Water for the World

Designing Compost Toilets
Technical Note No. SAN. 1.D.6

A compost toilet consists of a pair of waterproof vaults that receive excreta, ashes, sawdust, straw, and grass. Each vault is equipped with a slab for defecating, a rear opening for removing compost, and a hole for a vent pipe. Designing a compost toilet involves selecting a location, calculating the size of the vaults, and determining the labor, materials, and tools needed for construction. The products of the design process are: (1) a location map, (2) design drawings of the compost toilet, and (3) a materials list. These products should be given to the construction foreman before construction begins.

This technical note describes how to design a compost toilet and arrive at these three end-products. Read the entire technical note before beginning the design process.

Useful Definitions

BACTERIAL ACTION - The process of organic matter being digested and broken down by tiny organisms.

COMPOST - A dark, fairly dry, crumbly, odorless material that is produced by sealing excreta, ashes, woodchips, straw, and vegetable wastes for 6-12 months in the vault of a compost toilet. Compost can be used to fertilize crops.

Materials Needed

Measuring tape - To obtain accurate field information for a location map.

Ruler - To draw a location map.

Location

The compost toilet should be on fairly level ground and at least:

6m from the nearest dwelling,
6m from the nearest water supply,
3m from the nearest property line.

Select a site that allows easy access to the toilet for use and for removing compost. If possible, the site should be downwind from the dwelling as there will be an odor. When the site has been selected, draw a location map similar to Figure 1 showing correct distances from the compost toilet to dwellings, water supplies, property lines, and roads. Give this map to the construction foreman before construction begins.

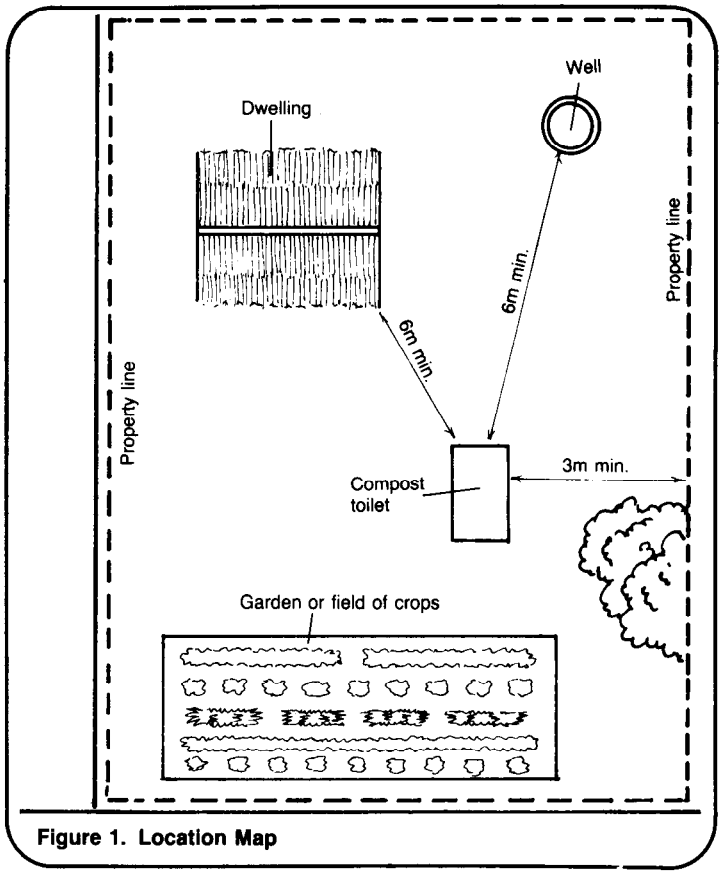

Figure 1. Location Map

General Design Information

A double-vault compost toilet is usually made from reinforced concrete or brick and mortar, and it rests on a base of similar material. See Figure 2. The vaults must be waterproof. If they are made from brick and mortar, the inside walls should be coated with a 12-25mm thick coating of cement plaster. The minimum thickness of the walls and base are shown in Table 1.

Design the vaults to be the same size. The maximum dimensions of each vault are shown in Table 2.

The rear wall of each vault must have an opening at least 0.4m by 0.4m for removal of compost, and a hole about 100mm in diameter for a vent pipe. The openings must have wood or metal covers that are larger than the openings themselves. The covers should be braced. The vent pipes are generally 100mm in diameter and made of galvanized metal.

