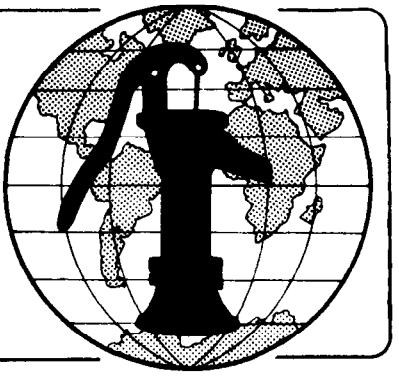
Water for the World

Designing Sumps, Soakage Pits and Soakage Trenches
Technical Note No. SAN. 1.D.7



Sumps, soakage pits, and soakage trenches receive washwater or effluent from an aqua privy and allow it to soak safely into the ground. Designing these disposal systems involves selecting a location, determining the type and size of the system, and determining necessary labor, supplies, and tools for construction. The products of the design process are: (1) a location map, (2) technical drawings of the disposal system, and (3) a detailed materials list. These products will be given to the construction foreman before construction begins.

This technical note describes how to design sumps, soakage pits, and soakage trenches and how to produce the three end-products listed above. Read the entire technical note before beginning the design process.

Useful Definitions

CONTAMINATE - To make unclean by introducing an infectious (disease-causing) impurity such as bacteria from washwater.

EFFLUENT - Settled sewage.

GROUNDWATER LEVEL - The level to which subsurface water rises during any given time of year.

IMPERVIOUS - Not allowing liquid to pass through.

PERMEABLE - Allowing liquid to soak in.

WASHWATER - Water that has been used for bathing, washing clothes, dishes, or kitchen utensils.

Materials Needed

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

Scale - To draw a location map.

Location

Washwater disposal systems should be downhill from water wells. They should be at least:

30m from the nearest water supply,
6m from the nearest dwelling,
3m from trees or bushes,
3m from nearest property line.

Do not put the system in an area where surface water will stand on it or flow over it.

After a proposed site has been selected, it must be tested for soil suitability. The three tests which must be made are: soil type; groundwater levels; and impervious layers.

Soil Type. The soil must be permeable, but it must not allow washwater or effluent to soak in too fast or the groundwater may become contaminated. Soil may be divided into roughly six types:

(1) Sand. Individual grains are easily seen and felt.

(2) Sandy Loam. Contains a large percentage of sand, but squeezed when moist a handful will hold its shape.

(3) Loam. Feels fairly smooth, yet slightly gritty.

(4) Silt Loam. Feels soft and floury; clods are easily crumbled.

(5) Clay Loam. Fine-textured; clods are hard.

(6) Clay. Fine-textured; clods are very hard.

If you have trouble identifying the soil, see "Determining Soil Suitability," SAN.2.P.3, for a more complete description. When the soil at the proposed disposal site has been identified, use Table 1 to determine soil suitability.

Table 1. Soil Suitability

Soil Type	Suitable
Sand	No
Sandy loam	Yes
Loam	Yes
Silt loam	Yes
Clay loam	No
Clay	No

If the soil is not suitable, select another location. If no good location can be found on the lot, washwater will have to be piped or carted to another location. If no suitable location can be found, design a more complex disposal system (see "Designing Sewer Systems," SAN.2.D.4, and "Designing Non-Conventional Washwater and Excreta Disposal Systems," SAN.2.D.8). If the soil is suitable, test for groundwater levels.

Groundwater Levels. Washwater disposal systems must be at least 1.0m above the groundwater level during the wettest season of the year. This information may be available from local residents, water well owners, or water well drillers. If the information is not available or reliable, field tests must be made. These tests are described in detail in "Determining Soil Suitability," SAN.2.P.3. In brief, a test hole must be dug 1.0m deeper than the proposed disposal system. Dig the test hole during the wettest season. If no groundwater is observed, groundwater levels are suitable.

If groundwater levels are not suitable, select another location. If groundwater levels are suitable, test for impervious layers.

Impervious Layers. Washwater disposal systems must be at least 1.0m above impervious layers such as creviced rock, hardpan, shale, or clay. The same test hole dug for determining groundwater levels can be used to determine the presence or absence of impervious layers. If impervious layers appear while the test hole is being dug, another location must be found. If there are no impervious layers, the site is suitable for washwater disposal.

