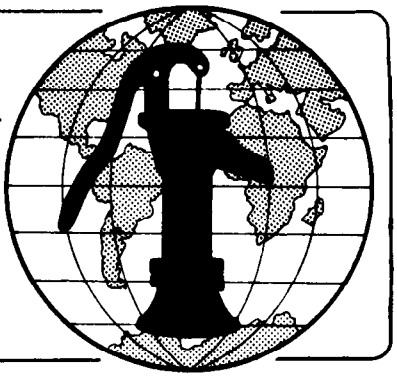
Water for the World

Methods of Combined Washwater and Excreta Disposal

Technical Note No. SAN. 2.M.



Combining excreta and washwater disposal in a single system is an efficient and safe method of disposal that prevents the spread of disease. Combined disposal systems are slightly more expensive and more difficult to construct and maintain than simple methods of excreta disposal. Combined systems are suitable where a piped water supply is available in the home or other place of waste generation. In such locations, all waterborne wastes, including that from toilets, kitchens, baths, and laundry facilities are piped from the house to the treatment and disposal site. Used with enough water, combined systems are as convenient as pour-flush slabs, flush toilets, or similar facilities.

The four methods of combined disposal are: (1) cesspool, (2) septic tank with subsurface disposal system, (3) septic tank with nonconventional disposal system, and (4) sewer with stabilization ponds. This technical note describes the basic features of each method.

Useful Definitions

ANAEROBIC POND - Stabilization pond that receives sewage from a sewer system and discharges sewage effluent to a facultative pond.

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

EFFLUENT - Settled sewage.

EXCRETA - Human body wastes

FACULTATIVE POND - Stabilization pond that receives sewage effluent from an anaerobic pond or sewer system and discharges treated sewage to a dry ditch or maturation pond.

GROUNDWATER - Water stored below the ground's surface.

MATURATION POND - Stabilization pond that receives treated sewage from a facultative pond, further treats the sewage, and discharges it to a dry ditch or waterway.

PERCOLATION - Movement of water downward through the pores of the soil.

RETENTION TIME - The time (usually one to three days) that sewage remains in a septic tank.

SETTLED SEWAGE - The liquid that flows out of a septic tank after the soilds have separated and settled. Settled sewage is hazardous and must be disposed of in a subsurface absorption system.

SEWAGE - All washwater, excreta, and water used to flush excreta that flows from a building or buildings, through a sewer pipe, and into a septic tank, cesspool, or stabilization pond.

SLUDGE - Settled solids at the bottom of a septic tank.

TOILET - A bowl filled with water often covered by a lid, and designed to receive excreta and flush it through a pipe to a cesspool, septic tank or sewer.

TREATED SEWAGE - The liquid that flows out of a stabilization pond (or series of ponds). Treated sewage is safer than settled sewage and may be used to irrigate crops not intended for human consumption.

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

Four Disposal Methods

1. Cesspool. Cesspools, shown in Figure 1, are covered pits, with open-joint or perforated walls, that receive sewage. A cesspool is the least expensive and easiest to construct combined disposal system. Its main features are the inlet and the pit. Sometimes an outlet pipe equipped with a "T" fitting and leading to a subsurface absorption field is added.

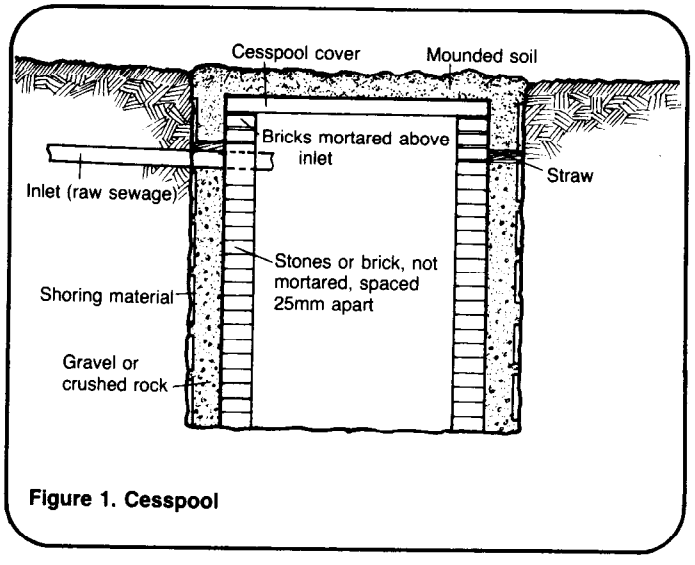


Figure 1. Cesspool

The inlet is the end section of sewer pipe which carries sewage from a building to the pit. The pipe and inlet are usually 100mm in diameter.

