DRAFT GUYANA STANDARD

Code of Practice
for
The design and construction of ventilated improved pit (VIP) latrine as a sanitary household solution for human excreta

Prepared by
GUYANA NATIONAL BUREAU OF STANDARDS

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Foreword

Members of the Technical Committee

Members of Sub-committee – VIP latrines

Code of Practice
for
The design and construction of ventilated improved pit (VIP) Latrine as a sanitary household solution for human excreta

1 Scope

This code gives recommendations for the design, location, construction, and maintenance of VIP Latrine as a sanitary household solution for human excreta.

The code is applicable to individual housing units or institutions where each unit is designed to serve equivalent of 5 persons living per day.

2 Definitions

For the purpose of this standard the following definitions shall apply:

2.1 **authority:** The relevant statutory authority such as the local authority.

2.2 **cover:** Slab serve to isolate the pit from the atmosphere (to prevent the escape of flies and odors) and to support the superstructure and vent pipe.

2.3 **fly trap:** A device (usually mesh) that is attached to the top of the ventilation pipe. The purpose of the flytrap is to prevent the passage of flies and mosquitoes.

2.4 **human excreta:** Human faeces and urine.

2.5 **mound:** A mound is a general term for an artificial heaped pile of earth, gravel, sand, rocks, or debris. The purpose of the mound is to support the part of the pit that extends above the ground level.

2.6 **pit lining:** A layer of impermeable material to prevent seepage.

2.7 **single pit latrine:** The most economical and basic form of improved sanitation available. It consists of a square, rectangular or circular pit dug into the ground. It is covered with a specially designed hygienic and safe cover slab or floor, with a hole through a seat where excreta fall into the pit.

2.8 **sub-structure:** The portion of the VIP latrine that is below the cover slab and foundation. This includes the mound and pit.

2.9 **super-structure:** The housing unit above the pit. The function of the superstructure of any type of latrine is to provide the user with privacy, comfort and protection from the elements.

2.10 **twin pit latrine:** Two separate pits with their own vent pipe, but only one superstructure. The cover slab within the superstructure has two holes, one over each pit. Only one pit is used at a time.

2.11 **ventilation pipe:** A tall vertical pipe which extends above the roof of the superstructure and has a fly screen fitted at its top. The vent pipe is responsible for both odor and fly control.

2.12 **VIP – latrine:** Ventilated Improved Pit Latrine which is an improved sanitary household solution for human excreta. A VIP latrine differs from a traditional pit latrine in that it has a tall vertical vent pipe which has a fly screen fitted at its top. There are two basic types of VIP latrine: the single-pit latrine and one with two pits, known as the alternating VIP latrine or twin-pit latrine.

3 Preliminary data for design

In order to design a VIP-Latrine, the following information should be obtained:

3.1 Site conditions

All information on the nature of the soil and subsoil conditions should be obtained. This should include the approximate height of water-table and any available record of flood levels or information as to the variation, seasonal or otherwise, in the high water-table.

3.1.1 The soil should be explored to a sufficient maximum depth of 2.4 meters to determine the soil horizons and soil types, grading, structure and permeability.

3.1.2 The external drainage factors such as slope of ground and the position and nature of surface water drains should be ascertained.

3.2 Number of users

The number of full-time and part-time users shall be determined in order to determine the capacities and sizes of the VIP Latrine.

3.3 Other information

Other information that should be taken into account in the design VIP Latrine includes the following:

(a) the position and nature of outfall ditches and small streams;

(b) the position of any boreholes, wells, or spring.

3.4 Information to be given to the authority

Before the commencement of any work, plans of the proposed sanitation facility, in such form as may be prescribed by the Neighbourhood Democratic Council (NDC) or Town Council.

4 Ventilated improved pit (VIP) latrines

4.1 Single-pit VIP latrines

A VIP latrine differs from a traditional pit latrine in that it has a tall vertical vent pipe which has a fly screen fitted at its top. The vent pipe is responsible for both odor and fly control. A single pit VIP latrine as the name implies has only one pit which is used until it reaches it nominal capacity. When the pit is full, it is covered with soil of 0.3 meters high and a new pit is dug to replace that one. Depending on the condition of the superstructure, it can be transferred over the new pit.

Excreta are deposited directly into the pit, which has two essential functions:

(a) The liquid fraction of the excreta (mainly urine), together with the small amount of water that enters the pit from cleaning the cover slab, infiltrates into the surrounding soil.

(b) the fecal solids in the excreta are digested anaerobically by bacterial activity - this results in the production of

  (a) gases such as methane, carbon dioxide and hydrogen sulphide which are exhausted from the pit via the vent pipe; and

  (b) Soluble compounds which are either further oxidized in the pit or are carried into the surrounding soil by the infiltrating liquid fraction.

