RWANDA STANDARD

RS 143

Second edition

2019-09-13

Wastewater treatment systems — Design and construction of septic tanks and associated effluent disposal systems — Code of practice

ICS 13.030.40

Reference number

RS 143: 2019

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Foreword

Rwanda Standards are prepared by Technical Committees and approved by Rwanda Standards Board (RSB) Board of Directors in accordance with the procedures of RSB, in compliance with Annex 3 of the WTO/TBT agreement on the preparation, adoption and application of standards.

The main task of technical committees is to prepare national standards. Final Draft Rwanda Standards adopted by Technical committees are ratified by members of RSB Board of Directors for publication and gazettment as Rwanda Standards.

RS 143 was prepared by Technical Committee RSB/TC 09, *Civil engineering and building materials*.

In the preparation of this standard, reference was made to the following standard:

1) BS EN 1085:2007 *Wastewater treatment – Vocabulary*

2) ASTM D5879 – 95-18 *Standard Practice for Surface Site Characterization for On-Site Septic Systems*

The assistance derived from the above source is hereby acknowledged with thanks.

This second edition cancels and replaces the first edition RS 143: 2012, [Clause 2, Normative reference was revised and clauses; 7.1 was revised.)] of which have] been technically revised.

Committee membership

The following organizations were represented on the Technical Committee on *Civil engineering and building materials* (RSB/TC 09) in the preparation of this standard.

General Reliance Ltd

Rwanda Polytechnic (RP) - Musanze

JV CSC&EC(Property) and Fair Construction Ltd

Rwanda Public Procurement Authority (RPPA)

Rwanda Transport Development Authority (RTDA)

Standards for Sustainability (SfS)

University of Rwanda-College of Science and technology (UR-CST)

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Introduction

Septic tanks are widely used in Rwanda for the disposal of domestic wastewater.

At present, the urban and suburban population of Rwanda use septic tanks. However, unless a septic tank and associated effluent disposal system are properly designed and implemented, failures occur with consequent aesthetic nuisance, public health hazard and environmental pollution.

It is important that the requirements of the septic tank system be considered during the planning stage of any development.

This code of practice is therefore intended to serve as a guide for the design and construction of septic tanks and associated effluent disposal systems in Rwanda. It is intended for use by consultants, designers, manufacturers, certifying bodies, installers and regulators.

Wastewater treatment systems — Design and construction of septic tanks and associated effluent disposal systems

1 Scope

This Draft Rwanda standard gives technical aspects to be considered in the planning stages of wastewater control systems using septic tank systems and sets out the requirements for installation and operation of the systems.

This draft standard covers the design, construction, testing and maintenance of septic tanks for the disposal of domestic wastewater including all waste, black water and grey water 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 systems recommended are soakage systems for the disposal of septic tank effluent below ground (soakage pits, seepage trenches, and seepage beds) for the disposal of septic tank effluents

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

RS EAS 18-1, *Cements — Part 1: Composition, specification and conformity criteria for common cements*

RS EAS 18-2, Cement — Part 2: Conformity evaluation

RS EAS 148 (All parts), *Cements — Test methods*

RS EAS 94, *Burnt clay building blocks — Specification*

RS 107, *Building sand from natural sources — Specification*

RS EAS 54, *Burnt building bricks — Specification*

RS 144, *Concrete building blocks and bricks — Specification*

RS ISO 22965-2, *Concrete — Part 2: Specification of constituent materials, production of concrete and compliance of concrete*

RS ISO 1920 (All parts), *Methods of testing concrete*

RS EAS 412-2, *Steel for the reinforcement of concrete — Part 2: Ribbed bars*

RS ISO 6935-1, *Steel for the reinforcement of concrete — Part 1: Plain bars*

RS 373, *Aggregates for Concrete — Specification*

RS ISO 22475, *Geotechnical investigation and testing — Sampling methods and groundwater measurements — Part 1: technical principles for execution*

3 Terms and definitions

For the purposes of this standard, the following terms and definitions apply.

3.1

aerobic bacteria

bacteria that grow in the presence of oxygen

3.2

all waste septic tank

tank receiving the discharge of combined black water and grey water

3.3

anaerobic bacteria

bacteria that grow in the absence of oxygen

3.4

daily inflow

volume in litres of sewage and liquid wastes flowing into a septic tank during a 24 h period

3.5

desludging

removal of the accumulated sludge and scum from the septic tank

3.6

DN100

nominal pipe diameter in millimetres

3.7

drain

underground pipe for conveying sewage and liquid wastes to the septic tank

3.8

effluent

liquid discharged from a septic tank

3.9

effluent disposal system

constructed system utilising various methods and materials to effectively dispose of septic tank effluent

.11

hydraulic loading

liquid flow required to be handled by the treatment process

3.12

multiple occupancy residential premises

more than one residential dwelling unit or flat constructed on one or more allotments and discharging into a common or multiple septic tanks

3.14

percolation

movement of water into the soil

3.15

soakage trench

subsurface soakage system using perforated pipe to convey the effluent along a trench

3.16

primary treatment

treatment of sewage that occurs in the septic tank compartment/s of a waste control system

3.17

relevant authority

local authority where the proposed septic tank system is to be installed in an area subject to local government control

3.18

reticulated water

any water supply obtained from a reticulated system and includes any bore, river or dam water supply

3.19

sanitary fixtures

plumbing fixtures connected to the system including a bath, basin, clothes and dishwashing machines, food waste disposal unit, kitchen sink, laundry trough, spa bath, toilet and other sanitary

3.20

scum

material floating on the surface of the septic tank which usually contains fats, oils and greases

3.21

septic tank system

includes the sanitary plumbing fixtures, traps, waste pipes, vents, inspection openings, drains, septic tank and/or other treatment units and methods of effluent disposal

3.22

sludge

solids which have settled to the bottom of the septic tank

3.24

soil permeability

capability of a soil to allow water to percolate

3.25

subsurface soakage

trench, bed, well or pipe system from which effluent percolates into the soil

3.26

suspended solids

solid particles held in suspension including settleable and non settleable matter

3.27

waste control system

includes any system providing for the collection, treatment or disposal of human, commercial or industrial wastes in solid or liquid form incorporating biological, chemical or artificial means and fixtures, fitting, appliances, plant, processes associated with such a system

