On-site Wastewater Management Training Course

Soil Absorption Systems; Trenches and Beds

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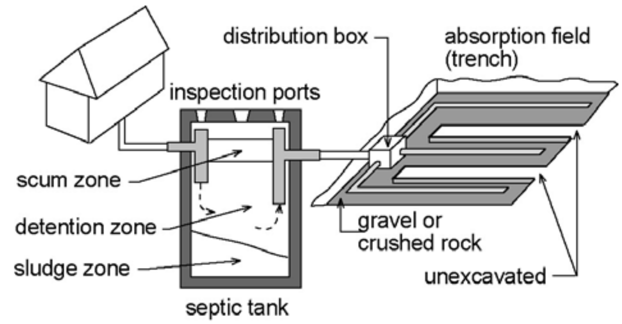
Schematic of On-site System Design Using Soil Absorption

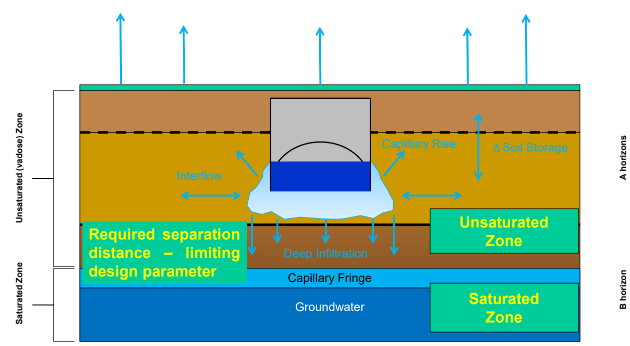


Soil Based Systems

Design of soil absorption system and calculation of lineal metres of trench needs to be based on hydraulic capacity of most limiting horizon or layer

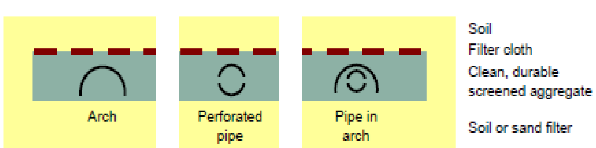
- Significant physical, chemical and microbiological treatment of effluent occurs in unsaturated soils
- Older absorption systems often rely on the distribution of effluent subsurface by gravity, but operate better when pressurised
- The poor performance of systems is often related to an inadequate understanding of the hydraulic capacity of the receiving soils

Subsurface Effluent Disposal



Standard Trench Designs

All trenches for effluent comprise a basic distribution module surrounded by soil

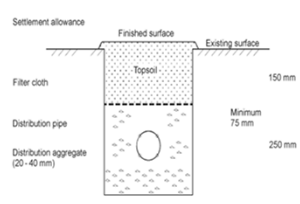


Source: Cromer (2013)

Soil absorption trenches may involve piped, boxed or arch trenches

Conventional Piped/Boxed Trench

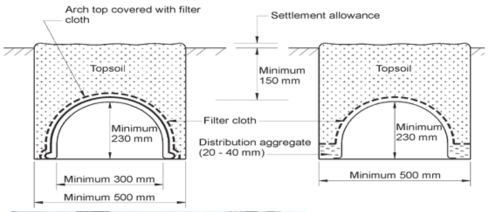
(AS/NZS 1547: 2012)



Perforated Pipe

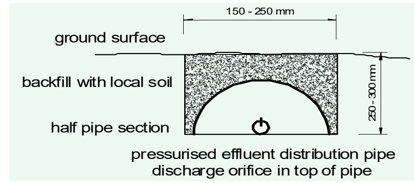
Boxed Trench Leach Drains

Self Supporting Arch Trench
(AS/NZS 1547: 2012)



