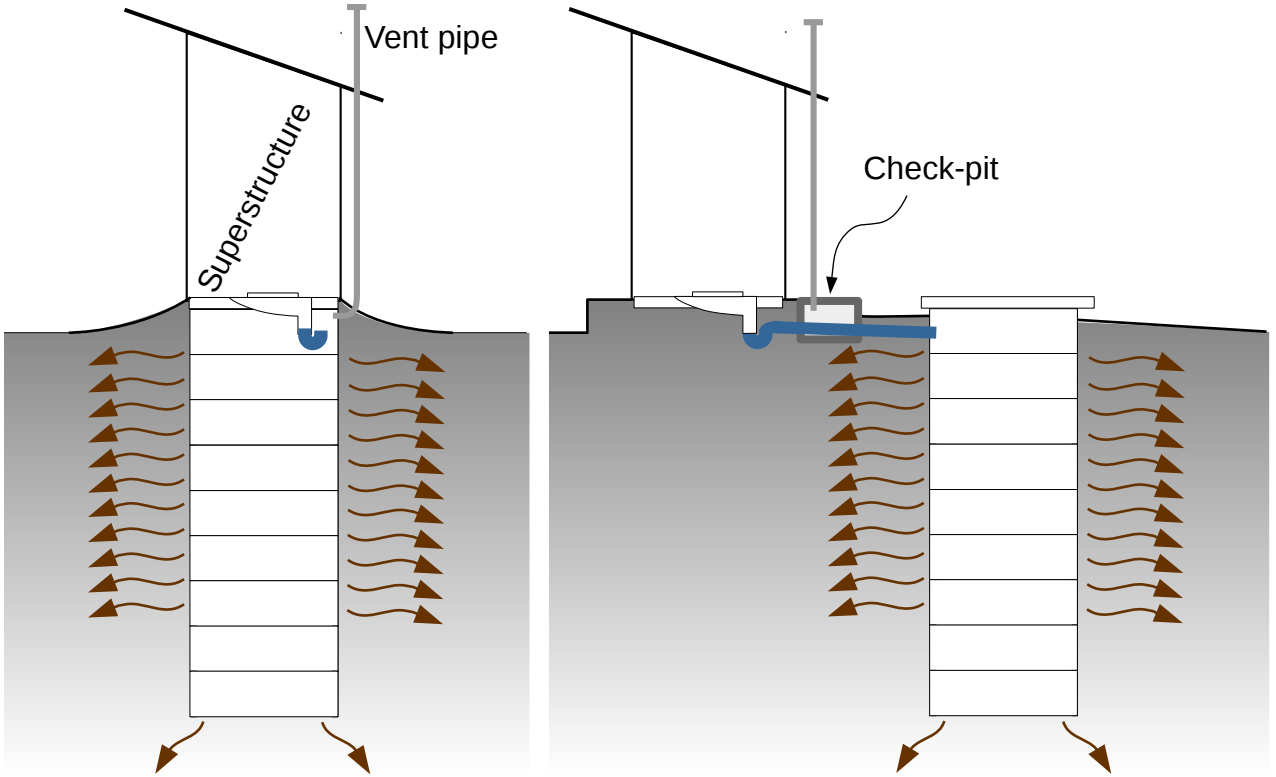
SEPTIC TANK

An on-site storage and treatment facility for human wastewater

Aspects of pour flush pit latrine



Direct pit **Off-set pit**

	A	B	C	D
1	**Simple Flush toilet calculator**			
2	Data			
3	P =	**20**	persons	
4	N =	**2**	Years	
5	q =	**40**	lpcd	
6	D =	**1.2**	m	
7	C =	**0.04**	m^3/person/yr	
8	I =	**30**	l/m^2/d	
9	Calculations			(formula given in cells)
10	V_s =	1.6	m^3	=B7*B3*B4
11	V_l =	8	m^3	=B3*B5*B6/4/B8
12	V_e =	**9.6**	m^3	=B10+B11
13				
14	H =	**8.49**	m	=ROUND(4*B12/PI()/B6^2,2)
15		27.85	ft	=ROUND(B14*3.28,2)

Safe disposal of water volume
In soil is a main challenge

Example 1
P = 10 persons
N = 2 yrs.
q = 30 lpcd
I = 30 l/m^2/d
D = 1.2 m

$$V_e = 0.04\times10\times2 + \frac{300\times1.2}{4\times30}$$
$$= 0.8 + 3.0 = 3.8\,m^3$$

$$V_e = \frac{\pi D^2}{4} H$$
$$\Rightarrow H = \frac{4\,V_e}{\pi D^2} = \frac{4\times3.8}{\pi\times1.2^2}$$
$$= 3.36\,m$$

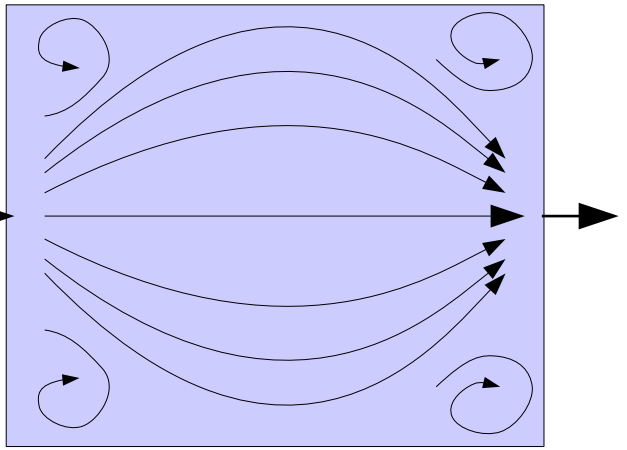
Example 2
P = **20** persons
N = 2 yrs.
q = **30** lpcd
I = 30 l/m^2/d
D = 1.2 m

$$V_e = 0.04\times20\times2 + \frac{600\times1.2}{4\times30}$$
$$= 1.6 + 6.0 = 7.6\,m^3$$

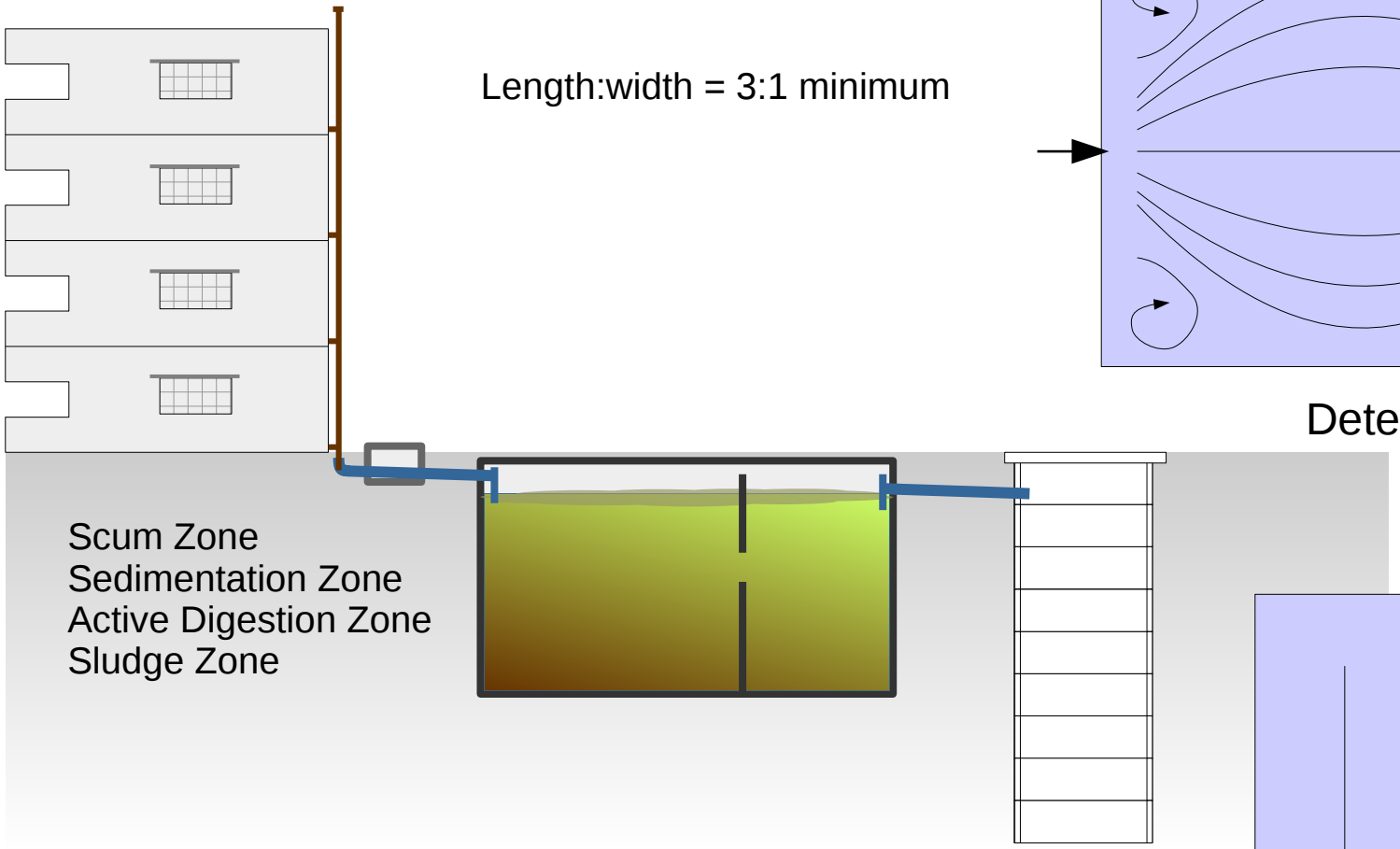
$$V_e = \frac{\pi D^2}{4} H$$
$$\Rightarrow H = \frac{4\,V_e}{\pi D^2} = \frac{4\times7.6}{\pi\times1.2^2}$$
$$= 6.72\,m$$