3.28

wastewater

water which is collected and transported through waste pipes and sewers and normally includes water from domestic, commercial and industrial sources

3.29

grey water

wastewater drained from sinks, tubs, showers, dishwashers, clothes washers, and other non-toilet sources

3.30

black water

liquid and solid human body wastewater with only faecal matter and urine and the carriage waters generated through toilet usage

3.31

septic tank

closed sedimentation tank in which settled sludge is in immediate contact with the wastewater flowing through the tank, and the organic solids are partially decomposed by anaerobic bacterial action

3.32

baffle

device used in a tank to reduce eddies and promote a more uniform flow through the tank

3.33

Biochemical Oxygen Demand (BODt)

concentration of dissolved oxygen consumed under specified conditions (t days at 20 °C with or without nitrification inhibition) by the biological oxidation of organic and/or inorganic matter in water

3.34

Chemical Oxygen Demand (COD)

concentration of oxygen equivalent to the amount of dichromate consumed when a water sample is treated with that oxidant under defined conditions

3.35

discharge point

point where the final effluent is discharged into the receiving water

3.36

inspection port

opening in the top of the tank which allows inspection of the contents

3.37

invert

lowest point on the inside of a pipe or drain at a given cross section

3.38

competent authority

organization with appropriate statutory powers of controlling environment protection

3.39

wastewater treatment system

system relying on natural processes and/or mechanical components that is used to collect, treat, and disperse/discharge wastewater from single dwellings or buildings.

4 Information required

4.1 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.

4.2 Number and type of users

4.2.1 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 6.

4.2.2 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 according to the provisions given in Annex B. Site plan.

4.2.3 A site plan and layout of the building 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.

4.3 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 should 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 or in accordance with the provisions given in RS ISO 22475. Information on seasonal variation of the local groundwater table can often be obtained by interviewing residents in the locality.

4.4 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 Annex A.

4.5 Elevations

Invert elevations of all wastewater outlets from the building shall be determined, together with any external factors which may 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.

4.6 Existing soakage pits

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

4.7 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.

4.8 Options for effluent disposal or reuse

Potential options for effluent disposal shall be explored with the consultation of the users and/or developers. Potential for effluent reuse for uses such as gardening, irrigation, toilet-flushing, and landscaping shall be evaluated. Significant savings in fresh water consumption should be achieved through on-site effluent reuse.

4.9 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 noted (e.g. are there drinking water wells in the immediate vicinity? Are any streams used for drinking / bathing downstream? What is the condition of the roadside drains? etc.).

4.10 Building layout plan

A detailed building layout plan shall be provided showing:

a) the position and description of all the sanitary fixtures to be connected to the septic tank e.g. water closet pan, basin, bath, shower, laundry trough, washing machine, kitchen sink, dishwasher and food waste disposal unit;

b) method of connecting the fixtures to the drainage system including location of the sewer, drain, inspection openings, junctions and bends, size and grade of sewer drain, position and size of traps (sanitary fixture, floor waste and overflow relief gully), vents and waste pipes.

c) Site plan layout- should include setbacks from septic tank to adjacent buildings and to the nearest road.

5 Flow estimation

5.1 General

The required hydraulic capacity for an on-site wastewater treatment system is determined initially from the estimated wastewater flow. Reliable data on existing and projected flows should be used if onsite systems are to be designed properly. In situations where onsite wastewater flow data are limited or unavailable, estimates should be developed from water consumption records.

The overall urban water consumption in Rwanda for drinking and basic sanitation services, human hygiene and food preparation should be 180 liters average per capita per day for high standing premises, 80 liters average per capita per day for medium standing premises and 50 liters average per capita per day for low standing premises of which 60 % - 70 % average is transformed into greywater, while most of the rest is consumed for toilet flushing and released as blackwater and this shall be the basis for the system design.

In rural areas, the system design should base on the average daily per capita consumption of 20 liters.

When using water meter readings or other water use records, outdoor water use should be subtracted to develop wastewater flow estimates.

Accurate wastewater characterization data and appropriate factors of safety to minimize the possibility of system failure are required elements of a successful design. System design varies considerably and is based largely on the type of dwelling under consideration. For example, daily flows are usually expressed on a per capita basis.

Applying these data to characterize residential or non residential wastewater therefore requires that a second parameter of the number of persons living or present in the residence be considered.

5.2 Residential wastewater flows

5.2.1 Average daily flow

The average daily wastewater flow from residential premises shall be estimated from indoor water use in the home.

Average daily flow is the average total flow generated on a daily basis from individual wastewater generating activities in a building. These activities typically include toilet flushing, showering and bathing, clothes washing, dishwashing and other miscellaneous uses.

5.3 Non-residential wastewater flows

For non-residential premises, daily flows are generated from a variety of commercial, institutional, and recreational premises.

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 wastewater flow for each category of user based on daily water consumption per capita is given in Table 1 below.

Example computations of average daily flow based on per capita daily flow are given in Table B.1.

Table 1 — Per capita daily flows for different user categories

User Category		Per capita wastewater flow (litres/person/day)*		
		All waste	Blackwater	Greywater
Houses, housing estates and apartment complexes	Residents	130	39	91
Shops, Offices, etc.	Daytime employees	50	15	35
	Overnight employees	120	36	84
	Customers / Visitors	10	3	7
Schools, Universities, etc	Residents	120	36	84
	Daytime	50	15	35
Restaurants (dine-in)	Overnight employees	120	36	84
	Day-time employees	50	15	35
	Meals served	25 l/meal	10 l/meal	15 l/meal
Restaurants (take-away)	Overnight employees	200	50	150
	Day-time employees	50	30	20
	Meals served	15 l/meal	N/A	15 l/meal
Hotels	Guest	240	60	180
	Staff (residential)	200	50	150
	Staff (non-residential)	100	50	50
	Kitchen	l/meal	N/A	l/meal
	Swimming pool	l/user/d	N/A	l/user/d

* Except where otherwise shown.

6 Design of waste water control systems

6.1 Process selection

The proper selection of an appropriate effluent disposal process is essential to the satisfactory functioning of a septic tank. This code of practice recommends the use of soakage pit, seepage trench and seepage beds for the disposal of septic tank effluent or other approved means of subsurface disposal of effluent, or by conservancy tank, which shall be emptied regularly.

