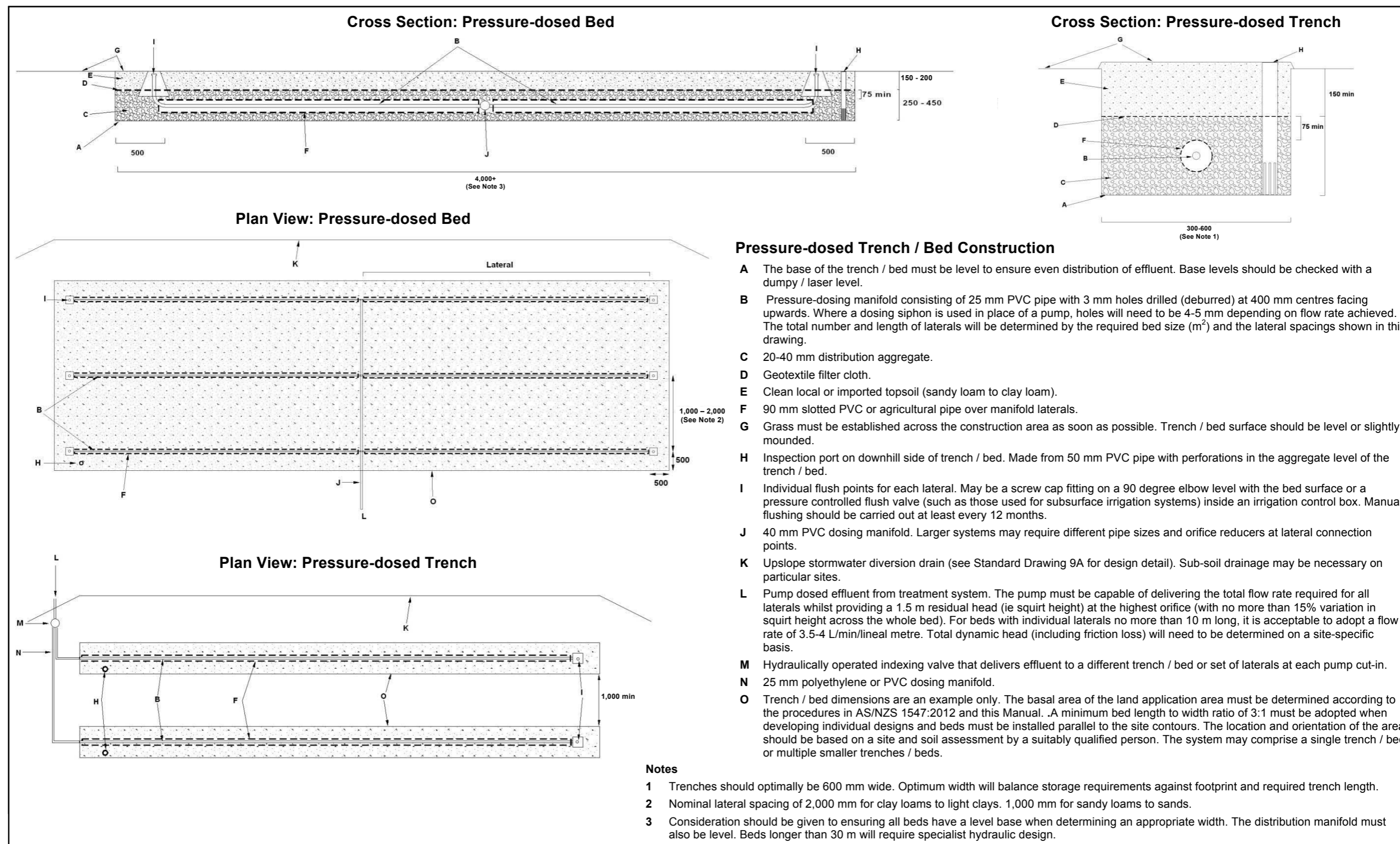
Checklist 10.2 details items to be checked during a regular maintenance inspection for an absorption system.



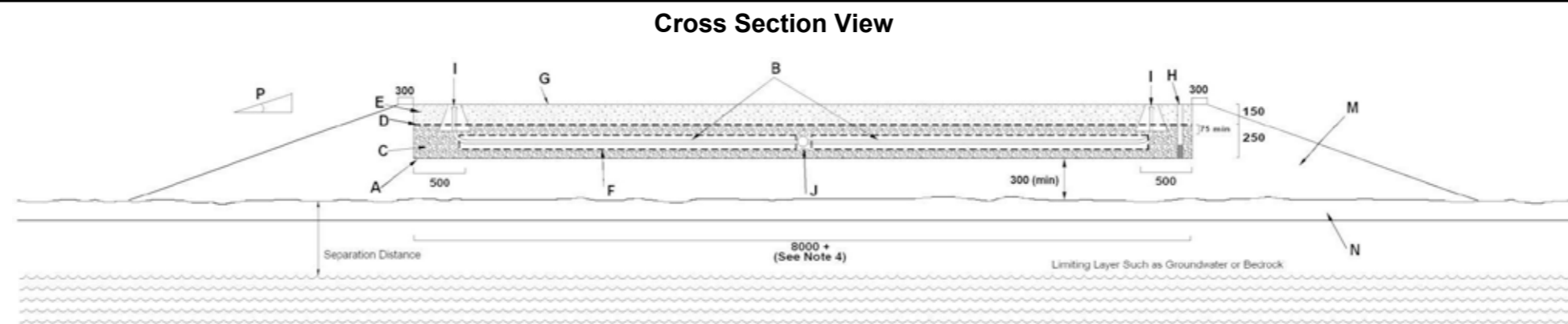
Standard Drawing 10A - Upslope Diversion Drain
(not to scale)



Standard Drawing 10B - Absorption Trench / Bed
(not to scale)

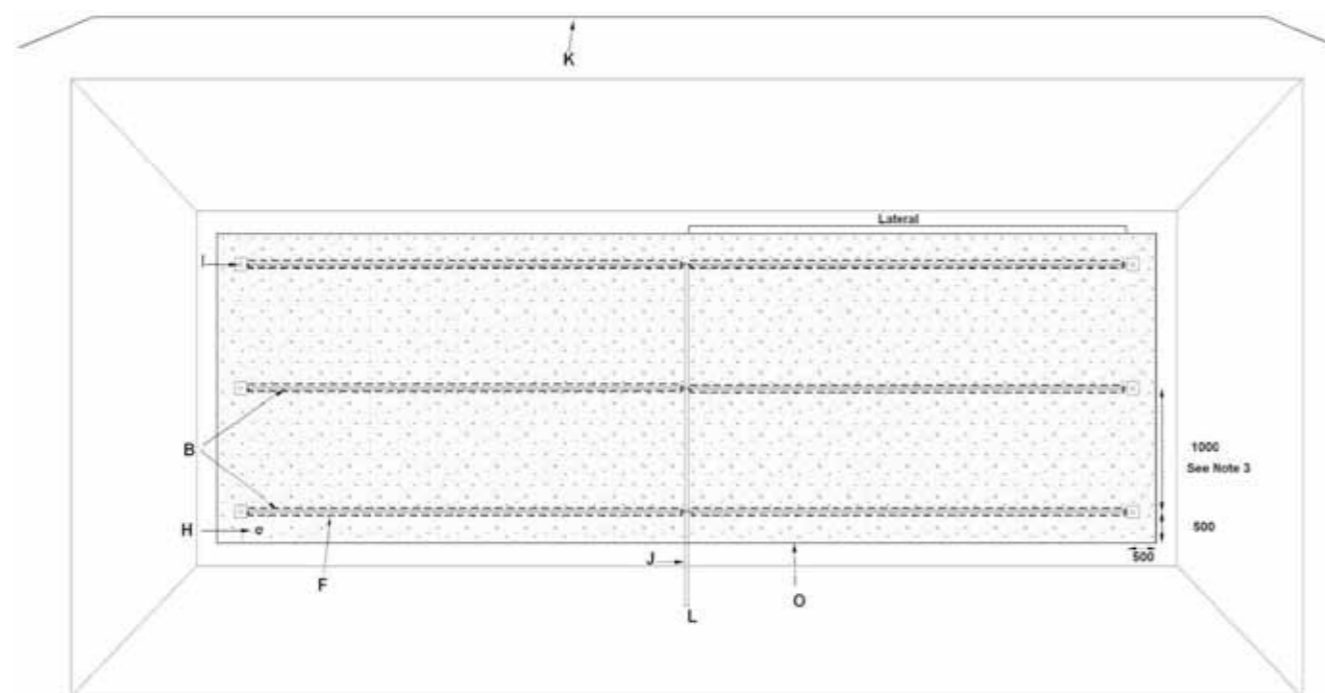


Standard Drawing 10C - Pressure-dosed Bed / Trench
(not to scale)



Raised Pressure-Dosed Absorption Bed Construction

Plan View



- A** The base of the trench must be level to ensure even distribution of effluent. Base levels should be checked with a dumpy / laser level.
- B** Pressurised dosing laterals consisting of 25 mm PVC pipe with 3 mm holes drilled (deburred) at 400 mm centres facing upwards. The total number and length of laterals will be determined by the required bed size (m^2) and the lateral spacings shown in this drawing. It is essential that effluent is distributed evenly across the distribution bed. A residual head (or squirt height) of 1.5 m should be achieved across the distribution laterals. The squirt height across the laterals must be tested prior to covering with agricultural / slotted pipe, with no more than 15% variation in height observed. Consideration must also be given to static head and friction loss when sizing pumps. A full hydraulic design must be carried out.
- C** 20-40 mm distribution aggregate.
- D** Geotextile filter cloth.
- E** Clean local or imported topsoil (sandy loam to loam).
- F** 90 mm slotted PVC or agricultural pipe over manifold laterals.
- G** Grass must be established across the construction area as soon as possible. The bed surface should be slightly mounded.
- H** Inspection port on downhill side of trench / bed. Made from 50 mm PVC pipe with perforations in the aggregate level of the trench / bed.
- I** Individual flush points for each lateral. May be a screw cap fitting on a 90 degree elbow level with the bed surface or a pressure controlled flush valve (such as those used for subsurface irrigation systems) inside an irrigation control box. Manual flushing should be carried out at least every twelve months.
- J** PVC or polyethylene dosing manifold. Larger systems may require different pipe sizes and orifice reducers at lateral connection points.
- K** Upslope stormwater diversion drain. Subsoil drainage may be necessary on particular sites.
- L** Pump dosed effluent from treatment system (minimum primary treatment with an outlet filter).
- M** The base of each absorption bed is to be raised to a height of 300 mm above the final ground surface (total bed height 700 mm). Compaction should be minimised when installing the bed. The fill must be a loam to sandy loam with minimal clay content.
- N** Prepare the site by clearing all shrubs, trees and boulders. Cut trees to ground level and then grind the stump out to a depth of 300 mm and backfill with permeable material such as the natural topsoil or sand (definitely not clay). Scarify the natural soils across the entire basal area to a minimum depth of 200 mm taking care not to compact the basal area in the process. This should extend to at least 1m beyond the perimeter.
- O** The bed dimensions shown are an example only. The basal area of the land application area must be determined based on the load and soil characteristics of the site. **A minimum bed length to width ratio of 3:1 must be adopted when developing individual designs and beds must be installed parallel to the site contours.** The location and orientation of the area should be based on a site by a suitably qualified person. The system may comprise a single bed or preferably multiple smaller beds.
- P** Batter slope 1 (vertical):3 (horizontal) maximum.

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

Note 2 Consideration should be given to ensuring all beds have a level base when determining an appropriate width. The distribution manifold must also be level. Beds longer than 30 m will require specialist hydraulic design.

Standard Drawing 10D - Raised Pressure Dosed Absorption Bed Construction

(not to scale)

Checklist 10.1 Installation of trenches and beds for use by plumbers / installers and Council inspectors			
Type of system:			
Method of application	<input type="checkbox"/> Gravity	<input type="checkbox"/> Pump	<input type="checkbox"/> Siphon
Configuration	<input type="checkbox"/> Trench	<input type="checkbox"/> Absorption bed	
Pre-construction considerations			
Is the soil moisture too wet for construction?			<input type="checkbox"/> Yes <input type="checkbox"/> No
Site preparation			
Trench / bed area marked according to site plan / conditions of consent including buffer and setback distances			<input type="checkbox"/> Yes <input type="checkbox"/> No
Trenches / beds positioned according to design requirements for contours			<input type="checkbox"/> Yes <input type="checkbox"/> No
Trench or bed dimensions			
Number of trenches / beds			
Width:	mm	Length:	mm
Depth:		mm	
Trench / bed dimensions consistent with council's consent			<input type="checkbox"/> Yes <input type="checkbox"/> No
Confirm all system elevations			<input type="checkbox"/> Yes <input type="checkbox"/> No
Stake trench / bed boundaries with elevations			<input type="checkbox"/> Yes <input type="checkbox"/> No
Method of excavation:			
Trench / bed bottom graded to specifications			<input type="checkbox"/> Yes <input type="checkbox"/> No
Inspection ports			
Type:		Diameter: mm	
Perforations		<input type="checkbox"/> Slotted	<input type="checkbox"/> Drilled
Grade⁽¹⁾ from tank to trench		<input type="checkbox"/> Above grade (a pump will be required)	<input type="checkbox"/> Below grade
Media			
<input type="checkbox"/> Gravel		<input type="checkbox"/> Sand	<input type="checkbox"/> Other (specify)
Media size and source:		Cleaned and graded <input type="checkbox"/> Yes <input type="checkbox"/> No	
Total media depth: mm		Total amount of media used: m ³	
Distribution system			
Gravity distribution device			<input type="checkbox"/> Yes <input type="checkbox"/> No
Type	<input type="checkbox"/> Splitter box	<input type="checkbox"/> Sequencing valve	<input type="checkbox"/> Drop box <input type="checkbox"/> Other (describe)
Description of header:			

Distribution system access <input type="checkbox"/> None (surface) <input type="checkbox"/> Riser <input type="checkbox"/> Other (give details):			
Valve type (where applicable)			
Alternating / sequencing valve (describe):			
Field sequencing <input type="checkbox"/> Globe <input type="checkbox"/> Gate ball <input type="checkbox"/> Other			
Installation access <input type="checkbox"/> In valve box in the field <input type="checkbox"/> In bedding material <input type="checkbox"/> In dosing tank			
Pressure manifold		Specification:	
Laterals feed configuration			
<input type="checkbox"/> End <input type="checkbox"/> Top <input type="checkbox"/> Centre <input type="checkbox"/> Bottom <input type="checkbox"/> Other (give details):			
Type			
Diameter: _____ mm		Length: _____ mm	
Orifices specifications / spacing / size / orientation (describe):			
Access / protection <input type="checkbox"/> Yes <input type="checkbox"/> No Describe:			
Laterals			
Specification:		Type:	
Diameter: _____ mm	Spacing: _____ mm	Length: _____ mm	
Installation			
Geotextile fabric cover placed over media		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Final topsoil cover			
Depth of topsoil: _____ mm			
Imported material needed		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Nature of material (describe; should be clay loam – sandy loam):			
Stormwater diversion berm / drain where needed		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Grass vegetation cover established over site:			
Service provider:			
Contact number:			
Comments, action or repairs needed: (Where a response in the above Checklist needs extra information or action, specify the action plan and/or the process to fix the problem, or specify an alternative that is being offered)			

Name / title of inspector:	
Signature:	Date:

⁽¹⁾ Grade must be consistent with 'PCA 2004 Plumbing Code of Australia'.

10.5 Inspection

Council should inspect all trenches and beds, and all associated pipe and drainage work before backfilling, to ensure all components are correctly positioned and installed according to 'PCA 2004 Plumbing Code of Australia'. Council should inspect the final installation to ensure it complies with all conditions of consent before issuing an approval to operate the system.

Plumbers, Council inspectors and system owners can use Checklist 10.2 to inspect an absorption system and check that it is operating properly.

10.6 Common technical issues

Plumbers, property owners and regulatory authorities have observed a number of common problems with absorption trench or bed installations, including:

- undersized trenches
- trenches that are connected in series
- trench/bed has an uneven base
- the side of the trench has been smeared with excavator bucket, reducing the hydraulic conductivity of the soil around the trench walls
- uneven distribution of effluent caused by gravity trickle feeding, which predominantly loads the upstream end of the trench or the first trench of a system of trenches
- trenches are constructed too long for even distribution of effluent
- trenches are constructed too short in shallow soils (linear loading rate)
- ineffective distribution boxes to split the flows evenly to trenches
- old trenches that have exceeded their operational life.

Checklist 9.2 Operational mound system inspection report for use by councils and system owners (Note: system includes septic tank and pump well plus mound)		
Owner's name:		
Address:		Council area:
System brand and model:		<input type="checkbox"/> Domestic <input type="checkbox"/> Commercial
Date of service:	Date of last service:	Next service due:
General Comments		
General condition of tank <input type="checkbox"/> Good <input type="checkbox"/> Fair <input type="checkbox"/> Poor		
Comments:		
Septic Tank		
Crust <input type="checkbox"/> Yes <input type="checkbox"/> No		Odour <input type="checkbox"/> Yes <input type="checkbox"/> No
Sludge depth <input type="checkbox"/> High <input type="checkbox"/> Med <input type="checkbox"/> Low		Desludge needed <input type="checkbox"/> Yes <input type="checkbox"/> No
Inlet/outlet junctions clear <input type="checkbox"/> Yes <input type="checkbox"/> No		Good biological activity <input type="checkbox"/> Yes <input type="checkbox"/> No
Pump well (where installed)		
Pump operational <input type="checkbox"/> Yes <input type="checkbox"/> No		Float switches operational and set at appropriate levels <input type="checkbox"/> Yes <input type="checkbox"/> No
Presence of sludge <input type="checkbox"/> Yes <input type="checkbox"/> No		Standby pump switched (if relevant) <input type="checkbox"/> Yes <input type="checkbox"/> No
Electrical components		
Alarm operational		<input type="checkbox"/> Yes <input type="checkbox"/> No
Electrical compartment in good working order		<input type="checkbox"/> Yes <input type="checkbox"/> No
Mound		
Evidence of physical damage (eg digging, erosion) <input type="checkbox"/> Yes <input type="checkbox"/> No		Comments:
Presence of surface ponding / toe leaching / seepage		<input type="checkbox"/> Yes <input type="checkbox"/> No
Excess weed growth on mound and in the area		<input type="checkbox"/> Yes <input type="checkbox"/> No
Incomplete or inappropriate vegetation cover		<input type="checkbox"/> Yes <input type="checkbox"/> No
Inspection port interiors clear (ie no standing water suggesting internal flooding) and in good condition		<input type="checkbox"/> Yes <input type="checkbox"/> No
Service provider:		
Contact number:		

10.7 Case study

A septic tank and absorption trench were installed on a sloping site. The trench was located upslope of the tank. A pump was fitted to the unbaffled septic tank to pump to the trench. Within months the trench began to overflow and the pump burnt out.

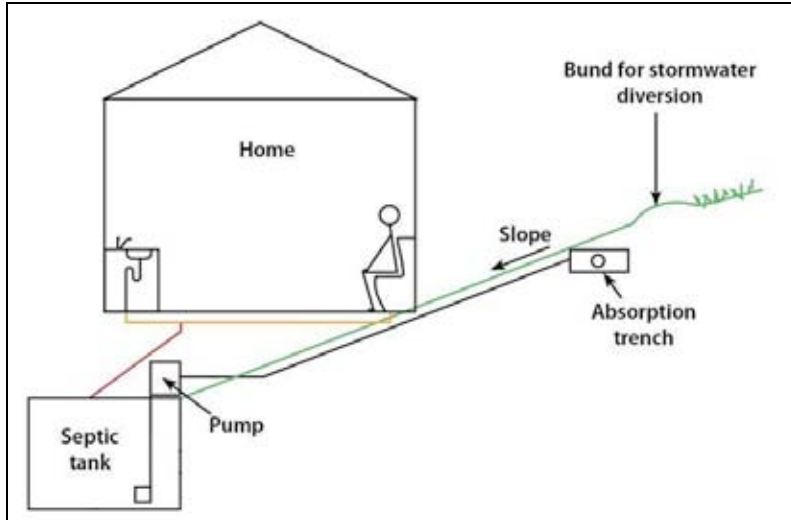


Figure 10.8 Septic tank and upslope trench - design problem

Problem

The pump began to pump solids to the trench causing the trench to clog and overflow (Figures 10.9 and 10.10). The pump was working hard to pump solids to the trench that eventually caused a blockage and the pump to burn out.

