Surface and Subsurface Drip Irrigation

► This Power Point presentation is a general information of Surface and Subsurface Drip Irrigation.

► We will discuss components of a drip system, beginning from the well pump through the system, then ending with manifold flushing.

► We will also discuss installation of components, testing the system and maintenance of the drip irrigation.
General Components of Subsurface Drip Irrigation
From well pump to manifold flush line

1. Power source
2. Electric motor-well pump
3. Air relief valve (ARV)
4. Check valve or backflow valve
5. Flow meter-optional location
6. Butterfly valve-Flush well water
7. Booster pump
8. Sand separator & ARV

Filter station:
9. Sand media filter station
10. Sand media tanks
11. Pressure relief valve
12. ARV & continuous acting ARV
13. Filter back flush line
14. Filter back flush line ARV
15. Gate valve
16. Pressure gages inlet/outlet
17. Filter station Control box
18. Screen filter
19. Pressure sustaining valve
20. Chemical Injection point
21. Injection system
22. Chemical tanks
23. Pressure relief valve
24. ARV & continuous acting ARV

Field components:
25. Type of drip tape & Emitters
26. Drip design
27. Main line
28. Sub-main line
29. Control valves
30. Manifold flush line
31. Blocks of the design
32. Maintenance
33. Windbreak

Filtered water into the field
► Subsurface drip irrigation, is a method of micro-irrigation that applies small amounts of water slowly and frequent through emitters spaced along polyethylene tape or tubing, buried or above the surface.

► It applies water precisely where it is needed with a high distribution uniformity and application efficiency.

► It reduces evaporation, deep percolation, water runoff, and eliminates the need to over-irrigate the crop due to uneven application.

► The micro-irrigation systems need to be carefully designed, maintained, and managed to achieve its potential. It requires several components to build-up the system.
1. Power source

- It is very important to select the engine or the motor to deliver the correct pressure and flow rate at the highest possible efficiency for micro-irrigation systems.

- There are several sources of power: natural gas, diesel or gasoline engines, and electric motor.

1.1. Natural gas engine

- They became obsolete

1.2. Diesel engine

- Some farmers still use this type of engines

- They are able to adjust the flow rate needed by adjusting the rpm of the engines.
The electric motors are the most often used.

They need little maintenance like checking the oil for the motor and the oil for the line shaft bearings, and the pump bearings.
There are several types of irrigation water pumps: Deep-well turbine, submersible and centrifugal pumps.

- **Deep-well turbine** pumps, are installed inside the well casing under the water.
- Consist of a screen, a pump and the shaft.
- The shaft connects the motor to the head and the pump bowls, and transfers the power to the impellers, and the column carries the water to the surface.
- The turbine pumps may be either water or oil lubricated.
- If the well produces a lot of sand, select the oil lubricated pump to keep the sand out of the bearings. In some states, Minnesota, water lubricated pumps are required for new wells.
- Deep-well turbine pumps, includes several bowls stacked one above the other. This is called staging. A four-stage bowl assembly contains four impellers attached to a common shaft.
Lately some farmers are using submersible pumps for deep wells.

Submersible pumps consist of a turbine pump, a screen and a submersible electric motor, hermetically sealed.

Both pump and motor are suspended in the water, eliminating the long drive shaft and bearings retainers.

The pump is connected to the electricity through a power cable.

Submersible pumps used for irrigation need three phase electrical power.

The advantage of this type of pump is the minimum equipment on surface and very little maintenance.

This type of pump is efficient and does not rely on external air pressure to lift the fluid.
The centrifugal pumps are used to pump water from reservoirs, lakes and shallow wells.

They are also used as booster pumps in irrigation systems.

**Centrifugal pumps** consist of one impeller, a pump casing and a shaft.

The shaft and the impeller rotate, creating centrifugal forces in the water inside the impeller.

These forces cause water to flow to the outer edge of the impeller and into the impeller eye or center.

The amount of pressure developed by the impeller depends on the impeller diameter and rpm, while the impeller flow rate is determined by the impeller width and diameter.
The **Air relief valve** (ARV) shall be installed in between the irrigation supply pump and the check valve.

It allows the air to escape when the system is turned on and to re-enter when the system is turned off.
3.1. Types of air relief valves

- Air Relief Valve, is a valve that allows the air to escape and re-enter the pipeline.
- It breaks the vacuum caused when the system is draining or turned off.
- There are several types of air relief valves, the more often used are:
  1. Air relief valve (ARV)
  2. Combination of air relief valve and continuous acting air relief valve.

