On-site Wastewater Management Training Course

Soil Absorption Systems; Trenches and Beds

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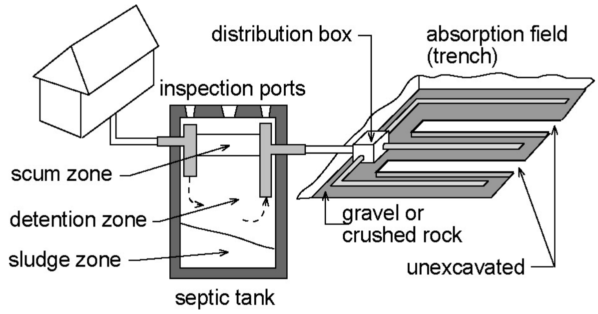
Schematic of On-site System Design Using Soil Absorption

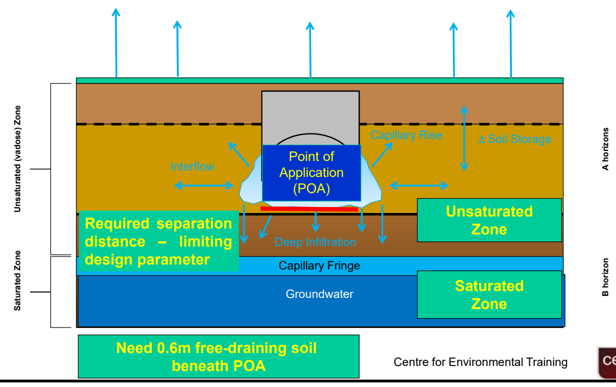


Soil Based Systems

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

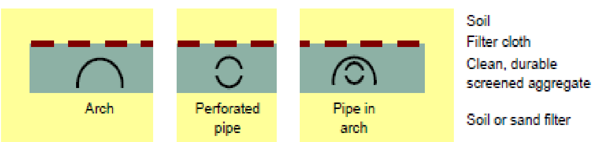
- Significant physical, chemical and microbiological treatment of effluent occurs in unsaturated soils
- Rely on infiltration & percolation of effluent through an unsaturated aerobic soil where treatment occurs
- The poor performance of systems is often related to an inadequate understanding of the hydraulic capacity of the receiving soils resulting in under-design & overloading

Subsurface Effluent Disposal



Standard Trench Designs

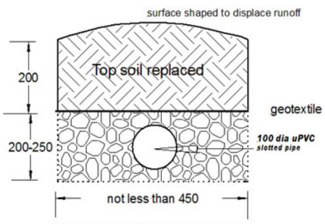
- All trenches & bed systems are constructed below ground; can be media filled or consist of a durable self-supporting arch resting on gravel or coarse sand
- Effluent delivered is along a manifold laid along the entire length
- Soil absorption trenches may involve piped, boxed or arch trenches; dosed by pressure, low pressure or gravity



Source: Cromer (2013)

Conventional Piped/Boxed Trench

Source for figure:
https://www.lanfaxlabs.com/septic_tanks.htm#DOMESTIC%20WASTEWATER

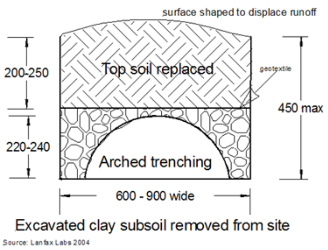


Drainfield with pipe distribution

Perforated Pipe

Boxed Trench Leach Drains

Self Supporting Arch Trench



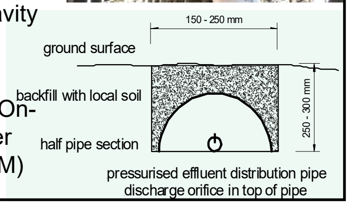
Tunnel Trench

Drainfield with plastic trenching

Source for figure:
https://www.lanfaxlabs.com/septic_tanks.htm#DOMESTIC%20WASTEWATER