Solution

Install an outlet filter in the septic tank to improve effluent quality. Install a pump well (Figure 10.10) after the septic tank with a suitably sized pump to pump the clarified liquid to the absorption trench. This minimises the work required of the pump and reduces the amount of solids discharged to the trench, prolonging its life. Ideally a baffled tank should be installed.



Figure 10.9 Failing trench



Figure 10.10 Failing trench

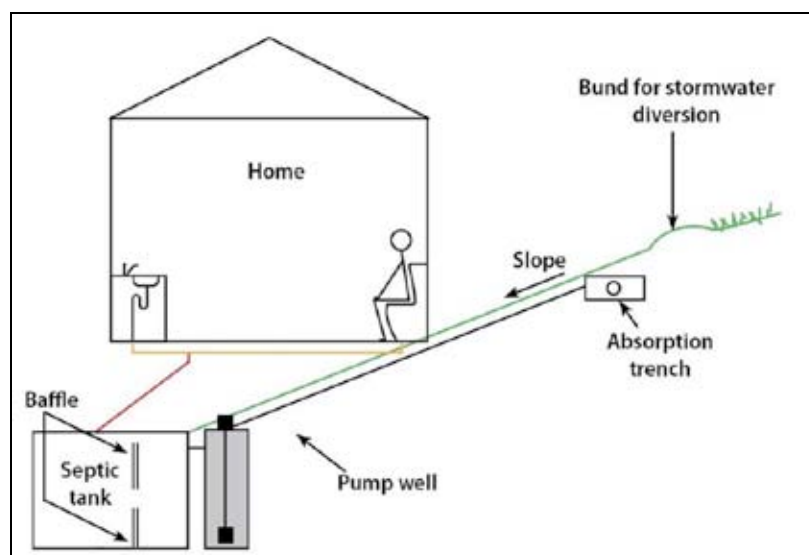


Figure 10.10 Septic tank and upslope trench - design solution

10.8 'Wick' trenches

'Wick' trenches are an emerging technology that may be suitable for small sites with limited space for land application and where low hydraulic conductivity soils need extensive trench lengths. The 'Wick' trench combines absorption and evapotranspiration to best use the available space between trenches in the land application area.

These trenches were developed by Kerry Flanagan Wastewater to use in clay soil areas. The design is provided as an alternative to standard absorption trenches. The non-woven, needle punched geotextile fabric (250 g/m² minimum weight) acts as a wick to distribute effluent over a transpiration bed adjacent to the trench. This provides a larger surface area with more potential for evapotranspiration and greater infiltration capacity than would be available using a standard absorption trench. The 'Wick'

trench also allows reserve in the design. It can be used on sloping sites by creating terraces for each trench.

'Wick' trench sizing

Typically the 'Wick' trench will be built with an evapotranspiration bed approximately twice the width of the trench. For example, a bed 1,200 millimetres wide with a 600 millimetre wide trench as shown in Figure 10.10. The trench is built using an arch trench that is a plastic self supporting arch 410 millimetres wide and 1,500 millimetres long.

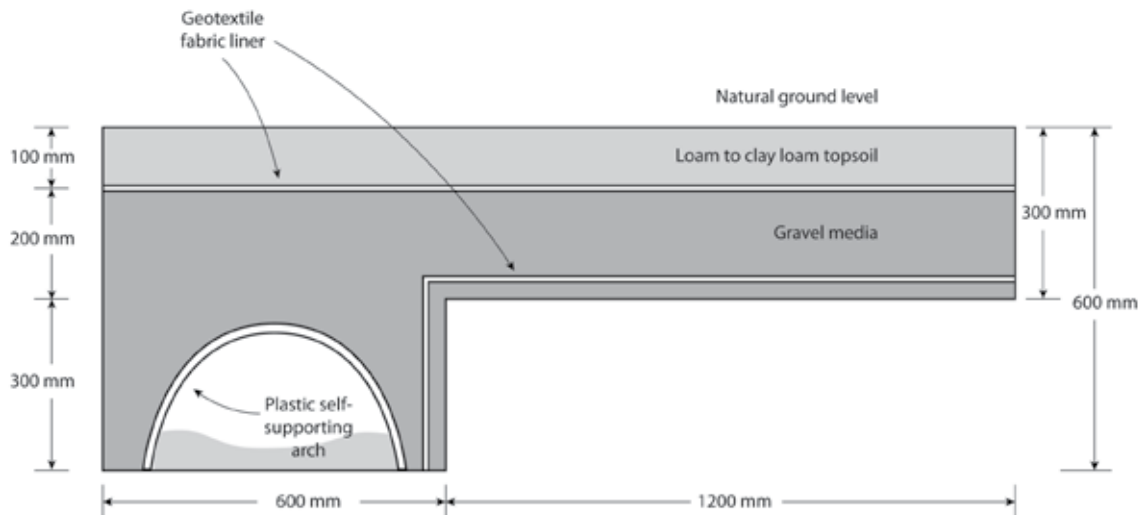


Figure 10.11 Cross section of a "Wick" trench

The required length of 'Wick' trench can be calculated using the daily design wastewater load (L/day) and the design loading rates (DLR) for absorption trenches and evapotranspiration beds in AS/NZS 1547:2012.

For a conservative design, the designer recommends using the formula:

$$L = Q / \text{DLR} \times (W/1.2)$$

Where:

- L = total length of 'Wick' trench required in metres
- Q = design daily wastewater load in litres a day
- DLR = design loading rate for trenches in mm per m² per day
- W = total width of trench and bed in the combined 'Wick' trench

Example

To size a 'Wick' trench for a typical three bedroom, five person home on a Category 4 clay loam soil with tank water supply:

Design daily wastewater load $Q = 3 \times 200 \text{ L} = 600 \text{ L}$

Design loading rate = 10 mm/m²/day for primary treated effluent

- 1) For an arch trench of 0.6 m width alone, the required trench length is determined by

$$L = 600 / (10 \times 0.6)$$

$$L = 600/6$$

$$L = 100 \text{ m}$$

Therefore 5 X 20 m arch trenches are recommended.

- 2) For a 'Wick' trench comprising an arch trench of 0.6m width with a 1.2m 'Wick' bed.

$$L = 600 / (10 \times (1.8/1.2))$$

$$L = 600 / (10 \times 1.5)$$

$$L = 600 / 15$$

$$L = 40 \text{ m}$$

Therefore 3 x 14 m 'Wick' trenches are recommended.

The following points should be noted when installing a 'Wick' trench:

- NSW Health non-disinfected effluent to be disposed of at a soil depth of more than 300 millimetres for both trenches and beds (NSW Health, 2008).
- Avoid uneven areas when choosing where to put the trench. If a level area cannot be used, terrace the area for the trench.
- Ensure the trench has a uniform depth of soil across the finished surface for even, uniform performance along the trench.
- Avoid filling hollows across the contour as this may interfere with effluent distribution.
- The original ground level of the land application area should be 100 to 150 millimetres below the invert of the tank outlet. If the tank outlet invert is 400 millimetres from the top of the tank, the ground level where the trench will be built must be at least 550 millimetres lower than the ground where the tank is located.
- Where it is impossible to achieve 550 millimetres height separation between the tank and trench, use a pump and pump well to load the trench
- The septic tank must be desludged at appropriate intervals to ensure that sludge does not flow into the trench, reducing trench performance.

'Wick' trench installation

1. Set out the trench area and instruct the excavator operator where to cut (Figures 10.12 and 10.13).



Figure 10.12 and 10.13 Excavation of the bed of the "Wick" trench

2. Excavate the transpiration pan while digging the trench for the self supporting drain.
3. Excavate the pan 300 millimetres deep and the trench 600 millimetres deep. Levels need to be continuously checked.
4. After excavation is complete, lay the liner fabric (not geotextile fabric) in the trench and position the self-supporting arch trench (Figure 10.14).
5. Lay the geotextile fabric only on the side of the trench and then so it continues across into the pan area (Figure 10.15). This is the 'wick'. Do not use geotextile fabric on the bottom of the trench as it will clog.



Figure 10.14 and 10.15 Laying the liner in the trench and then the geotextile fabric as the 'wick' across the pan

6. Spread clean recycled 20 millimetre gravel across the pan and into the trench (Figure 10.16). Gravel should be as clean as possible. Some recycled gravel may not be washed (check with your supplier).
7. Place another layer of geotextile fabric over the top of the trench (Figure 10.17).



Figure 10.16 Backfilling gravel layer



Figure 10.17 Adding the second geotextile fabric layer

8. Select a good permeable soil for back filling. Never backfill with the clay soil from the lower soil horizons.
9. Ensure that connection points can be inspected whether pumped or gravity fed. Use inspection openings at trench entry points and connection points to other trenches (Figure 10.18).
10. Install a mica-flap vent at ground level, at the end of the trench to allow air to flow through the trench, up the drain line into the tank, and continue up the drainage and expel through the roof vent. This will improve the environment in the system by increased aeration.



Figure 10.18 Backfilling and the inspection ports

Section 11:

Evapotranspiration Absorption Beds

11. Evapotranspiration Absorption Beds

11.1	Design	143
11.2	Installation	143
11.3	Testing	151
11.4	Operation	151
11.5	Inspection	151
11.6	Common technical issues	151
11.7	Case study	154

An evapotranspiration absorption (ETA) bed maximises loss of water by evapotranspiration, whilst reducing the reliance on absorption. ETA beds are often used where site limitations prevent the use of irrigation (lack of space) or absorption trenches (presence of clayey soils). An ETA bed is usually used to dispose of wastewater from a septic tank, but it can also be used to manage secondary treated effluent.

ETA beds are generally unlined beds with some deep seepage. Capillary action draws effluent up through the sand in the upper part of the ETA bed from the storage in the void spaces in the gravel bed beneath. This supplies the root zone of the vegetation (usually grass) on the top of the bed to optimise evapotranspiration. Effluent is distributed through the bed by a system of slotted pipes.

Vegetation cover must be well maintained to ensure strong growth for maximum uptake by transpiration. The surrounding landscape and vegetation must also be maintained to minimise shading and maximise exposure.

Figure 11.1 shows an ETA bed and Standard Drawing No.11A shows a cross section view.



Figure 11.1 An evapotranspiration absorption bed

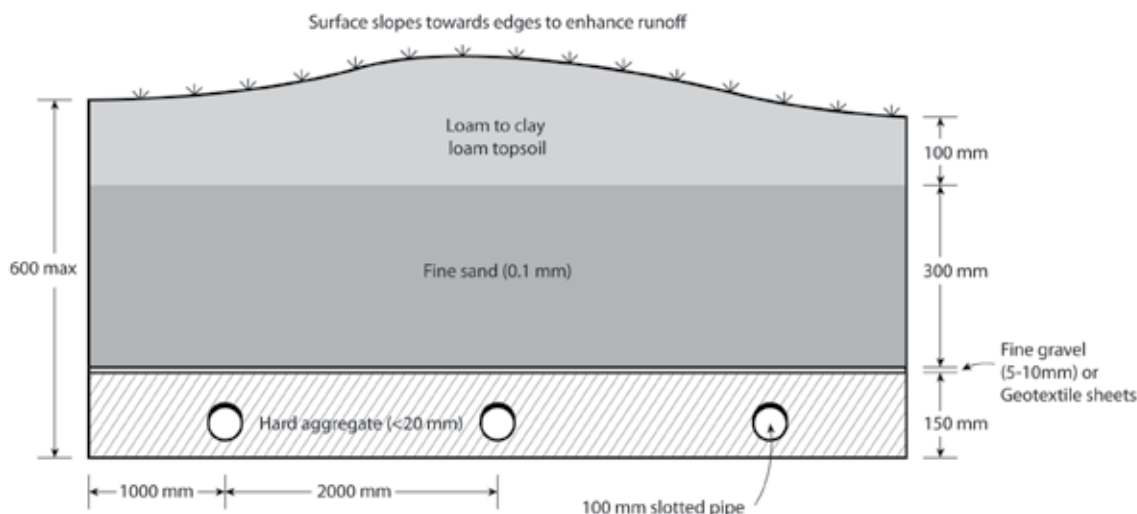


Figure 11.2 Cross section of an ETA bed (unlined) (after Patterson, 2006)

11.1 Design

The ETA bed should be designed with consideration for the site and soil assessment detailed in Section 2 of this Manual. The ETA bed should be sized according to the recommendations in AS/NZS 1547:2012. Council approval is required to install an ETA bed requires council approval under the *Local Government Act 1993* and it must comply with Sydney Catchment Authority and Council requirements for buffer distances and setbacks from significant site features. The following points should also be considered.

- All ETA beds should be designed using hydraulic balance modelling. This will ensure the best bed size and contain construction costs.
- The hydraulic balance determines the volume of storage in the gravel bed. This ensures the bed does not overtop in prolonged wet periods when evapotranspiration losses are lower than inputs from rainfall and effluent load.
- The bed must be turfed immediately following construction.
- ETA beds are constructed with a domed upper surface to shed rainfall. The steeper the slope the more rainfall that will be shed.
- The bed must be located where it will be well exposed to ensure maximum evapotranspiration.

Designer accountability

More accountability for the design is provided by the designer providing a Design Producer Statement where they warrant the design. Appendix 2 includes an example of a Design Producer Statement.

11.2 Installation

A number of installation techniques should be used for effective long term operation of an ETA bed. Common failures of ETA beds are often caused by poor installation practices. Follow the steps below when installing an ETA bed.

Step 1 Site preparation

- Obtain a copy of the Council approved plans and conditions of consent. Locate beds accurately as shown on the site plans and according to the specified and approved design and/or any covenant. If there is any change in their position from the site plans, a Section 96 application (from the *Environmental Planning and Assessment Act 1979*) must be made to council to alter their position.

Step 2 Positioning

- Beds must be built along the contours to ensure even distribution and avoid any one part of the bed being more heavily loaded. Failure to do this could lead to premature failure of the most heavily loaded part of the bed, followed by creeping failure as the effluent is forced to more distant parts of the bed.
- Avoid cutting beds through existing weakened ground (eg through the alignments of former underground pipes, cables or conduits) as they may provide preferential pathways for effluent to escape from the bed. If these pathways cut downslope through the ground occupied by a series of beds, effluent may preferentially flow to the lowest bed causing it to fail or surcharge. Where the bed must be cut into an alignment or it is done accidentally, seal any weaknesses in the trench walls with cement or bentonite grout.

Step 3 Timing

- Beds should be built in fine weather. If rain does fall before the beds are completed, cover the beds to protect them from rain damage.
- Once dug, beds must be completed promptly to avoid foreign material being washed into the open excavation. Puddling (where clay settles at the bottom of a water filled bed left exposed to rain) must be avoided, as the clay on the base of the bed will reduce its performance.

Step 4 Excavation

- The base of any bed should be carefully excavated and levelled with a dumpy or laser level. The bed must be level both along and across the line of the bed. Effluent will drain down any slope across the base of the bed and preferentially load the downslope side of the bed, which may then fail or surcharge.
- Where beds are dug along the contour on sloping ground, and by an excavator that does not have a pivoting bucket, the base of the bed will probably be cut parallel to the ground surface. In this case, the base of the bed will have a fall towards the down-slope side. The bed should be further hand dug to ensure a level base, and to prevent effluent accumulating against the downslope wall of the bed.
- Where beds are dug by an excavator in more clayey soils, scarify the bed walls to remove any smearing caused by the excavator bucket.

Step 5 Construction

- Do not use ETA beds if the soil is dispersive. However, if a degree of dispersiveness is identified after the trenches are dug, add gypsum to the trench base at the rate of one kilogram a square metre. ETA beds are not suitable for medium to heavy clay soils.
- Ensure that the sides of beds are not damaged or caused to collapse when the beds are filled.

- Lay geotextile on top of the gravel media in a bed and beneath the sand to ensure that the sand does not penetrate and block the gravel media.
- Test piping with clean water before filling with gravel or sand to ensure that effluent is evenly and effectively distributed.
- Apply 150 millimetres of topsoil to the top of the bed and leave it mounded above the completed bed to allow for settlement and encourage rainfall to run off.
- Turf the top of the bed promptly after construction to ensure the best uptake of effluent by evapotranspiration. Ensure that deep rooting trees or shrubs are not planted close to the beds to reduce the chance of roots intruding and clogging the beds.
- Build a stormwater diversion berm/drain on sloping sites to avoid stormwater filling the ETA bed. Standard Drawing No. 11A provides detail about building a stormwater diversion drain.

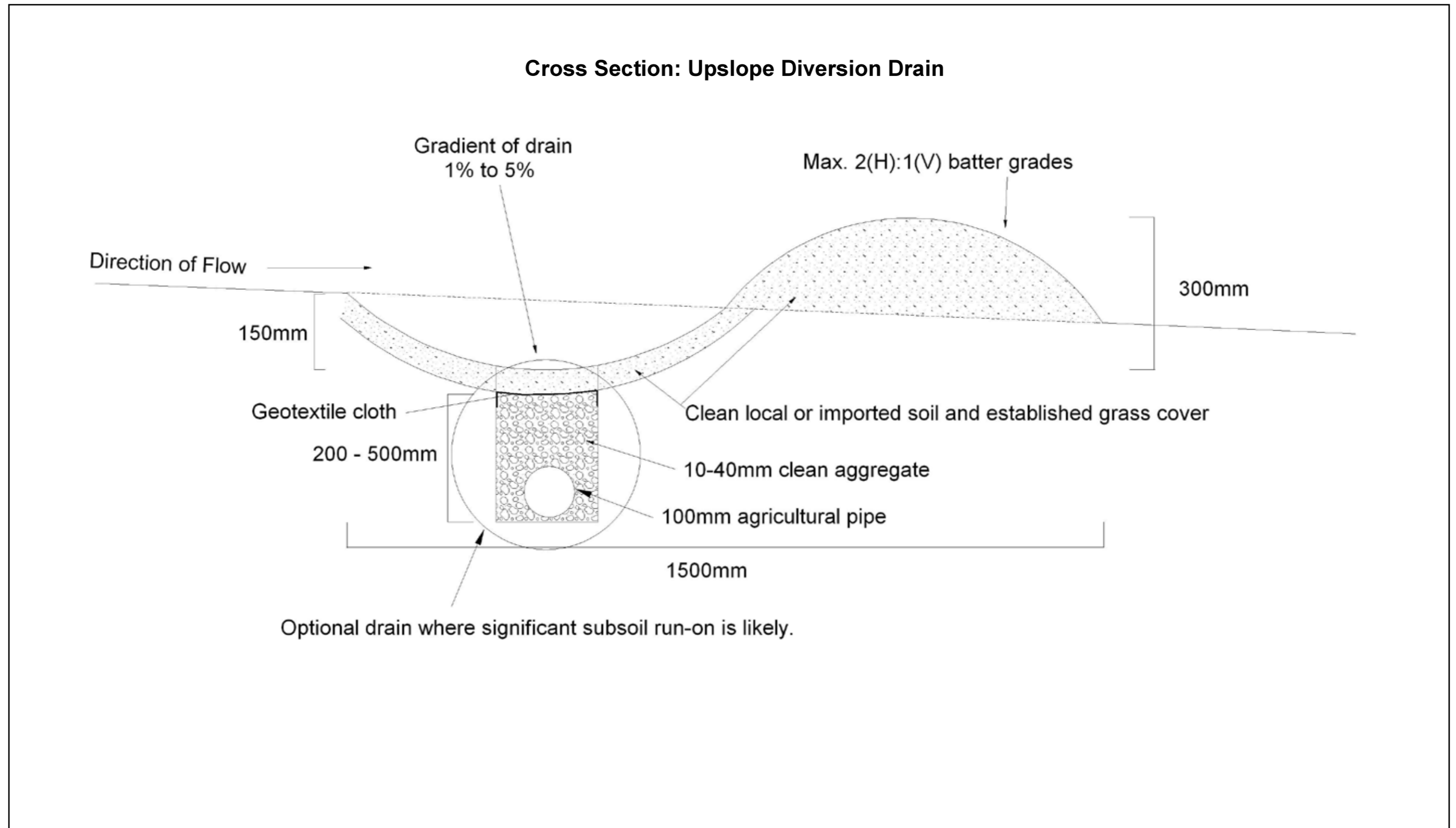
Step 6 Dosing

- ETA beds may be gravity-fed or pressure-dosed using pumps or dosing siphons. Where there are shallow soil limiting layers present (eg bedrock or water table), and there is not enough separation distance (Section 2) from such layers, raised pressure-dosed ETA beds are a possible alternative. In these situations the linear loading rate must also be addressed.
- The annotated Standard Drawing No. 11B describes the installation of evapotranspiration absorption beds. Checklist 11.1 provides guidance on aspects of an evapotranspiration absorption system that should be checked by the installer and regulator.