Table 1. Walls and Base Design Criteria

Feature	Minimum Thickness
Outside Wall	75mm
Inside Wall (between vaults)	150mm
Base	100mm

The compost toilet may have two vent pipes which are permanently installed, or one vent pipe which is moved to whichever vault is in use. The vent hole in the vault not in use must be covered with wood or metal.

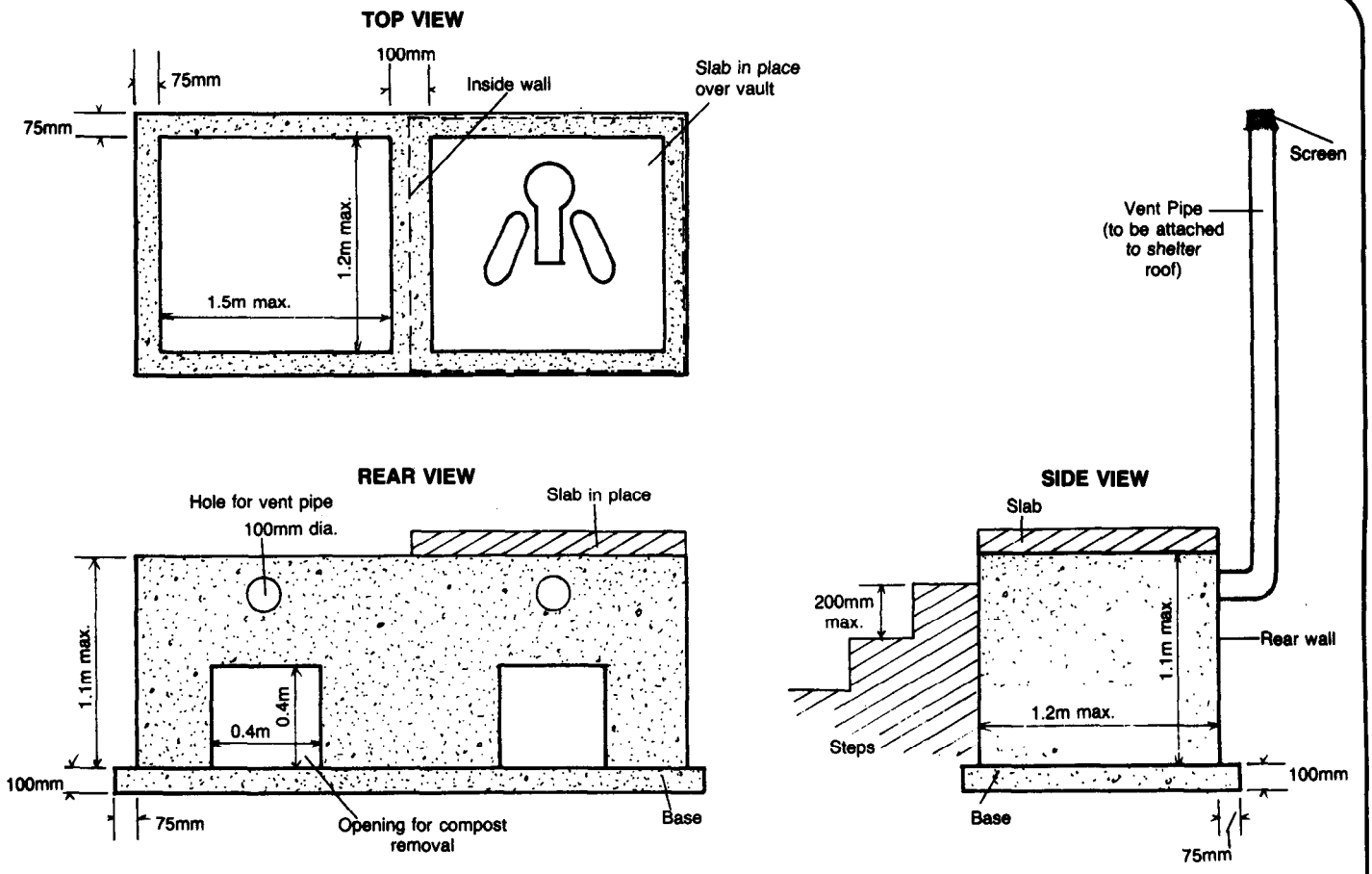

Figure 2. Compost Toilet

Table 2. Vault Dimensions

Feature	Maximum Dimension
Inside Height	1.1m
Inside Length (front to rear)	1.2m
Inside Width	1.5m

Design the steps leading up to the compost toilet so that the maximum height of each step is 200mm. See Figure 2.