The anaerobic digestion of the fecal solids, which proceeds rapidly at tropical temperatures, does not however remove all of the solids. Some compounds are biodegraded only very slowly; as a result there is a gradual accumulation of solids in the pit, although the rate of solids accumulation is much smaller than the rate of excreta addition. In dry pits the solids accumulation rate is about 0.06 m^3 per person per year, and in wet pits it is around 0.04 m^3 per person per year. Accumulation rates are lower in wet pits because biodegradation is faster under wet conditions than under the only just moist conditions in dry pits.

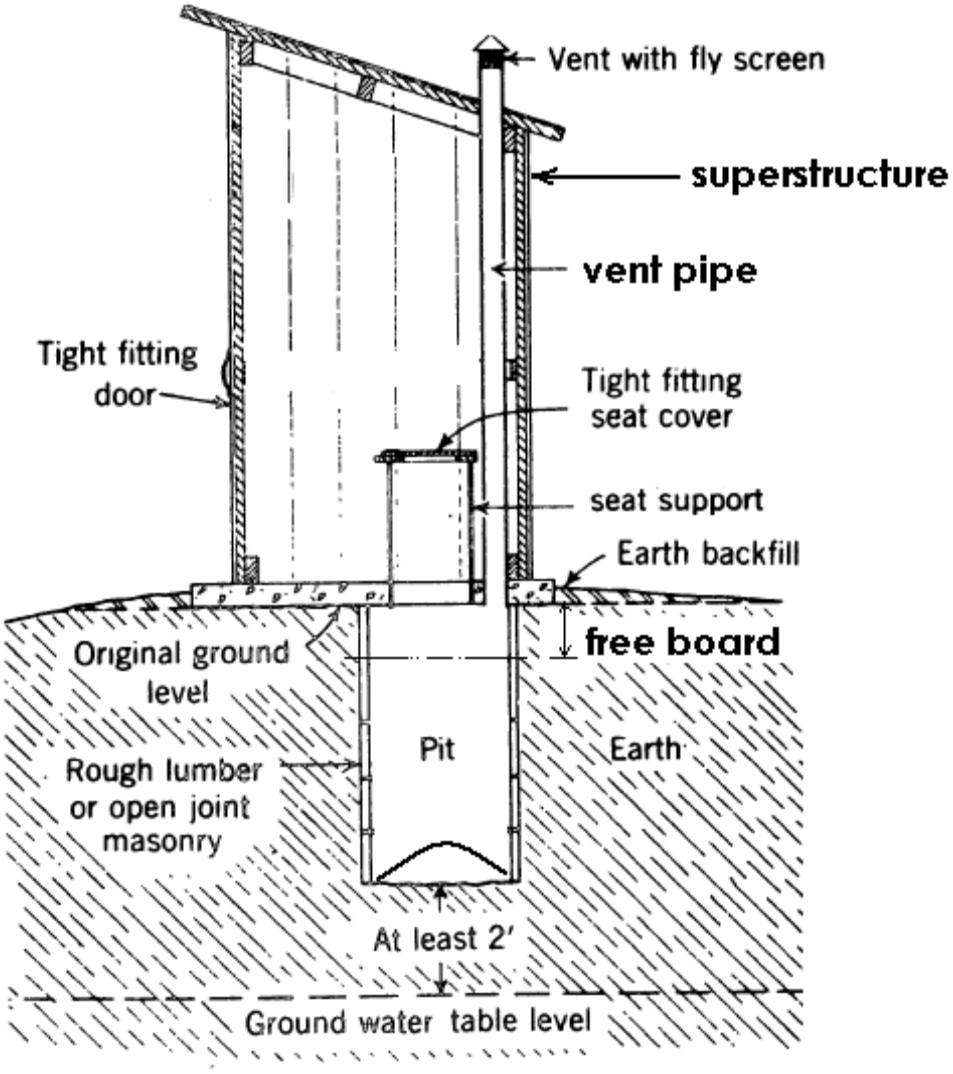


Figure 1: Illustrated Single Pit - Ventilated Improved Pit Latrine

4.1.1 Location

The site of the latrine should be well drained and above flood level. Latrines should also be constructed at a minimum safe distance from water source. The latrine should not penetrate ground water and should be at least 0.6 meters above the mean water table level. The latrine should be at least 30 meters away from well and springs.

The latrine should be located at a minimum safe distance of 4 meters away from any dwelling, so that it is easy to reach during bad weather and will not cause problems of odour in the house.

The latrines should be located at least 2 meters away from overhanging branches and any other obstacle that might impede the action of the wind across the top of the vent pipe. The doorway of the VIP latrine should face the wind.