Tunnel Trench

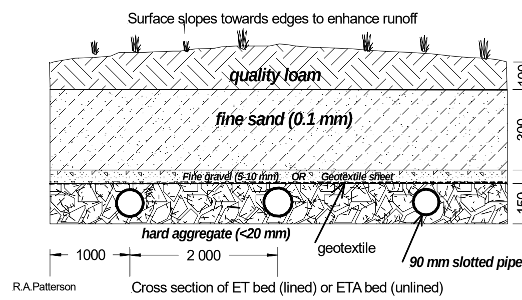
LPED Pressure Dosed Shallow System



Standard ET or ETA Bed

- Lined or unlined systems use absorption, as well as evaporation and transpiration (evapotranspiration)
- Vegetation cover must be maintained to optimise evapotranspiration
- Effluent drawn up from storage into root zone of plants by capillary action
- Shape of surface designed to maximise runoff
- Surface area calculation (water balance required)
- Often used where site limitations exist e.g. in locations with low permeability soils and useful in drier climates

Typical Cross-section of Piped ET Bed



Source: Patterson (2006)

Design of Subsurface Systems …

Depends on:

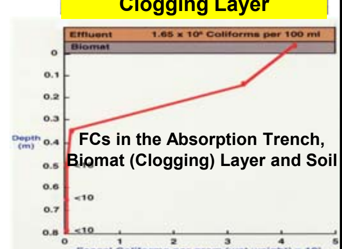
- Hydraulic capacity of soil - limiting design parameter (LDP) for soils of low hydraulic conductivity
- Purification ability of soil - not easily assessed
- Hydraulic load - application rate of wastewater

- *A simple set of design criteria which adequately considers all the above factors does not exist*

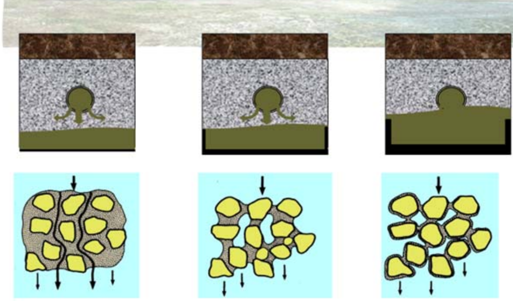
Design Loading Rate (DLR)

- Infiltration of effluent into soil is limited by clogging layer, but soil texture and structure are important too
- DLR of soil expressed in $L/m^2/d$
- DLR is always < < clean water permeability

Clogging Layer



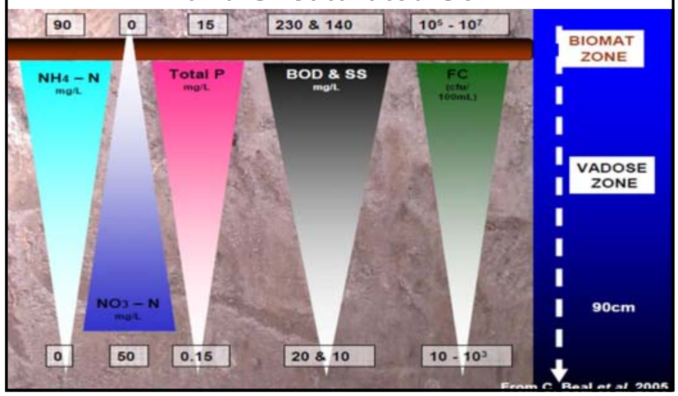
BIOMAT ZONE HYDRAULICS



The greater resistance of the biomat zone, the more unsaturated the underlying soil ∴ the slower the infiltration (and ↑↑ treatment)

cet

ST Effluent Quality Change through Biomat and Unsaturated Soil



DLR for Trenches and Beds

(Adapted from Table L1 AS/NZS1547:2012)

Soil Category	Soil Texture	Structure Range of categories not shown	Indicative K (m/d)	Primary Conserv. DLR (mm/d)	Primary Max. DLR (mm/d)
1	Gravels & sands	Massive	> 3.0	See note	See note
2	Sandy loams	Range	1.4 - 3.0	15	25
3	Loams	Range	0.5 – 3.0	10	25
4	Clay loams	Range	0.06 – 1.5	4	15
5	Light clays	Range	0.06 – 0.5	5	8
6	Heavy clays	Range	< 0.06 – 0.5	See note	See note

For primary treated effluent conservative DLR should be used

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Soil Absorption - Simple Example

