



Overseas Building Note

Housing and construction information for developing countries

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Disposal of domestic effluents to the ground

R F Carroll



Increasing the infiltrative surface area
of a seepage pit

SUMMARY

Forms of unsewered sanitation are the most likely systems to be installed on low-income housing plots where sewerage is not practicable, due often to shortage of water and high cost.

Updated advice is required on ways of evaluating the suitability of the ground to dispose of wastewater and latrine effluents. Most advice currently available relies on a simple percolation test to identify the suitability of soil for soakage. Relying solely on percolation testing frequently leads to uneconomically large or inadequately sized soakage systems, or to the installation of soakaways in unsuitable ground, with the likelihood of early blockage and flooding.

A method of classifying a soil by sight and feel has been identified as the main test for soil soakage

suitability. The classification is then verified by carrying out a soil percolation test. These tests can be carried out on site, without specialised equipment, to determine the likely suitability of the site for soakage. If the result of the percolation test does not support the classification, then a more detailed assessment of the site will be required.

This Note outlines the three main on-site sanitation systems, the problems of effluent disposal and possible groundwater pollution, and types of soakage system currently in use. Recommendations are made for site soil testing, application rates of effluent to soakaway infiltrative surfaces, and sizing of soakage systems.

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OVERSEAS BUILDING NOTES

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DISPOSAL OF DOMESTIC EFFLUENTS TO THE GROUND

by R F Carroll C Eng M I Mech E 1

1 INTRODUCTION

Considerable literature exists describing the need for effective sanitation, the range of technical options, and design details of many individual on-site sanitation systems^{1,2,3}. Much of this information resulted from research and development in many countries, stimulated by the United Nations 'Water and Sanitation Decade 1980-90'. In developing communities most on-site systems are designed to dispose of excreta into the ground, with or without other domestic wastewater, usually via forms of septic tank or pit latrine.

Septic tanks have been used for many years in the more developed countries, such as the UK and USA. In 1980 about 25% of new houses in the USA had septic tanks installed to treat domestic sewage, with effluent disposal to the ground through a subsurface soakage system. They are also common in many developing countries, mainly in higher income households and commercial premises. For rural and semi-urban low-income housing, forms of pit latrine are most common. Septic tanks, aqua privies and pit latrines all produce potentially polluting effluents, that are then disposed of to the ground by soakage. Soakage is itself a purifying treatment stage for effluent before it enters the groundwater, by removing harmful organisms and other pollutants.

There is increasing evidence of problems arising from blockage of soakage systems, particularly from aqua privies. Not only are overflowing soakaways offensive, due to odour and unsightliness, but they can also result in serious public health risks.

In this Note, the common forms of on-site sanitation and the problems of effluent disposal are outlined. A methodology for classifying soil types is recommended, together with a percolation test so that, used together, the test results can assist in predicting site suitability for soakage. Application rates for effluents are listed, relative to soil types, to enable a soakage system to be sized. For detailed design advice for septic tanks and aqua privies, see Overseas Building Note, OBN187⁴.

2 SEPTIC TANKS, AQUA PRIVIES AND PIT LATRINES

2.1 Septic tanks (Figure 1)

A septic tank⁴ is a basic primary sewage treatment system, commonly used for single or small groups of dwellings. A retention period for the sewage in the tank of from one to three days provides settlement and partial digestion of organic solids. The tank is usually divided into two connected compartments to reduce turbulence and encourage settlement. The conversion of the organic matter in a sewage to liquids

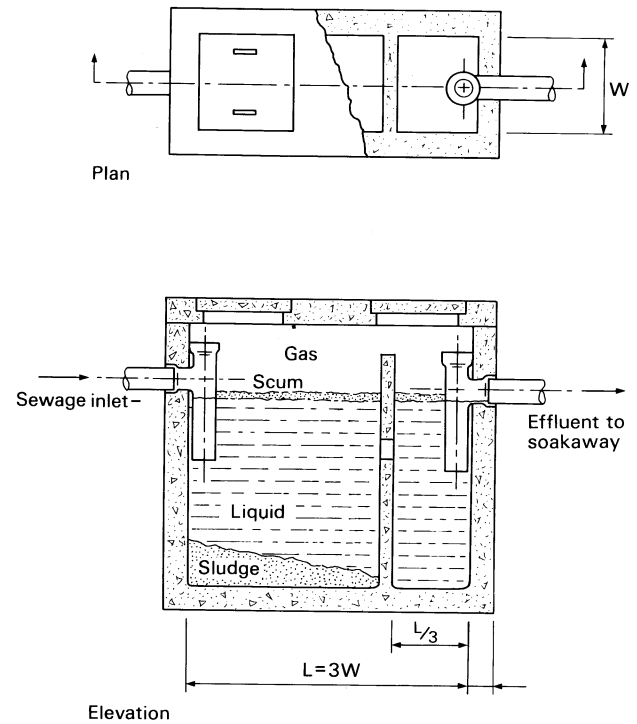


Figure 1 The Septic Tank

and gases is only partially accomplished in a septic tank; the sludge settling on the bottom of the tank must be removed periodically.

