United States Department of Agriculture

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 used to accomplish one or more of the following purposes:

- 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 or nutrients
- Establishment of vegetation such as windbreaks and buffers
- Improve poor plant productivity and health

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).

This 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 gallons per hour at individual application discharge points.

Use NRCS Conservation Practice Standard (CPS) Sprinkler System (Code 442) for systems that uniformly wet the entire field and typically have design discharge rates of 60 gallons per hour 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. Include enough system capacity to meet water application requirements during critical crop growth periods. In computing capacity requirements, provide an allowance for system maintenance downtime by ensuring that the maximum application time needed to apply the peak water requirement does not exceed 22 hours per day or six 24-hour periods per week. If system capacity is limited and unable to meet the peak evapotranspiration requirement, adhere to the deficit irrigation plan as provided in the accompanying irrigation water management plan.

In the design capacity, include an allowance for reasonable water losses (evaporation, runoff, deep percolation, and system deterioration over time) and auxiliary water needs such as frost protection and cooling. If water test results indicate a need, include adequate water for leaching to maintain a steady state salt balance in the gross application volume calculation.

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

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.

Water management plan
Develop an irrigation management plan meeting the requirements of NRCS CPS Irrigation Water Management (Code 449) for use with this practice.

Surface microirrigation systems
Install surface drip lateral lines on the ground along the plant row(s). Lay out lines in a serpentine pattern to provide at least 2 percent extra length for surface laterals to allow for expansion and contraction of the line. Pin or anchor aboveground 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 inches) below the soil surface and under mulch or plastic row covers.

Subsurface drip irrigation
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.

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

Emitters
Microirrigation emitters have inherent variabilities as a result of the manufacturing process. Use the manufacturer’s coefficient of variation (CV) to assess acceptability of a particular product for a given application. Use products that have a CV of less than 0.05 for point source emitters and less than 0.07 for line source emitters.

Determine the design discharge rate for emitters based on manufacturer’s data for expected operating conditions. Limit discharge rates to avoid creating runoff within the immediate application area. Select emitter spacing along each lateral to provide adequate water distribution and percent wetted area (Pw) to the plant root zone. Use procedures found in NRCS National Engineering Handbook (NEH) (Title 210), 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 effect. 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 such as valves and filters. Maintain flow velocities at no more than 5.0 feet per second in all mains and submains or provide measures to adequately protect the pipe network against surge pressures where velocity restriction is not feasible (e.g., system flushing). Do not exceed the manufacturer's recommendations for maximum pressure in any lateral or manifold during any phase of operation.

Design manifold and lateral lines operating at the design pressure to provide uniform discharge to all applicators in an irrigation subunit or zone. The flows to all emitters in an irrigation subunit or zone must 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.

Use the criteria in NRCS CPS Irrigation Pipeline (Code 430) to design mains and submains.

Emission uniformity
Size mains, submains, and laterals to maintain subunit (zone) emission uniformity (EU) within recommended limits. Use procedures found in 210-NEH-623-7 to determine EU. Emitter uniformity for microirrigation systems equipped for chemigation must be at least 85 percent.

Filters
Provide a filtration system at the system inlet. Design the filters for a maximum head loss of 5 pounds per square inch (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, use a maximum head loss across a filter of 10 psi before cleaning.

Size the filtration system to prevent the passage of solids in sizes or quantities that might obstruct 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 or greater than one-tenth the emitter opening diameter.

Ensure filter backflush does not cause discharge of media material, excessive flush water, or unacceptable EU. To prevent erosion and/or chemical contamination, ensure the design provides for disposal and utilization of filter backflush water.

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. Install air and 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 the end of all mains, submains, and lateral flush manifolds to facilitate flushing. An acceptable alternative to flush manifolds is the installation of fittings at the end of individual laterals to provide flushing above ground or into a drainage ditch.

Design the system to provide a minimum flow velocity of 1 foot per second during flushing. Do not exceed flush velocities of 7 feet per second 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 systems.

Make provisions for flush water discharged so that it does not cause erosion, water quality problems, or problems for electrical equipment, control valves, or hookups.

Additional Criteria for Preventing Contamination of Ground and Surface Water

Ground and surface water contamination from microirrigation can occur when nutrients, pesticides, or water treatment chemicals (collectively known as chemigation) are applied through the system. Apply nutrients and pesticides based on the criteria in NRCS CPS Nutrient Management (Code 590) and NRCS

CPS Pest Management Conservation System (Code 595). For water treatment chemicals, follow the manufacturer's requirements for safe application.Conduct chemigation in the minimum amount of time necessary to deliver the chemicals and flush the lines.

Provide backflow prevention devices on all microirrigation systems equipped for chemigation. Install injectors for chemigation and other automatic operating equipment in accordance with manufacturer's recommendations.