When a suitable site has been found, draw a location map similar to Figure 1, showing the disposal site and distances to water supplies, dwellings, and property lines. Give this map to the construction foreman before construction begins.

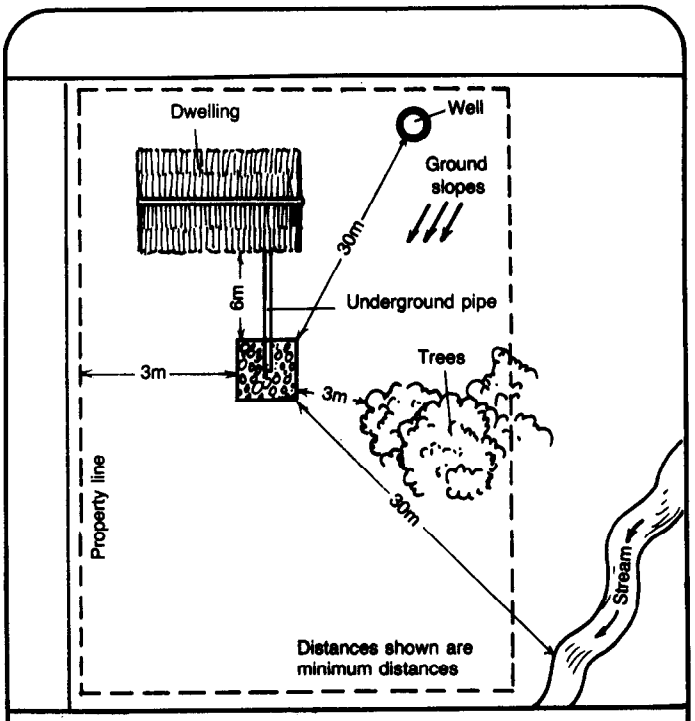


Figure 1. Location Map

Table 2. Selecting a Disposal Method Based on Washwater Quantities

Quantity of Washwater	Disposal Method
More than 50 liters per person per day	See "Planning Combined Washwater and Excreta Disposal Systems," SAN.2.P.1
Less than 50 but more than 5 liters per person per day	Soakage pit or soakage trench
Less than 5 liters per person per day	Sump (pit-type or drum-type)

Determining Type of Washwater Disposal Method

There are four factors to consider when selecting a disposal method: quantity of washwater; available materials; depths of groundwater and impervious layers; and lot size.

Quantity of Washwater. Estimate the average amount of washwater generated daily by each person in the dwelling to be served. "Estimating Sewage or Washwater Flows," SAN.2.P.2, describes several ways of doing this. When the quantity has been determined, use Table 2 to select a washwater disposal method.

Available Materials. To keep costs down, washwater disposal systems should be made from locally available materials. Table 3 lists the materials required for each disposal method. The table can be used to help decide between a pit-type sump and drum-type sump, or between a soakage pit and a soakage trench.

Depths of Groundwater and Impervious Layers. These factors may affect the decision between a soakage pit and a soakage trench because trenches are shallower than pits. Trenches are 0.6-1.0m deep and pits are 1.0-3.0m deep. Groundwater levels and impervious layers must be at least 1.0m below the bottom of these systems. Groundwater and impervious levels for soakage trenches are 1.6-2.0m below ground, and for soakage pits they are 2.0-4.0m below ground. Table 4 summarizes this information.

Table 4. Groundwater and Impervious Layers Affecting Disposal Methods

Depth of Groundwater or Impervious Layers	Acceptable Disposal Method
1.6m - 2.0m	Soakage Trench
2.0 or more	Soakage Pit or Soakage Trench

Table 3. Materials for Washwater Disposal Methods

Method	Materials
Sump (pit-type)	Concrete blocks, bricks, or stones; gravel or pebbles; a lid (wood or metal)
Sump (drum-type)	200-liter steel drum; a lid (wood or metal)
Soakage Pit	Rocks; straw, hay, or grass; clay, plastic, or galvanized metal pipe (50-100mm diameter) long enough to extend from dwelling to pit
Soakage Trench	Gravel, pebbles; concrete blocks or perforated or open-jointed sewer pipe; clay, plastic, or galvanized metal pipe (50-100mm diameter) extending from dwelling to trench; straw, hay, or grass