1. Air relief valve (ARV):
- The valve has a large venting orifice.
- When the system is turned on, it releases large volumes of air from the pipeline.
- As the system builds pressure, it fills with water forcing the float to close the valve.
- Once the valve is closed and the system is pressurized, it does not allow the air to escape.
- When the system is turned off, it allows the air to re-enter the system.
- It prevents pipe line and accessories from collapsing, and suction of soil and debris into the emitters.
- They are installed at the check valve, filter back flushing pipe, sub-main and manifold lines of the system.

2. Combination of ARV and Continuous acting ARV:
- During start-up, the valve releases large volumes of air from the pipeline
- At shut down, it allows the air to re-enter the system.
- While the system is pressurized, the automatic function, continuously expels accumulated air.
- This valve combines two functions: ARV and continuous acting ARV.
- They are recommended to be installed at the sand separator, filter station, screen filter and main line of the irrigation system.

- There is also a variety of air relief valves, brands, material and sizes.
A **check valve** is a device that prevents water back flow and prevents contamination to the water source.

- It Shall be installed at the pump discharge.
- The check valve may be in the form of ball, tilting or lifting disc, and swinging disc.
- The water pressure flowing in the normal direction, lifts the disc to open the check valve.
- It returns to the closed position due to gravity or gravity combined with spring action when the flow stops.

Any inline check valve system shall have the following features: an automatic quick closing, spring assisted, an automatic low pressure drain valve; an air relief valve; an inspection port or viewing device to determine if water has drained out of the system.

Check valves shall be installed according to the current draft regulations of New Mexico Department of Agriculture.
A flow meter is a device to measure the flow rate of a well or the total amount of water being applied.

It is a component of a drip irrigation system, required by law in some areas.

It shall be installed following the check valve or downstream the pressure sustaining valve for irrigation purposes.

There are several types of flow meters: Bolted propeller flow meters, Magnetic, Ultrasonic, and Turbine flow meters.

The propeller flow meters are often used, consisting of a propeller linked by a shaft and gears to a flow indicator and inserted into a closed pipeline.

It becomes essential for managing irrigation scheduling, to monitor the performance of the irrigation system, and to assure that the system is operating correctly.

By reading the flow meter, always at the same pressure, is possible to identify changes in flow rate during the season. It may indicate problems such as clogging of emitters or filters, leaks in the system, or problems with the pump or well.
To install a drip system, it is very important to know the amount of water that the well can produce.

This well production can be measured using any type of flow meters.

The designer will design and size the blocks accordingly to the field dimensions and the well production.

It is recommended to check the flow rate under the pressure that your system may need.

You may check the flow rate of the well with a free flow. However, when the system is pressurized the gpm will be less.
An optional **butterfly valve** may be installed following the check valve, to drain and clean the water from the well before entering the filter station.

The first 15-20 minutes, the water will come out with sand, some deposits, and rust from the well casing.

By opening the flushing valve and closing the valve toward the system, the water will be flushed out to the discharge manifold until it is clean. Then by opening the valve toward the system and closing the flushing valve, the water filtration may start.

This will remove the large deposits before it enters the filter station.

However, some of the producers start the well and pump the water straight to the filters.

The only disadvantage is that the first 15-20 minutes the filters will be constantly back flushing until the water is clear of deposits.

Make sure one of the butterfly valves is opened when turning the system on, or the pipe will blow out, unless you install a pressure relief valve.
A booster pump is a centrifugal pump that helps to increased water pressure through the irrigation systems, where the normal system pressure is low.

Booster pumps are made of cast iron closed impellers, for high efficiency and resistance against erosion, caused by abrasive particles.

Cast iron construction provides durability, low maintenance, easy cleanout design, replaceable volute diffuser and casing o-ring for servicing.

Single stage irrigation pump models, feature a built-in check valve to insure fast self priming after initial liquid is added to the pump.

Two-stage models, provide additional pressure in fractional horsepower sizes for multi-irrigation head applications.

They are installed upstream of the sand separator or the filter station.
8. Sand Separator

Hydrocyclone or Sand separator

- A sand separator is a device that separates the sand from the water, using centrifugal force. The water spins inside the hydrocyclone and forced into the center of the separator and up through an outlet, and the sand and particles fall into the bottom chamber of the separator.
- This collection chamber can be manual or automatic to flush out the sediments.
- For automatic systems, one sand separator flushes out for 60-90 seconds one at a time.
- A sand separator system shall be installed when the well produces a lot of sand and large suspended particles (larger than 200 mesh).
- They are installed between the well pump and the filter station to remove the sand before it enters the filters.
- There are several types of hydrocyclone or sand separators and sizes.
- The size of the sand separator depends of the well production.
- The size of the small sand separators ranges from 80-150 gpm.
- Several units may be installed to meet the well production or install one large sand separator.
- The sand separator’s cone wears out quicker if the water velocity is greater then 5fps.
- An air relief and continuous acting air relief valve shall be installed at the sand separator.
The filter station is the most important component of a subsurface drip irrigation. Selecting the appropriate filter, requires considering water quality factors.