6.2 Septic tanks

6.2.1 General provisions

6.2.1.1 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.

6.2.1.2 Septic tanks shall be watertight, with sufficient structural strength and integrity to withstand external soil pressures, internal and external water pressures and any likely imposed loading.

6.2.1.3 Septic tanks situated under driveways and parking areas shall be designed to carry the appropriate vehicle loads.

6.2.1.4 All septic tanks either precast concrete septic tank or cast in-situ septic tank, unless otherwise specified by the competent authority, shall be designed and constructed as follows:

a) septic tanks over 2500 litres shall be divided into two chambers so that the effective capacity of the first chamber is twice that of the second chamber,

b) the length to width ratio shall be not less than 2:1 and a length to depth ratio of approximately 2:1,

c) the effective liquid depth shall be not less than 900 mm,

d) connections for the inlet, outlet and inspection openings shall be integrally cast for concrete constructed septic tanks,

e) the septic tank shall be installed on a compacted, level base and the top cover for inspection chamber or manhole of the tank shall terminate at least 50mm above the finished ground surface level, with the surrounding surface graded away from the septic tank and be provided with access covers constructed of a material as approved and be of sufficient strength to withstand all imposed loadings including vehicle loads where situated in vehicle access areas, be constructed so as to be child proof and effectively sealed to prevent the ingress and/or egress of water or gas and be removable for maintenance purposes, be positioned centrally over the dividing compartment wall and have an access opening of at least 900mm long and 500mm wide, or be positioned over the inlet and outlet fittings and have dimensions to ensure an access opening of at least DN500 or 500 mm x 450 mm, and

f) for septic tanks over 5000 litres capacity, they shall be provided with access opening of at least 900 mm long and 500 mm wide and be positioned centrally over the dividing wall or have access openings of at least DN600 and be positioned to permit inspection of the inlet and outlet fitting and enable access to each compartment for maintenance.

6.2.1.5 Cast in situ concrete septic tanks should be generally used where larger capacity septic tanks are required e.g., greater than 10 000 litres. The tank shall be structurally sound, smooth internally, watertight and the concrete used shall have a compressive strength of not less than 25 MPa at 28 days.

6.2.2 Location

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.

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

6.2.3 Tank geometry

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

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.

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

6.2.4 Dimensions

The working capacity of the septic tank shall be estimated as described in Annex C.

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

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.

Septic tank for all wastes for residential dwellings shall have the capacity of not less than 3 m^3 for all water closet and household liquid wastes for up to 6 persons. For each additional 2 persons 1 m^3 shall be added.

Septic tanks for sewage only shall have the capacity of not less than 1.620 m^3 for sewage from pan for up to 6 persons. For each additional 2 persons, 0.540 m^3 shall be added.

For multiple occupancy residential premises such as flats, units and town houses the capacity of the septic tank shall be calculated on the basis of total number of bedrooms plus one bedroom and multiply by 2 persons per bedroom.

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

The minimum depth below liquid level shall be 1 m.

Annex D shows the arrangement of a typical septic tank.

6.2.5 Inlet and outlet arrangements

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

The inlet fitting shall extend a minimum of 20 % of the liquid depth below the liquid level.

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

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

6.2.6 Access openings

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

Openings may be 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.

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

6.2.7 Freeboard

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

The air space thus provided shall have a volume equivalent to at least 10 % of the total tank volume.

6.2.8 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 % – 70 % of liquid depth from the bottom of the tank. The minimum dimension of an opening shall be 100 mm.

6.2.9 Vent pipe

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

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

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

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 that each chamber of the tank is vented.

6.2.10 Principles of operation

Wastewater enters the septic tank where settlement of solid matter subsequently occurs. Anaerobic bacteria then partly breakdown this solid matter within the tank. The heavier solid matter falls to the bottom and forms sludge, whilst the fats and other lighter matter float to the surface and form a scum.

The effective settling of solids is directly dependent upon the detention time within the tank.

Excessive build up of sludge and scum reduces the capacity of the detention zone, resulting in discharge of suspended solids to the effluent disposal system.

The minimum period of time in the detention zone should be at least 24 h to ensure 60 % to 70 % of the suspended solids are removed and that the Biochemical Oxygen Demand (BOD5) is reduced by 30 %. Therefore, the septic tank should be of sufficient capacity to provide for a-24 h retention of the daily inflow into the tank.

Small capacity septic tanks are adversely affected by flow surge, hence it is important that the types of discharge be taken into account when sizing the septic tank.

The inlet and outlet shall be baffled to avoid undue disturbance to the contents, especially the scum.

Where the daily inflow for the septic tank is excessive, or the tank is not regularly desludged, the inflow retention time may be reduced, thus increasing the carryover of suspended solids to the effluent disposal system. This may decrease the effective life of the disposal system, failure of which may result in backflow into the house system, or overflow to the ground surface.

6.2.11 Prohibited discharges

Unless otherwise approved by the relevant authority, no person shall permit or cause any of the following discharges into a septic tank system:

a) any storm water, including roof and rainwater tank overflow, and surface drainage waters,

b) any back flush waters from a swimming pool or water softener;

c) any sanitary napkin, clothing or plastic material or liner;

d) any trade waste;

e) any petrol or other flammable or explosive substance whether solid, liquid or gaseous;

f) any disinfectant or deodorant, antiseptic or germicide powder or fluid, unless specifically stated to be suitable for use in a septic tank;

g) any other matter or substance which would impair the effective working of a septic tank.

6.3 Soakage pits

6.3.1 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.

6.3.2 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 and 125 mm/hr.

6.3.3 Location

6.3.3.1 Soakage pits 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) 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/d)	**Minimum distance between soakage pits** (m)
< 2	10
2 - 10	20
10 - 30	36

6.3.3.2 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.

6.3.4 Geometry

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

6.3.5 Dimensions

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

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.

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** ($m^2/m^3.d$)
25	34
50	17
75	11
100	8.4
125	6.6
NOTE Intermediate values may be determined by linear interpolation.	

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

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

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

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 Ground Water Table (GWT) from bottom of soakage pit

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

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.

Annex E shows a typical arrangement of a soakage pit.

