Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

IRRIGATION SYSTEM, MICROIRRIGATION

CODE 441

(Ac.)

DEFINITION

An irrigation system for frequent application of small quantities of water on or below the soil surface: as drops, tiny streams, or miniature spray through emitters or applicators placed along a water delivery line.

PURPOSE

This practice is applied to achieve the following purpose:

- Efficiently and uniformly apply irrigation water and maintain soil moisture for plant growth.
- Prevent contamination of ground and surface water by efficiently and uniformly applying chemicals.
- Establish desired vegetation (e.g., windbreaks).

CONDITIONS WHERE PRACTICE APPLIES

This practice applies on sites where soils and topography are suitable for irrigation of crops or other desirable vegetation and an adequate supply of suitable quality water is available for the intended purpose(s).

Microirrigation is suited to virtually all agricultural crops, and residential and commercial landscape systems. Microirrigation is also suited to steep slopes where other methods would cause excessive erosion, and areas where other application devices interfere with cultural operations.

Microirrigation is suited for use in providing irrigation water in limited amounts to establish desired vegetation such as windbreaks, living snow fences, riparian forest buffers, and wildlife plantings.

This practice standard applies to systems that wet only a specific area (e.g., an individual plant or tree) and typically have design discharge rates less than 60 gal/hr at individual application discharge points.

Use NRCS Conservation Practice Standard (CPS) Code 442, Sprinkler System, for systems that uniformly wet the entire field and typically have design discharge rates of 60 gal/hr or greater at individual application discharge points.

CRITERIA

General Criteria Applicable to All Purposes

Design the system to uniformly apply water and chemicals without excessive water loss, erosion, reduction in water quality, or salt accumulation.

Provide backflow prevention devices on all microirrigation systems equipped for chemical injection. Locate and install injectors (chemical, fertilizer, or pesticides) and other automatic operating equipment in

accordance with manufacturer's recommendations and include integrated back flow prevention protection.

Include all system appurtenances necessary for proper operation. Size and position each appurtenance in accordance with sound engineering principles and site-specific features. Appurtenances may include but are not limited to totalizing flow measurement devices, water filtration, air vent valves, vacuum relief valves, pressure relief valve(s), water control valve(s), pressure gauges, pressure regulators, and pressure reducers.

Water Quality. Test and assess the irrigation water supply for physical, chemical, and biological constituents commonly encountered in the area that may cause clogging of microirrigation system emitters. Use water test results to determine irrigation suitability and treatment requirements.

Emitter Discharge Rate. Determine the design discharge rate of applicators based on manufacturer's data for expected operating conditions. Limit discharge rates to avoid creating runoff within the immediate application area.

For bubbler irrigation, design a basin around the plant for water control, and confine applications to the basin area.

Number and Spacing of Emitters. Provide adequate water distribution to the plant root zone and percent plant wetted area (Pw) with proper emitter selection and spacing of emitters along each lateral. Use procedures found in NRCS National Engineering Handbook (NEH), Part 623, Chapter 7, Microirrigation, to calculate Pw.

Operating pressure. Select the design operating pressure in accordance with published manufacturer's recommendations. Account for pressure losses and gains through system components and field elevation effects.

Do not exceed the manufacturer's recommendations for maximum pressure in any lateral or manifold during any phase of operation.

Emitter manufacturing variability. Obtain and use the manufacturer's coefficient of variation (Cv) to assess acceptability of a particular product for a given application. Select products that have a Cv of less than 0.05 for point source emitters and less than 0.07 for line source emitters.

Allowable pressure variations.

Manifold and lateral lines. Design manifold and lateral lines operating at design pressure to provide uniform discharge to all applicators in an irrigation subunit or zone. The flows to all applicators in an irrigation subunit or zone will not have a total variation greater than 20 percent of the design discharge rate. Follow manufacturer recommendations concerning internal pressure during all phases of operation.

Main and submain lines. Design mains and submain lines 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. Provide adequate pressure to overcome all friction losses in the pipelines and appurtenances (valves, filters, etc.). Maintain flow velocities at no more than 5.0 ft/sec in all mains and submains during all phases of operation, or provide special consideration to flow conditions and take measures to adequately protect the pipe network against surge pressures.

NRCS CPS Code 430, Irrigation Pipeline, applies to mains and submains but not to manifolds.

Emission Uniformity (EU). Pipe sizes for mains, submains, and laterals shall maintain subunit (zone) emission uniformity (EU) within recommended limits as determined by procedures contained in NEH,

Part 623, Chapter 7, Microirrigation. System design EU must be 85 percent or higher where fertilizer, pesticides, or treatment chemicals are applied through the system.

