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Installing a Subsurface Drip Irrigation System for Row Crops

Juan Enciso*

The success of a subsurface drip irrigation (SDI) system for row crops depends on its design, installation, operation, management and maintenance. All phases are equally important. This publication describes the components and installation of an SDI system. Steps in the installation process are:

- tape injection;
- trenching;
- installing the mainlines, manifolds (submains) and flush lines;
- connecting the tape with the manifolds and flush lines;
- back filling; and
- installing filtration equipment.

Components of the irrigation system

The main components of an irrigation system are the filters, mainlines, manifolds (submains), field blocks, flush lines, drip lines (laterals) and accessories (Fig. 1).

All the drip lines (laterals) connected to the same submain make up a field block. Several field blocks can be grouped together as one station and operated simultaneously. Water is supplied to drip lines in the field blocks by the manifold (submain). In some permanent systems, the drip lines are also connected to a flush line so that accumulated sediments can be flushed from the drip lines using a single valve. The flush line is also called a collector line. In some field blocks, particularly those with longer lateral lengths (more than 200 m), the flush line may also be connected to the mainline by a separate valve and manifold, so that water can be supplied to both ends of the drip line. This prevents excessive pressure loss in longer drip lines. The flush line should always contain a flush-out valve, even if it is also used as a supply line. Seasonal systems do not use flush lines; their tapes last only a season or two before needing to be replaced. The drip lines may be connected to the manifold in several ways as shown in Figure 2. The manifold can be placed at the soil surface or buried.

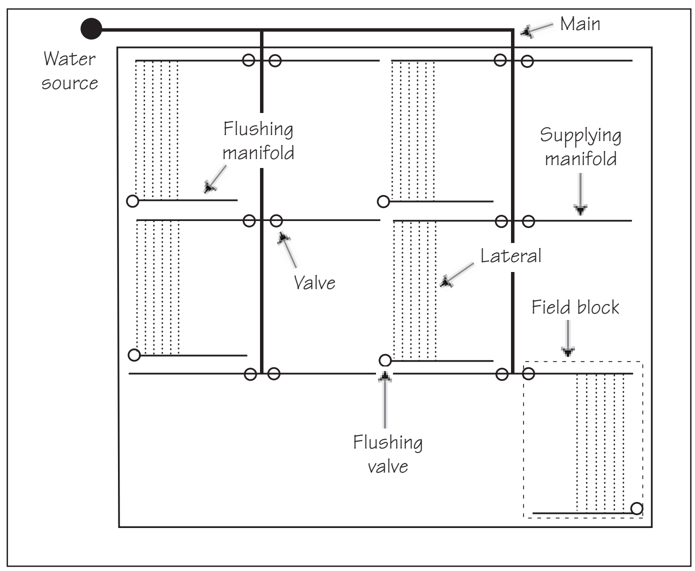

Figure 1. Typical layout of a drip irrigation system.

*Assistant Professor and Extension Agricultural Engineer, The Texas A&M University System.

