Water for the World

Constructing Sewer Systems
Technical Note No. SAN. 2.C.4

A sewer system is a network of underground pipes that carries sewage by gravity flow from a number of dwellings. The sewage may be a direct flow of wastewater or the effluent after settling in septic tanks or aqua privies. It flows to a stabilization pond or other central treatment facility. Constructing a sewer system requires the services of an experienced construction foreman and surveyor. Construction involves assembling labor, materials and tools; staking pipeline and grade; excavating trenches; and laying pipe.

This technical note describes the elements involved in constructing a sewer system. It does not attempt to explain everything needed to build a sewer system.

Useful Definitions

BASE POINT - A point of reference from which all other points are measured.

EFFLUENT - Settled sewage.

GRAVITY FLOW - Flow of water from high ground to low by natural forces.

INVERT - The inside bottom of a pipe; that is, the pipe's lowest inside surface.

Materials Needed

Before construction can begin, the project designer must provide maps and drawings similar to Figures 1-3, and a detailed materials list similar to Table 1. Also needed are all labor, materials, equipment, and tools described in the materials list.

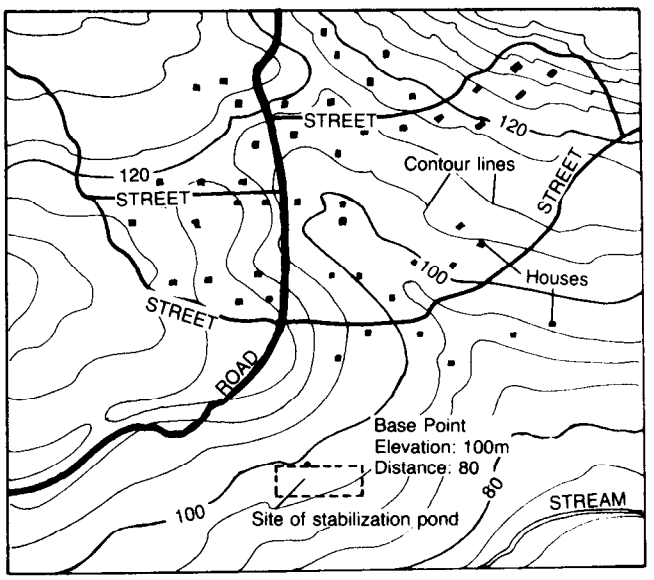

Figure 1. Contour Map

Table 1. Sample Materials List

Item	Description	Quantity	Estimated Cost
Labor	Construction foreman, experienced with large-scale projects	1	
	Surveyor	1	
	Worker, skilled with carpentry	1	
	Worker, skilled with concrete mortar	1	
	Workers, unskilled	12	
Supplies	Sewer pipe; 200mm diameter		
	Sewer pipe; 100mm diameter		
	"T" fittings; 100-200mm		
	Other fittings		
	Gravel		
	Mortar mix		
	Wooden stakes		
	Wood for shoring		
	Nails (double-head and standard)		
Equipment and Tools	Surveyor's transit	1	
	Surveyor's level	1	
	Grade rods	2	
	Pipe sling for lowering pipe into trench	2	
	Heavy chains or ropes for lowering pipes	2	
	Shovels	12	
	Picks	4	
	Mattocks	2	
	Pry bars	2	
	Hammers	4	
	Saws	2	
	Sledgehammer	1	
	Trowels	2	
	Hoes	2	
	Wheelbarrows	2	
	Barricades	6	