4.1.2 Superstructure

The function of the superstructure of any type of latrine is to provide the user with privacy, comfort and protection from the elements. There are two additional functions in the case of VIP latrines:

(a) to provide sufficient shade so that newly emergent flies are not attracted to leave the pit via the seat opening; and

(b) to channel air through the seat opening and up the vent pipe, in order to control both flies and fecal odors.

Provided the superstructure is able to perform these functions, its design details are relatively unimportant from a strictly technical point of view. The superstructure can be built in a wide variety of forms and from a wide variety of materials.

In urban areas materials such as brick, concrete block, timber or corrugated galvaluminium sheeting are often used for walls. The roof can be made from a thin concrete slab or corrugated galvalume sheeting. In rural areas, it is generally more appropriate to use local materials such as thatch leaves or sun-dried earth blocks for walls; the roof is often made from thatch leaves. The design adopted in any one locality depends largely on social preference and the availability of materials.

4.1.3 Minimum dimensions of pit

(a) **Volume**: The required volume of the pit depends on the rate of accumulation of solids, the number of users and the desired life of the pit. Generally, the pit must not be allowed to fill up completely. A small free space at the top of the pit (the underside of the cover slab) must be allowed for in the design. Usually 0.5 meters is adequate for this.

The effective pit volume (m^3), which is the total volume less the free space volume, is calculated as the product:

$$V = K \times N \times T$$

Where:

V = effective pit volume (m^3)

K = rate of accumulation of solids (m^3/person/year),

K = 0.04 in wet pits and 0.06 in dry pits

N = number of users,

T = design life in years

The rate of accumulation of solids (K) may for design purposes be taken as 0.04 and 0.06 m^3/person/year in wet and dry pits respectively. The design life of the latrine should be as long as possible; a minimum of 5 years should be considered desirable. The longer the design life, the longer the interval between emptying or relocating the latrine.

(b) **Dimensions:** The pit cross-sectional area should not be more than 1.5 m in order to avoid a cover slab with large span. In practice VIP latrines serving one household commonly have a diameter of 1-1.5 m or, in the case of square or rectangular pits, a width of 1-1.5 m; communal or institutional latrines can of course be much larger.

Rectangular design for the pit is possible, although round pits are more stable. Optimum depth choice depends on local parameters such as, soil structure and groundwater table. The bottom of the pit should be at least 0.6m or 2 ft above the yearly average groundwater level.

The pit depth is calculated from its required effective volume, and the total depth is this depth plus the desired free space (freeboard) which is normally 0.5 meters from the underside of the cover slab.

$$D = \left[\frac{V}{A_s} \right] + F_b$$

Where:

D = pit depth (m)
V = volume of pit
A_s = area of cover slab
F_b = freeboard

4.1.4 Capacities

VIP latrines shall have capacities not less than the capacity shown in table 1.0 and as derived from the equation in section 4.4. The capacities shall be obtained by measurement of the internal volume of the pit, the depth being taken from the underside of the slab plus the free space.

Table 1.0: Nominal capacity for VIP Latrines – dry and wet pits.

Number of users	Cross sectional area (m^2)	Effective depth (m)	Nominal capacity (litres)	Effective life (years) WET PITS	Effective life (years) DRY PITS
4	0.84	1.52	1277	8	5.32
5	1.0	1.53	1530	7.65	5.10
6 - 8	1.0	2.0	2000	7.14	4.76

4.1.5 Pit lining

In stable soils, that is to say soils with undrained shear strength greater than 20 kN/m^2, the pit sidewall surface is lined by plastering it with cement mortar.

In unstable soils with lower undrained shear strength the pit is protected against collapse by lining it with a more substantial material. Specialized hardwood, such as greenheart, can be used. Bricks or concrete blocks could also be used. The vertical joints are not mortared or sealed to allow liquids to infiltrate away. However, the part of the pit above ground level and about 0.5m below ground are mortared or sealed.

Table 2.0: Method of pit lining depending on soil type

Soil type		Method of Pit Lining	
		Stable	**Unstable**
1.0	Clay soils (≥ 20 kN/ m^2 shear strength)	√	√
2.0	Pagasse/ Peaty Soil (contains humus)		√
3.0	Loamy Soil (40% sand, 40% silt, 20% clay)		√
4.0	Granular/Sandy Soil		√
5.0	Silt Soil		√

4.1.6 Ventilation pipe

Wind passing over the top of the vent pipe causes a flow of air from the pit through the vent pipe to the atmosphere and a downdraft from the superstructure through the seat into the pit. This continuous flow of air removes odour resulting from the decomposing excreta in the pit and vents the gases to the atmosphere at the top of the vent pipe rather than through the superstructure. The door should be kept shut at all times to keep the inside of the latrine reasonably dark. There should be a small space just above the door, for air to enter. The total area of this gap should be at least three times the cross-sectional area of the vent pipe.