The pit receives sewage from the inlet. It is generally cylindrical in shape and may be from 2 to 4m deep and 2m in diameter. The pit walls are lined with unmortared stone or concrete blocks below the inlet to allow percolation of the settled sewage out of the pit into the surrounding soil. The pit is covered with a heavy wood, metal, or concrete slab to prevent persons or animals from falling into it. The slab is covered with 150 to 300mm of soil.

Cesspools should not be used where groundwater is the source of water for a village. They should be located downslope at least 60 to 150m from any water supply. In all cases, the bottom of the cesspool should be at least 1.2m above the highest rainy season groundwater level.

Cesspools will eventually fail as they become full of sludge or overflow onto the ground. This failure is caused by the soil's loss of percolation ability as, over time, it clogs up with sludge. Pumping out the cesspool will extend its life for a short time.

2. Septic Tank with Subsurface Disposal System. Septic tank systems cost about one and one half to two times as much as a cesspool and require more skilled labor and more expensive materials. Septic tank systems consist of: (1) a watertight septic tank to settle out the solids and (2) an underground system of jointed or perforated pipes that dispose of the sewage underneath the ground's surface.

The septic tank is a large, underground, waterproof tank made of concrete, brick and mortar, or prefabricated steel with a capacity of 1100 to 3800 liters or more of sewage. The tank receives sewage from the sewer inlet, holds it for a predetermined retention time, then discharges the settled sewage into a subsurface absorption system. The septic tank is large enough to accommodate sewage produced by a home or other building during a 24- to 72-hour period and to slowly discharge it for disposal. During this time, some treatment of the waste materials occurs in the septic tank as the solids settle to the bottom and bacterial action partially decomposes excreta and other organic matter. The tank has at least one manhole to allow for periodic cleaning out of the accumulated sludge. Normally, "T" fittings are placed on the inlet and outlet pipes as shown in Figure 2 to reduce physical disturbance so that the settling process of the solids is not impaired.

The subsurface disposal system (also called soil absorption field or trenches, leachfield, drainfield, seepage bed, seepage pit) consists of either a pit similar to a cesspool, or a shallow field or trench excavation 0.6-1m deep, containing open-joint or perforated pipe in a bed of gravel and covered with soil. The disposal system accepts the settled sewage from the septic tank and disperses it over the entire area of the disposal system for percolation into the soil. The area covered by the subsurface disposal

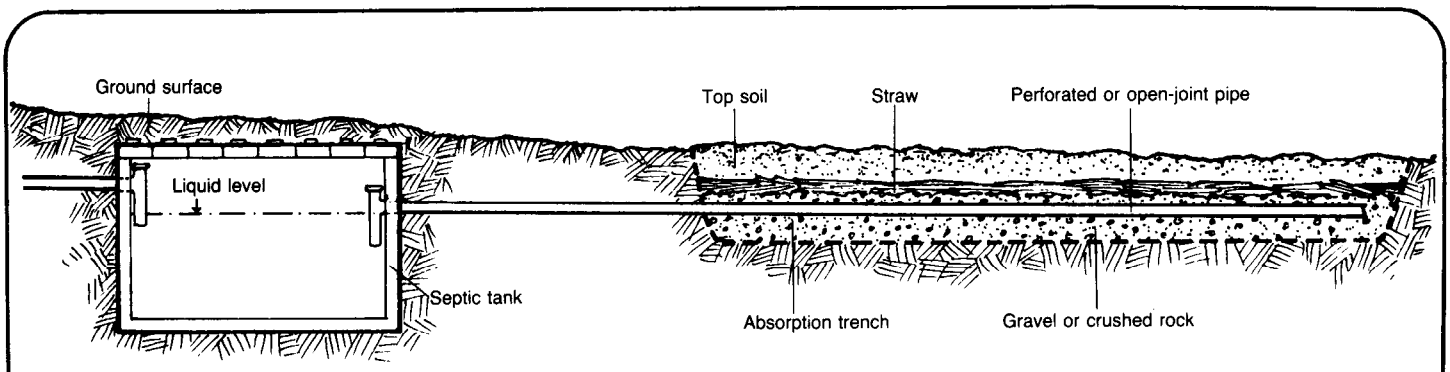


Figure 2. Septic Tank with Subsurface Absorption System

system is determined by the anticipated amount of sewage and by the type of soil.

