SRI LANKA STANDARD 745 PART 2 : 2009
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CODE OF PRACTICE FOR THE DESIGN AND CONSTRUCTION OF SEPTIC TANKS AND ASSOCIATED EFFLUENT DISPOSAL SYSTEMS

PART 2 : SYSTEMS DISPOSING TO SURFACE, SYSTEMS FOR ON-SITE EFFLUENT REUSE AND LARGER SYSTEMS DISPOSING TO GROUND

(First Revision)

SRI LANKA STANDARDS INSTITUTION

Sri Lanka Standard

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SLS 745 Part 2 : 2009

Gr. 17

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Sri Lanka Standards are subject to periodical revision in order to accommodate the progress made by industry. Suggestions for improvement will be recorded and brought to the notice of the Committees to which the revisions are entrusted.

This standard does not purport to include all the necessary provisions of a contract.

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FOREWORD

This Sri Lanka Standard Code of Practice was approved by the Sectoral Committee on Building and Construction Materials and was authorized for adoption and publication as a Sri Lanka Standard by the Council of the Sri Lanka Standard Institution on 2009-03-30.

This Standard was first published in 1986. This is the first revision. This code of practice is intended to serve as a guide for the design and construction of septic tanks and associated effluent disposal systems in Sri Lanka. It is intended for use by consultants, designers, manufacturers, certifying bodies, installers and regulators.

Since the original version of this code was published in 1986, many technological advancements have been made in this field and several new technologies have emerged – mainly for the treatment and disposal of septic tank effluent beyond traditional disposal of effluent to ground via soakage pits. This code identifies technologies appropriate for most Sri Lankan conditions and presents guidelines for their design and implementation. It is presented in two parts. Part **1** (published in 2004) is a revision of the original code and deals with small systems, disposing to ground. This is Part 2, which deals with larger systems as well as those systems where ground disposal is not an option (such as in the case of high ground water table or low soil percolation rate). It presents Anaerobic biofilters, Subsurface flow constructed wetlands and gravel percolation beds as alternative post treatment technologies for the treatment of septic tank effluent up to standards suitable for surface discharge and/or onsite effluent reuse.

The maintenance of the treatment and disposal systems described in this code of practice as per **9** is of paramount importance to their sustainable operation. Failure to adhere to the recommended maintenance procedure may result in untimely malfunctioning of the system.

It should be noted that the design guidelines presented in this code have been developed for optimal treatment efficiency and operation. No assurance is implied that following these guidelines would result in effluent conforming to a particular effluent standard. Such standards may include regulations under the National Environmental Act No 47 of 1980, and any, regulations of the relevant local authority. It remains the responsibility of the designer and the implementer to find out the regulations that govern their particular situation and to ensure a design that conforms to any specific effluent standard that might be applicable.

Pipe diameters specified in this code refer to the internal diameter of pipes.

This standard does not purport to include all the necessary provisions of a contract. Users are responsible for its correct applications.

For the purpose of deciding whether a particular requirement of the standard is complied with the final value, observed value or calculated, expressing the result of a test or an analysis shall be rounded off in accordance with **SLS 102**. The number of significant places retained in the rounded off value shall be the same as that of the specified value in this standard.

In the preparation of this standard code of practice the assistance derived from the publications of the British Standards Institution, Standards Australia and Standards New-Zealand are gratefully acknowledged.

Compliance with this Sri Lanka Standard Code of Practice does not of itself confer immunity from legal obligations.

1 SCOPE

This Code of practice covers the design, construction, testing and maintenance of septic tanks for the disposal of domestic wastewater including allwaste, blackwater and greywater systems. It also recommends guidelines for the selection, design, construction and maintenance of systems for the on-site disposal of effluents from septic tanks. The disposal systems recommended are soakage systems for the disposal of septic tank effluent below ground (soakage pits, seepage trenches, and seepage beds), and anaerobic bio-filters, constructed wetlands and percolation beds for the disposal of septic tank effluents above ground, or for on-site effluent reuse.

Part **1** of this code deals with small systems (i.e. with an average daily flow of less than 5 m^3/d) disposing to ground and Part **2** deals with systems disposing to surface, systems for on-site effluent reuse and larger systems (i.e. with and average daily flow greater than 5 m^3/d) disposing to ground.

2 DEFINITIONS

The following definitions shall apply for the purpose of this Code of Practice:

2.1 access opening : An opening on the top of the tank fitted with a removable cover to allow access for desludging and other maintenance activity.

2.2 allwaste : Combined blackwater and greywater.

2.3 biological filter : A chamber filled with inert material (e.g. gravel, broken stones, plastic, broken burnt clay tiles, etc.) which facilitates growth of biological film on the material surfaces and treats septic tank effluent as it flows through the material.

2.4 blackwater : Waste discharged from the human body through toilets and urinals.

2.5 constructed wetland : A vegetated bed filled with gravel, broken stones or similar inert material, in which wastewater is treated as it flows either horizontally or vertically through the bed. Constructed wetlands are also commonly referred to as reed beds, planted gravel filters and plant rock filters in literature.

2.6 desludging : The removal of accumulated scum and sludge from a septic tank.

2.7 domestic wastewater : Wastewater originating from household and personal activities including toilets, baths showers, sinks, kitchens and non-commercial laundries. This includes such wastewater from homes, schools, shops, offices, hotels, etc., while specifically excluding wastes from industrial processes.

2.8 effluent : The liquid discharged from a wastewater treatment unit (e.g. septic tank, bio-filter, etc.).

2.9 freeboard : The height of the air space between the liquid level and the ceiling of a tank.

2.10 greywater: Domestic wastewater from baths, showers, washbasins, kitchens etc., other than blackwater.

2.11 ground water table : The level below the ground surface at which groundwater is first encountered during excavation.

2.12 influent : The wastewater entering a tank or treatment unit.

2.13 inlet : The device through which influent is fed into a tank or treatment unit during normal operation.

2.14 inspection port : An opening in the top of the tank which allows inspection of the contents.

2.15 invert : The lowest point on the inside of a pipe or drain at a given cross section.

2.16 liquid depth : The distance between the liquid level and the inside bottom of a tank.

2.17 liquid level : The liquid level in a tank during normal operation of the tank.

2.18 outlet : The device through which effluent leaves a tank or treatment unit during normal operation.

2.19 partition : An internal wall which separates compartments of a tank or treatment unit.

2.20 percolation bed : A bed of prepared inert (gravel, broken stones, sand or similar inert material) contained within an impermeable liner or chamber. Wastewater is treated while percolating through the bed from top to bottom and treated effluent is collected from the bottom.

2.21 scum : The floating mass of solids which form an accumulating layer on the liquid surface inside a septic tank.

2.22 seepage bed : A bed of prepared aggregate (i.e. gravel, broken stones or similar inert material) through which effluent is allowed to seep into the ground.

2.23 seepage trench : A trench filled with prepared aggregate (i.e. gravel, broken stones or similar inert material) through which effluent is allowed to seep into the ground.

2.24 septic tank : A single or multiple-chambered tank in which wastewater is retained sufficiently long to permit separation of solid particles and partial digestion of accumulated solids.

2.25 serviceable life : The period of time in which a unit performs satisfactorily with only normal and routine maintenance.

2.26 sewage: Any wastewater, including all faecal matter, urine, household and commercial wastewater that contains human waste.

2.27 sludge : Settled solids in a semi-liquid state.

2.28 soakage pit : A pit from which septic tank effluent is allowed to seep into the surrounding soil.

2.29 vent: A device – usually a pipe – which allows gases to escape from a wastewater treatment unit.

2.30 wastewater : The spent or used water of domestic or commercial origin which contains dissolved and suspended matter.

2.31 working capacity : The liquid volume of wastewater that would be contained in a tank during normal use.

NOTE : *Septic tank alone, does not constitute a complete effluent tr*eatment.

3 INFORMATION REQUIRED

Prior to proceeding with the design, the following information shall be gathered. Accurate site information and assessment is vital to avoid failure of septic tank systems.

3.1 Intended use of building

The intended and/or current use of the building shall be identified (e.g. individual home, shop, office building, etc.). Possible future uses, which could differ from the current use, should also be identified, as usually, septic tanks are not refitted when buildings undergo change of usage.

3.2 Number and type of users

The maximum number of users who would reasonably be expected to use the building and facilities on a daily basis shall be estimated as accurately as possible. It should be noted that septic tank systems shall be designed for the maximum and not the average number of daily users. In the case of separate dwelling units, the number of estimated users shall be at least 5.

In the case of commercial buildings, the number of each type of users such as residents, day-time users, visitors, customers, service staff etc. shall be determined.

3.3 Site plan

A site plan and layout of the building/s and facilities shall be obtained. The plan should show all relevant details such as building outlines, location of water sumps, wells, property boundaries, street lines, etc.

3.4 Natural drainage and ground water table

The natural drainage features of the site shall be assessed, either by means of a contour plan of the site or by visual assessment or both. Storm water drainage paths should be identified. The highest seasonal level of the local groundwater table shall be determined. This could be done either by observing water levels in wells on the site or in the immediate vicinity, or by digging trial pits to determine the location of the groundwater table. Information on seasonal variation of the local groundwater table can often be obtained by interviewing residents in the locality.

3.5 Soil conditions

The soil shall be explored to sufficient depth to ascertain the soil types, grading structure, stability and permeability. Where soakage of effluent is being considered, a percolation test shall be carried out as described in Appendix **A**.

3.6 Elevations

Invert elevations of all wastewater outlets from the building shall be determined, together with any external factors which might affect the invert elevation of the inlet to the septic tank. In cases where treated effluent is to be discharged to the surface, the elevations of potential discharge points shall be determined.

3.7 Existing soakage pits

The locations and size of any existing soakage pits in the vicinity shall be noted.

3.8 Maintenance capability

The maintenance capability of the potential users or owners of the facility should be assessed. Septic systems frequently fail due to inadequate or inappropriate maintenance and ignorance of users.

3.9 Options for effluent disposal or reuse

Potential options for effluent disposal shall be explored with the consultation of the users and/or developers. As stated in the foreword it remains the responsibility of the designer and the implementer to find out the regulations that govern their particular situation and to ensure a design that conforms to any specific effluent standard that might be applicable. Potential for effluent reuse for uses such as gardening, irrigation, toilet-flushing, and landscaping shall be evaluated. Significant savings in freshwater consumption could be achieved through on-site effluent reuse.

3.10 Neighbourhood land use and environment

The land use and local environmental conditions in the immediate neighbourhood of the site shall be investigated and relevant details should be noted (e.g. drinking water/ bathing wells in the immediate vicinity, any streams used for drinking / bathing downstream, and condition of the roadside drains etc…).

4 FLOW ESTIMATION

The average daily flow of wastewater to the system shall be estimated as accurately as possible. In the absence of more accurate information, the flow shall be estimated for each category of user by multiplying the maximum number of users in each category by the respective per capita daily flows. The average daily flow is the summation of the flows of all the contributory user categories.

The per capita daily flow for each category of user is given in Table **1** below.

Example computations of average daily flow based on Table **1** are given in Appendix **B.**

TABLE 1 - Per capita daily flows for different user categories.

User Category	Per Capita Wastewater Flow (litres/person/day)[a]		
	Allwaste	**Blackwater**	**Greywater**
Houses, Housing estates and Apartment Complexes Luxury - Residents Non Luxury - Residents Low income - Residents	240 200 160	60 50 40	180 150 120
Shops, Offices, etc. - Daytime employees - Overnight employees - Customers / Visitors	50 200 10	30 50 5	20 150 5
Schools, Universities, etc - Residents - Daytime	200 50	50 30	150 20
Restaurants (dine-in) - Overnight employees - Day-time employees - Meals served	200 50 25 l/meal	50 30 10 l/meal	150 20 15 l/meal
Restaurants (take-away) - Overnight employees - Day-time employees - Meals served	200 50 15 l/meal	50 30 N/A	150 20 15 l/meal
Hotels - Guest - Staff (residential) - Staff (non-residential) - Kitchen - Swimming pool	240 200 100 15 l/meal 10 l/user/d	60 50 50 N/A N/A	180 150 50 15 l/meal 1/user/d

a - Except where otherwise shown.