- Assume soil DLR is 15 mm/d*
- Assume hydraulic load is 150 L/p/d
- 1 Litre of water or effluent applied to 1 m^2 covers to a depth of 1 mm
- Maximum effluent loading rate should therefore not exceed 15 L/m^2 otherwise failure will occur
- Required contact area is therefore 10 m^2 (based on hydraulic load (150 L divided by DLR of 15 L/m^2)

*Remember – 1 mm/day is equivalent to a loading rate of 1 L/m^2/day
For example, 20 mm/day is dimensionally equivalent to 20 L/m^2/day

Design Method - Trenches and Beds

(AS/NZS1547:2012)

- Undertake SSE procedure and determine land capability constraints and setbacks or buffers - need suitable deep soil for absorption
- Assuming site and soil appropriate (not in medium or heavy clay), select primary DLR taking into account any limiting factors raised in SSE report
- Size disposal areas according to:

$$L = Q/(DLR \times W)$$

where L = trench length (m), Q = design daily flow (L/d), DLR = design loading rate (mm/d) and W = width (m)

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Design Method - Trenches and Beds

(AS/NZS1547:2012)

- Example: L = Q/(DLR × W)
- Daily design hydraulic load Q = 750 L/d
- DLR 15 L/m^2/d (assessed by designer based on field measurement or field/lab textural method; conservative DLR used for primary effluent)
- Assume a trench 1 m wide then,
- L = 750/(15 × 1) = 50 lineal metres
- DLR in AS/NZS1547 (2012) is to be used to size horizontal bottom area only in trenches and beds

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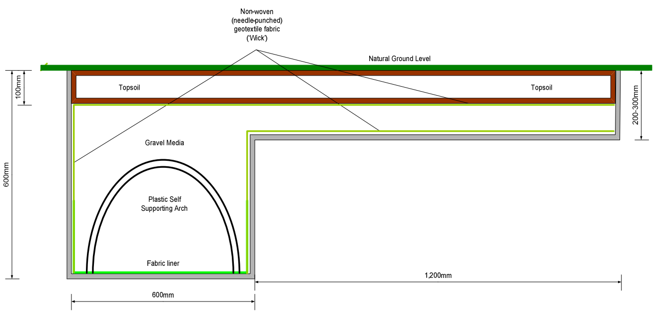
Alternative Trench Systems and Non-conventional Beds

- Variety of alternatives to traditional trench and bed designs
- NcBs seek to enhance the performance of more traditional trenches and bed designs
- Make use of larger basal area, inter-trench space for evapotranspiration using various plants and/or provide additional treatment (i.e. filtration) so that higher design loading rates can be applied

Wick Trench and Bed

- For use in clay soils but can be used in other soil types too
- Suitable for both Primary and Secondary effluent
- Suited to small blocks
- Assists trench seepage with evapotranspiration from adjacent bed
- Evapotranspiration bed can be either side of trench
- Trench and bed are linked by a geotextile wrap which lies both under and over the trench and bed
- Geotextile wick draws moisture upwards by capillary action into the root zone of the vegetation above
- Design calculation uses loading factor to reflect improved storage/ET efficiency in the design

Cross-section of a Wick Design



Designer: Kerry Flanagan
Source: WaterNSW (2019)


Excavated Trench and Bed


Lay Geotextile Over Trench and Bed to Complete Wrap


Place Gravel Over Bed and Over Arch

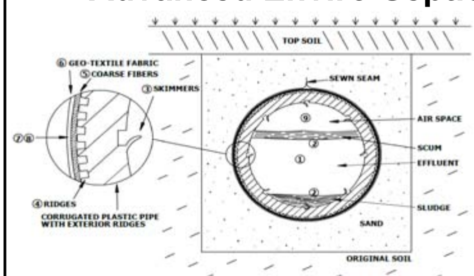

Lay Geotextile Over Trench and Bed to Complete Wrap and Cover with Topsoil

Advanced Enviro-Septic (AES)