(a) **Length:** The vent pipe should be sufficiently long so that the roof does not interfere with the action of the wind across the top of the vent pipe. The top of the vent pipe should be at least 0.3 m higher than the nearest roof.

(b) **Location:** The vent pipe itself should be located on the windward side of the superstructure.

(c) **Material:** A wide variety of different materials can be used: for example, non pressure polyvinyl chloride (PVC) pipes, unplasticized PVC (uPVC, galvanize pipes, and large diameter bamboo with the cell dividers removed.

(d) **Diameter:** The internal diameter of the vent pipe depends on the required venting velocity necessary to achieve the recommended ventilation. The dimension of the vent pipe is important as the airflow up it has to be big enough to carry away all the odours, but not excessively big. A pipe of diameter of more than a 100 mm will be adequate to achieve the required ventilation and should be painted black.

4.1.7 Mound (Optional)

The presence of a high water table near the ground surface usually affects the depth of the pit. In such circumstances, the latrine can be built on a mound as shown in **Figure 2**. It is also necessary to build on a mound depending on the vulnerability of the area to flooding. The pit walls need to be built up before the mound is constructed. The pit should be carefully lined with brick, hollow concrete blocks, solid hardwood or concrete masonry and the lining continue above the ground to the top of the mound. Steps should be built up on the outside of the mound for easy access using suitable material.

The table below (**Table 3**) shows the height of the mound required for the different areas being considered. The height should conform to the minimum height of the ground floor of the house as stipulated by the National Building Code.

Table 3.0: Height of mound for different areas

Area		**Height of Mound** *(h)*	
		m	**ft.**
1.0	Low Coastal Plain	0.9 – 1.0	3.0 – 3.28
2.0	Higher Coastal Regions (above sea level)	0.3 – 0.6	1.0 – 2.0
3.0	Hilly, Sand & Clay Belt	0 – 0.3	0 – 1.0
4.0	Hinterland Regions		

4.1.8 Construction

The VIP Latrine can be built from different materials. These should be chosen according to availability and cost of materials, skills available, and soil type. The different materials that can be used require alternative methods of construction. In all cases, the slab is built using the available materials, such as concrete or hardwood.

(a) **Cover slab**

The cover slab and its foundation serve to isolate the pit from the atmosphere (to prevent the escape of flies and odors and influx of water into the pit) and to support the superstructure and vent pipe. The cover slab must be much larger than the pit, so there is no danger of collapse. The slab can be built from wood or concrete. A mould can be use to pre-cast the concrete slab. The slab will contain both the opening to the pit and the hole for the ventilation pipe.

(b) **Seat**

The seat should be elevated above the cover slab with an opening into the pit. The seat can be constructed from solid timber, hollow concrete blocks, concrete or plastic. The opening can either be circular, rectangular or square and should not be too large. A 200mm diameter circular or square hole is a good size. In the case of a twin pit VIP latrine the seat is designed and constructed is a manner in which it can be easily removed and relocated for use in the other pit after one pit has been closed. The seat must be constructed using materials that are strong and resistant to rupture.

(c) **Fly trap**

The purpose of the flyscreen is to prevent the passage of flies and mosquitoes. The size of the openings in the fly screen (mesh aperture) must not be larger than 1.5 mm. Smaller apertures are not recommended as they will result in decreased ventilation rates, due to increased frictional losses. The flyscreen must be made of corrosion-resistant material that is able to withstand intense rainfall, high temperatures and strong sunlight.