5 DESIGN

5.1 Process selection

5.1.1 In the past, the indiscriminate use of soakage pits for the disposal of septic tank effluent without due consideration to local site conditions has resulted in the failure of a large number of septic tank systems. The proper selection of an appropriate effluent disposal process is essential to the satisfactory functioning of a septic tank.

5.1.2 This code of practice recommends the use of seepage beds, seepage trenches, anaerobic biofilters, constructed wetlands and percolation beds as alternatives to soakage pits for the disposal of septic tank effluent.

5.1.3 In Sri Lanka, the following configurations are suggested as most likely options for the disposal of septic tank effluent, and should be considered prior to making a selection. The final selection should be based on a combination of technical, financial and regulatory considerations and the preferred option of disposal (i.e. reuse for non potable and non contact uses, disposal to ground, drain etc.). The technical considerations governing the applicability of the different technologies are given in the subsections “applicability” under each separate category heading later in this standard.

NOTE : *Care should be taken in reusing treated effluent as it may cause health hazards due to presence of disease causing micro organisms.*

a) **disposal to ground**

i. Septic Tank → Soakage Pit → Ground

ii. Septic Tank → Seepage bed → Ground

iii. Septic Tank → Seepage trench → Ground

b) **disposal to surface water and/or ground**

i. Septic Tank → Biofilter→ Surface water and /or ground

ii. Septic Tank → Secondary Constructed Wetland (unlined) → Surface water and/or Ground

iii. Septic Tank → Secondary Constructed Wetland (lined) → Surface water and /or ground

c) **reuse and/or disposal to surface water and/or ground**

i. Septic Tank → Secondary Constructed Wetland (lined) → Tertiary Constructed Wetland (lined) → Surface water and/or ground

ii. Septic Tank → Secondary Constructed Wetland (lined) → Percolation Bed → Reuse and/or surface water and/or ground

iii. Septic Tank → Biofilter → Tertiary Constructed Wetland (lined) → Reuse and/or surface water and/or ground

iv. Septic Tank → Biofilter → Percolation Bed → Reuse and/or surface water and/or ground.

NOTE : *The options listed above are most likely to be suitable for Sri Lankan conditions in general. Other options deemed more suitable for specific cases, provided they are designed comprehensively on a case-by-case basis.*

5.2 Septic Tanks

5.2.1 *General*

a) The main function of a septic tank is to separate, retain and partially digest, settleable and floatable solids in wastewater. The working capacity of a septic tank shall be sufficient for all these functions to occur.

b) Septic tanks shall be water-tight, with sufficient structural strength and integrity to withstand external soil pressures, internal and external water pressures and any likely imposed loading. Septic tanks situated under driveways and parking areas shall be designed to carry the appropriate vehicle loads.

5.2.2 *Location*

a) Septic tanks shall be located in an open area wherever possible. However they may be located under car parks, driveways, terraces etc., in order to save space, provided due consideration is given to the structural integrity of the tank and adjacent features.

b) Sufficient preferable access to the tank shall be available for inspection and desludging activities.

5.2.3 *Tank geometry*

a) The preferred geometry of a septic tank is rectangular, with length between 2 to 4 times the width. Tanks of other shapes such as circular section (with axis either horizontal or vertical) may be used provided the area of the water surface in the tank during normal operation is sufficient to ensure proper solids separation.

b) In the absence of detailed analysis, the minimum surface area requirement may be estimated empirically as follows.
Minimum surface area (m^2) = working capacity of tank (m^3) / 3.

c) In the case of multi-compartment tanks the compartments shall be of unequal size to avoid mass oscillations of liquid in the tank.

5.2.4 *Dimensions*

a) The working capacity of the septic tank shall be estimated as described in Appendix **C**.

b) In any event the working capacity of a single tank shall always be greater than $1m^3$ and less than $12\ m^3$.

c) Where the required working capacity exceeds $12\ m^3$, parallel sets of tanks shall be used such that the working capacity of each is less than $12\ m^3$.

d) The minimum internal width of a tank shall be 750 mm.

e) The minimum depth below liquid level shall be 1 m.

Appendix **D** shows the arrangement of a typical septic tank.

5.2.5 *Inlet and outlet arrangements*

a) Tee fittings, elbows or baffles shall be provided at the inlet and outlet.

b) The inlet fitting shall extend a minimum of 20 per cent of the liquid depth below the liquid level.

c) The outlet fitting shall extend a minimum of 300 mm below the liquid level of the tank.

d) The invert of the outlet pipe shall be at least 50 mm below the invert of the inlet pipe.

5.2.6 *Access openings*

a) One or more access openings shall be provided for inspection and desludging.

b) Openings maybe circular, square or rectangular. Circular access openings shall be at least 500 mm in diameter. Square or rectangular openings shall have a minimum minor dimension of 500 mm.

c) Openings shall be provided with a suitable cover to prevent the ingress of surface and ground water into the tank.

5.2.7 *Freeboard*

a) A minimum of 200 mm freeboard shall be provided between the liquid level and the highest point on the ceiling of the tank.

b) The air space thus provided shall have a volume equivalent to at least 10 per cent of the total tank volume.

5.2.8 *Chamber partitions*

In the case of multiple compartment tanks, chamber partitions shall have one or more openings, of total area greater than the area of the inlet to the tank, at a height between 30 per cent to 70 per cent of liquid depth from the bottom of the tank. The minimum dimension of an opening shall be 100 mm.

5.2.9 *Vent pipe*

a) Each chamber in a septic tank shall be vented through an opening of minimum 25 mm diameter.

b) A vent pipe of minimum 25 mm diameter shall be provided extending outside the tank to a height sufficient to avoid odour nuisance.

c) The pipe shall be covered with a suitable mosquito proof mesh at the top.

d) A single vent pipe is sufficient, provided the air space in each chamber of the tank is interconnected with another through an opening of minimum 25 mm diameter. If not, multiple vent pipes shall be provided to ensure each chamber of the tank is vented.

5.3 Soakage Pits

5.3.1 *General*

Soakage pits are used to soak septic tank effluent into the surrounding soil. They do not provide any direct treatment and are based on the principle that the effluent gets treated as it moves through the surrounding soil before entering the groundwater table or other water body.

5.3.2 *Applicability*

Soakage pits shall be applicable only in areas where the seasonal high groundwater table is greater than 2.5 m below the ground surface and the soil percolation rate is between 25 mm/h and 125 mm/h.

5.3.3 *Location*

a) Soakage pits shall be located in an open area and satisfy the following requirements:

i. At least 18m away from the nearest well or other drinking water source;

ii. At least 5 m away from the nearest building; and

iii. A minimum distance from other soakage pits, either existing or proposed, within or outside the property shall be maintained as specified in Table **2** below.

TABLE 2 - Minimum distance between soakage pits.

Average daily flow (m^3/day)	**Minimum distance between soakage pits (m)**
< 2	10
2 – 5	15
5 - 10	20
10 – 30	36

NOTE: *In the case of soakage pits with flows differing from each other the spacing requirement shall be that required for the pit receiving the highest flow.*

5.3.4 *Geometry*

Soakage pits are usually circular or square in plan, although other regular shapes may be used.

5.3.5 *Dimensions*

a) Soakage pits shall be sized to provide sufficient effective area for the absorption of the average daily flow.

b) The effective area of a soakage pit shall be the area of the side walls lying between a level 150 mm below the invert of the inlet pipe and the bottom of the pit.

c) The required effective area shall be determined by multiplying the appropriate specific effective area given in Table **3** by the average daily flow.

TABLE 3 - Specific effective areas for soakage pits.

Percolation Rate mm/hr	**Specific effective area (**m^2 / m^3 per day**)**
25	34
50	17
75	11
100	8.4
125	6.6

NOTE : *Intermediate values may be determined by linear interpolation.*

d) No single soakage pit shall be designed for an average daily flow greater than 30 m^3/day.

e) Multiple soakage pits may be used in parallel, provided the spacing requirements specified in Table **2** are satisfied.

f) The minor dimension of a soakage pit (in plan) shall be greater than 900 mm and the major dimension less than 3 m.

g) The depth of the soakage pit shall be such that a minimum distance is maintained between the bottom of the pit and the highest seasonal groundwater table (GWT) according to the values given in Table **4** below.

TABLE 4 - Minimum depth to groundwater table from bottom of soakage pit.

Percolation rate (mm/h)	**Minimum depth to GWT (m)**
25 – 50	1.2
50 – 75	1.8
75 – 100	2.4
100 – 125	3.0

h) If a rock layer exists below the soakage pit, a similar minimum distance to the rock layer from the bottom of the pit shall be maintained.

Appendix **E** shows a typical arrangement of a soakage pit.

5.3.6 *Cover*

a) Soakage pits shall be provided with a suitable permanent cover that prevents the ingress of surface water, insects and rodents into the pit.

b) The cover shall be fixed in place and capable of withstanding reasonable imposed loads.

5.4 Seepage beds

5.4.1 *General*

a) Seepage beds are used to soak septic tank effluent into the surrounding soil in situations where soakage pits are not applicable. They provide some partial treatment of the septic tank effluent prior to soil absorption.

b) A Seepage bed is a bed of prepared aggregate, usually sand, gravel or other inert media, through which the effluent percolates prior to soaking into the soil. Septic tank effluent is applied to the bed through perforated distributor pipes laid at intervals along the bed.

c) Seepage beds may be either gravity fed or pressure dosed at intervals using an automated pump and sump arrangement.

A typical arrangement of a seepage bed is shown in Appendix **F**.

5.4.2 *Applicability*

Seepage beds shall be applicable only in areas where the seasonal high groundwater table is greater than 1.5 m below the surface, the soil percolation rate is between 25 and 250 mm/hr., and the ground slope is less than 5 per cent.

5.4.3 *Location*

Seepage beds shall be located in an open area and satisfy the following requirements:

a) At least 18 m away from the nearest well or other drinking water source;
b) At least 5 m away from the nearest building;
c) At least 5 m away from the nearest soakage pit; and
d) At least 1 m away from the nearest seepage bed or trench.

5.4.4 *Geometry*

Seepage beds are usually rectangular but maybe of any convenient shape in plan.

5.4.5 *Dimensions*

a) Seepage beds shall be sized to provide sufficient effective area for the absorption of the average daily flow.

b) The effective area of a seepage bed shall be the area of the bottom of the bed.

c) The required effective area shall be determined by multiplying the appropriate specific effective area given in Table **5** by the average daily flow.

NOTE : *The specific effective area for seepage beds and trenches differs from that of soakage pits. This is due to differences in clogging characteristics and corresponding safety factors.*

TABLE 5 - Specific effective areas for seepage beds and seepage trenches

Percolation rate (mm/h)	**Specific effective area (m^2 / m^3 per day)**
25	50
50	25
75	17
100	12.5
125	10
150	8.3
175	7.1
200	6.25
225	5.6
250	5.0

d) Minimum, maximum and typical values of bed dimensions are given in Table **6** below.

TABLE 6 - Minimum, maximum and typical dimensions of seepage beds.

Bed dimension	**Typical Range (mm)**	**Maximum (mm)**	**Minimum (mm)**
Width	1000-6000	6000	1000
Depth of aggregate	300-600	600	300
Depth of topsoil	100-150	N/A	100
Spacing between beds (sidewall to sidewall)	-	N/A	1000

e) The maximum bed length shall be 20 m.