The settled and partly treated effluent from a septic tank has an objectional smell and still contains a considerable organic content. It can be highly polluting if discharged directly to a stream or into groundwater. When considering disposing of septic tank effluent to the ground, the following points should be considered:

- (i) the soakage system must be effective in disposing of the tank effluent with minimum risk of blockage and overflowing
- (ii) the filtering capability of the ground should be satisfactory and the depth to the water table should be sufficient to minimise the risk of groundwater pollution, or
- (iii) where the groundwater is already contaminated, there should be access to a safe drinking water supply for the dwellings being served.

2.2 Aqua privies (Figure 2)

Aqua privies⁴ are effectively very small septic tanks, ie they work on septic tank principles. They are relatively common in some developing countries, eg in parts of Africa. Instead of sewage being piped to a separate septic tank, which can be located away from the house, an aqua privy has a toilet pan in a privy superstructure located directly over the tank. A drop pipe conveys excreta from the pan to below the surface of the liquid in the tank. Small amounts of kitchen wastewater are often directed into the tank to maintain the liquid level, making up losses due to evaporation.

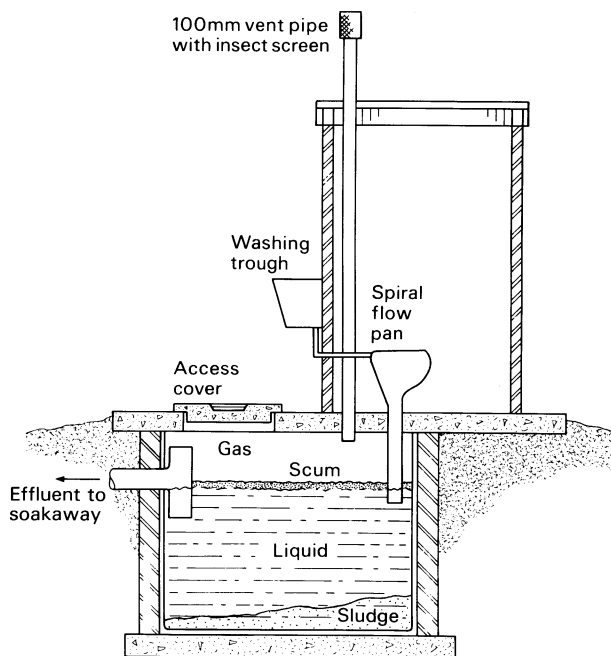


Figure 2 The Aqua privy. The type B, used in Botswana

The effective volume of an aqua privy tank is often as little as 1,000 litres. Because it is a single compartment tank of small volume, and hence subject to turbulence and inefficient settlement, a high proportion of solids can pass out of the tank in the effluent. Consequently aqua privy soakaways are prone to early blockage, much more so than a soakaway for a properly sized septic tank. They are, however, cheaper to install.

2.3 Pit latrines (Figures 3 and 4)

The pit latrine, in its most basic form, is simply a hole in the ground that receives and retains human excreta. More recent designs, called Ventilated Improved Pit (VIP) latrines, with single or double pits¹, can provide a good standard of service. The pit is ventilated by a pipe discharging above the latrine roof and, coupled with regular cleaning of the latrine floor, can eliminate offensive odour and fly nuisance.

Unlike the two water tank examples described, a pit latrine is intended to be a 'dry' system, in the sense that putting in additional water, eg wastewater from the kitchen or personal washing, should be discouraged. Ideally, liquids from faeces and urine, and liquids from their decomposition, should be the only liquids in a pit. The problems of disposing of organic liquid (effluent) from a pit latrine to the ground can be similar to those from septic tanks and aqua privies. However, the organic loading of pit effluent is likely to be much higher than for either of the tank systems and consequently the tendency for the soil pores to block is much greater. There is the advantage that the volume of liquid to be absorbed by the ground can be much less than that from a septic tank or aqua privy, if additional washwater is not put into the pit.

Pit latrine chambers are generally sized according to the number of persons served in a household. A

