Water for the World

Constructing Community Distribution Systems
Technical Note No. RWS. 4.C.4

The successful construction of a community distribution system depends on careful planning and preparation, both before and during construction. Before beginning construction, see "Installing Pipes," RWS.4.C.1. Constructing a distribution system requires an experienced construction foreman and should involve an engineer to oversee the work. This technical note only describes the major steps in constructing a community distribution system.

Before construction begins, the following things must be done:

1. The construction drawings must be completed and available.

2. All appropriate clearances must be obtained.

3. Arrangements must be made for materials and labor.

4. Construction equipment must be identified.

5. Contracts, if used, must be signed.

6. Preliminary construction staking must be completed.

7. A construction schedule must be developed.

Construction drawings must be completed and available with sufficient copies for the foreman and the construction inspector if there is one. Drawings should include an overall plan view, profiles of individual lines, and details for constructing the standposts and other structures. Standard details should be included for installing valves and other fittings and equipment. Where appropriate, specifications should be included for the method of installation. Figure 1 shows a design map of a transmission main and distribution system and Figure 2 shows typical sections of a map that might be used for construction.

All appropriate clearances must be obtained. Clearances needed may include a water use permit, rights of way across public land, easements across private land, permits to cross other existing rights of way, including public roads, railways, and public utility lines. It is expensive to have to stop construction or remove pipe or fittings but this may happen if all clearances have not been obtained.

Materials, supplies and labor must be arranged for prior to construction. Make sure that the necessary materials and supplies have been purchased and are available at the construction site. Labor arrangements must be made and understood by the project manager and the community. When labor is to be supplied by the community as an in-kind contribution, keep in mind that the workers may have other jobs and will be available only for relatively short periods of time.

Construction equipment must be identified and arrangements must be made to have it on the site when needed. This equipment may include are compressors, trenching equipment, front-end loaders and dump trucks.

Contracts must be signed. If all or any part of a project is dependent on a contract, make sure it is ready when construction begins.

Preliminary construction staking must be completed. Construction stakes should be placed at all changes in direction, valve locations and public standposts. These stakes should indicate a number which corresponds to the same number on the plan.