5.4.6 *Aggregate*

a) Coarse sand, gravel, stone chips or any other suitable inert material, which is insoluble in water and resistant to the corrosive nature of septic tank effluent, may be used as aggregate.

b) The depth of aggregate in the bed shall be greater than 300 mm and less than 600 mm.

c) The nominal aggregate size shall be greater than 20 mm and less than 40 mm.

5.4.7 *Soil cover*

a) A minimum depth of 100 mm of topsoil shall be provided above the bed as a soil cover.

b) An effective soil barrier such as a reverse filter arrangement, filter cloth or polyethylene liner shall be provided between the soil cover layer and the aggregate layer in the bed to prevent infiltration of soil into the bed.

c) The soil cover may be turfed or vegetated with shallow rooted plants.

5.4.8 *Distribution pipes*

a) The minimum internal diameter of distribution pipes shall be 100 mm.

b) Perforations in pipes shall be between 10 mm to15 mm diameter with a total area of 10,000 mm^2 / m length of pipe.

c) The spacing between adjacent pipes in a bed shall be between 300 mm minimum and 2000 mm maximum.

d) Pipes shall be laid horizontally.

e) A minimum of 2 distributors shall be provided per bed.

5.4.9 *Pressure dosed systems*

a) For pressure dosed systems, the dosing arrangement shall be automatic.

b) The volume of a single dose shall always be less than the sum of the volume within the distribution system plus one fifth the bed volume.

5.5 Seepage trenches

5.5.1 *General*

Seepage trenches are similar to seepage beds except that they are suitable for sloping ground where the ground slope is less than 25 per cent.

A typical arrangement of a seepage trench is shown in Appendix **G.**

5.5.2 *Applicability*

Seepage trenches shall be applicable only in areas where the seasonal high groundwater table is greater than 1.5 m below the surface, the soil percolation rate is between 25 and 250 mm/hr., and the ground slope is less than 25 per cent across trenches and less than 5 per cent along trenches.

5.5.3 *Location*

Seepage trenches shall be located in an area that satisfies the following requirements:

a) At least 18 m away from the nearest well or other drinking water source;
b) At least 5 m away from the nearest building;
c) At least 5 m away from the nearest soakage pit; and
d) At least 1 m away from the nearest seepage bed or trench.

5.5.4 *Geometry*

Seepage trenches are rectangular in plan.

5.5.5 *Dimensions*

a) Seepage trenches shall be sized to provide sufficient effective area for the absorption of the average daily flow.

b) The effective area of a seepage trench shall be the area of the trench bottom.

c) The required effective area shall be determined by multiplying the appropriate specific effective area given in Table **5** by the average daily flow.

d) Minimum, maximum and typical values of trench dimensions are given in Table **7** below.

TABLE 7 - Typical dimensions of seepage trenches.

Trench dimension	**Typical Range (mm)**	**Maximum (mm)**	**Minimum (mm)**
Width	300-600	600	300
Depth of aggregate	300-600	600	300
Depth of topsoil	100-150	N/A	100
Spacing between adjacent trenches (sidewall to side wall)	1000-2000	N/A	1000

e) The maximum length of a trench shall be 20 m.

5.5.6 *Aggregate*

a) Coarse Sand, gravel, stone chips or any other suitable inert material, which is insoluble in water and resistant to the corrosive nature of septic tank effluent, may be used as aggregate.

b) The depth of aggregate in the trench shall be greater than 300 mm and less than 600 mm.

c) The nominal aggregate size shall be greater than 20 mm and less than 40 mm.

5.5.7 *Soil cover*

a) A minimum depth of 100 mm of topsoil shall be provided above the trench as a soil cover.

b) An effective soil barrier such as a reverse filter arrangement, filter cloth or polyethylene liner shall be provided between the soil cover layer and the aggregate layer in the trench to prevent infiltration of soil into the trench.

c) The soil cover may be turfed or vegetated with shallow rooted plants.

5.5.8 *Distribution pipes*

a) The minimum internal diameter of distribution pipes shall be 100 mm.

b) Perforations in pipes shall be between 10 mm to 15 mm diameter with a total area of 10,000 mm^2 per metre length.

c) Pipes shall be laid horizontally.

5.5.9 *Pressure dosed systems*

For pressure dosed systems, the dosing arrangement shall be automatic. The volume of a single dose shall always be less than the sum of the volume within the distribution system plus one fifth the trench volume.

5.6 Biofilters

5.6.1 *General*

a) Biofilters may be used to treat septic tank effluent for discharge to surface drains or as a secondary treatment step prior to further treatment and effluent reuse.

b) This code recommends the use of upflow anaerobic filters for the secondary treatment of septic tank effluent. This is due to their robust reliability and low-maintenance requirements.

c) Aerobic biofilters may be used provided special provisions are made for the regular disposal of secondary sludge produced by the aerobic process. The design of such systems is outside the scope of this code and they should be done on a case-by-case basis by a competent environmental professional.

d) Anaerobic filters shall be contained within tanks which are water-tight and structurally capable of withstanding internal and external water pressures and external soil pressure (in the case of buried tanks) together with any anticipated imposed loads.

5.6.2 *Applicability*

a) Anaerobic biofilters may be used wherever septic tanks are used and further treatment of septic tank effluent is required provided the soil is capable of bearing the weight of the filter.

b) Where discharging directly to a drain, the drain shall be of sufficient size and capacity to carry the discharge flow without stagnation of effluent in the vicinity.

5.6.3 *Location*

Anaerobic biofilters may be located above or below ground and may be buried under car parks, driveways, terraces etc., provided due consideration is given to the structural integrity of the filter tank and other adjacent features.

5.6.4 *Geometry*

a) Anaerobic biofilters are usually rectangular in plan. However other shapes (e.g. circular, square etc.) may be used provided adequate distribution of flow across the filter is achieved.

b) Anaerobic biofilters may be designed as separate units or as an integral part of a multiple chamber septic tank.

A typical anaerobic biofilter arrangement is shown in Appendix **H.**

5.6.5 *Dimensions*

a) Anaerobic filters shall be sized based on design hydraulic retention time (HRT), where

HRT (days) = Volume of filter bed (m^3) / Average daily flow (m^3/day).

b) The minimum design HRT shall be 0.6 days and the maximum shall be 1.5 days.

c) For filters in series, the total HRT of all the filters in series may exceed 1.5 days provided the HRT of each individual filter in the series is between 0.6 days and 1.5 days.

d) For filters discharging directly to surface drains, an HRT greater than 1 day is recommended.

e) The surface area (plan area) of an anaerobic filter shall be such that the surface loading rate is less than 2.8 m/day, where

$$\text{Surface loading rate (m/day)} = \frac{\text{Average daily flow } (m^3/\text{day})}{\text{Plan area of filter } (m^2)}$$

5.6.6 *Filter material*

a) Gravel, crushed stone, plastic or any other suitably inert material may be used provided it is insoluble in water and resistant to the corrosive nature of septic tank effluent and the anaerobic environment within the filter.

b) The minimum nominal size of filter material shall be 2 mm.

c) The material shall have an overall minimum ratio of 35 per cent of total void space to bulk volume. i.e.

$$\frac{\text{Total volume of void space in the bed}}{\text{Volume of the bed}} > 35 \text{ per cent}$$

d) The height of the filter bed shall be between 0.6 m and 1.8 m. Bed heights in excess of 1.8 m may be used in the case of plastic or similar material which is lighter than water (i.e. density < 1000 kg/m^3).

5.6.7 *Flow distribution*

a) A suitable arrangement shall be made to ensure adequate distribution of flow across the filter bed.

b) A perforated filter floor, perforated distributor pipes or purpose designed distributor heads may be used for flow distribution. Perforations shall be at least 10 mm diameter.

c) In the case of a perforated filter floor, a minimum clearance of 200 mm shall be provided between the bottom of the tank and the filter floor.

5.6.8 *Inlet and outlet arrangements*

a) The inlet to an anaerobic biofilter shall be at least 100 mm diameter.

b) The outlet shall be at least 50 mm diameter.

c) The invert of the outlet shall be at least 50 mm below the invert of the inlet.

d) A tee, elbow or baffle fitting shall be provided at the outlet to prevent scum carry out from the filter.

e) Where plastic or other buoyant media is used, appropriate provisions shall be made to prevent material from washing out through the outlet pipe.

5.6.9 *Access opening*

a) One or more access openings shall be provided at the discretion of the designer.

b) Openings maybe circular, square or rectangular. Circular access openings shall be at least 500 mm in diameter. Square or rectangular openings shall have a minimum minor dimension of 500 mm.

c) Openings shall be provided with a suitable cover to prevent the ingress of surface and ground water into the tank.

d) In the case of anaerobic filters to be built as an integral part of a septic tank unit, an access opening of the septic tank may satisfy this requirement, provided the maintenance activity described in **9.2** could be performed effectively through this access opening.

5.6.10 *Freeboard*

A minimum freeboard of 200 mm shall be provided between the liquid level and the tank ceiling.

5.6.11 *Vent pipe*

a) The filter chamber shall be properly vented. A vent pipe of minimum 25 mm diameter shall be provided with a suitable mosquito proof mesh at the top for this purpose.

b) The height of the pipe shall be sufficient to avoid odour nuisance.

c) Where a separate inlet chamber is used the inlet chamber shall be vented as well. A single vent pipe is sufficient provided a contiguous volume of air exists above all the chambers in the tank. If not, multiple vent pipes shall be provided to ensure each chamber of the tank is vented.

5.7 Constructed wetlands

5.7.1 *General*

a) Constructed wetlands may be used as follows:

i. As a secondary treatment step to treat septic tank effluent prior to discharge to surface drains or surface water bodies;
ii. As a tertiary treatment step to further treat anaerobic filter effluent prior to effluent re-use for gardening, toilet-flushing, landscaping etc; and
iii. Unlined constructed wetlands may be used for secondary treatment of septic tank effluent prior to partial soakage of effluent into the surrounding soil with the balance discharging to surface drain.

b) This code specifies the exclusive use of subsurface flow constructed wetlands, (i.e. where the entire flow occurs below the surface of the wetland bed) in order to avoid breeding of mosquitoes, flies etc.

c) The flow in the beds may be horizontal, vertical or a combination of both (mixed flow).

d) Wetland beds shall be contained within impermeable sidewalls which are capable of withstanding internal and external water pressures, external soil pressure and any other reasonable load.

e) The wetland bed shall be lined with an impermeable lining along the wetted perimeter of the bed section including the bottom and sides. The bottom shall be left unlined only in unlined constructed wetlands.

f) Constructed wetlands may be either gravity fed or pressure dosed at intervals using a sump and pump arrangement.

A typical horizontal flow wetland arrangement is shown in Appendix **J** and a typical vertical flow wetland arrangement is shown in Appendix **K**.

5.7.2 *Applicability*

a) Constructed wetlands are applicable for the treatment of septic tank or anaerobic filter effluent wherever sufficient space is available. However, constructed wetlands require a minimum level of regular maintenance to maintain the vegetation in the beds. Therefore discretionary judgement shall be used in applying them only to situations where such a level of maintenance activity by the users of the system may be considered likely.

b) Unlined constructed wetlands shall be applicable only where the seasonal high groundwater table is below the bottom of the bed in the case of vertical flow beds, and greater than 1 m below the bottom of the bed in the case of horizontal flow beds.

5.7.3 *Location*

Constructed wetlands shall be located in an open area at least 2 m away from the nearest building.

5.7.4 *Geometry*

a) Horizontal flow wetlands shall be rectangular in plan.

b) Vertical and mixed flow wetlands may be of any convenient shape in plan, provided adequate distribution of flow over the bed is achieved.

5.7.5 *Dimensions*

a) The surface area (plan area) of a constructed wetland shall be such that the minimum specific area requirements in Table **8** are satisfied.