Filters. Provide a filtration system at the system inlet. Design the filters for a maximum head loss of 5 psi under clean conditions. Base the maximum design head loss across a filter before cleaning on manufacturer's recommendations. In the absence of manufacturer's data, maximum head loss across a filter before cleaning is 10 psi.

Size the filtration system to prevent the passage of solids in sizes or quantities that might obstruct the emitter openings. Design the filtration system to remove solids based on the emitter manufacturer's recommendations. In the absence of manufacturer's data or recommendations, design filtration systems to remove solids equal to and larger than one-tenth the emitter opening diameter.

Ensure filter back flush does not cause discharge of media material, excessive flush water, or unacceptable EU. Ensure design provides for disposal and utilization of filter back flush water. Back flush water should not cause erosion or chemical contamination.

Air/Vacuum Relief Valves. Design and install air and vacuum relief valves at system manifolds and lateral summits. Design and locate all vacuum relief valves to prevent introduction of soil particles into the irrigation system due to vacuum. Install air/vacuum relief valves on both sides of all subunit or manifold water supply control valves.

Pressure regulators. Use pressure regulators where topography and the type of applicator dictate their use.

System flushing. Install appropriate fittings above ground at ends of all mains, submains, and lateral flush manifolds to facilitate flushing. An acceptable alternative to flush manifolds would be to install fittings at the end of individual laterals to provide flushing above ground or into a drainage ditch.

Design and install the system to provide a minimum flow velocity of 1 ft/sec during flushing. Do not exceed flush velocities of 7 ft/sec in submains or manifolds **located downstream from a control valve.** Do not exceed the manufacturer's maximum recommended flushing pressure in laterals. Include a pressure gauge and/or Schrader valve tap at each flushing manifold outlet serving subsurface drip irrigation (SDI) systems.

Make provisions for flush water discharged from flush valves. Locate flush valves such that flows are directed away livestock, electrical equipment, and other control valves or hook-ups. Ensure discharge of flush water is in a non-erosive manner

Water Management Plan. Develop an Irrigation Water Management Plan meeting the requirements of NRCS CPS Code 449, Irrigation Water Management, for use with this practice.

Additional Criteria Applicable to Efficiently and Uniformly Apply Irrigation Water

System capacity. Design the system with sufficient capacity to meet water application requirements during critical crop growth periods. Include in the design capacity an allowance for reasonable water losses (evaporation, runoff, deep percolation, and system deterioration over time), and auxiliary water needs such as leaching, frost protection, and cooling. If water test results indicate a need include adequate water for leaching in the gross application volume calculation to maintain a steady state salt balance.

Subsurface Drip Irrigation (SDI). Tubing depth and spacing are soil and crop dependent. Select the emitter line depth based on the auxiliary irrigation methods used for leaching, germination, and initial development. The maximum lateral line distance from the crop row is 24 inches for annual row crops.

Surface Microirrigation Systems (SI). Install surface drip lateral lines on the ground along the plant row(s). Provide 2 percent extra length to surface laterals to allow for expansion and contraction of the line. Pin or anchor above-ground drip lines to prevent dislodging or movement of the line away from the plants or pots. In lieu of pins, laterals may be buried (2–4") below the soil surface and under mulch or plastic row covers.

When lateral emitter spacing or capacities vary with each row, design the laterals separately. Design and install main and submain lines to have safe velocities. Anchor mains, submains, manifolds, and laterals as needed to prevent undesired movement. NRCS CPS Code 430, Irrigation Pipeline, applies to mains and submains but not to manifolds.

Additional Criteria Applicable to Preventing Contamination of Ground and Surface Water

Chemigation and Chemical Water Treatment. System EU shall not be less than 85 percent where fertilizer or pesticides, or treatment chemicals are applied through the system.

Backflow prevention devices shall be provided on all microirrigation systems equipped for chemical injection.

Injectors (chemical, fertilizer, or pesticides) and other automatic operating equipment shall be located and installed in accordance with manufacturer's recommendations 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 minimum amount necessary, and rate shall not exceed maximum rate recommended by chemical label.

Proper maintenance and water treatment shall be followed to prevent clogging based upon dripper and water quality characteristics.

Irrigation water supply tests shall be used to plan for addressing or avoiding chemical reactions with injected chemicals to prevent precipitate or biological plugging.

Additional Criteria Applicable to Establishing Desired Vegetation

System capacity. Design the system with capacity to provide supplemental water at a rate that will ensure establishment and survival of planned vegetation.

Net application volumes per plant are dependent on the species of tree or shrub and the age (e.g., first, second, and subsequent years).

Determine the gross application volume per plant using field application efficiency consistent with the type of microirrigation system planned.