LPED Pressure Dosed Trenches

- Pressure dose primary (or secondary) effluent in shallow trenches (0.2 × 0.2 m)
- Perforated pressure line within a distribution pipe
- LPED not suitable for gravity distribution
- Commonly used in NZ
- See AS/NZS 1547:2012 On-site Domestic Wastewater Management (Appendix M)

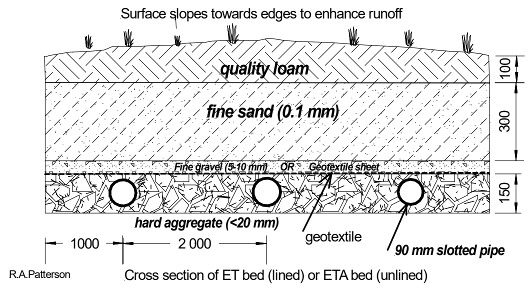


Standard ET or ETA Bed

- Lined or unlined systems use subsurface absorption, as well as evaporation and transpiration (evapotranspiration)
- Require good sun & wind exposure; 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
- Useful in locations with low permeability soils and in drier climates

Source: Water NSW (2023)

Typical Cross-section of Piped ET Bed



Source: Patterson (2006)

Effluent Distribution

- Dosing to multiple trenches can be by gravity or pressure
- Passive options (flout, siphon) covered elsewhere in course
- Distribution methods aim to distribute effluent doses evenly rather than trickle loading
- Distribution boxes can use gravity but need to ensure that outlets are level
- Sequencing valves require pressure and automatically switch flow to separate outlet port each time pump activates

https://reln.com.au/product-range/distribution-pit/

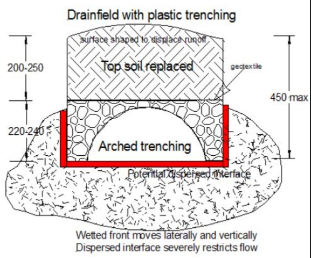
https://wastewaterequipment.com.au/products/K-Rain-Valve-4-Outlet.aspx

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*



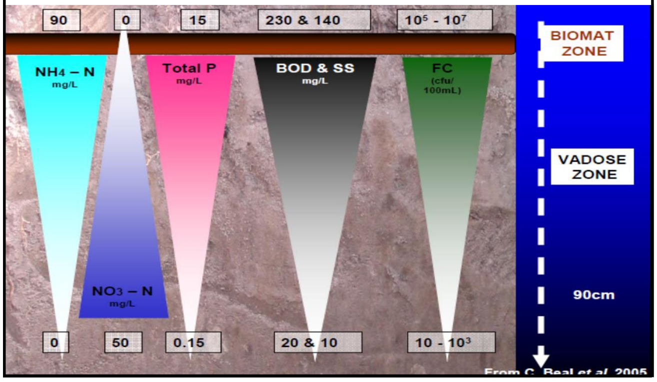
Source of Figure:
https://www.lanfaxlabs.com/aggregate_stability.htm

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 much less than clean water permeability

Clogging Layer

ST Effluent Quality Change through Biomat and Unsaturated Soil



DLR for Trenches and Beds

(Adapted from Table L1 AS/NZS1547:2012)
(See also Table 6.4 NSW Guideline (2025))

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

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 = daily hydraulic load (L/d), DLR = design loading rate (mm/d) and W = width (m) * suitable on sites with no climatic constraints*

Design Method - Trenches and Beds

(AS/NZS1547:2012)

- Example: L = Q/(DLR × W)
- Daily design hydraulic load (Q) 5 EP (3 brm) = 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*
- If width is 0.45 m, L = 111 lineal metres*
- DLR in AS/NZS1547 (2012) is to be used to size horizontal bottom area only in trenches and beds
- * Individual trench or bed lengths should not exceed 20 m unless even distribution can be provided by pressure dosing