Where Specific area (m^2/m^3.day) = plan area of bed (m^2)/ average daily flow (m^3/day)

TABLE 8 - Minimum specific areas for constructed wetlands

Wetland type	**Minimum specific area (m^2 / m^3 .day)**
Horizontal flow – secondary	1.8
Horizontal flow – tertiary	0.6
Vertical flow – secondary	2.5
Vertical flow – tertiary	0.9

NOTES

1. *Secondary implies wetlands receiving septic tank effluent directly and tertiary implies wetlands receiving septic tank effluent which has already been treated in a biofilter or secondary wetland.*

2. *For wetlands treating only kitchen wastewater from hotels and restaurants a value of 4.5 m^2/m^3.day shall apply for vertical flow tertiary wetlands and a value of 3 m^2/m^3.d shall apply for horizontal flow tertiary wetlands. Secondary wetlands are not recommended for this case.*

b) The minimum depth of a wetland bed shall be 600 mm.

c) For horizontal flow wetlands, the maximum length of a bed shall be 12 m, and the width shall be between 1.0 m and 2.5 m.

d) The maximum water level in the bed shall be at least 50 mm below the bed surface.

5.7.6 *Aggregate*

a) Sand, gravel, stone chips or any other suitable inert material which is insoluble in water and resistant to the corrosive nature of septic tank effluent may be used as aggregate.

b) The minimum depth of aggregate in the bed shall be 600 mm.

c) The nominal aggregate size shall be greater than 2 mm.

5.7.7 *Type of wetland vegetation*

a) It is recommended that edible plants are not be used as wetland vegetation.

b) Any plant may be used to vegetate constructed wetlands, provided they have a dispersed root structure and the roots are not likely to damage the bed liner or side walls.

c) Some suggested plant species may be common Reed (*Phragmites spp.*), Sedges (*Scirpus spp.)*, Bullrush (*Thypa spp.*), Dwarf Bamboo, Ornamental Herbaceous Plants (*Cannas spp., Coleus spp.*)

d) Plants with deep tap roots or roots that form large tubers, yams and the like shall not be used for wetland vegetation.

e) Plants shall initially be spaced at a minimum of 1 m intervals and shall be shaded from strong sun until properly established.

5.7.8 *Inlet and outlet arrangements*

a) Any suitable inlet arrangement may be used, provided adequate distribution of flow across the bed is achieved.

b) The outlet arrangement shall be such that the maximum water level in the bed does not exceed that specified in **5.7.5** above.

c) Provision shall be made for the bed to be drained when required.

5.7.9 *Freeboard*

A minimum freeboard of 100 mm shall be provided above the aggregate surface in the bed.

5.7.10 *Pressure dosed systems*

a) For pressure dosed systems, the dosing arrangement shall be automatic.

b) The volume of a single dose shall always be less than the sum of the volume within the distribution system plus one fifth the bed volume.

5.8 Percolation beds

5.8.1 *General*

a) Percolation beds may be used as a tertiary treatment step for treatment of anaerobic filter effluent or secondary constructed wetland effluent prior to reuse of effluent for toilet-flushing, gardening, landscaping etc. or discharge to a surface water body.

b) Percolation beds shall be lined on the bottom and sides with an impermeable liner.

c) Percolation beds may be gravity fed or pressure dosed.

A typical arrangement of a percolation bed is shown in Appendix **L.**

5.8.2 *Applicability*

Percolation beds are applicable in cases where tertiary treatment of septic tank effluent is required and constructed wetlands cannot be used for the purpose.

5.8.3 *Location*

Percolation beds may be located below ground under car parks, garages, driveways, terraces, etc.

5.8.4 *Geometry*

Percolation beds are usually rectangular in plan. However other shapes may be used provided adequate distribution of flow over the bed is achieved.

5.8.5 *Dimensions*

Sizing of percolation beds shall based on minimum specific area of 1.2 m^2/m^3.d. where,
Specific area (m^2/m^3.d) = plan area of bed (m^2)/ average daily flow (m^3/d)

5.8.6 *Aggregate*

a) Sand, gravel, stone chips or any other suitable inert material which is insoluble in water and resistant to the corrosive nature of septic tank effluent may be used as aggregate.

b) The minimum depth of aggregate in the bed shall be 300 mm.

c) The nominal aggregate size shall be greater than 2 mm.

5.8.7 *Inlet and outlet arrangements*

a) The inlet to the percolation bed shall have a minimum diameter of 50 mm.

b) The influent shall be distributed over the bed through perforated distributor pipes.

c) The maximum spacing between distributor pipes shall be 1 m.

d) The effluent from the bed shall be collected through a system of under drains or perforated collector pipes.

e) The minimum diameter of the outlet pipe shall be 50 mm.

5.8.8 *Draft tubes*

a) A series of horizontal perforated draft tubes shall be provided at intervals not exceeding 1.5 m along the bed to ventilate the bed.

b) The draft tubes shall be connected to a pipe of minimum 25 mm diameter extending above the ground surface in a manner which allows air to enter the draft tubes.

5.8.9 *Soil cover*

a) A minimum depth of 100 mm of soil backfill shall be provided above the bed.

b) An effective soil barrier such as a reverse filter arrangement, filter cloth, appropriate geotextile or polyethylene liner shall be provided at the base of this soil layer to prevent infiltration of soil into the bed.

5.8.10 *Pressure dosed systems*

For pressure dosed systems, the dosing arrangement shall be automatic.

The volume of a single dose shall always be less than the sum of the volume within the distribution system plus one fifth of the bed volume.

6 MATERIALS AND CONSTRUCTION

6.1 General

As the treatment process in septic tanks and anaerobic filters is anaerobic, a certain amount of hydrogen sulphide (which is a corrosive gas) will be generated. While this can be controlled to a certain extent by proper ventilation, the designer should make every possible effort to specify materials suitable for these conditions. Further, all materials used to manufacture septic tanks and their fittings shall have a serviceable life of at least 15 years.

6.2 Tanks

a) Septic tanks and anaerobic biofilters may be constructed in-situ in reinforced concrete, lined brick masonry or lined cement block masonry. Alternatively, they may be pre-cast in reinforced concrete, steel, glass fibre or Polyethylene.

b) Brick masonry shall not be used in situations where the tank would be either wholly or partly below the seasonal high groundwater table. However, cement block masonry may be used in such cases.

c) Materials used in the construction of tanks, such as cement, reinforcing steel, aggregate, etc., shall conform to the relevant Sri Lanka Standards where applicable.

6.3 Soakage pits

The walls of soakage pits shall be constructed with open jointed brick or open jointed cement block masonry or perforated concrete and left unlined in the main. However, walls shall be lined and made impervious up to an appropriate distance from the top of the soakage pit in order to prevent ingress of surface water into the pit, where necessary.

6.4 Aggregate media

Aggregate media in anaerobic filters, seepage beds, seepage trenches, constructed wetlands and percolation beds shall be immersed in water and washed to make free of fines and debris prior to placing in the beds.

a) Where a minimum size of aggregate has been specified, all aggregate shall be sieved through a sieve with the appropriate mesh size and only aggregate retained in the sieve shall be used.

b) Due care shall be taken when placing aggregate to avoid damage to sidewalls, trench / bed bottoms, liners and pipework.

6.5 Excavation

Excavation   for seepage beds and trenches shall be done with due care to avoid damaging and / or compacting the surrounding soil.

Damages may by caused by

i. Smearing – where the soil surface is smoothed, filling cracks and pores.
ii. Compacting – where the soil porosity is reduced.
iii. Puddling – where washed clay settles on the base of the trench / bed.

The guidelines given here shall be followed for excavation of seepage beds and trenches to reduce the risk of damage to the soil.

a) Plan to excavate only when the weather is fine.

b) During wet seasons or when construction cannot be delayed until weather becomes fine, smeared soil surfaces shall be raked carefully with a fine-tined rake to restore a more natural soil surface. Care shall be taken to rake only at the surface.

c) Avoid excavation when soil has a moisture content above the plastic limit. If the soil forms a “wire” when rolled between the palms, it is generally above the plastic limit.

d) When excavating by machine, use a bucket with “raker teeth” and excavate in small “bites” to minimize compaction.

e) Avoid compaction by keeping people off the finished trench or bed floor.

f) If rain is likely, cover any open trenches to protect them from rain damage.

g) Excavate parallel to the contours of sloping ground, wherever possible.

h) Ensure that trench or bed bottoms are horizontal.

j) Divert all surface water well away from excavations.

6.6 Liners

a) Two layers of type 1000 polyethylene sheets or appropriate geotextile may be used wherever impermeable liners are specified in this code.

b) Such sheets could be joined as follows :

i. by placing the two ends of adjacent sheets together and folding over repeatedly 3 – 4 times to form a neat 'hem' of at least 50 mm width;

ii. the hem shall be stapled at 500 mm intervals; and

iii. the minimum distance between adjacent joins shall be 1500 mm.

c) Alternatively, a commercially produced geomembrane liner may be used and shall be installed according to the manufacturers' specifications.

d) The bottom and sides of the bed to be lined shall be cut to grade, and cleared of all debris, stones and plant roots which may damage or puncture the liner.

e) The liner shall be laid on a layer of sand, of minimum 25 mm thickness, placed on the bottom of the bed or trench. A similar layer of sand shall be placed on top of the liner prior to placing aggregate in the bed.

6.7 Pipework

All pipes, fittings, sealers and solvents used shall conform to the relevant Sri Lanka Standards where applicable and installed according to the manufacturers' recommendations.

6.8 Wetland Vegetation

See **5.7.7** for wetland vegetation.

7 INSPECTION AND TESTING

All systems shall be inspected for structural defects and constructional defects. All such defects detected shall be repaired and rectified to satisfy the original requirements prior to commissioning the system and conformity with design satisfaction prior to commissioning.

In addition, the following pre-commissioning tests shall be performed.

7.1 Water tightness

All septic tanks and biofilter tanks shall be tested for water-tightness and leaks as follows:

Step 1

Once construction and installation has been completed, empty any water in the tank and clean the tank, making sure to clear the tank bottom of any construction debris, mud, clay, sand etc. and brush the tank walls and bottom thoroughly with a stiff bristled brush. Close the tank and let it stand for 24 hours;

Step 2

Inspect the tank walls and bottom for any signs of water leaking in. If evidence of leaks exist, repair as necessary and repeat steps 1 and 2 prior to proceeding to step 3;

Step 3

Fill all chambers of the tank up to the liquid level and let it stand for 24 hours; and

Step 4

Check for any drop in the water level. If there is a drop in the water level, top up to the liquid level and re-check after a further 24 hours. If the drop in level persists, empty the tank and repair or replace as necessary and repeat step 3 and step 4.

7.2 Partition test.

All multiple chambered septic tanks and biofilter tanks shall be subject to the following test after satisfying the water tightness test in **7.1** above:

Step 1

Fill only one side of each partition wall with water up to the level of the lowest opening in the partition wall. Keep the other side empty, and let stand for 24 hours; and

Step 2

Inspect the partition wall for cracks or other structural damage. If water has leaked to the other side, the depth of such water shall be less than 250 mm.

7.3 Flow-through test for Biofilters

All biofilters shall be tested as follows after checking for watertightness according to **7.1**:

Step 1

The filter shall be filled with water up to the liquid level and a continuous flow of clean water shall be applied to the inlet of the biofilter tank. The flow rate applied shall be six times the average daily flow to the filter.

For combined septic tank-filter units, the flow shall be applied to the septic tank inlet or the first compartment of the septic tank. For biofilters with separate inlet chambers the flow may be applied directly to the inlet chamber ; and

Step 2

The flow shall be sustained continuously for a period of 30 minutes after the full flow appears from the outlet of the filter.