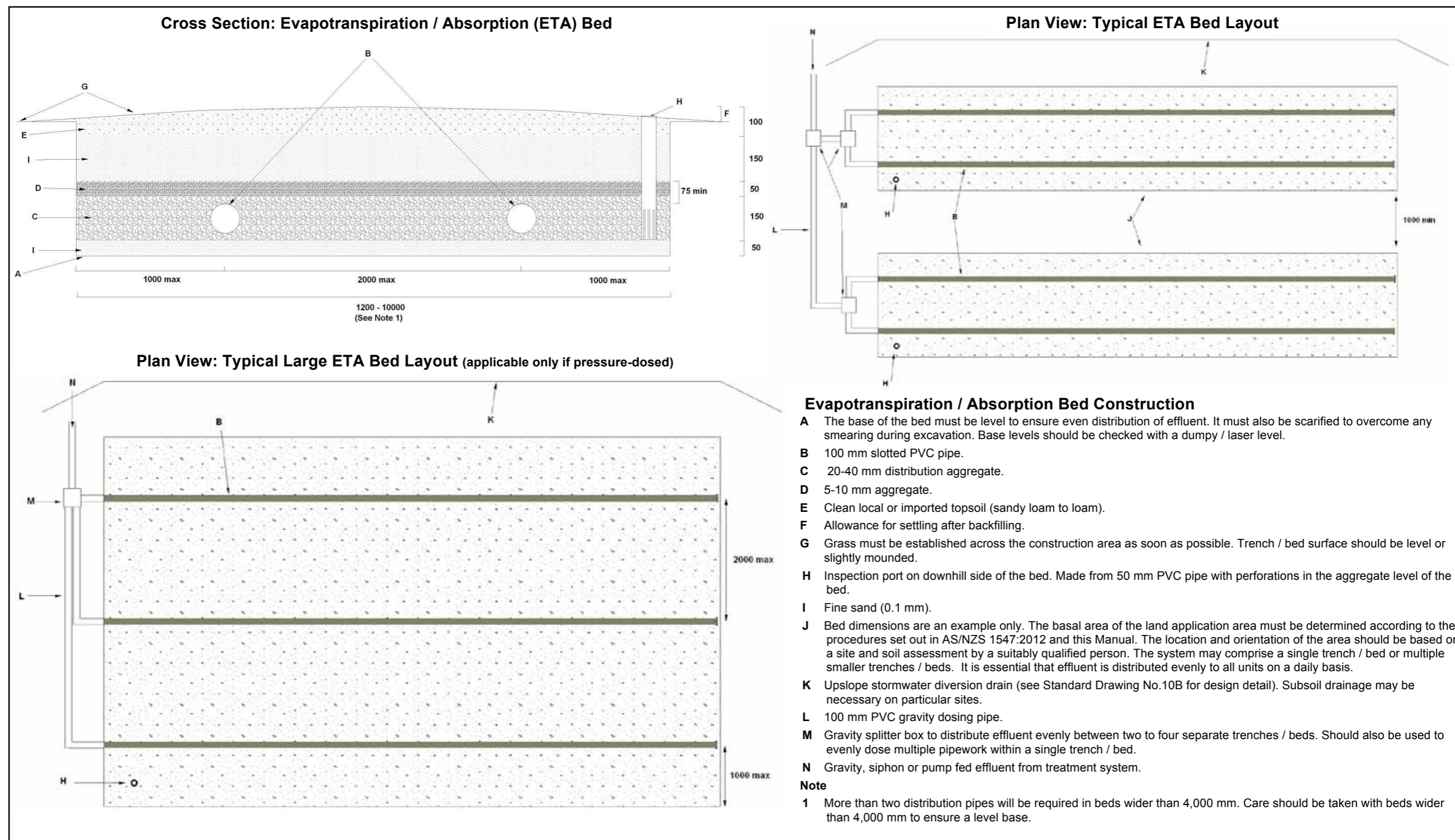
System Design

Communication between the designer and installer is improved by the designer preparing a System Design. This report conveys critical details of the design to the installer. It describes and quantifies the design and illustrates the appropriate layout and configuration of the system with appropriate plans and sketches. Appendix 3 includes an example of a System Design.

Finally, the installer provides an Installation Certificate that confirms the system was installed as described in the relevant sections of the Design Producer Statement. Appendix 4 includes an example of an Installation Certificate.



Standard Drawing 11A - Upslope Diversion Drain
(not to scale)



Standard Drawing 11B - Evapotranspiration / Absorption Bed
(not to scale)

Checklist 11.1 Installation of ETA beds for use by plumbers / installers and Council inspectors					
Type of system:					
Method of application		<input type="checkbox"/> Gravity	<input type="checkbox"/> Pump	<input type="checkbox"/> Siphon	
Configuration		<input type="checkbox"/> Trench	<input type="checkbox"/> Absorption bed		
Pre-construction considerations					
Is the soil moisture too wet for construction?				<input type="checkbox"/> Yes	<input type="checkbox"/> No
Site preparation					
Bed area marked according to site plan / conditions of consent including buffer and setback distances				<input type="checkbox"/> Yes	<input type="checkbox"/> No
Bed is positioned according to design requirements for contours				<input type="checkbox"/> Yes	<input type="checkbox"/> No
Bed dimensions					
Number of beds:					
Width:	mm	Length:	mm	Depth:	mm
Bed dimensions are consistent with council's consent				<input type="checkbox"/> Yes	<input type="checkbox"/> No
Confirm all system elevations				<input type="checkbox"/> Yes	<input type="checkbox"/> No
Stake bed boundaries with elevations				<input type="checkbox"/> Yes	<input type="checkbox"/> No
Method of excavation:					
Bed bottom graded to specifications				<input type="checkbox"/> Yes	<input type="checkbox"/> No
Inspection ports					
Type:			Diameter:		
			mm		
Perforations:		<input type="checkbox"/> Slotted	<input type="checkbox"/> Drilled		
Grade⁽¹⁾ from tank to trench		<input type="checkbox"/> Above grade (a pump will be needed)		<input type="checkbox"/> Below grade	
Media					
Coarse aggregate specifications and source:			Fine aggregate specifications and source:		
Gravel type:			Aggregate type:		
Depth:			Depth:		
Cleaned and graded	<input type="checkbox"/> Yes	<input type="checkbox"/> No	Cleaned and graded	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Total media depth:			mm		
Amount of media used:			m ³		

Distribution system					
Distribution device:					
<input type="checkbox"/> Gravity			<input type="checkbox"/> Pressure		
Type: <input type="checkbox"/> Splitter box		<input type="checkbox"/> Drop box (for serial distribution)		Type: <input type="checkbox"/> Pump <input type="checkbox"/> Siphon	
Description of header:			Valve type:		
Installation level:			<input type="checkbox"/> Alternating / sequencing		<input type="checkbox"/> Globe
Type of stable bedding material used:			<input type="checkbox"/> Gate ball		<input type="checkbox"/> Other
Manual valve (describe):					
Access					
<input type="checkbox"/> Riser	<input type="checkbox"/> In valve box in the field	<input type="checkbox"/> In bedding material	<input type="checkbox"/> In dosing tank	<input type="checkbox"/> Other (give details):	<input type="checkbox"/> None
Pressure manifold Specification:					
Lateral feed configuration					
<input type="checkbox"/> End <input type="checkbox"/> Top <input type="checkbox"/> Centre <input type="checkbox"/> Bottom <input type="checkbox"/> Other (give details):					
Type					
Diameter: mm			Length: mm		
Orifices specifications / spacing / size / orientation (describe):					
Access / protection:			<input type="checkbox"/> Yes <input type="checkbox"/> No		Describe:
Laterals					
Specification:			Type:		
Diameter: mm		Spacing: mm		Length: mm	
Installation					
Geotextile/fabric cover placed over gravel			<input type="checkbox"/> Yes		<input type="checkbox"/> No
Final topsoil cover					
Depth of topsoil cover:			mm		
Imported material used			<input type="checkbox"/> Yes		<input type="checkbox"/> No
Nature of material (describe; should be clay loam-sandy loam):					
Stormwater diversion berm/drain constructed			<input type="checkbox"/> Yes		<input type="checkbox"/> No
Turf planted:					
Nature of protection of ETA beds (describe):					

Service provider:	
Contact number:	
Comments or repairs needed: (Where a response in the above Checklist needs extra information or action, specify the action plan and/or the process to fix the problem, or specify an alternative that is being offered)	
Name / title of inspector:	
Signature:	Date:

11.3 Testing

Test ETA beds with clean water before placing any media to ensure even distribution. If pressure-dosed, pressure test the piping to ensure uniform squirt height at each orifice and that any sequencing valve is working (Figure 11.2).

11.4 Operation

The owner should inspect the bed regularly. This detailed maintenance inspection should include:

- checking any pumps or siphons are working correctly. If the system includes a standby pump, it should be alternated with the working pump regularly to ensure that the work hours on both are approximately equal
- checking any splitter or drop down boxes are working effectively, and/or manual valves are switched between beds
- inspecting the control system and ensuring that it is set to deliver appropriate volumes of effluent to specific irrigation fields according to the design hydraulics
- checking around the bed for signs of leakage
- checking the water level in any inspection ports to ensure the bed is not flooded. Beds are designed to hold water for evapotranspiration, but if the bed becomes flooded the turf covering will die off.

General maintenance

The system owner must complete a number of general maintenance and operational tasks, including:

- addressing maintenance issues identified by the service provider
- ensuring all products used in the household are safe for the system (bleaches and many household cleaning products are not safe)
- ensuring the tank is regularly desludged to limit the amount of solids carried over into the bed. Section 3 of this Manual contains details on desludging a septic tank
- inspecting and cleaning the outlet filter of any septic tank every three months
- managing vegetation around the tank and bed (including mowing and trimming back bushes for maximum exposure)
- ensuring the system has a continuous power supply. The system power should not be turned off when the house is unoccupied
- ensuring a plumber is contacted as soon as practicable if an alarm activates.

11.5 Inspection

The ETA bed and all associated pipe and drainage work should be inspected by a Council inspector before backfilling, to ensure all components are correctly positioned and installed according to 'PCA 2004 Plumbing Code of Australia'. Council should make a final installation inspection to ensure compliance with all conditions of consent before issuing an approval to operate the system.

Checklist 11.2 can be used by plumbers, council inspectors and system owners to inspect operating ETA beds.

11.6 Common technical issues

Plumbers, property owners and regulatory authorities have observed a number of common problems with ETA bed installations including:

- inadequate hydraulic design resulting in undersized beds

- uneven distribution on flat sites, commonly caused by gravity feeding through a slotted pipe where most effluent escapes from the first few slots and is not evenly distributed throughout the bed. This can be fixed by pressure dosing through a smaller aperture drilled pipe
- inadequate 'in-bed' storage that causes surface saturation and surcharging
- beds that are built too large in surface area to sustain the surface vegetation in dry weather
- beds that are built too short along the contour (linear loading rate)
- inadequate exposure to wind, or shading by shrubs and trees lowering the rate of evapotranspiration
- accumulated salts due to a lack of deep seepage that is needed to ensure salts are periodically flushed from the system.

Checklist 11.2 Operation of ETA beds for use by plumbers, Council inspectors and system owners	
Is there evidence of surface water or soggy ground on the trench / bed area (eg after emptying a bath)?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Are some trenches or beds greener than others?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is there evidence of stormwater intrusion?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is there any indication that water on the surface of the trench or bed is effluent (can test for using Nessler's reagent)?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is there an indication of poor drainage on or near the bed area?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is there evidence of vehicle, human or animal traffic over the trench / bed area?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is there evidence of protective measures to prevent trench / bed damage (eg shrubs, fencing)?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is a good vegetation cover established over the trench / bed surface?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Does the trench / bed have good exposure to wind and sun?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Are the inspection port interiors clear (ie no standing water suggesting trench flooding) and in good condition?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is the dosing siphon or splitter box working properly and not blocked or clogged?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is any pump or siphon operating correctly?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is the control system set correctly to deliver appropriate volumes of effluent to specific irrigation fields according to the hydraulic design?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Are regular desludges of the tank undertaken?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Has the septic tank outlet filter been cleaned by way of hosing the filter off?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Service provider:	
Contact number:	
Comments or repairs needed: (Where a response in the above Checklist needs extra information or action, specify the action plan and/or the process to fix the problem, or specify an alternative that is being offered)	
Name / title of inspector:	
Signature:	Date:

11.7 Case study

An ETA bed was installed on a flat site with limited available area for on-site wastewater management. A few months later the bed began to show signs of surface seepage at one end.

Problem

The bed was not pressure-dosed or dosed by a siphon. All effluent was seeping out of the first few holes in the distribution laterals and not reaching the other end of the bed. The soil at the upstream end of the bed became saturated and could not accommodate the daily wastewater load from the house. The other end of the bed was not receiving any effluent.

Solution

A pump well was installed to pump or siphon the clarified effluent to the ETA bed. The pump was hydraulically sized taking into account the head needed from the pump well to the bed, pressure loss in the pipes, and the desired flow pressure needed from the laterals to evenly distribute effluent throughout the bed. Once pressurised, the ETA bed was restored to operation and it continues to work well. Figure 11.2 shows the testing for squirt height from the distribution laterals to ensure even distribution of effluent. Gravity feeding a bed may be acceptable on sloping sites.



Figure 11.2 Pressure testing the distribution laterals for even distribution of effluent (www.inwater.com.au)

Section 12: Surface Irrigation

12. Surface Irrigation

12.1	Design	156
12.2	Installation	158
12.3	Testing	163
12.4	Inspection	163
12.5	Operation	168
12.6	Common technical issues	168
12.7	Case study	169

Surface irrigation (Figure 12.1) of secondary treated and disinfected effluent is permitted in NSW. However, surface irrigation has limitations because it increases the chance of human contact with the effluent. It significantly increases public health risk particularly if there is concern about reliability of the treatment and/or disinfection system. The most common disinfection process, chlorination, does not kill all pathogens. Surface saturation and runoff of effluent are also more likely with surface irrigation.

When considering installing surface irrigation effluent disposal, a number of factors must be examined on a case-by-case basis, including:

- whether the site is high risk due to high slope, shallow soil or unsuitable soil type
- whether the site is subject to severe frosts
- proximity of any neighbours
- proximity of the proposed irrigation area to the dwelling
- annual average rainfall (should be less than 1,200 millimetres)
- slope of the effluent irrigation area (should be less than seven percent (four degrees)).



Figure 12.1 A surface irrigation sprinkler

A wide variety of surface irrigation systems are available including rotary, impact, spray nozzle and dripper systems. Spray heads can be a fixed riser or pop-up sprinkler. The Sydney Catchment Authority does not permit the use of moveable sprinklers. Sprays must not generate aerosols and must have a throw and plume height that is suitable for the site. This will vary depending on proximity to buildings, recreation areas and other sensitive environments. Owners must also consider the logistics of maintenance and mowing grass.

12.1 Design

A surface irrigation system should be designed considering the site and soil assessments outlined in Section 2 of this Manual. An irrigation system should be sized according to Appendix 6 of the 'Silver Book' using design irrigation rate data for the soil from Table M1 of 'AS/NZS 1547:2012 On-site Domestic Wastewater Management' (for hydraulic balancing), the 'Environment & Health Protection Guidelines: On-site Sewage Management for Single Households' (the 'Silver Book', Department of Local Government 1998; for nutrient balancing), and the Sydney Catchment Authority's requirements. Installing a surface irrigation system requires council approval under the *Local Government Act 1993*, and must comply with 'Silver Book', Sydney Catchment Authority and council requirements for buffer distances from significant site features. The following points must also be considered.

- Carefully size the effluent irrigation area(s) using water and nutrient balances to determine the minimum area needed.
- All irrigation systems require careful hydraulic design to ensure appropriate equipment selection and satisfactory operation.
- Protect the effluent irrigation area from potential run-on water by building an upslope diversion drain. Standard Drawing No.12A shows the construction of a diversion drain.
- It is critical to choose an appropriate pump to adequately service the demands of the designated effluent irrigation areas. It must be able to overcome friction and head losses in the system and meet the required head and irrigation flow rates of the chosen irrigation sprays, sprinklers or emitters at the most distant point in the system. The effluent irrigation area may need to be divided into two or more fields supplied via a distribution or sequencing valve. Fields should be less than 200 square metres.
- Surface irrigation must use fixed sprinkler points with quick-coupling valves or similar. Rotate sprinklers throughout the effluent irrigation area.
- Typical heavy droplet rotary sprinklers with a design throw radius of two metres and a height of 400 millimetres are designed to maintain a flow rate of 0.05 litres per second at an operating pressure of 80-100 kPa.
- The system must be designed to deliver an appropriate dosing volume that fully charges the irrigation lines in each field.
- Program irrigation to ensure even delivery of effluent to the fields in the effluent irrigation area.
- Carefully choose and specify the irrigation system components needed to ensure satisfactory operation. The standard irrigation kit supplied with an aerated wastewater treatment system is inadequate. Matching the components of an irrigation system is a critical part of design.
- Lateral and sprinkler spacing should be at least five metres.

- The system must incorporate adequate filtration. Install a disc filter or a 100-150 micron filter before the sequencing valve. The filter must be cleaned at least every three months.
- Bury the effluent distribution line from the aerated wastewater treatment system to the effluent irrigation area at least 300 millimetres underground in a manner that prevents damage or deformation. Where vehicles pass over the effluent distribution line, it should be buried at 450 millimetres (light vehicular traffic) or 500 millimetres underground (heavy vehicular traffic; see Table 2.6).
- The laterals in the effluent irrigation field should be buried 100 to 150 millimetres underground.
- The system specifications must be clearly conveyed to the system installer. The system should be installed by a licensed contractor who should also complete and sign the Installation Certificate. Council should inspect the installed system to ensure it meets the design specifications.
- The aerated wastewater treatment system or secondary treatment system must be serviced regularly to provide adequate treatment and ensure that the irrigation system does not become clogged with suspended solids or organic material.
- The system should use demand dosing, particularly where the load generated varies over time. Most aerated wastewater treatment systems dose load the effluent irrigation area. An adequately sized pump well will need to be incorporated in the system. Standard Drawing No.12B shows a demand dosed pump well.
- Incorporate air valves, pressure reducing valves and non return valves into the design as needed.
- The system must have the capacity to enable flushing to remove any suspended solids and organic growth that accumulate. Effluent should be flushed back to the treatment system or to a soakage pit in the irrigation field. Ensure that chlorinated effluent is not returned to the primary chamber of the treatment system as chlorine can adversely affect the biological treatment processes. Most aerated wastewater treatment systems use chlorine for disinfection.
- Where the effluent irrigation area is located above the treatment system or pump well, fit a non-return valve.
- Surface effluent irrigation area slopes should be less than seven percent (four degrees).
- Adequately vegetate effluent irrigation areas with suitable grass species before commissioning the irrigation system.
- Install adequate signs to indicate that the area is being irrigated with treated effluent.
- Where vehicles, animals or children could access the effluent irrigation area, protect the effluent irrigation area by fencing or planting suitable shrubs around the outside edge.
- Mow the effluent irrigation area to ensure maximum evapotranspiration and removal of nutrients. Dispose of clippings outside the effluent irrigation area.

Hydraulic design

A suitably qualified consultant must prepare a hydraulic design for the effluent irrigation area. The hydraulic design is essential to ensure the irrigation system will work appropriately and distribute the effluent evenly.

Designer accountability

More accountability for the design is provided by the designer providing a Design Producer Statement, where they warrant the design. Appendix 2 includes an example of a Design Producer Statement.

12.2 Installation

A number of installation techniques should be used for effective long term operation of a surface effluent irrigation area. Common failures of irrigation systems are often caused by poor installation practices and using inappropriate system components. The irrigation system must be installed by a licensed contractor. Follow the steps below when installing a surface irrigation system.

Step 1 Site preparation

Obtain a copy of the council approved plans and conditions of consent. Accurately locate the irrigation areas as specified in the conditions of consent and shown on the site plans, and according to the specified and approved design and/or any covenant. If there is any variation in their position from the site plans, a Section 96 application (from the *Environmental Planning and Assessment Act 1979*) must be made to council to alter their position.

