Operation of a Subsurface Drip Irrigation System Under National Organic Plan (NOP) Organic Certification Standards

<u>Final Report</u>

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Partial funding has also been received from the Western Sustainable Agriculture Research and Education Program (Western SARE).

All work completed at Rio Grande Community Farm, Albuquerque, New Mexico.

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Section I- Introduction and Acknowledgements

The subsurface drip irrigation system (SDI) began as an idea in 2007 when Rio Grande Community Farm (RGCF) made a conscious decision to move into organic vegetable production in a much more intentional manner. RGCF is a non-profit farm “working on public land in the public interest”. We farm approximately 50 acres in a variety of crops, located on a 140 acre plot owned by the City of Albuquerque. We have farmed the land as a non-profit since 1997. With the recession and after a reexamination of our Mission, the RGCF Board decided to focus on growing food crops for our citizens, particularly targeting vegetable crops for our school system, Albuquerque Public Schools (APS). Since 2008 RGCF has had a contract to sell vegetables to APS.

At the same time, the City of Albuquerque applied to utilize an existing well on the property that had not been used for several years. The City had the water rights, but in order to perfect the rights was required by the State Engineer to install “highest and best use” technology in utilizing the well water. This coincided with our application under the NRCS EQIP program to install a drip irrigation system on 16 acres. We appreciate the strong support given us by Josh Sherman and his staff in the Albuquerque USDA office for the EQIP grant which partially funded the installation of the SDI system. Josh suggested we install “subsurface drip” as it was considered the #1 technology regarding water use efficiency for vegetable crops

During the installation period from 2008-2010 I had blithely assumed there would be ample information available on the operation of a SDI system under organic certification. This turned out to be far from true- in fact there is almost no information available on organic operation of an SDI system. Realizing that what we would be doing would be of great interest to many farmers in the Southwest and across the nation, we applied for a USDA Conservation Innovation Grant (CIG) and a Western SARE grant. The CIG program in particular requires the integration of two or more existing proven technologies that have been proven effective in agriculture, but whose integration together has not been proven or well documented. Western SARE targets farmers utilizing innovative technology to meet demonstrated regional challenges. Our use of SDI technology clearly met these criteria. Under the Western SARE grant we have operated under the mentorship and collaboration with the Bernalillo County Extension office which is part of our land grant university, New Mexico State University. Our mentor and Western SARE sponsor, Joran Viers, has been a tireless and always supportive partner in the rollout and implementation of the SDI irrigation system. Joran is the Bernalillo County Extension Director and has been a supporter of organic and sustainable farming for many years. We also appreciate the ongoing support of Norm Vigil and Seth Fiedler in the USDA New Mexico State office for the CIG grant. We could not have completed this project without the expert advice of Seth on navigating the myriad federal forms involved and Norm for ongoing support in the concept of organic SDI.

A brief description of subsurface drip technology. Simply stated, SDI is the use of plastic drip irrigation tape that is semi-permanently buried in the ground. Subsurface drip and above ground drip share many of the same challenges and vary in the overall system components only slightly. Both require pumps to pressurize the system and filters to clean the water. Both require valves, zone stations and pressure regulators to control the areas irrigated. Both involve extensive piping in the form of manifolds, flush valves and main lines to distribute the water. Both involve drip tape with emitters that release the water to the plants. For subsurface drip (SDI) the tape is buried in the ground anywhere from 6”-18” below grade and the expectation is that it is not removed for several years. Surface tape is often rolled out every year. Occasionally it is re-used but standard practice is often to throw it away and use new tape every year.

For both surface and subsurface drip tape, a major challenge is to keep the emitters clear and water flowing out of the emitters. There are a number of reasons why emitters get clogged- these will be addressed in our report. In addition to the many benefits of burying the tape the main challenge is how to keep the tape intact and damage free from a variety of 4 legged and 2 legged creatures. And herein lies one of the major conclusions of our study.

As funny as it may sound, neither Dan our Chief Farmer, nor myself fully understood the implications of subsurface drip. It hit us one day full force after the system was installed and we were planning for crop production. Dan had literally hooked up the 5 ton double gang heavy discs and was preparing to disc the field. In one of those “ah-ha!” moments Dan and I looked at each other and exclaimed “Holy Cow! We can't do this anymore!”

Subsurface drip requires you to engage in minimal/no till tillage operations to avoid cutting the lines. Our lines are buried 6” below the surface and we have had to retool and rethink all our tillage practices. So here is a major conclusion: **If you install subsurface drip, you will be engaged in no/minimal till tillage.** Both Dan and myself are traditional farmers in that we have used shanks, discs, plows and other implements that greatly disturb the soil. But with the installation of the SDI, we were now instantly no till!

Having realized that we were not only beginning to use new drip technology but also needed to retool all our operations, we went screaming to our USDA partners and Western SARE mentor Joran Viers: “What the heck do we do?!?” Well, we formed the Brain Trust. This is a group of several individuals that have met on a regular basis in 2010/2011 and intermittently since. Their brain power, and more importantly their emotional and psychological support have been invaluable in overcoming the many challenges of operating an SDI system under organic certification, using no/minimal till methods. Members of the Brain Trust are:

Joran Viers, Bernalillo County (NM) Extension Director
Dean Schwebach, 4th generation farmer
Tim Cavalier, Engineer and developer of the Zetacore water treatment system
Lee Orear, retired Sandia National Laboratories hydrologist
Rudy Garcia, USDA soil conservationist, NM State office, Albuquerque
Clarence Chavez, USDA soil conservationist, NM State office, Albuquerque
Walter Dodds- soil scientist and owner of Soilutions Organic Compost
Nick Penalosa, organic farmer
Dan Schuster, Chief Farmer, RGCF
Minor Morgan, Executive Director, RGCF

This group met regularly and their feedback and collaborative spirit was truly inspiring. Without their sagacity- and sense of humor- we could not have made the transition to SDI no/minimal till.