During the 30-minute test period, the water level in all chambers of the tank shall be below the invert level of the inlet to the tank. At the end of the test, filter media shall not be permanently displaced or dislodged from the bed.

7.4 Flow distributor test for pressure dosed systems

a) All pressure dosed seepage beds, seepage trenches, constructed wetlands and percolation beds shall be tested as follows after all on-site components, including the pump, float switches etc., have been installed, but prior to covering the effluent distribution system in the trench or bed.

b) Fill the sump with water up to the ‘pump on’ level, start the pump and allow to run until the level in the sump drops to the ‘pump off’ level.

c) Inspect the effluent distributor network and ensure water flows uniformly from all perforations.

d) Inspect the pumping line and ensure that there are no leaks.

7.5 Flow-through test for constructed wetlands and percolation beds

All constructed wetlands and percolation beds shall be tested as follows:
a) Apply a continuous flow of water to the inlet of the bed. In the case of pressure dosed systems, this shall be applied to the dosing sump and allow the dosing pump to operate as normal;

b) The applied flow rate shall be equal to three times the average daily flow to the bed;

c) The flow shall be maintained for 30 minutes after the full flow appears at the outlet of the bed;

d) The water level at all points in the bed shall be below the bed surface throughout the test period; and

e) In above ground systems, check for leaks through and under the sidewalls and repair as necessary.

8 COMMISSIONING

a) All septic tanks, anaerobic filters and constructed wetlands shall be filled up to the liquid level with water prior to commissioning.

b) It shall be noted that septic tanks, anaerobic filters, constructed wetlands and percolation beds all rely mainly on biological processes which may take up to six to eight weeks to reach full functioning capacity. Due consideration shall be given to allow adequate time for the system to “mature” before reaching operational levels of performance, particularly in the case of surface discharge and effluent reuse systems.

c) Septic tanks and anaerobic filters may be ‘seeded’ to accelerate the start-up of the process in the tanks.

d) Seeding shall be done by adding a small quantity (up to one fifth the working capacity of the tank) of digesting sludge from a functioning septic tank, or fresh cow dung slurry or pig slurry. The ‘seed’ shall be added to the first chamber of the tank, in the case of a multiple chambered septic tank, or the inlet chamber of an anaerobic filter in the case of an anaerobic filter.

e) Seeding shall be considered mandatory for septic tanks receiving only kitchen wastewater from restaurants and hotels.

f) Vegetation shall be properly established in constructed wetland beds prior to commissioning.

9 MAINTENANCE

Appropriate and timely maintenance is the key to the successful continued function of any system and due care and attention shall be given to inform and educate users and owners of septic tanks and associated effluent disposal systems of all the routine maintenance requirements of their system.

9.1 Septic Tanks

9.1.1 *Desludging*

a) Septic tanks shall be desludged at the appropriate intervals according to the design and use of the tank. Typically, this is when the tank is between one third and one half full of sludge and / or scum.

b) The depth of sludge and scum in a septic tank can be effectively measured using the ‘white towel’ test described in Appendix **M**.

c) Tanks should not be completely emptied during desludging. Between 100 mm – 150 mm of sludge should be left in the bottom of the tank as ‘seed’ for the next cycle of operation.

d) Septage from desludged septic tanks shall be either disposed in a facility intended for that purpose, such as a sewage treatment plant, or where no such facility is available, shall be buried in a pit with due care being taken not to pollute the local groundwater and the neighbouring environment.

9.1.2 *Access covers*

a) All access covers shall be properly replaced and sealed after each opening.

b) Broken and damaged access covers shall be promptly repaired or replaced.

9.1.3 *Mosquitoes*

Septic tanks are a prime breeding location for mosquitoes. Due care shall be taken to ensure that tanks are properly sealed, with particular attention being given to prompt repair of structural cracks which allow mosquitoes to enter the tank. The mosquito-proof mesh cover over vent pipes shall be inspected regularly and replaced as required.

9.1.4 *Blockages*

The most common form of blockage is due to solids blocking the inlet device in a septic tank. This may be cleared by rodding the inlet device from above (through an access opening or inspection port) with a suitably flexible rod.

9.1.5 *Anaerobic filters*

Anaerobic filters do not require regular maintenance as such. However an annual inspection is recommended. Bubbles forming at the filter surface are an indicator of a filter which is functioning well.

9.1.6 *Filter cleaning*

a) The most common cause of filter backup is due to gas blockages caused by expanding gas bubbles as they move up through the filter bed. These may be cleared by rodding the filter bed from above with an appropriate rod to release the trapped gases.

b) If rodding is not sufficient to clear the filter, the filter shall be emptied by pumping out the contents from the inlet chamber. If a layer of scum is present on the surface of the filter this shall be removed prior to emptying. The empty filter bed shall then be sprayed from above with water until a continuous flow of water appears from the bottom of the bed. A simple garden hose may be used for the purpose.

c) The cleaned filter shall be filled with water up to the liquid level prior to re-commissioning.

d) Anaerobic filters should not be backwashed under pressure in the manner of rapid sand filters as this would dislodge the biofilm growth on the filter media.

9.1.7 *Constructed wetlands*

a) The vegetation in constructed wetlands shall be maintained as required to ensure continuous vegetative cover in the bed. Lack of proper vegetative cover will cause surface clogging of the bed.

b) In the event surface clogging does occur, the bed shall be drained and the bed surface prodded at regular intervals (typically 100 mm intervals) with a stick, until the clogging is released and all water ponded on the surface of the bed has drained out.

c) Proper vegetative cover shall be re-established prior to re-commissioning the bed.

APPENDIX A
PERCOLATION TEST

A.1 Whenever soil absorption of septic tank effluent is considered a percolation test shall be performed as follows prior to the design of a soil absorption system.

A.2 The percolation test shall be carried out at the location where the soil absorption system is to be installed. In cases where this is uncertain, several percolation tests at likely locations shall be performed.

A.3 A square or circular hole of size (or diameter) between 100 mm – 300 mm shall be dug or bored up to the depth where soakage is to take place. A larger hole may be dug up to the depth required prior to digging the specified hole in order to facilitate access to conduct the test.

A.4 The bottom and sides of the hole shall be carefully scraped with a fine tined fork to remove any smeared soil and restore a natural soil surface.

A.5 All loose materials shall be removed from the bottom of the hole and fine gravel or coarse sand of nominal size approximately 6 mm placed at the bottom to a depth of 50 mm.

A.6 The hole shall then be filled with water up to a depth of 300 mm above the gravel layer and let stand for 24 hours.

A.7 After 24 hours, the water level in the hole shall be adjusted to 150 mm above the gravel layer, and the drop in water level over a 30 minute period shall be measured.

A.8 The percolation rate shall be calculated as follows.

Percolation rate (mm/h) = drop in water level (mm) / (0.5 h)

A.9 Where there is no water remaining in the hole after step **A.6**, water shall be added to the hole up to a level 150 mm above the gravel layer and the drop in water level measured at 30 minute intervals over a period of 4 hours, topping up the level to 150 mm after each measurement. The drop in water level over the final 30 minute period shall be taken to calculate the percolation rate.

A.10 Where the water in the hole drains out completely, within the 30 minute measurement period, the soil percolation rate exceeds 300 mm/h, and is unsuitable for soakage of septic tank effluent.

APPENDIX B
EXAMPLE COMPUTATIONS OF AVERAGE DAILY FLOW BASED ON TABLE 1

Example 1:
For an office building with 50 day-time employees, 6 overnight employees and 200 customers / day, the average daily flow would be computed as follows

Average daily flow (all waste) = 50 day-time employees x 50 l/p/day
+
6 overnight employees x 200 l/p/day
+
200 customers x 10 l/p/day.

= **5700 l/day**

Average daily flow (blackwater) = 50 day-time employees x 30 l/p/day
+
6 overnight employees x 50 l/p/day
+
200 customers x 5 l/p/day

= **2800 l/day**

Average daily flow (greywater) = 50 day-time employees x 20 l/p/day
+
6 overnight employees x 150 l/p/day
+
200 customers x 5 l/p/day

= **2900 l/day**

Example 2:
For a hotel building with 20 rooms, 12 residential staff, 8 non-residential staff, serving a maximum of 400 meals/day, the average daily flow would be computed as follows

Average daily flow (all waste) = 20 rooms x 2 guests / room x 240 l/p/day
+
8 non-residential staff x 100 l/p/day
+
12 residential staff x 200 l/p/day
+
400 meals/day x 15 l/meal.

= **18,800 l/day**

Average daily flow (blackwater) = 20 rooms x 2 guests/room x 60 l/p/day
+
8 non-residential staff x 50 l/p/day
+
12 residential staff x 50 l/p/day

= **<u>3400 l/day</u>**

Average daily flow (greywater) = 20 rooms x 2 guests/room x 180 l/p/day
+
8 non-residential staff x 50 l/p/day
+
12 residential staff x 150 l/p/day
+
400 meals/day x 15 l/meal

= **<u>15,400 l/day</u>**

Example 3:
For a restaurant with 20 non-residential staff, 5 residential staff, serving a maximum of 150 dine-in meals / day and 100 take-away meals / day, the average daily flow would be computed as follows

Average daily flow (all waste) = 20 non-residential staff x 50 l/p/day
+
5 residential staff x 200 l/p/day
+
150 dine-in meals /day x 25 l/meal
+
100 take-away meals / day x 15 l/meal

= **<u>7250 l/day</u>**

Average daily flow (blackwater) = 20 non-residential staff x 30 l/p/day
+
5 residential staff x 50 l/p/day
+
150 dine-in meals /day x 10 l/meal

= **<u>2350 l/day</u>**

Average daily flow (greywater) = 20 non-residential staff x 20 l/p/day
+
5 residential staff x 150 l/p/day
+
150 dine-in meals /day x 15 l/meal
+
100 take-away meals / day x 15 l/meal

= **<u>4900 l/day</u>**

APPENDIX C
DETERMINATION OF WORKING CAPACITY OF SEPTIC TANKS

C.1 The working capacity of a septic tank shall be the sum of the volumes required for settling, sludge digestion and sludge and scum storage and shall be estimated as follows.

C.2 The volume required for settling shall be calculated as follows.

$V_s = t_s .Q$

Where, V_s = volume required for settling (m^3)

Q = average daily flow of wastewater (m^3/day)

t_s = time required for settling (days)
= (1.5 – 0.3.logQ), (> 0.2) (days)

C.3 The volume required for sludge digestion shall be calculated as follows.

$V_d = q_s .t_d.p$

Where, V_d = Volume required for sludge digestion (m^3)

q_s = volume of fresh sludge per person per day (m^3/person/day)
= 0.001 m^3/p/d for allwaste or grey water
and = 0.00055 m^3/p/d for blackwater only

t_d = time required for sludge digestion (days)
= 33 days (for an ambient temperature of 20^0C)

p = population equivalent.
= Q (m^3/d)/ 0.2 (m^3/p/day) for allwaste
= Q (m^3/d)/ 0.05 (m^3/p/day) for blackwater
= Q (m^3/d)/ 0.15 (m^3/p/day) for greywater

C.4 The volume required for sludge storage shall be calculated as follows.

