

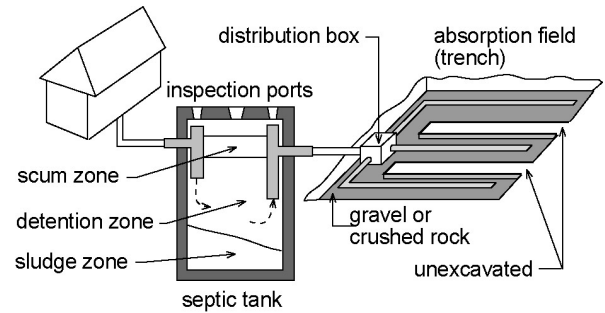
## On-site Wastewater Management Training Course

### Soil Absorption Systems; Trenches and Beds

Honorary Associate Professor Phillip Geary  
School of Environmental & Life Sciences  
The University of Newcastle NSW

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## Schematic of On-site System Design Using Soil Absorption



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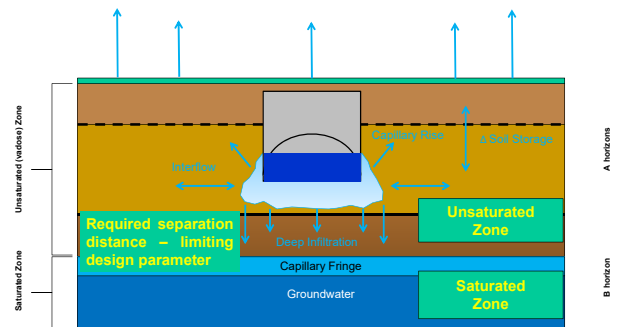
## Soil Based Systems

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

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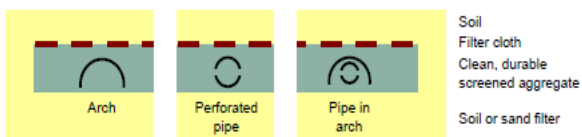
## Subsurface Effluent Disposal



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## Standard Trench Designs

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



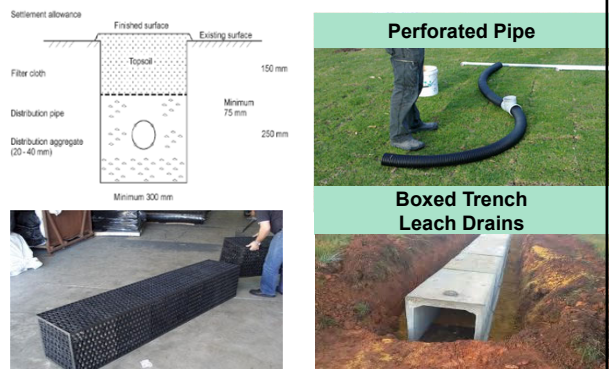
Source: Cromer (2013)

Soil absorption trenches may involve piped, boxed or arch trenches

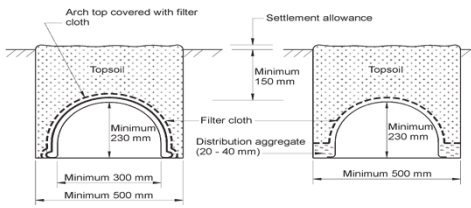
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## Conventional Piped/Boxed Trench (AS/NZS1547: 2012)

(AS/NZS1547: 2012)



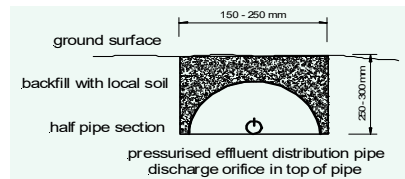
## Self Supporting Arch Trench (AS/NZS1547: 2012)



Tunnel Trench

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## LPED Pressure Dosed Shallow System



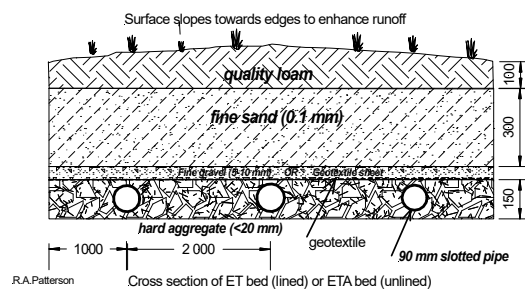
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## Standard ET or ETA Bed

- 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

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## Typical Cross-section of Piped ET Bed



Source: Patterson (2006)

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## 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

