On-site Wastewater Management Training Course

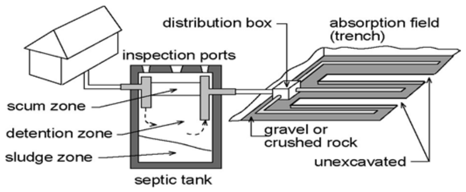
Soil Absorption Systems

Trenches and Beds

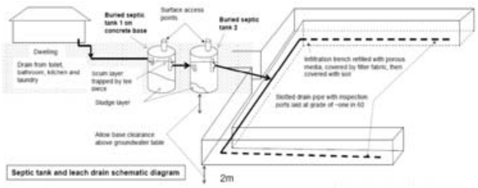
Acceptable Treatment Systems

Treatment method	Water Quality Criteria	Acceptable Land Application System
Primary Treated Effluent from Septic Tank	n\a	Soil Absorption Trench/Bed Evapo-transpiration Bed Mound
Secondary Treated Effluent with no disinfection	<20 mg/L BOD, <30mg/L suspended solids	Soil Absorption Trench/Bed Evapo-transpiration Bed Mound Subsurface drip
Secondary Treated Effluent with disinfection	<20 mg/L BOD, <30mg/L suspended solids, <10 E.coli/100mL, ≥1mg/L total chlorine	Surface Spray Covered Drip

Soil Absorption Trench/Bed



In WA



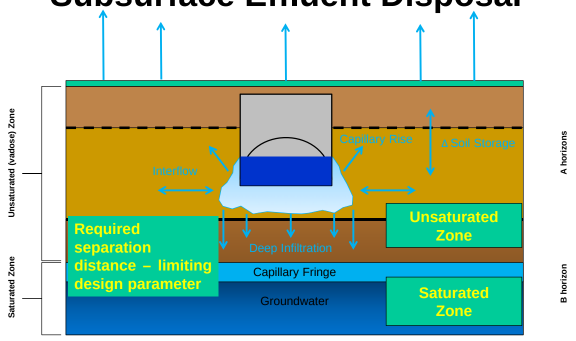
Soil Based Systems

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

Soil Based Systems

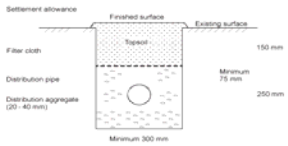
- Soil is used to receive and absorb/assimilate effluent
- Significant physical, chemical and microbiological treatment of effluent occurs in unsaturated soils
- Older absorption systems often rely on the distribution of effluent subsurface by gravity, but operate better when pressurised
- The poor performance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

Subsurface Effluent Disposal



Trench Designs

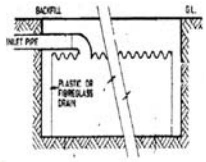
- Absorption trenches may involve piped, boxed or arch trenches



Conventional Piped Trench
AS/NZS 1547: 2012

Perforated Pipe

Trench Designs

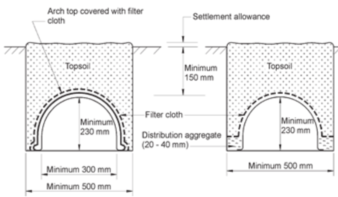


Side view of a leach drain

Box Trench Leach Drains

Trench Designs

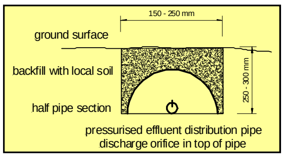
Tunnel Trench



Self Supporting Arch Trench
AS/NZS 1547:2012

Trench Designs

- Pressure dosed shallow soil absorption system



Design of Subsurface Systems for Wastewater Disposal

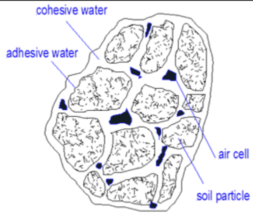
Depends on:

