

On-site Wastewater Management Training Course

Soil Absorption Systems; Trenches and Beds

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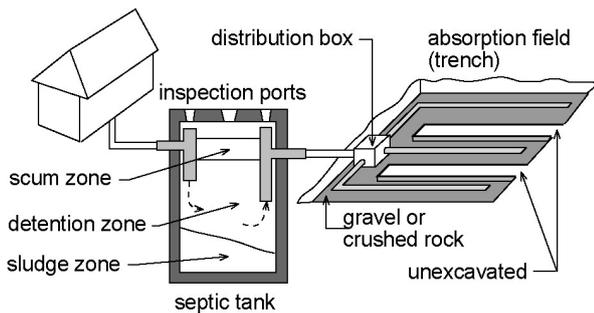
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Soil Based Systems

- 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
- Different systems are suited to different sites based on site & soil limitations
- Poor performance of systems is often related to an inadequate understanding of the hydraulic capacity of the receiving soils resulting in under-design & overloading

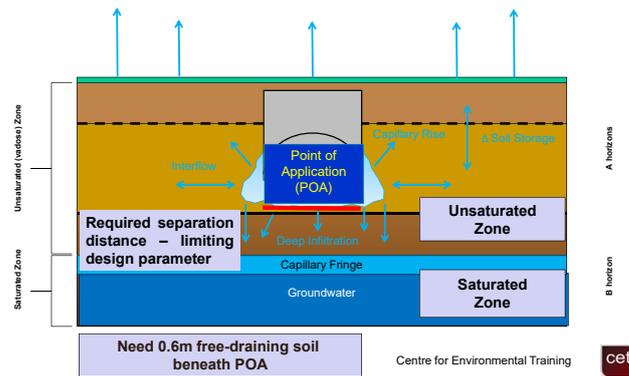
Design of soil absorption system and calculation of lineal metres of trench needs to be based on hydraulic capacity of most limiting horizon or layer

Schematic of On-site System Design Using Soil Absorption



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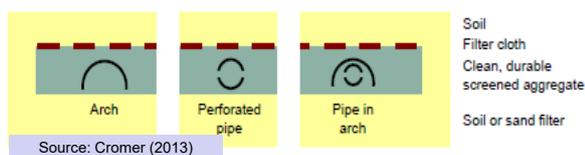
Subsurface Effluent Disposal



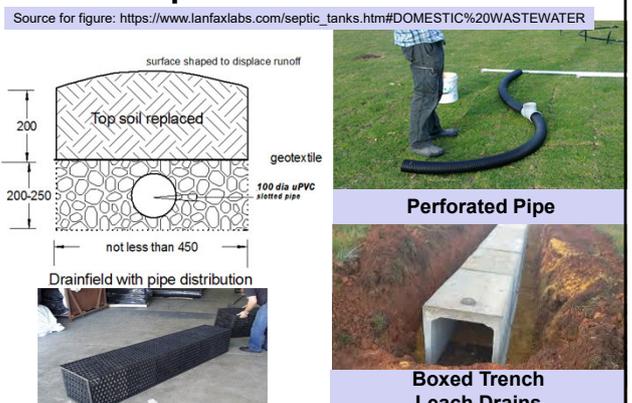
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Standard or Conventional Trench Designs

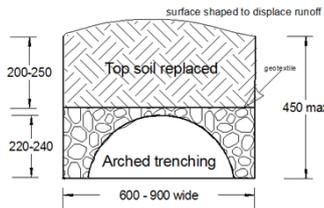
- All trenches & bed systems are constructed below ground; can be media filled or consist of a durable self-supporting arch resting on gravel or coarse sand & rely on soil absorption
- Effluent delivered is along a manifold laid along the entire length
- Trenches for effluent dispersal may be piped, boxed or arch trenches; dosed by pressure, low pressure or gravity
- Only base of trench used to calculate application area



Piped/Boxed Trench



Self Supporting Arch Trench



Tunnel Trench

Drainfield with plastic trenching

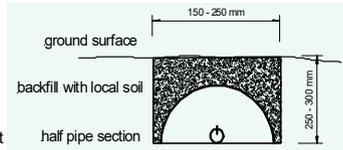
Source for figure: https://www.lanfaxlabs.com/septic_tanks.htm#DOMESTIC%20WASTEWATER

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Low Pressure Effluent Distribution

- Dispersal of wastewater to subsoils using thin gravel trenches
- Pressure dose primary (or secondary) effluent in shallow trenches (0.2 x 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) & Section 2.4.3.2 EPA Guideline for onsite wastewater effluent dispersal & recycling systems (2024)



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Evapotranspiration Trenches or Beds

- Lined or unlined systems use subsurface absorption plus evaporation and transpiration (evt - evapotranspiration)
- Require good sun & wind exposure; vegetation cover must be maintained to optimise evt
- Effluent drawn up from storage into root zone of plants by capillary action
- Water balance required to calculate surface area
- ET or ETA bed recommended for environmentally sensitive sites e.g. where site limitations exist such as heavy clay
- Useful in locations with low permeability soils and in drier climates with high evt