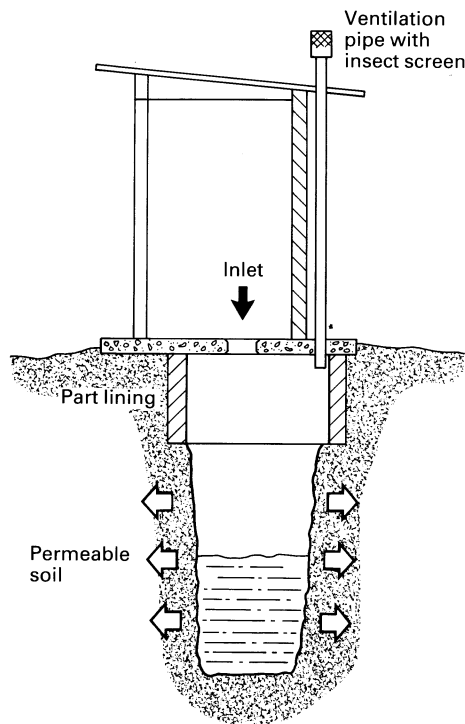


Figure 3 Ventilated improved pit (VIP) latrine

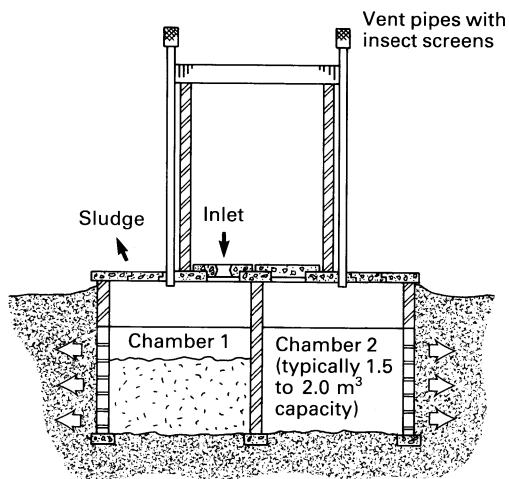


Figure 4 Ventilated improved double pit (VIDP) latrine (alternating chambers — three-year emptying cycle)

typical fill rate is 40 litres of sludge per head per year, where wastewater is not put into the pit. If water is added then soakage problems can arise in poorly drained soils; seepage rates can become very low, due to slime blocking the infiltration surfaces of the pit. The pit then becomes virtually a cesspool or holding tank.

Pits serving as cesspools can give satisfactory service if a reliable means of emptying is available. Mechanised emptying of pit latrines, of wet or dry material, is now an established practice⁵. Offsite disposal of the sludge is necessary, either to a sewage treatment works or to landfill, where it should be covered with soil to prevent access by animals and insects.

3 SEWAGE AND EFFLUENT

The characteristics of septic tank effluents are mainly

influenced by domestic water consumption, which varies widely between social groups. Water use is the most likely factor to influence the composition of sewage entering a septic tank and it is the suspended solids remaining in a tank effluent that is likely to eventually block the soil pores in a soakaway system. Another factor affecting the passage of water through a soil is the biological slime that forms on the infiltrative walls of a soakage pit or trench, due to the nutrients in the effluent.

3.1 Water consumption

Because of low water consumption the dilution of wastewater will generally be much less in a low-income household. Where water is obtained from a communal standpipe and entails considerable effort in carrying water to the house, consumption is likely to be in the range of 10 to 20 litres per head per day. It is also likely that the associated sanitation system would be a form of pit latrine or, less likely, an aqua privy.

Septic tanks taking all domestic wastewater are usually sized to accept water consumptions typically of from 100 to 250 litres per head per day. They are not a low-cost sanitation option and tend only to be installed in higher income housing developments, with an adequate and continuous piped water supply, similar to that required for full sewerage.

3.2 Characteristics of domestic sewage

Sewage is the combined wastewater produced by a household, it includes excreta and personal cleaning materials, washwater and kitchen sink wastewater. Sewage is usually more than 99.9% water.

The two main characteristics quoted to describe the strength of sewage are the five day Biochemical Oxygen Demand (BOD_5), a measure of organic load, and the Suspended Solids (SS). The higher the concentration of waste matter in a sewage, the stronger it is said to be. The strength of a sewage is governed mainly by the water consumption of its producers. For example, in East Africa where water use is relatively low, BOD_5 and SS could both be of the order of 500 mg/l. In the USA with generally much higher water consumption, BOD_5 and SS could be around 200 mg/l.

3.3 Septic tank effluent

The organic or polluting load of a sewage (BOD_5) is not necessarily reduced in a septic tank, even though some biological action takes place to degrade and reduce the solids in the sewage. The main function of the tank is to drastically reduce the amount of suspended solids, generally by from 50 to 90%. A high SS content of a tank effluent entering a soakaway, would lead to early blockage of the soil pores of a soakage system.

There is also very little reduction in pathogens after septic tank treatment. Transfer of bacteria and viruses to the groundwater can occur unless a filtration stage

is introduced before the effluent reaches a water source.

4 POLLUTION OF GROUNDWATER

By discharging effluents into underground strata from septic tanks or pit latrines, there can be a considerable risk of groundwater pollution⁶ unless sufficient treatment takes place beforehand. Soil can be a very effective purification system, being able to remove micro-organisms and break down many chemical compounds. The soil zone above the water table (unsaturated) is the most important means of preventing pathogens from contaminating the groundwater. There should be at least a 1m deep barrier of suitable soil⁷ (eg sandy loam) between the possibly contaminated material and the water table to prevent such pollution.

The problems of chemical pollution from pit latrine seepage can be worse than for septic tank soakaways. High levels of nitrates in the groundwater downstream from communities using pit latrines have been reported in Botswana⁶, although livestock concentrations as well as the many pit latrines could be responsible. To safeguard community health, standpipe water of potable quality is provided.

5 DISPOSAL OF EFFLUENTS

In many developed countries, local water authorities stipulate minimum standards for effluents before discharge to the ground or a watercourse, to prevent pollution of water sources. These restrictions on wastewater discharges are being, or are likely to be, adopted in the future in the developing countries, for the same reason.