Concept of septic tank

Plug flow

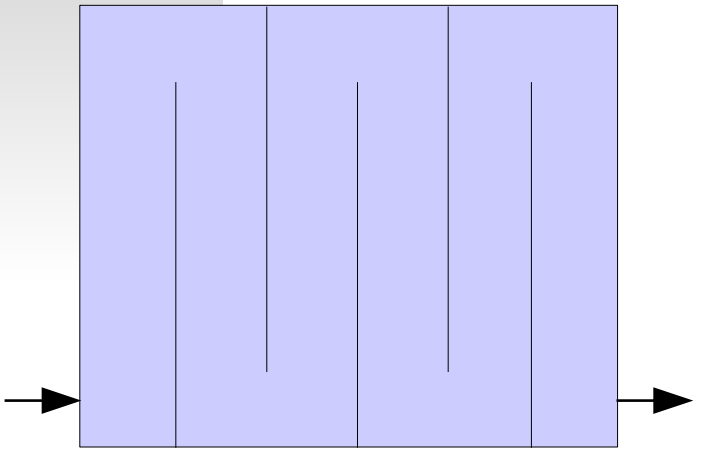


Length:width = 3:1 minimum



Detention time

Scum Zone
Sedimentation Zone
Active Digestion Zone
Sludge Zone



Septic tank: Online resources

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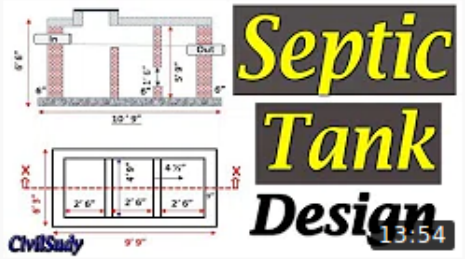


Septic Tank Design - Septic Tank Construction - How To Design A Septic Tank In Urdu/Hindi

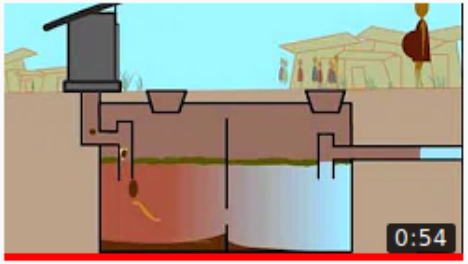
Civil Study ✔ 525K views • 2 years ago

Hello Everyone In This Video I Am Going To Show You That How To Design A Septic Tank In Urdu/Hindi. So Keep Watching The ...

Septic tank and Drainage pipeline system.

ABCD SAB KUCH • 1.2M views • 1 year ago

Dosto Septic tank ka system bahot tariqa hota hai. Main jo eis video m bataya hun o hamare yaha village m Jada Chalta hai.



How a septic tank works

Healthabitat Australia • 4.2M views • 8 years ago

This video was developed by Judith Torzillo for Healthabitat, to help explain the process of how a septic tanks works, what the by ...

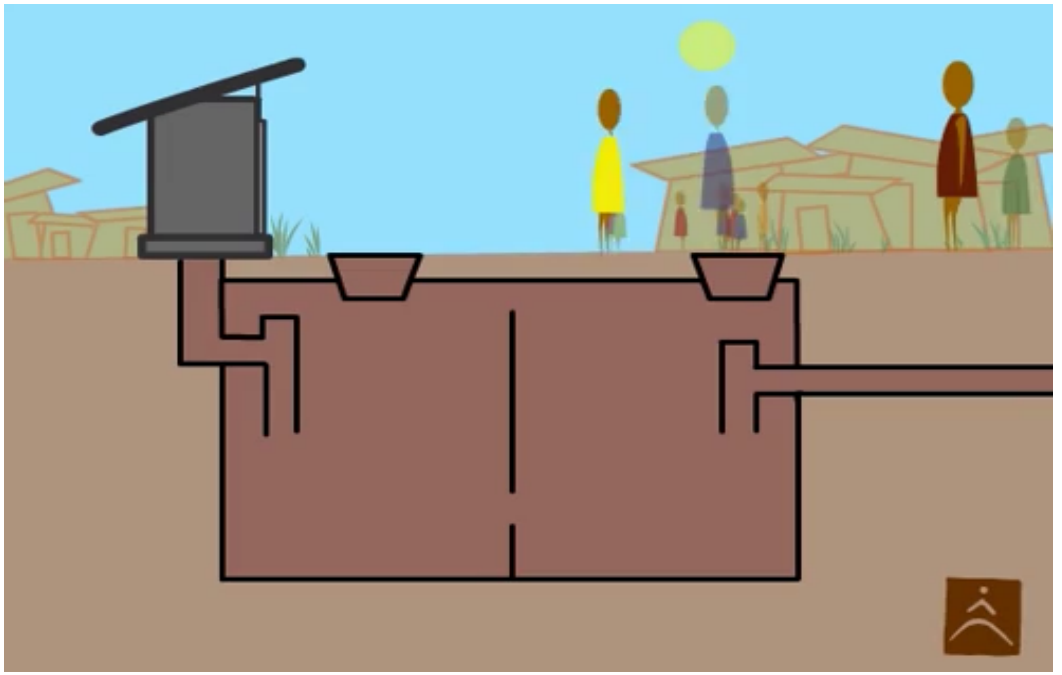
How to Maintain your Septic System Safely

Designing Spaces • 962K views • 3 years ago

A visit with a homeowner leads to a better understanding of septic tanks and how to maintain them. After experiencing the horrors

Septic tank: Online resources

How a septic tank works. By:
Healthabitat Australia (0:52 minutes)
https://www.youtube.com/watch?v=uuORuwb4cfs