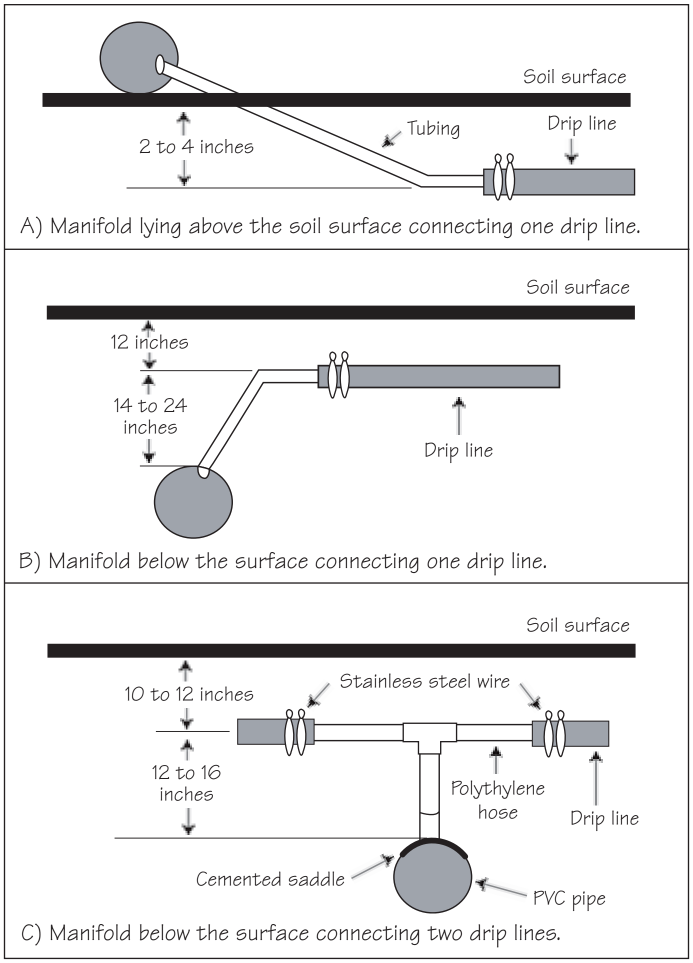

Figure 2. Typical connections from manifold to drip lines or laterals. In this case the manifold is connected to the drip line with a stainless steel wire (there are many ways to connect it).

Tape injection

The injector consists of a roll that holds the tape and a shank that opens the soil to bury the tape (Figs. 3 and 4). As the shank opens the soil, the tape is guided into the soil, usually through a curved pipe mounted behind the shank. The shank must be durable enough to resist the impact of rocks and other obstructions in the soil. The pipe that is mounted behind the shank should be smooth and curved so it does not tear the tape. Drip line injection is shown in Figures 4 and 5.

The steps for injecting the tape are:

1. Mark the locations where the manifold and flush lines will be installed, using flags or lines of gypsum on the field.
2. If the tape will be more than 8 inches deep or the soil is rocky, pre-rip the rows using the shank alone without the tape. Pre-ripping makes depth and spacing more uniform and helps to clear away rocks that could damage the tape. Pre-ripping is not necessary on easily plowed fields.

Figure 3. Toolbars with drip tape injector.

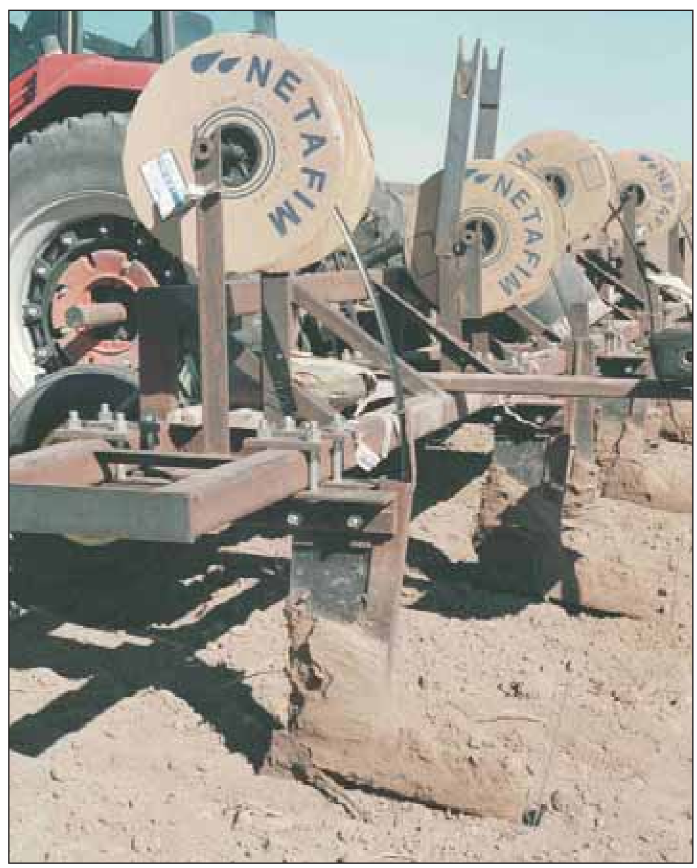

Figure 4. Installing the drip tape.