Filters remove fine sand and smaller suspended particles (200 mesh in size or less) before they enter the drip system.

The filters cannot remove dissolved minerals, bacteria or algae, and it may be necessary to do a water treatment.

There are 3 types of filters generally used: Screen, Disc and Sand media filters.
Screen filters can be manual or self cleaning and only used for clean water.

- They vary in size 3-10 inches outlets, they have a replaceable stainless steel screen, the screen ranges from 40 to 200 mesh, and the filter flow rate ranges from 35 to 1600gpm.

- They use minimum water during flushing, less than 1%, and no interruption of downstream flow during flushing.

- The screen can be easily removed from the housing to be rinsed manually.

- Screen filters are installed as one unit filter station.

- Screen filter may be installed downstream the Sand media as a preventive filter in case the Sand media fails.

- The filter station shall remove all solids larger than one-fourth the emitter opening diameter (NRCS specifications).
Disc filters have a flat plastic rings with microscopic grooves, stack together to form a cylindrical element.

They filter through the entire ring depth, and corrosion is not an issue.

During filtration mode, pressure increases and compresses the rings increasing efficiency and protecting the system from clogging.

They can be manual or automated flushing.

The degree of filtration is easily changed by replacing the disc rings with desired mesh size from 40-280 mesh.

The disc filter station may work as a unit alone or combined to form a filter battery.

During back flushing mode, the disc filter stacks are separated, and multi-jets nozzles provide tangential spray on the loosened discs, making them to spin and flush the debris and deposits outward.

The volume of water required for back flushing is less than sand media filters.

It requires 50 psi of pressure for proper and adequate back flushing.
Sand media filters are widely used for subsurface drip irrigation or any irrigation application.

- They are reliable and effective to remove inorganic contaminants from the water source.
- It requires a minimum maintenance.
- There are several brands and sizes.
- After installing the filter station, the media tanks shall be filled out with silica sand #16 and 20 (170 and 230 mesh) or recommended by manufacturers to prevent excess back flushing.
- Sand media works as a series of tanks, with a minimum of 2 tanks, for proper filter back flushing.
- They are designed to be self-cleaning through a “backflush” mechanism, or they can be manually operated.
- The recommended flow rate for sand media filters is 17 to 25 gpm per square foot of filter surface area.
- Higher flow rates can be used with clean water (less than 10ppm of suspended material), and lower flow rates are used when water contains 100ppm or more.
- Sand media requires a minimum of 30 psi of pressure for proper and adequate back flushing.
- To accomplish the minimum pressure it may be necessary to installed a pressure sustaining valve downstream the filter station.
Aerospace-grade resins with the highest strength-to-weight ratio, laminates and composite materials. Polymer that provides corrosion resistance, and light weight.

Carbon steel with an enamel or Epoxy coated and fiberglass housings, for corrosion resistant, but not rust proof.

Stainless steel (Carbon steel type 304 or 316)

Carbon steel filters are sensitive to localized forms of corrosion such as pitting, crevice, or stress cracking; specially when the water salinity is above 750 ppm, or when a combination of chloride greater than 300 ppm and phosphate less than 300 ppm takes place.

A single hole in the coating will serve as “magnet” for corrosion action, so care must be taken during internal repair work, and during installation of the media and gravel packs to avoid chipping and damaging the tank coating.

A 36” tank diameter has 7.1 ft$^2$ of filtration area, and a 48” tank diameter has 12.5 ft$^2$. Manufacturers already designed the capability of the sand media tanks to size the filter station.

-Corrosion (breaking down the essential properties by chemical reaction).
-Rust (oxidation of the metal).
Sand media filter station - Components

- Pressure Relief valve
- Water line supply
- Sand media tanks
- Three way diaphragm valve
- Filters back flush line
- ARV and Continuous acting ARV
- Air relief valve
- ARV and Continuous acting ARV
- Screen filter
- Pressure Sustaining valve
- Control box
- Gate valve
- Pressure gage
- Filtered water to the field
- Pressure relief valve
- Filtered water to the field
- Water line supply
11. Pressure relief valve
- It is a protection valve, usually spring-loaded, to open and relief the pressure that might damage filter housings or pipelines, when the system is over pressurized by any reason.
- It shall be installed at the filter station water inlet, down stream the pressure sustaining valve, at the main line of the system, and at the main line flush valve.