A septic tank must be cleaned every two to six years, depending on type and amount of sewage, to prevent accumulated sludge from discharging into the disposal field, clogging the soil, and shortening the life of the field. To prevent groundwater contamination, the bottom of the absorption field must be at lease 1.2m above highest groundwater levels. A properly maintained septic tank and subsurface absorption field will last 10 to 20 years, or possibly longer.

3. Septic Tank with Nonconventional Disposal System. The septic tank with nonconventional disposal system uses the same septic tank described above, but employs different disposal systems. Special systems are sometimes required for very porous soils (sand and gravel), for impermeable soils (clay), or where groundwater or bedrock is found near the surface of the ground. The cost of nonconventional systems is high and they are unsuitable for most homes. They may be suitable for community buildings such as health clinics or schools. The three types of nonconventional disposal systems are mound systems, evapotranspiration systems, and sand filters.

Mound systems, shown in Figure 3 are used when groundwater or bedrock lies near the surface of the ground.

By placing the perforated or open-jointed pipe and the gravel bed above ground, and by mounding soil over the top, the necessary 1.2m of suitable soil is maintained between the groundwater or bedrock and the bottom of the disposal field. Some effluent is evaporated through the mound.

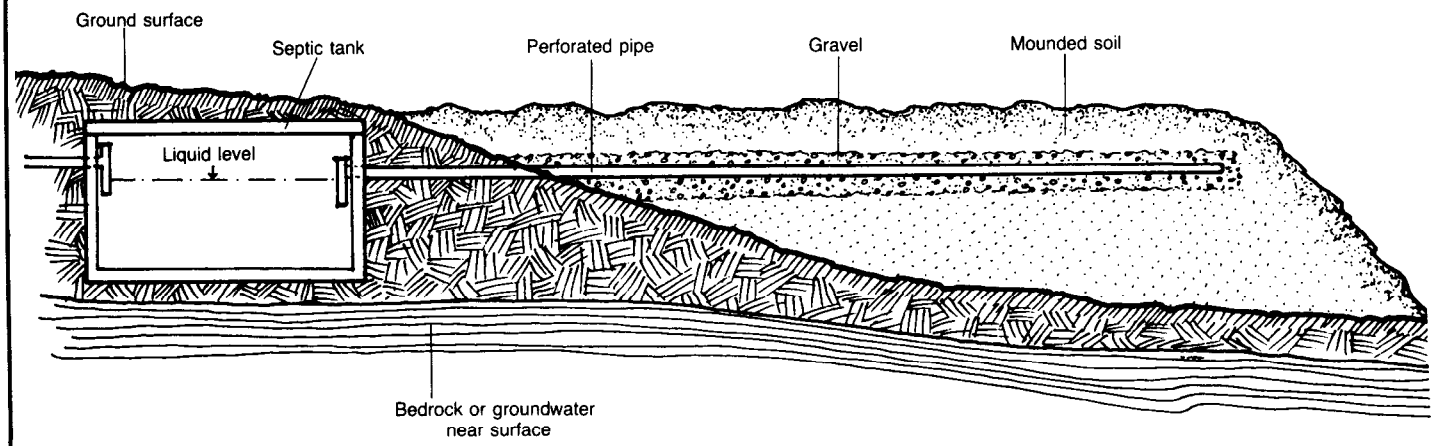


Figure 3. Mound System

Evapotranspriation systems are used when groundwater is near the surface or where the soil is clay. These systems work well in dry, hot climates, but perform poorly in rainy or cold climates.

Evapotranspiration systems rely on evaporation and plant absorption (transpiration) of water to dispose of the effluent. Grasses and other selected plants are planted over the system. This system requires surface areas of three to five times that of conventional disposal systems, but is otherwise similar to a conventional system. If it is used in areas of high groundwater, the system should be underlaid with plastic or other waterproof material to prevent contamination of groundwater supplies.