6.3.6 Cover

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

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

6.3.7 Seepage beds

6.3.7.1 General

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.

Seepage beds are 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.

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 Annex F.

6.3.7.2 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 mm and 250 mm/hr, and the ground slope is less than 5 %.

6.3.7.3 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.

6.3.7.4 Geometry

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

6.3.7.5 Dimensions

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

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

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

Table 5 — Specific effective areas for seepage beds and seepage trenches

Percolation rate (mm/hr)	**Specific effective area** ($m^2/m^3.d$)
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

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 (mm)**	**Maximum (mm)**	**Minimum (mm)**
Width	1000 - 6000	6 000	1 000
Depth of aggregate	300 - 600	600	300
Depth of topsoil	100 - 150	N/A	100
Spacing between beds (sidewall to sidewall)	-	N/A	1000

The maximum bed length shall be 20m.

6.3.7.6 Aggregate

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.

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

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

6.3.7.7 Soil cover

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

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.

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

6.3.7.8 Distribution pipes

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

Perforations in pipes shall be between 10 mm – 15 mm diameter with a total area of 10000 mm^2 / m length of pipe.

The minimum spacing between adjacent pipes in a bed shall be between 300 mm min. and 2000 mm max.

Pipes shall be laid horizontally.

A minimum of 2 distributors shall be provided per bed.

6.4 Seepage trenches

6.4.1 General

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

A typical arrangement of a seepage trench is shown in Annex G.The maximum length of a trench shall be 20 m.

6.4.2 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 mm and 250 mm/hr, and the ground slope is less than 25 % across trenches and less than 5 % along trenches.

6.4.3 Location

Same as in sub-clause 6.3.7.3

6.4.4 Geometry

Seepage trenches shall be rectangular in plan.

6.4.5 Dimensions

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

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

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

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

Table 7 — Typical dimensions of seepage trenches

Bed dimension	Typical (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)	-	N/A	1000

The maximum length of a trench shall be 20 m.

6.4.6 Aggregate

Same as in sub-clause 6.7.7.6

6.4.7 Soil cover

Same as in sub-clause 6.3.7.7

6.4.8 Distribution pipes

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

Perforations in pipes shall be between 10 mm – 15 mm diameter with a total area of 10000 mm^2 per metre length. Pipes shall be laid horizontal.

7 Materials and construction

7.1 Tanks

Septic tanks 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 or Polyethylene.

The material and construction details of pre-cast septic tanks are outside the scope of this standard. However, in all cases, tanks shall be water-tight, structurally sound, and resistant to the corrosive nature of a septic, anaerobic environment.

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

Materials used in construction of septic tanks shall conform to the requirement specified in relevant existing standards, some of them are mentioned below.

The cement to be used for construction of tanks shall conform to RS EAS 18-1 and RS EAS 18-2. The cement shall be testes in accordance with relevant part of RS EAS 148. The building sand for masonry works shall comply with RS107.

When the tank is made of lined brick masonry or lined cement block masonry, the burnt bricks and burnt blocks shall conform to RS EAS 94 and RS EAS 54 respectively. Cement block shall conform to RS 144.

When the tank is constructed in-situ in reinforced concrete, or pre-cast in reinforced concrete, the concrete shall conform to the requirements specified in RS ISO 22965-2. Testing of concrete shall be conducted in accordance with the relevant part of RS ISO 1920.

The steel reinforcement for reinforced concrete shall comply with RS EAS 412-2: Steel reinforcement for concrete shall conform to RS ISO 6935-1 for Plain bars and RS ISO 6935-3 for welded fabric. Aggregates to be used for concrete production, shall comply with RS 373.

7.2 Soakage pits

The walls of soakage pits shall be constructed with open jointed brick or open jointed cement block masonry and left unlined. 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.

7.3 Aggregate media

Aggregate media shall be immersed in water and washed free of fines and debris prior to placing in the beds.

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.

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

7.4 Excavation

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

Damage can be done by:

a) Smearing where the soil surface is smoothed, filling cracks and pores,

b) Compacting where the soil porosity is reduced, and

c) Puddling where washed clay settles on the base of the trench/bed.

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

Plan to excavate only when the weather is fine.

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.

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

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

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

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

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

Ensure that trench or bed bottoms are horizontal.

Divert all surface water well away from excavations.

7.5 Pipework

All pipework from the building to septic tank and from the septic tank to the soakage system shall be a minimum of DN 100.

8 Inspection and testing

8.1 General

Inspection of the system may be made either during installation or upon completion.

Where regular inspections are made, the work shall be inspected before covering/backfilling.

All systems shall be inspected for structural defects, defects in construction and conformity with the design specifications. All such defects detected shall be repaired and rectified such that the original requirements have been satisfied.

8.2 Water tightness

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

a) 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 h.

b) Inspect the tank walls and bottom for any signs of water leaking in. If evidence of leaks exist, repair as necessary and repeat steps a) and b) prior to proceeding to step c).

c) Fill all chambers of the tank up to the liquid level and let it stand for 24 h.

d) Check for any drop in water level. If there is a drop in water level, top up to the liquid level and re-check after a further 24 h. If the drop in level persists, empty the tank and repair or replace as necessary and repeat steps c) and d).

8.3 Partition test

All multiple chambered septic tanks shall be subject to the following test after satisfying the water tightness test in 8.1 above.

Fill one side only 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 h.

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.

9 Plumbing & drainage

All sanitary plumbing and drainage work including the installation of fixtures and connection to the septic tank system via traps, waste pipes and drains shall be carried out in accordance with relevant plumbing and drainage standards.

10 Maintenance

10.1 Septic Tanks

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.

10.2 Desludging

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 half full of sludge and / or scum.

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.

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.

10.2.1 Access covers

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

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

10.2.2 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.

10.2.3 Blockages

The commonest 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.

10.3 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.

10.3.1 Filter cleaning

The commonest 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.

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.

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.

Annex A
(normative)

Percolation test

Whenever soil absorption of septic tank effluent is considered, a percolation test shall be performed prior to the design of a soil absorption system in the following steps:

A.1 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.2 A square or circular hole of side (or diameter) between 100 mm – 300 mm shall be dug or bored up to the depth where soakage is to take place.

A.3 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.4 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.5 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.6 After 24 h, 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 minutes period shall be measured.