Figure 5. Changing a roll of drip tape in the middle of the field.

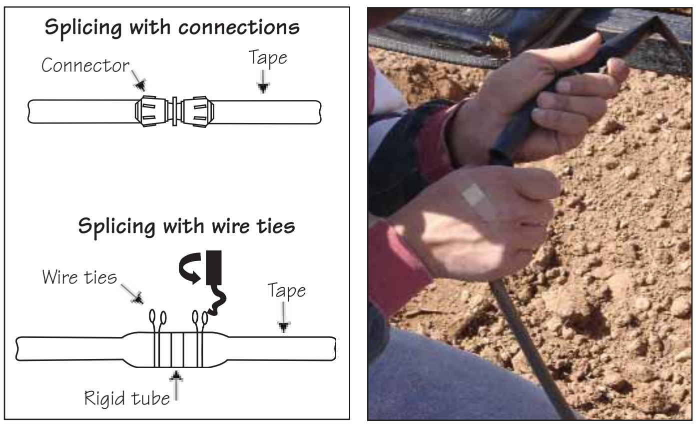

Figure 6. Drip line splicing.

3. Be extremely careful not to cut the tape when unwrapping the plastic that covers the roll. (Sometimes the unwrapping is done with a knife.) Careless or rough handling of the tape may lead to major leaks after installation.
4. Lay the tape down with the emitters facing upward to avoid soil plugging. The rolls have indicators showing the direction of the emitters.
5. Just before lowering the shank, anchor the tape temporarily by hand or with a stake so it can be pulled into the soil. Stakes can be made of welding rods or rigid wire (Fig. 4).
6. The depth of the tape will depend on the crop. Tape has been installed 12 to 14 inches deep for permanent SDI systems in crops such as cotton and alfalfa in the St. Lawrence, Trans-Pecos and Lubbock areas. In the Lower Rio Grande Valley, tape has been installed 2 to 6 inches deep for vegetable crops such as onions and melons. Check to see that the tape is at the correct depth and adjust the control roller if necessary.
7. If the drip tape runs out in the middle of the field it must be spliced (Figs. 5 and 6). A 3- to 4-inch-long PVC tube can be used to splice the old and new rolls together by securing the tape to the ends of the tube using two stainless steel wires or special connections.

Trenching

Trenching may be necessary for mainlines, manifolds and flush lines. Manifolds and flush lines sometimes can be installed above the soil surface, with a trench only for the mainline. Trenching can be done with a rotary trencher or a backhoe. A rotary trencher is recommended. The steps are as follows:

1. Before trenching, pack the tape on the field with a tractor, passing a wheel on each side of the tape. (Fig. 7)
2. Trenches should be 2 feet wide or the size of the bucket on the backhoe. The trenches for the submains should be at least 16 inches below the depth of the drip line and 1 foot below the flushing line.
3. Expose the tape from the ditch forming a triangle (Fig. 8). Leave enough space to work with the hands and tie the drip line to the PVC pipe.
4. Level and pack the ditch bottoms with soil that falls from exposing the tape.
5. Place some flags where each station ends.

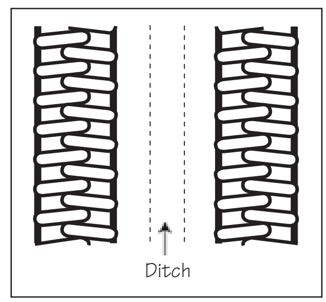

Figure 7. Pack the soil with a tractor tire on each side of the ditch.

Figure 8. Cross-section of the drip tape connection to the PVC manifold.