Sand filters, shown in Figure 4 are used where fractured or creviced bedrock is near the surface of the ground. Normally, the bedrock is excavated or blasted away from the filter location. A bed of filter sand (with optional underdrain) is topped by a bed of gravel with perforated pipe, and the system is backfilled with topsoil.

Sand filter systems require the transport of large quantities of specially selected sand, and also may require the use of explosives. These systems are expensive.

4. Sewer with Stabilization Pond. Sewers and stabilization ponds shown in Figure 5, are the most expensive sanitation methods discussed in this technical note. They are community systems, not meant for single homes or even small clusters of homes. Sewers (underground pipes that carry sewage) are designed to reach as many homes as possible in such a way that the collected sewage is carried by gravity downhill to the stabilization pond. The pond itself is specially designed for sewage treatment, and normally has a discharge to use for irrigation of certain crops.

This system requires professional engineering, organized financing, skilled labor, and heavy excavation equipment. Constructed and operated properly, this system can serve communities ranging in size from several hundred to several thousand persons.

Sewers are a collection network of pipes that resemble the branches on a tree with many small pipes coming together into larger ones. The entire sewer system is composed of different sized pipes, all laid at a slight downhill slope to insure gravity flow of the sewage to the stabilization pond. The pond and the sewer system, also called sewerage, must be laid out and designed by an engineer.

If the system takes raw sewage from houses, large diameter sewer pipe must be used. If the system takes settled sewage from individual aqua privies, septic tanks, or cesspools, smaller diameter, less expensive pipe may be used.