A.7 The percolation rate shall be calculated as follows:

A.8 Percolation rate (mm/hr) = drop in water level (mm) / (0.5 hrs.)

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 minutes intervals over a period of 4 h, 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 minutes measurement period, the soil percolation rate exceeds 300 mm/hr. and is unsuitable for soakage of septic tank effluent.

Annex B
(informative)

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:

$$\begin{aligned}\text{Average daily flow (all waste)} \\ &= (50 \text{ day time employees } \times 50 \text{l/p/d}) + (6 \text{ overnight employees } \times 200 \text{ l/p/d}) \\ &+ (200 \text{ customers } \times 10 \text{ l/p/d} \\ &= 5700/\text{l/d}\end{aligned}$$

$$\begin{aligned}\text{Average daily flow (blackwater)} \\ &= (50 \text{ day time employees } \times 30 \text{l/p/d}) + (6 \text{ overnight employees } \times 50 \text{ l/p/d}) \\ &+ (200 \text{ customers } \times 10 \text{ l/p/d} \\ &= 2800/\text{l/d}\end{aligned}$$

$$\begin{aligned}\text{Average daily flow (greywater)} \\ &= (50 \text{ day time employees } \times 20 \text{l/p/d}) + (6 \text{ overnight employees } \times 150 \text{ l/p/d}) \\ &+ (200 \text{ customers } \times 5 \text{ l/p/d} \\ &= 2900/\text{l/d}\end{aligned}$$

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:

$$\begin{aligned}\text{Average daily flow (all waste)} \\ &= (20 \text{ rooms } \times 2 \text{ guests/room } \times 240/\text{l/p/d}) + (8 \text{ non residential staff } \times 100 \text{ l/p/d}) \\ &+ (12 \text{ residential staff } \times 200 \text{ l/p/d} + 400 \text{ meals } \times 15 \text{ l/meal} \\ &= 18\,800/\text{l/d}\end{aligned}$$

$$\begin{aligned}\text{Average daily flow (blackwater)} \\ &= (20 \text{ rooms } \times 2 \text{ guests/room } \times 60/\text{l/p/d}) + (8 \text{ non residential staff } \times 50 \text{ l/p/d}) \\ &+ (12 \text{ residential staff } \times 50 \text{ l/p/d} \\ &= 3\,400/\text{l/d}\end{aligned}$$

Average daily flow (greywater)

$= (20 \text{ rooms } \times 2 \text{ guests/room } \times 180/\text{l/p/d}) + (8 \text{ non residential staff } \times 50 \text{ l/p/d})$
$+ (12 \text{ residential staff } \times 150 \text{ l/p/d} + 400 \text{ meals } \times 15 \text{ l/meal}$
$= 15\,400/\text{l/d}$

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)

$= (20 \text{ non residential staff } \times 50 \text{ l/p/d}) + (5 \text{ residential staff } \times 200 \text{ l/p/d})$
$+ (150 \text{ dine in meals/d } \times 25 \text{ l/meal} + 100 \text{ take away meals} \times 15 \text{ l/meal}$
$= 7250/\text{l/d}$

Average daily flow (black water)

$= (20 \text{ non residential staff } \times 30 \text{ l/p/d}) + (5 \text{ residential staff } \times 50 \text{ l/p/d})$
$+ (150 \text{ dine in meals/d} \times 10 \text{ l/meal}$
$= 2350 \text{ /l/d}$

Average daily flow (grey water)

$= (20 \text{ non residential staff } \times 20 \text{ l/p/d}) + (5 \text{ residential staff } \times 150 \text{ l/p/d})$
$+ (150 \text{ dine in meals/d} \times 10 \text{ l/meal}$
$+ 100 \text{ take away meals/d } \times 15 \text{ l}$
/meal
$= 4900 \text{ /l/d}$

Annex C
(informative)

Determination of Working Capacity of Septic Tanks

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

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/d)

t_s time required for settling (days)

= (1.5 – 0.3.logQ), (> 0.2) (days.)

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 all waste or grey water

= 0.00055 m^3/p/d for black water 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/d) for all waste

= Q (m^3/d)/ 0.05 (m^3/p/d) for black water

= Q (m^3/d)/ 0.15 (m^3/p/d) for grey water

The volume required for sludge storage shall be calculated as follows:

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

where,

$\boldsymbol{V_{st}}$ volume required for sludge storage (m^3)

$\boldsymbol{n}$ desludging interval (> 1) (years)

$\boldsymbol{r}$ Volume of digested sludge per person per year (m^3/p/y)