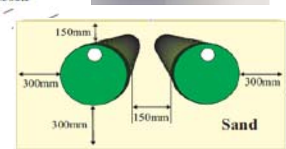
- Combined treatment and disposal pipe system
- Pipes installed in the land application area as either absorption trenches or evapo-transpiration beds and surrounded by a layer of coarse washed sand
- Pipes are corrugated, perforated, high-density plastic with a series of ridges and “skimmers” extending into its interior
- Skimmers capture grease and expose to aerobic degradation
- A non-woven geo-textile plastic fabric around the mat of fibres – acts as filter and surface for biomat growth
- Sand allows air transfer to biomat surface and further filtration before effluent enters underlying soil

https://www.enviro-septic.com.au/

Advanced Enviro-Septic (AES)



Sits in bed of “System Sand” of defined specification



System Sizing

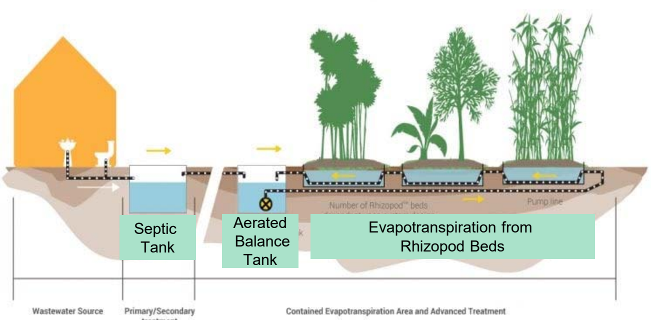
- Manufacturer recommends maximum hydraulic load of 114 L per pipe length (3 metre) – loading rates approx. 38 L/m^2 for secondary or 30 L/m^2 for advanced secondary
- Trench or bed basal area sized on Secondary treated effluent loading rates of AS/NZS 1547:2012 (Table L1)
- In QLD considered a Secondary treatment system
- In NSW not considered a sewage management facility but a land application system and requires approved system for Primary treatment (septic tank)

Evapotranspiration Trenches

- Use balance tank after ST and consists of separate linked concrete pods
- Small footprint raised garden beds filled with imported suitable soil
- Suitable for poor soils and difficult sites
- Effluent remains subsurface and is recirculated
- Commercial term Rhizopods

Rhizopod Beds

www.arris.com.au



Evapo(transpiration) Beds

- Above ground land application evaporative system
- Bed of substrate where wastewater is evaporated
- Materials such as treated timber, corrugated iron and brick used to enclose substrate
- Suitable for poor soils and difficult sites
- Plants and landscaping can be incorporated into the design
- 4 bdr 1,000 L/day system footprint: 10m × 4m × 0.6m ht

http://www.evapocycle.com/home/

Summary

- Trenches and beds utilising soil absorption (and evapotranspiration) continue to provide an effective means of land application and treatment of effluent
- Soils can provide excellent renovation capacity when loaded at an appropriate DLR but trenches not suited to heavy soils without some site and soil modification
- Systems incorporating evapotranspiration require water balance sizing
- SSE very important in designing systems and design needs to be undertaken by trained persons

Further Reading

- AS/NZS 1547:2012 On-site Domestic Wastewater Management
- Cromer, WC (2013) Nonconventional Beds: Notes for Designers, Installers and Regulators, Unpublished Report William C Cromer Pty Ltd
- Patterson, RA (2006) Evapotranspiration Bed Designs for Inland Areas http://lanfaxlabs.com.au/papers/P51-Technical%20Sheet%20%20Evapotranspiration-aug06.pdf
- WaterNSW (2019) Designing and Installing On-Site Wastewater Systems A WaterNSW Current Recommended Practice https://www.waternsw.com.au/__data/assets/pdf_file/0003/58251/Designing-and-Installing-On-Site-Wastewater-Systems-WaterNSW-CRP-2019.pdf
- https://www.enviro-septic.com.au/
- http://www.evapocycle.com/home/
- www.arris.com.au

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Appendix E: Wick Trench and Bed System

The Wick Trench and Bed land application system was developed by Kerry Flanagan of 'Kerry Flanagan Wastewater' for use in clay soils for primary and secondary effluent. The Wick System may also be used in other soil categories and on small lots (where applicable), as the system is designed to maximise the movement of effluent up through the soil to plant roots and the atmosphere.