Total Estimated Cost =

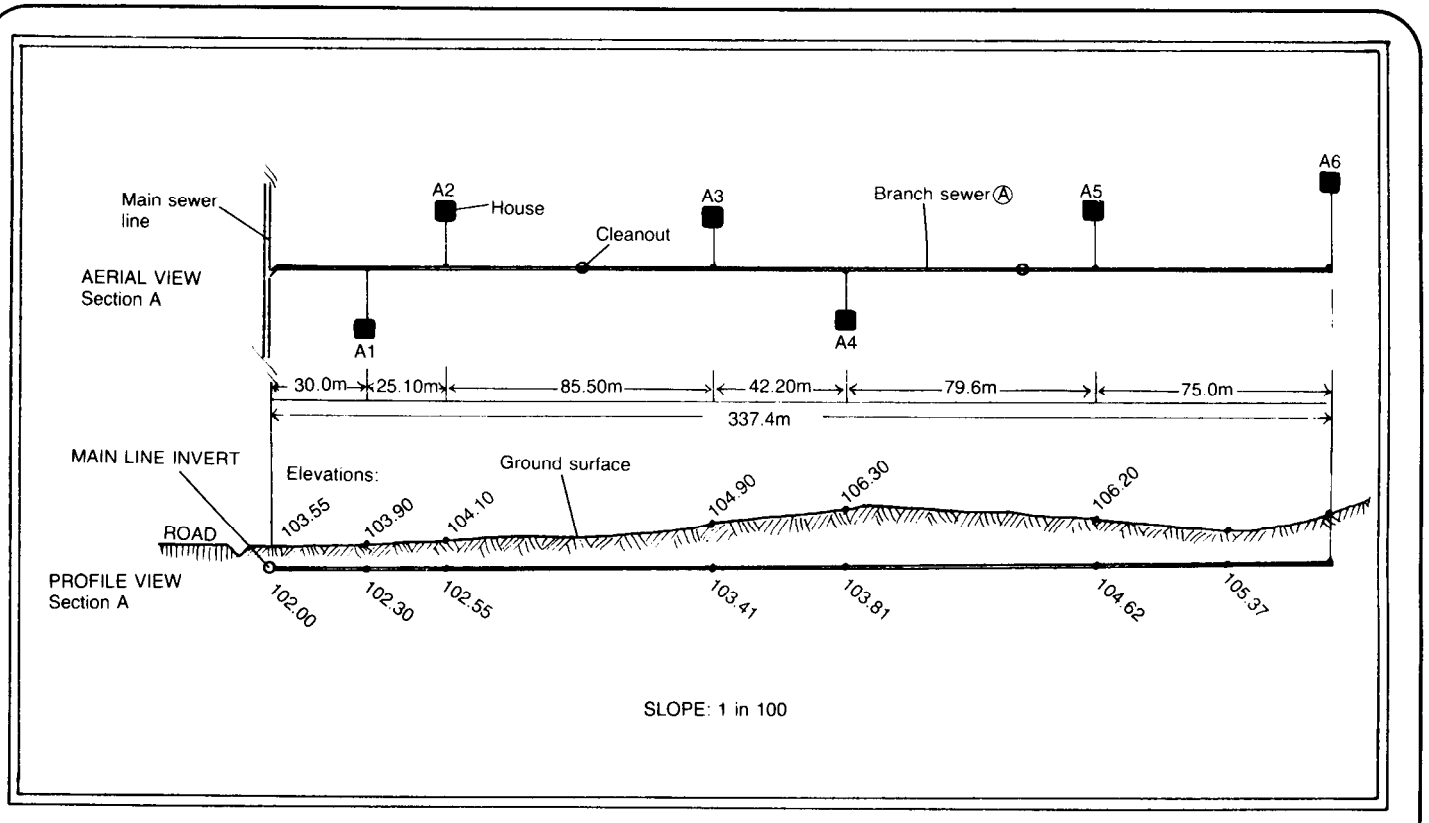

Figure 2. Section Drawing

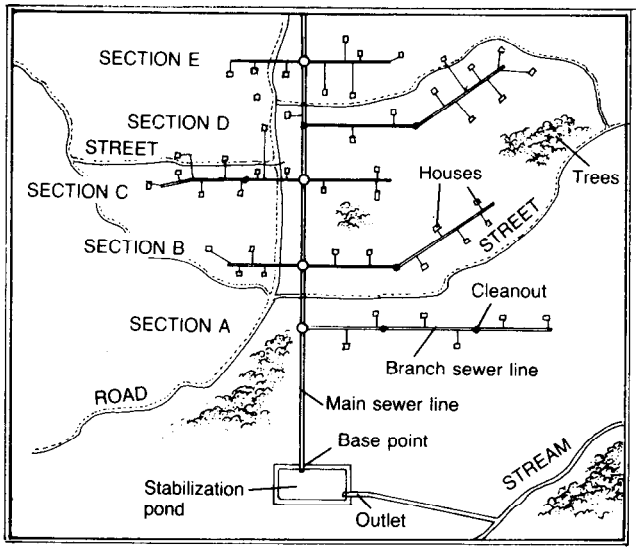

Figure 3. Master Sewer System Map

Steps in Construction

Construction of a sewer system begins at the lowest point. This is the point at which the system empties into the stabilization pond. Sometimes work on the pond begins first, depending on local conditions and the judgment of the construction foreman. See "Constructing Stabilization Ponds," SAN.2.C.5.

To avoid leaving survey stakes exposed and trenches open for a number of days, a sewer system is generally constructed in sections. A section of sewer line is staked out, the trench is dug, pipe is laid, and the trench is backfilled. Then the adjoining section is staked, the trench is dug, and so on.

Depending on local conditions, availability of materials, and skills of workers, some construction steps will require a few hours, while others may take a day or longer. One way of organizing the work is to prepare a work schedule similar to Table 2. This gives the constuction foreman an idea of when specific workers, materials, and tools are needed, and allows him to judge if the work is proceeding on schedule.

1. Assemble workers, materials, and tools. Because of the size of the project, workers are often assembled in small crews with crew leaders and each crew is assigned a specific task: one crew excavates trenches, one lays pipe, and so on. Or, individuals may be assigned specific tasks throughout the project.

Materials and tools must often be available for several weeks or more, so they are generally kept in a fenced yard with a locked gate or in some way are protected against theft and damage.