Step 2 Positioning

Build the laterals of an irrigation system along the contours to avoid uneven distribution and more heavily loading part of the irrigation area, which can lead to premature failure of the effluent irrigation area.

Step 3 Excavation

Bury irrigation lines and distribution laterals at least 100 millimetres below natural ground level to protect them from UV damage and lawn mowers. These lines can be installed using a small trench digger.

Step 4 Construction

The irrigation distribution mains and laterals can be installed and sprinkler heads attached to the lines. Before backfilling, flush and check the lines for leaks or breaks.

The effluent irrigation area should be turfed or planted with grass to establish vegetation cover promptly after construction. This ensures the best uptake of effluent by evapotranspiration. Ensure that deep rooting trees and shrubs are not planted close to irrigation lines to reduce the chance of roots intruding and clogging the laterals.

Build a stormwater diversion berm / drain on sloping sites to prevent stormwater inundation of the effluent irrigation area. Standard Drawing No. 12A provides detail on building a stormwater diversion drain.

Step 5 Dosing

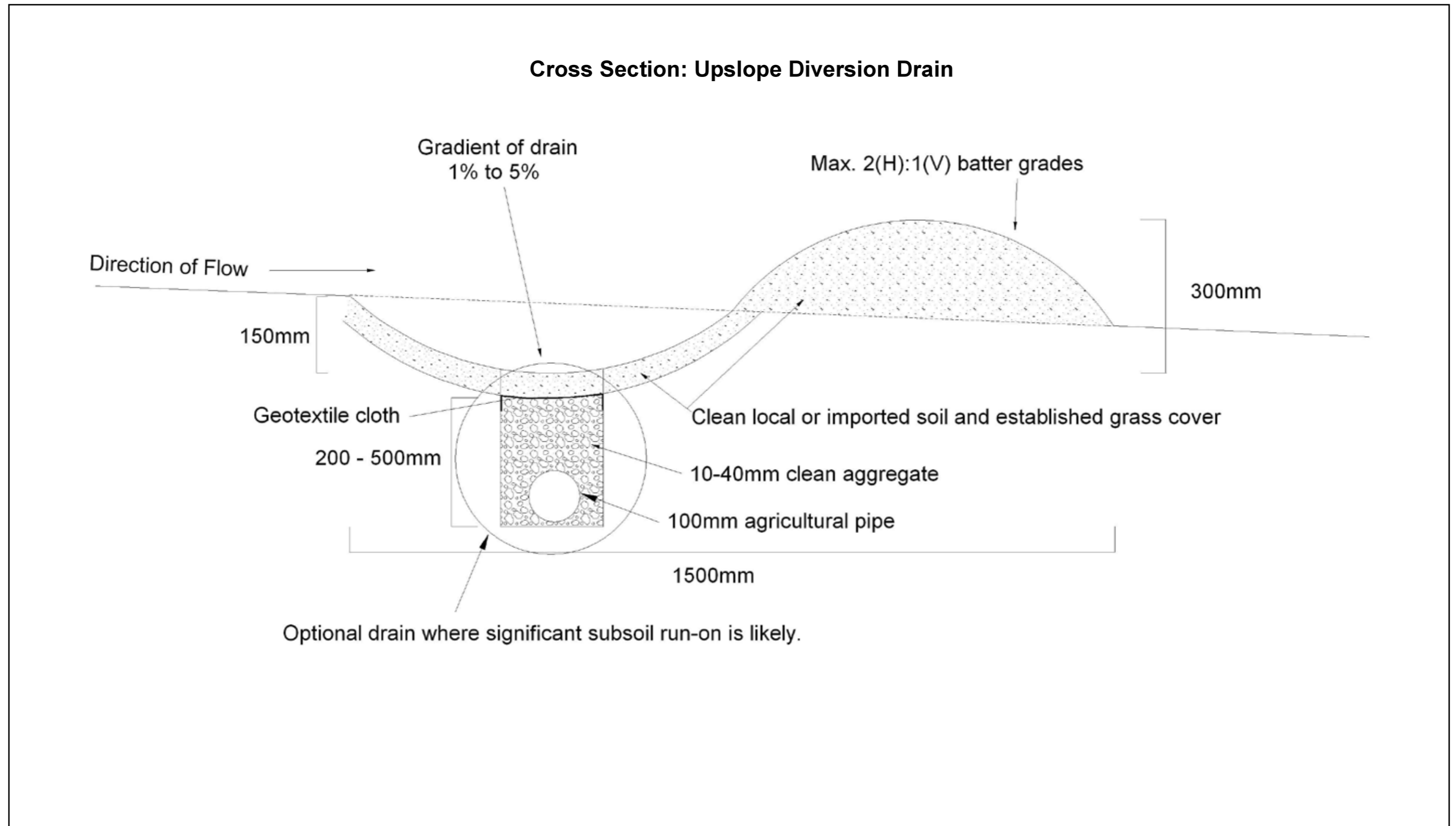
Pressure dose irrigation systems to provide even distribution throughout the entire area. Standard Drawing No.12B shows a demand dose pump well. Annotated

Standard Drawing No. 12C describes the installation of a surface effluent irrigation area.

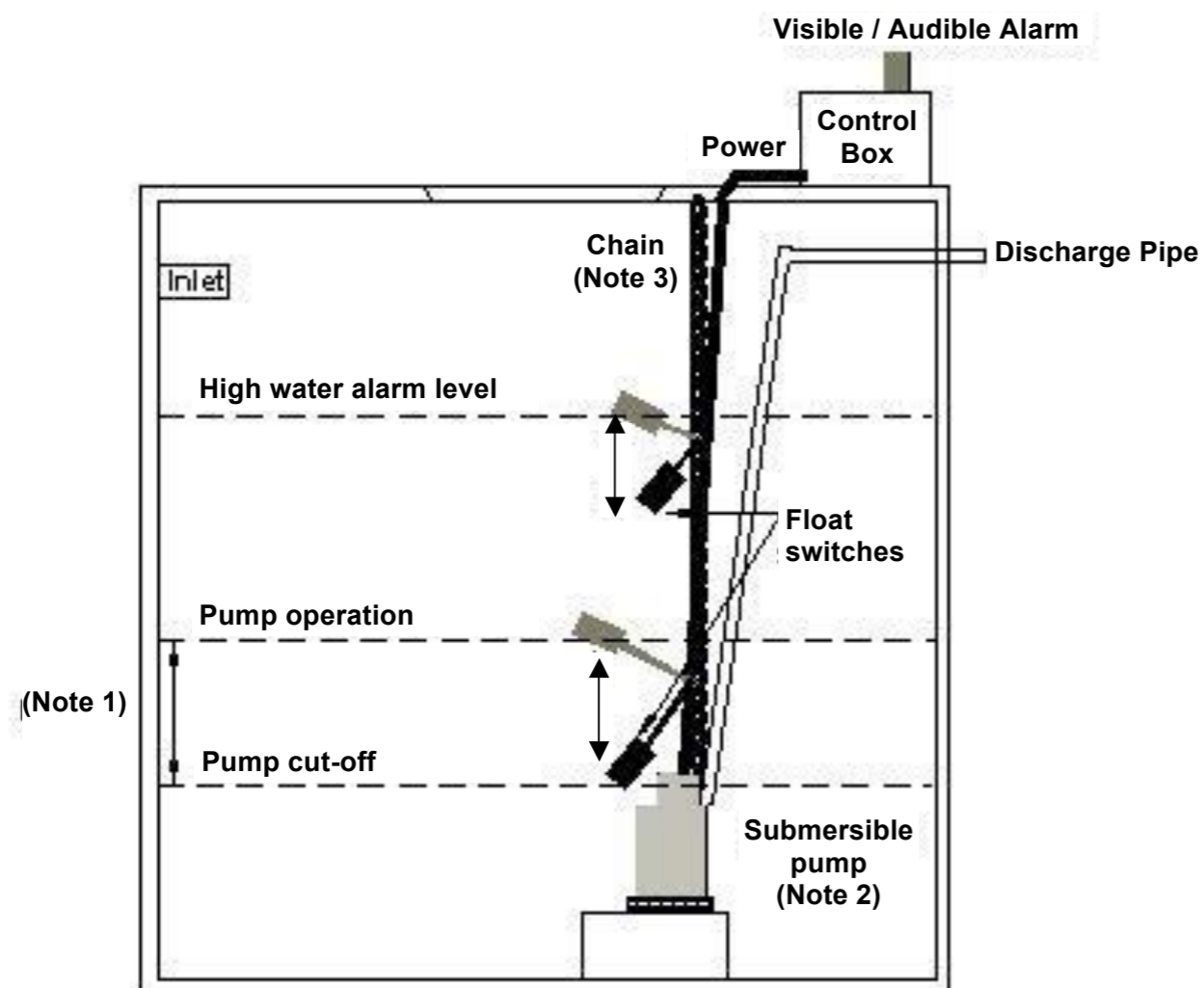
System Design

Communication between the designer and installer is improved by the designer preparing a System Design. This report conveys critical details of the design to the installer. It describes and quantifies the design and shows the appropriate layout and configuration of the system with appropriate plans and sketches. Appendix 3 includes an example of a System Design.

Finally, the installer provides an Installation Certificate to confirm that the system is installed as described in the relevant sections of the Design Producer Statement. Appendix 4 includes an example of an Installation Certificate.



Standard Drawing 12A - Upslope Diversion Drain
(not to scale)



Notes

- 1 The depth of effluent pumped within each cycle of the float switch (ie the depth between pump Cut-off and Operation) is calculated by:

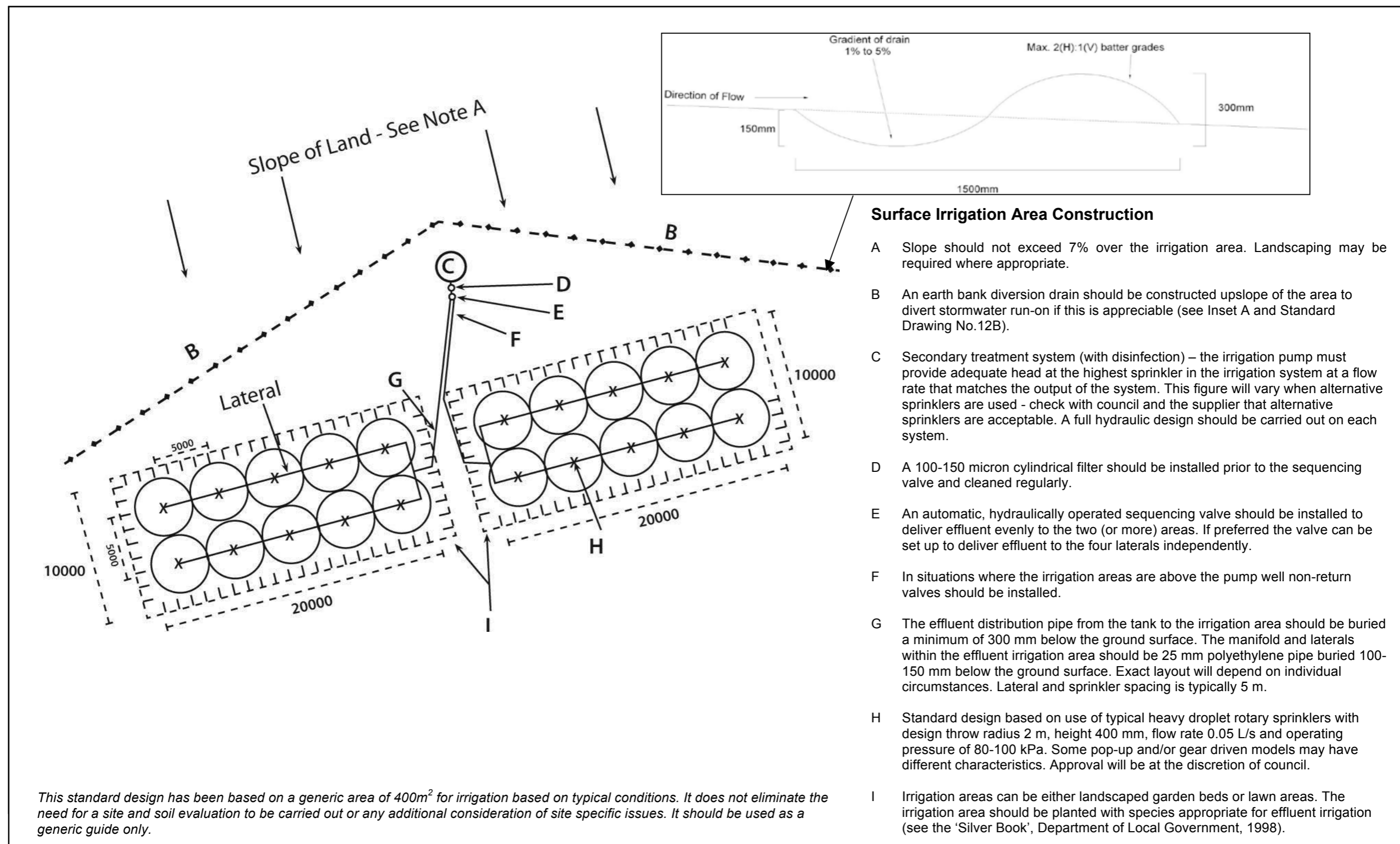
$$\text{depth of pumped effluent (m)} \times \text{basal tank area (m}^2\text{)} \times 1,000 = \text{discharge volume (litres per pump cycle)}.$$

This volume must match the hydraulic capabilities of the receiving component based on flow rate and total dynamic head.

- 2 Submersible pump used as an example only. The pump will need to be selected based on the specific task. It may be a centrifugal pump or vortex pump depending on the type of effluent being pumped and the hydraulic characteristics of the system. It may sit on top of the tank and draw effluent from the tank.
- 3 Submersible pumps must not be removed from a tank by their power cord. Heavier pumps may require the installation of a solid steel bar configuration according to manufacturer's specifications.
- 4 Cumulative storage must be assessed carefully to ensure that the pump well is large enough to buffer peak loads without the level exceeding that at which the high level alarm is triggered. The pump well should be sized to ensure that the volume of storage in the pump well reaches the low-level cut-off depth at least once every week.

Standard Drawing 12B - Demand Dose Pump well

(not to scale)



Standard Drawing 12C - Surface Irrigation of Effluent
(not to scale)

12.3 Testing

Surface irrigation systems should be clean water / pressure tested before commissioning to ensure even distribution of effluent and a uniform squirt height (Figure 12.2) at each sprinkler location and to ensure that sequencing valves are working.



Figure 12.2 Testing squirt height of a surface irrigation system

12.4 Inspection

The irrigation system must be inspected by Council before backfilling, to ensure all components are installed according to 'PCA 2004 Plumbing Code of Australia' and the conditions of consent. Council must make a final installation inspection to ensure compliance with all conditions of consent, before issuing an approval to operate the system.

Council inspectors can use Checklist 12.1 for the final installation inspection of a newly installed operational surface irrigation system.

Service and maintain all effluent irrigation areas at least every three months, except those systems specifically accredited with a four month maintenance period. The aerated wastewater treatment system (or other secondary treatment system) should be serviced and maintained at the same time and included in the written report submitted to council. Checklist 12.2 can be used to inspect working surface irrigation systems (as well as the standard quarterly inspection by the service provider). Plumbers, council inspectors and the system owner can use the checklist to ensure the irrigation system is operating properly, and also for council compliance inspections.

Checklist 12.1 Installation of surface irrigation system for use by plumbers, installers and Council inspectors	
Is the effluent irrigation area located according to the conditions of consent and the wastewater report or any covenant?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is the size of the effluent irrigation area consistent with the conditions of consent and the wastewater report?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is the effluent irrigation area located according to buffer distances⁽¹⁾ relating to:	
Dwelling and other buildings (15 m)?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Swimming pool and other sensitive receptors (6 m; irrigation area should not be located upslope of feature)?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Driveways and property boundaries (3 m downslope and where flat, or 6 m upslope)?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Drainage features (150 m to an SCA named river; 100 m to permanent or intermittent watercourses or 40 m to dams and drainage depressions)?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Are appropriate authorised fittings used as part of the system?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Fixed sprinkler type: <input type="checkbox"/> Bayonet <input type="checkbox"/> Pop-up <input type="checkbox"/> Other (describe):	
Sprinkler head type (describe):	
What is the sprinkler plume height? ⁽²⁾	mm
What is the sprinkler throw? ⁽²⁾	m
Are the sprinklers appropriately spaced given their throw and plume height?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Do the sprinklers receive uniform amounts of effluent?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Have manual or automatic sequencing valves been installed?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Has a disc filter been installed upstream of any sequencing valve?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Have air, pressure-reducing and/or non-return valves been incorporated into the design (as needed)?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Does the irrigation system have a flushing valve?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Does the flushing line return to the wastewater treatment system (not the primary chamber)?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is the flushing line directed to a small absorption pit?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Has the pump sufficient capacity to service the demands of the effluent irrigation area and overcome friction and headlosses in the system?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is the effluent distribution line from the tank to the effluent irrigation area buried at an appropriate depth (minimum 300 mm) and in a manner that provides protection against mechanical damage or deformation? ⁽³⁾	<input type="checkbox"/> Yes <input type="checkbox"/> No
Are the distribution laterals buried at a depth of between 100-150 mm?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Has the effluent irrigation area been turfed?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Has the irrigation area been protected to prevent damage (eg using fencing)?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is remedial action needed?	<input type="checkbox"/> Yes <input type="checkbox"/> No

NB: some of the questions in the above checklist may not be relevant for either the initial installation inspection or ongoing operational inspections. In this case, answer N/A.

Comments, action or repairs needed: (Where a response in the above Checklist needs extra information or action, specify the action plan and/or the process to fix the problem, or specify an alternative that is being offered)

⁽¹⁾ See Table 2.4

⁽²⁾ AS/NZS 1547:2012 On-site domestic wastewater management

⁽³⁾ See Table 2.6

Checklist 12.2 Operation inspection⁽¹⁾ of land application area for use by service agents, Council inspectors and system owners		
Does the system owner have a set of plans of the irrigation system and an Operational and Maintenance Manual?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Land Application Area		
Is there any evidence of physical damage?	<input type="checkbox"/> Yes	<input type="checkbox"/> No Comment:
Is surface ponding evident or is there evidence of runoff from the effluent irrigation area?	<input type="checkbox"/> Yes	<input type="checkbox"/> No Comment:
Is there evidence of diversion of effluent outside the irrigation area?	<input type="checkbox"/> Yes	<input type="checkbox"/> No Comment:
Is there uneven or excess weed growth in the irrigation area?	<input type="checkbox"/> Yes	<input type="checkbox"/> No Comment:
Are there dry areas or areas lacking vegetation in the irrigation area?	<input type="checkbox"/> Yes	<input type="checkbox"/> No Comment:
Is any stormwater run-on effectively diverted around the irrigation area?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Has the effluent irrigation area been mown to maintain the grass short, particularly around the pop-up sprinkler heads or bayonet points?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Are all the sprinkler heads working appropriately?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
If not, have the sprinkler heads been replaced or repaired with approved sprinkler heads?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is the irrigation pump working?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
If an automatic sequencing valve is fitted, does it switch between the different fields sequentially?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
If a manual valve is fitted, has it been switched between the different fields?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Have any bayonet sprinkler heads been moved to different parts of the irrigation area?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Has the irrigation filter been checked and cleaned?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Are all irrigation lines working (ie all sections of the effluent irrigation area work without leaking)?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Note, if as a system owner, you answered 'No' to any of the above questions, or there are any other problems, you should contact your service provider immediately.		
Does the system require air bleeding?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is the irrigation area adequately protected from livestock, vehicles, children etc through the use of fencing, or shrub barriers etc.	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is there any inappropriate use of the irrigation area eg vegetable growing?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Service provider:		
Contact number:		

Comments, action or repairs needed: (Where a response in the above Checklist needs extra information or action, specify the action plan and/or the process to fix the problem, or specify an alternative that is being offered)

Name / title of inspector:

Signature:

Date:

⁽¹⁾ In addition to the standard quarterly inspection by the service provider.

