



Ministry of Works and Human Settlement
Department of Engineering Services
Urban Infrastructure Service Division



SEPTIC SYSTEM MANUAL



Foreword

The Urban Infrastructure Service Division (UISD), Department of Engineering Services (DES) under the Ministry of Works and Human Settlement is currently working in partnership with the Netherlands Development Organisation (SNV Bhutan), to develop a Sustainable Sanitation and Hygiene for All (SSH4A) in Small Towns programme (STP) in Bhutan under a two year framework agreement (2011-July 2013). The aim of the programme is to enhance access to improved sanitation and hygiene practices and services in three small pilot towns under Chukka District-namely, Tsimasham, Tsimalakha and Gedu.

I am pleased to inform that the partnership programme has developed a much needed handbook titled, 'Septic System Manual'. As most of us are aware septic system is the most common on-site disposal system in Bhutan. The system is cost effective and appropriate for low-density urban and rural areas of Bhutan.

The handbook is particularly intended to be used by municipal engineers, building inspectors and technicians as a quick reference to understand the basic principles of how a septic system functions and its operation and maintenance. Further, leaflets within the handbook are targeted towards building owners for their technical know-how on operation and maintenance of septic tanks. Taking respective responsibilities within their abilities will ultimately help in improving sanitation and protecting our health and environment.

I am also confident that this handbook will be very useful in implementation of sanitation related programmes, particularly in construction of septic tanks both within urban and rural Bhutan.

The Ministry of Works and Human Settlement is very grateful to the Netherlands Development Organisation (SNV) and highly acknowledge their support in bringing out this publication.

Tashi Delek



Dr. Sonam Tenzin
SECRETARY

Ministry of Works and Human Settlement

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Introduction

The households in Bhutan depend on septic systems as an affordable and safe option for the treatment and disposal of sewage. It is cost effective and appropriate for low-density urban and rural areas. The septic system consists of a septic tank and soak pit. Adequate care must be taken to design, construct, operate and maintain the septic system so that it can provide years of reliable service. A poorly designed or maintained septic system can be a source of pollution, which causes disease outbreaks and other environmental problems. Therefore, it is important to understand the consequences of a poorly designed and maintained septic system and to take necessary precautions.

This manual provides an introduction to the septic system, the basic information of its functions, components, and maintenance requirements. Municipal engineers, building inspectors and even homeowners can use the manual as a quick guide to improving urban sanitation which will help in protecting our health and the environment as well.

Septic System

Components of a Septic System

A septic system consists of four main components:

- 1) Connecting Pipe
- 2) Inspection Chamber
- 3) Septic Tank
- 4) Soak Pit

- 1) **Connecting Pipe:** The wastewater from the toilet flows to the septic tank through the connecting pipe. The minimum diameter of the pipe should be 4 inches. The pipe should be made of material that is corrosion free such as PVC, uPVC, HDPE or cast iron.
- 2) **Inspection Chamber:** The chamber lies in the connecting point of sewer lines coming from different toilets and where there is a change in the direction of the flow of wastewater and diameter of the pipes. The inspection chamber provides easy access for cleaning or clearing of any blockages. The inspection chamber must be covered securely.
- 3) **Septic Tank:** The septic tank collects



Figure 1. Components of septic system

and stores sewage from the households. The septic tank contains anaerobic bacteria that decomposes or disintegrates the sewage. The material used in the construction of septic tank range from stone or brick masonry to concrete for a bigger community septic tank. It is usually buried underground.

- 4) Soak Pit: The effluent (clarified wastewater) from the septic tank flows into the soak pit. The soak pit is a covered walled chamber that is porous and allows wastewater to slowly soak into the ground after a secondary treatment.

Septic Tank

Functions of a Septic Tank

The septic tank provides a number of important functions in terms of physical and biological changes. The essential functions of a septic tank are:

- To collect wastewater from the house.
- To act as a sedimentation tank. As the sewage enters the tank, the rate of flow is reduced so that the larger solids in the sewage sink to the bottom of the tank.
- For primary treatment of wastewater in the tank, as the solids and the liquids are partially decomposed by anaerobic bacteria and other natural processes.
- To provide a storage space for the separated solids (sludge and scum).
- To pass the effluent into the soak pit for final treatment and disposal.

Different layers of sewage in the septic tank

When the sewage enters into septic tank, it separates into three distinct layers:

- a) Sludge layer
- b) Clear zone
- c) Scum layer

- a) Sludge Layer: All solids that are heavier than water settle at the bottom of the tank to make up the sludge layer. The anaerobic bacteria breakdown and digest the biodegradable solids in the sludge. During the process, the solids become lighter and migrate upwards to the middle of the tank or the clear zone.

