

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

IRRIGATION SYSTEM, MICROIRRIGATION
(No. and Acre)

CODE 441

DEFINITION

An irrigation system for distribution of water directly to the plant root by means of surface or subsurface applicators.

PURPOSE

This practice may be applied as part of a conservation management system to support one or more of the following purposes:

- To efficiently and uniformly apply irrigation water and maintain soil moisture for optimum plant growth
- To apply chemicals

CONDITIONS WHERE PRACTICE APPLIES

This practice applies on sites where the soils and topography are suitable for irrigation and proposed plants and where a microirrigation system has been determined to be the most desirable method of irrigation.

Microirrigation systems, including subsurface drip irrigation (SDI), shall consist of bubblers (generally <60 gallons/hour), drip or trickle emitters and tapes (generally <2 gallons/hour), or spray or spinners (generally <45 gallons/hour).

Microirrigation is suited to orchard and row crops, windbreaks, gardens, greenhouse crops, and residential and commercial landscape systems and on steep slopes where other methods would cause excessive erosion or on areas where other application devices interfere with cultural operations.

CRITERIA

General Criteria Applicable To All Practices

This practice must conform to all federal, state, and local laws and regulations. Laws and regulations of particular concern include those involving water rights, land use, pollution control, property easements, wetlands, preservation of cultural resources, and endangered species.

The system shall be designed to uniformly apply water and/or chemicals directly to the plant root zone to maintain soil moisture within the range for good plant growth without excessive water loss, erosion, reduction in water quality, or salt accumulation.

Depth of application. Net depth of application shall be sufficient to replace the water used by the plant during the plant peak use period or critical growth stage without depleting the soil moisture in the root zone of the plant below the management allowed depletion (MAD). Gross depth of application shall be determined by using field application efficiencies consistent with the conservation use of water resources.

Applications shall include adequate water for leaching to maintain a steady state salt balance. The net depth of application shall be expressed as inches per day per unit of design area.

$$F_n = 1.604 \frac{QNTE}{AF}$$

Where: F_n = net application depth, in/day/design area

Q = discharge rate, gal/hr/emitter

N = number of orifices or emitters

T = hours of operation per day, 22 hours maximum

E = field application efficiency, expressed as a decimal, not greater than 0.90 for design purposes.

A = ft² of field area served by N (number of emitters)

F = the design area as a percentage of the field area, expressed as a decimal

1.604 = units conversion constant

System capacity. The system design capacity shall be adequate to meet the intended water demands during the peak use period for all plants to be irrigated in the design area. Design capacity shall include an allowance for reasonable water losses (evaporation, runoff from spray or spinners, and deep percolation) during application periods. The system shall have the capacity to apply a specified amount of water to the design area within the net operation period. The rationale for using a design capacity less than the peak daily irrigation water requirement shall be fully explained and agreed upon by the end user. Field application efficiency (E) for design purposes shall not exceed 90 percent.

The system should have a minimum design capacity sufficient to deliver the peak daily irrigation water requirements in 90 percent of the time available but not to exceed 22 hours of operation per day.

For orchard crops and windbreaks, the design area may be less than 100 percent of the field area (A) but no less than the mature plant root zone.

Emitter discharge rate. The design discharge rate of applicators shall be determined from manufacturer's data for the expected operating range. The discharge rate shall not create runoff within the immediate application area. For bubbler irrigation, a basin beneath the plant canopy is required for water control, with applications confined to the basin area.

Number and spacing of emitters. The number and spacing of emitters along the lateral line shall be adequate to provide water distribution to the plant root zone and percent plant wetted area (P_w). National Engineering Handbook (NEH), Section 15, Chapter 7, shall be used to determine the P_w .

Operating pressure. The design operating pressure shall be in accordance with the manufacturer's recommendations. The system operating pressure must compensate for pressure losses through system components and field elevation effects.

Emitter manufacturing variability. The manufacturer's coefficient of variation (C_v) shall be less than 0.07 for point source emitters, 0.10 for SDI emitters, and less than 0.20 for line source emitters.

Allowable pressure variations.

Manifold and lateral lines. Manifold and lateral lines, operating at the design pressure, shall be designed to provide discharge to any applicator in an irrigation subunit (zone) operated simultaneously such that they will not exceed a total variation of the design discharge rate as listed below:

- 20 percent for deep-rooted, low value crops
- 15 percent for shallow-rooted, high value crops

Pressure shall conform to the manufacturer's recommendations.

Main and submain lines. Main and submain lines shall be designed to supply water to all manifold and lateral lines at a flow rate and pressure not less than the minimum design requirements of each subunit. Adequate pressure shall be provided to overcome all friction losses in the pipelines and appurtenances (valves, filters, etc.) Pipe sizes for mains and submains shall maintain flow velocities and emission uniformity (EU) within recommended limits as determined by procedures contained in NEH Section 15, Chapter 7.

Economic considerations shall include both installation and operating costs. Main and submain lines shall be designed and installed according to NRCS Conservation Practice Standard 430, Irrigation Water Conveyance, Pipeline.