12.5 Operation

A surface irrigation system requires additional operational maintenance which is usually the responsibility of system owners. Operational maintenance includes:

- regularly mowing the effluent irrigation area and disposing of the grass clippings outside of the effluent irrigation area
- ensuring all sprinklers are working. Contact the service agent immediately if there are any problems with sprinklers or blockages
- clean the filters installed on some irrigation systems regularly. System owners are responsible for regularly cleaning these filters
- where manual switching valves are installed, switch them as indicated
- fit moving bayonet sprinkler heads.

Property owners can use Checklist 12.2 to ensure regular maintenance on their system is carried out.

12.6 Common technical issues

Plumbers, regulatory authorities and property owners have observed a number of common technical problems with surface irrigation, including:

- using irrigation components that are not designed for use with wastewater effluent
- inadequate hydraulic design causing uneven effluent distribution
- effluent irrigation area too small causing hydraulic overloading and saturation
- owners supplementing irrigation during high rainfall events using freshwater to establish or maintain vegetation that needs more water to survive. This can cause surface runoff, ponding or saturation
- irrigation fields too large so that the hydraulic load does not reach the more distant ends of the irrigation lines and overloads the nearer ends. Effluent irrigation areas should be zoned so that each field is of a size that can be adequately serviced by the pump, with fields irrigated using an automatic sequencing valve
- pumps poorly matched to the demands of the irrigation system. The capacity of many pumps supplied with proprietary aerated wastewater treatment systems is exceeded where large irrigation areas are located upslope of the treatment system. Typically, each sprinkler has a design operating pressure (4 to 20 metres) and flow rate (2 to 10 litres per minute). If the pump is too small, flow distribution will not be equal
- insufficient irrigation lines and sprinklers are installed to adequately distribute effluent over the required effluent irrigation area
- irrigation lines are exposed and not buried underground, causing potential problems such as UV deterioration, frost damage, lawn mower damage, vehicle and animal access, children playing and dog chewing
- reliance on the homeowner to move lines to ensure even distribution of effluent
- appropriate buffer distances are not observed
- over-spray onto paved surfaces causing localised runoff
- sprinklers spray outside the designated effluent irrigation area onto other sensitive receptors such as buildings, stormwater drains, children's play areas, barbecues, washing lines and pools

- irrigation lines are moved to the garden beds for lawn mowing and not moved back
- irrigation lines are coiled on top of the aerated wastewater treatment system for lawn maintenance and not moved back. This can cause overloading or flooding of the system or electrical hazards
- irrigation lines are moved to garden beds and over-irrigate a small area or spray onto, over or through garden fences and hedges and onto adjoining property
- irrigation onto sites that are too steeply sloping causing surface runoff
- sprays generate aerosols which can be caused by the pump being too large
- water hammer in the irrigation lines which can be caused by the pump being too large
- pop-up sprays become overgrown and do not pop up causing concentrated irrigation around the spray head instead of over the larger effluent irrigation area
- sprinkler heads become overgrown and can't be moved
- irrigation lines become blocked due to inadequate treatment or filtration of effluent
- effluent irrigation area not maintained and grass not mowed
- effluent irrigation area inappropriately used to grow vegetables or fruit for consumption
- owner neglect.

12.7 Case study

A new aerated wastewater treatment system was installed. The supplier included the tank, its internal components and a 30 metre poly hose with four standard garden sprinklers. The hose was left coiled on top of the tank after the system was commissioned and the sprinklers were not fitted (Figure 12.3). The owner decided to leave the sprinklers off and just move the hose around the yard to irrigate the gardens. The treated effluent drained freely from the irrigation pipe into the yard and, if left, it would saturate the soil and run down into the stormwater drainage line.

Problems identified

- The owner did not know the council, Sydney Catchment Authority or NSW Health requirements.
- The owner did not have a copy of the approval conditions and did not know how the effluent irrigation area should have been installed.
- The system supplier did not provide the relevant fittings and components that the owner needed to comply with the approval.
- The 30 metre hose, even with the four sprinklers, did not evenly distribute the treated effluent over the allocated area.
- The pump in the irrigation well was not big enough to evenly distribute effluent.
- The system was never inspected by council.
- The owner had not been well informed by the installer of the aerated wastewater treatment system about operating and maintaining the system.



Figure 12.3 A surface irrigation system left coiled on top of treatment tank

Solution

- Discard the supplied pipe and sprinklers.
- Install a number of fixed distribution lines (suitable for burial) with sprinklers that comply with council's approval to evenly distribute effluent across the allocated area.
- Place pop-up sprinklers at one every 12 square metres to ensure even sprinkler coverage.
- Install a sequencing valve to ensure effluent is evenly irrigated throughout each field.

Section 13: Subsurface Irrigation

13. Subsurface Irrigation

13.1	Design	172
13.2	The KISSS™ wick system	176
13.3	Installation	176
13.4	Inspection	184
13.5	Operation.....	184
13.6	Common technical issues.....	184
13.7	Case study.....	188

Subsurface irrigation (Figures 13.1, 13.2 and 13.3) reduces the chance of human contact with the effluent and significantly reduces public health risk. By placing the effluent in the root zone of plants, beneficial reuse of both the hydraulic and nutrient components of the effluent is maximised, offering enhanced environmental benefits. Homeowners have less maintenance obligations when a subsurface irrigation system is installed. There are also potential amenity benefits offered by subsurface irrigation, such as less chance of surface saturation and effluent runoff.

NSW Health requires non-disinfected effluent, such as that from septic tanks and most wet composting treatment systems, to be disposed of at least 300 millimetres underground ie **subsoil** (as opposed to **subsurface**, as discussed in this section). **Subsoil** irrigation puts effluent largely below the depth of the root zone of most grasses. This means there is limited nutrient uptake and it is unlikely to result in a healthy growing lawn. However, it does minimise the risk of human contact with untreated effluent and minimises surface runoff during extended wet weather. Subsoil irrigation also creates an easy-to-maintain effluent irrigation area. Supplementary disinfection units cannot be added to a treatment system unless they are already part of a NSW Health approved system. Disposal using trenches is often a more attractive option as it provides a much smaller footprint system.



Figure 13.1 A subsurface irrigation system under construction (Smart Sewage Solutions)



Figure 13.2 An installed subsurface irrigation system (Whitehead & Associates)

There have been significant developments in subsurface drip technology for effluent irrigation in the domestic market. Subsurface irrigation involves pressure-dosing of a polyethylene pipe fitted with turbulent flow or pressure compensating drip emitters. Proprietary systems may have built-in protection against root intrusion and biofilm development. Pressure compensation / regulation ensures even distribution of effluent and low application rates across a variety of gradients and elevations.

Subsurface irrigation of disinfected effluent puts the effluent directly in the root zone to optimise hydraulic and nutrient take-up. It minimises the risk of human contact and reduces surface runoff during extended wet weather. Subsurface irrigation allows better amenity and easier maintenance of an effluent irrigation area.

Careful hydraulic design of subsurface irrigation is essential to ensure correct sizing and choice of components, including providing for adequate effluent pumping, effluent filtration, line flushing, placement of vacuum release valves, and correct spacing of laterals and emitters. Consideration of rainfall is as important for sizing subsurface irrigation areas as for surface irrigation, however subsurface irrigation may allow for higher nutrient uptake in the same location.

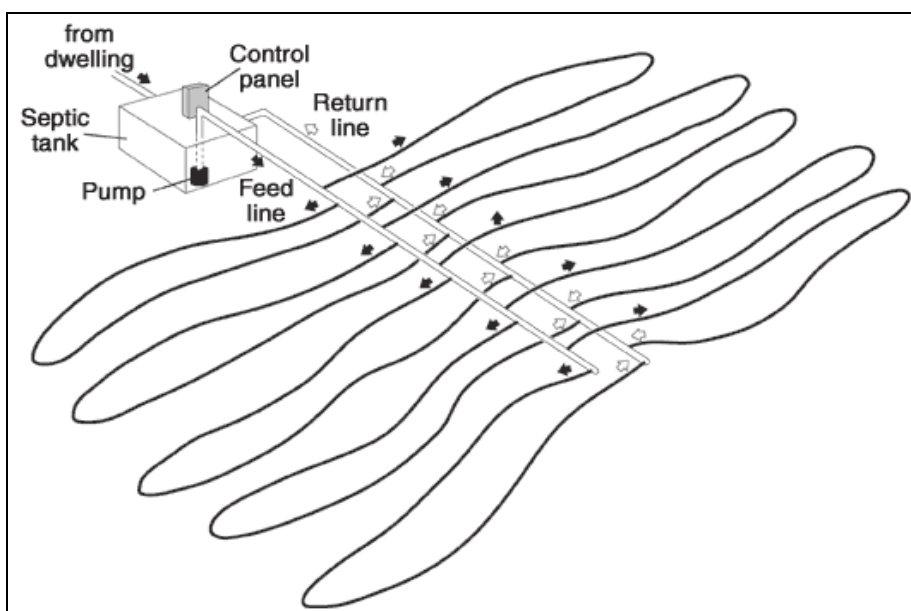


Figure 13.3 Subsurface irrigation schematic (Ohio Installer)

13.1 Design

A subsurface irrigation system should be designed with consideration for the site and soil assessments detailed in Section 2 of this Manual. The irrigation system should be sized according to the recommendations in the 'Silver Book' (Department of Local Government, 1998) and Sydney Catchment Authority requirements. Installing a subsurface irrigation system requires council approval under the *Local Government Act 1993*. It must also comply with the Sydney Catchment Authority and council requirements for buffer distances and setbacks from significant site features and infrastructure.

The following factors should be considered when designing a subsurface irrigation system.

- All effluent irrigation areas require appropriate sizing based on the greater of either hydraulic or nutrient balances as a limiting factor.

- Careful hydraulic design is needed to ensure appropriate equipment selection and satisfactory operation.
- Protect the effluent irrigation area from potential run-on and stormwater by building an upslope diversion drain or berm. Standard Drawing No.13A shows the construction of such a diversion drain/berm.
- Choose an appropriate pump that can adequately service the demands of the designated effluent irrigation area. It must overcome the friction loss and headloss in the system, and meet the required head and irrigation flow rates of the selected emitters at the most distant point in the system. The effluent irrigation area may need to be split into two or more fields, supplied via a distribution or sequencing valve. Individual fields should be no larger than 400 square metres (typically 250 to 300 square metres).
- Design the system to deliver an appropriate dosing volume that fully charges the irrigation lines in each field. Non-return valves may be needed.
- Program irrigation to ensure even delivery of effluent to the fields in the effluent irrigation area.
- Irrigation system components need to be carefully selected and specified to ensure satisfactory operation. The standard irrigation kit supplied with many aerated wastewater treatment systems is **not** suitable for subsurface irrigation.
- The distribution pipe should be 25 millimetre uPVC or polyethylene pipe, buried 300 millimetres underground.
- Use only subsurface drip line designed specifically for effluent irrigation. Pressure-compensating subsurface drip line (typically 16 millimetre) is used with emitters and laterals at approximately 600 millimetre spacings (a maximum of 1,000 millimetre spacings) and buried 100 to 150 millimetres deep. A pressure regulator may be needed where non-pressure compensating line is used. This is only relevant for use with a wick-based system.
- Adequate filtration must be incorporated in the system. Install a disc filter or a 100 to 150 micron filter before the sequencing valve. The filter must be cleaned regularly - at least every three months. A filter flush valve should be fitted downstream of the field flush valve.
- Either impregnate the drip line with root inhibitor, or use a tech filter that dispenses a root inhibitor (a chemical injector assembly or impregnated emitter tube) to protect drip line from root ingress. A wick-based system (Figure 13.5; see also Section 13.2) may reduce the susceptibility of the drip lines to root incursion.
- The design specifications of the system must be clearly communicated to the system installer. A licensed contractor should install the system and complete and sign the Installation Certificate. Council should inspect the installed system to ensure that it meets the design specifications.
- An aerated wastewater treatment system or other secondary treatment system must provide adequate treatment and be serviced regularly to ensure the irrigation system does not become clogged with suspended solids or organic material.

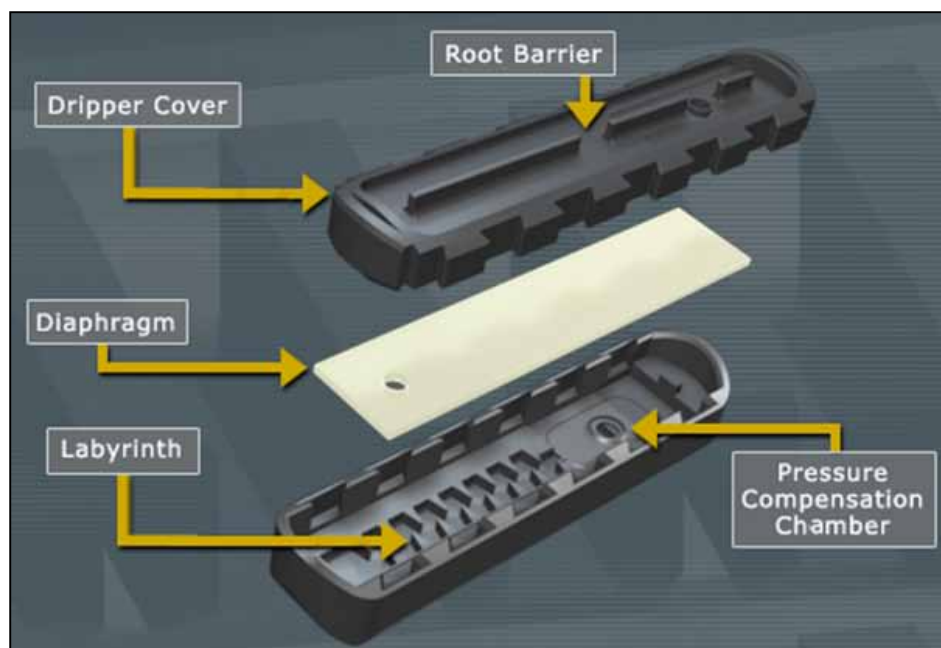


Figure 13.4 Pressure compensating drip emitter (Netafim, 2009)



Figure 13.5 The KISSS™ wick system
(Irrigation and Water Technologies Pty Ltd)

- The system should use demand dosing, particularly where load generation varies over time. This will require an adequately sized pump well to be incorporated.
- Air release valves need to be installed at high points in each area or field, and additional air release valves may be needed in undulating terrain.

- Incorporate air/vacuum valves, pressure-reducing valves and non-return / tube non-leakage valves into the design as needed. The non-leakage valve shuts off flow through the valve when line pressure drops below a selected pressure and opens and passes flow when the line pressure exceeds a higher selected pressure. This removes the need for the irrigation system to refill at the beginning of each irrigation cycle by holding pressure in the irrigation lines and keeping them filled. This ensures the system reaches operating pressure in minimum time. It also prevents the system draining to the lowest point where it is installed on a slope and more even distribution of the effluent. The air/vacuum relief valve serves two purposes – it evacuates air from the laterals during system start-up and prevents a vacuum forming after the pump turns off. This prevents debris getting into the drippers at the higher locations in the field.
- The system must have the capacity to enable flushing to remove any suspended solids and organic growth that may accumulate. A field flush valve must be installed on the return line to facilitate flushing back to the treatment system, an in-field soakage pit or a small (maximum of 10 m long x 0.6 m wide x 0.7m deep) self-supporting arch absorption trench. Ensure that chlorinated effluent is not returned to the primary chamber of the treatment system where the chlorine may adversely affect the biological treatment processes. The flushing return manifold should be 25 millimetre uPVC or polyethylene line buried at 300 millimetres.
- Fit a non-return valve where the effluent irrigation area is located above the treatment system or pump well.
- Additional hydraulic design will be needed where effluent irrigation area slopes exceed 12% (6.8°). For example, the design may need a much larger pump for the head required to evenly distribute the effluent throughout the effluent irrigation area, or where the effluent irrigation area is at some distance or height above the wastewater treatment system.
- Consideration should be given to the requirement for wet weather storage or emergency storage. The volumes required are calculated by hydraulic balance. Where possible, avoid wet weather storage by providing an adequate effluent irrigation area. Occasionally on constrained sites, a system may be designed to store the treated effluent during extended wet weather and then dose the effluent to the effluent irrigation area after the soil has dried out. Provision may also be made by having an appropriately sized absorption trench connected to the outlet chamber of the treatment system through a gravity fed transfer pipe. Providing this type of storage makes an allowance until repairs can be made that may be needed if components, such as pumps, malfunction.
- Adequately vegetate the effluent irrigation areas with species suited to effluent irrigation before the irrigation system is commissioned. Appendix 7 of the 'Silver Book' (Department of Local Government, 1998) includes a list of vegetation suitable for land application areas.
- Erect adequate signs to indicate that the area is being irrigated with treated effluent.
- Where vehicles, livestock, domestic animals or children may access the effluent irrigation area, exclude them and protect the area by fencing or planting shrubs around the edge of the effluent irrigation area.

Other useful and detailed information about designing subsurface irrigation systems and choosing appropriate components is available on the websites of the major subsurface irrigation technology suppliers.

Hydraulic design

A suitably qualified consultant must prepare a hydraulic design of the effluent irrigation area. The hydraulic design is essential to ensure the irrigation system will work and distribute the effluent evenly.

Designer accountability

More accountability for the design is provided by the designer preparing a Design Producer Statement, warranting the design. Appendix 2 includes an example of a Design Producer Statement.

13.2 The KISSS™ wick system (Irrigation and Water Technologies Pty Ltd)

KISSS™ subsurface textile irrigation delivers water directly to the root zone at a rate that matches the soil capillary action. The design enhances uniform vegetation growth, reduces water logging and drainage losses caused by deep drainage and tunnelling, and minimises soil salinity levels. The system deters root intrusion without using chemicals and can be fully automated.

Water is supplied to the soil from the surface of a geotextile fabric instead of from individual emitters in a drip line. Dispersing the water over a larger area reduces the rate of water discharged to the soil bringing it closer to the capillary absorption rate. It also converts the dripline from a series of point sources to a single, broad line source (Figure 13.6).

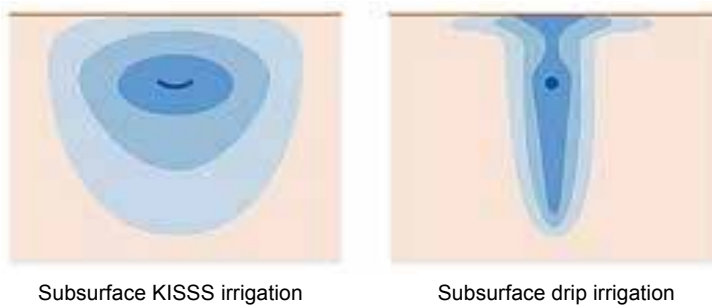


Figure 13.6 The KISSS™ irrigation wetting patterns (Irrigation and Water Technologies Pty Ltd)

13.3 Installation

A number of installation techniques should be used for effective long term operation of a subsurface effluent irrigation area. Common failures of irrigation systems are often caused by poor installation practices. System installation needs to be timed in relation to other construction activities (eg for a dwelling) so that the irrigation system is not destroyed or damaged. Follow the additional steps below when installing a subsurface irrigation system.

Step 1 Site preparation

Obtain a copy of the council approved plans and conditions of consent. Accurately locate irrigation areas as indicated in the consent, on the site plans and according to the specified and approved design and/or any covenant. Check the location of the irrigation system against the approved site plans and if there is any change in the position from the site plans, a Section 96 application (from the *Environmental Planning and Assessment Act 1979*) must be made to council to alter their position.

Step 2 Positioning

Ensure the laterals of an irrigation system are built along the contours to ensure even distribution. This will avoid more heavily loading part of the area, which can lead to premature failure of the effluent irrigation area.

Step 3 Excavation

Bury irrigation lines and distribution laterals 100 to 150 millimetres below natural ground level to ensure irrigation occurs in the root zone and protect against UV damage and lawn mowers. These lines can be installed with a small trench digger.

The main distribution line from the treatment system to the effluent irrigation area and the return flush manifold to the wastewater treatment system must be buried at least 300 millimetres deep and in a manner that protects against mechanical damage or deformation (see also Table 2.6).

Step 4 Construction

Install the irrigation distribution laterals, then flush and check the lines for leaks or breaks before backfilling.

Turf or plant grass over the effluent irrigation area to establish vegetation cover promptly after construction. This ensures the best uptake of effluent by evapotranspiration. Ensure that deep rooted plant species are not planted close to irrigation lines, to reduce the chance of roots intruding and clogging the laterals.