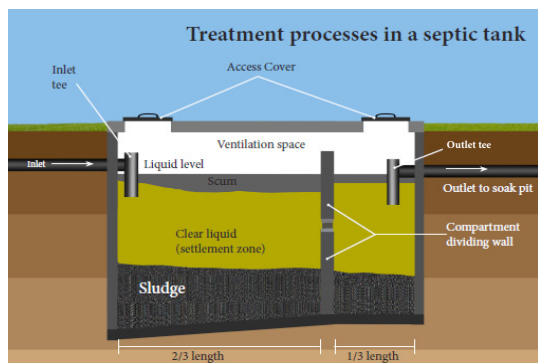


Figure 2. Different layers of septic tank

- b) **Clear Zone:** The clear zone in the septic tank holds grayish or brown coloured murky water that contains fine and microscopic biodegradable and non-biodegradable materials suspended in the liquid. It is in this liquid environment that the bacteria further break down most of the remaining biodegradable solids. The clarified liquid then flows into the soak pit.
- c) **Scum Layer:** The scum layer at the top of the septic tank contains grease, oils, soap films and other materials that are lighter than water. Both aerobic and anaerobic bacteria are found in the scum layer. The anaerobic bacteria are the dominant kind in this layer. As the bacteria digest the scum at the top layer of the tank, the digested wastes from the bacteria become heavier than water and sink to the bottom of the septic tank to settle on the sludge layer.

The baffle wall and outlet TEE prevent any of the scum on the top layer from exiting the septic tank before being treated. The inlet, outlet and the baffle wall are designed and constructed to allow only the liquid from clear zone to exit into the soak pit (shown in Figure 2).

Minimum Retention Time

Effective volume: The floating scum and sludge layers take up the top and bottom space of the septic tank respectively. The effective volume is the liquid volume in the clear space between the scum and sludge layers in the septic tank.

Retention time: This is the time that elapses from the entry point of sewage into the clear zone to the time of exit of the sewage from the clear zone of the septic tank. This is an important parameter for the design of septic tank, as each molecule of the incoming sewage enters and exits the clear zone under the design retention time period.

The retention time is the function of the effective volume and the daily household wastewater flow and is calculated as given below:

$$\text{Retention time (days)} = \frac{\text{Effective volume (liter)}}{\text{Flow rate (liter per day)}}$$

The septic tank is generally designed with a minimum retention time of 24 hours. The minimum retention time in the design takes into consideration the worse conditions when sludge and scum occupy half to two thirds of the septic tank volume. Under normal conditions that include routine maintenance and emptying, a tank should be able to provide up to two or three days of retention time.

As sludge and scum accumulates and occupy more volume in the tank, the effective volume is gradually reduced, thereby affecting the retention time. If the sewage is not retained in the

clear zone of the septic tank for the minimum retention time period, then the effluent does not get treated to the desired level. Therefore, the solids in the waste do not separate and can go untreated. The solids may also flow out of the tank along with the effluent into the soak pit. This will result in clogged pipes and the soak pit filled with untreated sewage. This is one of the most common causes of septic system failure. Therefore, it is very important to check the depth of the sludge and de-sludge regularly or after every 2 years.

Tank Configuration

The commonly used septic tank has two compartments. The plan and section of the septic tank are illustrated as below:

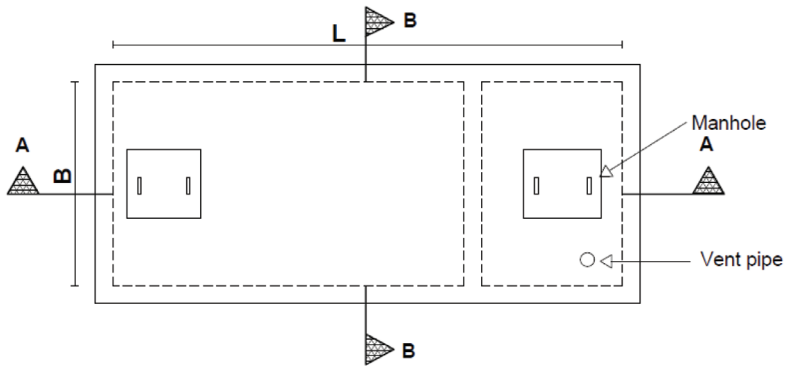


Figure 3. Plan

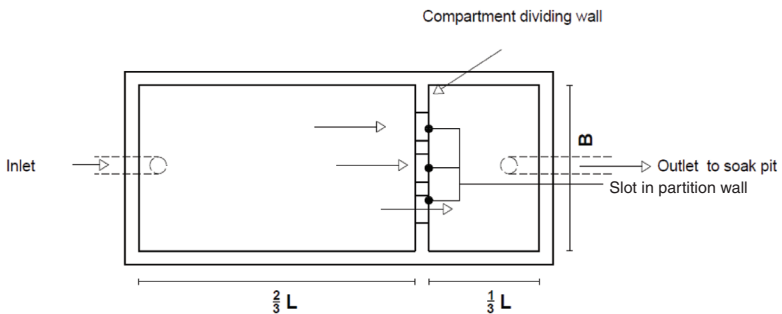


Figure 4. Plan at mid level

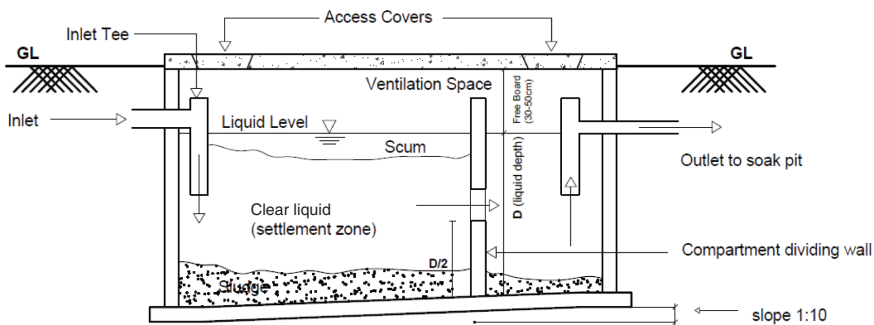


Figure 5. Section AA

Tank Size

Table 1: Minimum Size for Users with Desludging Every 2 Years

No. of user	Length(m)	Width(m)	Height(m)
5	1.5	0.75	1.30
10	2.00	0.90	1.30
15	2.00	0.90	2.00
25	2.60	1.30	1.80
50	4.00	1.40	2.00
75	5.00	1.50	2.00
100	5.70	2.10	1.70

Source: Specifications for Building and Road Works, 2009. Erstwhile Standards and Quality Control Authority, Ministry of Works and Human Settlement.

The height mentioned in the table above is the total height of the tank (i.e. from tank base to the bottom of the cover slab). It is very important to consider the liquid depth for the effective functioning of the septic tank. The total height minus free board is the effective depth of the septic tank. The standard free board measurement is taken from 30 to 50 centimetres range.

Key components of a Septic Tank

Base

The base is usually constructed of plain concrete with the thickness of about 100-150 millimetres. This is the minimum thickness required to withstand the uplift pressure when the tank is empty. The base also acts as a foundation for the side walls. A designer may also reinforce the base slab in larger tanks.

Side Walls

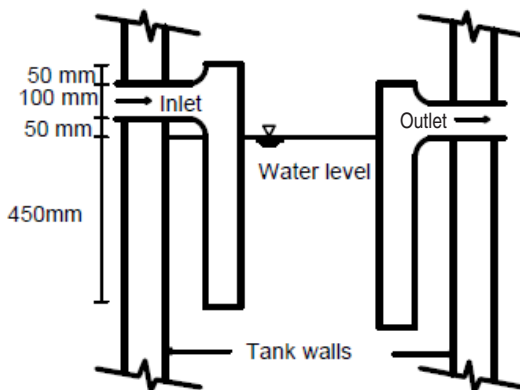
The side walls of the septic tank are made of brick, stone masonry or concrete. The septic tank must be watertight. The quality can be assessed through a water tightness test.

Manhole

The manhole provides an access to the compartments in the septic tank. The manhole should be made of medium duty cast iron, with a minimum dimension of 20 inches or equivalent and with a removable cover in each compartment.

Inlet and Outlet

The correct installation of the inlet and outlet are critical in the performance of the septic tank. The wastewater must enter and leave the tank with minimum disturbance. The arrangement of inlet and outlet with the minimum required dimensions is given in Figure 6 below.



Note: The dimensions given in the illustration above is of the minimum requirements. For communal septic tanks, the size of the pipe should be as per the drawings and designs. The “TEE” must reach to the clear zone.