Filters. A filtration system (filter element, screen, strainer, or filtration) shall be provided at the system inlet. Under clean conditions, filters shall be designed for a head loss of 5 pounds per square inch (psi) or less. For a self-cleaning filter in which head loss is created by orifice plates at the inlet of the filter, the allowable pressure loss across the filter for clean conditions shall be 8 psi or less.

The filter shall be sized to prevent the passage of solids in sizes or quantities that might obstruct the emitter openings. Filtration systems shall be designed to remove solids equal to or larger than one-fourth the emitter opening diameter or the emitter manufacturer's recommendations, whichever is more stringent.

The filter system shall provide sufficient filtering capacity so that backwash time does not exceed 10 percent of the system operation time. Within this 10 percent time period, the pressure loss across the filter shall remain within the manufacturer's specification and not cause unacceptable EU.

Filter/strainer systems designed for continuous flushing shall not have backwash rates exceeding 1.0 percent of the system flow rate or exceeding the manufacturer's specified operational head loss across the filter.

Pressure regulators. Pressure regulators shall be used where topography and the type of applicator dictate their use. Pressure regulators shall not be planned to compensate for improperly designed pipelines.

Chemical water treatment. Proper maintenance and water treatment shall be followed to prevent clogging based upon dripper and water quality characteristics. American Society of Agricultural Engineers (ASAE) EP405.1 contains guidelines for chemical water treatment.

System flushing. Appropriate fittings shall be installed above ground at the ends of all mains, submains, and laterals to facilitate flushing. A minimum flow velocity of 1.2 feet/second is considered adequate for flushing.

Chemigation. System and individual lateral line EU(s) shall not be less than those values stated above when fertilizer or pesticides are applied through the system.

Injectors (chemical, fertilizer, or pesticide) and other automatic operating equipment shall be located adjacent to the pump and power unit,

placed in accordance with the manufacturer's recommendation and include integrated back flow prevention protection.

Chemigation shall be accomplished in the minimum length of time needed to deliver the chemicals and flush the pipelines.

Application amounts shall be limited to the minimum amount necessary, not to exceed maximum amounts recommended by the chemical label.

Subsurface irrigation system design. Tubing depth and spacing are soil- and crop-dependent. Emitter line depth shall consider the auxiliary irrigation methods used for leaching, germination, and initial development. Maximum lateral line distance from the crop row shall be 24 inches for high value annual row crops; 30 inches for grain crops; and 48 inches for perennial (pasture/alfalfa), vineyard, and orchard crops. EU for the system (zone) shall be designed for a minimum of 85 percent.

For individual lateral lines (hose), the EU shall not be less than the following:

- 88 percent for deep-rooted, low value crops
- 92 percent for shallow-rooted, high value crops

Water flow in the dripline shall be level to 2 percent downgrade with a maximum length of 660 feet. If these conditions are not met, the design shall be supported by engineering (hydraulic) documentation that shows the EU for the system (zone) or individual lateral lines shall equal or exceed the values stated above.

A flush line shall be included at the outlet end of the lateral lines, with flush valves located on each end of the flush line. A minimum flow velocity of 1.5 feet/second is considered adequate for flushing.

Pressure gauges or taps shall be included at the manifold inlet and flush line to monitor pressure drop or rise in the irrigation zone.

A method of air release shall be installed at the summit of the main and submain and end of flush lines to release air upon filling of the system. Vacuum relief valves shall be installed at the high points on the main and submain flush lines and along the lateral lines as needed to relieve vacuum from developing during drainage and to avoid the potential plugging problem from soil being drawn into the emitters within the lateral tubing.

Additional Criteria for Windbreaks

Microirrigation systems for windbreaks shall be designed to provide proper functioning for the design life of the system. The life of the system is dependent upon the time needed for establishment of the various tree and shrub varieties in the windbreak. Typically, a minimum of 3 years after planting is required for establishment.

Filters. A filtration system (filter element, screen, strainer, or filtration) shall be provided at the system inlet. The filter shall be designed to retain any material larger than 100 mesh size. Filter/strainer systems designed for continuous flushing shall not have backwash rates exceeding 1.0 percent of the system flow rate or exceeding the manufacturer's specified operational head loss across the filter. Two pressure gages should be installed near the filter (one before and one after the filter) to provide an indication if the filter is clogged or partially blocked.

Air release and vacuum relief. A method of air release shall be installed at the summit of the main and submain and end of flush lines to release air upon filling of the system. Vacuum relief valves shall be installed at the high points on the main and submain flush lines and along the lateral lines as needed to relieve vacuum from developing during drainage and to avoid the potential plugging problem from soil being drawn into the emitters within the lateral tubing.

Pressure regulators. A 15 psi pressure regulator shall be placed in the mainline or submain between the filter and the connection to the first lateral line.

System flushing. In addition to the general criteria a minimum of 5 feet of tubing length shall be added to all manifolds and lateral lines for temporary sediment storage. The main line and submain only require flushing at the time of initial installation.

Subsurface irrigation design. Tubing depth shall be between 12 and 18 inches. The emitter spacing shall be no less than 12 inches nor more than 24 inches apart based on the plant spacing within the row.