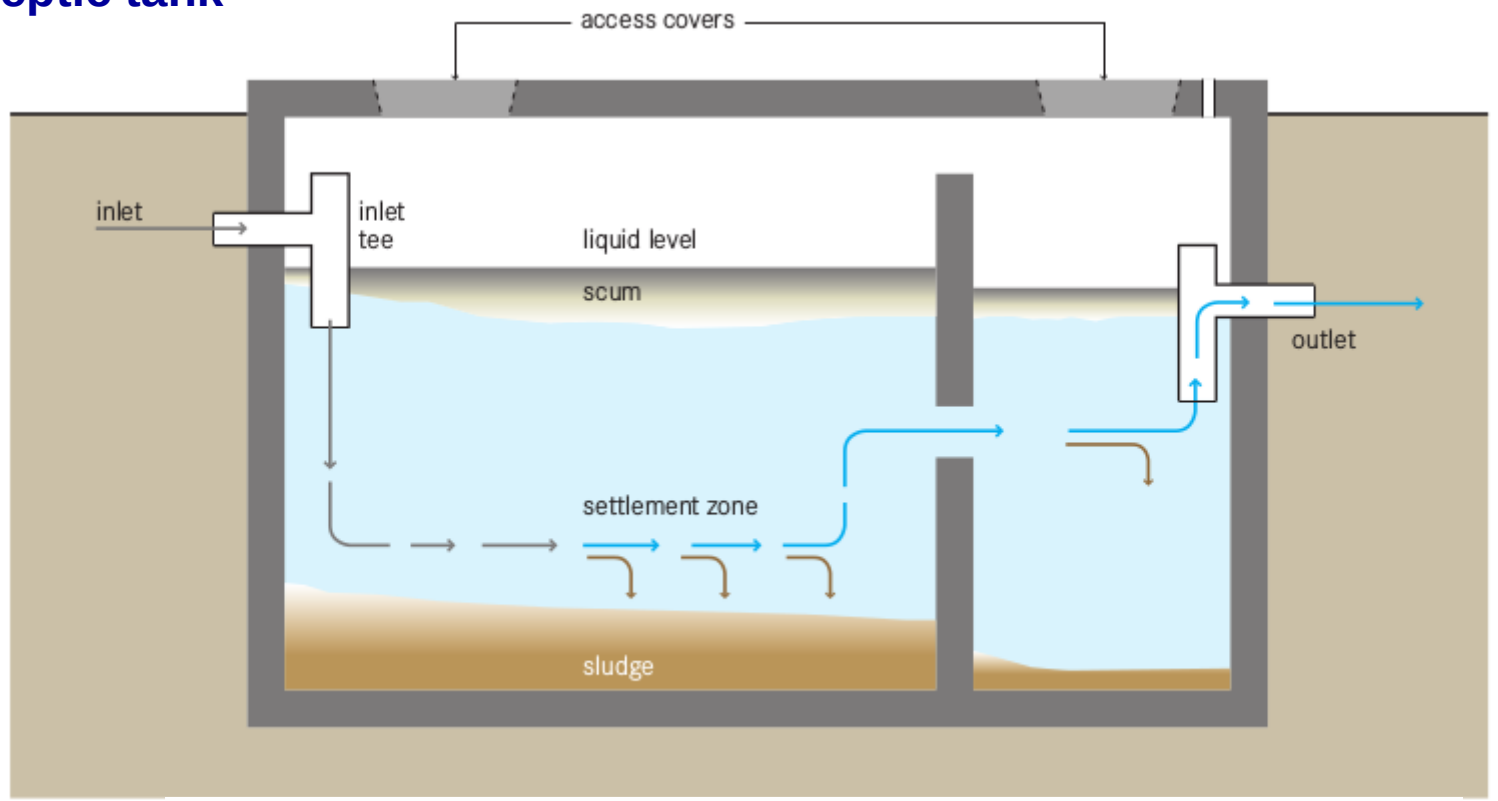


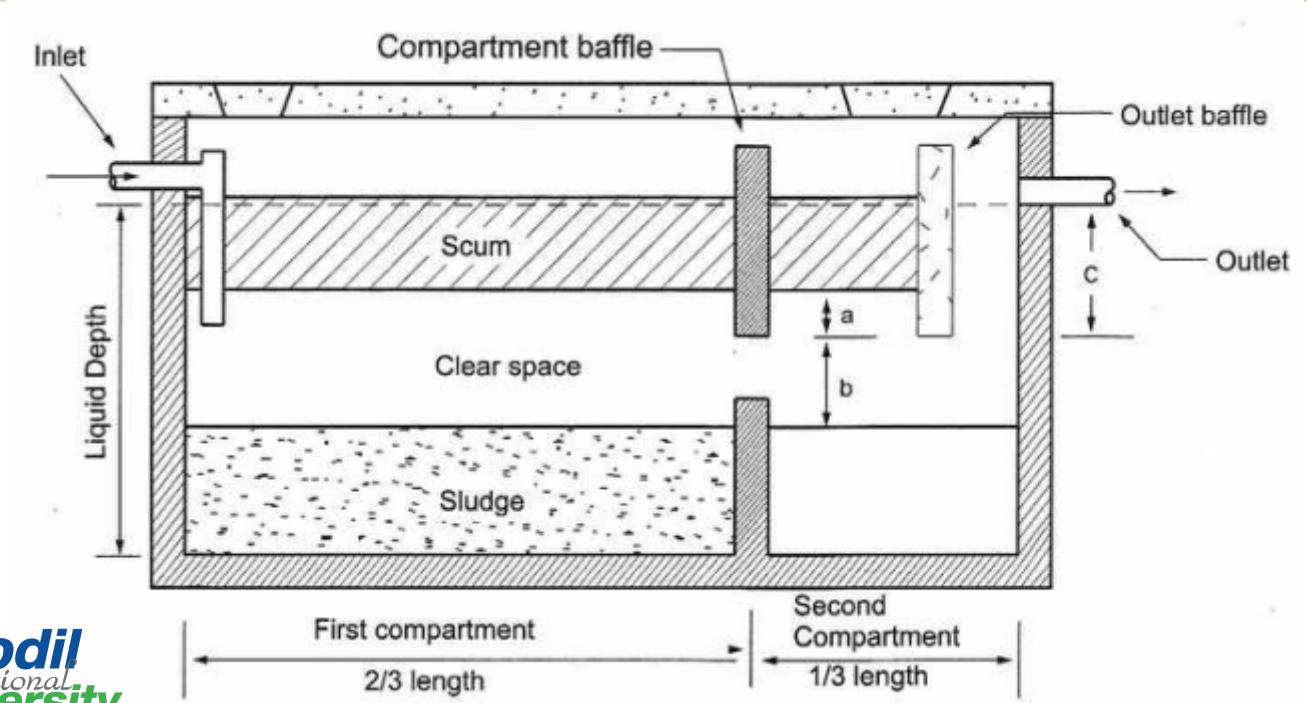
Construction of Septic tank and soak pit as per Tamilnadu Government procedure Tamil (8:08 minutes)
https://www.youtube.com/watch?v=4gU7ru9-B2A

Septics101 (Full Course): A Guide to Septic System Maintenance (19:02 minutes)
https://www.youtube.com/watch?v=udBaGyzJyU8

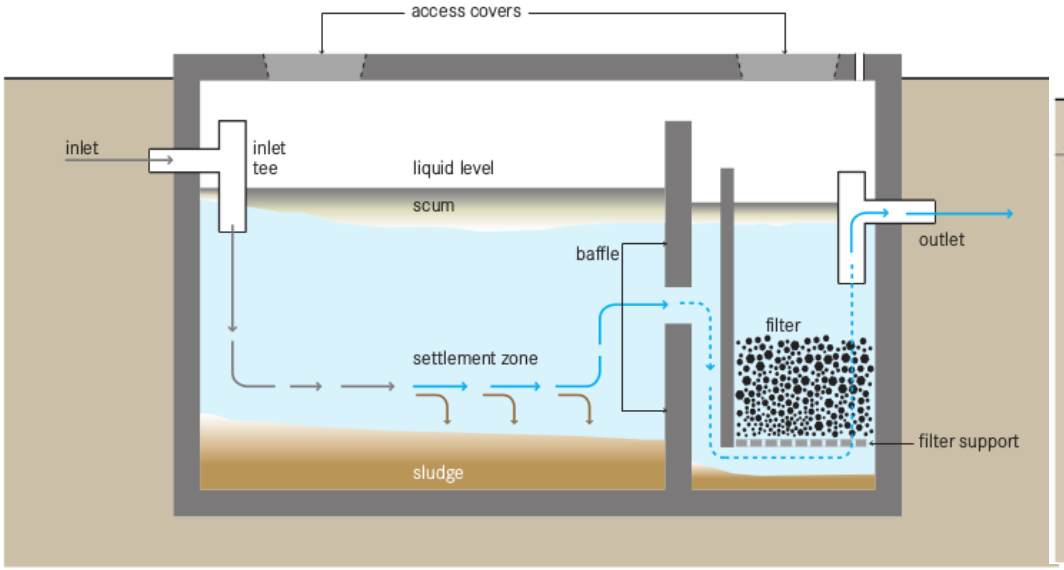
Nice Resources
https://www.epa.gov/septic/types-septic-systems