$V_{st} = r.p.n$

Where, V_{st} = volume required for sludge storage (m^3)

n = desludging interval (> 1) (years)

r = Volume of digested sludge per person per year (m^3/p/y)
= 0.04 m^3/p/y for allwaste or grey water
= 0.022 m^3/p/y for black water only

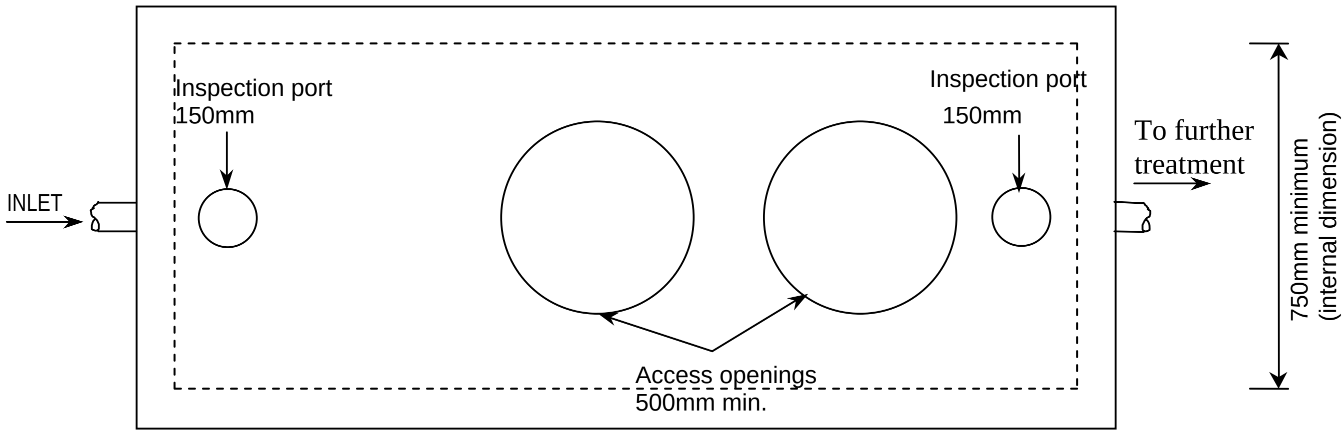
C.5 The volume required for scum storage shall be taken as $0.5V_{st}$.

C.6 Then the design working capacity of the septic tank shall be

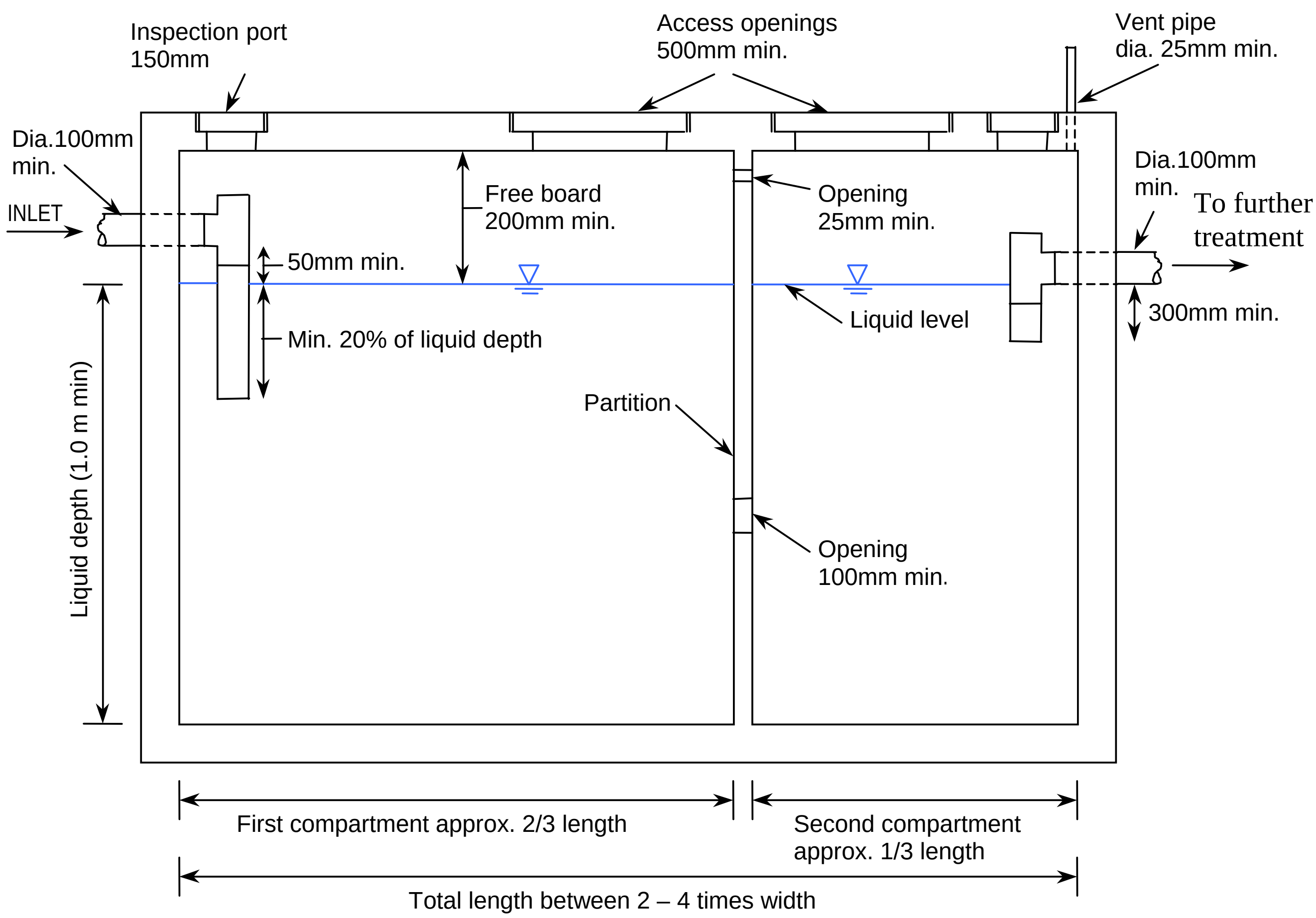
Required volume, $V = V_s + V_d + 1.5V_{st}$ (m^3)

APPENDIX D

TYPICAL SEPTIC TANK ARRANGEMENT



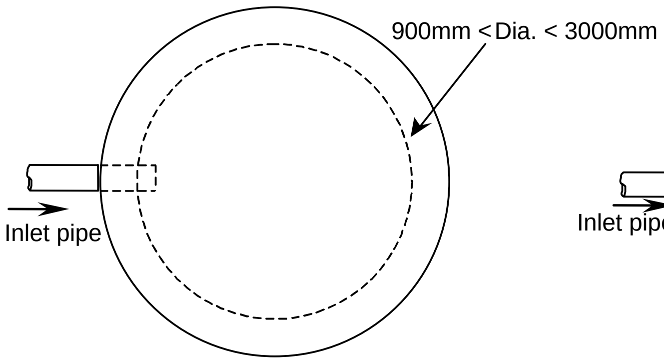
PLAN



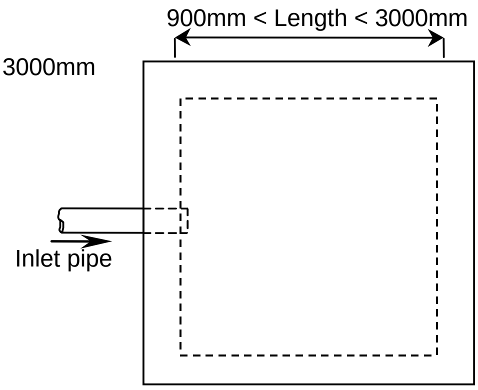
SECTION

APPENDIX E

TYPICAL SOAKAGE PIT ARRANGEMENT



PLAN (CIRCULAR TYPE)



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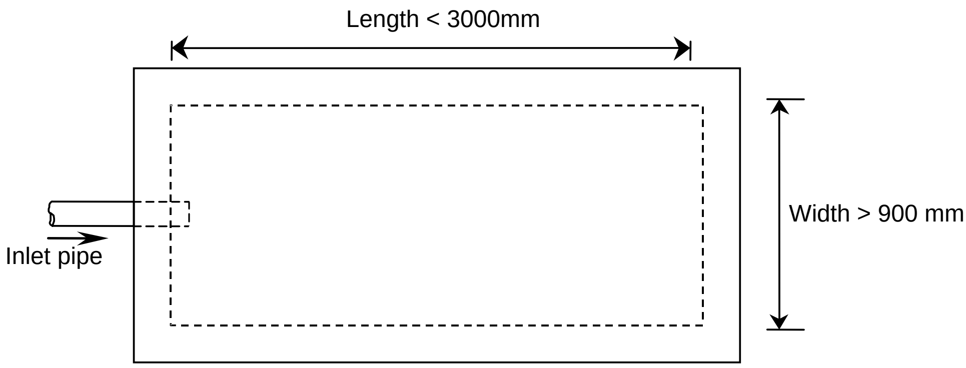
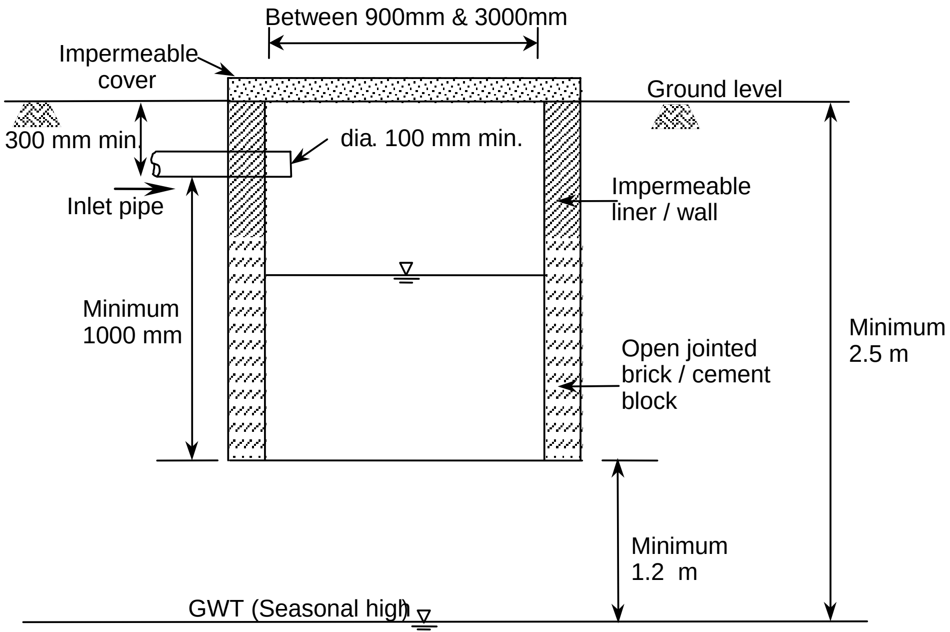


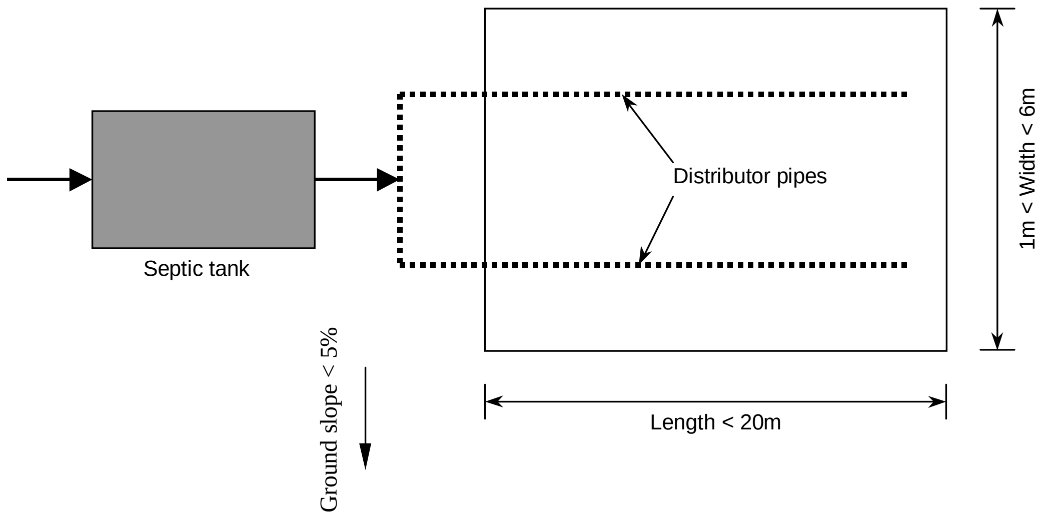
PLAN (RECTANGULAR TYPE)