12. ARV and continuous acting ARV

► **Pressure relief valve**
- It is a protection valve, usually spring-loaded, to open and relieve the pressure that might damage filter housings or pipelines, when the system is over pressurized by any reason.
- It shall be installed at the filter station water inlet, down stream the pressure sustaining valve, at the main line of the system, and at the main line flush valve.

► **Air relief valve** and Continuous acting **ARV** shall be installed at the filter station water inlet, at the main line, and at the control valve.
Each sand media tank has a **3 way diaphragm valve** located at the top of each tank.

These valves are designed to detect the drop in pressure through a “**backflush mechanism**” to switch the system into **filtration or back flush mode**.
The filter back flush line, allows to drain the waste water during the filter back flushing.

The Air relief valve, allows the air to escape and re-enter the line during filter back flushing.

The Gate valve, allows to adjust the back flush flow rate for filter back flushing.

- Higher flow rate will remove too much media sand.
- Lower flow rate will not provide sufficient fluidization of the media bed for proper cleaning.
- To adjustment should start with a close valve, and slowly open in small increments until it is properly set.
- Never start the adjustment with a high flow rate.
- It may destroy the integrity of the media/gravel layer in the tank.
- Between each increment, check the discharged water for the presence of media sand, using a 100 mesh screen or nylon stocking into the water discharge.
- Give enough time from adjusting and the checking, to allow the water to flow from the tank to the pipe end.
- Some sand will show up. Do a final adjustment when the system is operating at its typical pressure and flow rate, and no media should be filtered out.
16. Pressure gages

► Pressure gage is a device that measures the water pressure in the system.

► Pressure gages may reveal system performance anomalies that may require attention.

► They are installed at the filter station, Screen filter, pressure sustaining valve, main line, sub-main and control valves.

► It is very important to monitoring the pressure gages to assess irrigation performance and ensure that components are working correctly.

► Pressure gages and a flow meter should be part of every micro-irrigation system, to indicate how much water the system is applying at a certain pressure.

► If the flow rate decreases during the season at the same pressure may be a sign of clogging, or if flow rate increases and pressure drops may indicate a leak in the system or several valves open.

► Use a quality liquid filled pressure gauge.
The control box is a component of an automatic filter to set features for filtration.

**Flushing time**, is the duration of back flushing which must be sufficient to allow complete cleaning of the media bed, 60 to 90 seconds per tank.

To properly adjust the duration of flushing, use the clear plastic tube or a cylinder glass to view when the water of back flushing is clean.

**Back flushing frequency**, it is how often the filters will be back flushing, every 12 hrs or at least once a day, regardless of the pressure differential.

**Pressure differential**, is the pressure recommended by the manufacture for the filters to start back flushing, the switch is usually set from 8-10 psi.

**Dwell time**, is the time between flushing each tank, it allows the system to build up pressure before the next tank starts flushing, it ranges from 20 to 45 seconds.
When setting the **pressure differential** for an automatic filter station at 10 psi.

It means, if the water inlet reaches 40 psi and the water outlet is 30 psi, the difference between the 2 pressures is 10 psi.

Then the controller senses the difference in pressure and the system goes into back flush mode.
During **filtration mode**, the water comes from the well, into the inlet, through the sand media, and filtered water goes into the field.

When the mechanism detects the drop in pressure through the entire system, due to the accumulation of filtered particles, the system goes into **back flush mode**.

During **back flush mode**, one of the filter tanks is going to be closed to unfiltered water inlet, by the 3 way diaphragm valve, and opened up to the flush discharge manifold.

Filtered water from filter tanks that are not flushing, flows into the bottom of the tank through the under drain, pushes up and lifts the sand media (fluidization process) and floats up.

Then the clay, silt and organic particles are disposed to the waste water system for 60-90 seconds. Then the valve closes and the tank goes into filtration mode.

When back flush mode starts, it goes in a sequence, one filter tank at a time, until the filter station is finished, and then it goes back into **filtration mode**.

The **sand media filter** station requires a minimum pressure of 30 psi for proper back flushing.

The **flow rate** for adequate filtration ranges from 17-25 gpm/ft² of filtration area, depending of the water quality.

A 36” filter tank diameter, will use 110gpm during back flushing, and a 48” tank will use 200gpm.
A preventive **screen filter** may be installed downstream the sand media to prevent sand going into the drip lines in case the filter station fails.

An automated **pressure-sustaining valve** may be necessary to install downstream of the filter station to maintain a constant pressure required of 30 psi for proper and adequate filter back flushing.

Pressure sustaining valve, automatically monitors and control the pipeline pressure upstream, and has a pressure regulator where you can adjust the pressure needed.

The controller senses the water pressure upstream and begins to close to reduce the flow rate and increases the pressure until it reaches the pre-set level, or begins to open to increase the flow rate and reduce the pressure in the system until it reaches the desired level.