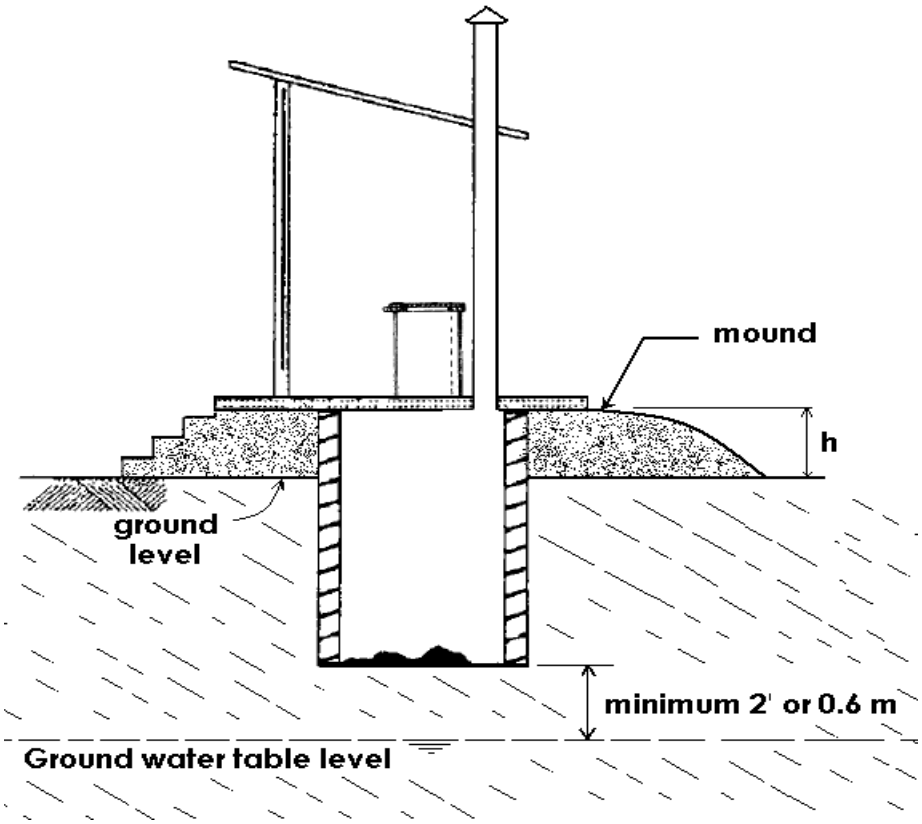


Figure 2: Single pit VIP latrine on an elevated mound

4.2 Alternating twin pit VIP latrines

Alternating twin-pit VIP latrines (**Figure 3**) have two separate pits, each with their own vent pipe, but only one superstructure.

4.2.1 Operation

The cover slab within the superstructure has two openings, one over each pit. The opening of the pit not in use is usually kept sealed. Only one seat over the opening and pit are used at a time. When this pit is full, depending on its capacity, the seat is transferred to the next opening and the second pit is put into service. After a further period of use, when this pit is full, the contents of the first pit are removed to enable it to be used again. This alternating cycle is repeated continuously. The contents of the latrine are removed when the pit has reached its nominal capacity and can be used for soil enrichment.

4.2.2 Location

This type of VIP latrine is a permanent sanitation facility suitable for use in areas with high water table level due to the fact that the entire pit is lined including the bottom. Therefore, no liquid fraction will escape from the pit into the water table and surrounding soils. Also, this is a viable option where there is insufficient space on each housing plot for two or more single-pit VIP latrines. Like single pit VIP latrines, the site of the twin-pit latrine should be well drained and above flood level. Latrines should also be constructed at a minimum safe distance from water source and from the dwelling unit.

4.2.3 Design

Many of the design details for alternating twin-pit VIP latrines are the same as for the single-pit type. This includes the super structure, mound and substructure. The substructure consists of two lined pits which are separated by a permanent central wall.

The holes for the seating and the ventilation pipe for the pit not in use are sealed. As with single VIP latrines, the superstructure must be kept partially dark at all times to discourage flies.

4.2.4 Pit Lining and walls

The pits are usually lined with bricks or blocks. Each pit may have its own opening or seat. Alternatively, slabs may be movable, one with a hole for the pit in use and a plain slab for the other pit. Which ever design is used, only one hole must be available for defecation at any time. The latrine may be provided with two ventilation pipes (one for each pit) but more usually only one is fitted, to the pit in use.

The central wall between the two pits should be made with full mortar joints and may be plaster with cement mortar on both sides. As with the single-pit VIP latrine, the double-pit VIP latrine has the advantages of reduced smell and fly nuisance.