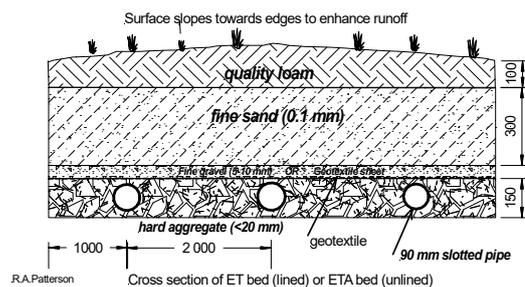


Source: Water NSW (2023)

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Typical Cross-section of Piped ET Bed



Source: Patterson (2006)

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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/>

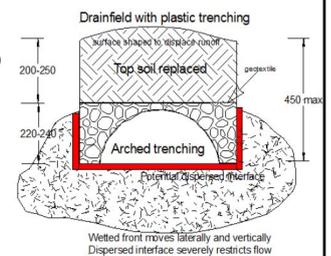


<https://wastewaterquipment.com.au/products/K-Rain-Valve-4-Outlet.aspx>

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



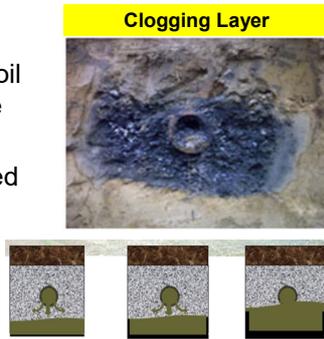
Source of Figure: https://www.lanfaxlabs.com/aggregate_stability.htm

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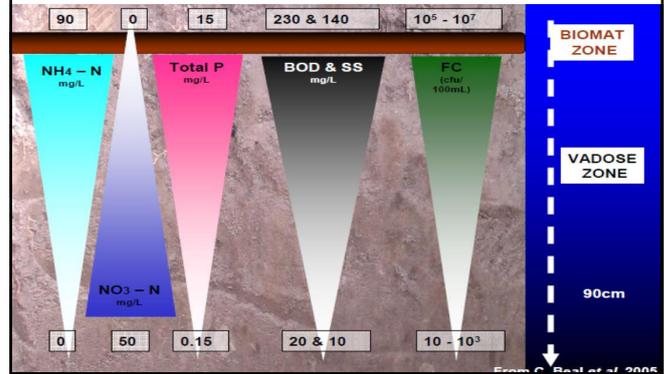
Design Loading Rate (DLR)

- Infiltration of effluent into soil is limited by clogging layer, but soil texture and structure are important too
- DLR of soil expressed in L/m²/d
- DLR is always << clean water permeability



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ST Effluent Quality Change through Biomat and Unsaturated Soil



From C. Best et al. 2005

DLR for Trenches and Beds

(Adapted as an example from Table L1 AS/NZS1547:2012)
(Refer to Tables 4-8 & 4-9 for similar tables used in Victoria (EPA 2024))

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 DLRs should be used

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Soil Absorption - Simple Example

- Assume soil DLR is 15 mm/d*
- Assume hydraulic load for 1 EP is 150 L/d
- 1 Litre of water or effluent applied to 1 m² covers to a depth of 1 mm
- Maximum effluent loading rate should therefore not exceed DLR (15 L/m²/d) otherwise failure may occur
- Divide hydraulic load by DLR to calculate required contact area
- Contact area is therefore 10 m² for 1 EP (150 L/d divided by 15 L/m²/d)

*Remember - 1 mm/day is equivalent to a loading rate of 1 L/m²/day
For example, 20 mm/day is dimensionally equivalent to 20 L/m²/day

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Design Method - Trenches and Beds

(AS/NZS1547:2012)

- Undertake SSE as part of LCA & determine soil and land capability constraints; identify setbacks or buffers required & location of EDRS
- Assuming site and soil appropriate for soil absorption, select primary DLR taking into account any limiting factors raised in SSE report as part of LCA
- 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) *only suitable on sites with no climatic constraints. Note that only base of trench used to calculate application area & spacing between trenches is in accordance with soil texture.