In the UK for example, the minimum standard for a discharge to a watercourse is generally the Royal Commission Standard (20/30 Standard). This limits the BOD_5 to 20 mg/l and SS to 30 mg/l. In some particularly environmentally sensitive areas an even better quality of effluent is required. To achieve the 20/30 Standard requires at least another treatment stage after retention in a septic tank. Generally this would be achieved in an aerobic second stage, which could be by passage through a drainfield, where aeration takes place, leading to a great reduction in BOD_5 and pathogenic organisms.

5.1 On-site disposal options

In general, facilities designed to discharge partially treated wastewater, eg pit or tank effluent, to the ground can be reliable and the least cost on-site systems. Little pre-treatment of the wastewater is necessary before soakage into the ground, because soakage itself is a purifying treatment.

Water can be returned to the environment by evaporation, but evaporative systems are only practicable in the tropics, with high temperatures and

low rainfall. Disposal by evaporation implies that only water is discharged to the environment; solids, chemicals and pathogens are not transmitted as pollution. An example of using an evaporation process is a sludge drying bed.

Evaporation of water through plants is called transpiration and this can be an effective process in the more arid and warm parts of the world. A process that combines both evaporation and transpiration of water is called evapotranspiration. Although evapotranspiration beds or mounds are discussed as options^{8,9,10}, there is little recorded operational experience in developing countries.

5.2 Soakage systems

For design information on soakaways (pits and trenches), see Section 11.

- (i) **Soak pit, seepage pit (Figures 5 and 6).** The simplest and probably the cheapest to install effluent disposal system is the soak pit or seepage pit, commonly called a soakaway. Relatively little land space is required but, because of the depth of a pit, there may be a risk of contaminating the groundwater unless a second stage treatment is used to ensure a satisfactory standard of effluent.

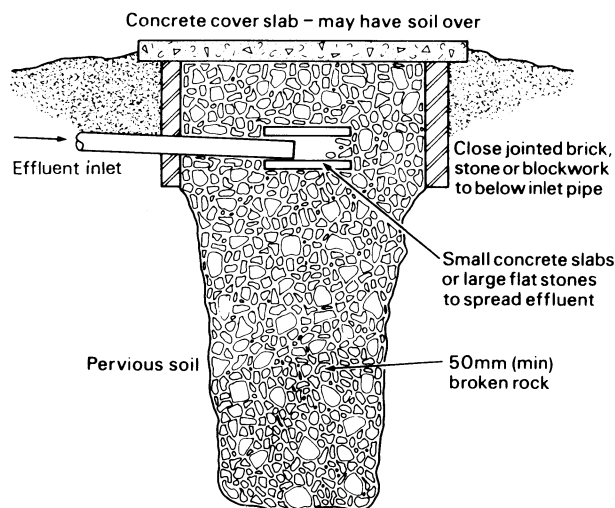


Figure 5 Soak pit, unlined

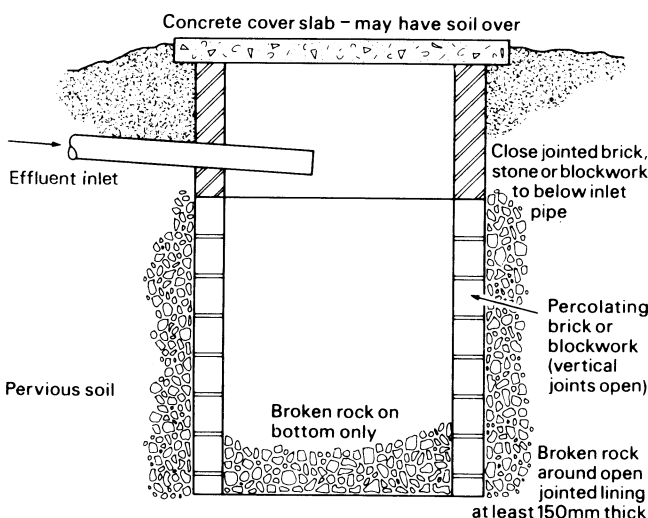


Figure 6 Soak pit with lining

Soak pits are commonly used instead of drainfields in higher density housing, where house plots are small. They are the likely disposal method for effluent from aqua privies, because of their simplicity and moderate cost. Also, there is usually a much smaller amount of effluent to be disposed of than that from the larger septic tank.

- (ii) **Subsurface irrigation or drainfield (Figure 7)**^{2,10}. A subsurface irrigation system is one in which an effluent flows through a series of perforated or open jointed pipes, laid in shallow, horizontal trenches in porous media (e.g. clean gravel, clinker, broken stone); the effluent is distributed in the soil surrounding the pipes.