4.2.5 Capacity

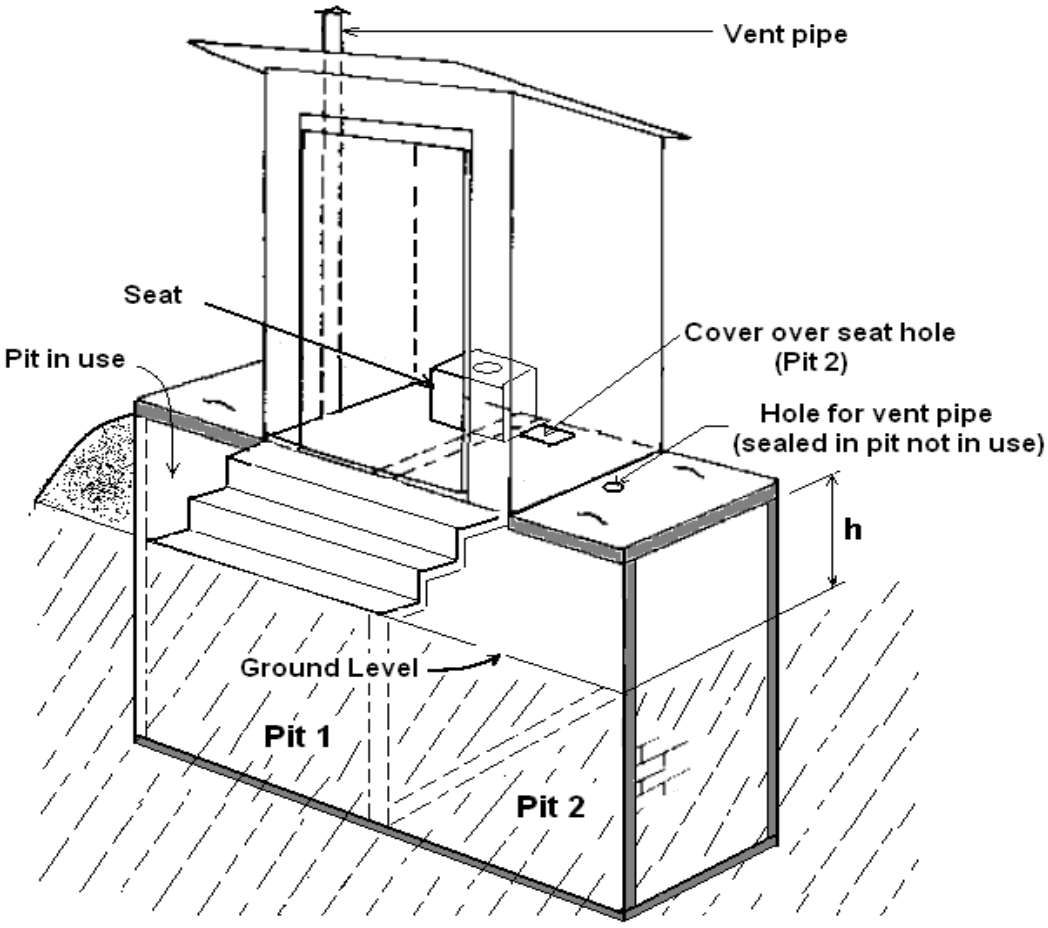
The pits must have a nominal capacity to allow each pit to be used for at least two years. However, the depth must be such that it allows for easy access for the removal of the contents. The pits should extend beyond the superstructure, either to the sides or at the back, with removable slabs for emptying. These slabs should be easy to lift, but should be sealed to prevent flies getting in or out and the influx of water.

Table 4.0: Nominal capacity for Alternating (Twin Pit) VIP Latrines.

Number of users	Cross Sectional Area of both pits (m^2)	Cross Sectional Area of one pit (m^2)	Effective depth (m)	Nominal capacity for one pit (litres)	Design life for one put (years)
4	1.4 (1.5m L x 0.9m W)	0.70 (0.8m x 0.9m)	1.0 (1.0m)	700 (0.7 m^3)	2.9
	1.67 (1.8m L x 0.9m W)	0.83 (0.9m x 0.9m)	1.0 (1.0m)	830 (0.83 m^3)	3.45
5	1.67 (1.8m L x 0.9m W)	0.83 (0.9m x 0.9m)	1.0 (1.0m)	830 (0.83 m^3)	2.8
6	1.67 (1.8m L x 0.9m W)	0.83 (0.9m x 0.9m)	1.22 (1.22m)	1.013 (1.013 m^3)	2.8
7-8	1.67 (1.8m L x 0.9m W)	0.83 (0.8m x 0.9m)	1.22 (1.22m)	1.013 (1.013 m^3)	2.1

Twin – pit VIP latrines are usually (but not always) more expensive than single-pit VIP latrines, and require a greater operational input from the user, particularly in changing over pits.

Figure 3: Alternating twin Pit VIP Latrine



5 Work on site, inspection, testing and routine maintenance

5.1 Work on site

Work on site shall conform to acceptable levels of good engineering practice and in conformity with the recommendations of this code.

5.2 Inspection

The work should be carefully inspected at all stages of construction to ensure that it is being undertaken according to the recommendations of this code.

5.3 Maintenance

The total depth of solid accumulations should not be greater than 0.5 meters from the underside of the cover slab. When the contents have reached this level, then the pit should be covered over with soil and a new pit should be dug. The same superstructure could be used over the new pit depending on its condition and strength.