Design the slab so that it is flush with the outside walls of the compost toilet. For details, see "Designing Slabs for Privies," SAN.1.D.1.

Calculating Size

Volume. Each vault must be large enough so that it takes about one year to become 3/4 full. Each person produces about $0.2m^3$ of waste per year, taking into account volume reduction to excreta and grass clippings by bacterial action. This number is multiplied by 1.33 because the vault is filled with soil and sealed when it becomes 3/4 full. Therefore, the volume factor equals:

$0.2m^3 \times 1.33 = 0.27m^3$ per person.

To calculate the required volume of each vault, multiply the volume factor times the number of persons using the compost toilet. For example, if the toilet is to serve a family of five, the volume of each vault must be five times $0.27m^3$:

$5 \times 0.27m^3 = 1.35m^3$ (Worksheet A, Lines 1-2).

Because of the limitations on dimensions shown in Table 2, this type of compost toilet will serve a maximum of seven persons. If eight or more persons must be served, design more than one toilet.

Inside Dimensions of Each Vault. Determine the inside dimensions of each vault based on the required volume and on the information in Table 2. The volume equals the inside height times the inside length times the inside width. For example, if the required volume of each vault is $1.35m^3$, the inside dimensions could be:

1.00m (height) x 1.10m (length) x 1.23m (width) = $1.35m^3$ (Worksheet A, Lines 3-5).

Outside Dimensions of Toilet. The outside dimensions of the toilet depend on the inside dimensions of each vault and on the information in Table 1.

The outside height equals the inside height.

The outside length (front to rear) equals the inside length plus two times the outside wall thickness.

The outside width equals two times the inside width plus two times the outside wall thickness plus the thickness of the inside wall between the vaults.

For example, if the inside dimensions of each vault are:

height = 1.00m, length = 1.10m, width = 1.23m, then the outside dimensions of the compost toilet are:

outside height = 1.00m;
outside length = 1.10m + (2 x 0.075m) = 1.10m + 0.15m = 1.25m;
outside width = (2 x 1.23m) + (2 x 0.075m) + 0.15m = 2.46m + 0.15m + 0.15m = 2.76m (Worksheet A, Lines 6-8).

Dimensions of Base. The dimensions of the base are as follows:

length (front to rear) = toilet length plus 0.15m,
width = toilet width plus 0.15m.

This leaves a 75mm area around the base to support the privy shelter. For example, if the outside dimensions of the toilet are:

length = 1.25m, width = 2.76m, then the dimensions of the base are:

length (front to rear) = 1.25m + 0.15m = 1.40m,
width = 2.76m + 0.15m = 2.91m (Worksheet A, Lines 9-10).

Dimensions of Slabs. Each vault is covered with a squatting or sitting slab. For design criteria, see "Designing Slabs for Privies," SAN.1.D.1. The outside dimensions of each slab are as follows:

length (front to rear) = compost toilet length;
width = compost toilet width divided by two. For example, if the dimensions of the toilet are:

length = 1.25m, width = 2.76m, then the dimensions of the slab are:

length = 1.25m
width = $\frac{2.76m}{2}$ = 1.38m (Worksheet A, Lines 11-12).

When all dimensions have been calculated, draw up a plan view similar to Figure 2 showing correct inside and outside dimensions. Give this drawing to the construction foreman before construction begins.

Determining Materials, Tools and Labor

The walls and base of a compost toilet are made from reinforced concrete or brick and mortar. The slab is made from reinforced concrete. Concrete walls and base require cement, sand, gravel, and water; containers and tools for mixing and smoothing concrete; reinforcing materials; wood, hammer, saw, and nails for building forms; and at least one worker with some experience with concrete. See "Designing Septic Tanks," SAN.2.D.3, for complete details and specifications on concrete ingredients and reinforcing materials.

Brick and mortar walls and base require bricks or concrete blocks; cement, sand, and water for mortar and cement plaster; containers and tools for mixing and spreading mortar; and at least one worker with some experience with concrete.

A concrete slab requires the same materials, tools, and workers as for concrete walls and base.

Quantities. The quantities of materials needed can be estimated by adding the volumes of the slabs, outside walls, inside wall, and base.

Volume of slabs: see "Designing Slabs for Privies," SAN.1.D.1.
Volume of outside walls = 2 x [(length x height x thickness) + (width x height x thickness)].
Volume of inside wall = height times length times wall thickness (0.15m).
Volume of base = base length times base width times base thickness (0.10m).

