NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

IRRIGATION SYSTEM, MICROIRRIGATION

(No. and Ac.)

CODE 441

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 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 plant growth.
- To prevent contamination of ground and surface water by efficiently and uniformly applying chemicals.
- To establish desired vegetation

CONDITIONS WHERE PRACTICE APPLIES

On sites where soils and topography are suitable for irrigation of proposed crops and an adequate supply of suitable quality water is available for the intended purpose(s).

Microirrigation is suited to vineyards, orchards, field crops, windbreaks, gardens, greenhouse 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 with design discharge less than 60 gal/hr at each individual lateral discharge point.

Georgia Conservation Practice Standard 442, Irrigation System, Sprinkler applies to systems with design discharge of 60 gal/hr or greater at each individual lateral discharge point.

CRITERIA

General Criteria Applicable to All Purposes

Plan all work to comply with all federal, state and local laws and regulations.

Design the system to uniformly apply water and/or chemicals while maintaining soil moisture within a range for good plant growth without excessive water loss, erosion, reduction in water quality, or salt accumulation.

Microirrigation systems, including subsurface drip irrigation (SDI), consist of bubblers (generally< 60 gal/hr), drip or trickle emitters and tapes (generally <2 gal/hr), or spray or mini-sprinkler systems (generally < 45 gal/hr).

Include all irrigation appurtenances necessary for proper operation in the system design. Size and position appurtenances in accordance with sound engineering principles and site-specific features.

Appurtenances 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.

Operate all microirrigation systems in accordance with an irrigation water management (IWM) plan. Prepare IWM plans in accordance with Georgia Conservation

Practice Standard 449, Irrigation Water Management.

Water Quality. Test and assess the irrigation water supply for physical, chemical and biological constituents to determine suitability and treatment requirements for use in a microirrigation system.

Emitter discharge rate. Determine the design discharge rate of applicators (orifices, emitters, porous tubing, or perforated pipe) based on manufacturer's data relating to discharge and operating pressure. Design the discharge rate to not create runoff within the immediate application area.

For bubbler irrigation, provide a basin beneath the plant canopy for water control, and confine applications to the basin area.

Number and spacing of emitters. Provide an adequate number and spacing of emitters along a lateral line to provide water distribution to the plant root zone and percent plant wetted area (P_w). Use procedures found in National Engineering Handbook (NEH), Part 623, Chapter 7, to calculate Pw.

Locate applicators to provide an overlap of the wetting pattern within the root zone of the crop, except when the crop is trees or shrubs.

Operating pressure. Provide a design operating pressure in accordance with published manufacturer recommendations. Design the system operating pressure to compensate for pressure losses through system components and field elevation effects.

Emitter manufacturing variability. Obtain the manufacturer's coefficient of variation (Cv) and use it to assess the acceptability of a particular product for a given application.

Do not use point source emitters with a C_V value equal to or greater than 0.07 or line source emitters with a C_V value greater than 0.20.

Allowable pressure variations.

Manifold and lateral lines. Design manifold and lateral lines, operating at the design pressure, to provide discharge to any applicator in an irrigation subunit or zone operated simultaneously such that they will not exceed a total variation of 20 percent of the design discharge rate. Do not exceed manufacturer recommendations for internal pressure during any phase of operation.

Main and submain lines. Design main 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 less than 5 ft/sec in all mains and submains during all phases of operation, unless special consideration is given to flow conditions and measures taken to adequately protect the pipe network against surge.

Design and install main and submain lines according to criteria in Georgia Conservation Practice Standard 430 DD, Irrigation Water Conveyance, Pipeline.

Emission Uniformity. Design pipe sizes for mains, submains, and laterals to maintain subunit (zone) emission uniformity (EU) within recommended limits as determined by procedures contained in NEH, Part 623, Chapter 7.

Filters. Provide a filtration system (filter element, screen, strainer, or filtration) at the system inlet. Under clean conditions, design filters for a maximum head loss of 5 psi. Base the maximum design head loss across a filter before cleaning on manufacturer recommendations. In the absence of manufacturer data maximum permissible design head loss across a filter is 7 psi before filter cleaning is required.

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

Design the filter system to provide sufficient filtering capacity so that backwash time does not exceed 10% of the system operation time. Within this 10% time period, design the systems so that the pressure loss across the filter remains within the manufacturer's specification and does not cause unacceptable

EU.

Design continuous flush filter/strainer systems with backwash rates that do not exceed 1.0% of the system flow rate or the manufacturer's specified operational head loss across the filter.

Air/Vacuum relief valves. If there are summits in the system laterals, design and install vacuum relief to prevent ingestion of soil particles.

Install air/vacuum relief valves on both sides of all block or manifold water supply control valves.

Pressure regulators. Use pressure regulators where topography and the type of applicator dictate their use. Do not use pressure regulators to compensate for improperly designed pipelines.

System flushing. Install appropriate fittings above ground at the ends of all mains, submains, and laterals to facilitate flushing. Design and install the system to provide a minimum flow velocity of 1 ft/sec during flushing. During flushing submain and manifold (pipelines located downstream from a control valve) do not exceed 7 ft/sec velocity. Include a pressure gauge and/or Schrader valve tap at each flushing discharge outlet.

Criteria Applicable to Efficiently and Uniformly Apply Irrigation Water

Depth of application. Provide a net depth of application that is 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). Determine the gross depth of application by using field application efficiencies consistent with the type of microirrigation system planned. Include adequate water for leaching to maintain a steady state salt balance in all application depths. Express the net depth of application 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

A = ft^2 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. Design the system to have either (1) a design capacity adequate to meet peak water demands of all crops to be irrigated in the design area, or (2) enough capacity to meet water application requirements during critical crop growth periods when less than full irrigation is planned. Fully explain the rationale for using a design capacity less than peak daily irrigation water requirement and obtain agreement for using the reduced capacity from the end user. Do not exceed 90 percent field application efficiency (E) for design purposes. Include an allowance for reasonable water losses (evaporation, runoff, and deep percolation) in the design capacity during application periods.