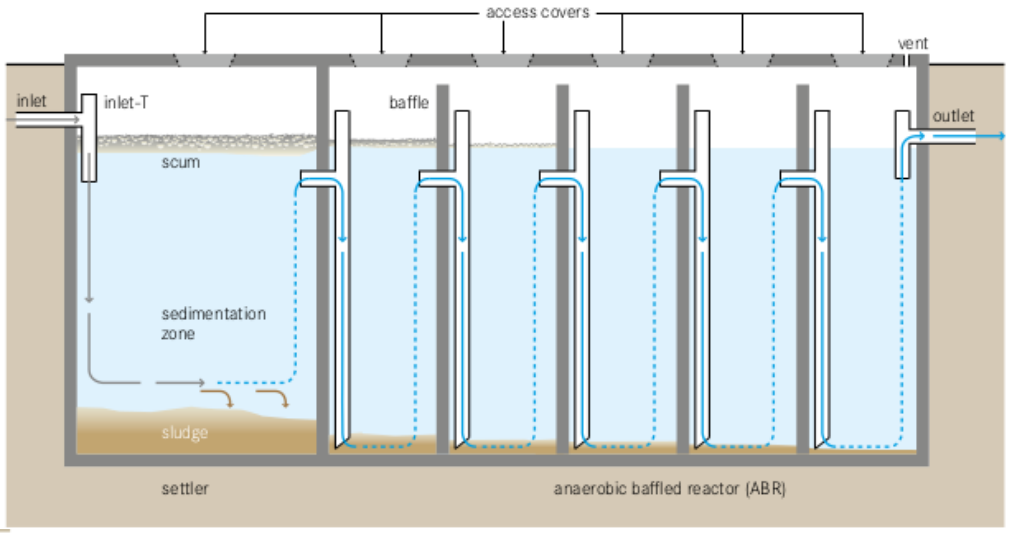
Septic tank

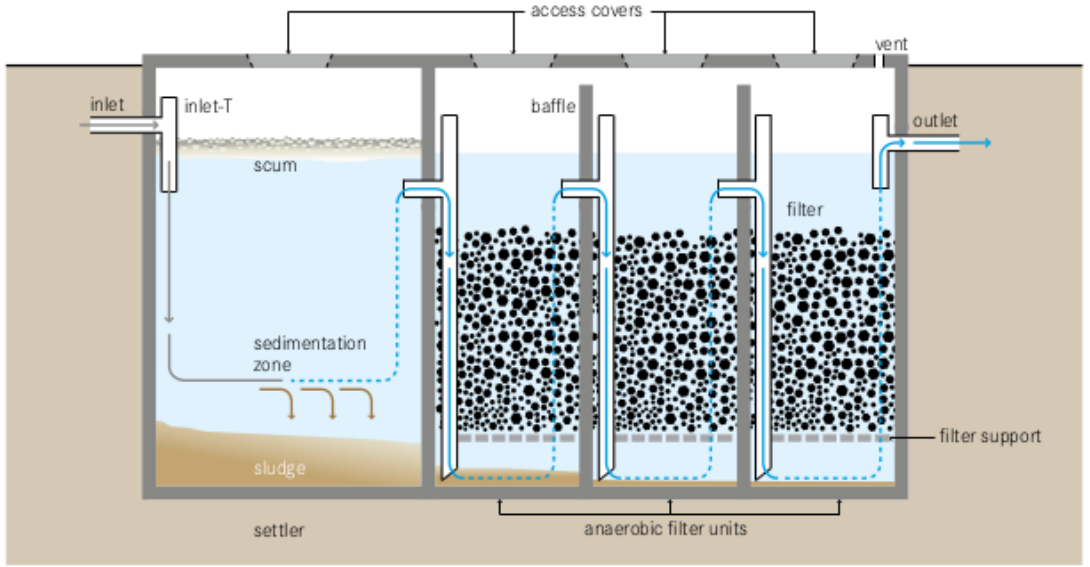

access covers
inlet
inlet tee
liquid level
scum
outlet
settlement zone
sludge

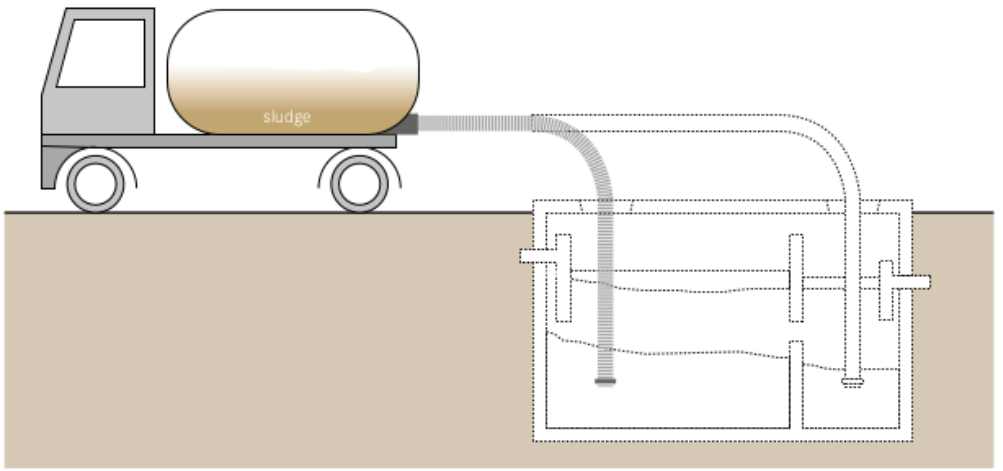

Inlet
Compartment baffle
Outlet baffle
Scum
Outlet
c
a
Clear space
b
Liquid Depth
Sludge
First compartment
2/3 length
Second Compartment
1/3 length