= 0.04 m^3/p/y for all waste or grey water

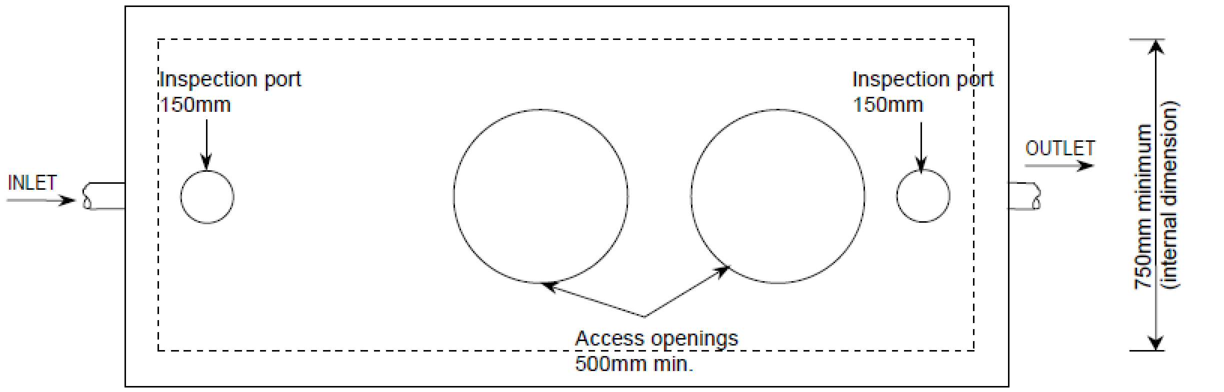
= 0.022 m^3/p/y for black water only

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

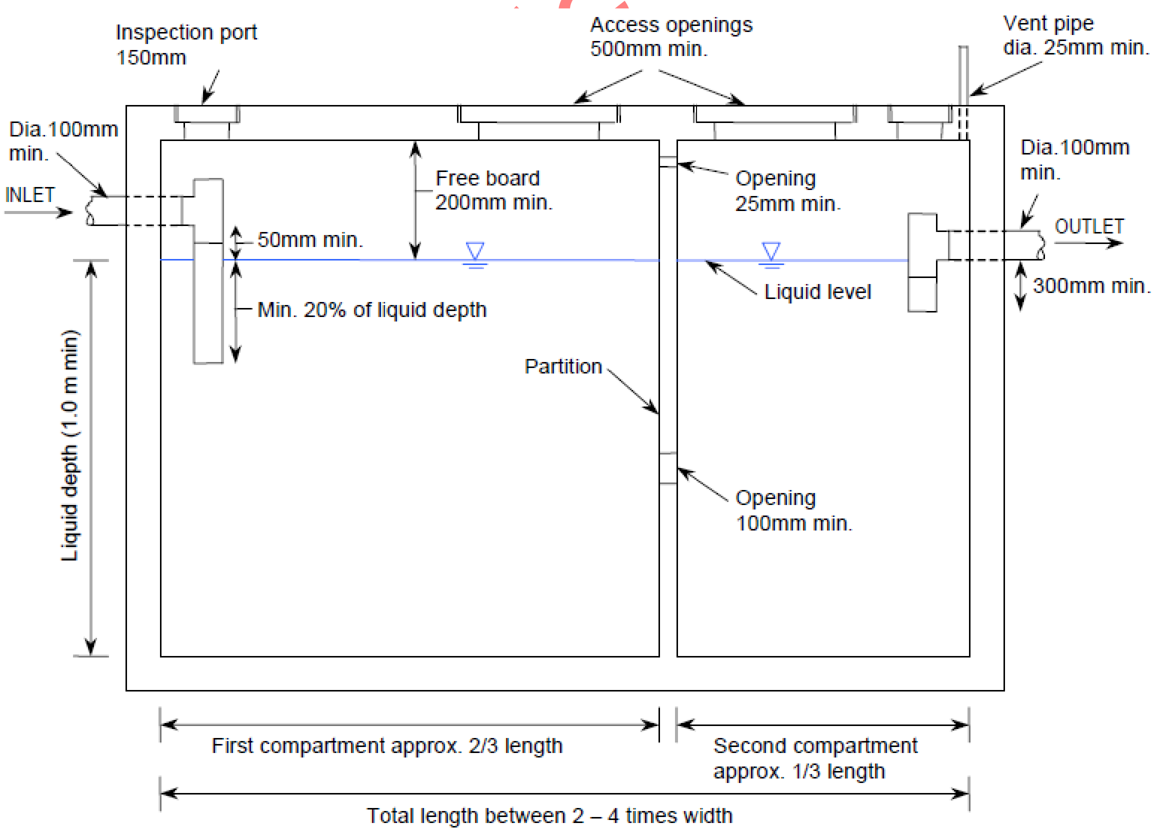
Then the design working capacity of the septic tank shall be the required volume, $\boldsymbol{V = V_s + V_d + 1.5\, V_{st}\ (m^3)}$

Annex D
(informative)

Typical septic tank arrangement



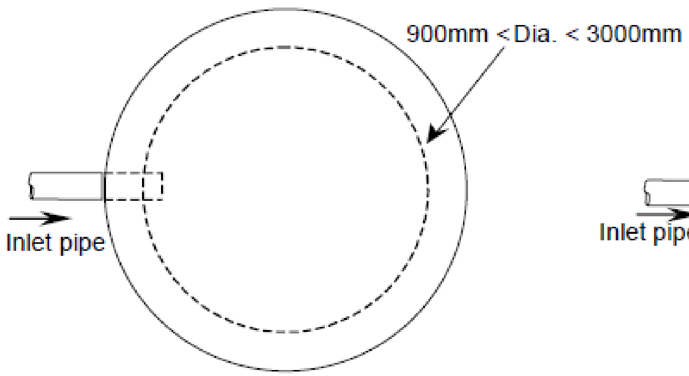
Plan



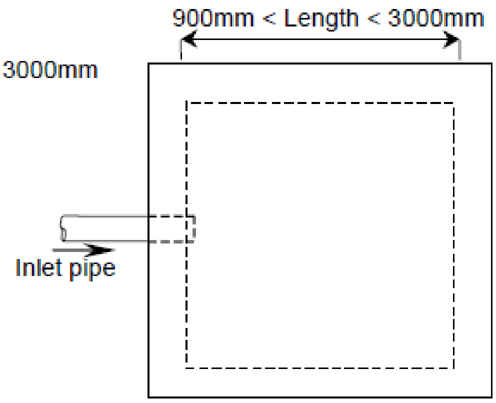
Section

Annex E
(informative)