EU for the system (zone) shall be designed for a minimum of 85 percent.

Surface drip irrigation design. The maximum

pressure drop across any lateral shall be limited to 10 psi. The lateral tubing shall be placed on the ground so that the line has 5 percent additional length to account for contraction and expansion due to temperature changes.

The number and spacing of emitters, drippers, applicators, orifices, micro-tubing, etc., along the lateral line shall be adequate to provide water distribution to the plant root zone. Size and flow rate depend upon desired application rate and time.

CONSIDERATIONS

Where natural precipitation and/or stored soil water is not sufficient for germination, special provisions shall be made for germination, or the microirrigation system shall apply water at a rate sufficient to adequately wet the soil to germinate seeds or establish transplants. The depth of a subsurface system for use on annual crops shall be limited by the ability of the system to germinate the seeds, unless it is stated in writing that other provisions will be made for this function.

Water quality is usually the most important consideration when determining whether a microirrigation system is feasible. Well and surface water often contains high concentrations of undesirable minerals (chemicals). Surface water can contain organic debris, algae, moss, bacteria, soil particles, etc. Well water can also contain sand. The irrigation water supply shall be properly tested to determine feasibility and treatment needed for use in microirrigation systems.

Microirrigation can influence runoff and deep percolation by raising the soil moisture level and decreasing available soil water storage capacity, increasing the probability of runoff or percolation below the root zone from storm events. The movement of sediment, soluble chemicals, and sediment-attached substances carried by runoff may affect surface water quality. The movement of dissolved substances below the root zone may affect ground water quality.

Microirrigation may affect downstream flows or aquifers and the amount of water available for other water uses.

Microirrigation may effect a change in plant growth and transpiration because of changes in the volume of soil water.

Chemigation may or may not be required at the same time the plant requires irrigation, which may affect the economics of chemigation. Weather conditions should be considered before applying chemicals. Chemicals should not be applied if rainfall is imminent.

On systems where chemicals are injected, care shall be taken so the injected nutrients do not react with other chemicals in the irrigation water to cause precipitation and plugging. Chemical reactions in the water can cause precipitates such as iron or calcium deposits to form. Pest and nutrient management planning following Conservation Practices 590, Nutrient Management, and 595, Pest Management, should address the timing and rate of chemical applications.

Plugging of emitters by physical, chemical, or biological materials is the major cause of system failure. The filtration system is one of the most important components of an SDI system. Its operation and maintenance must be well understood by the irrigator to help ensure the longevity of the SDI system. Screen and sand media filters are used to remove the suspended solids such as silt, sand, organic debris, and inorganic debris from the water. Surface water often requires more extensive filtration than ground water, but filtration is required for all systems.

Plugging can be caused by either natural water conditions or by chemicals such as fertilizer added to the water. To avoid chemical clogging, the water should be analyzed to determine what chemicals are prevalent and which chemical additives should be avoided. Chemical water treatment may be required on a continuous or intermittent basis. Acids are sometimes used to prevent plugging and also to help renovate partially plugged emitters. The water source and the emitter size dictate the need for treatment. A thorough chemical analysis of the water source should be made prior to development of an SDI system.

Biological clogging problems may consist of bacterial slimes and algae. Some problems can be eliminated in the filtration process, but an injection of chlorine into the driplines on a periodic basis is required to stop the biological activity. The source and composition of the water will determine, to a large extent, the need for chlorinating.

There may be a potential for development of saline seeps or other salinity problems resulting from increased infiltration near restrictive layers.

Field shape and slope frequently dictate the most economical lateral direction. Whenever possible, laterals should be laid downslope for slopes of less than 5 percent if lateral size reduction can be attained. For steeper terrain, lateral lines should be laid along the field contour and pressure-compensating emitters should be specified, or pressure control devices should be used along downslope laterals.

Percent P_w is not required on high water table soils when the water table is managed at a depth where capillary action (upflux) will supply a portion or the entire daily consumptive use rate.

PLANS AND SPECIFICATIONS

Plans and specifications for the microirrigation system shall be in keeping with this standard and shall describe the requirements for properly installing the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

An operation and maintenance (O&M) plan shall provide specific instructions for operating and maintaining the system to ensure that it functions properly, including reference to periodic inspections and the prompt repair or replacement of damaged components.

All microirrigation systems shall be operated in accordance with an irrigation water management (IWM) plan. IWM plans shall be in accordance with Conservation Practice Standard 449, Irrigation Water Management, and shall provide an operation schedule as to when and how long to irrigate.

Frequent maintenance is essential to keep emitters functioning at design flow rate.

Typical maintenance items include:

- Clean or back flush filters when needed
- Flush lateral lines regularly
- Check applicator discharge often and replace applicators as necessary
- Check operating pressures often - A pressure drop (or rise) may indicate problems.

- Check pressure gauges to ensure proper operation; repair/replace damaged gauges
- Inject chemicals as required to prevent precipitate buildup and algae growth
- Check chemical injection equipment regularly to ensure it is operating properly
- Check and assure proper operation of backflow protection device