The Wick System is a series of trenches with adjacent evapo-transpiration (EVT) beds that are underlain and joined by a layer of geotextile. The EVT bed may be installed on either side of the trench. The surface of the combined trench and EVT bed, which is approximately three times the width of a conventional trench, is planted with herbaceous vegetation to maximise the wicking effect over the large surface area. The geotextile acts as the 'wick' to continuously draw liquid upwards through capillary action. Plant roots and leaves, the sun and the wind act as 'pumps' to draw the liquid upwards out of the soil and into the atmosphere.

Design and Installation

Photographs of the Wick Trench and Bed System installation procedures can be found on pp. 137–141 of the Sydney Catchment Authority's manual *Designing and Installing On-Site Wastewater Systems* (SCA 2012). The manual can be downloaded at http://sca.clients.squiz.net/__data/assets/pdf_file/0020/39314/Designing-and-Installing-On-Site-Wastewater-Systems-complete-document.pdf . The design and installation procedures to be followed in Victoria, particularly in regard to the geotextile component of the system, are listed below.

Design

- The Wick Trench and Bed System must be installed on flat land. Where the available land is not flat, it must be terraced to provide a flat platform.
- The trench must have uniform depth to provide uniform performance along its length.
- For effective gravity flow from the septic tank to the Wick Trench the surface level of the Wick Trench must be at least 150 mm below the invert of the septic tank outlet (e.g. where the tank outlet invert is 400 mm below the top of the tank, the ground level of the Wick Trench must be at least 550 mm lower). On sites where it is not possible to have a 550 mm height difference between the septic tank outlet invert and the Wick Trench, a suitably-sized distribution pump must be used.

Sizing calculations:

Legend:

Q = Daily design flow rate in L/day

W = Width of trench and bed

DLR = Design Loading Rate in mm/day (see Table 9 for primary and secondary effluent loading rates)
F = factor of 1.2

Arch trench refers to a plastic self-supporting arch 410 mm wide x 1.5 m long.

EXAMPLE for Primary Treated Effluent:

Length of Wick Trench System for a standard 3-bedroom house on clay loam soil:

Length of Trench / Bed = Q / [DLR x (W / F)]

= [(3 bedrooms + 1) x 180 L/day] / [10 L/ m^2 x 1.6 m / 1.2]

= 720 L/ [10 L/m^2 x 1.6 m / 1.2]

= 720 L / 13.3 L/m

= 54 m

This would be built with two 27 m long Wick Trench/Beds or three 18 m long systems.

Area of the Wick Trench and Bed System = Length x Width

= 54 m x (600 mm + 1000 mm)

= 54 m x 1.6 m

= 86.4 m^2 (plus spacing between the Trench/Bed units)

EXAMPLE for Secondary Treated Effluent:

Length of Wick Trench System for a standard 3-bedroom house on clay loam soil:

Length of Trench / Bed = Q / [DLR x (W / F)]

= [(3 bedrooms + 1) x 180 L/day] / [30 L/ m^2 x 1.6 m / 1.2]

= 720 L/ [30 L/ m^2 x 1.6 m / 1.2]

= 720 L / 40 L/m

= 18 m

This would be built with one 18 m Wick Trench/Beds or two 9 m long systems.

Area of the Wick Trench and Bed System = Length x Width

= 18 m x (600 mm + 1000 mm)

= 18 m x 1.6 m

= 28.8 m^2 (plus spacing between the Trench/Bed units).

