



Small Acreage Low Flow (Micro or Drip) Irrigation System Design and Installation

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Irrigation has been an essential part of Utah's agriculture since pioneer days. Over half of Utah's 1.3 million irrigated acres are watered using surface methods such as flood, furrow, border, or basin irrigation. About 40% of the irrigated acreage is under some form of sprinkler irrigation, including hand move, wheel move, center pivot, and other types. Low flow or micro-irrigation systems, including drip emitters, emitter tubes, drip tapes, bubblers and micro-sprinklers (sprays) are currently used on only a small fraction of the total irrigated area, but will become more common as water becomes more scarce and expensive. Currently, low flow and micro-irrigation is primarily used in orchards, vegetables and landscapes. When designed and operated properly, low flow or micro-irrigation systems apply water more efficiently and uniformly than sprinklers or surface irrigation systems, conserving water and generating higher yield per unit of water applied.

Most low-flow systems are designed to operate at pressures of 10 to 25 pounds per square inch (psi). Municipal water systems typically deliver water at 50 to 70 psi. Water pressure can be tested with a pressure gage designed for water systems. Some gages are designed to test static pressure and can be fastened directly onto the hose bib or pipe. Other gauges are designed to test the pressure of flowing water, such as in a sprinkler nozzle, by inserting the tester directly into the stream of water. Simple pressure gages can be purchased at a local plumbing or irrigation supply store.



For most low-flow systems, a pressure reducer will need to be installed to provide the manufacturer-recommended pressures for low-flow components and fittings. Be sure to install the pressure reducer *before* testing for flow rate.

Low Flow Irrigation System Characteristics

Individual Drip Emitters & Emitter Tubes



Individual drip emitters apply water at a given rate to a specific location. Emitters are typically rated at 1 – 4 gallons per hour. Emitters are usually attached at the end of a 1/4" tube that is connected to the main supply line. Some emitters are pressure compensating and can be connected to higher-pressure lines or to lines that have variable pressure due to changes in elevation. Other emitters must have the supply pressure reduced in order to function properly.

Another type of emitter is the emitter tube, which has minute laser-drilled holes spaced at six or twelve-inch intervals. Each hole emits 1/2 gallon per hour. Emitter tubing is typically 1/4" in diameter. It is used to supply water to plants growing in rows, or to cover large areas that would otherwise require numerous individual emitters. Good filtration is needed to minimize plugging of holes.

Drip Tape

Drip tape is a thin-walled single or double tube which has emitter holes spaced at regular intervals. It is designed for short-term use (such as annual row crops or vegetable gardens) but can last several years if carefully rolled up and stored through the winter. It may also last for multiple seasons if buried. Drip tape is deployed on the soil surface, with the emitters facing *upward*. It can be spaced at whatever interval is needed to provide adequate coverage. Like emitter tubing, drip tape will become plugged if unclean water is used.



Bubblers

Care must be taken when selecting bubblers for a low-flow irrigation system. Some bubblers measure output in gallons per minute. For a low-flow system a bubbler should not exceed 60 gallons per hour or one gallon per minute.

Bubblers are typically used to fill a small basin area very quickly and should not be used where run-off may occur.

Micro-sprinklers and Sprayers

In some situations it is desirable to wet more soil surface than is wetted by a typical drip emitter. Root growth occurs only in the portion of the soil wetted by precipitation or irrigation. If a large plant (such as a tree) is irrigated using a drip emitter, only a small area is wetted and the tree may become “root bound” and stunted, much like a large house plant growing in a small pot. This can be prevented by installing multiple drip emitters, or by using emitters that wet more soil.



Micro-sprinklers (which have moving parts) and micro-sprayers (which have no moving parts) are low-flow emitters that wet a relatively

large area of soil. They are useful in orchards, flower beds, ground cover plantings and other situations where more irrigation coverage is needed. Micro-sprinklers and sprayers provide better lateral coverage of water on sandy soils than drip emitters, and minimize ponding and soil saturation problems that may occur under drip

emitters on clay soils. They are available in several patterns (full or part circle), coverage and flow rates.

Because micro-sprinklers and sprayers emit a mist of water over a relatively large area, evaporation losses are higher than under traditional drip emitters. A larger wetted area also means more potential for weed growth. Flow rates from micro-sprinklers and sprayers may be four to ten times higher than flows from traditional emitters, so system design and zoning must account for required flow rates.

Micro-sprinklers and sprayers are typically installed several inches above the soil surface on a ¼” feeder tube attached to a supply line. It is important that micro-sprinklers and sprayers be mounted with the spray discharge parallel to the soil surface to avoid distorted spray patterns and uneven coverage. They are less prone to plugging than drip emitters, but water filtration is still needed to minimize plugging. With many different sizes and styles of sprinklers and sprayers available, irrigation coverage and volume can easily be adjusted by simply changing emitters.



Sub-surface (buried drip)

Sub-surface drip tape or tape covered with mulch can be even more efficient than surface systems, since there is less evaporation from the soil surface. Buried components can be connected to underground or above-ground supply lines, and deliver water directly to the root zone.

Sub-surface drip tape should be buried deep enough to avoid problems with tillage operations, yet shallow enough to supply moisture to the majority of the plants’ feeder roots, which are typically in the top 12 inches of the soil. In instances where the system is providing water for germinating seeds, the drip line should be within 4 to 5 inches of the soil surface. These factors should be carefully considered before a buried drip line is installed. One point of caution regarding subsurface irrigation systems—rodents, such as gophers, voles, ground squirrels and mice, can cause serious operation and maintenance problems as they seem to like chewing through the buried tubes.