Provide enough system capacity to apply a specified amount of water to the design area within the net operation period. Provide a minimum system design capacity sufficient to deliver the specified amount of water in 90% of the time available, but not to exceed 22 hours of operation per day.

For non-orchard crops, the design area may be less than 100 percent of the field area (A) but not less than the mature crop root zone area.

For orchard crops, it is desirable to wet the entire area under the canopy of the mature tree. The percent of the total crop area wetted (P_w) shall be a minimum of 33% for the tree’s canopy. This 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. Use NEH, Part 623, Irrigation, Chapter 7, to calculate P_w and determine desirable P_w on other crops.

Subsurface Drip Irrigation (SDI). Tubing depth and spacing are soil and crop dependent. Consider the auxiliary irrigation methods used for leaching, germination, and initial development when determining emitter line depth. Place lateral lines a maximum of 24 inches from the crop rows for annual row crops and 48 inches for vineyard and orchard crops. Design EU for a minimum of 85 percent.

Design the dripline gradient between 0 to -2% (downgrade) with a maximum length of 660 feet. If these conditions are not met, support the design by engineering (hydraulic) documentation that shows EU of 85 percent or greater.

Criteria Applicable to Preventing Contamination of Ground and Surface Water

Chemigation and Chemical Water Treatment. Design the system EU to be 85 percent or greater where fertilizer or pesticides, or treatment chemicals are applied through the system.

Provide a minimum of 2 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.

Accomplish chemigation in the minimum length of time needed to deliver the chemicals and flush the pipelines. Limit the application amounts to the minimum amount necessary, and the application rate to the maximum rate recommended by the chemical label.

Follow proper maintenance and water treatment techniques to prevent clogging based upon dripper and water quality characteristics. ASABE EP405.1 contains guidelines for chemical water treatment.

Use irrigation water supply tests to plan for addressing or avoiding chemical reactions with injected chemicals to prevent precipitate or biological plugging.

Follow the pest or nutrient management plan on the timing and rate of application, according to Georgia Conservation Practice Standards, 590, Nutrient Management, and 595, Pest Management.

Criteria Applicable to Establishing Desired Vegetation

System capacity. Design the system with adequate capacity to provide supplemental water at a rate that will insure survival and establishment of planned vegetation for a period of at least 3 years. Design the system with adequate capacity to apply the specified amount of water to the design area within the net operation period.

Determine gross application volume per plant using field application efficiency consistent with the type of microirrigation system planned. If a need is indicated by water test results, include adequate water for leaching to maintain a steady state salt balance in all applications.

Design microirrigation systems installed solely to deliver supplemental water for establishment of windbreaks or riparian vegetation to deliver a minimum of eight gallons per tree or shrub per week to assist in the establishment process. Design net application volumes per plant are dependent on the species of tree or shrub and the age (first, second, or third year).

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 drip line to prevent the line from being dislodged or moved away from the trees or shrubs.

When lateral emitter spacing or capacities vary with each row, design the laterals separately.

Operation and maintenance items specific to vegetation establishment are included in Chapter 6 of NEH, Part 652, Irrigation Guide.

CONSIDERATIONS

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

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

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

Water quality is usually the most important consideration when determining whether a microirrigation system is feasible. Well and surface water often contain high concentrations of undesirable minerals (chemicals). Surface water can contain organic debris, algae, moss, bacteria, soil particles, etc. Well water can also contain sand. Properly test the irrigation water 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. Surface water quality may be affected by the movement of sediment, soluble chemicals, and sediment attached substances carried by runoff. Ground water quality may be affected by the movement of dissolved substances below the root zone.

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

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. Pest or nutrient management planning should address the timing and rate of chemical applications.

On systems where chemicals are injected, take care so the injected nutrients do not react with other chemicals in the irrigation water to cause precipitation and plugging. Microirrigation will affect a change in plant growth and transpiration because of changes in the volume of soil water.

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, lay laterals downslope for slopes of less than 5% if lateral size reduction can be attained. For steeper terrain, lay lateral lines along the field contour and specify pressure compensating emitters or use pressure control devices along downslope laterals.

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.

Include equipment and installation as well as operating costs in the economic assessments of alternative designs.

Longer, less frequent irrigations of windbreaks during establishment are recommended to encourage deeper root development that increases drought tolerance.

Installation and operation of microirrigation systems have the potential to save energy as a result of reduced seasonal irrigation application, and in some situations reduced operating pressures.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for the microirrigation system in accordance with this standard and that describe the requirements for properly installing the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

Develop a site specific operation and maintenance (O&M) plan and review the completed plan with the landowner/operator. 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 in the O&M plan. Include, as a minimum, the following in the Operation and Maintenance Plan:

- Monitor water application.
- Clean or backflush filters when needed.
- Flush lateral lines at least annually.

- Check applicator discharge often; 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 devices.

Use 441-GA-O&M Plan to develop the site specific plan.

REFERENCES

1. Design and Installation of Microirrigation Systems, American Society of Agricultural Engineers (ASAE), ASAE EP405.1, February 2003.
2. National Engineering Handbook, Part 652, Irrigation Guide, 1996.
3. NRCS, Conservation Practice Standard Irrigation Water Conveyance, Pipeline, High Pressure Plastic, Code 430DD, 1988.
4. National Engineering Handbook, Part 623, Chapter 7, Trickle Irrigation, 1984.
5. National Engineering Handbook, Part 623, Chapter 2, Irrigation Water Requirements, 1993