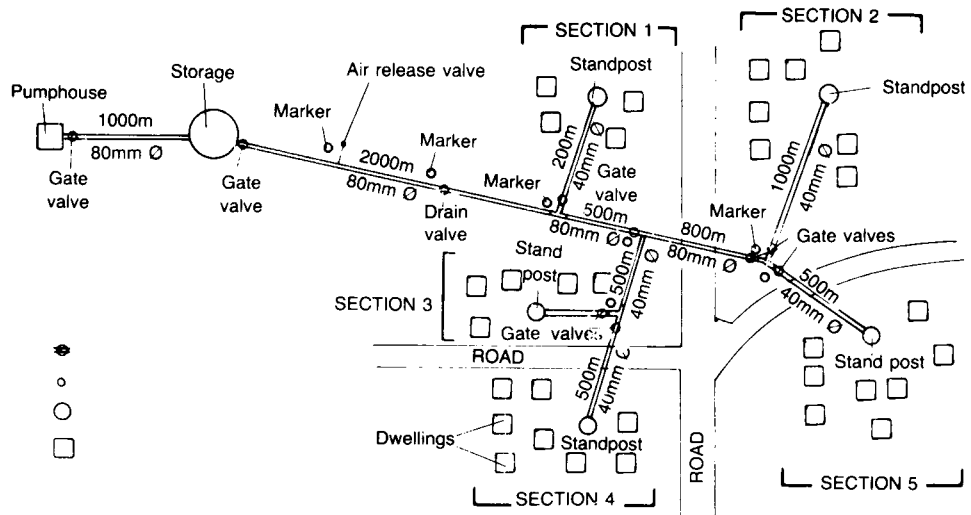

Figure 1. Design Map of Transmission Main and Distribution System

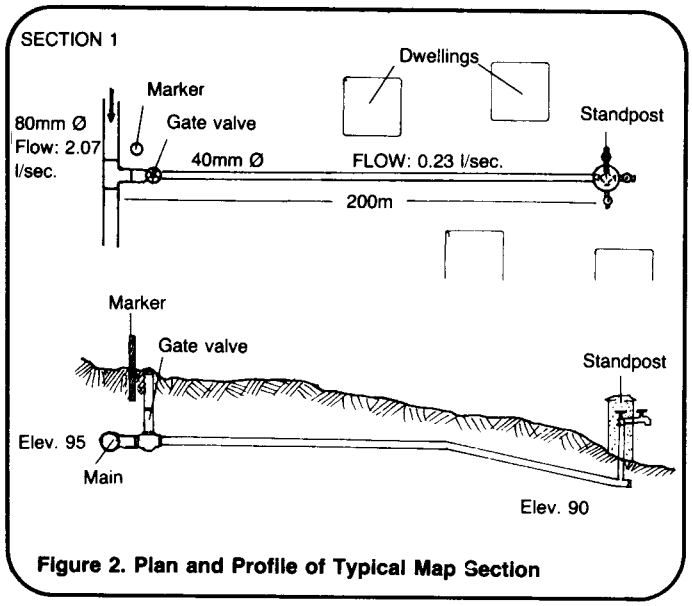

Figure 2. Plan and Profile of Typical Map Section

A construction schedule must be developed. Scheduling is important for several reasons. It provides a plan for when material is required on a job, gives laborers and contractors a goal to reach and helps to assure that construction is completed on time. In developing estimates of times needed for construction, there is usually a tendency to be overly optimistic about the time it takes to accomplish a job. For this reason, estimate the shortest time a job could be accomplished under ideal conditions and the longest time it would take if everything went wrong. The actual time required will usually fall between these. It is standard practice to average the two and use this for a construction schedule. Table 1 shows a typical format for project scheduling. This is filled out with the estimated times and dates for completing the project. These are changed to show the actual times and dates once construction is underway. Serious delays in meeting the project schedule can result from problems with labor availability and material delivery. Labor, particularly volunteer labor, may not be readily available because of illness, the need to work for food, the need to attend markets one or more times a week, and religious activities. Morale is a very important factor and usually remains high if the project stays on schedule. Material delivery can be a major problem. When material is not delivered on time, the morale of the laborers drops. It is important to keep material deliveries on schedule.

Construction Steps

If delivery of materials is reliable, work can start on schedule. If not, it is better to wait to begin construction until the material is on site. In either case, it is important that an area be designated to store project materials, tools and equipment. The storage site should be a secure shelter with a lock, at least for tools, and should be fenced to protect materials and equipment. Arrangements should be made to keep certain material, such as plastic and rubber rings, out of the sun. Accessibility should be good to allow for delivery and removal to the job site. Care should be taken not to locate materials where they might be contaminated by human or animal wastes.

Table 1. Construction Schedule

Project_____
Date prepared_____
Construction start_____
Construction finish_____

Item	Week									
	1	2	3	4	5	6	7	8	9	10
Construction staking										
Material delivery										
Trenching										
Pipe laying										
_____m of _____mm										
_____m of _____mm										
_____m of _____mm										
Backfill										
Pressure test										
Storage tank start										
Storage tank complete										
Water source start										
Water source complete										
Equipment required*										
Chlorinate system										

*l-loader, d-dump truck, p-pickup, b-backhoe, t-trencher, o-other

It is common practice to deliver pipe directly along the route of the trench and unload it along the trench line. This is called stringing. This saves double handling of the pipe and is recommended.

Trench excavation can be done by hand labor or motorized equipment including backhoes and small and large trenching equipment. Hand labor can dig trench in meters per day per worker, backhoes in hundreds of meters per day, and trenching equipment in thousands of meters per day when trenching in easily moved soil. If rock is encountered, the backhoe is usually the fastest.

No matter how the trench is excavated, the bottom must be smooth and free of rocks and boulders. If they are encountered, the trench must be dug deeper than the finished grade will be. Then backfill the trench with material which is free of rocks to make a smooth bed. Figure 3 shows examples of good bedding backfill materials. Backfill usually should be 15cm deep and tamped to compact it. The installation of the pipe varies with the type of material and with the method of connection. This is covered in "Installing Pipes," RWS.4.C.1.