Pressure sustaining valves are recommended if pressure loss is excessive through the filters during back flushing.
The chemical injection points, are the points or valves to inject the chemicals into the irrigation system.

They are installed downstream the pressure sustaining valve, between 2 and 3 feet apart.
Chemicals are often injected through the micro-irrigation systems.

Several injection systems are available: Electric Diaphragm or piston pumps and Venture injectors.

They vary in cost and deliver the chemical with accuracy.

This process is known as chemigation.

The injection system allows to apply chemicals at any time, at any dosage without the need of equipments in the field.

It simplifies the chemical application directly to the root zone of the plants.

It increases efficiency of application, reduces chemical use and cost, reduces labor and hazard to people handling and applying the chemicals, and potentially less harmful to the environment, compared to air applications.

Over irrigation may result in deep percolation, so the fertilizer application shall be done at the end of the irrigation cycle, or adjusted to the irrigation time.

For any chemical application, it is highly recommended to do a Jar test, to ensure that the chemicals and minerals stay suspended or in solution.

To perform a Jar test, mix a sample of your chemical, add water from your well, shake until it’s well mixed. Let it sit for 24 to 48 hours. If the solution precipitates or makes a sludge, that chemical will not be good for your emitters.
Chemical tanks shall be installed besides the filter station or close to the injection system.

Several chemicals may be injected though irrigation systems: chlorine, acid, fertilizers, herbicides, micronutrients, nematocides, and fungicides. However, very few are labeled to be injected in drip irrigation.

Chlorine, sulfuric acid and acid fertilizers are the chemicals most often injected though irrigation systems.

It is recommended to use filters for any chemical injection.
Now the filter station is constructed, and the chemical tanks are installed.

It is recommended to construct a filter station shed to protect it from UV light and vandals damages.
Pressure relief valve and main line ARV (ARV & continuous acting ARV) shall be installed just before the main line goes into the field.

The pressure relief valve should be used in conjunction with an air relief valve, and shall not be planned to compensate for improperly designed pipeline.

The pressure at which the valve starts to open shall be marked on each pressure-valve, and sealed to ensure that the adjustment mark on the valve is not changed.

Manufacturers mark the pressure valves for use under this standard, based on performance test.
• Field components

Installation
25. Type of drip tape and emitters

25.1. Thin wall Drip Tape

- **Thin wall drip tape** has internal emitters molded or glued together at equally space within the distribution line.
- The drip line is available in a wide range of diameters (1/2", 3/4", 7/8", 1", 1 3/8").
- Wall thickness (6, 8, 10, 12, 13, 15 mil).
- Drip tape emitters spacing (8", 10", 12", 16", 18", 24", 30").
- Emitters flow rate is expressed in gph per 100ft., it ranges from 0.16 to 0.80 gph.
- In row crops emitters spacing is 12", and row spacing ranges from 30", 38" to 40".
- In Orchards and Vineyards emitters spacing 24” and row spacing from 10ft to 30ft.
- Drip tape depth in row crops ranges from 6-8 inches, and orchards 10-12 inches.
- The recommended working pressure for drip tape ranges from 10-15 psi for high water application efficiency.
- The drip tape length will depend of the field dimensions 500-2000 ft, the longer the run the bigger the tape diameter.
- For a large field of ½ mile, it is recommended to split the field in half and use ¼ mile runs for higher water distribution uniformity and application efficiency.
- It is highly recommended to use a tractor with GPS equipment to inject the drip tape into the ground, to minimize row movement.
Thick wall drip hose is a robust variation of a drip tape.  
- It can be a plain hose and use point source emitters attached to the outside of the lateral or distribution line at a variable spacing.  
- Thick wall hose is also made with internal emitters, molded or glued together at equal spacing within the distribution line as thin wall tape.  
- The wall thickness is up to 40-60 mil and the tubing diameter is similar to the drip tape.  
- Common emitters spacing are 24, 30, 36 inches.  
- The point source emitters flow rate ranges from 0.5 to 2 gph.  
- The internal emitters flow rate ranges from 0.2 to 2 gph.  
- The working pressure is higher, it ranges from 20 to 40 psi).  
- The drip hose can be laid on the ground, above ground or buried for vineyards and pecan orchards.  
- For vineyards a single hose per plant row is almost universal, it is installed 1 foot above ground, for other orchards like pecans two buried hoses may be necessary.  
- Subsurface drip and micro-sprinklers irrigation for vineyards and orchards are becoming more popular.
Micro-sprinklers are mini-sprays, micro-sprays, jets, or spinners.

The emitters operate by throwing water through the air in predetermined patterns.

Micro-sprinklers can be installed as a movable system, using external emitters or spinner heads individually connected to the lateral pipe line, with a spaghetti tubing and mounted on a support, for young trees.