- 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 of the above factors does not exist*

Methods to Assess Hydraulic Capacity of Soils

- Determine soil hydraulic capacity using either:
  - *field measurement in-situ permeability*
  - *laboratory measurement, or*
  - *field textural method*
- Design according to relevant Code or Standard and size system using design hydraulic load - need to undertake SSE procedure on-site
- Calculate required contact area and lineal metres of trenching for soil absorption based on soil hydraulic capacity and daily hydraulic load

Soil Porosity



- Portion of soil occupied by air and water
- Determined by arrangement of solid particles
- Sand has large pore spaces between the particles, but few compared to silt or clay
- Soil pores are fine spaces in soil between particles - contain part solid matter, water and air

Unconsolidated Deposits	%
Gravel	25-50
Sand	25-50
Silt	35-50
Clay	40-70
Rocks	
Sandstone	5-30
Limestone	5-50
Shale	0-10
Dense Crystalline Rock	0-5

Soil Permeability – Hydraulic Conductivity

- The ability of a soil to transmit or conduct water (equated with hydraulic conductivity K) under unit hydraulic potential
- Use of a constant head rather than a falling head
- Measured in-situ or in laboratory under standard conditions
- Not possible to precisely correlate percolation (determined by a "perc" test) and permeability

Centre for Environmental Training

In-situ Measurement of Permeability

- Field measurement requires measurement at a number of sites
- Measured in field using constant head (Talsma-Hallam, Guelph, disc, Cromer) permeameter
- Recommended procedure Appendix G AS/NZS1547:2012 (Talsma-Hallam constant head test)

Centre for Environmental Training

Soils and their Permeabilities

Texture	Structure	Permeability m/day
Coarse sand, Gravel	Single grain (none)	More than 12
Medium Sand	Single grain (none)	6 - 12
Loamy Sand, fine Sand	Medium crumb, singe grain	3 - 6
Fine Sandy Loam, Sandy Loam	Coarse blocky, granular, fine crumb	1.5 – 3
Light Clay Loam, Silt Loam, very fine Sandy Loam, Loam	Prismatic, angular blocky	0.5 – 1.5
Clay, Silty Clay, Clay Loam, Sandy Clay Loam	Fine to medium Prismatic, angular blocky	0.1 – 0.5
Clay, Silty Clay, Clay Loam, Sandy Clay Loam	Very fine prismatic, angular blocky	0.05 – 0.1
Clay, heavy Clay	Massive, very fine or columnar	< 0.05

Centre for Environmental Training

Field Textural Method Using Soil Morphology

- Examine soil structure in soil pit – important for soil drainage
- Examine soil texture in pit – important indicator of drainage

- Determine relative proportions of silt, sand clay fractions based on moistened bolus
- Used to assess soil hydraulic capacity

Centre for Environmental Training

Laboratory Textural Method Using Soil Morphology

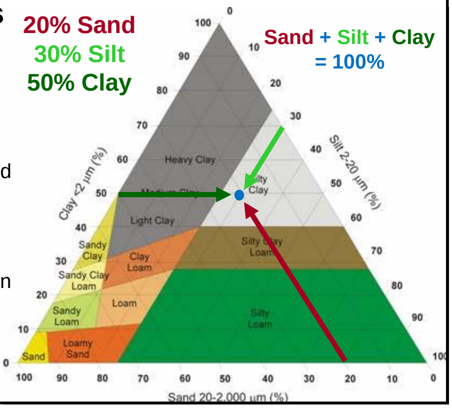
- Determine relative proportions of silt, sand, clay fractions based on laboratory sieving
- Relate texture/structure characteristics from field and laboratory work to indicative clean water permeability using established test data
- Used to assess soil hydraulic capacity

Centre for Environmental Training

Particle Size Analysis

Soil Texture

- Determine relative proportions of silt, sand clay fractions based on laboratory sieving
- Soil textural triangle used in Australia



