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 zone 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

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 gal/hr), drip or trickle emitters and tapes (generally< 2 gal/hr), or spray or spinners (generally< 45 gal/hr).

Microirrigation is suited to orchard and row crops, windbreaks, 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 Purposes

Planned work shall comply with all Federal, state, and local laws and regulations.

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 = 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

Where consumptive use data is not available, the net water requirement can be estimated by using National Weather Service Class A Pan Evaporation and Pan Coefficients. Table 1 shows the average daily National Weather Service Class A Pan Evaporation in inches by months for selected stations. The values were determined from monthly evaporation totals and do not reflect extremes or day-to-day variations. The net water requirement can be determined by multiplying the appropriate coefficient by the value in Table 1. The coefficient normally varies from 0.6 to 0.8. The 1972 Texas A&M Drip Irrigation Handbook recommends a coefficient of 0.7 for orchards unless better data is available. NEH 15, Chapter 1, provides guidance on relationship of pan evaporation to evapotranspiration.

The following equation may be used as a design aid to estimate gpm per acre for the net application:

24 hours operation gpm/ac = Fn x 18.856 x f

18 hours operation gpm/ac = Fn x 25.141 x f

12 hours operation gpm/ac = Fn x 37.712 x f

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

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 manufacturer 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 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 operated simultaneously such that they will not exceed a total variation of 20 percent of the design discharge rate. Pressure shall conform to 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 Irrigation Water Conveyance, Pipelines, Code 430.

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 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% of the system operation time. Within this 10% 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% 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. 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 ft/sec is considered adequate for flushing.

Subsurface Irrigation. 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 annual row crops and 48 inches for vineyard and orchard crops. EU shall be designed for a minimum of 85 percent.

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 show EU of 85 percent or greater.

Chemigation. System EU shall not be less than 85 percent where fertilizer or pesticides are applied through the system.

Injectors (chemical, fertilizer or pesticides) and other automatic operating equipment shall be located adjacent to the pump and power unit, placed in accordance with 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, as recommended by the chemical label.

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 groundwater quality.

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. Chemicals should not be applied if rainfall is imminent. Pest or nutrient management planning should address the timing and rate of chemical applications.

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.

Microirrigation will effect 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, laterals should be laid downslope for slopes of less than 5% 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 used 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.

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. Typical maintenance items include:

- Clean or backflush filters when needed.
- Flush lateral lines regularly.
- 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.

TABLE 1.

AVERAGE DAILY EVAPORATION BY MONTH (INCHES)

STATION	MAY	JUNE	JULY	AUG.	SEP.
Amarillo	0.34	0.40	0.40	0.36	0.29
Angleton	0.20	0.22	0.22	0.21	0.19
Austin	0.25	0.32	0.35	0.34	0.26
Balmorhea	0.34	0.37	0.35	0.32	0.26
Beaumont	0.21	0.24	0.22	0.22	0.19
Beeville	0.25	0.30	0.30	0.30	0.24
Big Spring	0.36	0.42	0.43	0.41	0.31
Buchanan Dam	0.27	0.36	0.38	0.38	0.27
Chillicothe	0.31	0.37	0.40	0.37	0.29
College Station	0.24	0.27	0.30	0.29	0.22
Dalhart	0.32	0.37	0.38	0.35	0.29
Del Rio	0.35	0.42	0.47	0.43	0.33
Denton	0.22	0.30	0.31	0.31	0.25
Dilley	0.27	0.33	0.36	0.35	0.26
Fort Stockton	0.41	0.47	0.45	0.40	0.31
Grandfalls	0.42	0.47	0.44	0.41	0.30
Iowa Park	0.22	0.30	0.31	0.30	0.24
Laredo	0.37	0.44	0.49	0.45	0.33
Lubbock	0.30	0.36	0.35	0.32	0.25
Nacogdoches	0.19	0.22	0.24	0.24	0.19
Prairie View	0.22	0.26	0.27	0.27	0.22
Riesel	0.27	0.33	0.36	0.37	0.31
San Antonio	0.25	0.32	0.36	0.36	0.27
Spur	0.29	0.35	0.37	0.32	0.25
Temple	0.22	0.27	0.31	0.32	0.25
Tyler	0.18	0.22	0.24	0.23	0.19
Weslaco	0.30	0.33	0.36	0.35	0.26
Ysleta	0.45	0.49	0.43	0.36	0.31

APPROVAL AND CERTIFICATION

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PRACTICE STANDARD APPROVED:

John W. Mueller
State Conservation Engineer

6/12/02
Date