Build a stormwater diversion drain or berm above the effluent irrigation area on sloping sites to avoid stormwater run-on. Standard Drawing No. 13A provides detail on building a stormwater diversion drain/berm.

Step 5 Dosing

The pressure-dosed irrigation system should evenly distribute the effluent throughout the entire effluent irrigation area. Annotated Standard Drawing No. 13B details the installation of a subsurface effluent irrigation area.

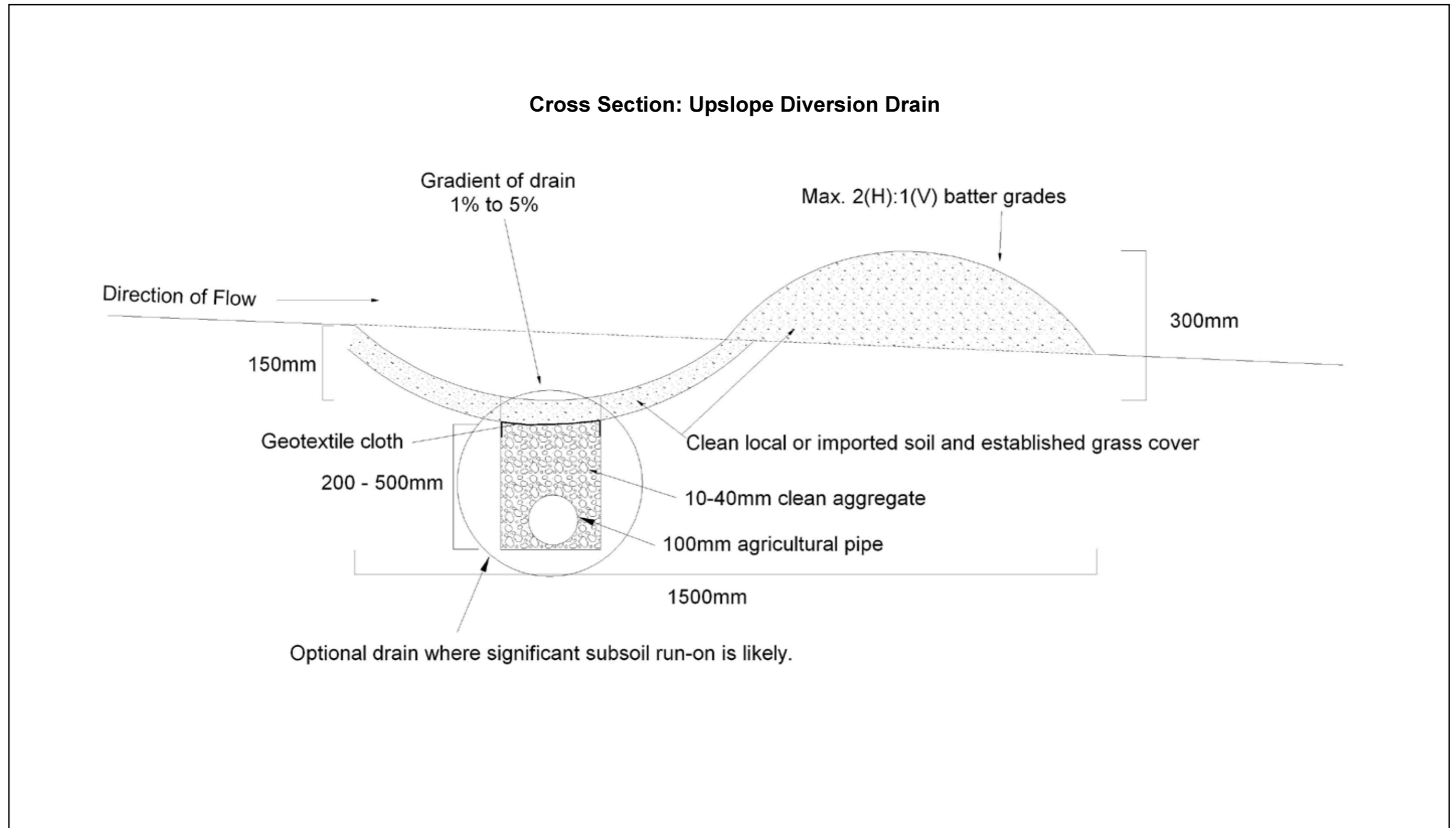
Where the water table is high or a shallow subsurface limiting layer otherwise reduces the depth of free draining soil the effluent can pass through, or where soil storage is otherwise limited, consider building a raised subsurface irrigation bed. Annotated Standard Drawing No. 13C details installation of a raised subsurface irrigation bed.

Checklist 13.1 outlines features of a subsurface drip irrigation system that should be checked on installation.

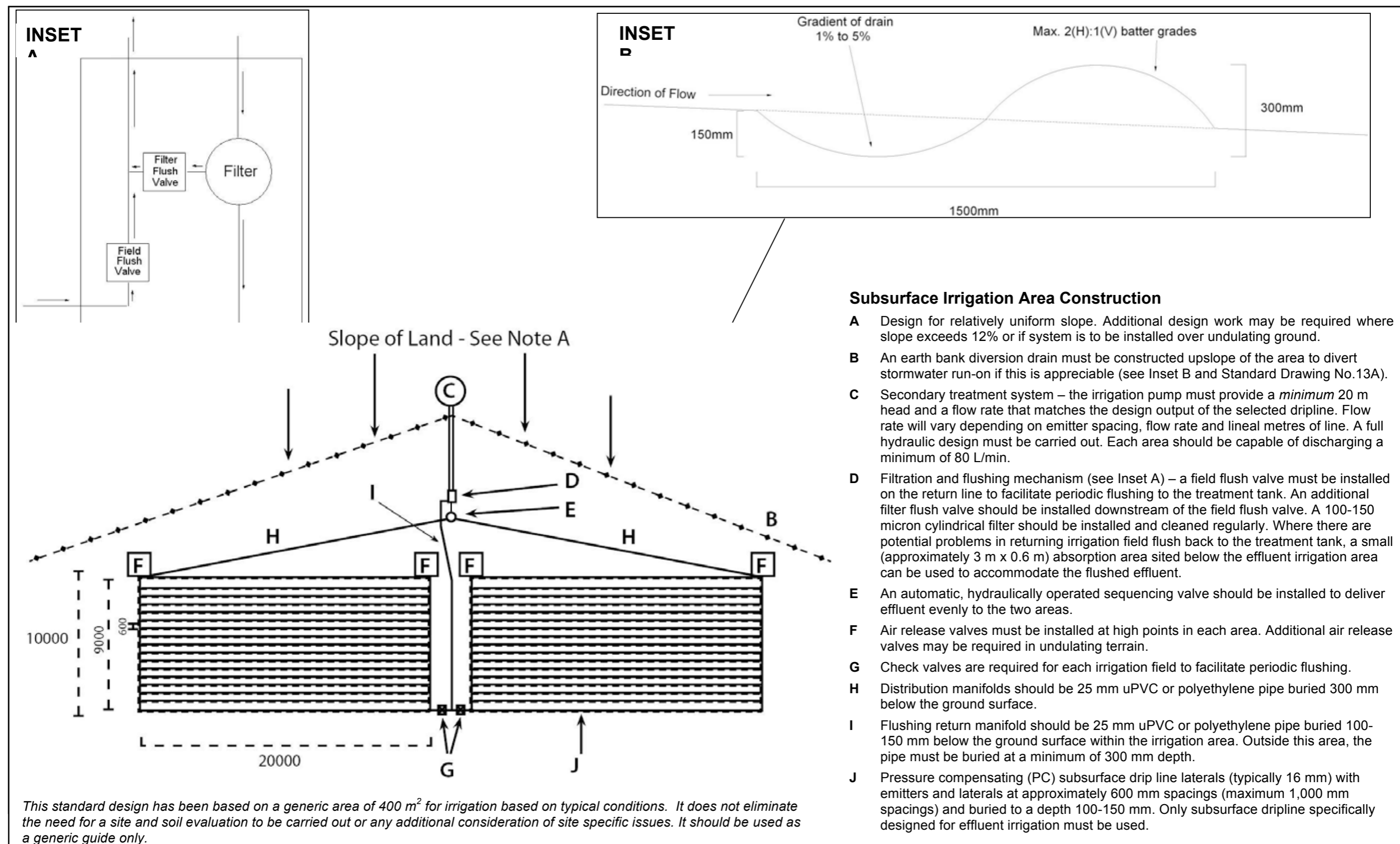
System design

To improve communication between the designer and installer, the designer should prepare a System Design. This report conveys critical details of the design to the installer. It describes and quantifies the design and illustrates the appropriate layout and configuration of the system with plans and sketches. Appendix 3 includes an example of a System Design.

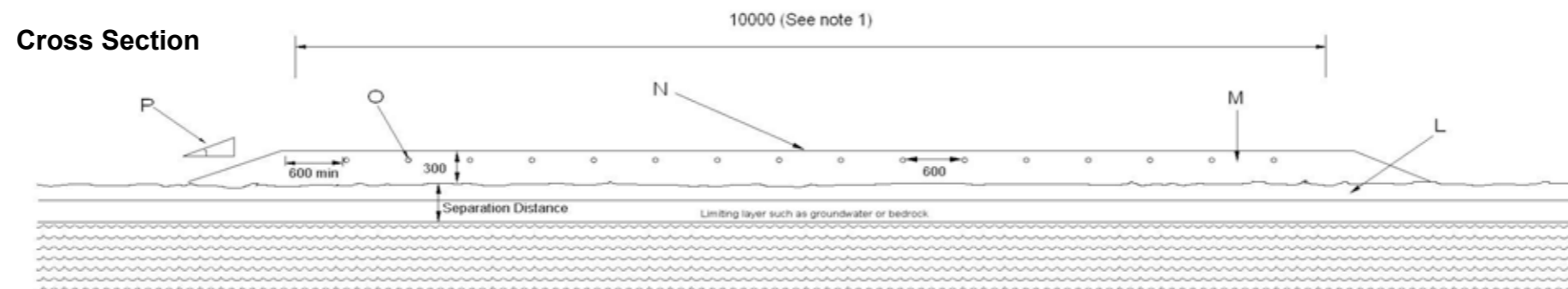
Finally, the installer must provide an Installation Certificate to certify that the installation is as described in the relevant sections of the System Design. Appendix 4 includes an example of an Installation Certificate.



Standard Drawing 13A - Upslope Diversion Drain
(not to scale)



Standard Drawing 13B - Subsurface Effluent Irrigation
(not to scale)

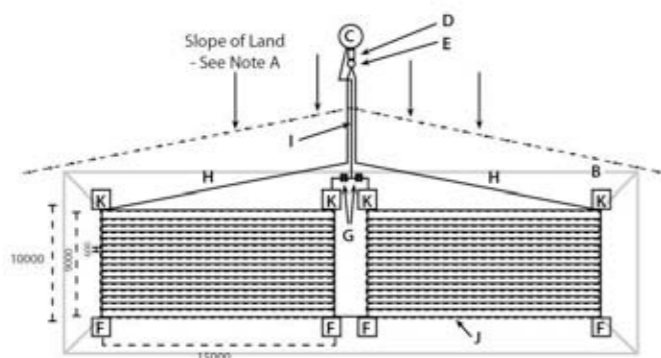


Raised Subsurface Irrigation Bed Construction

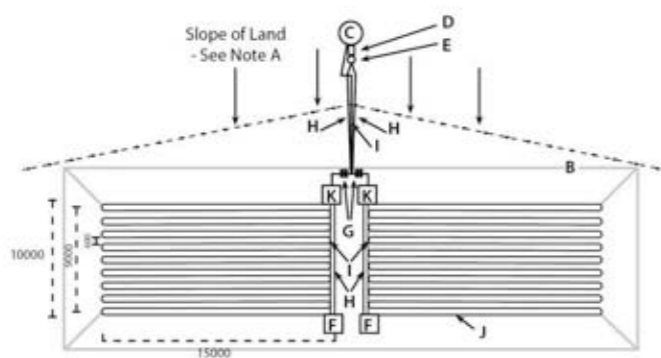
Note 1

The layout and dimensions used in this drawing are based on a total required area of 300 m² for demonstration purposes only. The location, configuration and layout of individual subsurface irrigation fields will need to be determined on a site-specific basis. The purpose of this Standard Drawing is to illustrate a typical configuration and specify minimum system components (eg flush lines, separate fields and dripline spacing). Minimum subsurface irrigation areas for different dwelling sizes should be determined by a hydraulic balance and according to AS/NZS 1547:2012 and this Manual.

Plan View - 'End to End' Manifold Design



Plan View - 'Single Trench' Manifold Design



- A** Design for relatively uniform slope. Additional design work may be required where slope exceeds 12% or if system is to be installed over undulating ground.
- B** An earth bank diversion drain must be constructed upslope of the effluent irrigation area to divert stormwater run-on if this is appreciable (see Standard Drawing No.13A).
- C** Secondary or Advanced Secondary Treatment System – the irrigation pump must provide a minimum 20 m head to the driplines (after static lift and friction loss) and a flow rate that matches the design output of the selected dripline. Flow rate will vary depending on emitter spacing, emitter flow rate and lineal metres of dripline. A full hydraulic design must be carried out. Each area should be capable of discharging a minimum of 80 L/min.
- D** Filtration system – a suitable filter must be installed on the system. Minimum standard is a 100-150 micron cylindrical filter however some systems will require a disc filter with finer filtration capacity. Some proprietary driplines require the installation of a 'tech-filter' that doses the system with a root and biofilm inhibitor.
- E** An automatic, hydraulically operated sequencing valve should be installed to deliver effluent evenly to a minimum of two separate fields.
- F** Automatic field flush valves must be installed to provide line flushing at each pump operation. One valve should be installed for every 100 lineal metres of line in the field/system. The valves can be installed in-field in irrigation boxes (backfilled with aggregate) or back at the treatment system.
- G** Check valves are required on the return flush manifold of each field to facilitate periodic manual flushing.
- H** Distribution (supply) manifolds should be 25 mm uPVC or polyethylene pipe buried a minimum 300 mm below the ground surface. Where possible, the supply and flush manifolds should be located in the same trench.
- I** Flushing return manifold should be 25 mm uPVC or polyethylene pipe buried 100-150 mm below the ground surface within the irrigation area. Outside this area, the pipe must be buried at a minimum of 300 mm depth.
- J** Subsurface drip lines with emitters at 300 mm spacings and laterals at 600 mm spacings and buried to a depth 100-150 mm. Only subsurface dripline specifically designed for effluent irrigation must be used. Irrigation fields may be installed with manifolds at opposite ends or at the same end (with laterals coiling back) as shown in the Standard Drawing.
- K** Air release or vacuum breaker valves must be installed at high points in each field. Additional air release valves may be required in undulating terrain.
- L** Prepare the site by clearing all shrubs, trees and boulders. Cut trees to ground level and then grind the stump out to a depth of 300 mm and backfill with permeable material such as the natural topsoil or sand (not clay). Scarify the natural soils across the entire basal area to a minimum depth of 200 mm taking care not to compact the basal area in the process. This should extend to at least one metre beyond the perimeter.
- M** Subsurface irrigation bed is to be raised to a total height of 300 mm above the final ground surface. Compaction should be minimised when installing the bed. The fill must be an organic loam to sandy loam with minimal clay content.
- N** Grass (turf) must be established over the raised bed immediately after completing construction.
- O** Dripline laterals must be buried 100-150 mm below the surface.
- P** Batter slope 1(vertical):3(horizontal) maximum.

Standard Drawing 13C - Raised Subsurface Irrigation Bed

(not to scale)

Checklist 13.1 Installation of subsurface irrigation systems		
Do you have a copy of the consent / approval?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Does it specify the nature / sizing / location of the effluent irrigation area?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is the irrigation system located as detailed in the conditions of consent / approval?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Headworks		
Is the control panel/controller installed according to manufacturer's instructions and the irrigation system design details?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is a foot valve fitted to the suction inlet in the treated effluent tank?	<input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is an appropriate pump installed according to the manufacturer's specifications and/or the irrigation system design requirements?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is a standby pump available for the system?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
If yes, has it been installed, or stored or available within 24 hours?	<input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is a permanent pressure gauge installed following the pump?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is a non-return valve installed following the pressure gauge?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is an appropriate filter with 100-150 micron filter installed?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Are any solenoid valves, cabling, sequencing or manual valves installed to enable alternate dosing of the irrigation fields according to the design?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is the controller capable of operating the specified pump, filter and any solenoid valves for the irrigation fields according to the design?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Has the controller been tested to operate satisfactorily for each field?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is a low level cut-off float switch installed in the effluent tank that overrides the irrigation controller to prevent the system pumping dry?	<input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is a high level cut-in float switch installed in the effluent tank that overrides the standard irrigation schedule during times of high flow?	<input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Have the headworks been installed and located according to the design?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Do the headworks meet the hydraulic specifications of the design?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Mainline and dosing pipeworks		
Does all pipework match the size, pressure class specifications detailed in the design?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is all pipework installed, tested and commissioned according to 'AS/NZS 2566.2:2002 Buried Flexible Pipelines Part 2: Installation'?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Are all pipe fittings, clamps and joints made to match the pressure class of the pipe at that location?	<input type="checkbox"/> Yes	<input type="checkbox"/> No

Drip line and field layouts		
Is all installed drip line according to the design (eg pressure compensating, anti-siphon) with 600 mm dripper spacings and 1.6 L an hour dripper flow rate?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is all dripline installed under mulch or soil according to the hydraulic design?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Are dripline laterals spaced between 600 – 1,000 mm (ideally 600 mm spacings)?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Do all laterals comply with appropriate buffer distances?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Are the connections of laterals to mainlines, sub-mains and flushing manifolds according to the manufacturer's recommendations?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is all dosing and flushing pipework according to the manufacturer's recommendations?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Are air/vacuum release valves installed at all significant high points in each field?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is a flushing valve installed at the end of each flushing manifold as recommended by the manufacturer?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Has the field flush valve been connected back to the treatment system?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Has the field flush valve been directed to a small absorption trench (approximately 3 m x 0.6 m)?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Does each field have the facilities for measurement of pressure (eg needle test point or similar) immediately before the entrance to the first lateral and immediately following the exit of the final lateral?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Do the installed dripline subsections meet the hydraulic specifications detailed in the design?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Drip line fields hydraulic design		
Is the operating pressure at the pump within 10% of that specified for each field at the time of commissioning?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is the operating pressure at the pump within 10% of the design value?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is the pressure difference between the entrance to the first lateral and exit of the last lateral less than 15%?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Are all flushing velocities greater than 0.4 m/s for all fields?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Commissioning and testing		
Has the pump, filter and control equipment been commissioned and tested according to the manufacturer or supplier specifications?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Have all mainlines and sub-mains been commissioned and tested according to 'AS/NZS 2566.2:2002 Buried Flexible Pipelines Part 2: Installation'?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Have all drip line field layout, connections and fittings been checked before covering?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Have all fields been flushed with clean water adequately before pressurising to remove construction debris that may have accumulated during installation?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Have all drip line fields been tested for leakage from joints and fittings before covering?	<input type="checkbox"/> Yes	<input type="checkbox"/> No

Have all operating pressures been checked at the pump and the end of each field or subsection at the time of commissioning according to the design?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Has Council inspected the system before backfilling?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Has the owner/operator been provided with an Operation and Maintenance Manual, including layout?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Service provider:		
Contact number:		
Comments, action or repairs needed: (Where a response in the above Checklist needs extra information or action, specify the action plan and/or the process to fix the problem, or specify an alternative that is being offered)		
Name / title of inspector:		
Signature:	Date:	

13.4 Inspection

Council should inspect the irrigation system before backfilling to ensure all components are installed according to 'AS/NZS 2566.2:2002 Buried Flexible Pipelines Part 2: Installation'. Council should make a final installation inspection to ensure compliance with all conditions of consent before issuing an approval to operate the system.

13.5 Operation

A subsurface irrigation system needs regular maintenance in addition to the quarterly service inspection. System owners are usually responsible for this operational maintenance, including:

- regularly mowing the effluent irrigation area and disposing of grass clippings outside the effluent irrigation area
- regularly cleaning some filters installed on irrigation systems as per the manufacturer's specifications. Where these filters are used system owners are responsible for regularly cleaning them
- back flushing irrigation lines to remove any biofilm build up and prevent blockages.

Plumbers, council inspectors and system owners can use Checklist 13.2 to inspect operating surface irrigation systems (as well as the standard quarterly inspection by the service provider). The checklist can be used to ensure the irrigation system is operating appropriately and for council compliance inspections.