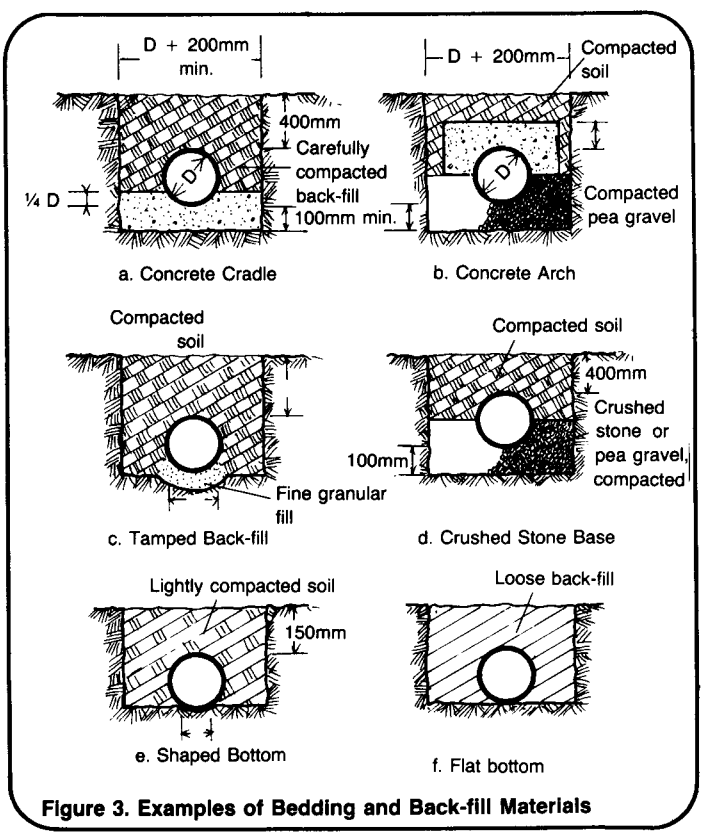

Figure 3. Examples of Bedding and Back-fill Materials

Once the pipe is installed, it should be partially covered with selected material to a depth of 30cm. The joints should be exposed. In small projects, the entire system would be installed this way and then pressure tested. Since the joints are exposed, any leakage can be quickly located. In large systems, it is good practice to pressure test the lines at the end of each day so that long lengths of trenches are not left open for long periods of time. This is accomplished by placing a valve at the end of the line and pumping water into the line under pressure. This way each day's work can be covered. Before pressure testing, be sure the pipe has earth over it and that thrust blocks are in place. Otherwise, the pipe will blow apart at the joints.

Whether the pipe is tested at the end of the day or of the job, it is essential that the pipe be capped each night and at all other times when installation is not underway. Otherwise, insects, rodents and snakes may crawl into the pipe or rain may deposit mud inside the pipe.

The depth of the trench will vary from place to place but normally will be from 45-75cm to protect it from the elements and from construction disturbances. Once the trench is dug, pipe is laid along one side and usually, except for polyethylene pipe, handed down by two men on top of the trench to two men in the trench who install the pipe. Most pipe used in a small system is light enough to be simply handed down to men in the trench. Small diameter cast iron pipe or larger diameters of asbestos cement must be lowered by ropes as shown in Figure 4. Large diameter cast iron or steel must be lowered by a boom. Usually several men will be backfilling behind the installation crew and several digging trench ahead of the crew and preparing the trench bed. Remember that select material must be used below and above the pipe.

In most instances, trenches for rural water systems are shallow. Occasionally, there is a need to dig deeper than 1-1.5m. This can be very hazardous for workmen in the trench and special care should be taken to prevent the trench from caving in either by

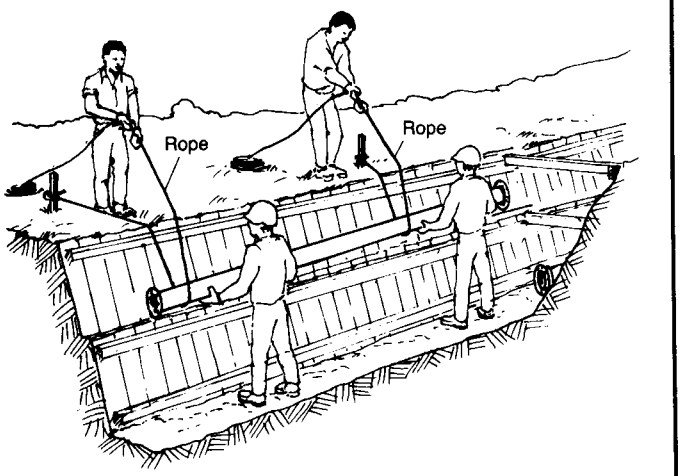

Figure 4. Lowering Heavy Pipe

sloping the banks or by shoring up the sides with support timbers or sheeting as shown in Figure 5. Care must be taken to keep rocks away from the edge of the trench.

Markers should be placed along the line at 1000m intervals and at all valves, changes in direction and laterals. These markers should be concrete or steel posts extending at least 60cm above the ground. These markers, as well as any changes in the construction system from the design system, should be clearly marked on a set of construction drawings as the changes occur. These are known as as-built plans and they are invaluable for the future operation and maintenance of the system.

The standposts should be constructed according to the plans. Figures 6 and 7 show typical standpost designs. Sand used for concrete or grouting must be clean and free of silt or organic material. Otherwise, premature failure of the concrete will occur. An important consideration is the drainage of wastewater and rainwater away from the standpost.