Figure 9. Drilling the manifold (A), inserting the grommet and the PVC hose (B), and connecting the PVC hose to the drip tape (C).

Connecting drip lines with manifolds and flush lines

If manifolds and flush lines are below the soil surface:

There are several ways to make the connections. The following example uses grommets and barb fittings.

1. Drill a hole in the top of the manifold or flush line just where the tape is to be connected. (Figs. 9A and B). Use a 13/16-inch drill bit for #700 grommets (1-inch or 7/8-inch tape). Use a 9/16-inch drill bit for #400 grommets (5/8-inch tape).
2. Clean the hole with a knife to remove all plastic residue. This plastic could produce leaks later in the season.
3. Insert the grommets in the hole.
4. Pre-assemble the insertion to the PVC hose, using glue.
5. Soak the insertion with soapy water so it will fit easily into the grommet.
6. Insert the PVC hose into the tape, being careful not to bend the hose.
7. Tie a stainless steel wire around the tape (Fig. 9C).

If submains and flush lines are above the soil surface:

The most common connection method is to insert small-diameter PE tubing (0.188 to 0.35 inches outside diameter) into the PVC, PE or lay flat hose as shown in Figure 10A. A hole is then made on the drip line and the tubing is inserted in the drip line. The tubing is attached to the drip line with a piece of folded tape. Another method is to use connections as shown in Figure 10b.

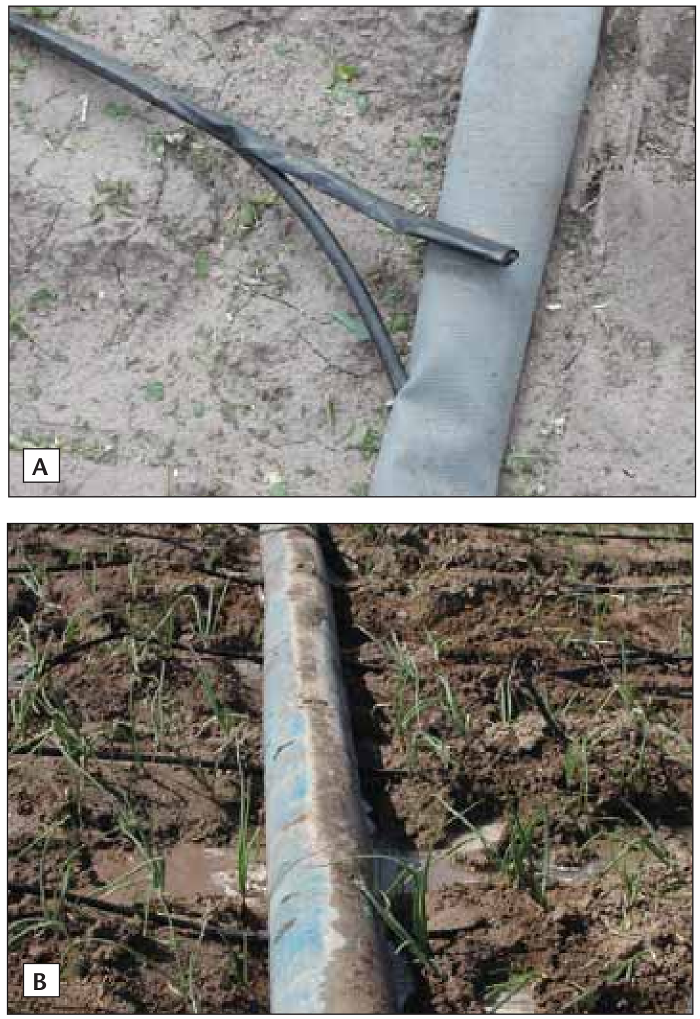

Figure 10. Connecting the drip tape to a manifold above the soil surface with tubing (A) and with a fitting (B).