2. Stake pipe lines and grade. Begin at the outlet end of the sewer system (pond inlet) and work "upstream." Stake out only that portion of the pipeline that can be constructed in a few days. See Figure 4.

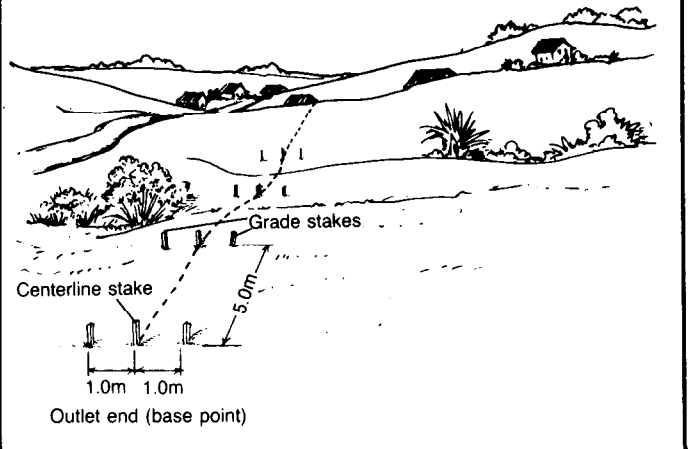

Figure 4. Centerline and Grade Stakes

Table 2. Sample Work Schedule

Time Estimate	Day	Task	Personnel	Materials/Tools
3 hours	1	Stake 50m of pipeline (center and grade stakes)	Foreman (always present), surveyor; 2 laborers	Transit, level, stakes, hammer, steel measuring tape, grade rod
2 days	1-3	Excavate trench	Crew chief, 4 laborers	Picks, shovels
4 hours	3	Install sheeting and braces	Crew chief, 4 laborers	Boards, beams, hammers, saw, nails
2 hours	4	Check trench bottom grade	Crew chief, 4 laborers	String line, grade rod
8 hours	4	Lay pipe; seal joints	Crew chief, 4 laborers	Sections of 100mm sewer pipe, rubber gaskets, cement mortar
1 hour	5	Test for watertightness	Crew chief, 4 laborers	Water
3 hours	5	Remove sheeting/braces	Crew chief, 4 laborers	Hammers, ropes
4 hours	5	Backfill trench	Crew chief, 4 laborers	Shovels
	6	Stake next 50m of pipeline		

First, stake the centerline of the pipe, setting a stake every 5m. Set a pair of grade stakes for each centerline stake. The grade stakes in each pair should be at the same elevation, should be equidistant from the center stake, and should be at right angles to the centerline of the pipe. The grade stakes should be set far enough from the centerline stake so as not to be disturbed during excavation of the trench.