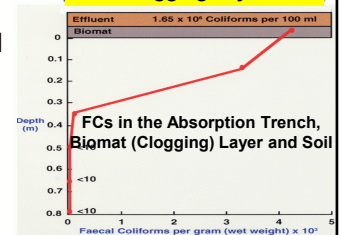
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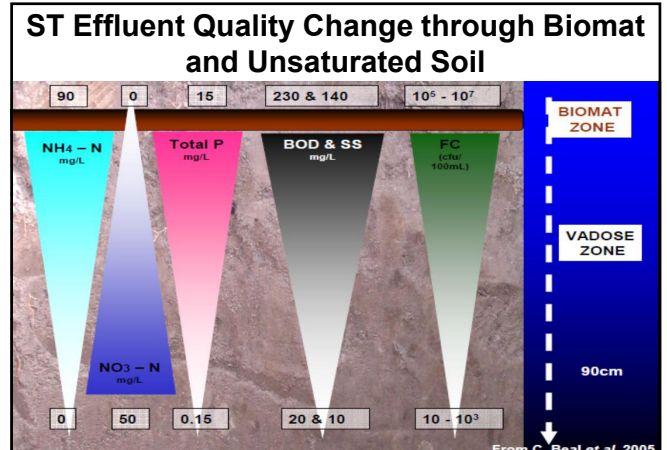
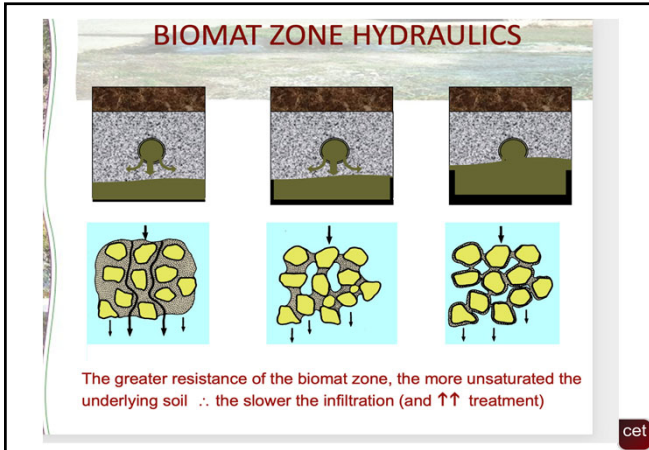
## Design Loading Rate (DLR)

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



Clogging Layer





### 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


- ### 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<sup>2</sup> covers to a depth of 1 mm
  - Maximum effluent loading rate should therefore not exceed 15 L/m<sup>2</sup> otherwise failure will occur
  - Required contact area is therefore 10 m<sup>2</sup> (based on hydraulic load (150 L divided by DLR of 15 L/m<sup>2</sup>))
- \*Remember – 1 mm/day is equivalent to a loading rate of 1 L/m<sup>2</sup>/day  
For example, 20 mm/day is dimensionally equivalent to 20 L/m<sup>2</sup>/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)

- ### Design Method - Trenches and Beds
- (AS/NZS1547:2012)
- Example:  $L = Q / (DLR \times W)$
  - Daily design hydraulic load Q = 750 L/d
  - DLR 15 L/m<sup>2</sup>/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,
  - $L = 750 / (15 \times 1) = 50$  lineal metres
  - DLR in AS/NZS1547 (2012) is to be used to size horizontal bottom area only in trenches and beds


## 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

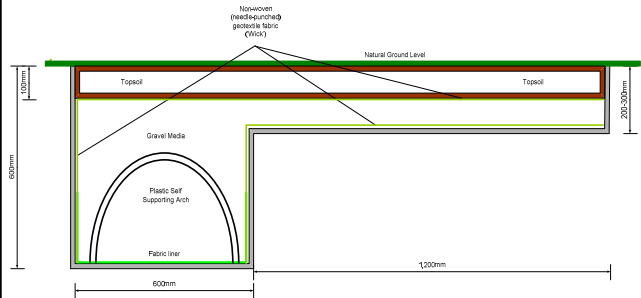
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## Wick Trench and Bed


- 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 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

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## Cross-section of a Wick Design



Designer: Kerry Flanagan  
Source: WaterNSW (2019)


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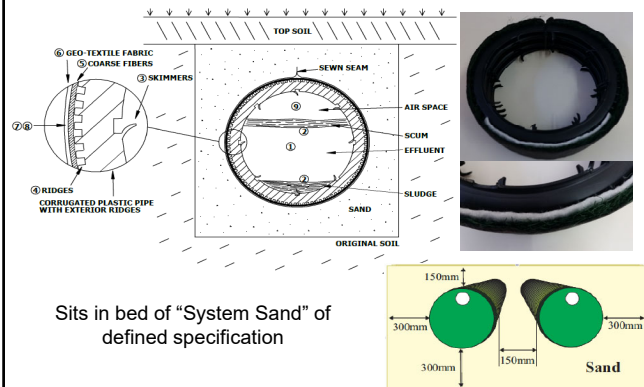
## Advanced Enviro-Septic (AES)

- 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/>

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## 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<sup>2</sup> for secondary or 30 L/m<sup>2</sup> 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)



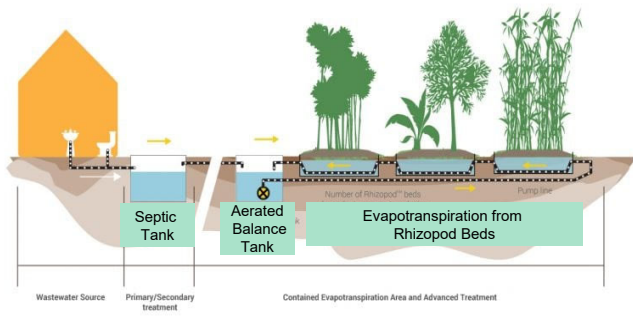
## Evapotranspiration Trenches

- 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](http://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

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## Further Reading

- AS/NZS1547:2012 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.waternsw.com.au/_data/assets/pdf_file/0003/58251/Designing-and-Installing-On-Site-Wastewater-Systems-WaterNSW-CRP-2019.pdf)
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