13.6 Common technical issues

Plumbers, property owners and regulatory authorities have observed a number of common problems with subsurface irrigation installations including:

- inadequate hydraulic design:
 - causing uneven distribution
 - causing hydraulic overloading and saturation where the effluent irrigation area is too small. This can be worsened if owners supplement the irrigation with other sources to try to establish and maintain unsuitable plant species that need more water to survive. Subdivide effluent irrigation areas so that the size of each field can be adequately serviced by the pump, and irrigated sequentially using a distribution or sequencing valve
 - preventing the hydraulic load reaching the more distant ends of irrigation lines and overloading the nearer ends of the irrigation lines (where the irrigation fields are too large).
- pump capacity does not meet the needs of the irrigation system. This is a common problem where the capacity of pumps supplied with many aerated water treatment systems is exceeded because the effluent irrigation fields are too large, too far away, or upslope of the treatment system. Typically, an irrigation pump must provide at least 20 metres head. The flow rate will vary depending on the emitter spacing, and the length of irrigation line. Each field should be able to discharge 80 litres per minute. If the pump is too small, flow distribution will not be uniform
- not enough irrigation lines installed to adequately distribute effluent over the required effluent irrigation area
- appropriate buffer distances are not accommodated
- irrigation onto sites that are too steeply sloping, causing surface breakout

- using non-pressure compensating lines or not laying them on the contour causing preferential irrigation of low points in irrigation lines
- irrigation lines become blocked due to treatment failure or inadequate filtration of effluent or lack of flushing capability
- inappropriate or too-wide line spacing or loading causing striping of lawns
- effluent irrigation area not maintained and grass not mowed.

Checklist 13.2 Operation inspection⁽¹⁾ of land application area for use by service agents, Council inspectors and system owners		
Does the system owner have a set of plans of the irrigation system and an Operational and Maintenance Manual?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Land Application Area		
Is there evidence of irrigation area damage by vehicle, livestock or domestic animal activities?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Comment:
Is a good vegetation cover established over the effluent irrigation area?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Comment:
Are there any green or boggy areas or surface ponding of effluent liquid in the irrigation area?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Comment:
Are there dry areas or areas lacking vegetation in the irrigation area?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Comment:
Is the effluent irrigation area associated with an unpleasant smell that would suggest untreated or poorly treated effluent is being used to irrigate?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Comment:
Has the effluent irrigation area been mown to maintain the grass short?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Treatment and Irrigation System		
Is any stormwater run-on effectively diverted around the irrigation area?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is the irrigation pump working?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is the irrigation system working without leaks?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Has the effluent irrigation area been back flushed?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Have the irrigation filters been checked and cleaned?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Does the system require air bleeding?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
If an automatic sequencing valve is fitted, does it appear to switch between the different fields sequentially?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
If a manual valve is fitted, has it been switched between the different fields?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is the irrigation area still adequately protected from livestock, vehicles, children etc through the use of fencing, or shrub barriers etc.	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is there any inappropriate use of the irrigation area eg vegetable growing?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Note, if as a system owner, you answered 'No' to any of the above questions, or there are any other problems, you should contact your service provider immediately.		
Service provider:		
Contact number:		

Comments, action or repairs needed: (Where a response in the above Checklist needs extra information or action, specify the action plan and/or the process to fix the problem, or specify an alternative that is being offered)	
Name / title of inspector:	
Signature:	Date:

⁽¹⁾ In addition to the standard quarterly inspection by the service provider.

13.7 Case study

An aerated wastewater treatment system was installed for a new home. Council and the Sydney Catchment Authority required all effluent to be applied using subsurface irrigation of lawn areas around the new home, to ensure appropriate buffer distances from a nearby watercourse. Approximately 800 square metres of drip line was installed on unvegetated ground with very thin soil and a significant amount of exposed rock. The effluent was distributed by a main distribution line from the system. The contractor laid the irrigation line and connected it to the aerated wastewater treatment system. The area was left without vegetation for a period of time, although the family had moved in and was using the system (Figure 13.7). There were a number of problems including:

- the surrounding soil began to erode and wash away as effluent was applied to the soil
- the pipes deteriorated from natural UV light and surrounding activities that caused cracks and breaks in the lateral
- the area became infested with weeds.



Figure 13.7 Poorly installed subsurface effluent irrigation system

The contractor was asked to move the effluent irrigation area to specified areas around the home according to council and Sydney Catchment Authority requirements. The irrigation lines were removed from the downslope area and re-laid in the turfed areas around the home, upslope of the aerated wastewater treatment system.

Within weeks the new effluent irrigation area again showed signs of failure and the property owner observed surface ponding. The irrigation pump failed and activated the high level alarm. Investigations identified the following issues:

- the perished and brittle irrigation lines had not been replaced and cracks and breaks in the lines (Figure 13.8) caused excessive application of effluent to some areas. This exceeded the hydraulic capacity of the soil and caused surface ponding



Figure 13.8 Damaged irrigation line sections cut out and replaced as part of an unsatisfactory repair.

- the irrigation pump was too small and could not pressurise such a large single area of irrigation lines (it could not overcome the friction loss and headloss in the system)
- the large single field was laid on rock in thin soil (Figure 13.9)
- no flushing valves were installed.



Figure 13.9 Rock outcrop and thin soils in original effluent irrigation area

Rectification measures undertaken by the contractor included:

- removing the damaged irrigation pipes and replacing them with new subsurface irrigation lines
- installing a suitably sized irrigation pump in the aerated wastewater treatment system
- splitting the irrigation into a number of fields
- installing an auto-sequencing valve.



Figure 13.10 One of the new fields at the rear of the property established upslope of the aerated wastewater treatment system on imported soil



Figure 13.11 Second field established at front of property on imported soil

The following design measures could have prevented these problems:

- preparing a hydraulic design for the subsurface effluent irrigation area (and subfields) and system components (including the irrigation pump)
- locating and installing the effluent irrigation area as specified by the hydraulic design, council and the Sydney Catchment Authority
- burying all irrigation dripper lines, laterals and distribution lines below ground to prevent UV deterioration
- vegetating or turfing the effluent irrigation area immediately after installation with suitable plant/grass species
- fitting the irrigation system with a flushing manifold
- dividing the effluent irrigation area into a number of smaller fields to ensure even distribution throughout the area
- installing an automatic sequencing valve to allow effluent irrigation areas to be irrigated alternately without the owner needing to switch the fields

- Council inspecting the installation to ensure compliance with requirements
- making the installer (and property owners) aware of the proposed system, the conditions of consent and their obligations to complete the system installation including testing the system and vegetating the irrigation area
- the installer certifying that the system was installed as needed and designed.

Section 14: Emerging Technology

14. Emerging Technology

14.1	Dosing siphon.....	192
14.2	“Flout [®] ” Floating Outlet	195
14.3	Solar power	197

This section of the Manual describes some emerging technologies that designers, installers and regulators in the Sydney drinking water catchment may encounter or wish to use.

Two emerging technologies that help with dose loading are described – the dosing siphon and the “Flout[™]”. Dose loading greatly improves performance compared with passively gravity feeding land application areas. This technology can provide a pressurised dose of effluent similar to what a pump would provide, without needing an electricity supply. This passive technology is well suited to sites where there is interrupted or no mains power supply, removing the need to replace pumps and provide electricity. Continual gravity loading of effluent management areas cannot be controlled; however dose loading using siphons (not for irrigation systems) or flouts can help ensure an effluent management area is used appropriately and not hydraulically over- or under-loaded.

14.1 Dosing siphon

Dosing siphons (Figures 14.1 and 14.2) are used extensively in the USA and are becoming more readily available from on-site wastewater system suppliers in Australia. They change low or variable flows into regular doses and suit pressurising laterals and land application areas. They have no moving parts and need no electricity. They are generally only recommended for use with sand filters (Figure 14.3) or absorption trenches/beds or evapotranspiration absorption beds.

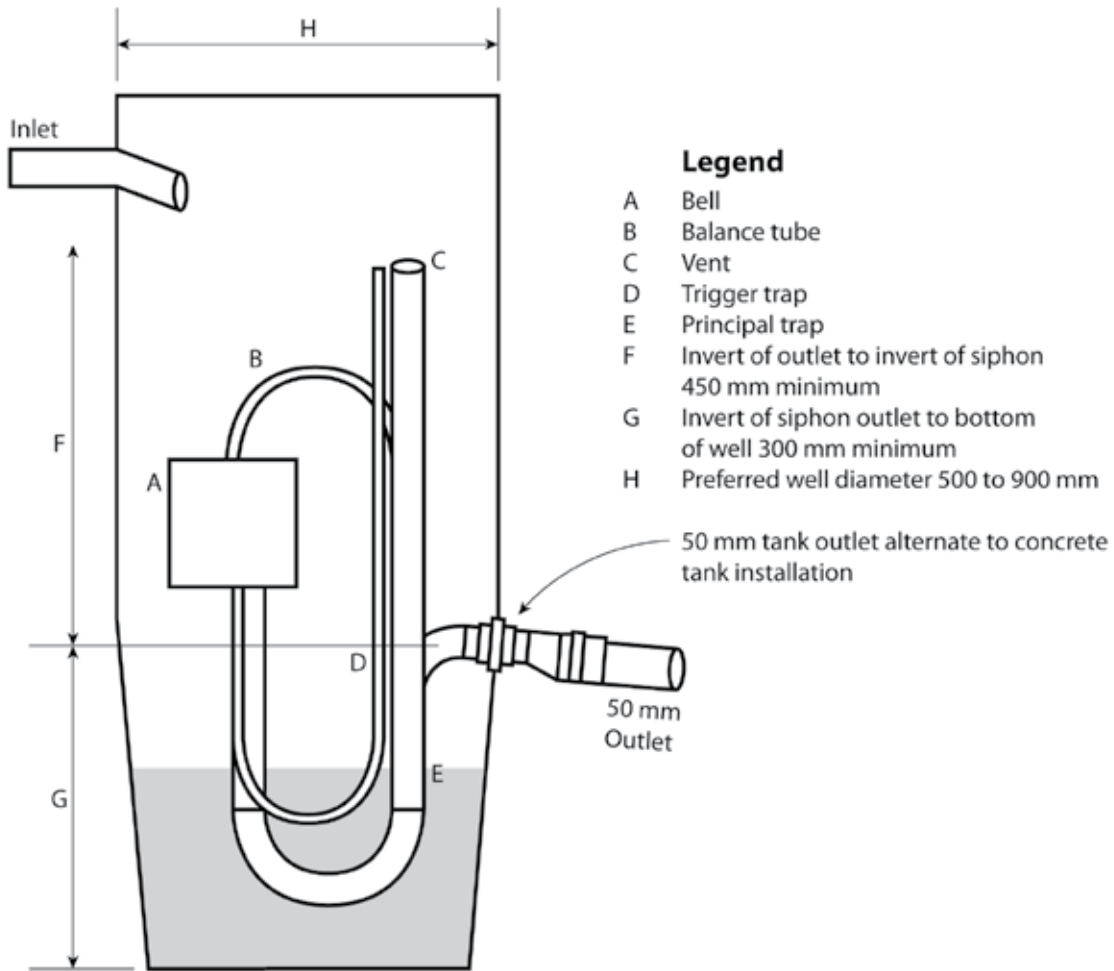


Figure 14.1 The dosing siphon (after Inwater)

An outlet filter must be fitted to the septic tank. Effluent is collected by gravity feed into a dosing chamber where the siphon is located. Effluent rises in the dosing chamber to the point where the dosing siphon is triggered. The volume of dose is determined by the diameter of the dosing chamber. After the dose is dispensed, the siphon breaks and the flow ceases. The siphon reliably resets and is automatically triggered again when the effluent level in the dosing chamber returns to the trigger level. Siphons are a low cost alternative to pumps and suit sites with no power or where power availability is limited. A fall of about 1.5 metres from the dosing chamber to the land application area is needed for the siphon to operate properly.



Figure 14.2 Dosing siphon in dosing chamber (Inwater)



Figure 14.3 Siphon being tested delivering pressure dosed load to a sand filter (Inwater)

14.2 “Flout[®]” Floating Outlet

The Flout[®] or Floating Outlet[™] is a trademarked proprietary product made by Rissy Plastics. It is a simple dosing distribution device that can be used to dose load a land application area from a dosing well (Figure 14.4 and 14.5). As effluent from the septic tank fills the dosing chamber, the Flout[™] (Figure 14.6) is empty, buoyant, and floats on the surface. High quality, flexible connectors allow the Flout[®] to rise. When the effluent reaches the maximum level in the chamber, it spills into the opening in the top of the Flout[®]. This causes the Flout[®] to sink (Figure 14.7). The effluent now discharges through the pipe exiting the dosing chamber and doses the land application area. The chamber continues to empty down to the top of the Flout[®] (Figure 14.8). Then the Flout[®] empties and resumes floating to repeat another cycle. The Flout[®] can be used to dose load trenches and beds or effluent irrigation areas in some cases where there are differences in elevation between the treatment system and the disposal area.

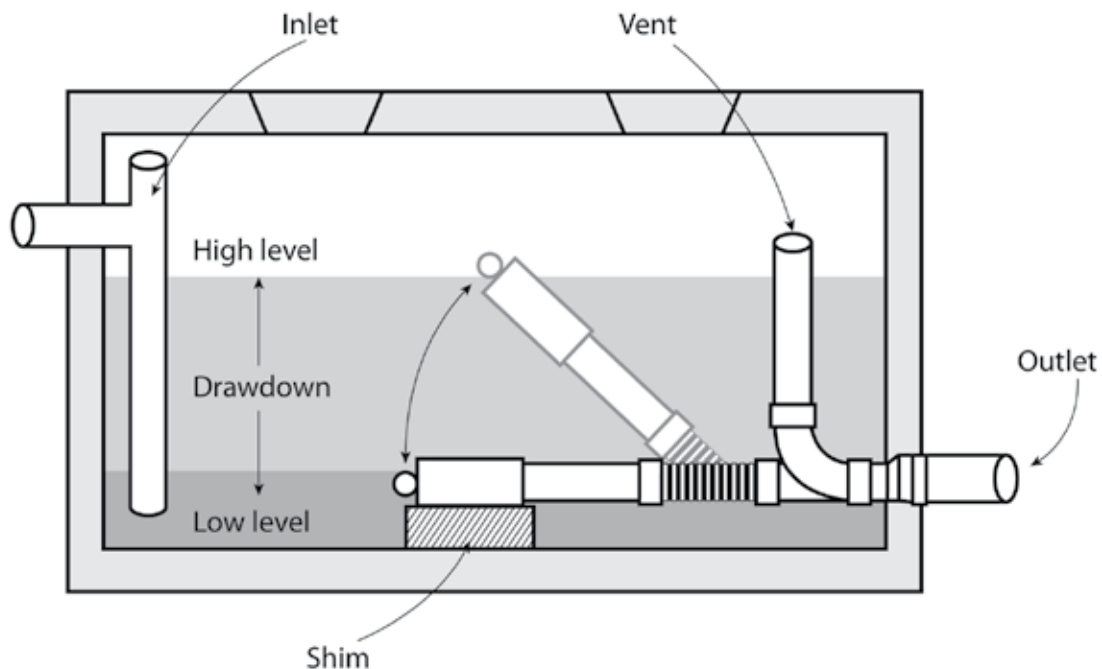


Figure 14.4 The Single Flout[®]



Figure 14.5 The Single Flout[®]



Figure 14.6 The Flout[®] is free floating



Figure 14.7 The Flout[®] reaches the maximum level in the chamber



Figure 14.8 The dosing chamber continues to empty down to the top of the Flout[®] (Figures 14.4 to 14.8 Rissy Plastics LLC)

14.3 Solar Power

The Sydney Catchment Authority will not generally accept solar powered wastewater systems that need continuous power for normal operation, such as aerated wastewater treatment systems. The Sydney Catchment Authority may, in exceptional circumstances, accept solar power for systems (eg some worm farms) where power is only periodically required to empty an effluent sump, if a detailed analysis is supplied of the power use of the pump operation relative to a proposed power source and storage. These will only be considered on a case-by-case basis.

15. Acronyms

AWTS	Aerated wastewater treatment system
BFS	Biological filter system
BOD₅	5-day biochemical oxygen demand
CRP	Current recommended practice
DIPNR	Former Department of Infrastructure, Planning and Natural Resources
DLG	Department of Local Government
DLR	Design loading rate
EMA	Effluent management area
EP	Equivalent persons
ETA	Evapotranspiration absorption (beds)
GIS	Geographic Information Systems
GTS	Greywater treatment systems
kPa	Kilopascals
NorBE	Neutral or beneficial effect (on water quality)
PC	Pressure compensating
SCA	Sydney Catchment Authority
SEPP	State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011
TSS	Total suspended solids
uPVC	Unplasticised (rigid) polyvinyl chloride
UV	Ultraviolet
WEM	Wastewater effluent model

16. Glossary

Accreditation	All domestic on-site wastewater treatment systems (including greywater treatment systems) installed in NSW must be accredited by NSW Health.
Catchment	A hydrological catchment or area of land where surface water drains through a network of drainage lines and streams to a single outlet.
Certifier	A person or entity accredited to issue certain certificates and perform specific duties under the <i>Environmental Planning and Assessment Act 1979</i> . For on-site wastewater systems, only qualified staff from a council can certify systems under the <i>Local Government Act 1993</i> .
CRP	Current recommended practice guidelines accepted or adopted by industry and natural resource management agencies to manage an aspect of the operation or development to ensure all activities are performed in a way that best protects the environment and water quality. A Sydney Catchment Authority endorsed CRP provides particular measures that ensure water quality is protected. State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011 requires endorsed CRPs to be used for developments or activities unless it can be shown that alternative measures will have equal or better water quality outcomes. A best management practice guideline is similar in concept to a CRP.
Concurrence	Concurrence is agreement from a government agency in relation to a development proposal in light of the agency's specialised functions and policies. Invariably the provision of concurrence to a consent authority will be subject to conditions. The Sydney Catchment Authority has a concurrence role in relation to proposed developments in the Sydney drinking water catchment.
Consent authority	The consent authority is the body responsible for the approval (or otherwise) of all development applications required to be submitted under the <i>Environmental Planning and Assessment Act 1979</i> . It is usually councils for most developments, but Joint Regional Planning Panels, the Planning Assessment Commission and the Planning Minister are responsible for regionally significant and major infrastructure projects.
Design loading rate	(DLR) The long term acceptance rate, reduced by a factor of safety, expressed in $L/m^2/day$ or mm/day as applied to the horizontal design area of a land application system.
Drainage depression	Naturally defined low points that carry water during rainfall events but dry out quickly when rainfall stops. A gully or incised drainage depression is considered to be a watercourse.

Drop box	A watertight structure that receives septic tank effluent and distributes it into one or more distribution pipes and into an overflow leading to another drop box and absorption system located at a lower elevation. A type of distribution box, used for serial distribution
Effluent	Treated wastewater.
Endogenous respiration	A reduced level of respiration (breathing) where organisms break down compounds within their own cells to produce the oxygen they need.
Evapotranspiration	Loss of water from the soil through evapotranspiration by plants.
Flood planning levels	The combinations of flood levels (derived from significant historical flood events or floods of specific annual exceedance probabilities) and freeboards selected for floodplain risk management purposes, as determined in management studies and incorporated in management plans. FPLs replace the “standard flood event” in the 1986 Floodplain Development Manual. FPLs consider the full range of flood sizes, up to and including the probable maximum flood (PMF) and the corresponding risks associated with each flood, whilst noting that with few exceptions, it is neither feasible nor socially or economically justifiable to adopt the PMF as the basis for FPLs. While the local council decides the flood that will be used to determine the residential FPL, the Floodplain Development Manual highlights that FPLs for typical residential development would generally be based around the 100 year flood plus an appropriate freeboard (typically 0.5 m). Unless there are exceptional circumstances, councils should use the 100 year flood as the FPL for residential development (Floodplain Development Manual, Department of Infrastructure, Planning and Natural Resources, 2005).
Greywater	Domestic wastewater from sources other than toilets, including washing machines and dishwashers.
Groundwater	Groundwater is water collected in saturated layers of soil, sediment or porous rock below the land surface as aquifers. Aquifers in geological formations are permeable enough for water to move within them and be discharged or extracted.
Headworks	A wastewater main is classed as headworks when its main function is to: <ul style="list-style-type: none">• transfer wastewater between or to a treatment plant or transfer facility, and• perform the above function for the entire length between two access chambers.
Licensed contractor	A contractor with at least three years experience in their specialised field and licensed by the NSW Department of Fair Trading.
Named river	These are rivers defined in the ‘Neutral or Beneficial Effect on Water Quality Assessment Guideline’ (Sydney Catchment Authority, 2011) for the Sydney drinking water

catchment, and include the Wingecarribee River, Wollondilly River, Nattai River, Nepean River, Coxs River, Shoalhaven River, Kangaroo River, Mongarlowe River, Tarlo River for the full length of each river as defined on a topographic map, and the Mulwaree River downstream from the Braidwood Road crossing.