Micro-sprinklers can be a solid set system, using emitters or spinner heads installed on a permanent PVC pipe riser connected to a manifold line.

The flow rate of micro-sprinkler emitters vary to cover large areas, it ranges from 3 to 30 gph depending on the orifice size and line pressure.
26.1. Land preparation

► Before installing a drip system, the land must be well prepared.
► It may include deep ripping, plowing, disking, and land leveling to allow draining excess water in case of heavy rain.
► For 10 years you are not going to able to do any major work on the land.
► You may keep the concrete ditches, when possible, for drainage or to flood irrigate the field for leaching purposes.
► Other issues are involved in the process, like wind erosion, rodents control, and wind breaks.

26.2. Tape injection

► Once the land is prepared, the tape injection is the next step, following the drip design specifications.
► It is recommended to use a tractor with GPS unit for tape injecting to minimize row movement when listing the borders.
► It means that through the years without using GPS when listing the rows, they move the borders off drip line.
► This is a tractor with six rolls unit for tape injecting, 2 drip line per 60” bed, 6 drip lines at the time, and 40” drip line spacing, and 6-8 inches drip tape depth.
► The unit can be adjusted to the spacing needed by the crop, 38” or 40” row spacing.
► After injecting the tape make the borders for the entire field.
26.3 Tape is injected
27. Main line

27.1. Trenching the main line

► Once the tape is injected, follow NRCS specifications for trenching requirements of the main, sub-main and manifold lines, using a trencher.

► The minimum depth of cover shall be 30 inches, but in soils subject to deep cracking 36 inches, and the maximum depth shall be 48 inches. If you are installing a 6" main line, the trenching depth shall be at 36 inches.

► The bottom of the trenching shall be uniform so that the pipe lies on the bottom without bridging.

► Clods, rocks and uneven spots that can damage the pipe, shall be removed.

► If the trench bottom is rocky, it shall be filled with bedding material consisting of sand or compacted fine-grained soil.
The main line of the drip system is made of PVC pipe, schedule 80, and delivers the water to the sub-main line.

The pipe shall be install at sufficient depth below the ground surface to provide protection from farming operations, freezing temperatures, or soil cracking.

The pipes shall be place uniformly and continuously supported over its entire length.

**Thrust blocks** are anchors or supports of the pipe line, and shall be used at each turning point where it changes direction like elbows, tees, reducers, or stops at a dead end or valve.

**Thrust blocks** are constructed of concrete in the space between the pipe line and the trenched wall, filled to the height of the outside diameter of the pipe to protect from water hammered.
Air relief valve and Continuous acting Air relief valve

The main line requires a pressure relief valve to relief the pressure in case the system over pressurized by any reason.

Requires a Air relief valve continuous acting air relief valve to expel the air at start up and let pockets of air out when the system is pressurized, and allows the air to enter the system when shut off.

Also, the main line needs a flush valve to flush out the deposits accumulated in the line.
Sub-main is made of PVC pipe, schedule 80, installed at the same depth that the main line.

Using the polyethylene tubing, the tape is connected to the manifold using the connectors, stainless steel rings or wire ties, to construct the manifold.
The sub-main line delivers water to the lateral lines and emitters.

It requires an **air relief valve** to expel the air at start up and let air out when system is shut off.

Requires a **flush valve** to flush the sediments out after an irrigation cycle or when needed.
Control valves (Pressure Reducing Valve or PRV) are valves that allow the water to enter the drip system's blocks at the field. They are designed with simplicity.

The most common used are hydraulic control valves, manual or automatic.

In manual mode, the operator opens and closes the valve by means of a 3-way selector.

In automatic mode, the valve opens and closes in response to an electric command using a 3-way solenoid.

These valves maintain a constant downstream pressure through an adjustable pressure regulator.
29.1. Control valve mechanism

► **Closed mode**, by turning the 3 way selector to closed mode, upstream water pressure is applied to the control chamber, initiated by the spring; the diaphragm is pressed down to close the valve drip-tight and no water flows through.

► **Open mode**, by turning the 3 way selector to open mode, it releases the water or air pressure to atmosphere from the control chamber causing the valve to open and let the water flow to the field.

► **Automatic mode**, the port of the 3-way selector is connected to an electric solenoid, which controls the valve. The 3-way selector connects the control chamber to the direction the selector is pointed, to close or to open.

► The valve maintain a constant downstream pressure through an adjustable pressure regulator.
29.2. Control valves installations

► All these are hydraulic control valves.
► There are several forms and shapes to construct a control valve.
► They can be installed above ground or buried.
► They can be installed at the head of each block saving additional pipe line.
► They can be installed outside of the field by the fence, using extra pipeline but the field will be clear of valves to work the land.
► For the new system, record the pressure of the control valves per block to compare in the future.
29.3. Air relief valves installation

- **Air relief valve and continuous acting ARV**, installed at the main line of the system.