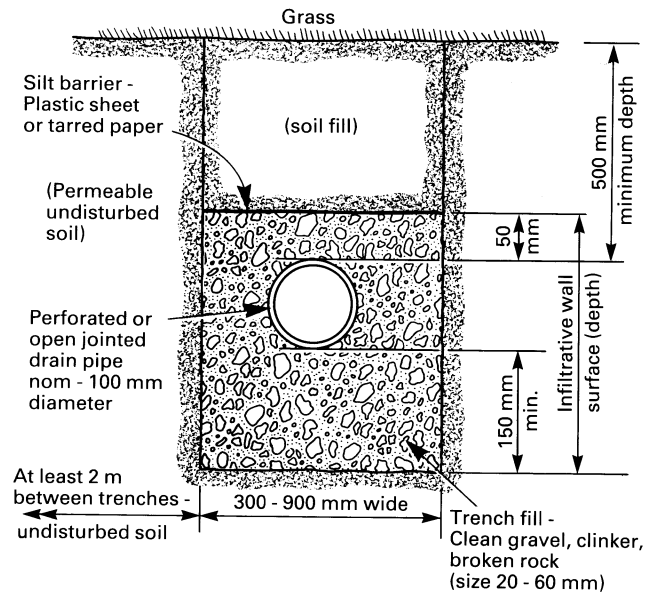


Figure 7 Section through soakage trench

6 SOAKAGE PROBLEMS

6.1 Soil blockage

Many soakage systems will eventually block unless provision is made to 'rest' the soil. By duplicating a drainfield or soak pit and diverting the effluent flow, say in a twelve month cycle, self-cleaning of the soil pores can occur (Figures 8 and 9)¹⁰. However, for a drainfield this is only likely to be feasible where cost and lack of suitable land area are not the limiting factors. Small soak pits can more readily be duplicated (Figure 9), they are cheaper to install and do not require so much space on the housing plot.

6.2 Improving soil absorption capacity

By increasing the soil surface area exposed to the effluent that is being soaked away, increased soakage capacity can be achieved. For example, a lined soak pit in soil of low to medium permeability can be surrounded with porous media (see cover picture), such as a 500 mm thickness of coarse sand, gravel, small clinker or crushed rock. This is not just a case of providing a larger soakaway; by retaining the smaller lining and backfilling with porous material, the span of the cover slab is not increased and the overall cost of the lining is also not increased.

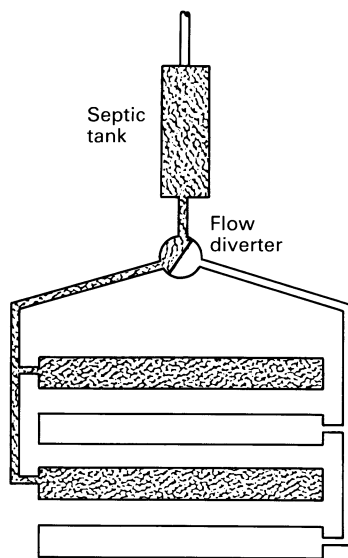


Figure 8 Alternating soakage trench — annual cycle

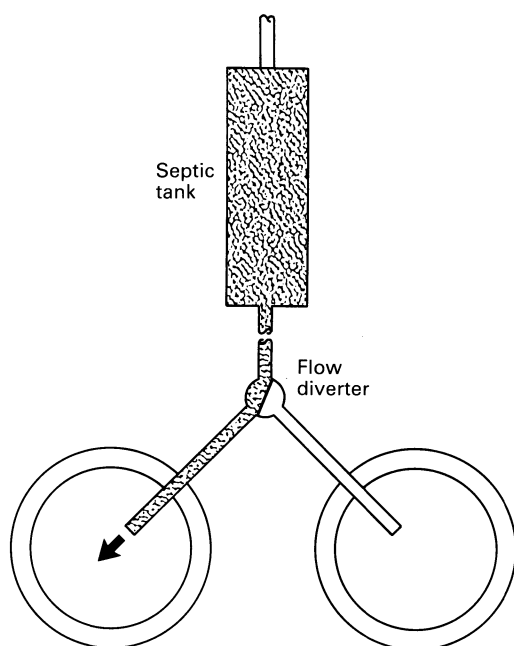


Figure 9 Alternating soak pits — annual cycle

7 ASSESSING SITE SUITABILITY

Many text books give only limited advice on site assessment for soakage capacity. Most sources only recommend a simple percolation test, utilising clean water as the test medium, to establish the rate of wastewater or effluent absorption into the soil. This advice is generally too limited to give sensible results to guide practitioners in site evaluation and design of effluent disposal systems.

A lot of information is available on drainfields for septic tanks, particularly in the USA. However, problems of siting pit latrines and soak pits have not received the attention warranted by the huge increase in numbers of pits, installed in the developing countries during the 1980-90 UN Water and Sanitation Decade.

One of the most comprehensive and authoritative sources of information on the disposal of domestic wastewater via septic tanks, is the US Environmental Protection Agency's 'Design Manual: On-site wastewater treatment and disposal systems'¹⁰. The emphasis of the information in this Manual is on septic tank systems; some of the recommendations have been adopted in the advice presented in this present Note. In particular, it is recommended that site evaluation for soakage suitability should be based on a soil type classification, to be used together with a percolation test, to assess a soil's soakage potential. This advice is presented as the best available from current published material.