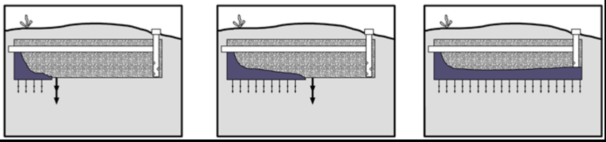
Soil Categories and Indicative K_{sat} (clean water)

Textural Classification/Typical Permeability	K_{sat} (m/d)
Gravels and sands	> 3.0
Sandy Loams	1.4 - 3.0
Loams	0.5 - 1.5
Clay Loams	0.06 - 1.5
Light Clays	< 0.06 - 0.5
Med to Heavy Clays	< 0.06

- Choice of representative values may depend on site and soil evaluation
- Coarser grained soils have higher K_{sat} than fine grained
- Some fine grained soils can have higher K_{sat} due to structure i.e. cracking

Long Term Acceptance Rate or Design Loading Rate

- Rate of infiltration of effluent into soil is limited by Long Term Acceptance Rate or Design Loading Rate - applies to distribution of effluent to design area & is equivalent to LTAR
- LTAR/DLR depends on development of clogging layer and soil texture and structure
- LTAR/DLR of soil expressed in L/m²/d and dependent on effluent quality and loading rate* and is always < < clean water permeability (* for dispersive soils use very low LTAR/DLR)



Soil Categories and Design DLR for Trenches and Beds

Adapted from Table 5.2 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

In WA – Minimum area per soil type for each litre/day

Soil category[1]	Soil texture	Minimum Land Application Area Required (m2)[1]	
		Primary Treatment[2]	Secondary Treatment[3]
1	Gravels and sands	0.377	0.2
2	Sandy loams	0.377	0.2
3	Loams	0.477	0.25
4	Clay loams	0.689	0.286
5	Light clays	1.284	0.333
6	Medium to heavy clays	1.284 *	0.5

Hydraulic Application Rates

- Remember - 1mm/day is equivalent to a loading rate of 1 L/m²/day

$1\ m^3 = 1000$ Litres

$1\ L = 0.001\ m^3$

$\frac{0.001\ m^3}{1\ m^2} = 0.001\ m$

$1\ m = 1000\ mm$

$0.001\ m = 1\ mm$

- As an example a determination of hydraulic capacity (K) of 40 mm/day is dimensionally equivalent to a hydraulic loading rate of 40 L/m²/day

Soil Absorption - Simple Example

- Assume soil DLR (from measured in-situ clean water permeability test or based on texture assessment) is 15 mm/d
- Assume hydraulic load is 150 L/d per person
- 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 effluent loading rate - 15 L/m^2)

Design Method - On-site Trenches and Beds

(AS/NZS1547:2012 & WA Code)

- Undertake SSE procedure and determine land capability constraints and setbacks or buffers
- If site and soil appropriate, select DLR taking into account factors raised in SSE report
- Size disposal areas according to: $L = \frac{Q}{DLR \times W}$

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

Design Method - On-site Trenches and Beds

(AS/NZS1547:2012, WA Code)

- Example: $L = \frac{Q}{DLR \times W}$
- Daily design hydraulic load Q = 900 L/d
- DLR 10 L/m^2/d (assessed by field measurement or field/lab textural method)
- Assume a trench 1.2 m wide then,
- L = 75 lineal metres
- DLR in AS/NZS1547 is to be used to size horizontal bottom area only in trenches and beds

Summary

- Trenches and beds utilising soil absorption still provide an effective means of land application and treatment of effluent
- Site and soil assessment is very important in designing these systems – needs to be undertaken by persons trained in site and soil evaluation and system design
- Soils can provide excellent renovation capacity when loaded at an appropriate rate
- Trenches and beds are inappropriate in heavy soils without modification
- Concern also with regard to very sandy soils and groundwater protection