3. Excavate the trench. Begin excavating the trench, making it as narrow as possible. A 600mm wide trench is sufficient for a 100mm pipe. Check the line and elevation of the trench bottom with a grade rod and a string stretched between a pair of grade stakes as shown in Figure 5. If the bottom of the trench is rocky or soft, excavate about 100mm below the invert grade and fill with gravel.

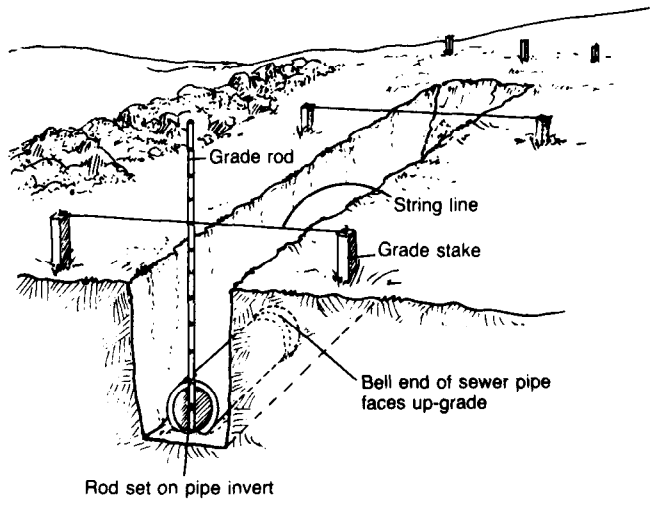

Figure 5. Excavating Trench

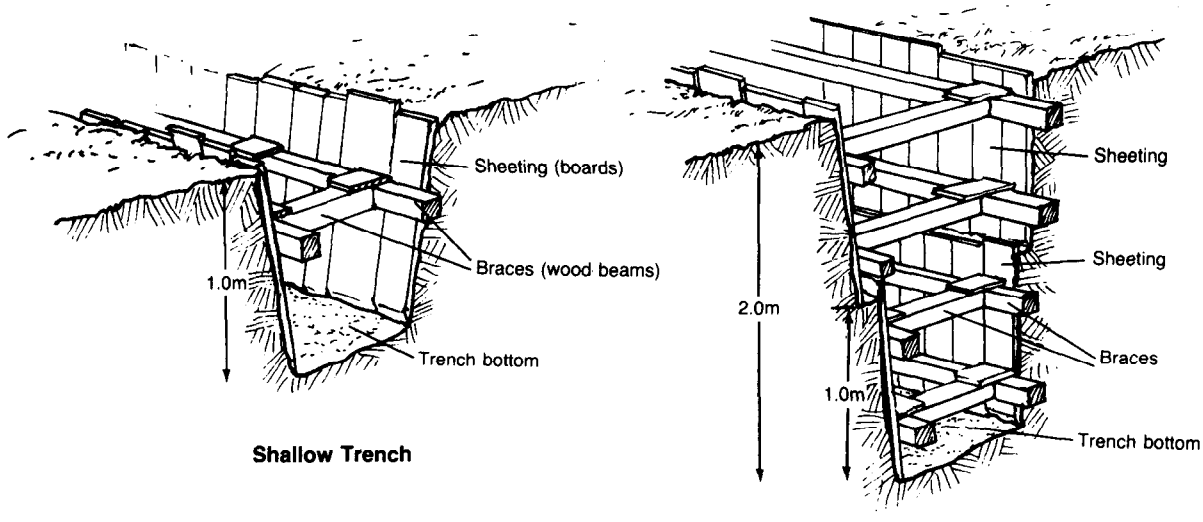

Figure 6. Sheeting and Braces

Caution!