- **Air relief valve**, installed at the sub-main line.

29.4. Pressure gages installation

- Pressure gages monitor the water pressure in the system.

- They must be properly installed at the main line, sub-main at control valves to provide feedback to operator.

- It is very important to monitor the pressure gages to assess irrigation performance and ensure that components are working correctly.

- Pressure gages may reveal system performance anomalies that may require attention.
The manifold or lateral flush line is a PVC pipe, installed at the end of the drip tape lines, at the same depth that the sub-main line, which will allow to flush the drip tape or lateral lines of the system.

The tape is connected to the manifold flush line, using the polyethylene tubing, with plastic connectors, stain less steel rings, or wire ties.
Manifold flush valves may be installed at the head of the blocks or by the fence of the field.

It allows to flush out accumulated deposits of chemical injections, silt, soil from leaks or deposits of biological growth from the lateral or drip lines.

The air relief valves allow the air to enter the drip lines when the system is shut off, and prevent suction of soil and debris into the emitters.

Some designs rely on flushing individual tape lines.
30.2. Backfilling

- **Backfilling** is the process to cover the exposed pipeline with dirt, after trenching and installing the pipeline and components.

- The methods for backfilling may be done by **hand, mechanical** and **water packing**. The **backfilling process** is simple:

  - For **initial backfill**, use selected soil or sand free from rocks or stones larger than 1 inch diameter or earth clods greater than 2 inches diameter.

  - The selected soil shall be place around the pipe to give lateral support.

  - Continue placing layers of dirt about 6 inches above the pipe, to hold the pipeline in place for testing purposes.

  - The initial cover depth with soil shall be sufficient to ensure complete coverage of the pipeline after consolidation occurs.

  - Only the body of the pipe sections may be covered.

  - All joints and connections shall be left uncover for inspection.
30.3. Backfilling

Water packing shall be used, when possible, to consolidate the initial backfill around the pipe, especially when the trenching is narrow.

- Before water packing, slowly fill the pipe line with water to hold it in place.
- Then water packing is accomplished by adding enough water into the trench, to saturate the initial backfill without excessive pooling.
- After water packing is finished and dry, the final backfill with dirt, shall be accomplished by placing layers of soil above the pipe line.
- Rolling equipment shall not be used to consolidate the final backfill.

All PVC pipe exposed to the sun shall be painted to protect it from UV light.
30.4. All components installed

- Filter station
- Filter back flush valve (Gate valve)
- Main line
- Submain line
- Main line flush valve
- Sub-main flush valve
- Manifold flush line
- Filter back flush line
Partial backfilling is needed to hold the pipe in place during testing.
Test the pipeline for pressure strength, leakage and proper functioning.
Bleed all entrapped air at the sand media tanks and let the water run to the water discharge until it is clean.
Make sure to open the main and sub-main flush valves before starting the well pump, then flush the main, sub-main line and manifold flush lines.
When the main and sub-main lines are clean, open the manifold flush valve of one or 2 blocks, then open the control valves for those blocks and flush the drip lines, one valve at the time, until clean water comes out, and finish flushing all the blocks.
Check for leaks and repair as needed.
The pressure shall be slowly built up to the maximum design capacity, to ensure that the pipe line will function properly at the design capacity.
After installing all the drip irrigation components, and checking the system, make the borders for the entire field.

Start the pre-irrigation to soak the soil.

It may takes 12-48 hours depending of the type of soil, and how dry the soil is.

After the pre-irrigation is finished, let the soil to get to field capacity, then it is time to plant the crop.
31. Blocks of the field

Filter station

Block 1
12.8 ac
Oats

Block 2
Zone 1
6.4 ac
Cotton
Zone 2
6.4 ac
Chili
Block 3
12.8 ac
Chili
Block 4
12.3 ac
Milo
Block 5
12.3 ac
Watermelons
32. Maintenance

Water test

- Take a water sample and test it for silt, sand, algae, bacteria, dissolved solids such as iron, sulfur, salts and calcium, and pH of the water.

Chemical treatment

- Treat the system with acid to lower the pH of the water and ensure that calcium carbonate do not precipitate out of the solution.

Acid treatment

- Acid flow meter
- Fertilizer
- Chlorine flow meter

Chlorination

- If water has high organic load, chlorinate the system continuously 1-2 ppm, or bi-weekly with 5-20ppm, and completely flush and drain all pipes with clean water.