Estimating System Flow Rate

Flow rate refers to the quantity of water that the system can safely deliver. The flow rate of a drip system is typically measured in gallons per hour (gph). The first

step in determining flow rate is measuring the output of the supply source, since it is important to match the system gph requirement to the water source supply. An easy way to measure the supply flow rate is to time how long it takes to fill a container such as a 5-gallon bucket. Using a larger container (or two 5-gallon buckets) will allow a more accurate measurement, since flow rate can be measured over a longer period of time. The following procedure uses a five-gallon bucket to determine flow rate, but can be adapted to larger containers:

- Mark the 5-gallon line on the bucket
- Get stopwatch ready to go
- Turn on supply water away from the bucket (be sure the pressure reducer has been installed previously).
- Simultaneously start the stopwatch and run the water into the bucket
- Stop the stopwatch as soon as the five-gallon mark is reached
- Turn off the water and calculate the gallons per hour using this formula:

$$\text{gallons per hour (gph)} = (5 \text{ gallons} \times 3600) / \text{time in seconds}$$

Example: If the time required to fill a 5 gallon bucket is 82 seconds then the flow rate is 220 gallons per hour ($220 = 5 \times 3600 / 82$). If a quantity other than 5 gallons is used, substitute the number of gallons measured where “5” is in the formula.

A general rule of thumb for flow rates of common-sized polyethylene pipe is:

1/4" – 35 gph; 1/2" – 220 gph; 3/4" – 480 gph; 1" – 780 gph

The next step is to design the irrigation zones so they will not exceed the supply flow rate. A zone is an area that would all be irrigated through the control of a single valve. Zones should be designed based on the needs of the plants and the soil type. High water use plants should not be grouped with drought tolerant plants, and sandy soils should not be irrigated using the same zones as clayey soils.

The flow requirement of a zone is calculated by adding up the flow from all the emitters in the zone. For example 1/4" emitter tubing usually has a flow rate of 1/2 gallon per hour per emitter hole. The holes are typically spaced at 6" or 12". This means that with a 1/2" supply pipe there could potentially be 440 emitter holes in each irrigation zone ($220 \text{ gph} / .5 \text{ gallons per emitter} = 440$ emitters). A word of caution: there is no way in the

world you will be able to force 220 gph through that much 1/4" tubing. The rule of thumb for the maximum length of 1/4" emitter tubing with 6" spacing between emitter holes is 19 feet of tubing. Beyond that, efficiency and consistency are lost. The rule of thumb for the length of emitter tubing with 12" spacing between emitter holes is 33 feet. Thus, if 1/4" emitter tubing is used the lines connected to the supply line should not exceed the amounts indicated above.

Filtration

Filtration requirements for a low-flow system depend on water quality and the intended flow rate of the system. Water from a culinary system may require little or no filtration, while canal or pond water may contain so many contaminants that water filtration becomes costly or impractical. Mineral particles, organic matter and algae are the primary concerns when filtering water for a low-flow system. The filtration system must be capable of handling the flow rate of the irrigation system.

The three standard filter types used in low-flow irrigation are sand media filters, screen filters and disk filters. Sand filters are metal or plastic canisters filled with sand or layers of sand and gravel. Water is filtered as it passes through the pores between sand grains. Most sand filters are designed to be self cleaning through a back-flushing mechanism. Screen filters consist of a plastic or metal mesh that traps contaminants, and are available in various mesh sizes. The higher the mesh number, the smaller the openings in the mesh. Disk filters are made by stacking metal or plastic disks inside a canister. Water is filtered as it negotiates small openings between the disks. Both screen and disk filters are cleaned by physically removing the filters and brushing or flushing the screens or disks.

Most culinary water is treated with chlorine, which eliminates algae problems. When using culinary water in a low-flow irrigation system, the main concern is mineral particles that may plug emitters. Depending on the emitter opening size, a 100 – 200 mesh screen should provide adequate filtration. This should be confirmed by referring to the manufacturer's specifications. While well water may have more sediment than municipal water it can generally be filtered in the same way as described above.

Irrigation water from a canal or pond may cause serious plugging problems without adequate filtration. Large and small organic particles, algae, and silt or other suspended minerals are common in surface water sources. In this situation a sand media filter combined with a screen or disk filter is much more effective than either filter alone.

When using muddy water from a canal or ditch, a settling structure may be needed in addition to the filtration system. A settling structure is typically a diversion designed to slow the current, allowing sand and silt to drop out of the water before it passes through the filters. Like other filtration components, settling structures must be cleaned periodically, either by physically removing sediment or through a flushing system.

In some instances it may be necessary to chlorinate raw water to prevent algae growth in a low flow system. This procedure will be dealt with in a separate fact sheet.

Other Considerations

The number and placement of emitters is critical, since the irrigation system must deliver water to the soil where plant roots are located. For closely spaced plants such as vegetables, bedding plants and herbaceous perennials the emitters should be spaced closely enough to provide uniform soil coverage.

Irrigation systems for young woody plants (trees and shrubs) should be designed with excess capacity to accommodate more emitters and higher flows as the plants grow. Mature woody plants not only use more water than younger plants, but have much larger root systems. Roots cannot grow in dry soil. If the irrigation system does not wet a large enough volume of soil, trees and shrubs become root bound, much like a large house plant in a small pot. Emitters can be added as the plants grow if extra capacity is built into the initial design. Low-flow irrigation systems can allow for precise application of fertilizer (fertigation) and other chemicals (chemigation) directly through the irrigation system. These topics are dealt with in a separate fact sheet.

Summary

Low flow irrigation systems provide an efficient and effective way to water plants. A wide variety of emitters and delivery systems are available. Plant type, system capacity and filtration requirements are all important considerations when designing a low flow system.

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Where Can You Get Help?

Utah State University - Extension Service
Utah Counties – Extension Office see:
<http://extension.usu.edu/htm/counties> for directory.

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