For example, if the outside dimensions of the compost toilet are: height = 1.00m, length = 1.25m, width = 2.76m, base length = 0.40m, base width = 2.91m, then the approximate volume of materials equals:

volume of slabs

+ volume of outside walls = 2 x [(1.25m x 1.00m x 0.075m) + (2.76m x 1.00m x 0.075m)] = 2 x (0.094 + 0.207) = $\underline{0.60}m^3$

+ volume of inside wall = 1.00m x 1.25m x 0.15m = $\underline{0.19}m^3$

+ volume of base = 1.4m x 2.91m x 0.10m = $\underline{0.41}m^3$.

Total volume equals volume of slabs + $0.60m^3$ + $0.19m^3$ + $0.41m^3$ = volume of slabs + $1.20m^3$ (Worksheet A, Lines 13-17).

When all materials, tools, and labor requirements have been determined, draw up a materials list similar to Table 3 and give it to the construction foreman before construction begins.

In summary, give the construction foreman a location map similar to Figure 1, design drawings similar to Figure 2, and a materials list similar to Table 3.

Table 3. Sample Materials List

Item	Description	Quantity	Estimated Cost
Labor	Foreman	1	_____
	Laborer (skilled with concrete)	1	_____
	Laborer (unskilled)	1	_____
Supplies	Wood (for forms)	_____	_____
	Nails (for forms)	_____	_____
	Cement (Portland)	_____	_____
	Sand (clean, sized fine to 6mm)	_____	_____
	Gravel (clean, sized 6-25mm)	_____	_____
	Water (clear)	_____	_____
	Reinforcing material	_____	_____
	Squatting slabs	_____	_____
	Vent pipes (with screens)	_____	_____
	Tin sheets (to cover rear wall openings)	_____	_____
	Other		
Tools	Measuring tape	1	_____
	Hammer	1	_____
	Saw	1	_____
	Shovels	2	_____
	Trowel	1	_____
	Container for mixing concrete	2	_____
	Carpenter's level or equivalent (optional)	1	_____
	Carpenter's square or equivalent (optional)	1	_____
	Tar or equivalent (for sealing covers over rear openings)	_____	_____
	Other		

Total Estimated Cost = _____

Worksheet A. Compost Toilet Calculations

1. Number of persons using compost toilet = 5

2. Volume of each vault = $0.27m^3$ x Line 1 = $0.27m^3$ x 5 = 1.35 m^3

Inside Dimensions of Each Vault

3. Proposed height = 1.00 m

4. Proposed length (front to rear) = 1.10 m

5. Required width = $\frac{\text{Line 2}}{\text{Line 3 x Line 4}} = \frac{(1.35m^3)}{(1.00m) \times (1.10m)}$ = 1.23 m

Outside Dimensions of Compost Toilet

6. Height = Line 3 = 1.00 m

7. Length (front to rear) = Line 4 + (2 x 0.075m) = 1.10 m + 0.15m + 1.25 m

8. Width = (2 x Line 5) + (2 x 0.075m) + 0.15m = (2 x 1.23 m) + 0.15m + 1.15m = 2.46 m + 0.30m = 2.76 m

Dimensions of Base

9. Length (front to rear) = Line 7 + 0.15m = 1.25 m + 0.15m = 1.40 m

10. Width = Line 8 + 0.15m = 2.76 m + 0.15m = 2.91 m

Dimensions of Each Slab

11. Length (front to rear) = Line 7 = 1.25 m

12. Width = $\frac{\text{Line 8}}{2} = \frac{(2.76m)}{2}$ = 1.38 m

Quantities

13. Volume of slabs - see "Designing Slabs for Privies," SAN.1.D.1

14. Volume of outside walls = 2 x [(Line 6 x Line 7 x 0.075m) + (Line 6 x Line 8 x 0.075m)]

= 2 x [(1.00 m x 1.25 m x 0.075m) + (1.00 m x 2.76 m x 0.075m)]

= 2 x (0.09 m^3 + 0.21 m^3) = 2 x 0.30 m^3 = 0.60 m^3

15. Volume of inside wall = Line 6 x Line 7 x 0.15m = 1.00 m x 1.25 m x 0.15m = 0.19 m^3

16. Volume of base = Line 9 x Line 10 x 0.10m = 1.40 m x 2.91 m x 0.10m = 0.41 m^3

17. Total volume - volume of slabs + line 14 + Line 15 + Line 16 = volume of slabs + 0.60 m^3 + 0.19 m^3 + 0.41 m^3 = volume of slabs + 1.20 m^3