NorBE

NorBE is an abbreviation for the neutral or beneficial effect on water quality test as required by the State Environmental Planning Policy. All proposed developments under Part 4 of the *Environmental Planning and Assessment Act 1979* requiring consent must be able to demonstrate that they will have a neutral or beneficial effect on water quality, whereas all Part 5 activities must consider NorBE. NorBE is demonstrated if a proposed development:

- has no identifiable potential impact on water quality, or
- can contain any such impact on the site of the development **and** prevent it from reaching any watercourse, waterbody or drainage depression on the site, or
- can transfer any such impact outside the site by treatment in a facility that will treat water to a required standard.

NorBE guideline

This guideline produced by the Sydney Catchment Authority collates relevant information and provides a clear direction as to what is meant by a neutral or beneficial effect on water quality, how to demonstrate it, and how to assess an application against the neutral or beneficial effect test. It also brings together relevant supporting information. The guideline is available at www.sca.nsw.gov.au.

NorBE tool

The NorBE Tool is a Windows-based GIS software application that guides the user to enter information derived from the information accompanying the development application eg the impervious area or the slope. Other data is automatically generated by the tool eg rainfall. The tool helps councils determine a neutral or beneficial effect or a Sydney Catchment Authority concurrence role and records the decision process for each development application.

Nutrients

Substances such as phosphorus and nitrogen that are essential for life. In excess they may stimulate the growth of plants, algae and cyanobacteria (blue-green algae).

On-site wastewater system

A system used to treat wastewater on-site, where no reticulated sewer is available.

Pathogen

A biological agent or organism such as a virus, bacterium, protozoan or other microorganism that causes disease or illness.

Permeability

The characteristic of a soil texture, structure and particle size and that governs the rate at which water moves through it. Sandy soils have a high permeability; clay soils generally have a low permeability.

Regulatory authority	The government authority responsible for managing or controlling an aspect of on-site domestic wastewater systems – usually the local council, Sydney Catchment Authority or the Office of Environment and Heritage.
Riser	A septic tank riser generally refers to a specific type of extension that is added to a septic tank. This structure can make accessing the tank easier, and help remove any tank lids. It may also make locating a septic tank easier. Many building regulation codes now require a riser as part of the septic unit.
Severe frosts	Areas of severe frost are defined as areas where the overnight minimum air temperatures (Stephenson screen) are regularly below -3°C , corresponding to a ground temperature of approximately -5°C . Frost hollows and areas of cold air drainage may result in localised areas where frost is more severe than indicated by temperature records for the region.
Soil depth	The vertical depth of soil from the soil surface to parent rock or to the water table (periodic or permanent). This does not include the C horizon consisting of weathered rock.
Special Areas	Land mostly around the Sydney Catchment Authority's drinking water storages that was originally set aside to protect drinking water quality.
State Environmental Planning Policy	A State Environmental Planning Policy (SEPP) is a policy proposed by the Minister and approved by the Governor under the <i>Environmental Planning and Assessment Act 1979</i> that deals with environmental planning matters involving several local authorities. In the catchment of Sydney's water supply reservoirs, State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011 is the relevant SEPP containing requirements to assess and approve new developments and activities in the catchment.
Suspended solids	Suspended solids are usually clay or silt particles suspended in the water as a result of the motion of water or as colloids, causing turbidity.
Wastewater (domestic)	All wastewater from the bathroom, laundry and kitchen, including toilet waste.
Wastewater Effluent Model	(WEM) A GIS-based, effluent plume generation modelling tool that supports evaluation of on-site wastewater systems.
Waterbody (artificial)	An artificial body of water, including any constructed waterway, canal, inlet, bay, channel, dam, pond, lake or artificial wetland. This does not include a dry detention basin or other stormwater management structure that is only intended to hold water intermittently.
Waterbody (natural)	A naturally occurring body of water, constant or intermittent, fresh, brackish or saline, including where the course has been artificially modified or diverted. This includes a river, creek, stream, lake, lagoon, natural wetland, estuary, bay, inlet or tidal waters (including the sea).

Watercourse

Any river, creek, stream or chain of ponds, whether artificially modified or not, in which water usually flows, either continuously or intermittently, in a defined bed or channel, but does not include a waterbody (artificial).

Weighted Psorp value

Where Psorp values of various layers of the soil are averaged taking into account the thickness of each layer.

Example of weighted average of phosphorus sorption of soil profile

Soil Depth (cm)	Psorption (mg/kg)	Psorption / soil layer
0-10	150	10 x 150 = 1,500
10-30	200	20 x 200 = 4,000
30-100	400	70 x 400 = 28,000

$$\text{Weighted Psorp} = \frac{(1,500 + 4,000 + 28,000)}{10 + 20 + 70} = 335 \text{ mg/kg}$$

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Appendix 1

Phosphorus Sorption Uptake Values

Soil Category	Texture	Structure	Typical P _{sorp} * (mg/kg)
1	Gravels and sands	Structureless	75
2a	Sandy loams	Weak	75
2b	Sandy loams	Massive	75
3a	Loams	High / moderate	150
3b	Loams	Weak / massive	150
4a	Clay loams	High / moderate	300
4b	Clay loams	Weak	300
4c	Clay loams	Massive	300
5a	Light clays	Strong	500
5b	Light clays	Moderate	500
5c	Light clays	Weak / massive	500
6a	Med-heavy clays	Strong	500
6b	Med-heavy clays	Moderate	500
6c	Med-heavy clays	Weak / massive	500

* If soil parent material is basalt then increase P_{sorp} by 100 mg/kg

Nutrient Uptake Rates

Vegetation Type	Total Nitrogen (kg/ha/year)	Total Phosphorus (kg/ha/year)
Good quality woodland	90	25
Poor quality woodland	65	20
Lawn – fully managed (clippings removed)	240	30
Lawn – unmanaged	120	12
Improved pasture	280	24
Perennial pasture	99	11
Shrubs and some trees – fully managed	150	16
Shrubs and some trees – unmanaged	75	8

For **bulk density (g/cm³)**, apply the following values:

- Sandy soil – 1.8 g/cm³
- Intermediate – 1.5 g/cm³
- Clayey soil – 1.3 g/cm³

Recommendation for improved practice and communication between designer and installer

Currently most wastewater reports are high-level design documents that specify the nature, location and size of wastewater and effluent management systems. These reports invariably do not provide practical details of effluent disposal system design that accommodate site specific hydraulic requirements. The details of site-specific design are usually left to the installer and sometimes ignored altogether.

This Manual addresses some of these issues but the most of the responsibility for detailed design remains with the wastewater consultant. A **System Design** that provides details of the technical and hydraulic design of wastewater management and effluent management systems is one way to address this issue. Through this System Design document, the wastewater consultant takes responsibility for the detailed design and installation instructions. The consultant will certify that the design, if installed correctly, will perform as expected. The templates in Appendices 2, 3 and 4 are examples of the types of statements that wastewater consultants and installers should use to certify that their work is complete according to the Conditions of Approval. These templates have been developed in consultation with industry representatives.

Appendix 2 contains the **Design Producer Statement** to be completed by the designer.

Appendix 3 contains the **System Design** to be prepared by the designer and supplied to the installer.

Appendix 4 contains the **Installation Certificate** to be prepared by the installer, and certifies that the installation is as described in the System Design.

Appendix 2

Design Producer Statement

DESIGN PRODUCER STATEMENT

On-site Wastewater and/or Effluent Disposal System Design

ISSUED BY:	<i>Wastewater System Designers Pty Ltd</i>	
TO:	<i>Catchment Council</i>	
DA No:	<i>DAXXX/YYYY</i>	
TO BE SUPPLIED TO:	<i>Mr & Mrs Consumer</i>	
IN RESPECT OF:	<i>On-site wastewater system for 1 Rural Road, Septicville</i>	
AT:	Lot/DP:	<i>XX/YYYYYYYY</i>
	Description:	<i>4,000 m² rural residential lot</i>
	Address:	<i>1 Rural Road, Septicville</i>

Wastewater System Designers Pty Ltd has been engaged by **Mr & Mrs Consumer** (property owners) to provide the technical design details for an on-site wastewater system.

The design has been carried out in accordance with:

- SCA, 2010 'Developments in Sydney's Drinking Water Catchment – Water Quality Information Requirements'.
- DLG, 1998 'Environment and Health Protection Guidelines: On-site Sewage Management for Single Households'
- AS/NZS 1547:2012 'On-site Domestic Wastewater Management'

For details of site assessment and design, refer to **Wastewater Management Report, 1 Rural Road, Septicville dated DD/MM/YYYY**.

Other resources used for this design include:

- Eg SCA, 2011 'Designing and Installing On-site Wastewater Systems'
-

This is an independent design, covered by a current policy of Professional Indemnity Insurance.

DECLARATION:

I believe on reasonable grounds that this design has been carried out in accordance with agency and council requirements, and best practice in on-site wastewater design principles and procedures.

NOTE: This statement does not approve the installed system.

Under certain conditions, **Wastewater System Designers Pty Ltd** is available to certify the installed system. These conditions include:

- the technology supplier(s) take(s) full responsibility for the stated quality and performance of technologies and other equipment supplied
- the installer(s) take full responsibility for installing the system as specified by any conditions of consent and **Wastewater System Designers Pty Ltd** design reports unless departure from the stated specification(s) is subsequently agreed between the installer and

Wastewater System Designers Pty Ltd and approved by the consent authority

- **Wastewater System Designers Pty Ltd** is to be informed before installation, and engaged, under separate contract, if required to supervise installation of all specified system components.

DISCLAIMER:

*Approval is to be sought from **Wastewater System Designers Pty Ltd** should variations to the specification and layout in this report/drawing be considered necessary by the installer before or at the time of installation. Failure to do so will invalidate the Design Producer Statement and **Wastewater System Designers Pty Ltd** will no longer take responsibility for the design.*

*The client is to make full disclosure of relevant information on existing and/or proposed activities on the site that will influence estimation of likely daily wastewater quantity (based on the number of potential bedrooms and other wastewater producing activities) and quality (in particular any chemicals in the water supply and/or wastewater stream potentially toxic to biological wastewater processes). This design is based on the site assessment carried out by **Wastewater System Designers Pty Ltd**.*

Subsequent changes to the site that might affect the topography and soil profiles are to be notified by the client. Failure, by the Client, to provide this information will invalidate this Design Producer Statement.

Signature:

Title:

Name:

For: **Wastewater System Designers Pty Ltd**

Date:

Other conditions that may be specified by **Wastewater System Designers Pty Ltd** under the contract to supervise installation:

-

Appendix 3

System Design

SYSTEM DESIGN

On-site Wastewater and/or Effluent Disposal System

(to be prepared by the designer for supply to the installer)

DATE: *DD/MM/YYYY*

ISSUED BY: *Wastewater System Designers Pty Ltd*

IN RESPECT OF: *Mr & Mrs Consumer On-site wastewater service for Lot XX DP YYYYYY, 1 Rural Road, Septicville (Catchment Council)*

DESCRIPTION OF PROJECT:

- *Installation of an on-site wastewater system for a [insert relevant proposal eg a four bedroom dwelling].*
- *Treatment system: NSW Health accredited [insert relevant system and model number].*
- *Nature of disposal system / Land application:..... [insert relevant land application eg 400 m² subsurface drip irrigation].*

DECLARATION:

This System Design dated DD/MM/YYYY has been prepared by:

Name:

Signature:

Title:

Date:

1. SITE LOCATION

The site is located at

Lot/DP:	XXX/YYY
Description:	4000 m ² rural residential lot
Address:	1 Rural Road, Septicville
Council:	Catchment Council

2. PROPOSED WASTEWATER SERVICING SYSTEM

2.1 System description

The proposed wastewater system to service the property consists of the following components:

- *Treatment system: eg secondary treatment with disinfection by a NSW Health accredited [insert treatment level, relevant system and model number]*
- *Nature of disposal system / Land application: [eg pumped dose loading via an automatic, hydraulically operated sequencing valve to two 200 m² fields of pressure compensating subsurface drip irrigation, each fitted with an automated field flush valve].*

2.2 System layout

The proposed location and set back distances of the land application area relevant to this site are to be consistent with the requirements in the Conditions of consent, SCA's 'Developments in Sydney's Drinking Water Catchment – Water Quality Information Requirements', and:

- 3 m from all downslope (or flat) and 6 m from all upslope property boundaries
- 15 m and not upslope of in-ground pools and potable water tanks
- 40 m from any drainage depression, farm dam or waterbody
- 100 m from the high water level of any permanent or intermittent watercourse, bore or other potable water source
- 150 m from any SCA named river.

For the location of the land application area see the Site Plan with the location marked (eg Figure 1) and for details of the subsurface irrigation system refer to the attached Standard Drawings [attach Standard Drawings 13B and 13C].

Key issues are:

- The exact location of the AWTS / septic tank is to be decided by the installer in consultation with the property owner. It is to be at least 3 m from any building.
- A power supply (and telephone line if telemetry or an automated monitoring/alarm is fitted), will be required to deliver power to the treatment unit.

2.3 Installation of AWTS / Septic Tank (examples of requirements)

- The recommended grade of influent drain line is no less than 1:80.

- Installation is to be done in accordance with the AWTS manufacturer's Installation Manual.
- For this site additional ground anchoring is recommended.
- The wastewater treatment unit is to be buried to near ground level but 100 mm above ground level to avoid accumulation and ingress of stormwater under the tank lid.

2.4 Subsurface irrigation (examples of requirements)

The proposed land application area and suggested layout of the subsurface irrigation system is illustrated in the Site Plan and Standard Drawings. Guidance on the installation of the subsurface irrigation system can be found in the attached Standard Drawing [attach Standard Drawing 13B].

The specifications are:

- The length of supply line and return flush line will depend on location of the AWTS / septic tank relative to the land application area. These lengths are to be checked by the installer. The recommended supply line (distribution pipe) and return flush pipe is 25 mm uPVC or polyethylene (low or medium density).
- Note that the irrigation field has been divided into two fields, serviced by an automatic, hydraulically operating sequencing valve.
- The effluent distribution lines are to be buried at a minimum depth of 300 mm.
- Dripper laterals:
 - a minimum of 670 m of pressure compensating 16 mm dripper line is required
 - drippers at 600 mm spacing
 - dripper laterals are typically to be spaced at 600 mm
 - dripper laterals are to be buried to a depth of 100-150 mm.
 - the effluent irrigation area is to be fenced off / protected from grazing animals or vehicular access.
- Air release valves to be installed at the north-east and north-west corners of each field of the irrigation field (which are the high points).
- The effluent irrigation area, valve boxes and any other surface fittings must be located and protected to prevent damage by animals, vehicles and/or lawn mower.
- All components must be protected from damage by vehicles and other activities during any construction activities.

2.5 Stormwater

Run-on and stormwater is to be diverted around each subsurface irrigation field by means of a berm or diversion drain. Guidance on the installation of an appropriate earth bank and diversion drain can be found in the attached Standard Drawing [attach Standard Drawing 13A].

3. APPROVAL

Approval to install this system has been granted by(insert Council name) Council. The Conditions of consent must be adhered to by the installer.

4. OPERATION AND MANAGEMENT

A servicing contract with an approved servicing agent is required for the life of the system by (insert Council name) Council. Copies of the written service reports should be lodged with (insert Council name) Council following each quarterly service.

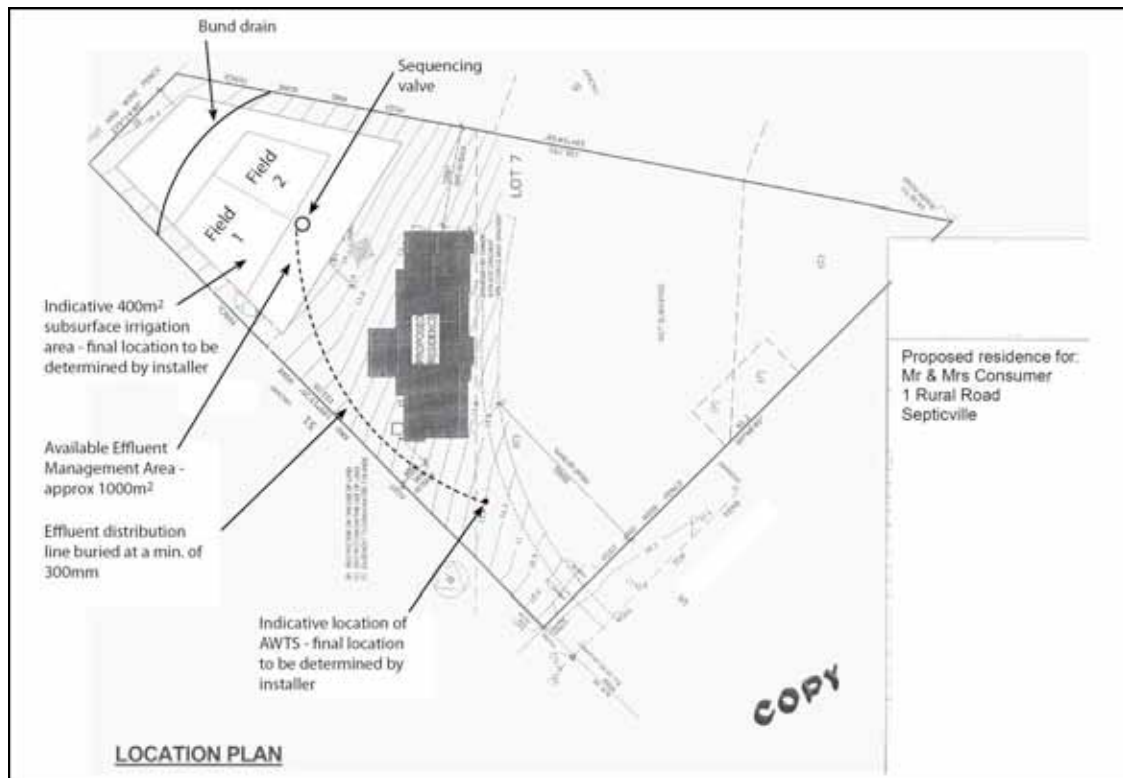


Figure 1. Example of the layout of an AWTS and irrigation field

Appendix 4

Installation Certificate

COMPLETION OF WORKS
INSTALLATION CERTIFICATE
On-site Wastewater and/or Effluent Disposal System

(to be prepared and issued by the licensed installer)

ISSUED BY: *On-Site System Installers Pty Ltd*

TO BE SUPPLIED TO: *Catchment Council (DA No. XXX/YYYYY)*

IN RESPECT OF: *Mr & Mrs Consumer, On-site wastewater service for 1 Rural Road, Septicville (Catchment Council)*

SITE DETAILS: Lot/DP: *XXX/YYY*
Description: [*insert relevant description*]

DESCRIPTION OF PROJECT:

- *Installation of an on-site wastewater system for a [*insert relevant proposal eg a four bedroom dwelling*].*
- *Treatment system: NSW Health accredited [*insert relevant system and model number*].*
- *Nature of disposal system / Land application: [*insert relevant land application eg 400 m² subsurface drip irrigation*].*

INSTALLED IN ACCORDANCE WITH: *Conditions of consent and Wastewater System Designers Pty Ltd System Design, 1 Rural Road, Septicville, dated DD/MM/YYYY*

DATE OF SITE INSTALLATION INSPECTION: *DD/MM/YYYY*

REPORT: *Variations: None. Installed as indicated on Site Plan in System Design.*

DECLARATION:

I believe on reasonable grounds that all of the wastewater works have been completed in accordance with Council Consent Number 123456 and Wastewater System Designers Pty Ltd System Design dated DD/MM/YYYY.

Name:

Title:

Signature:

For: *On-Site System Installers Pty Ltd*

Date: *DD/MM/YYYY*

cc: Mr & Mrs Consumer



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