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Design Method - Trenches and Beds

(Refer to Tables 4-3 & 4-8 EPA Guideline 2024)

- Using $L = Q / (DLR \times W)$ as an example
- Daily design hydraulic load (Q); reticulated supply with water reduction fixtures* 4 br (5 EP × 150 L/p/d) = 750 L/d
- DLR 15 L/m²/d - Soil Category is 3a (texture assessed based on field measurement or field/lab textural method; conservative DLR used for primary effluent)
- Assume a trench 1 m wide then,
- $L = 750 / (15 \times 1) = 50$ lineal metres
- If width is 0.45 m, $L = 111$ lineal metres**
- Note: only base of trench is used to calculate application area & reserve area needs to be considered
- *Council needs to be satisfied that fixtures installed & operating
- ** Individual trench or bed lengths should not exceed 20 m & should be level (spacing between 1-2 m depending on soil type)

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Alternative Trench Systems and Non-conventional Beds

- Variety of alternatives to traditional trench and bed designs for effluent dispersal & recycling
- NcBs seek to enhance the performance of more traditional trench and bed designs
- Some NcBs make use of geotextiles, have larger basal area, inter-trench space for evt using various plants and/or provide additional treatment (i.e. filtration) so higher DLRs can be applied
- Amended soil systems take many forms; some use engineered material to enhance the distribution of effluent; others involve importing media or soil such as mounds (considered elsewhere)

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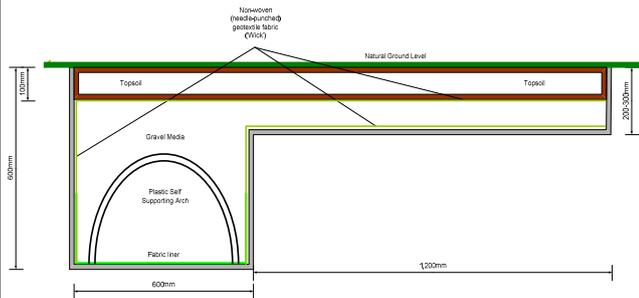
Wick Trench and Bed

- 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 enhanced evt from adjacent bed through wicking
- Evt 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

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Cross-section of a Wick Design



Designer: Kerry Flanagan
Source: WaterNSW (2019)

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Alternative Trench 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>

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Alternative Trench Systems

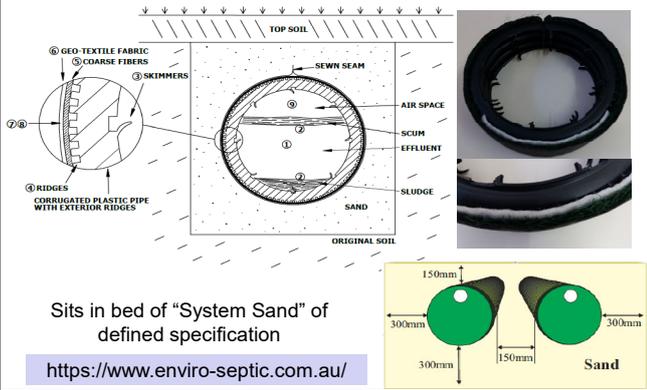
- Advanced Enviro Septic - combined treatment and disposal pipe system using proprietary geotextile
- Pipes wrapped in non-woven geo-textile fabric & installed in land application area as either absorption trenches or evt beds and surrounded by a layer of coarse washed sand
- Sand material promotes aerobic activity as primary effluent percolates through sand which allows air transfer to biomat surface and further filtration before effluent enters underlying soil
- 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

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

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Alternative Trench Systems



Advanced Enviro Septic

- Recommended maximum hydraulic load of 114 L per pipe length (3 metre) – loading rates approx. 38 L/m² for secondary or 30 L/m² 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)

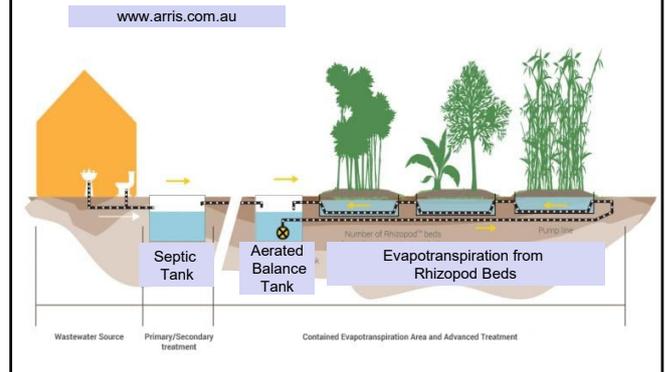


Vegetated Recirculating Evt Trenches/Beds

- Recirculating evapotranspiration channel system
- 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 (no release)
- Requires water balance for sizing



Rhizopod Beds



Summary

- Effluent dispersal options for Primary & Secondary treatment include trenches and beds which utilise soil absorption & evt
- Systems which incorporate evt require water balance sizing
- While soil can achieve excellent renovation, systems need to be loaded at appropriate DLRs
- As different systems are suited to different sites based on site & soil limitations, important that design be undertaken by trained persons
- Trenches & beds utilizing soil continue to provide an effective means of land application and treatment of effluent

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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>
- EPA Victoria Guideline for onsite wastewater management (2024) & Guideline for onsite wastewater effluent dispersal & recycling systems (2024) <https://www.epa.vic.gov.au/about-epa/publications/onsite-wastewater-management-guidance>
- 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.watnsw.com.au/_data/assets/pdf_file/0013/113431/Designing-and-Installing-On-Site-Wastewater-Systems-complete-document.pdf

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