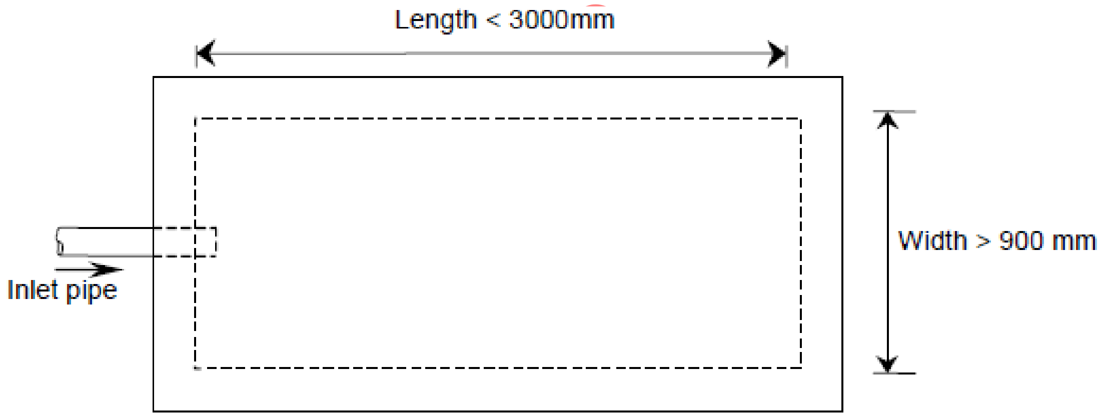
Typical soakage pit arrangement



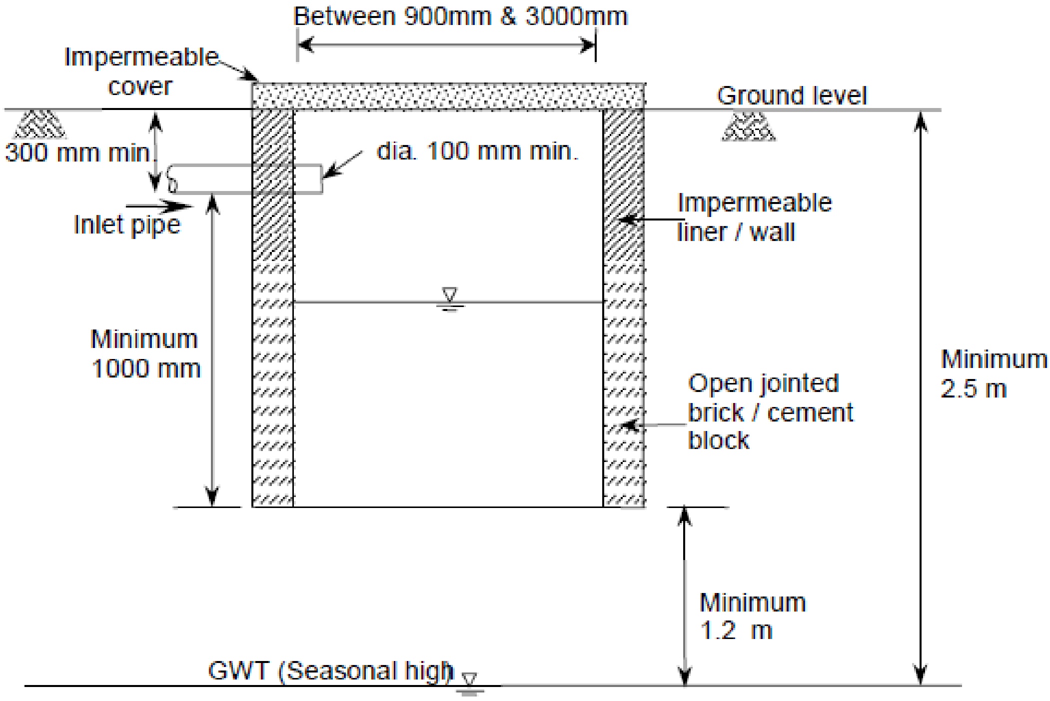
Plan (Circular type)



Plan (Square type)



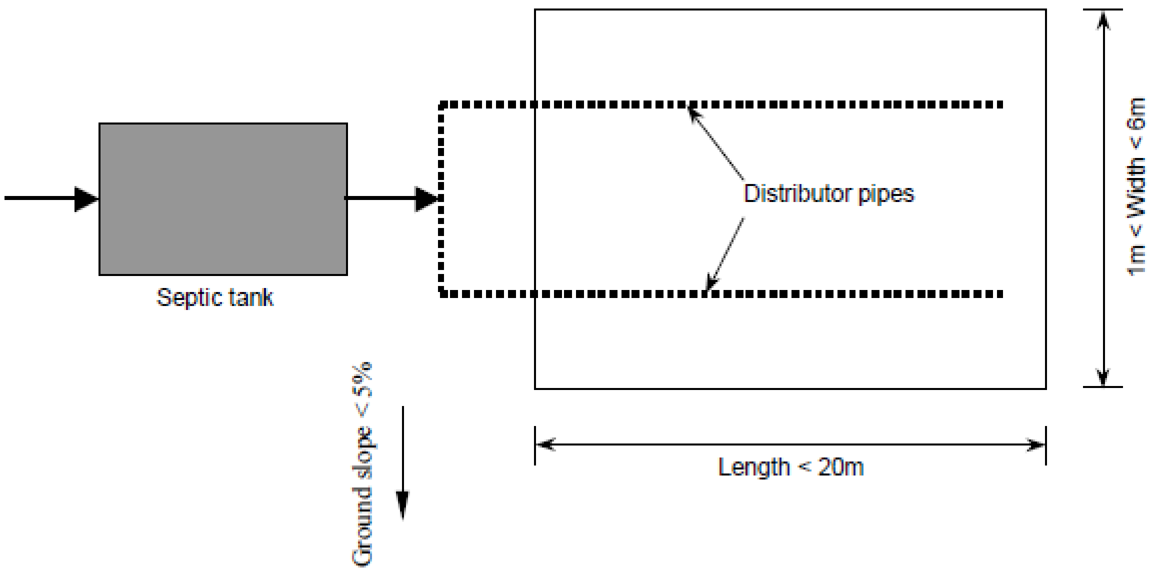
Plan (Rectangular type)


Between 900mm & 3000mm
Impermeable cover
Ground level
300 mm min
dia. 100 mm min.
Inlet pipe
Impermeable liner / wall
Minimum 1000 mm
Open jointed brick / cement block
Minimum 2.5 m
Minimum 1.2 m
GWT (Seasonal high)

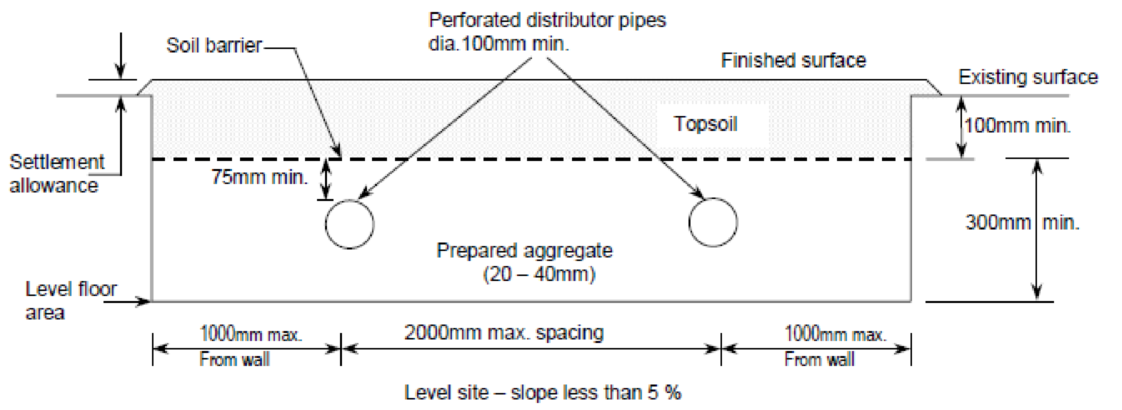
Section

Annex F
(informative)