Systems may utilize manual flush screen filters and manual flush valves or fittings at individual lateral ends. Filter screening criteria is in the section General Criteria for All Purposes. Place drip lateral lines installed on the ground surface along the plant row(s) in a serpentine pattern to allow for expansion and contraction of the line while keeping the emitter close to the tree or shrub. Pin or anchor above-ground laterals to prevent the line from being dislodged or moved away from the trees or shrubs.

Design each lateral separately when lateral emitter spacing or capacities vary with each row.

CONSIDERATIONS

System operation should not exceed 22 hours per day or 6 days per week.

In the absence of local experience, use a field application efficiency (E) of 90 percent to estimate system capacity.

In arid climates with subsurface systems, natural precipitation and stored soil water is often inadequate to provide crop germination. If the microirrigation system cannot germinate seeds or establish transplants, make special provisions for germination (i.e., portable sprinklers). Limit the depth of subsurface systems on annual crops to retain the ability of the system to germinate seeds, unless providing other provisions for this function.

Consider potential rodent damage when selecting materials and deciding on above-, shallow-, or below-ground system installation.

Organic farmers may apply less soluble fertilizers through the microirrigation system. Take precautions against potential emitter clogging.

Consider weather conditions before applying chemicals. Pest or nutrient management planning should address the timing and rate of chemical applications.

Field shape and slope often dictate the most economical lateral direction. Laying laterals down slope can allow for longer lateral run lengths and lateral size reduction. The designer must ensure pressure stays in a reasonable range. Uneven topography may require use of pressure-compensating emitters.

Economic assessments of alternative designs should include equipment and installation as well as operating costs.

It is preferable to have an air/vacuum relief with continuous air release function on the mainline side of zone valves.

During establishment of windbreaks, use longer, less frequent irrigations to encourage deeper root development that increases drought tolerance.

Include secondary screen filters following the media filters or a rinse cycle valve to prevent release of contaminants following the backwashing process.

Do not apply chemicals if rainfall is imminent unless system applies chemicals under plastic mulch.

Use irrigation water supply tests and/or the jar test to help avoid reactions with injected chemicals and prevent precipitate or biological plugging.

Place laterals upslope of crop rows when they are on the contour to assure even wetting patterns within the root zone.

Installation and operation of microirrigation systems has the potential to save energy due to reduced seasonal irrigation application, and in some situations reduced operating pressures.

PLANS AND SPECIFICATIONS

Describe the requirements for properly installing the practice to achieve its intended purpose in the plans and specifications.

Include in the plan:

- A plan map showing the location, key elevations, system layout documenting material, and sizes of all pipelines, control valves, air/vacuum valves, pressure regulating valves, wellhead components, and other appurtenances.
- System design pressure and flow rate.

- Subunit location, dimensions, and layout.
- Emitter type, design operating pressure, and flow rate.
- Appurtenance location, type, size, and installation requirements.

Provide site specific construction specifications that describe in detail installation of the irrigation system and all associated components.

Additional information regarding operation of the system will be included in the Irrigation Water Management Plan, Waste Utilization Plan and/or Nutrient Management Plan, as applicable for the practice purpose.

OPERATION AND MAINTENANCE

Operation and maintenance (O&M) items specific to vegetation establishment are included in NEH, Part 652, Chapter 6, 652.0603(h), Windbreaks.

Develop and review the site-specific O&M plan with the landowner/operator. Provide specific instructions in the O&M plan for operating and maintaining the system to ensure it functions properly, including reference to periodic inspections and the prompt repair or replacement of damaged components.

At a minimum, include the following items in the O&M plan:

- Inspect flow meter, if applicable, and monitor water application.
- Clean or backflush filters, as needed.
- Flush lateral lines at least annually.
- Perform visual inspection of crop performance and emission device flows if visible and replace applicators, as necessary.
- Measure pressure often on installed gauges or at Schrader valves with a handheld gauge to ensure proper system operation. A pressure drop (or rise) may indicate a problem.
- Check pressure gauges to ensure proper operation. Repair or replace damaged gauges.
- Follow proper maintenance and water treatment to prevent clogging based upon dripper and water quality characteristics
- 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 devices.
- Make provisions for the complete removal of water from the pipeline by gravity or other means when:
    - Freezing temperatures are a hazard,
    - The pipe manufacturer requires draining,
    - Draining of the pipeline is otherwise specified.
- The water drained from pipelines shall not cause water quality, soil erosion, or safety problems upon release.

REFERENCES

USDA-NRCS, National Engineering Handbook, Part 623, Chapter 7, Trickle Irrigation.

USDA-NRCS, National Engineering Handbook, Part 652, Irrigation Guide.