Figure 6. Arrangement of Inlet and Outlet with Dimensions

Baffle Wall

The baffle wall prevents the scum from flowing out of the septic tank without treatment. It also facilitates in the smooth settling of the sludge. The baffle wall has slots or openings that allow the sewage to flow from one compartment to another as shown in Figure 7. The openings should be designed to minimise the turbulence by ensuring an average maximum velocity of 0.1m/s. The opening must be in the middle of the clear zone and not in the sludge or scum layers. A clear gap of 6 inches should be maintained between the slab and the top of the baffle wall as ventilation space.

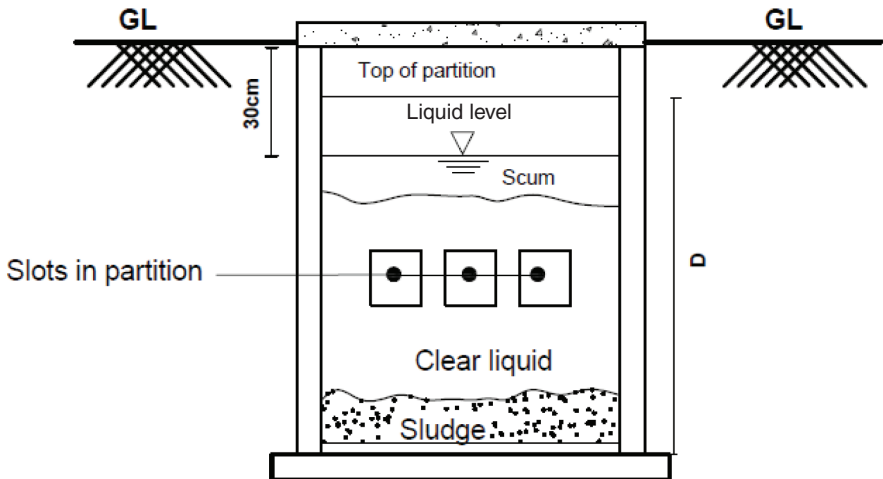


Figure 7. Section BB

Ventilation

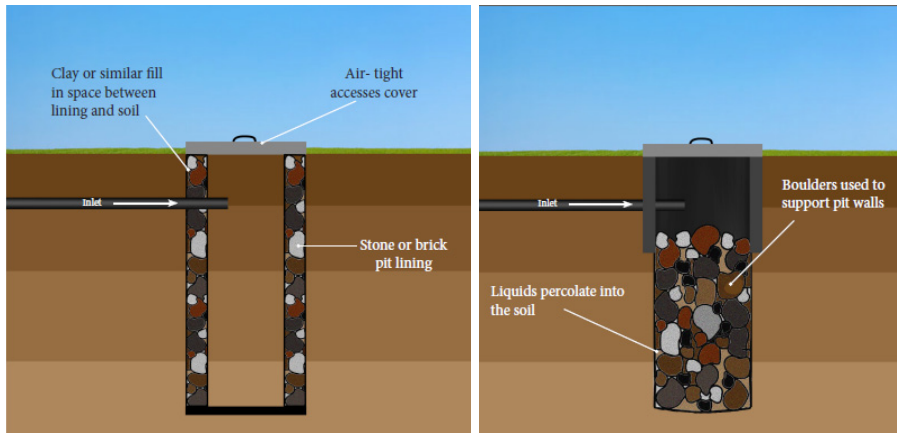
The decomposition of the organic wastes produce gases and the safe exit of the gases must be provided in the septic tank. The simplest option is to install a vent pipe with a screen on the roof slab of the septic tank. The gases coming out of septic tank has a strong stench and so the height of the vent pipe should be higher than the normal height of a person.

Commissioning of a Septic Tank

Before the tank is commissioned for use it must be tested for water tightness by filling it with water and allowing it to stand for 24 hours. The drop in the water level should not be more than 15 millimetres. It is not necessary to empty the tank as the water filled in the tank will enhance the separation process of the sewage and as the tank must remain filled with water when in use.

Soak Pit / Seepage Pit

A soak pit or seepage pit is a vertical leach line consisting of either a deep hole with porous walls or a hole filled with gravel or brickbats. Septic tanks should always be connected to a suitable soak pit or a sewer line. The soak pit can be constructed of pre-cast concrete-rings (with holes) or a dry cylindrical wall made of brick, block or stone as shown in Figure 8. The minimum diameter of the pit is 1.5 metres with a minimum depth of 3 metres. It must be located at least 10 metres away from any waterways in saturated soil conditions.



