NORTH DAKOTA
ENGINEERING PRACTICE PLANNING GUIDE
MICROIRRIGATION SYSTEMS

PRACTICE STANDARDS: 441 (Microirrigation), 430 (Irrigation Pipeline), 533 (Pump), 449 (Irrigation Water Mgt)

REFERENCES

In addition to Section IV of the Field Office Technical Guide, the following are recommended technical references for planning Microirrigation Systems:

- NRCS National Engineering Handbook, Part 623, Chapter 7- Microirrigation, October 2013. http://directives.sc.egov.usda.gov/ (Handbooks-Engineering-Part 623 Irrigation-Chapter 7).
- MN High Tunnel Production Manual for Commercial Growers, 2012. http://www.extension.umn.edu/garden/fruit-vegetable/mn-high-tunnel-production-manual/
- IA High Tunnel Fruit and Vegetable Production Manual, 2010. http://www.leopold.iastate.edu/pubs-and-papers/2010-01-iowa-high-tunnel-fruit-and-vegetable-production-manual
- MT NRCS Water Needs of Windbreaks for Trickle Irrigation System Design http://www.nrcs.usda.gov/wps/portal/nrcs/detail/mt/about/?cid=nrcs144p2_057206
- SDI Water Quality Assessment Guidelines, Kansas State Research & Extension, http://www.ksre.ksu.edu/irrigate/OOW/P03/RogersLammAiam_SDIWaterQuality.pdf
- NDSU Extension WQ-1341 Drinking Water Quality, 2012. http://www.ag.ndsu.edu/pubs/h2oqual/watsys/wq1341.pdf
- Rainbird http://www.rainbird.com/landscape/products/Drip-Irrigation.htm
- Toro http://www.toro.com/en-us/agriculture/pages/default.aspx
- John Deere https://www.deere.com/en_NAF/products/equipment/irrigation_and_water_management/drip_and_micro_irrigation_emission_devices/drip_tapes/t_tape/t_tape.page

RESOURCE INVENTORY

1. What type of crops are being grown on the property currently and how are they being irrigated? Does the producer feel that there have been production or disease issues associated with under or over watering? How have irrigations been scheduled, and how much water was applied at what frequency? What rooting depths have been observed to date?

2. Is the water quality of the proposed source adequate to support longterm irrigation of the planned crop types? At a minimum, the factors below will be tested for and any system proposed for use with water in the medium to severe ranges will be reviewed and approved by the Area Engineer. Cost of the tests are <$100, and can be ordered from multiple sources in ND – see NDSU Extension publication above for a listing of laboratories.

   Tests are required during the planning process, for both ground and surface water sources, with the exception of rainwater harvesting systems (which may be a good alternative to sources with severe water quality issues). Generally most water sources can be utilized for microirrigation, however we want to make sure producers are aware of any extra costs for necessary treatment infrastructure up front, prior to moving forward with a contract as that may impact feasibility of the project for them.

Table 7–2 Tentative water quality criteria for classifying waters used with MI (adapted from Hanson et al. 1994; Hassan 1998)

Type of factor	Minor	Moderate	Severe
Physical			
Suspended solids[a]	50	50–100	>100
Chemical pH	7.0	7.0–8.0	>8.0
Dissolved solids[a]	500	500–2,000	>2000
Manganese[a]	0.1	0.1–1.5	>1.5
Total iron[a]	0.2	0.2–1.5	>1.5
Hydrogen sulfide[a]	0.2	0.2–2.0	>2.0
Carbonate+bicarbonate[a]	50.0	50–100	>100
Biological			
Bacterial population[b]	10,000	10,000–50,000	>50,000

a Maximum measured concentration from a representative number of water samples using standard analytical procedures for analysis in ppm (mg/L)
b Maximum number of bacteria per milliliters can be obtained from a portable field sampler using standard analytical procedures for analysis

(210–VI–NEH, October 2013) 7–13

3. What is the capacity of the proposed water source and pump? For wells, determine static and drawdown water elevations at known flow rates. If a well test is not available, simply use the same pressure gage, bucket, and stopwatch method NRCS typically uses for livestock pipeline projects to develop a pump curve. What does the water source already supply water to (house, livestock water, lawn/garden irrigation) and what are those peak demands and their timing? Investigate the existing plumbing at the water source, including the locations of valves, tees, gauges, backflow prevention devices, pressure tank, air/pressure relief, and the diameter, pressure rating, and burial depth of existing pipeline.

4. What soils are in the area(s) proposed for the microirrigaiton system? Use Web Soil Survey and/or an onsite soils investigation to determine available water holding capacity for the soils, and investigate the presence of any subsurface limiting layers.

DEVELOPING AND EVALUATING ALTERNATIVES

1. Based on both the existing and proposed crops (or trees/shrubs in the case of shelterbelt microirrigation systems) to be grown, work with the producer to determine an appropriate row and plant spacing for the proposed area. For high tunnels, the IA and MN references listed above provide recommendations on bed and plant spacing for various vegetables and fruits. For shelterbelts the MT reference listed above provides recommendations.