Typical arrangement of a seepage bed



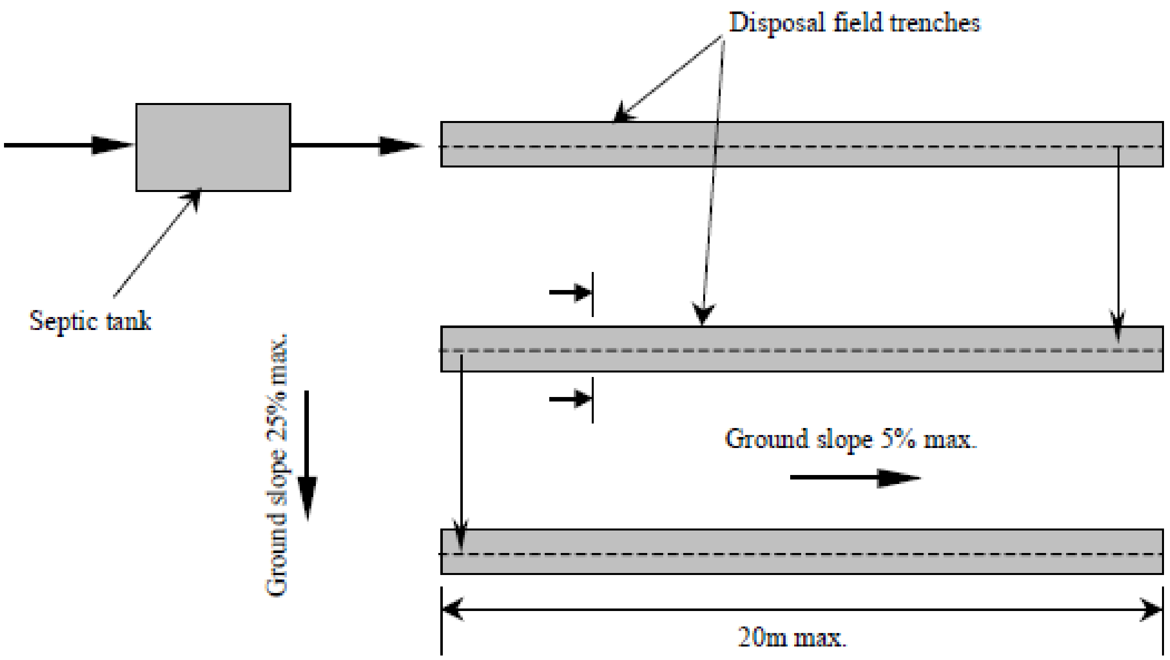
Plan



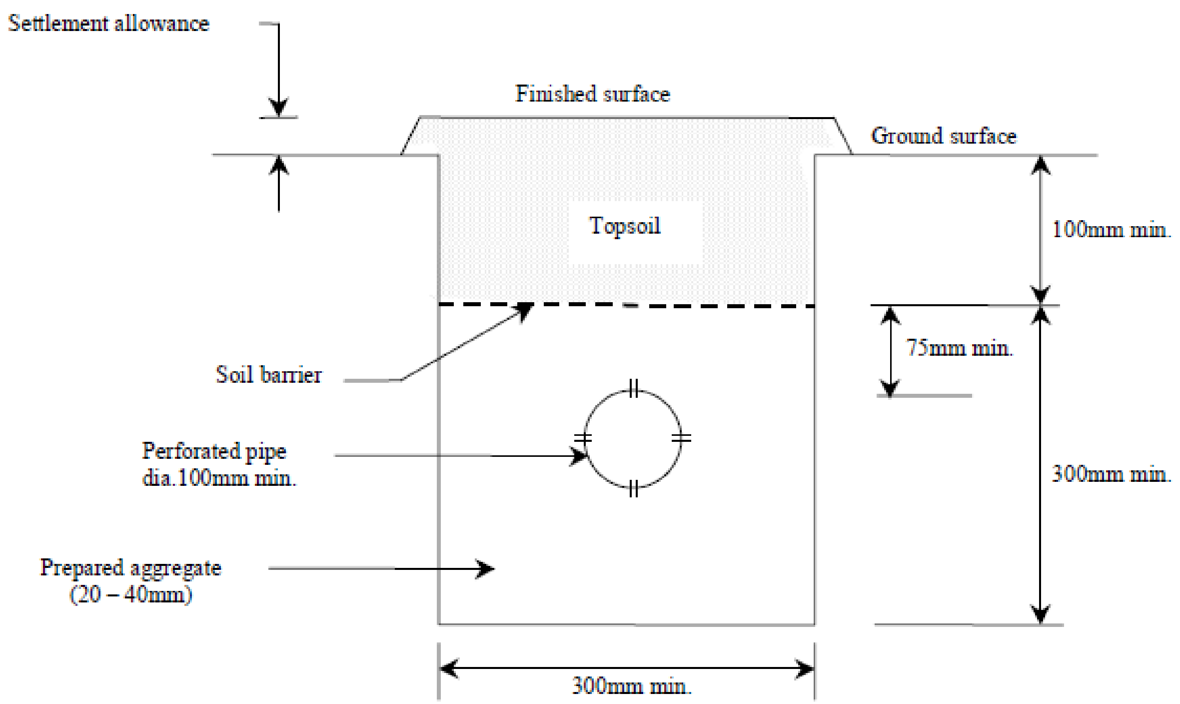
Section

Annex G
(informative)

Typical arrangement of a seepage trench system



Plan


Settlement allowance
Finished surface
Ground surface
Topsoil
100mm min.
75mm min.
Soil barrier
Perforated pipe
dia.100mm min.
300mm min.
Prepared aggregate
(20 – 40mm)
300mm min.

Section

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