A lined soak pit

An unlined soak pit

Figure 8. Details of lined and unlined soak pit

Operation and Maintenance of a Septic System

Locating the Septic Tank

The septic tank, soak pit, inspection chamber and pipes should be clearly shown on the “as built” drawing of the home. An “as-built” is a line drawing that accurately portrays the buildings and other structures on the property. A building inspector can help to locate the septic system with the help of the “as-built” drawings as the older tanks are often difficult to locate.

Maintenance of a Septic Tank

- Check for any structural damage to the septic tank regularly and repair if necessary.
- Measure the depth of the sludge and scum every year, and empty the septic tank when the sludge reaches a depth of 2/3 full or at least every two years.
- Check for any overflowing sewage from the septic tank regularly
- Ensure any sludge is disposed of safely either by using a cesspool service or ensuring it is safely buried.

Maintenance of the Pipes and Fittings

- Check all the connecting pipes and fittings and repair or replace when required.

Maintenance of Soak Pit

- Clean and clear any blockages in the pipes and the soak pit.

Potential System Problems

Signs of a failing system are:

- Slow draining toilets or fixtures.
- Sewage back flow into the house.
- Sewage odours near the field or tank.
- Sewage leakage into the lawn, footpaths or drains.
- Neighbours complaining about your septic system.

Problems in the failure of the septic system can be quite difficult to analyse. The sewage odour and sewage overflow are indications of a system overload. The problem can be caused by excessive water use and/or ground water intrusion into the septic tank through a leakage in tank. You should also check for leakages in the toilets and other fixtures. The septic tank should be emptied and checked for any ground water intrusion into the tank.



Figure 9. Sewage overflow from septic tank

Preventing System Problems

Stop, look, and smell!

DO'S

- Check the sludge depth in your septic tank every year and empty when it is two thirds full.
- Promptly repair leaky water faucets and toilets.
- Prevent surface water runoff from entering into your septic tank.
- Prepare and keep the “as-built” drawing for any future reference.
- Keep the records of emptying, inspections, and other maintenance works done.
- Ensure that tenants understand how to safely operate and maintain the septic system.

DON'TS

- Avoid driving or parking over any part of your septic system. The area over the system should be left undisturbed with just a mowed grass cover. Roots from nearby trees or shrubs may damage your system.
- Don't put any large quantity of cooking oil or grease into the septic system.
- Don't throw non-biodegradable materials such as disposable diapers, sanitary products or plastic into the septic system.
- Don't pour petrol, diesel, oil, paint, paint thinner, pesticides, antifreeze or other chemicals into the system.
- Don't wait for the signs of system failure. Use this manual to help you check the state of your septic tank.
- Don't use the septic tank as a garbage disposal.

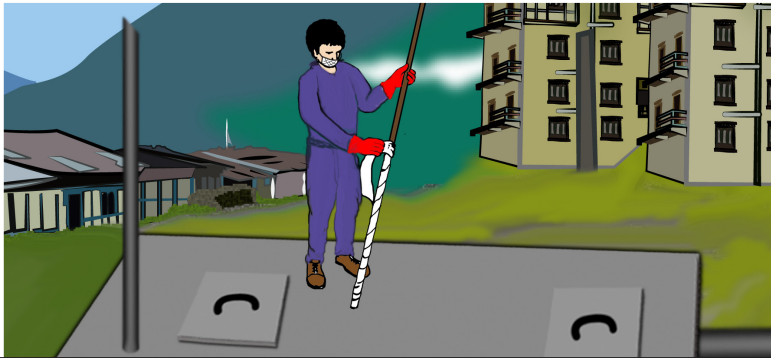
Septic Tank Emptying

- Do not wait until your system shows signs of failure to have your septic tank emptied. The waiting time can completely clog the tank, resulting in heavy repair charges.
- Check the sludge depth of your septic tank every year. When it is two thirds full call the municipal office for emptying.
- Stir your septic tank properly with a stick a little before the arrival of the municipal cesspool truck for proper emptying.
- It is necessary to leave some sludge in the tank as “seed” or plant in case of a new tank. Do not use any acids or bleaches.
- If the municipal services are not available then empty the tank manually, and dispose off the sludge safely as illustrated in Figure 10
- Protective mask/gears should always be worn while emptying the septic tank.
- The process of emptying is shown in next page.



Figure 10. Safe disposal of sludge manually

How to Check your Septic Tank



Properly wrap a 4m long metal or plastic stick with a white cloth or a towel.