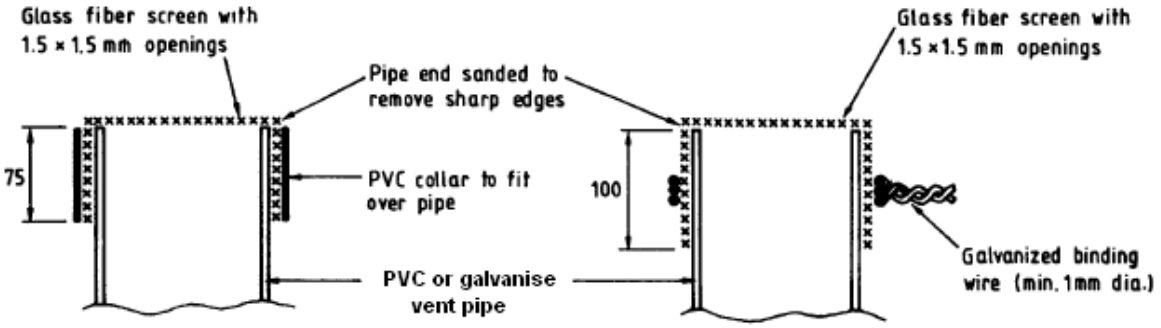
Surface water should not be allowed to enter the pit, as it would then fill up with accumulating sediments. A compacted clay mound or a mound capped with sand/cement mortar around the pit should offer sufficient protection against rain water.

Fly trap: The fly-screen at the top of the vent pipe needs to be checked frequently and anything that is lodged on top of it, leaves for example has to be removed.

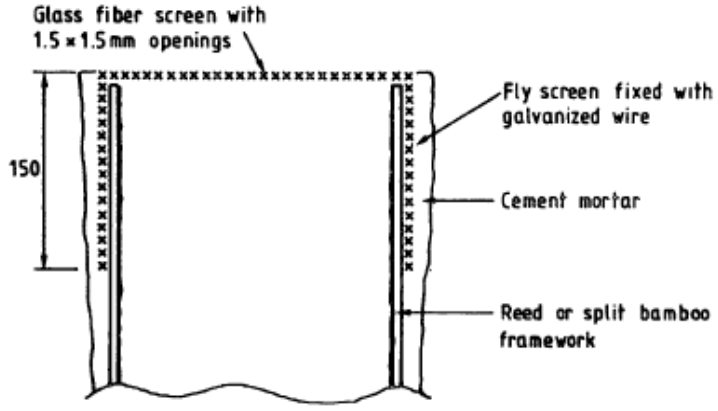
The latrine should be kept clean at all times. Any grass or plant growing around that latrine should be cut. The floor should be cleaned daily using water and detergent.

No disinfectant/bleach should be added to the pit. Tins, glass, plastics or other foreign materials must not be deposited into the pit.

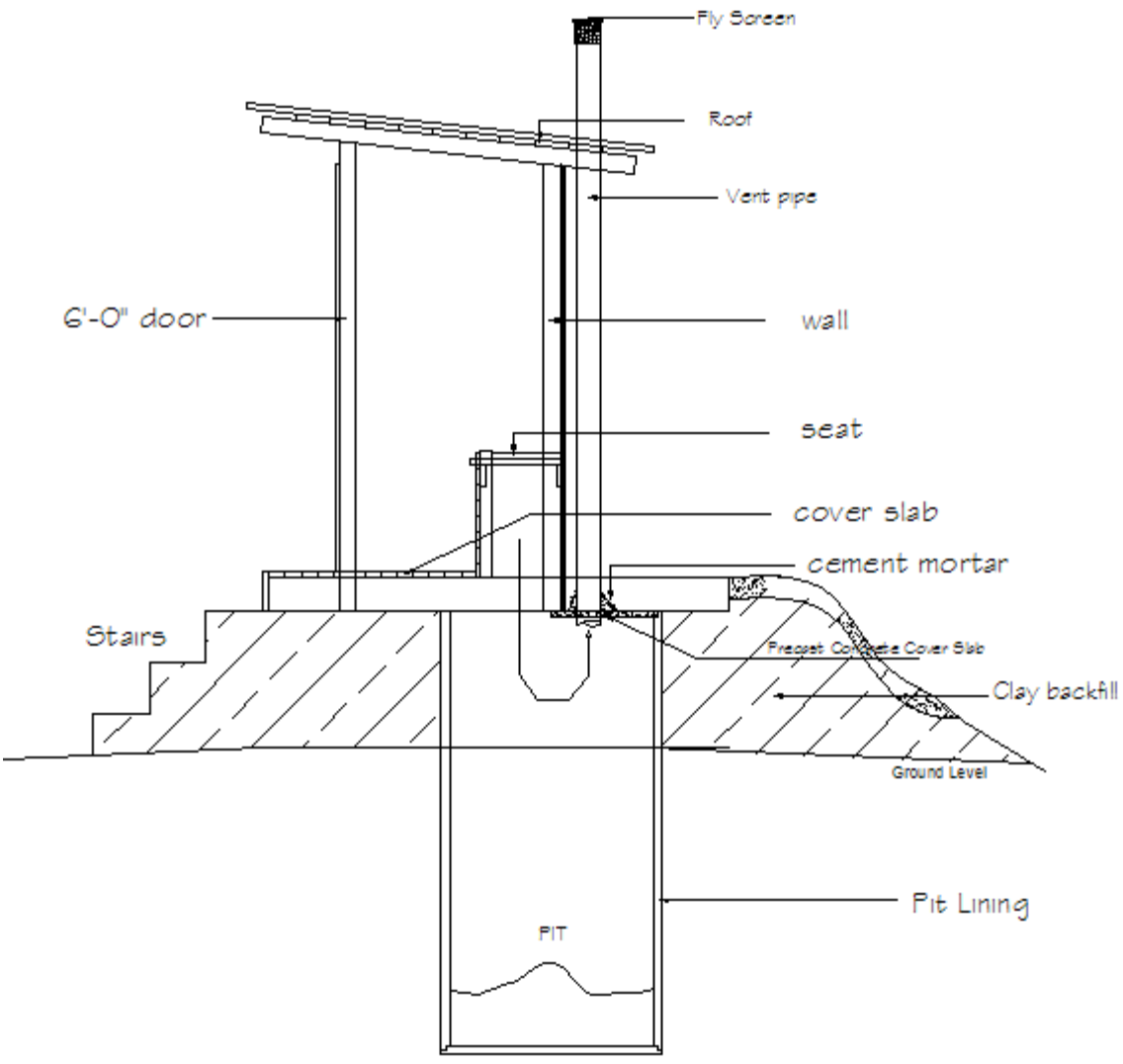
Appendix A
Method for fixing fly trap to the ventilation pipe