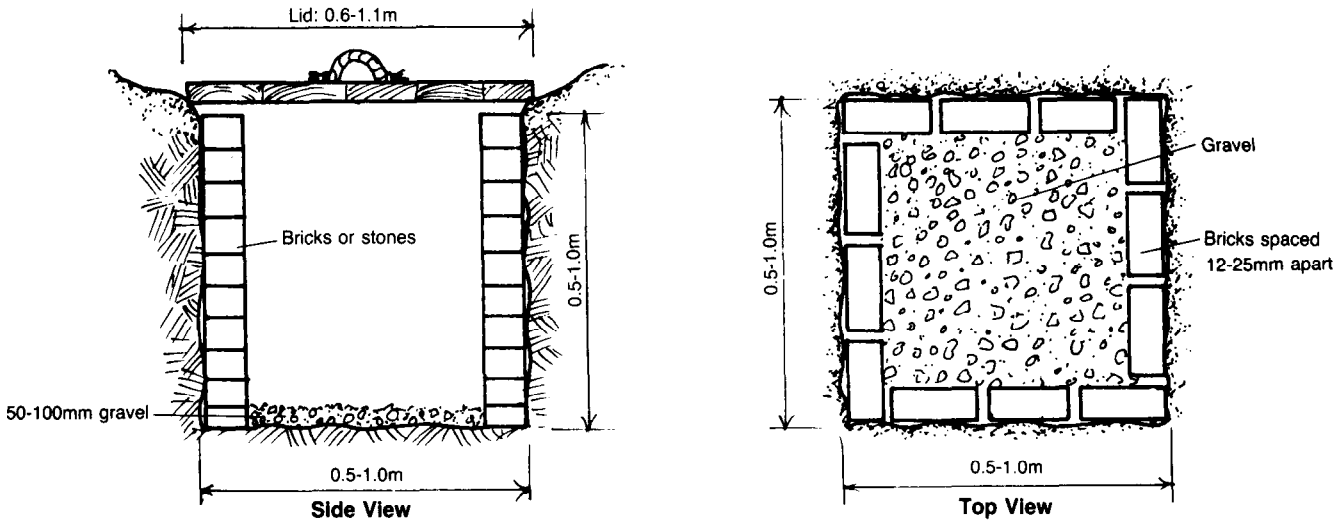


Figure 2. Pit-type Sump

Lot Size. This may affect the decision between a soakage pit and a soakage trench because trenches are longer than pits and may require more land area. Determine the size of the trench, then use the location map to determine if it will fit on the lot. If it will not, a pit may have to be used instead.

Determining the Size of the System

Because of the small amounts of washwater disposed of in a sump, the size is not too critical and need not be calculated. For a pit-type sump, it is sufficient if the pit is 0.5-1.0m deep and 0.5-1.0m in diameter as shown in Figure 2. For a drum-type sump, the pit should be dug just large enough to contain the 200-liter steel drum as shown in Figure 3.

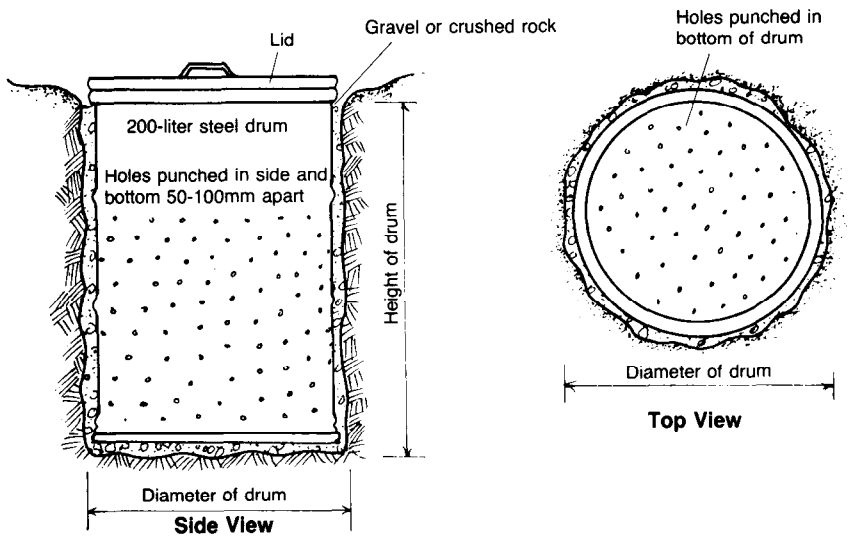


Figure 3. Drum-type Sump

The size of a soakage pit or soakage trench depends on the area of permeable soil needed. This varies according to the quantity of washwater generated each day and the rate at which the soil can soak up the liquid. It is safe to assume that the amount of washwater generated is 50 liters per person per day and that the soil will absorb liquid at a rate of 30 liters per square meter per day. The area of permeable soil needed for one person is 50 liters/day divided by 30 liters/day/square meter:

$$\frac{50 \text{ liters/day}}{30 \text{ liters/day/m}^2} = 1.7\text{m}^2$$

To find the area of permeable soil needed for washwater disposal for a dwelling, multiply 1.7m^2 times the number of people living in the dwelling. For example, if five persons live there, the required area for a disposal system is 5 x 1.7m^2 = 8.5m^2 (see Worksheet A, Lines 1 and 2).

Determining Trench Size. Trenches are 0.6-1.0m wide and can be as long as 30m as shown in Figure 4. The area of the bottom of the trench must be at least as great as the area of permeable soil needed. In the previous example, this area would be 8.5m^2.

To find the length of the trench, divide the area by the width. For example, if the desired width is 0.8m, then the length is:

$\frac{8.5\text{m}^2}{0.8\text{m}}$ = 10.7m (see Worksheet A, lines 3 and 4).

Determing Pit Size. Pits may be square, rectangular, or circular, as shown in Figure 5. The area of the pit below the inlet pipe must be at least as great as the area of permeable soil needed. If the pit is square or rectangular, find the area by adding the areas of the four earth walls below the inlet to the area of the bottom. If the pit is circular, find the area by adding the area of the circular wall below the inlet to the area of the bottom.

To find the size of a square or rectangular pit, first decide on the desired length and width, then calculate the depth below the inlet pipe that will give the pit the required area.

For example, suppose the area of permeable soil needed is 8.5m^2, the desired length is 1.5m and the desired width is 1.2m. The area of the bottom is the length times width = 1.5m x 1.2m = 1.8m^2. The area of the walls is the total area minus the bottom area = 8.5m^2 minus 1.8m^2 = 6.7m^2. The circumference is the sum of the lengths of the sides = 1.2m + 1.5m + 1.2m + 1.5m = 5.4m. The necessary depth of the pit below the inlet pipe is the wall area divided by the circumference = $\frac{6.7\text{m}^2}{5.4\text{m}}$ = 1.24m (see Worksheet A, Lines 5-10).

To find the size of a circular pit, first determine the desired diameter or circumference, then calculate the necessary depth below the inlet pipe. When calculating the area of a circular pit, the following information will be helpful:

d = diameter circumference = 3.1 x d

area of bottom = $\frac{3.1}{4} \times d^2$

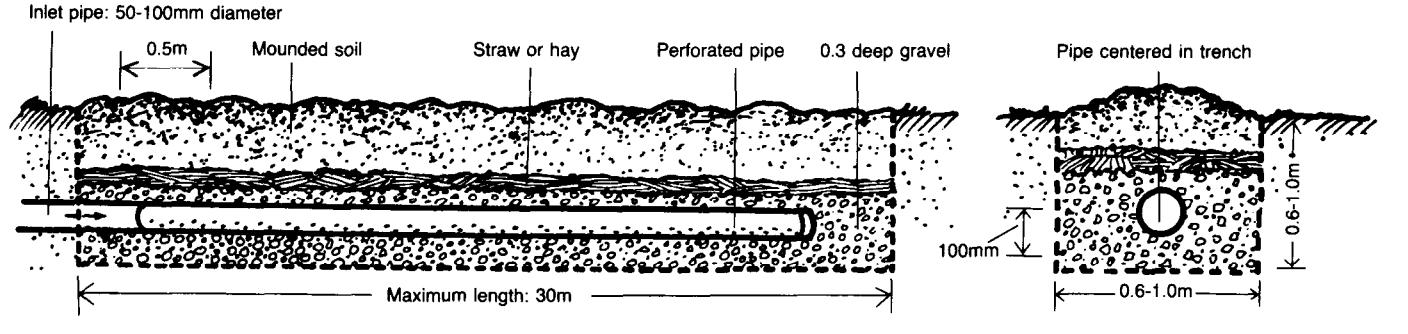


Figure 4. Soakage Trench

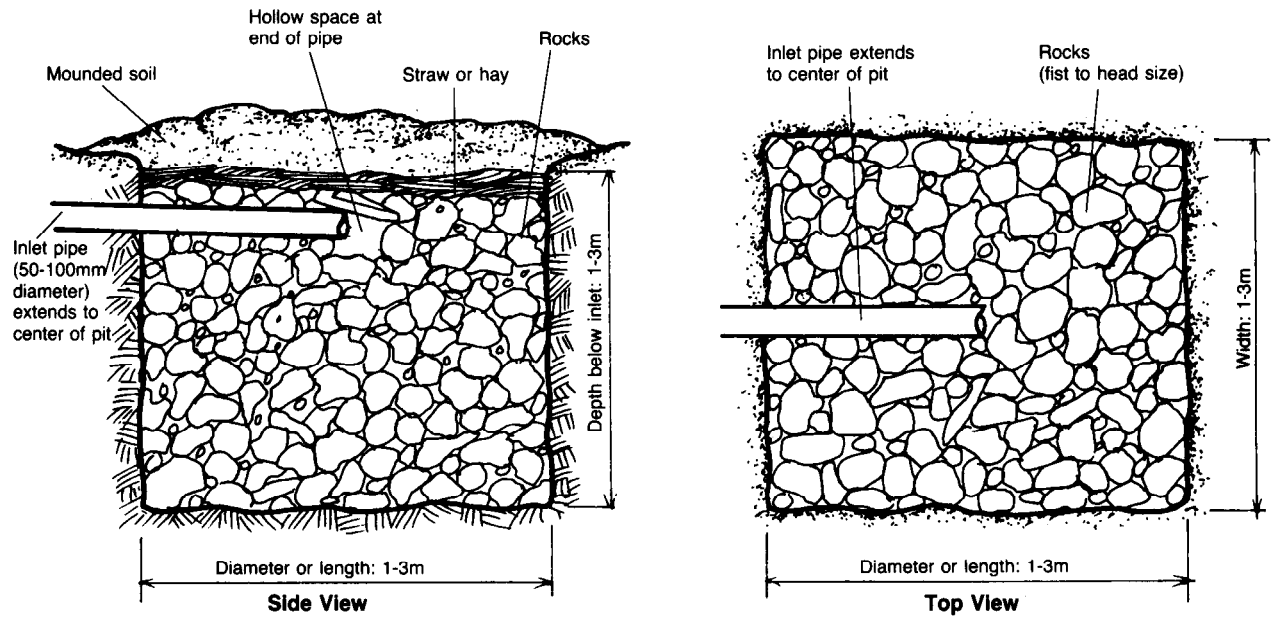


Figure 5. Soakage Pit

For example, suppose the necessary area of permeable soil is $8.5m^2$ and the desired diameter is 1.4m. The bottom area is the diameter squared times $\frac{3.1}{4}$ = 1.4 x 1.4 x .78 = $1.5m^2$. The wall area is the total area minus the bottom area = $8.5m^2 - 1.5m^2 = 7.0m^2$. The circumference is the diameter times 3.1 = 1.4m x 3.1 = 4.34m. The necessary depth of the pit below the inlet pipe is the wall area divided by the circumference = $\frac{7.0m^2}{4.34m}$ = 1.6m (see Worksheet A Lines 11-15).

Summary of Design Information

Pit-Type Sump. The pit is 0.5-1.0m deep and 0.5-1.0m in diameter. It is lined with concrete blocks, bricks, or stones to prevent the sides from collapsing, and the bottom is covered with 50-100mm of gravel or small pebbles. The pit is covered with a lid strong enough to prevent an adult from falling in.

Drum-Type Sump. The pit is deep enough and wide enough to just hold a 200-liter drum, with holes punched in the bottom and the lower half of the sides. A strong lid covers the drum.

Soakage Pit. The pit is 1.0-3.0m deep and 1.0-3.0m in diameter and is nearly filled with rocks ranging from fist-size to head-size. A 50-100mm pipe extends underground from the dwelling to a point near the top center of the pit and is covered with rocks. The pit is covered with hay or straw and mounded with soil.

Soakage Trench. The trench is 0.6-1.0m deep, 0.5-1.0m wide and up to 30m long. It is filled to a depth of 0.3m with gravel or small pebbles, equipped with open-jointed or perforated pipe or concrete blocks, covered with straw or hay, and mounded with soil. A 50-100mm pipe extends underground from the dwelling to a point 0.5m into the trench and about 100mm above the bottom. The bottom of the trench slopes gradually away from the inlet end.