8 SITE EVALUATION FOR SOAKAGE

The absorption capacity of the soil is not the only limitation on site suitability for effluent disposal by soakage. The general suitability of the site location should also be considered.

8.1 Site suitability

Landscape position: Level, well-drained areas, crests of slopes, and convex slopes are most desirable. Avoid depressions, bases of slopes and concave slopes, unless suitable drainage is provided.

Slope: Up to 25%. Land slopes in excess of 25% can be utilised but the use of construction machinery may be limited. Excavating the ground manually is less likely to damage the soil structure and is likely to be the lowest cost option in a developing country. Falls along trenches and beds should be less than 5%, and be in the direction of flow. Generally, trenches should follow the land contours.

Unsaturated depth: There should be at least a 1m depth of unsaturated soil between the bottom of the proposed soakage system and the seasonally high water table or bedrock, in case the rock is fissured.

8.2 Soil suitability

Preferred subsoils for the installation of drainfields, soak pits and pit latrines have the following basic characteristics:

Texture: Soils with sandy or loamy textures are best. Gravelly soils with open pores and slowly permeable clay soils are less desirable.

Colour: Bright uniform colours indicate well-drained, well-aerated soils. Dull, grey or mottled subsoils indicate continuous or seasonal saturation and are generally unsuitable.

9 RECOMMENDED SITE SOIL TESTS

9.1 Soil classification

In order to be able to determine the suitability of a soil for soakage, and then to specify an effluent application rate per unit area of infiltrative surface, it

is necessary to test and classify the soil. This can be done on site and can be sufficiently accurate to identify the type of soil by sight and feel, without the need for laboratory testing.

The soil sample should be obtained from the level of the anticipated bottom of the proposed soakage trench or pit. For trenches, assume a provisional depth of 700mm⁷, (500mm minimum cover over pipes, plus 100mm pipe diameter, plus 150mm pipe bed thickness). Soil samples for a soak pit should be taken from depths of 2 and 3m. If it is found necessary for a pit to be deeper than 3m, see Section 11, it is probably better to consider multiple shallow pits, for ease of excavation and to reduce the likelihood of the pit bottom being too close to the water table. If there is doubt about the depth of soil under the proposed soakage system, the sampling auger should be taken deeper, so that it can be ascertained that there is at least a 1m depth of suitable soil (see Section 4).

To verify the soil classification, a site percolation test¹ is required. If the percolation test confirms the classification, the effluent application rate can then be selected from Table 2. If the percolation test does not support the classification, then reasons should be sought to explain the discrepancy, eg presence of fissures, tree roots, compacted areas or ground¹ disturbances.

In addition to soil testing, and to assist in the overall assessment of soakage potential, local enquiry can often provide useful information on performance of existing systems. The reasons for failures can point to particular problems that need to be taken into account for any new installation.

Table 1 lists six main classes of soil from highly porous sand to impervious clay.

9.2 Soil percolation testing

There are several sources describing types of percolation test, often recommended as the only test necessary to determine the suitability of a site for soakage.

The percolation test recommended here is based on the test described in the US Environmental Protection Agency Design Manual¹⁰. It should be used to verify the soil classification test already described.

'Falling head percolation test' procedure:

- (i) **Number of tests.** A minimum of three percolation tests (ie three test holes) should be carried out within a proposed soakage system (drainfield)

Table 1 Soil classification by texture

Soil Class	Textural properties of mineral soils	
	Dry soil	Moist soil
Sand	Loose, single grains that feel gritty. Squeezed in the hand, a sample falls apart when the pressure is released.	Squeezed in the hand, forms a cast that crumbles when touched. Does not form a ribbon when squeezed between thumb and forefinger.
Sandy loam	Soil mass easily crushed; very faint velvety feel initially, but gritty feeling of sand soon dominates.	Forms a cast which bears careful handling without breaking. Does not form a ribbon between thumb and forefinger.
Loam	Soil mass can be crushed under moderate pressure; clods can be quite firm. When pulverised has velvety feel that becomes gritty with rubbing. Casts can bear careful handling.	Casts can be handled quite freely without breaking. Very slight tendency to ribbon between thumb and forefinger. Rubbed surface is rough.
Silty loam	Soil mass is firm but may be crushed under moderate pressure. Clods are firm to hard. Smooth, flour-like feel dominates when pulverised.	Casts can be freely handled without breaking. Slight tendency to ribbon between thumb and forefinger. Rubbed surface has broken or rippled appearance.
Clay loam	Soil mass very firm. Clods are hard and strongly resist crushing by hand. Soil takes on gritty feeling when pulverised, due to harshness of very small aggregates.	Casts can bear much handling without breaking. Forms a ribbon when pinched between thumb and forefinger which tends to feel slightly gritty when dampened and rubbed. Soil is plastic, sticky and puddles easily.
Clay	Soil mass is hard. Clods are extremely hard and strongly resist crushing by hand. Has grit-like texture when pulverised, due to harshness of numerous very small aggregates.	Casts can bear considerable handling without breaking. Forms a flexible ribbon between thumb and forefinger; retains its plasticity when elongated. Rubbed surface has very smooth satin feel. Sticky when wet and easily puddled.