Support the sides of trenches deeper than 1.0m with sheeting and braces. Install a section of sheeting and braces for each addition 1.0m of trench depth. See Figure 6. The collapse of a trench wall not only slows the progess of work, but has injured and killed workers buried in the fallen earth and rock.

4. Lay pipe. Position the first section of pipe with the bell-end upstream. Make a small excavation at the bell-end so that the entire length of pipe is supported by soil. See Figure 7. Position the second section of pipe, join it to the first section, and seal the joint with a rubber gasket and cement mortar, or with jute and tar.

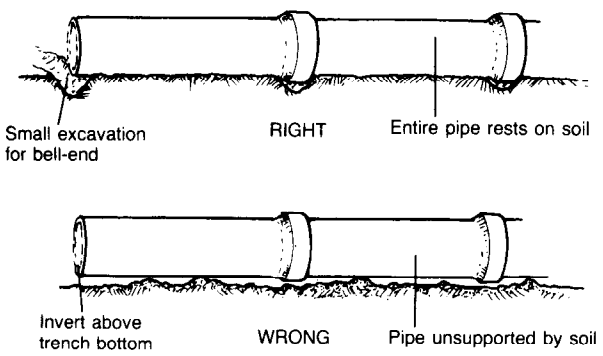

Figure 7. Positioning Pipe

Joints must be watertight. After a number of pipe sections have been installed and the joints have set up, test the system for leaks. Either plug the outlet, fill the pipe with water, and observe any water loss in the pipe, or pour a measured amount of water in one end and measure the amount that runs out the outlet end. Repair any leaks and retest the system before backfilling the trench.

At the end of each work day, plug the ends of the sewer pipe to prevent entry by rodents or snakes. See Figure 8.