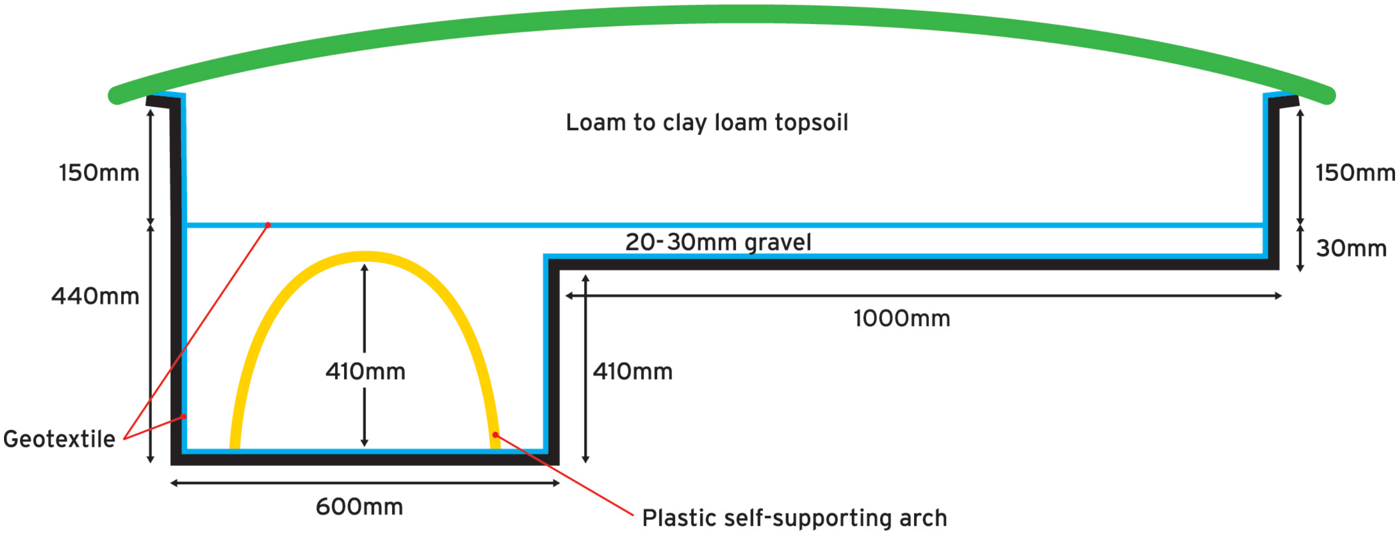
Installation

1. Peg out the trench and pan areas.
2. Remove the topsoil and stockpile. Where this is a friable, loamy soil it can be reused as the final layer of the Wick Trench and Bed. Otherwise neither the topsoil nor lower soil horizons are to be reused in the system, and suitable loamy soil must be imported.
3. Excavate the trench to a depth of 600 mm and the adjacent pan to 130 mm for secondary effluent and 180 mm for primary effluent systems.
4. Continuously check the level of the bed of the trench and the pan with a laser level to ensure they are flat.
5. Lay the 'A12 grade' geotextile fabric (with dry pore size 230 ↔m) in a continuous length across the trench and pan i.e. down the outer side wall of the trench, across the base of the trench, up the inner side wall of the trench, across the base of the pan and up the outer side wall of the pan.
6. Ensure the geotextile extends at least 50 mm further than the top of the side walls
7. Overlap the edges of the geotextile down the length of the trench and pan system until all bases and side walls are covered.
8. Place the plastic self-supporting arch in sections 410 mm wide and 1500 mm long, into the trench on top of the geotextile.
9. Install inspection ports at trench entry points and the connection points to other trenches.
10. Install a mica-flap vent at the end of the each trench to facilitate air being drawn into the trench, up the pipe line into the septic tank, through the pipe line into the house drainage system and up through the roof vent. The mica-flap acts as a marker for the end of the trench.
11. Spread clean 20 – 30 mm gravel over the arch in the trench and across the pan to a depth of 30 mm. Ensure the top of the gravel layer is level.
12. Lay overlapping lengths of geotextile across the top of the gravel layer, ensuring the geotextile extends at least 50 mm further than the side walls of the trench and pan.
13. Spread good quality friable and permeable loamy soil over the top of the geotextile to a depth of 100 mm for secondary effluent and 150 mm for primary effluent systems. Never use soil from lower soil horizons.
14. Slightly mound the surface of the topsoil across the trench and bed to help shed rainwater off the system (see the diagram below).
15. Plant the topsoil with a suitable grass or plants that thrive when their roots are continuously wet, especially those with large leaves as they will transpire more water than plants with small leaves.
16. Install stormwater diversion drains to direct stormwater away from the Wick System.

Maintenance

The septic tank must be periodically desludged to ensure proper functioning of the Wick Trench and Bed System.

Wick Trench & Bed System
For primary treated effluent



For secondary treated effluent