Septic tank: Enhanced systems

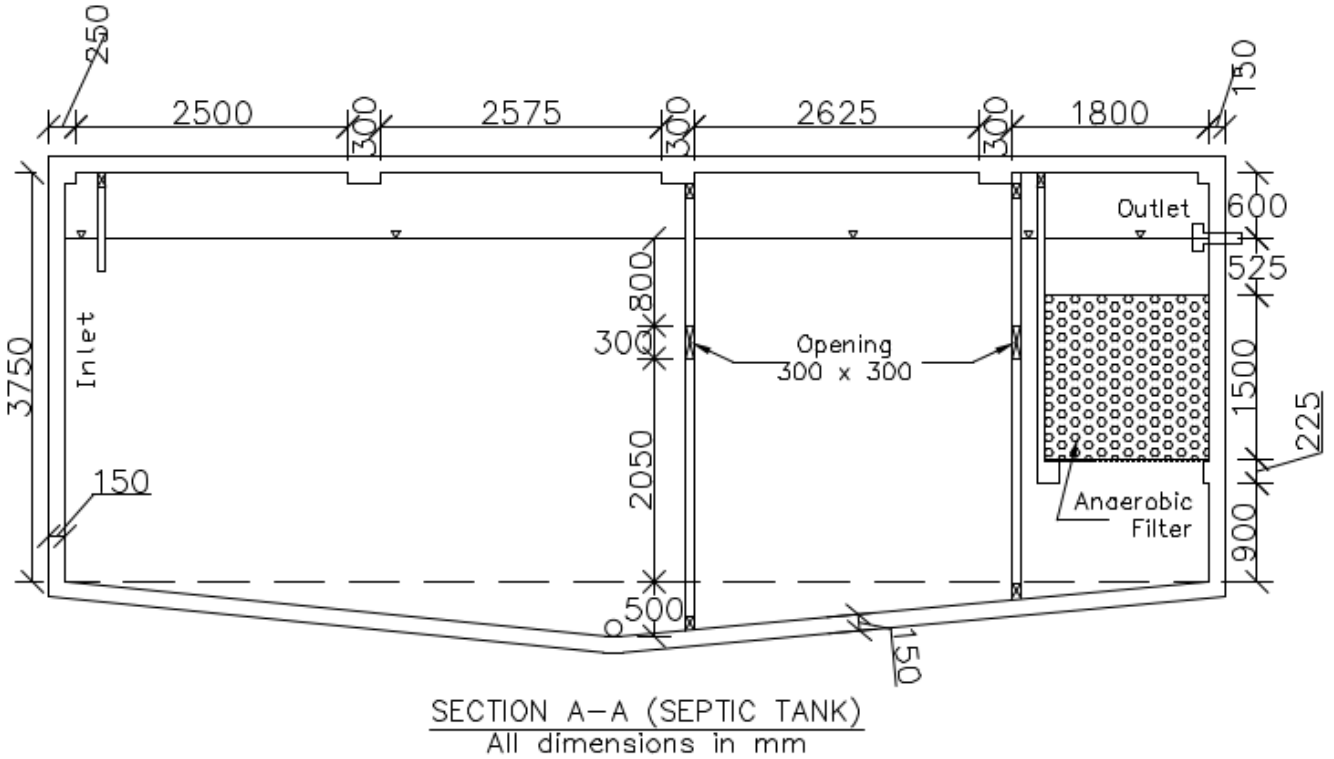




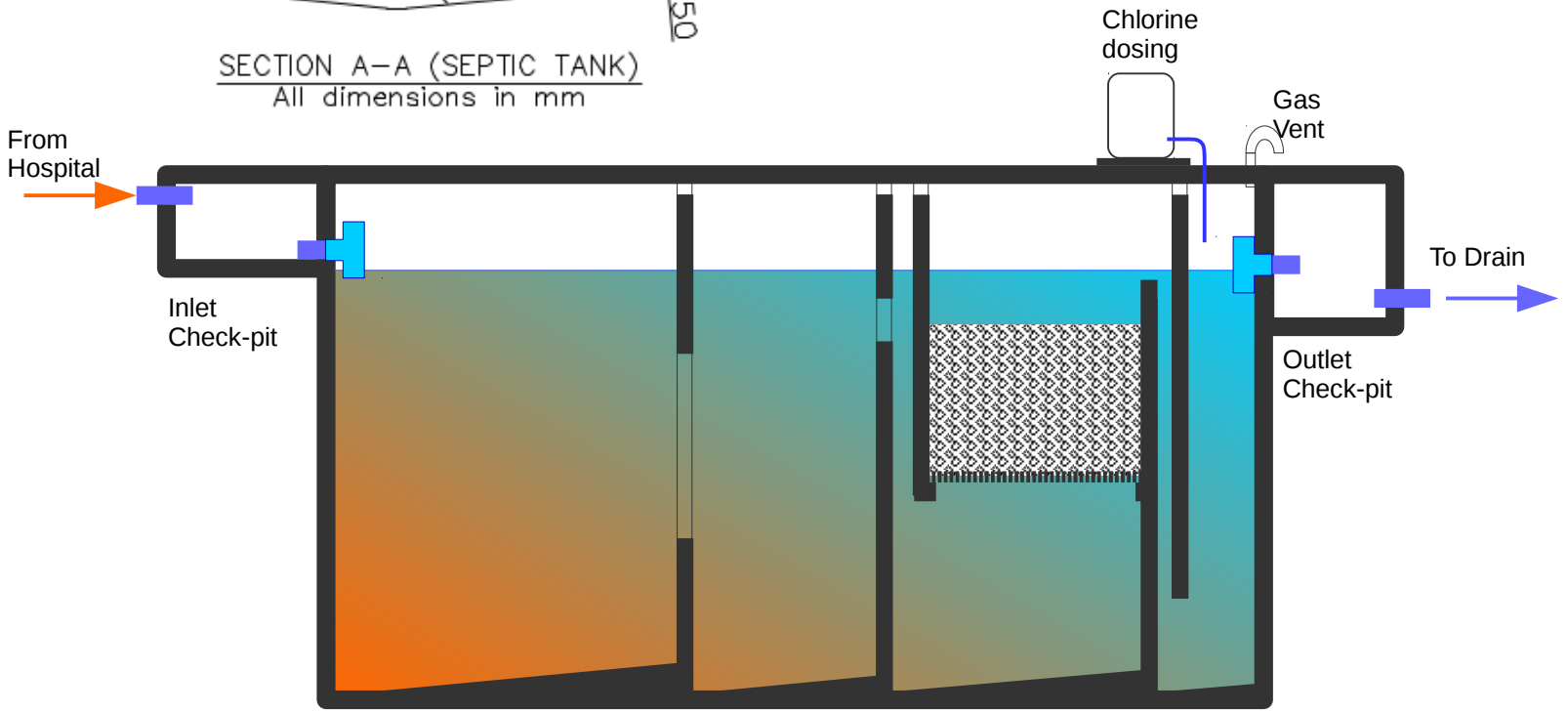




Septic tank: Enhanced system designs



SECTION A–A (SEPTIC TANK)
All dimensions in mm



Sedimentation and Digestion (Septic Tank)

Anaerobic Bio-Filter

Disinfection Chamber

Disposal of Septic Tank Effluent

- Absorption trenches
  - mathematical Problem
- Soakaways
- Evapotranspiration Mounds
- Disposal to nearby sewer

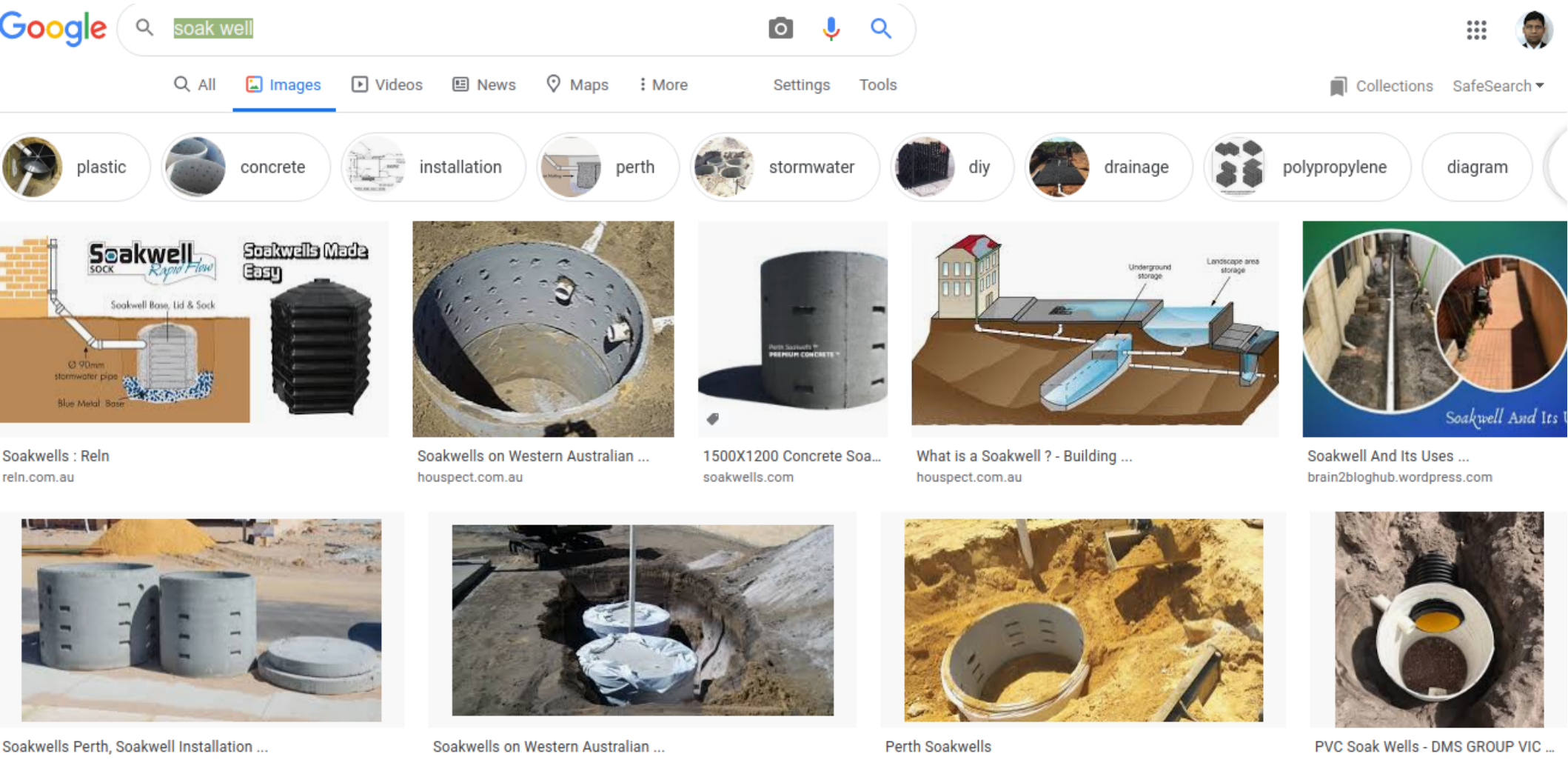
Septic tank: Disposal of Effluent

the position of the water table and the soil depth. The following general guidelines can be considered for selecting soil absorption sites.