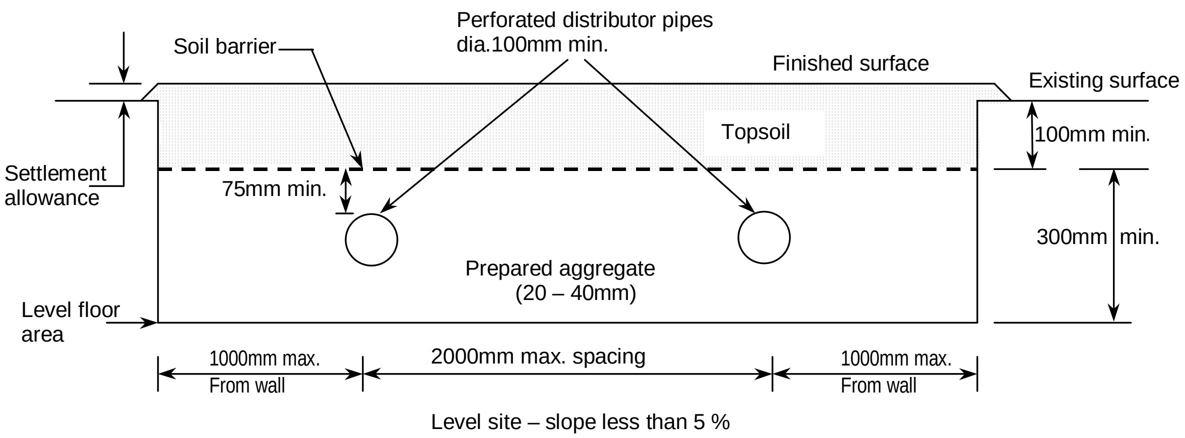
SECTION

APPENDIX F

TYPICAL ARRANGEMENT OF A SEEPAGE BED



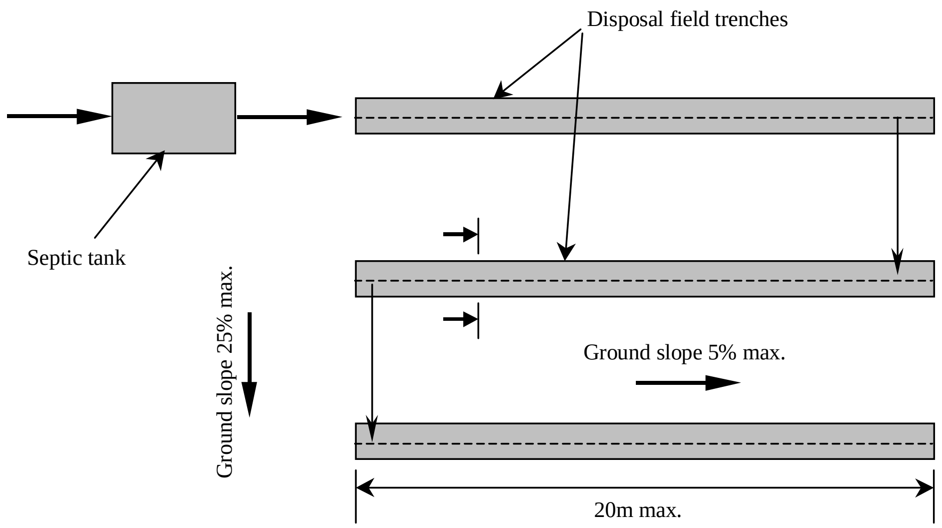
PLAN



SECTION

APPENDIX G

TYPICAL ARRANGEMENT OF A SEEPAGE TRENCH SYSTEM



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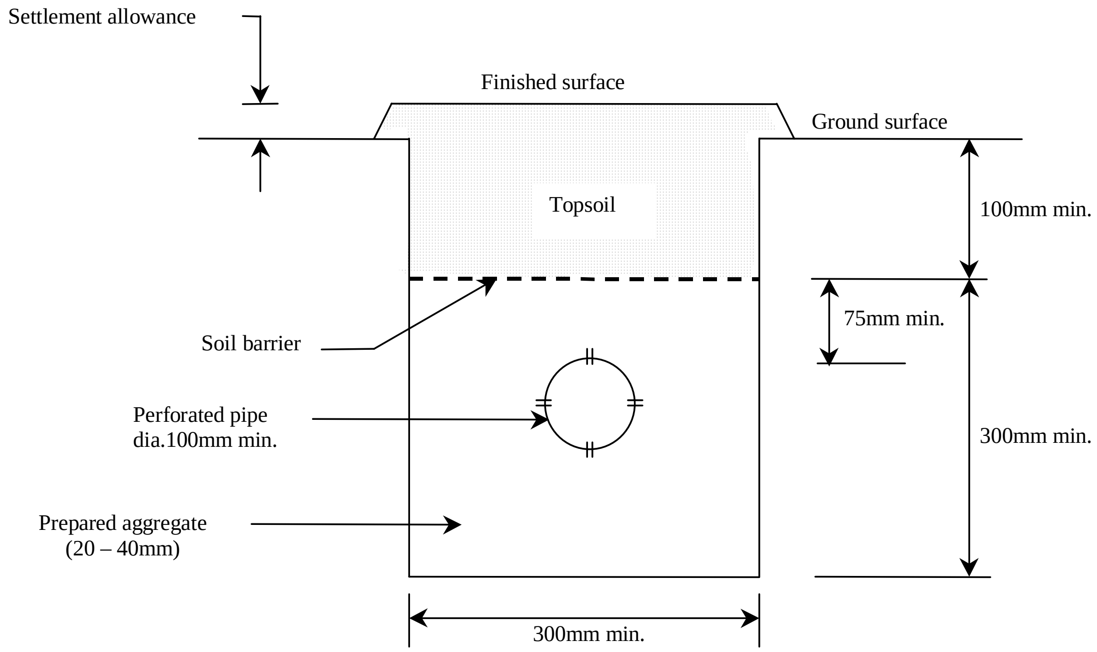
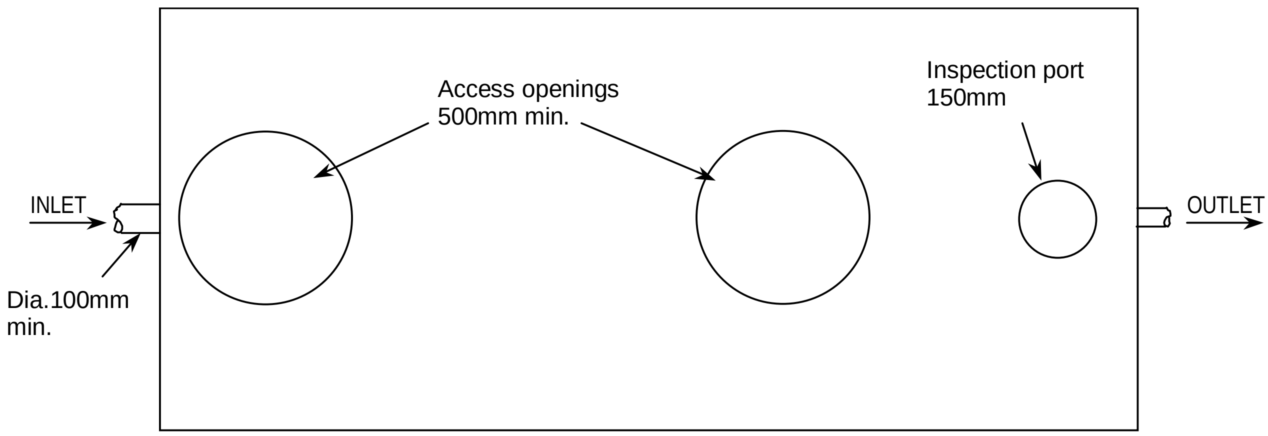


SECTION

APPENDIX H

TYPICAL ARRANGEMENT OF AN ANAEROBIC BIOFILTER



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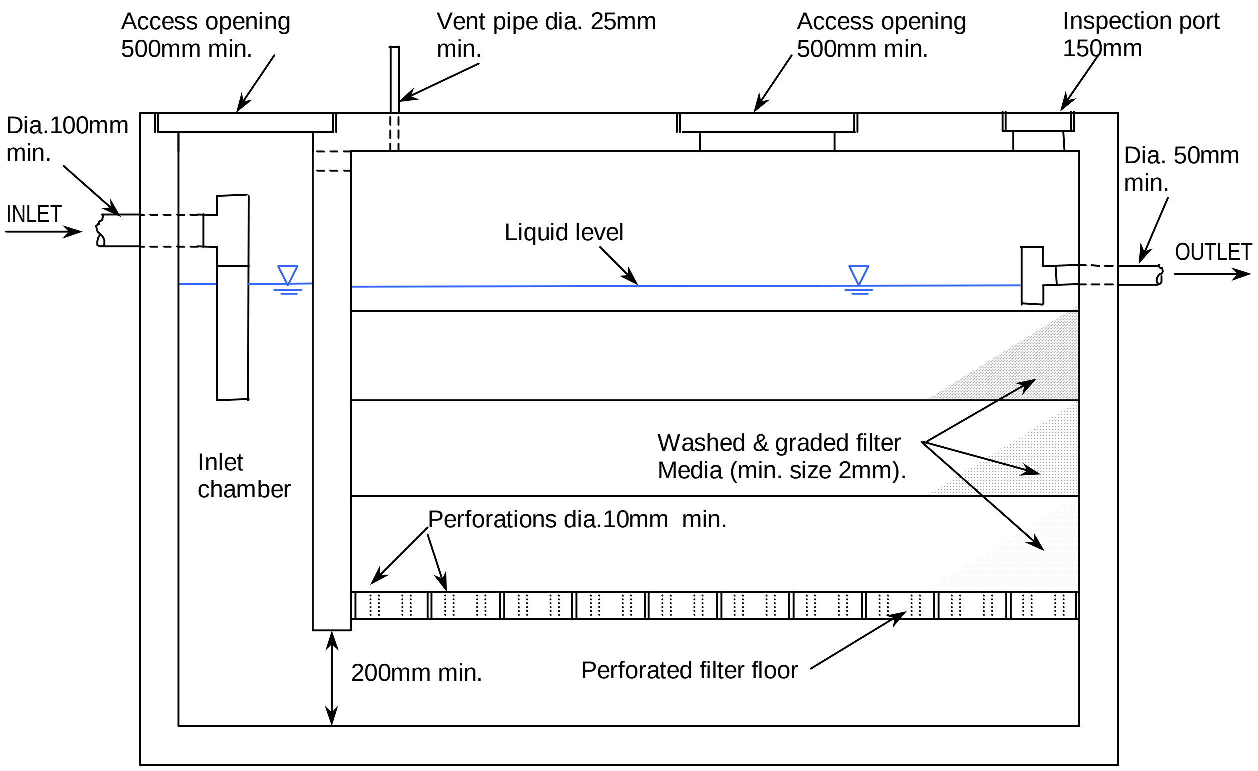
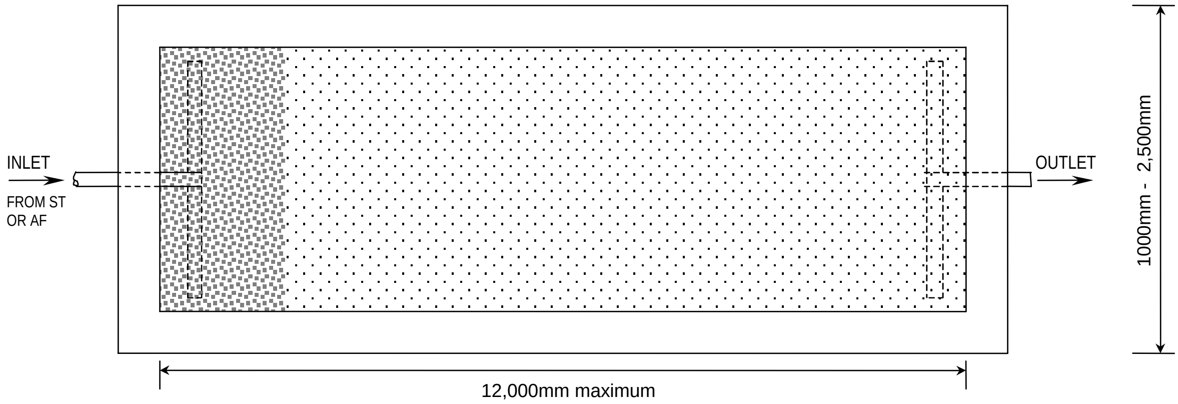