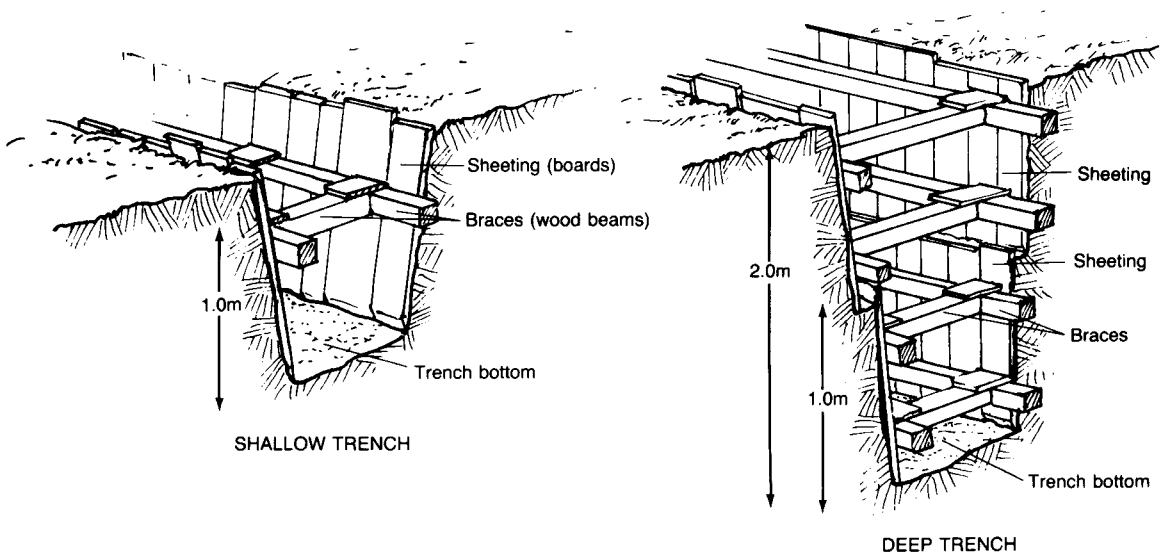

Figure 5. Sheeting and Braces

Once the pipe is installed, tested and covered to a depth of 15-30cm with rock free material, trench run material can be used to complete the back-filling. This can be done by hand or machine and, in either case, earth should be mounded over the line to allow for future settling.

After completing construction, thoroughly flush the pipe, including all laterals, with clean water and chlorinate as described in "Installing Pipes," RWS.4.C.1.

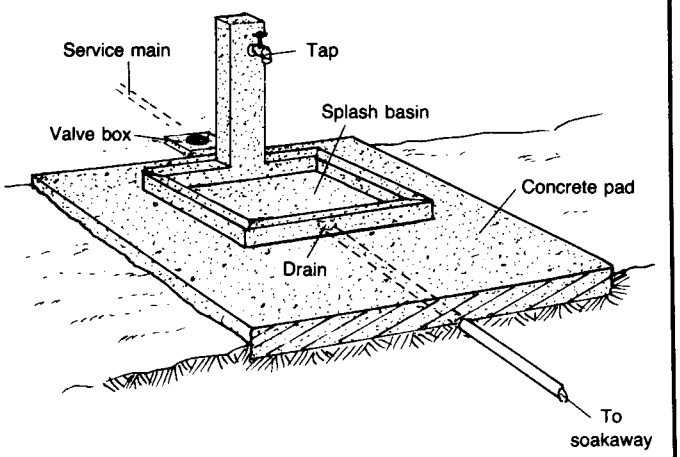

Figure 6. Standpost Design

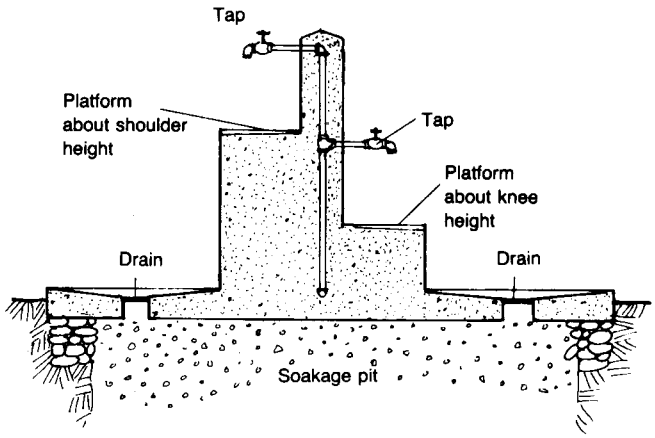

Figure 7. Standpost With Multiple Taps