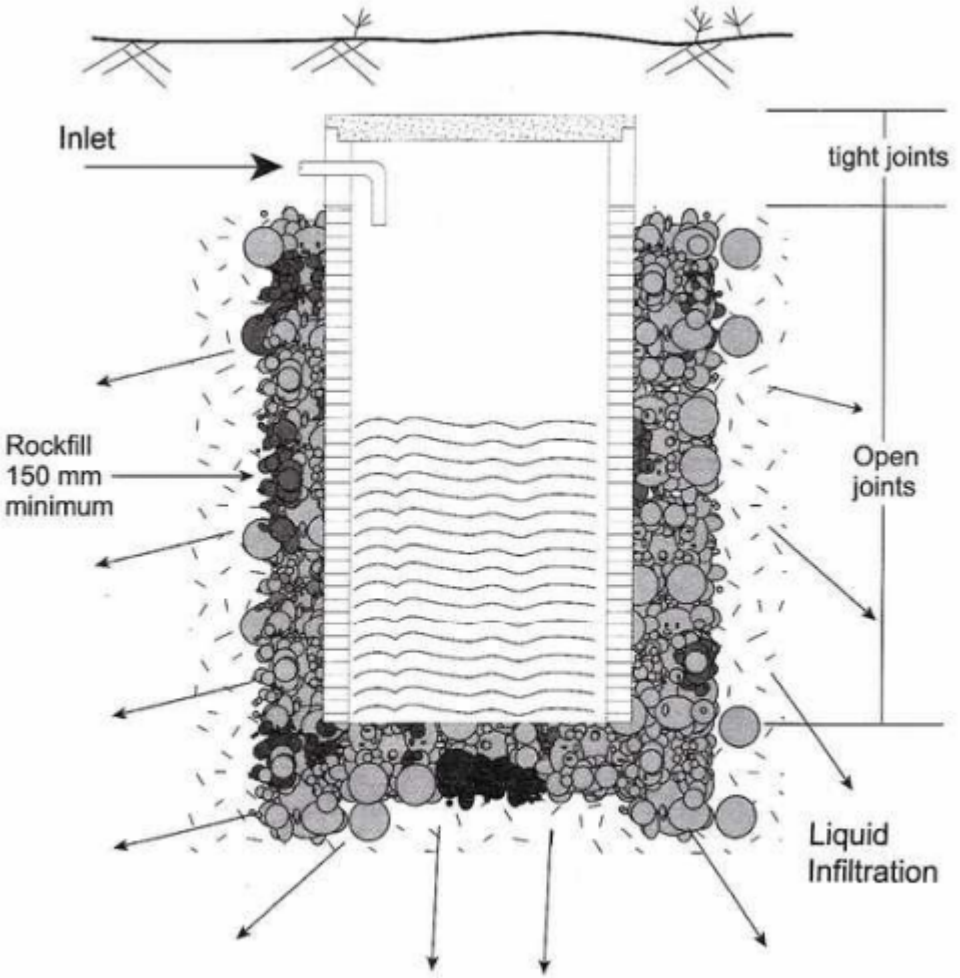
- Soil permeability should be moderate to rapid and the soil percolation rate should generally be 24 minutes per cm or less.
- The groundwater level during the wettest season should be at least 1.22 m (4 ft) below the bottom of the sub-surface absorption field or soak pit.
- Impervious layers should be more than 1.22 m below the seepage bed or the pit bottom.
- The site for an absorption field of a soak pit should not be within 15.24 m (50 ft) of a stream or other water body.
- A soil absorption system should never be installed in an area subject to frequent flooding.

Three different types of sub-surface soil absorption systems are commonly used: (a) absorption trenches, (b) absorption beds or seepage beds, and (c) absorption pits or soakage pits. The use of these types depends on the suitability of soil and other local conditions.

Septic tank: Disposal of Effluent



Septic tank: Disposal of Effluent



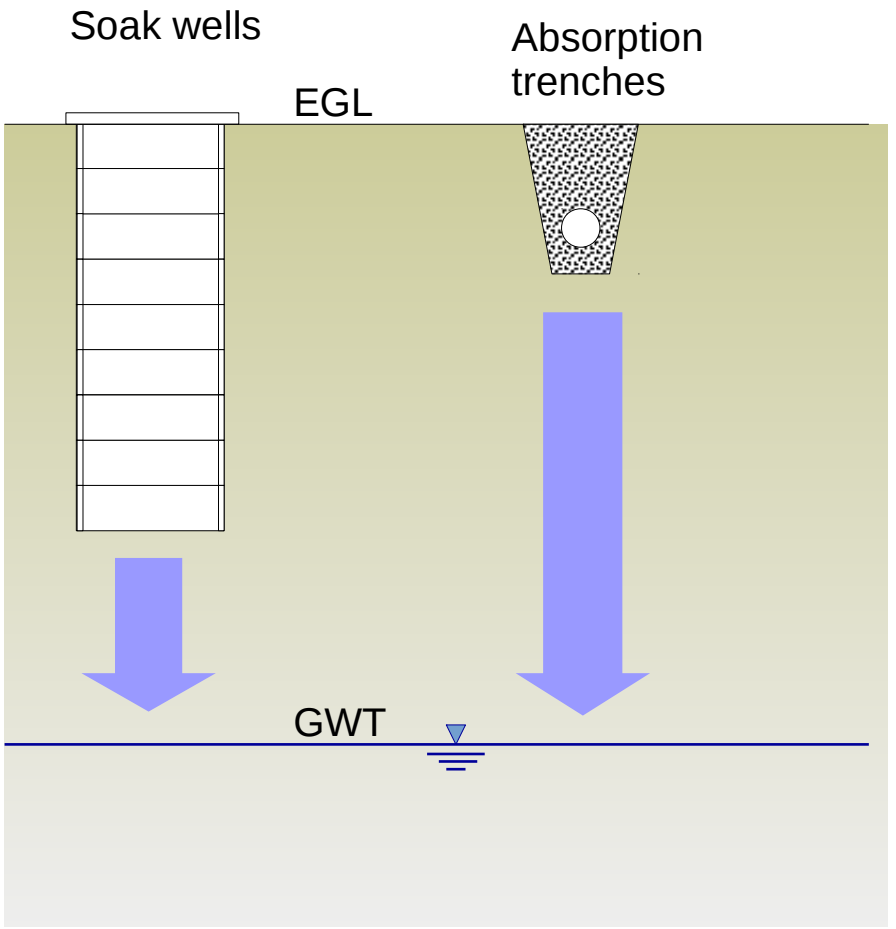
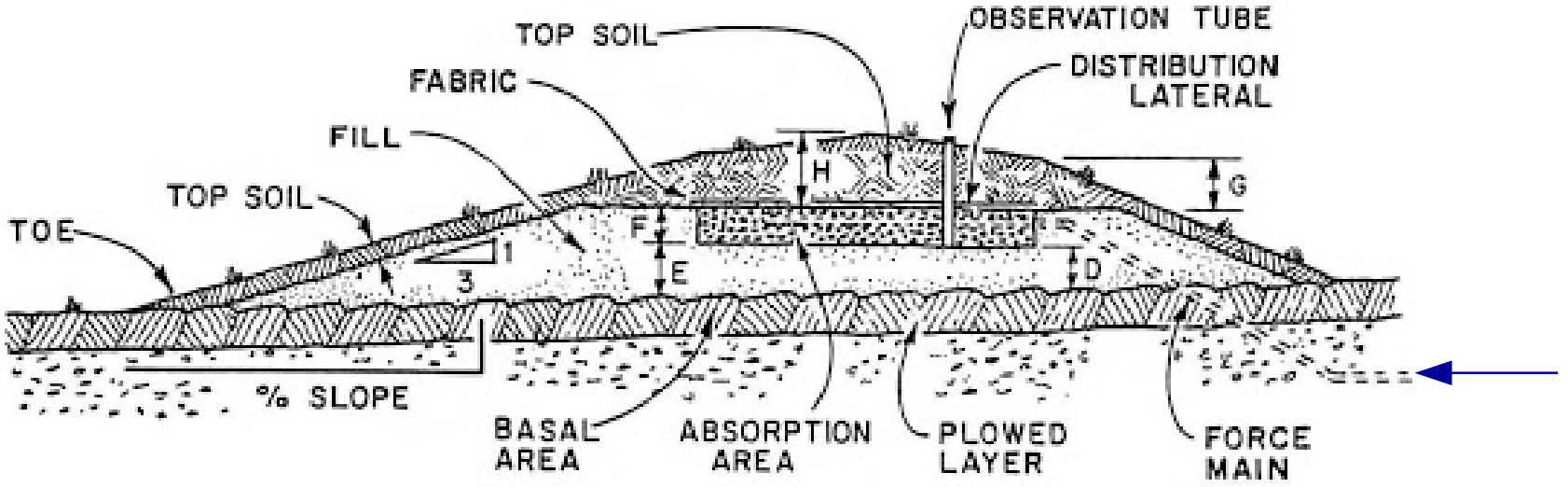