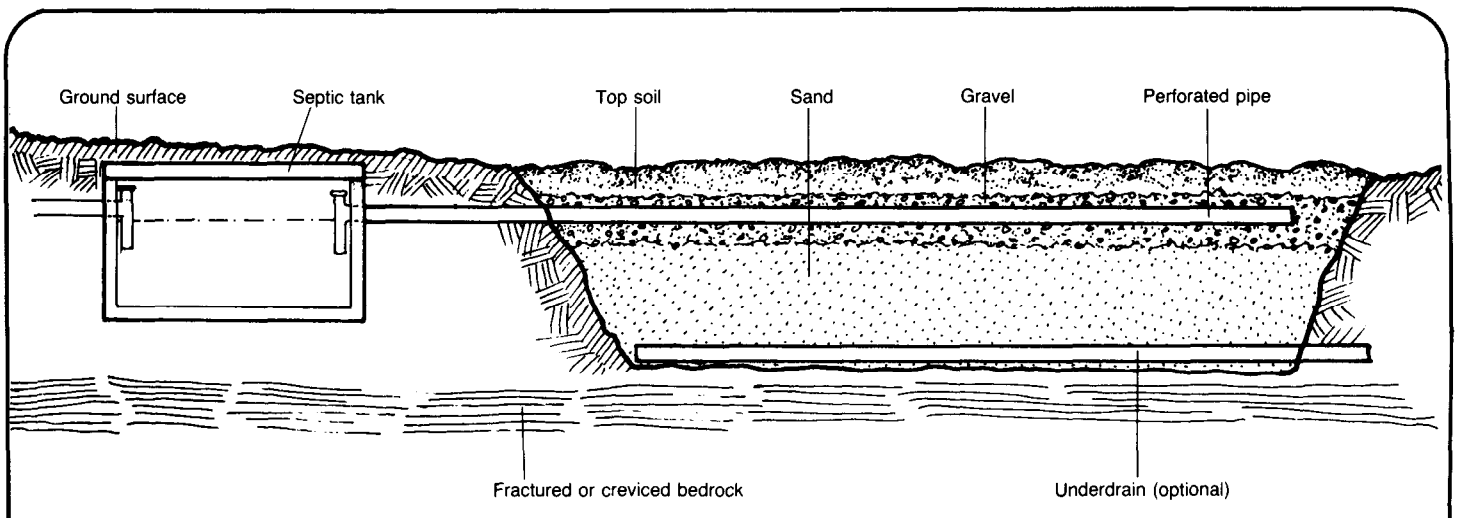


Figure 4. Sand Filter System

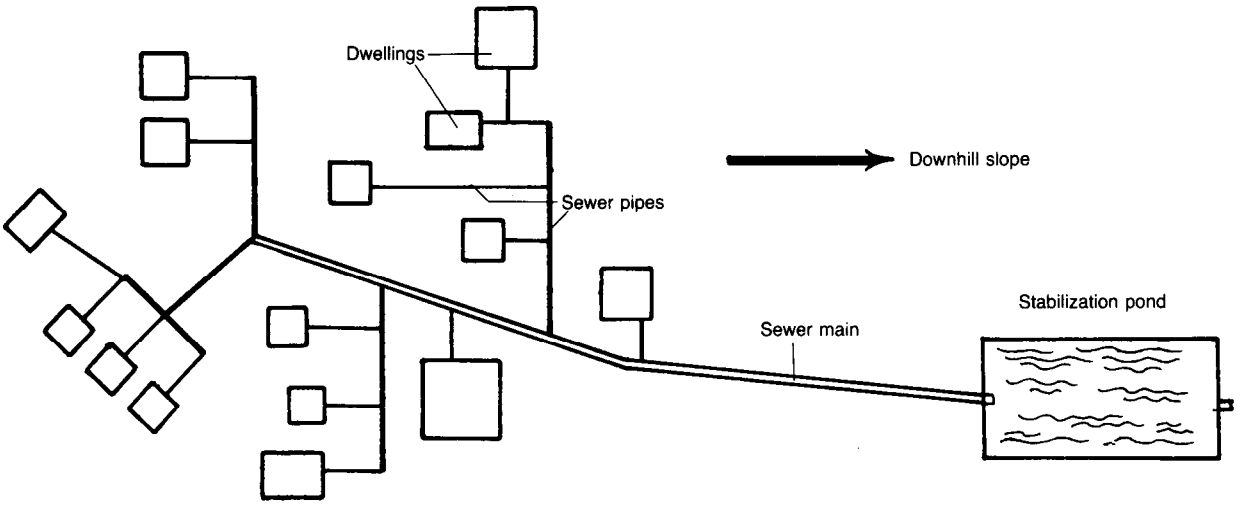


Figure 5. Sewer System

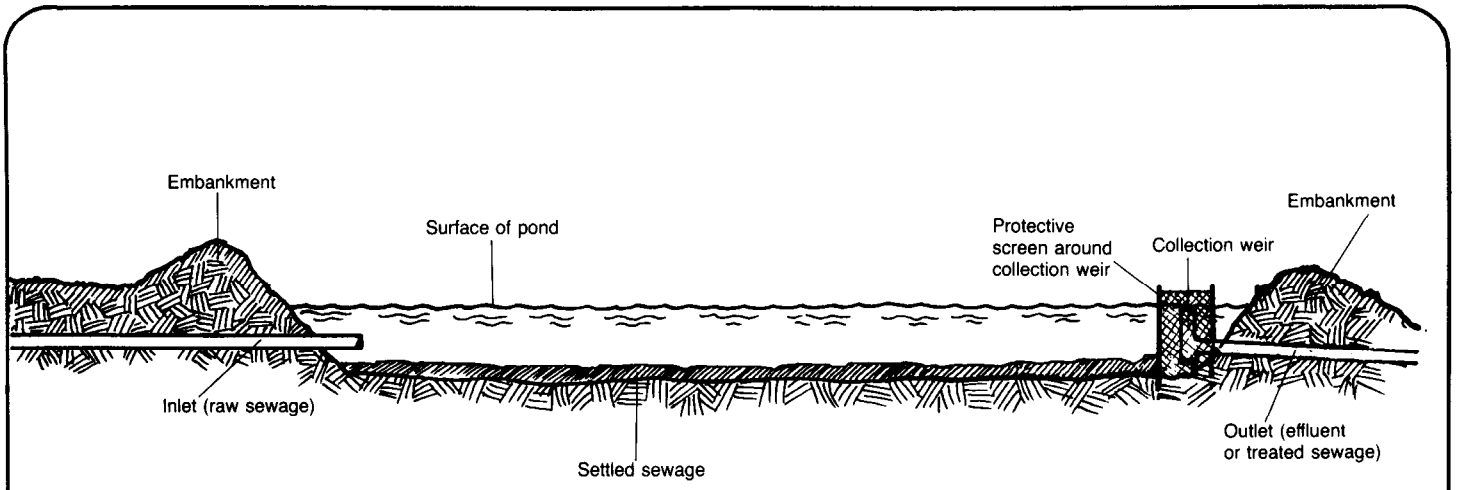


Figure 6. Stabilization Pond

Stabilization pond systems, shown in Figure 6, use a large sewer main pipe to carry the collected sewage to the inlet of the pond. The pond is normally 1m deep and its surface area is large enough to provide a predetermined time for treatment. An average-size pond is 15m wide and 30m long. The treated sewage is continually and slowly drained off to assure the proper retention time.