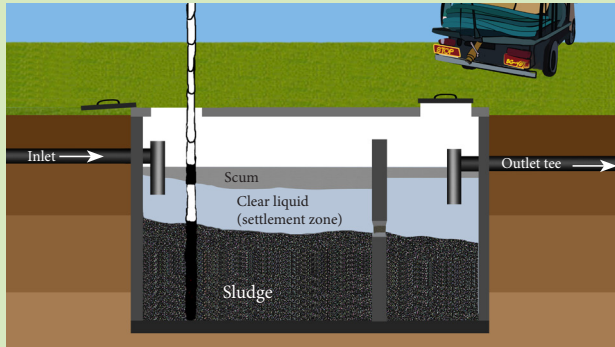


Remove inspection cover & insert the stick in your tank until it touches the bottom.

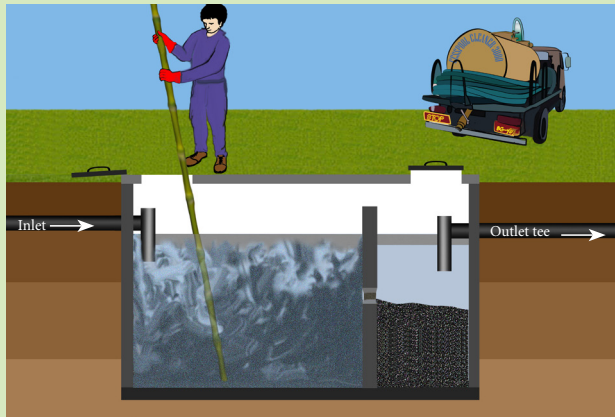


Then remove the stick. Observe the mark on your stick.

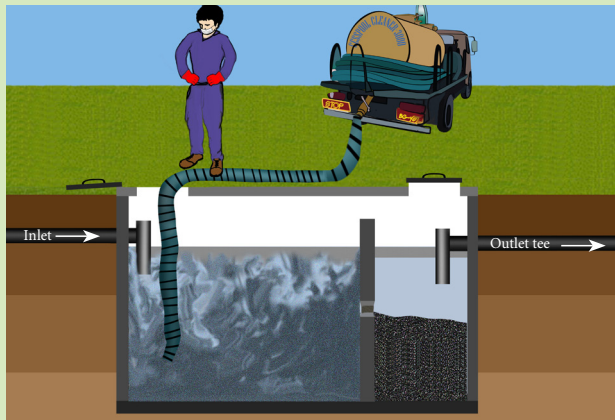
When & How to Empty your Septic Tank



If the dark layer mark on the stick is more than $\frac{2}{3}$ of the depth then call your municipal office to empty your tank



Before the arrival of the truck it is advisable to stir your septic tank for proper emptying



Check if your tank is properly emptied

Septic Tank Supervision Check List

Sl.No	Description of Items	Yes	No	Remarks
1	Presence of all components of the septic system (pipe, inspection chamber, septic tank and soak pit).			
2	All the dimensions of the septic tank are as per approved drawing or table incorporated in the manual.			
3	The effluent from the septic tank is connected to a soak pit.			
4	Presence of an access through the manhole in both the compartments of the roof slab.			
5	A clear gap of 150mm is maintained between the slab and top of the baffle wall for ventilation.			
6	The baffle wall is placed at two thirds of the length from the inlet wall (Septic tank with two compartments).			
7	The slots (holes) in the baffle walls are at the centre of effective depth (D/2) with horizontal spacing of 35cm between each slot.			
8	The bottom slope (1:10) towards the inlet is maintained.			
9	Septic tank is watertight.			
Pipes and fittings				
10	The outlet pipe is 50mm lower than the inlet pipe.			
11	Both the inlet and outlet is installed with the "TEE".			
12	The "TEE" is long enough to reach the inside of the clear zone.			
13	The septic tank has a vent pipe with a height of no less than an average human height.			
14	The minimum diameter of the connecting pipes is 110mm.			
15	The effective depth of the tank is maintained (total height minus free board which is about 30 to 50 cm from the roof slab).			
16	The septic tank is located within the reach of a cesspool pipe.			

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Ministry of Works & Human Settlement
Department of Engineering Services
Urban Infrastructure Service Division
Po Box 129, Opposite to UNDP Building,
Thimphu : Bhutan
Tel: +975-2-324339/321828 (Direct)
Pabx: +975-2-327998/328173/322182
Fax: +975-2-324338/323105



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