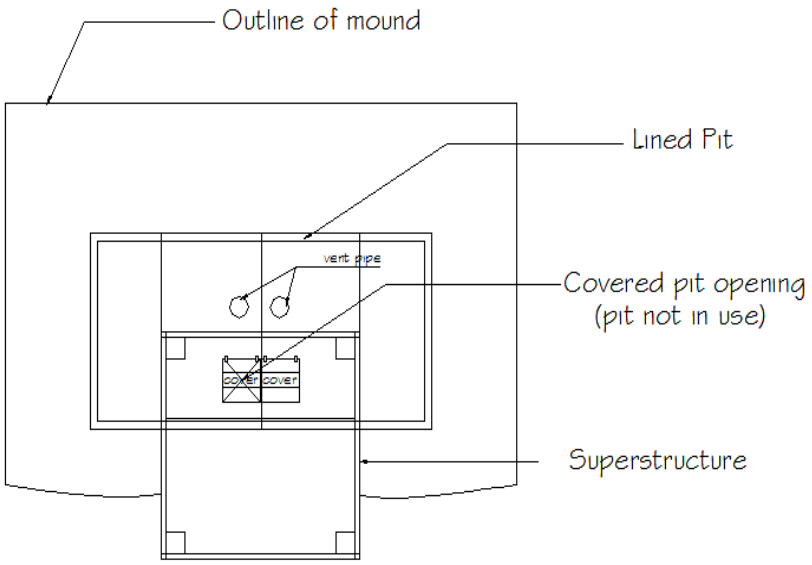
Alternative methods of fixing fly screen to PVC vent pipes



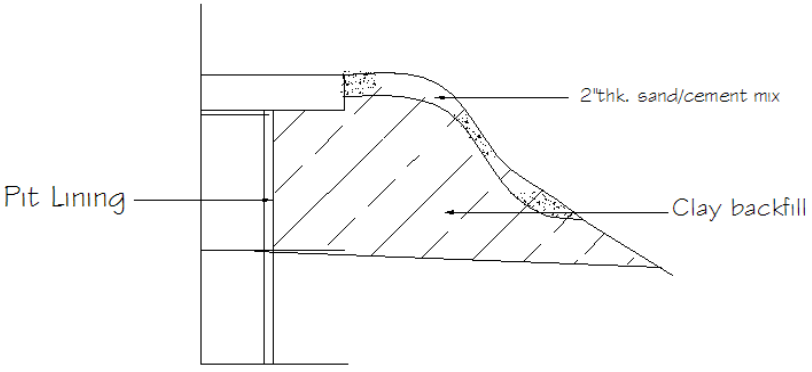
Appendix B
Sectional elevation of a ventilated improve pit latrine



Appendix C
Details of the mound for a twin – pit VIP latrine



PLAN SHOWING MOUND AND PIT



MOUND DETAIL