The stabilization pond treats the sewage biologically: bacteria multiply and consume excreta; algae multiply and consume chemical nutrients. Both bacteria and algae die and are replaced by new organisms; the dead ones settle to the bottom of the pond and accumulate as sludge. The sludge itself is biologically consumed by different bacteria and does not accumulate excessively in a properly designed pond. The treated

sewage that is discharged may be used for irrigation of crops not intended for human consumption. Human contact with treated sewage should be avoided.

Stabilization ponds may be designed in series with each pond providing a cleaner effluent than the previous one. Each pond in a series may have a slightly different design. The first pond, the anaerobic pond, may be slightly deeper, breaking down and removing most of the sludge. The second pond, the facultative pond, is the most common; its size and functions are described above. The third pond, the maturation pond, improves the final effluent. Maturation ponds have been used to grow fish for human consumption. The living fish should be placed in fresh water for two to three weeks before they are eaten.

In addition to receiving sewage from a sewer system, sewage may be brought to a stabilization pond by a bucket latrine worker or scavenger.

Stabilization ponds require skilled operation and maintenance. Aquatic weeds must be controlled to minimize the growth of mosquitoes that carry disease such as malaria and snails that spread schistosomiasis. A fence surrounding the pond must be kept in good repair and the sewers must be maintained. These ongoing costs must be budgeted in the early planning stages of this system. Improperly designed or poorly maintained ponds create offensive odors and effluent that is as hazardous to health as untreated wastewater.

Table 1. Comparison of Methods of Combined Washwater and Excreta Disposal

FACTORS	DISPOSAL METHODS				
	Cesspool	Septic tank with subsurface absorption system	Septic tank with nonconventional disposal	Sewer with stabilization pond	Sewer with mechanically aerated pond/lagoon
Design componets	Pit lined with concrete blocks	Septic tank and underground disposal	Septic tank and special disposal	Sewers and ponds	Sewer and aerated ponds/lagoons
Cost	Moderate	Moderately high	High	High	High
Ease of construction	Moderate	Moderately difficult	Difficult	Difficult, requires engineer	Difficult, requires engineer
Materials required	Concrete blocks, mortar, "T" pipe fittings	Concrete and/or concrete blocks, mortar, "T" pipe fittings, drainfield pipe, gravel	Concrete, and/or concrete blocks, mortar, "T" pipe fittings, drainfield pipe, gravel, plastic liner, special sand	Sewer pipe, cleanouts or manholes, valves, inlet and outlet devices	Sewer pipe, cleanouts or manholes, valves, inlet and outlet devices, aerators
Application	Individual and small cluster sites	Individual and small cluster sites	Individual and small cluster sites	Community	Community
Major maintenance required	Sludge removal	Sludge removal	Sludge removal	Weed control, bank erosion, sewer repair and cleaning	Equipment maintenance, weed control, bank erosion, sewer repair and cleaning
Maintenance personnel	Laborer	Laborer	Laborer	Laborer	Electrician/mechanic, laborer
Health issues	Minimal	Minimal	Minimal	May have odors and breed mosquitoes	May have odors and breed mosquitoes
Average life	5-10 years	10-15 years	10-15 years	15 + years	15 + years

The mechanically aerated lagoon is a variation of the stabilization pond. It is equipped with a mechanical aerator, which speeds up the treatment process and requires less area than other ponds. This arrangement is more costly in terms of equipment, required power, and maintenance, but in some communities the smaller land requirements may make a mechanically aerated lagoon feasible.

Comparison of Methods

Table 1 summarizes each of the methods of combined washwater and excreta disposal and helps visualize the similarities and differences between each method. It can be used later as an aid in selecting a method (see "Planning Combined Washwater and Excreta Disposal Systems," SAN.2.P.1).