Back-filling

Run each station for 4 hours and check for leaks. If there are leaks in the middle of the field, make a hole and splice the tape. If there is a leak in the manifold, the connection between the tape and manifold needs to be redone or the plastic remnants need to be removed from the hole drilled in

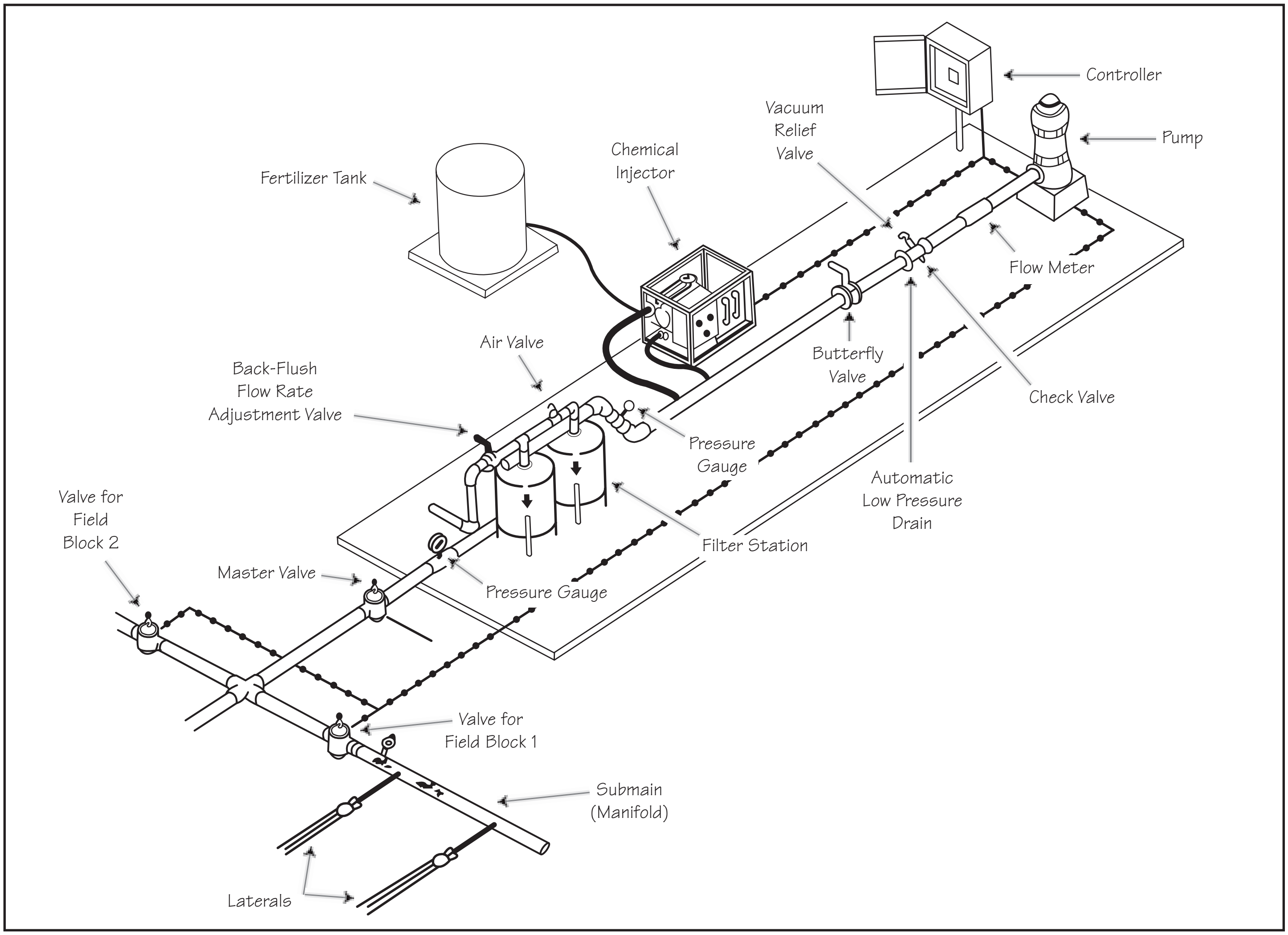

Figure 11. Typical layout of the pumping station showing the filtering equipment.

the manifold. If there are no leaks, GENTLY push some loose soil into the ditch. Then add water to the ditch so the soil will settle around the pipe to hold it and prevent it from moving. Do not move too much soil at once, as this can damage rigid pipe and connections. Pack the soil, then add more soil and water until the ditch is filled.