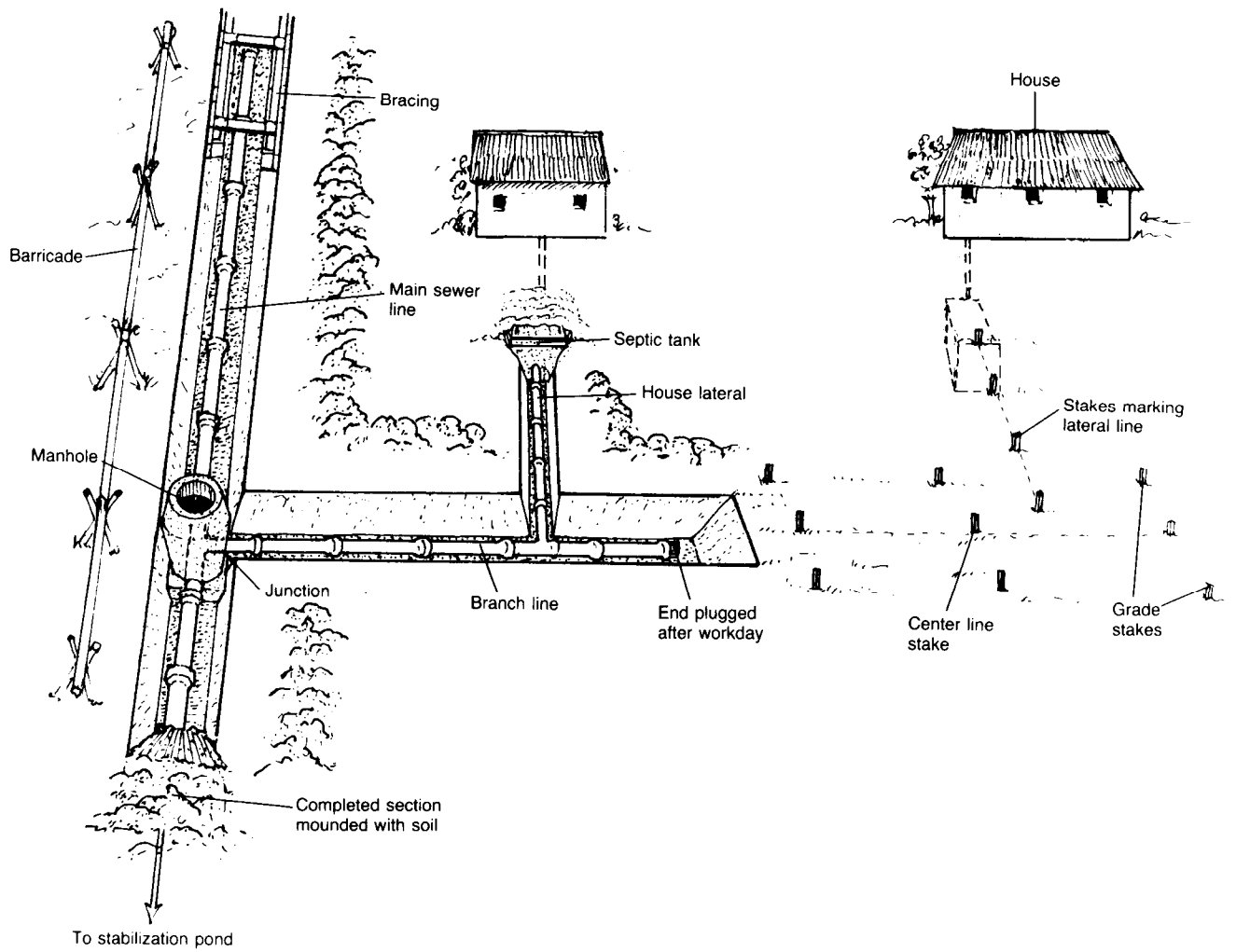

Figure 8. Installing Pipe

Install inspection ports, manholes, or clean-outs at or near the intersections of branch lines and the main sewer line. A clean-out is generally the same diameter as the sewer pipe. See Figure 9. It extends on an angle to the surface of the ground, and is plugged at the upper end, often with a threaded plug for easy removal. See Figure 10 for a manhole on a main.

Remove sheeting and braces, carefully cover the pipe with soil, and fill the trench. Carefully, but firmly, tamp the soil as the trench is filled.

The sewer pipe from a septic tank to the branch line may be laid at this time, but the septic tank must not be put into operation until the stabilization pond is constructed.

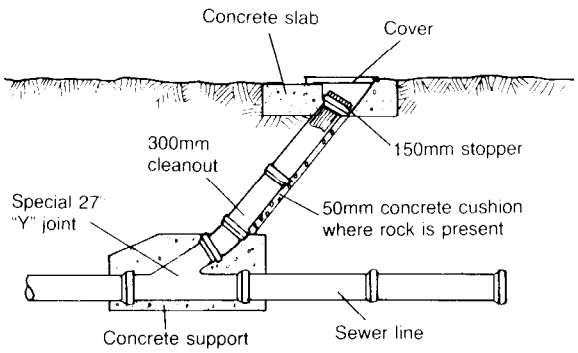

Figure 9. Standard Cleanout

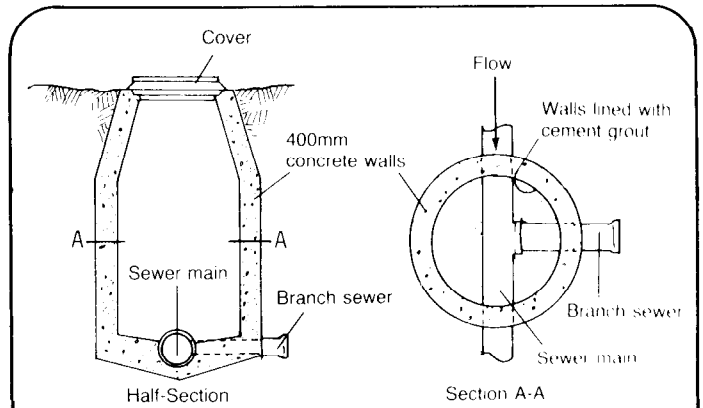

Figure 10. Manhole