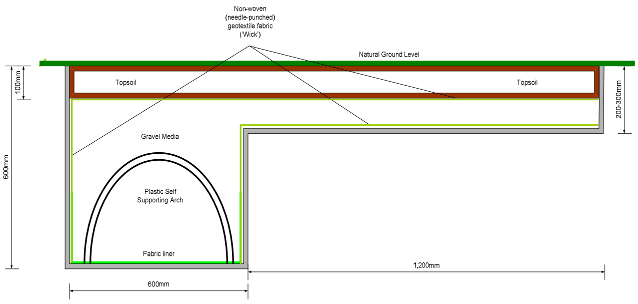
Alternative Trench Systems and Non-conventional Beds

- 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 geotextiles, 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

Proprietary Geotextile Systems

- Eljen geotextile sand filter (GSF)
- Secondary wastewater treatment system using geotextile modules and filter sand
- Two-stage biomat pre-treatment process, which improves the quality of septic tank effluent before it is released into the soil
- Approvals in South Australia, Tasmania, NSW and Queensland

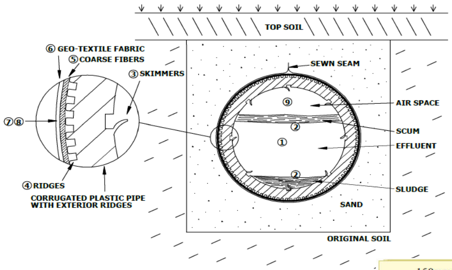
https://www.eljenpacific.com/services

Proprietary Geotextile Systems

- Advanced Enviro Septic - 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

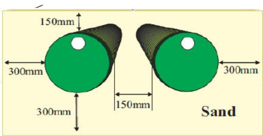
https://www.enviro-septic.com.au/

Proprietary Geotextile Systems



Sits in bed of "System Sand" of defined specification

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



Proprietary Geotextile Systems

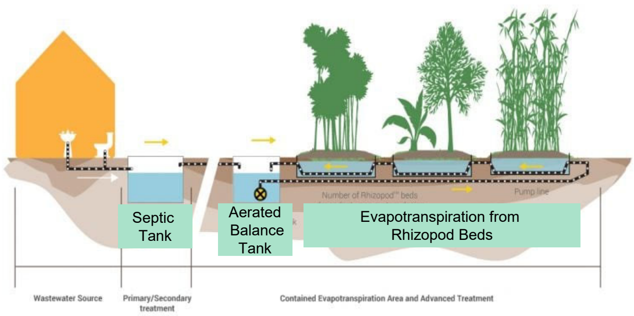
- AES recommends maximum hydraulic load of 114 L per pipe length (3 metre) – loading rates approx. 38 L/m^2 for secondary or 30 L/m^2 for advanced secondary
- Trench or bed basal area sized on Secondary treated effluent loading rates of AS/NZS 1547:2012 (Table L1)
- In QLD considered a Secondary treatment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

Recirculating Evapotranspiration Channel Systems

- 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 Rhizopod Beds

Rhizopod Beds

Source: www.arris.com.au



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 Table L1
- Cromer, WC (2013) Nonconventional Beds: Notes for Designers, Installers and Regulators, Unpublished Report - https://www.williamccromer.com/content/uploads/2012/11/Nonconventional-bed-design-notes-24-September-2013.pdf
- NSW Guideline (2025) Table 6.4 Design Loading Rates for Effluent Application Systems
- Patterson, RA (2006) Evapotranspiration Bed Designs for Inland Areas - http://lanfaxlabs.com.au/papers/P51-Technical%20Sheet%20%20Evapotranspiration-aug06.pdf
- WaterNSW (2023) Designing and Installing On-Site Wastewater Systems A WaterNSW Current Recommended Practice
- https://www.eljenpacific.com/services
- https://www.enviro-septic.com.au/
- www.arris.com.au