Based on the EPA Design Manual¹⁰

area. They should be uniformly spaced within the specified area. If soil conditions are highly variable, more than three test holes may be required. For siting a soak pit or pit latrine however, a single test hole is sufficient.

- (ii) **Test hole preparation** (Figure 10). Dig or bore a 150 mm diameter test hole to the depth of the bottom of the proposed soakage system (trench or pit, see Section 9). Because of the depth of a pit, the hole can be opened out above the lower 400 mm for convenience of access. To expose as natural a soil surface as possible, scratch the wall of the test hole with a sharp pointed instrument and remove any loose material from the bottom of the hole. Place a 50 mm depth of 12 to 18 mm gravel in the hole to protect the bottom from scouring action when water is added.

- (iii) **Soaking period.** Carefully fill the test hole with at least 300 mm depth of clean water. This depth of water should be maintained by topping-up, for at least 4 hours and preferably overnight if in clay soil. A funnel and hose or similar device is used when adding water, to prevent the water from

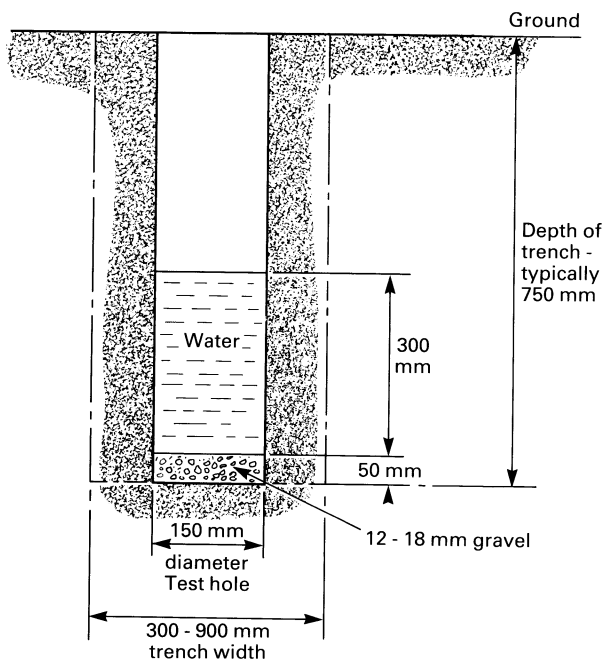


Figure 10 Test hole — for percolation test (soaking period)

washing down the wall of the hole. Automatic siphons or float valve devices can be used to automatically maintain the water level during the soaking period. It is important that the soil is soaked for a sufficient time to allow the soil to swell so as to give accurate results.

In sandy soil with little or no clay, soaking is unnecessary. If, after filling the 300 mm depth of hole twice, the water seeps completely away in less than 10 minutes, then measurement can proceed immediately

- (iv) **Measuring the water level drop.** Except for sandy soils, water level measurements should be made at least 15 hours, but no more than 30 hours, after soaking began. Remove any soil collecting in the hole during the soaking period and adjust the water level to 150 mm above the gravel (200 mm above the bottom of the hole). Do not allow the water level to rise more than 150 mm above the gravel during the test. Immediately after adjusting the depth, measure the water level from a fixed reference point (dimension 'A', Figure 11), to the nearest 2 mm and repeat at 30 minute intervals. The change in dimension 'A' equals the water level drop. The test is continued until two successive water level drops do not vary by more than 2 mm. At least three measurements are made and after each the water level is adjusted to maintain the 150 mm depth over the gravel. The last water level drop is used to calculate the percolation value.

In sandy soils, or soils in which 150 mm depth of water soaks away in less than 30 minutes, water level measurements are taken at 10 minute

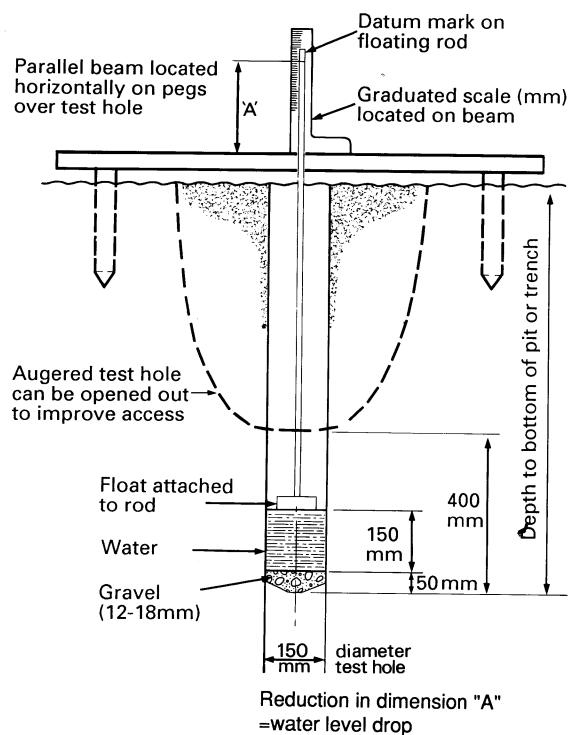


Figure 11 Suggested set-up for measuring water level drop (drop of datum mark against stationary scale)

intervals for a 1 hour period. The last water level drop is used to calculate the percolation value.