Apply chemicals at the rate and timing prescribed by the nutrient management plan, pest management plan, or manufacturer's recommendations. Do not exceed label recommendations.

Use testing of water supplies to avoid chemical reactions that might result in precipitate or biological plugging of emitters.

Additional Criteria for 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 their 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 used only for establishing vegetation may utilize manual flush screen filters and manual flush valves or fittings at individual lateral ends. Install laterals, manifolds, submains, and mains using requirements found under General Criteria Applicable to All Purposes.

CONSIDERATIONS

When planning this practice consider the following, as applicable:

- Because of the potential for emitter clogging, water quality is often the most important consideration when determining whether a microirrigation system is feasible.
- Chemical treatment of irrigation supply water may be required to prevent emitter clogging. This may include pH adjustment to prevent or remove scale and/or biocides to prevent or dissolve biological growth in the system. Calcium and iron precipitates are common when ground water is used. Biological growth often occurs when surface water is used.
- In the absence of local experience, use a field application efficiency of 80 percent to estimate system capacity.
- In arid climates with subsurface systems, natural precipitation and stored soil water is often inadequate to provide crop germination. Special provisions in addition to the microirrigation system, may be needed 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.
- During establishment of windbreaks, use longer, less frequent irrigations to encourage deeper root development to increase drought tolerance.
- Rodents can cause problems by chewing on plastic components of microirrigation systems. Take this into consideration when selecting materials and deciding on above, shallow, or belowground system installation.
- Organic farmers often apply less soluble fertilizers through microirrigation systems. This may require extra precautions against emitter clogging.
- Field shape and slope often dictate the most economical lateral direction. Laying laterals downslope can allow for longer lateral run lengths and lateral size reduction. However, the designer must ensure pressure stays in an acceptable range. Uneven topography may require the use of pressure-compensating emitters.

- Economic assessments of alternative designs should include equipment, installation, and chemigation alternatives as well as operating costs.
- It is preferable to have an air/vacuum relief with continuous air release function on the main-line side of zone valves.
- Include secondary screen filters following the media filters or a rinse cycle valve to reduce the potential for release of contaminants following the backwashing process.
- To reduce the potential for runoff contamination, avoid chemigation when rainfall is expected unless the system applies chemicals under plastic mulch.
- Place laterals upslope of crop rows when they are on the contour to assure even wetting patterns within the root zone.
- When considering irrigation alternatives, compared to systems that wet the entire soil surface, microirrigation has the potential to save energy due to reduced water usage, and in some situations, reduced operating pressures.

PLANS AND SPECIFICATIONS

Prepare plans and specifications that describe the requirements for properly installing the practice to achieve its intended purpose. As a minimum include—

- 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, exponent, flow coefficient, design operating pressure, and flow rate.
- Appurtenance location, type, size, and installation requirements.

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

OPERATION AND MAINTENANCE

Develop and review a site-specific operation and maintenance (O&M) plan with the landowner/operator. Refer to 210-NEH, Part 652, Chapter 6, Section 652.0603(h), “Windbreaks” for O&M items specific to vegetation establishment. Provide specific instructions in the O&M plan for operating and maintaining the system to ensure it functions properly, including references to periodic inspections and the prompt repair or replacement of damaged components.

At a minimum, include in the O&M plan—

- Inspecting flow meter, if applicable, at least monthly during the growing season, and monitor water application.
- Cleaning or backflushing filters, as needed.
- Flushing lateral lines at least annually.
- Performing visual inspection of crop performance and emission device flows if visible and replace applicators, as necessary.
- Measuring 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.
- Checking pressure gauges to ensure proper operation. Repair or replace damaged gauges.
- Following proper maintenance and water treatment to prevent clogging based on emitter and water quality characteristics.
- Injecting chemicals as required to prevent precipitate buildup and algae growth. Conduct proper

maintenance and water treatment after chemigation to prevent clogging of emitters.

- Checking chemical or nutrient injection equipment regularly to ensure it is operating properly.
- Checking and assuring proper operation of backflow protection devices.
- Requirements 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 the pipeline is otherwise specified.

REFERENCES

USDA NRCS. 2013. National Engineering Handbook (Title 210), Part 623, Chapter 7, Microirrigation. Washington, D.C. https://directives.sc.egov.usda.gov/

USDA NRCS. 2008. National Engineering Handbook (Title 210), Part 652, Irrigation Guide. Washington, D.C. https://directives.sc.egov.usda.gov/

Lamm, F. R., J.E. Ayars, and F.S. Nakayama. 2007. Microirrigation for Crop Production: Design, Operation and Management. The Netherlands: Elsevier.