Materials List

Building washwater disposal system requires a foreman and at least one laborer to excavate the sump, trench, or pit. Larger pits or trenches may require additional laborers. The type and amount of supplies needed depend on the size and kind of system. Table 5 shows a sample materials list.

Worksheet A. Calculating the Size of a Soakage Trench or Soakage Pit

System Type (check one) ☒ Trench ☒ Pit

1. Number of persons in dwelling to be served = 5

2. Necessary area of permeable soil = Line 1 x 1.7m^2 = 5 x 1.7m^2 = 8.5 m^2

If System is a Trench

3. Proposed width of trench = 0.8 m

4. Necessary length of trench = $\frac{\text{Line 2}}{\text{Line 3}}$ = $\frac{8.5 \text{ m}^2}{0.8 \text{ m}}$ = 10.7 m

If System is a Pit

Pit Type (check one) ☒ square or rectangular ☒ circular

For a square or rectangular pit:

5. Proposed length of pit = 1.5 m

6. Proposed width of pit = 1.2 m

7. Area of pit bottom = Line 5 x Line 6 = 1.5 m x 1.2 m = 1.8 m^2

8. Wall area = Line 2 minus Line 7 = 8.5 m^2 - 1.8 m^2 = 6.7 m^2

9. Circumference = Line 5 + Line 5 + Line 6 + Line 6 = 1.5 m + 1.5 m + 1.2 + 1.2 m = 5.4 m

10. Required depth below inlet = $\frac{\text{Line 8}}{\text{Line 9}}$ = $\frac{6.7 \text{ m}^2}{5.4 \text{ m}}$ = 12.4 m

For a circular pit:

11. Proposed diameter = 1.4 m

12. Area of bottom = Line 11 x Line 11 x $\frac{3.1}{4}$ = 1.4 m x 1.4 m x .78 = 1.5 m^2

13. Wall area = Line 2 minus Line 12 = 8.5 m^2 - 1.5 m^2 = 7.0 m^2

14. Circumference = Line 11 x 3.1 = 1.4 m x 3.1 = 4.34 m

15. Required depth below inlet = $\frac{\text{Line 13}}{\text{Line 14}}$ = $\frac{7.0 \text{ m}^2}{4.34 \text{ m}}$ = 1.6 m

Table 5. Sample Materials List for Washwater Disposal System

Item	Description	Quantity	Estimated Cost
Labor	Foreman Laborers	1 2	_____ _____
Supplies	Gravel or pebbles (enough to fill trench to a depth of 0.3m) Straw (enough to cover entire trench) Galvanized metal pipe, 100mm diameter, extends from dwelling to trench Open-jointed pipe (length of trench)	_____m^3 _____ _____m _____m	_____ _____ _____ _____
Tools	Measuring tape Shovels Wheelbarrow Other	1 2 1 _____	_____ _____ _____ _____

Total Estimated Cost = _____

Few tools are required to build these systems. A measuring tape is needed to lay out the system on the ground. One or more shovels are necessary for excavation. A wheelbarrow is useful to haul materials to the site and haul away excavated soil. For a drum-type sump, you will need a hammer and a spike or large nail to punch holes in the drum.

When the necessary labor, tools, and materials have been determined, estimate the cost of each item. Prepare a materials list similar to Table 5 showing each item and its estimated cost. Give this to the construction foreman before construction begins. In summary, give the construction foreman a location map similar to Figure 1, technical drawings similar to one or more of Figures 2, 3, 4 and 5, and a materials list similar to Table 5.

Technical Notes are part of a set of "Water for the World" materials produced under contract to the U.S. Agency for International Development by National Demonstration Water Project, Institute for Rural Water, and National Environmental Health Association. Artwork was done by Redwing Art Service. Technical Notes are intended to provide assistance to a broad range of people with field responsibility for village water supply and sanitation projects in the developing nations. For more detail on the purpose, organization and suggestions for use of Technical Notes, see the introductory Note in the series, titled "Using 'Water for the World' Technical Notes." Other parts of the "Water for the World" series include a comprehensive Program Manual and several Policy Perspectives. Further information on these materials may be obtained from the Development Information Center, Agency for International Development, Washington, D.C., 20523, U.S.A.

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