- (v) **Calculating the Percolation Value.** The Percolation Value, in seconds per mm, is calculated for each test hole by dividing the time interval between measurements by the last water level drop. To determine the Percolation Value for the area, take the average of the test hole results. However, if the area test results vary by more than 47 sec/mm, variations in soil type are indicated and results should not be averaged.

Example:

If the last measured water level drop in a test hole was 16 mm after 30 minutes, then the

$$\text{Percolation Value} = \frac{30 \times 60}{16} = 113 \text{ sec/mm}$$

10 RECOMMENDED EFFLUENT APPLICATION RATES

Having classified the subsoil, sampled at the bottom level of the soakaway, and calculated the relevant Percolation Value, check that the Value lies within the range given in column 2 of Table 2 for that particular soil class. The appropriate Effluent Application Rate can then be obtained from column 3 of Table 2 and used to calculate the minimum infiltrative surface area necessary for the soakage system. As explained at 9.1, if the percolation test does not support the soil classification, then reasons should be sought to explain the discrepancy.

Table 2 Effluent application rates for soakage system infiltrative surface areas

Soil class (range)	Percolation value (range) sec/mm	Effluent application rate l/day/m ²
Gravel to coarse sand	Less than 2.5	Not suitable for soakage without additional undersoil layer (loamy sand)
Coarse to medium sand	2.5 to 12	60
Fine sand to loamy sand	13 to 36	40
Sandy loam to loam	37 to 72	30
Loam to silty loam	73 to 143	20
Silty clay to clay loam	144 to 283	Generally not suitable for soakage. Where no other option, application rate less than 10.

Based on the EPA Design Manual¹⁰

11 DESIGN OF SOAKAGE SYSTEMS

The simplest soakaway is a hole in the ground (soak pit/seepage pit), filled with stones or coarse rubble to prevent collapse of the soil walls (Figure 5). The upper 0.5 m of the hole should be lined with solid masonry to support the cover slab and inlet pipe. Another type of soak pit without the rubble fill, has a perforated lining to allow seepage of effluent into the surrounding soil (Figure 6)¹¹.

Where space is available on the housing plot and the cost is affordable, the installation of a shallow soakage trench system (Figure 7) should be considered, because it is less likely to contaminate the groundwater than a pit. Because the infiltrative surfaces are near the ground surface, oxygen is available to encourage aerobic biological activity, which is very effective in purifying the effluent.

If it is important to protect the groundwater, soakage systems should always be located above the water table, having at least 1m of suitably pervious soil between the bottom of the pit or trench and the highest seasonal groundwater level.

In both soak pits and trenches the base area should be ignored for soakage calculations, because it quickly loses its porosity due to surface blocking

Sizing of a soakage system can be by the following formula:

$$A = \frac{V \times N}{R}$$

Where A = total infiltrative surface area (m²)
 V = volume of liquid to be disposed of (l/head/day)
 R = effluent application rate to infiltrative surfaces (l/day/m²) from Table 2.

Example 1: Find the minimum infiltrative surface area, 'A', of a soakaway for an aqua privy serving a household of 10 persons, each contributing 20 litres of

wastewater per day (V). The subsoil is a silty loam, allowing an effluent application rate (R) of 22 l/day/m²:

$$A = \frac{20 \times 10}{22} = 9.1\text{m}^2$$

Options:

- (a) Soak pit, 1m diameter × 2.9m deep, infiltrative area, A = 9.1m²
- (b) Soakage trench (2 walls of 0.5m infiltrative depth): A = 2 × 0.5m deep × 9.1m long = 9.1m²

Example 2: Find the minimum infiltrative surface area, 'A', of a soakaway for a septic tank serving 10 persons, when V = 150 l/day and the subsoil is a sandy loam (R = 30 l/day/m²):

$$A = \frac{150 \times 10}{30} = 50\text{m}^2$$

Options:

- (a) Soak pit, 1.5m diameter × 10.6m deep, A = 50.3m² (A single pit not practicable, could be four pits connected in parallel, each 2.7m deep)
- (b) Soakage trench (2 walls of 0.5m infiltrative depth): A = 2 × 0.5m deep × 50m long = 50m² (multiple trenches connected in parallel, total length 50m)

12 CONCLUDING COMMENTS

This Overseas Building Note describes the three most widely used on-site sanitation systems and the problems of their effluent disposal to the ground. The recommendations made for site testing of soil for soakage suitability is presented as the best information currently available. At the present time there is no single established soil test that will reliably classify suitability of a particular area of ground for effluent disposal by soakage.

However, the guidance given in classifying the type of soil, sampled at the level closest to the anticipated seepage plane, and supported by a satisfactory percolation test, can serve as a practical guide to site selection. Site personnel carrying out and interpreting the results of these tests should be trained in the techniques and have an appreciation of the problems and uncertainties involved.

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