Installing filtration equipment

The filters should be installed over solid surfaces, preferably concrete bases. A typical set up of the filtering equipment and its components is shown in Figures 11 and 12. Filters remove the solid matter suspended in the water to keep the drip emitters from clogging. The most common filtration size for subsurface drip irrigation is 200-mesh (200 openings per inch), which represents an opening of about 0.003 inches (0.076 mm). Centrifugal filters, media or sand filters, and screen and disk filters are commonly used, often in combination. For example, if water comes from an aquifer and some sand is being pumped, a centrifugal filter can be used to trap the sand, followed by a disk or sand media filter. When water comes from a canal, it is common to have both a media filter and a screen filter.

Media filters need the most adjustment during installation. Media filters consist of several tanks that filter the water, and each tank needs to be back-flushed. This is done by passing clean water through a tank in a reverse direction; the clean

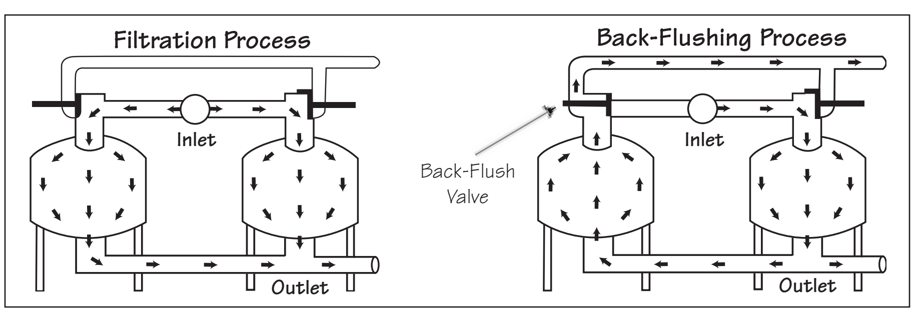

Figure 12. Filtration and back-flushing process.

water comes from the other tanks that are not being back-flushed (Fig. 13). Tanks must be back-flushed when they are dirty, a condition that is usually indicated by an increase of pressure of about 10 psi.

A sand media filter has some pressure loss–about 3 to 5 psi. Incorrect installation can increase the loss to about 10 to 25 psi. Follow these steps to install a sand media filter:

1. Order only pre-washed gravel.
2. Install the gravel and the sand at the depths recommended by the manufacturer.
3. Close all the valves downstream of the tanks (the back-flush valve).
4. Open the main valve (butterfly valve).
5. Open completely the back-flush valve of one of the media tanks. Then open the back-flush flow rate adjustment valve slowly. Remember that the back-flush flow rate adjustment valve should be calibrated just one time. The back-flush flow rate should be determined from visual observation.
    - The back-flush flow rate should be sufficient to expand the media bed and separate the sand into individual particles. The smaller particles and those with lighter specific gravity than the media need to be carried out of the tank.
    - The back-flush flow rate should not be excessive to limit the amount of sand removed from the tank. The first time a tank is back-flushed it is normal to remove some sand. Use a 100-mesh screen at the discharge to catch the sand discharged.
6. Repeat the process, opening the back-flush valve of each tank.
7. Adjust the frequency and the time of the back-flushing operation. It is important to back-flush at least once per day and to control the back-flushing automatically by triggering it with a differential pressure switch. This switch is usually set to start when the differential pressure increases to 5 to 8 psi.

Figure 13. Filtration equipment.

Texas Water Resources Institute

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