- End of season chlorinate at 40 ppm for at least one hour, leave the chlorine in the system for 24 hours, then completely flush and drain all pipes with clean water.

- Also, blow out lateral lines with air not to exceed 15 to 20 psi of pressure.
With proper Irrigation Water Management (IWM) percolation can be controlled, and water application can be managed.

Install Electrical Resistance Block or tensiometers to monitor the soil moisture.

Utilizing the tensiometers readings you can schedule crop irrigation. You may use the feel and appearance method.

The amount of water to apply shall be accordingly to crop consumptive use, evapotranspiration, stage of plant, and type of soil.
Main line flush valve

► The main and sub-main lines are usually clean, because of the filters.
► Flush the main line at least once a month to provide clean water to the rest of the system.
► It may take up to 5 minutes flushing depending on the water quality.

Sub-main flush valve

► The sub-main line may be flushed out once a month.
► At the end of the season flushing the sub-main is also required.
► It may take 5 to 10 minutes flushing depending on the water quality.

Flush the manifold lines frequently, at least once every two weeks, or at the end of every irrigation cycle, and at the end of the season.
► Flush one side at the time to give enough water velocity to flush out the sediments.
► It may take from 20 to 60 minutes of flushing, specially after the chemical applications (Phosphates).
► This is the most critical part of the flushing system, because of he emitters clogging.
Monitor your pressure gages

Check for rodents and get rid of them

Protect components from rodents

Repair leaks
**Control valves maintenance:**
- Turn the 3-way selector periodically to prevent sticking.
- Drain the control valve, water can be trapped, for winterizing.
- Keep Control valves clean from weeds and dirt.

**Air relief valves maintenance:**
- Remove the air vent body from the base
- Check the roundness of the seal, wash it with water or replace it if torn.
- Check and wash the air relief body and the float with clean water.
- Replace the float if it is damaged.
- Clean the drainage elbow to remove insects and debris.

**Replace damaged parts, clean Sand media and Disk filters as required by manufactures.**

**Open the upper cover of the filter tank and check the sand media level. Add sand media if required.**

**Relocate the drip tape using GPS guided tractor.**

**Relocate the drip tape without using GPS guided tractor:**
- The soil surface must be flattened out as well as possible.
- Turn the irrigation on, 1-2 blocks at the time, until the wet spots just begin to appear on the surface.
- Then turn the irrigation off.
- Now you can re-shape the beds or borders in the correct location.
The irrigation system shall be evaluated by a trained professional to ensure that the system is working properly.
References


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Water and electricity savings in drip irrigation

<table>
<thead>
<tr>
<th>Producer</th>
<th>Water</th>
<th>Electricity</th>
<th>Yield increased</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>30%</td>
<td>30%</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>30%</td>
<td>30%</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>30%</td>
<td>30%</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>50%</td>
<td>60%</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>40%</td>
<td>40%</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>40%</td>
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</tr>
<tr>
<td>7</td>
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<td>30%</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>50%</td>
<td>50%</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
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<td></td>
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<tr>
<td><strong>Average</strong></td>
<td><strong>39%</strong></td>
<td><strong>36%</strong></td>
<td></td>
</tr>
</tbody>
</table>

Note: The information of savings of water and electricity were provided by producers verbally.
Table 1. Relative clogging potential of irrigation water for micro-irrigation systems.

<table>
<thead>
<tr>
<th>Water characteristics</th>
<th>Plugging hazard based on concentration (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Slight</td>
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<tr>
<td><strong>Physical</strong></td>
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<tr>
<td>Suspended solids: silt, clay (ppm)</td>
<td>&lt; 50</td>
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<tr>
<td><strong>Chemical</strong></td>
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</tr>
<tr>
<td>pH</td>
<td>&lt; 7.0</td>
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<tr>
<td>Total dissolved solids TDS (ppm)</td>
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<tr>
<td>Manganese concentration (ppm)</td>
<td>&lt; 0.1</td>
</tr>
<tr>
<td>Iron concentration (ppm)</td>
<td>&lt; 0.1</td>
</tr>
<tr>
<td>Hydrogen sulfide concentration (ppm)</td>
<td>&lt; 0.2</td>
</tr>
<tr>
<td>CaCO₃ concentration (ppm)</td>
<td>&lt; 150</td>
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<tr>
<td><strong>Biological</strong></td>
<td></td>
</tr>
<tr>
<td>Bacterial population (units per 100 ml)</td>
<td>&lt; 10,000</td>
</tr>
</tbody>
</table>


Brian Benham, Assistant Professor and Extension Specialist; and Blake Ross, Professor and Extension Specialist; Virginia Tech. 2002. Filtration, Treatment, and Maintenance Considerations for Micro-Irrigation Systems. Publication Number 442-757.