Figure 9.16 Typical soakage pit

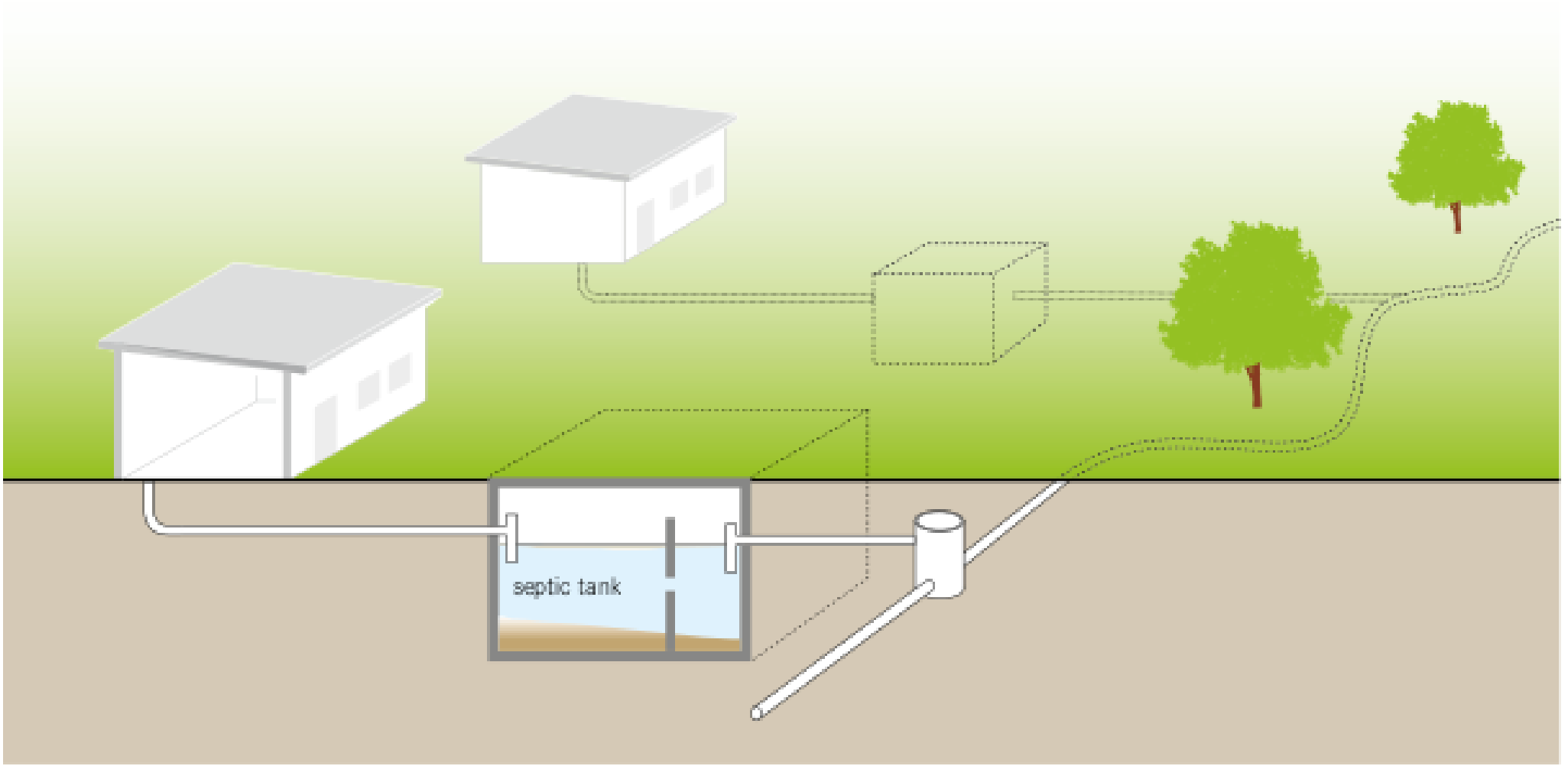
Soakaways or soakage pits (Figure 9.16) are mostly used in Bangladesh. The septic tank effluent flows through pit walls made of open jointed bricks, into the surrounding soil. Typically, soakaways can be 2 to 3.5 m in diameter, and 3 to 6 m deep depending on the amount of wastewater flow and the infiltration capacity of soil.

Septic tank: Disposal of Effluent



Evapotranspiration mounds: A mound system is a soil absorption system that is elevated above the natural soil surface in a suitable fill material. The purpose of the design is to overcome site restrictions that prohibit the use of conventional sub-surface absorption systems. The design of a mound for a particular site involves five steps: (a) sizing of the required base area, (b) sizing of the absorption trenches, (c) design of the distribution system, (d) final dimensioning of the mound, and (e) sizing of the dosing chamber.

Septic tank: Disposal of Effluent



Septic Tank: Mathematical Problem

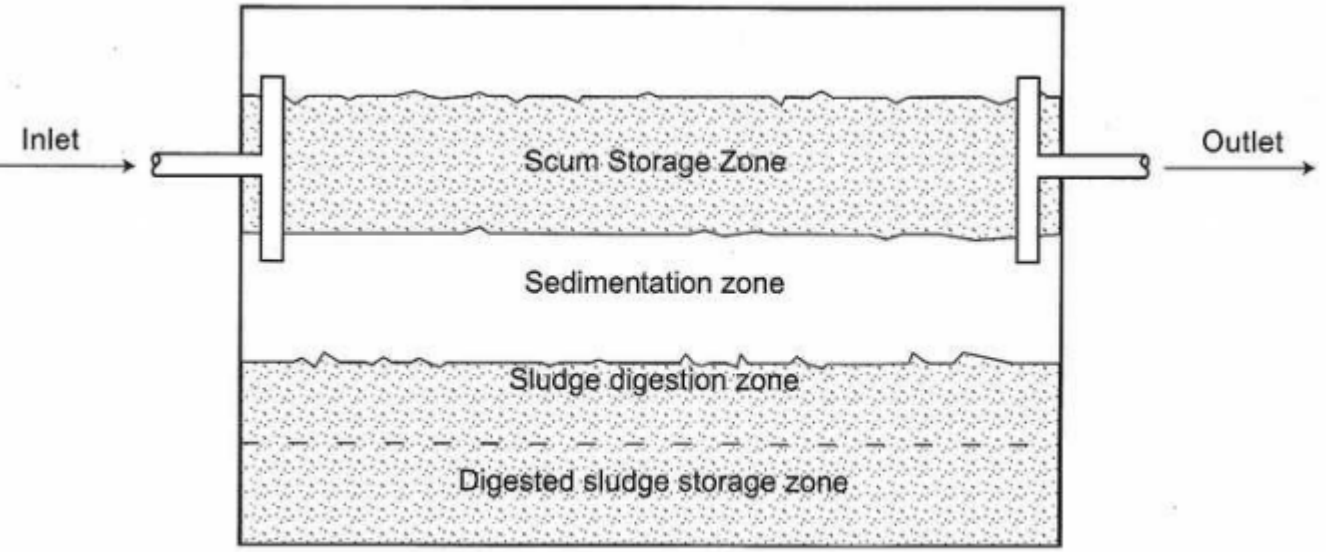
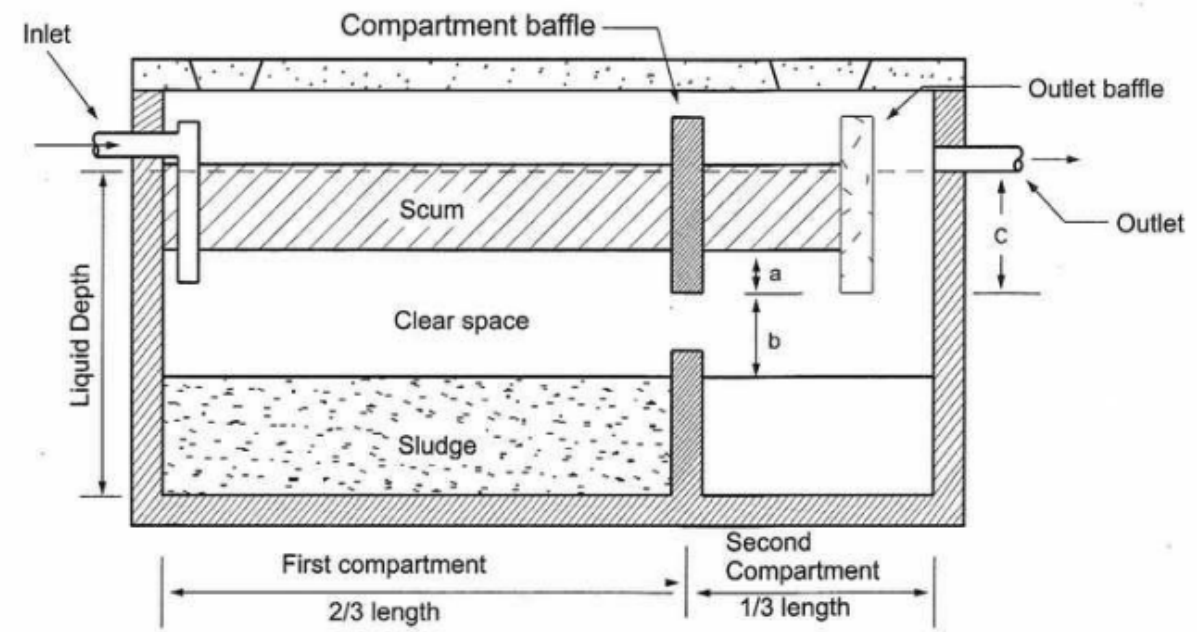


Figure 9.14 Functional zones in a septic tank

Scum Zone (Sc)		
Sedimentation Zone (h)		
Sludge Digestion Zone (d)		
Sludge Zone (Sl)		



Septic Tank: Mathematical Problem

P = 10 persons
N = 3 years
C = 0.06 m^3/person/yr
T = 25 °C
q = 90 lpcd

0.06 m^3/person/yr, N < 5 yrs
0.04 m^3/person/yr, N > 5 yrs

= (0.82 – 0.26 x 3.0)

= 0.04 m < 0.3 m \ 0.3 m is adopted.