2. Develop a conceptual layout of the microirrigation system from the proposed water source that includes the location of the mainline(s), manifold(s), zones, laterals, emitter types, valves, pressure regulators, and whether the system will be surface or subsurface. Given that PS441 requires a means of flushing the system, give special consideration to locating mainlines and laterals in a way they can be drained. At the planning stage, the following rules of thumb may be useful:

Plant/Soil Type	Emitter Flow Rate	Emitter Spacing
Vegetables, Sandy Soil	1-2 gal/hour	10-12” spacing along row
Vegetables, Loam Soil	0.5-1 gal/hour	16-18” spacing along row

Vegetables, Clay Soil	0.5 gal/hour	18-24” spacing along row
Low Shrubs, 2-3 ft tall	1-2, 1 gal/hour per plant	Place 6-12” from base of plant
Shrubs/trees, 3-5 ft tall	2-3, 1 gal/hour per plant	Place 12” from base of plant
Shrubs/trees, 5-10 ft tall	3-4, 1 gal/hour per plant or 1-2, 2 gal/hour per plant	Place 2-3 ft from base of plant
Trees >10 ft tall	4-6, 1 gal/hour per plant or 3, 2 gal/hour per plant	Place 4-8 ft from base of plant

Typical NRCS high tunnel projects use either twin chamber turbulent flow drip tape (line style emitter) or pressure compensating drip emitters (point source emitters). Many types and styles are on the market however the 441 practice standard has restrictions that preclude the use of some commonly available styles of dripline. During the planning process investigate whether the producer is particularly tied to a certain style of dripline, and if that is the case determine whether that will be acceptable under the standard, especially for the manufacturer coefficient of variation.

3. Determine minimum system capacity based on layout decisions made above, peak consumptive use (per the MN reference above 0.3 in/day is appropriate for vegetables in high tunnels), available water holding content of the soils to the rooting depth, system efficiency (generally 88% used for drip), choice of management allowed depletion (generally use 35% for vegetables, 50% for trees/shrubs), and design of zones for larger projects. The spreadsheet on the link above from MT NRCS is setup to do these computations for common trees and shrubs used in windbreaks. Attached is a basic spreadsheet that can be utilized to complete calculations on any type of row crop.

   Compare to available capacity of the water source/pump to determine feasibility of the project. A good assumption for residential water use requirements is 10 gpm @ 50 psi. Use typical stockwater pipeline design values to determine livestock water peak usage. For supply limited sources, note that there are design decisions that can be made around how to setup zones, frequency, and timing of water applications – for example setting up small enough zones that the system can run late night/early morning when residential and stockwater uses drop. But, in some cases a system simply is not feasible off an existing source- hence the need for at least a cursory analysis at the planning stage.

4. Evaluate water quality tests results, both in terms of if the quality is suitable for irrigating the proposed crops and if it will impact the lifespan of a microirrigaiton system. Both the NEH Part 623 and the Kansas State references listed above provide treatment options for individual water quality concerns. In cases where special treatment or filtration will be necessary, investigate both the initial purchase and longterm operating costs.

5. Prior to sharing engineering alternatives with the producer, determine the engineering job approval authority for the practices involved. If you do not have adequate Planning (I&E) JAA for the practices, have your work reviewed by another individual in the NRCS who does to make sure you have correctly evaluated all of the options and determined feasible and implementable alternatives. At the point those are presented to a producer, the planner is making a commitment on behalf of the agency that we have provided technically sound, implementable engineering plans.

ASSISTING THE PRODUCER TO MAKE AN INFORMED DECISION

1. Put together some example detail drawings, photos, and supplier information to explain alternatives for the system and give the producer a good idea of what NRCS standards will require on the project. Ensure they particularly understand that we require mainlines to be buried, backflow prevention devices to be installed if chemigation will be used (required by ND Century Code), filters to be in place, emitters to meet our standards, air/vac relief if high spots exist on the mainline, and an ability to flush all lines and laterals be designed into the system.

2. Discuss options for Irrigation Water Management, and strongly encourage producers to consider utilizing the “IWM Intermediate” EQIP option for microirrigation systems that will serve fruits and vegetables. Water needs of these crops vary widely through their development, and both quality and production are greatly impacted by irrigation. Not only will IWM help fund installation of soil moisture monitoring devices, but it is a great mechanism to ensure NRCS technical staff have the opportunity for onsite followup to continue to develop expertise for these systems.

3. Estimate approximate quantities of materials needed to construct the project, with adequate detail that the producer will be able to reasonably estimate costs. Calculate expected cost share, if planning is being done in conjunction with a program application. At this point in the process, it is expected that estimated quantities for cost share will be within 20% of the final design and constructed amount. It should be extremely rare for a situation to arise where significant contract modifications are necessary.

4. Meet with the producer, and go through each of the feasible alternatives discussing factors that will be important to them in their decision: installation requirements, initial investment, operating costs and time requirements, lifespan, and maintenance needs.

5. In the case of a program application, it is important that producers understand exactly how implementation would proceed and what restrictions they will operate under. Ensure that they understand that used materials are not acceptable (with a few exceptions), licensed well drillers and pump installers must be utilized (with some exceptions on tribal lands), no construction may proceed until they have received final design drawings and specifications, and that NRCS will be onsite inspecting during construction to ensure compliance with the design.

6. Provide adequate time for the producer to make an informed decision. If they don’t have time to meet to discuss alternatives, they likely haven’t had time to adequately complete a good decision making process resulting commitment to implement the plan. Offer and be willing to defer an application, to allow time for a quality planning process and good decision making on the part of the producer.

Provide documentation of above steps in the conservation plan narrative, assistance notes, and/or in separate documentation in Part 5 of the plan folder. Job class for each practice involved, and the approving individual for planning work, needs to be included.