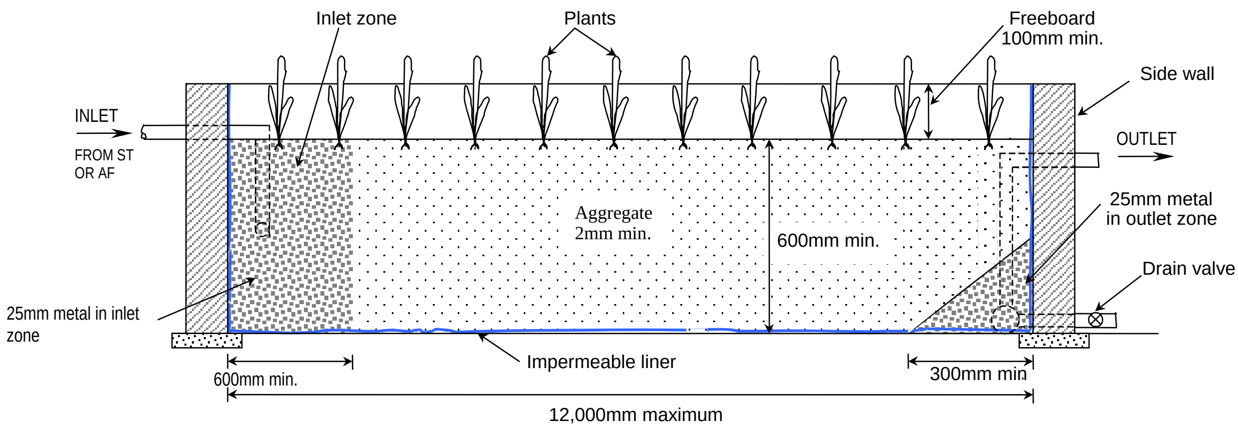
SECTION

APPENDIX J

TYPICAL ARRANGEMENT OF A HORIZONTAL FLOW CONSTRUCTED WETLAND



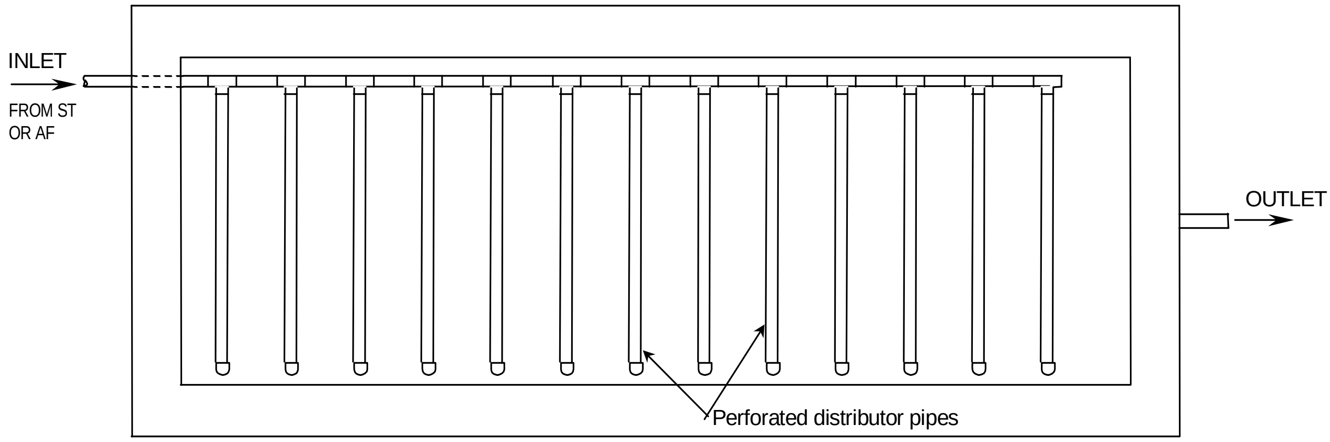
PLAN



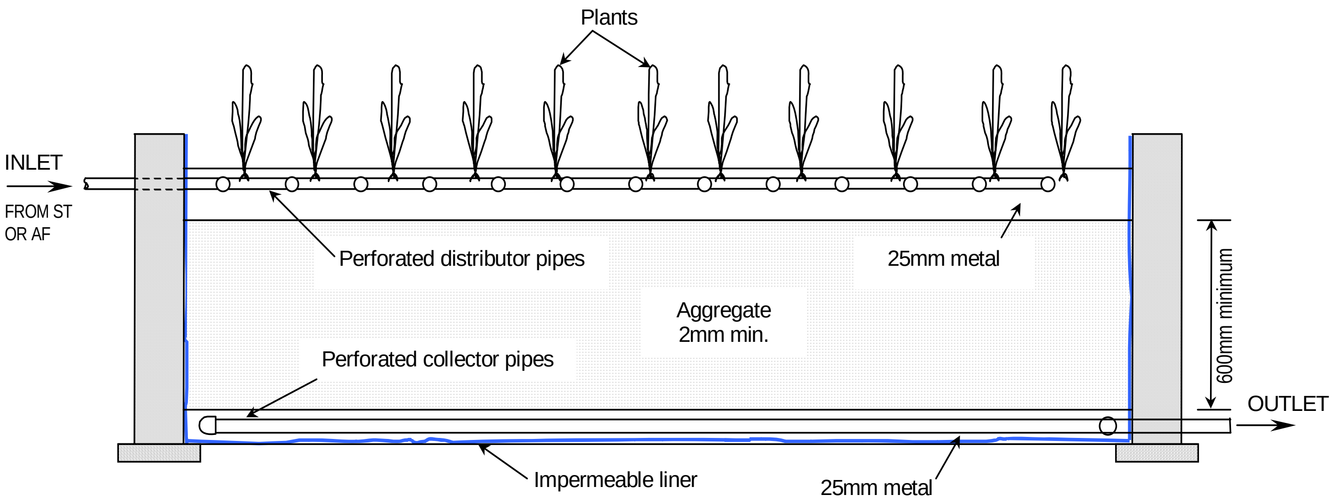
SECTION

APPENDIX K

TYPICAL ARRANGEMENT OF A VERTICAL FLOW CONSTRUCTED WETLAND



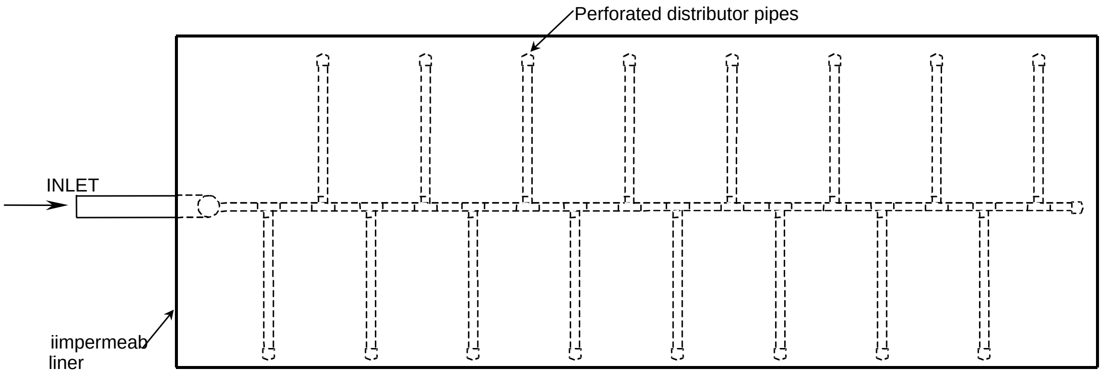
PLAN



SECTION

APPENDIX L

TYPICAL ARRANGEMENT OF A PERCOLATION BED.



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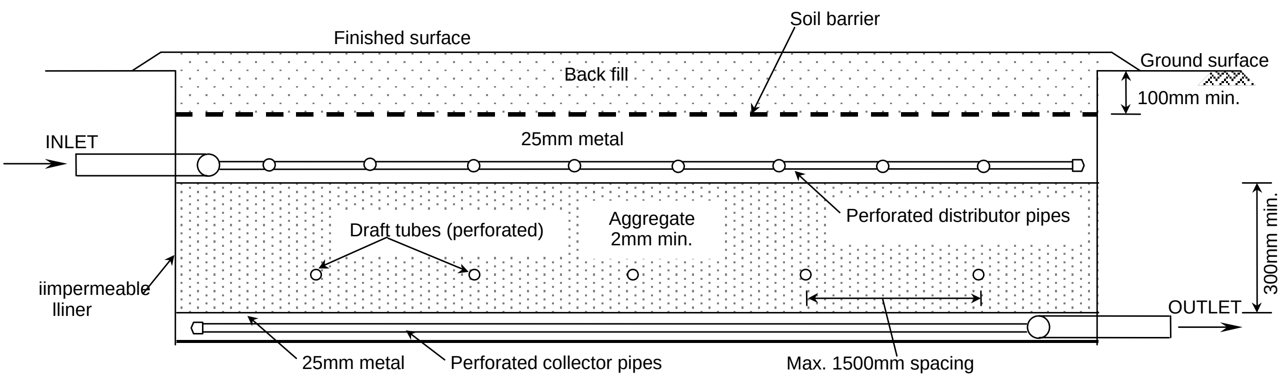

SECTION

APPENDIX M

WHITE TOWEL TEST FOR SEPTIC TANKS.

M.1 The scum depth in a septic tank may be measured as follows;

M.1.1 Insert a wire nail (approximately 100 mm long) perpendicularly into the end of a long pole or rod so that the nail protrudes horizontally when the pole is held vertical.

M.1.2 Lower the end with the nail carefully through the layer of scum in the septic tank. The pole should be lowered vertically until the nail is felt to break through the bottom of the scum layer.

M.1.3 With the nail below the bottom of the scum layer, rotate the pole through an angle of 90 degrees and slowly lift the pole upwards until resistance is felt.

M.1.4 Mark the position of the top of the scum layer on the pole.

M.1.5 Pull the pole out of the tank and measure the length between the mark and the nail. This is the depth of scum in the tank.

M2 The sludge depth in a tank may be measured as follows;

M.2.1 Wrap the end of a long pole with a light coloured towelling material up to 1.0 m – 1.5 m from the bottom of the pole.

M.2.2 Lower a pipe of 100 mm diameter (or greater), vertically into the septic tank until the end is resting on the bottom of the tank.

M.2.3 Remove any scum that may be inside the pipe and lower the pole wrapped in cloth vertically into the tank through the pipe until it reaches the bottom and pull out again.

M**.2.4** Lay the pole horizontally and measure the length from the bottom of the pole up to the point where there is no sludge adhering to the cloth. This length is equal to the depth of sludge in the tank.

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