A = 3.0 m^2

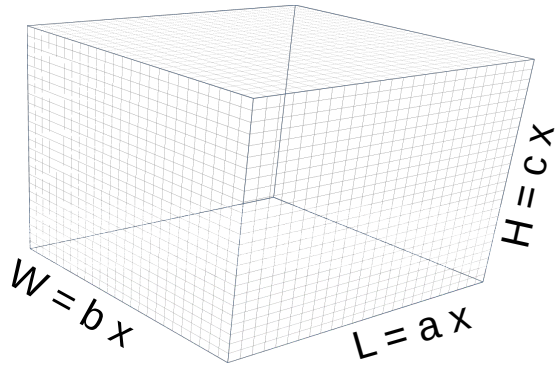
	Volume calculation (m^3)	Depth Calculation (m)
Scum Zone (Sc)	$V_{sc} = 0.4V_{Sl}$ 0.4 x 1.8 = 0.72 m^3	$d_{sc} = \frac{V_{sc}}{A}$ = 0.4 x 1.8 / 3.0 = 0.24 m
Sedimentation Zone (h)	$t_h = 1.5 - 0.3 \log(Pq) > 0.2$ 1.5 – 0.3 log (10 x 90) = 0.61 days. $V_h = 10^{-3}(Pq)t_h$ 10^{-3} (10 x 90) 0.61 = 0.55 m^3	0.82 – 0.26A +0.075 0.3 $\frac{V_h}{A}$ → d_h = 0.55 / 3.0 = 0.183 m < 0.375 m
Sludge Digestion Zone (d)	$t_d = 30(1.035)^{35-T}$ = 42.3 days $V_d = 0.5*10^{-3}Pt_d$ = 0.5 x 10^{-3} x 10 x 42.3 = 0.21 m^3	$d_d = \frac{V_d}{A}$
Sludge Zone (Sl)	$V_{sl} = CPN$ = 0.06 x 10 x 3 = 1.8 m^3	$d_{sl} = \frac{V_{sl}}{A}$ = 1.8 / 3.0 = 0.60 m.
Total =	$V = V_{sc} + V_h + V_d + V_{sl}$ = 0.55 + 0.21 + (1.4 x 1.8) = 3.28 m^3	$d = d_{sc} + d_h + d_d + d_{sl}$ = 0.60 + 0.375 + 0.24 = 1.215 m

1.0 m x 3.0 m x 1.5 m

Septic Tank: Mathematical Problem

P = 10 persons
N = 3 years
C = 0.06 m^3/person/hr
T = 25 °C
q = 90 lpcd

0.06 m^3/person/yr, N < 5 yrs
0.04 m^3/person/yr, N > 5 yrs



$$V = L \times W \times H$$
$$= ax.bx.cx$$
$$= abcx^3$$
$$x = \sqrt[3]{\frac{V}{abc}}$$

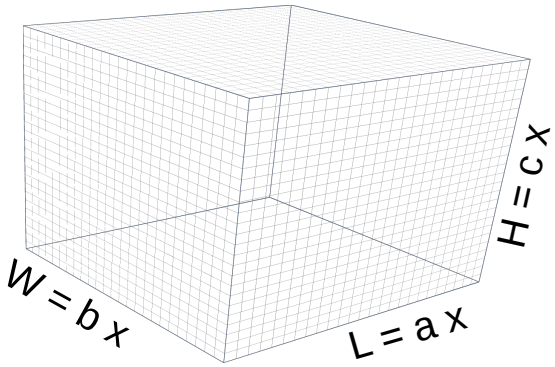
$A = a\ b\ x^2$

	Volume calculation (m^3)	Depth Calculation (m)
Scum Zone (Sc)	$V_{sc} = 0.4V_{Sl}$ 0.4 x 1.8 = 0.72 m^3	$d_{sc} = \frac{V_{sc}}{A}$
Sedimentation Zone (h)	$t_h = 1.5 - 0.3 \log(Pq) > 0.2$ 1.5 – 0.3 log (10 x 90) = 0.61 days. $V_h = 10^{-3}(Pq)t_h$ 10^{-3} (10 x 90) 0.61 = 0.55 m^3	0.82 – 0.26A 0.3 $\frac{V_h}{A}$ +0.075 → d_h
Sludge Digestion Zone (d)	$T_d = 30(1.035)^{35-T}$ = 42.3 days $V_d = 0.5*10^{-3}Pt_d$ = 0.5 x 10^{-3} x 10 x 42.3 = 0.21 m^3	$d_d = \frac{V_d}{A}$
Sludge Zone (Sl)	$V_{sl} = CPN$ = 0.06 x 10 x 3 = 1.8 m^3	$d_{sl} = \frac{V_{sl}}{A}$
Total =	$V = V_{sc} + V_h + V_d + V_{sl}$ = 0.55 + 0.21 + (1.4 x 1.8) = 3.28 m^3	$d = d_{sc} + d_h + d_d + d_{sl}$

Septic Tank: Mathematical Problem

P = 10 persons
N = 3 years
C = 0.06 m^3/person/hr
T = 25 °C
q = 90 lpcd

0.06 m^3/person/yr, N < 5 yrs
0.04 m^3/person/yr, N > 5 yrs



$$V = L \times W \times H$$
$$= ax.bx.cx$$
$$= abcx^3$$
$$x = \sqrt[3]{\frac{V}{abc}}$$

A = a b x^2

Let the initial size ratio,
a = 3
b = 1
c = 1

$$x = \sqrt[3]{\frac{V}{abc}} = \sqrt[3]{\frac{3.28}{3\times1\times1}} = 1.0306$$

$$A = abx^2 = 3\times1\times1.03^2 = 3.1864\,m^2$$

L = ax = 3.092 m
W = bx = 1.031 m
H = 1.232 m

Depth Calculation (m)

$$d_{sc} = \frac{V_{sc}}{A} = \frac{0.72}{3.1864} = 0.226$$

0.82 – 0.26A
0.3
$\frac{V_h}{A}$
+0.075 → d_h=0.375

$$d_d = \frac{V_d}{A} = 0.066$$

$$d_{sl} = \frac{V_{sl}}{A} = 0.565$$

$d = d_{sc} + d_h + d_d + d_{sl} = 1.232$ m

Soakage pit: Mathematical Problem

Example 6

If the soil is sandy loam with a long-term infiltration rate of about 30 l/m² day, design a soakage pit for the disposal of effluent from the septic tank of the previous example.

Solution: Effluent flow from septic tank $Q = 90 \times 10 = 900$ litres/day

Long-term infiltration rate $I = 30$ litres / m² day

The infiltration area required $A = Q / I$

$= 900/30 = 30$ m²

Assuming a 1.25 m diameter, the effective depth of the soak pit will be

$$A = \pi D H \Rightarrow H = \frac{A}{\pi D} = 30 / \pi \times 1.25$$

$= 7.6$ m

However, if the groundwater table is high, two soak pits each of 1.25 m diameter and 4.0 m deep may be provided. Alternatively, if sufficient land area is available, drain-field trenches can also be designed for the disposal of septic tank effluent.

Absorption trench: Mathematical Problem

The design of an absorption field can be done as follows:

$$L = \frac{Pq}{2DI}$$

Where,

L = trench length (m)
P = number of users
q = wastewater flow (litres/capita/day)
D = effective depth of trench (m)
I = design infiltration rate (litres/m²/day)