A hearty and deep felt thanks also goes out to the following folks for support:

Deb Thrall of the Albert Pierce Foundation
McCune Foundation
Albuquerque Community Foundation
Craig Maple, Brett Baker and Joanie Quinn of the NM Department of Agriculture
Dr. Ron Gooden and Don Bustos on advice regarding no till
The many vendors who donated time, expertise or materials to the project including Dusty Singh of Sierra Irrigation/Barron Supply, Franks Supply, Bern Maier of New Mexico State University, Keden Burk of EuroDrip USA, Mauro Herrera of NM office USDA, Brent McGill of Mueller, Inc.
Parks and Recreation Department and the Open Space Division, City of Albuquerque

We also visited or had discussions with the following farms using SDI:

David, Carol and Howard Wuertz, Arizona Drip- “The Grandfather” of subsurface drip
Todd Brendlin, Grimway Farms, California
Chris Sichler, Sichler Farms, New Mexico
Scott White, University of Arizona
Steve Bassi, Tanamura and Antle Farm, California
Dean Schwebach, Schwebach Farms, New Mexico

We are grateful to these farmers for the information they shared and their pioneering spirit. We appreciate Howard Wuertz and son David in particular for the many hours they spent showing us their 5,000 acres in subsurface drip. Howard pioneered this technology in the 1970’s and continues to this day to develop implements and processes for SDI and no/minimal tillage. We purchased our first no till implement- a “lister/peeler” from the Wuertz family during our visit in 2009. See Appendix A for information on Howard Wuertz and his farm.

System Design

Basic System Design: The RGCF SDI system consists of 7 plots ranging from 2.1-2.5 acres in Field 4, a total of 16 acres. This field also contains buried pipelines for use in flood irrigation. Having flood is an important asset in the operation of SDI because it can assist in germination as well as be used to flush salt accumulations back into the soil. Each plot is a "Zone" and can be operated independently of the other zones, through the use of electric valves controlled from the wellhouse. This allows us to grow several different crops requiring differing water needs at the same time, as well as leave plots fallow or grow cover crops. We have two water sources: surface water from the Gallegos Lateral ditch and subsurface water from an existing well. The City has determined that the well can be used for crop production up to the limit established by the State Engineer, approximately 12.8 acre feet per year. Water use on both the surface ditch and subsurface well water is measured and reports are made to Open Space and the State Engineer. When we are in full production we use more than the allotted 12.8 acre feet. We use the surface water during the main season and well water at the beginning and ending of the season, as well as in the winter time for winter crops such as garlic.

The hub of the system is a series of sand media filters, a booster pump to pressurize the system, the well pump for the subsurface water and valves, gauges, controls, etc. The system includes an injection system for the addition of nutrients and cleaners through the lines. The sand media filters backflush automatically to clean themselves. Backflush water is channeled into a french drain adjacent to field 4. Field permeability tests indicate no issues with the water percolating into the ground. This equipment is housed in a 24' X 24' metal building (well house) located adjacent to the well pump.

SECTION II- SYSTEM COMPONENTS

Here is a brief overview of the major components of our system.

1. Surface water distribution box. The SDI system at RGCF is designed to utilize both surface water from the adjacent Griegos Lateral ditch and well water from a shallow well located on the property. In order to access the surface water from the ditch we constructed a large concrete “intake box”. This box consists of one 24” inlet pipe with gate valve that brings water from the ditch into the box, and three smaller pipes that direct the flow of water to three different areas. Each pipe is controlled by a gate valve. Two of the pipes are 18” in diameter and feed underground piping connected to alfalfa pop-up valves. The 3rd pipe is an 8” diameter pipe that feeds the wellhouse for use in the drip system. There is a large grate at the inlet side of the box and a smaller grate to screen out debris from entering the pipe leading to the drip system. These pipes are buried below the frost line and are full of water year round. In NM our surface water seasons runs approximately from April-October. Many SDI systems rely exclusively on well water, but the water rights the City has for the on-site well are not sufficient to meet the complete needs of our crops. We must rely on surface water for the main growing season and use well water before and after the ditch is turned on.

One interesting note: The grate at the intake box screens out larger crawdads but not small babies. We notice after one season that full grown crawdads come out the other end into the drip system- the babies are overwintering and growing up inside our intake pipes! The buried pipeline runs approximately 600’ underground from the intake box to the wellhouse.

Construction of the Water Control Structure by Rio Grande Community Farm at the City of Albuquerque Los Poblanos Fields under USDA EQIP Grant # 748C3, February/March, 2008. Phase 1 successfully completed 3/27/08.

1. Ready to begin “the Box”!

2. Outer collar in place, digging stem wall

3. Outer forms go on

4. Stem wall is 24” deep

5. Inner collar is placed, ½” rebar goes in

6. Inner form goes in

7. “Snap tie” bracing

8. Have to inspect the work!

9. Closin’ up the box!

10. Rebar, forms and snap ties in place!

11. Note the “Jahn A” bracing system on box

12. Internal bracing for support

13. Ready to pour the walls and footings!

14. Concrete is pumped in and vibrated

15. Finishing out the walls

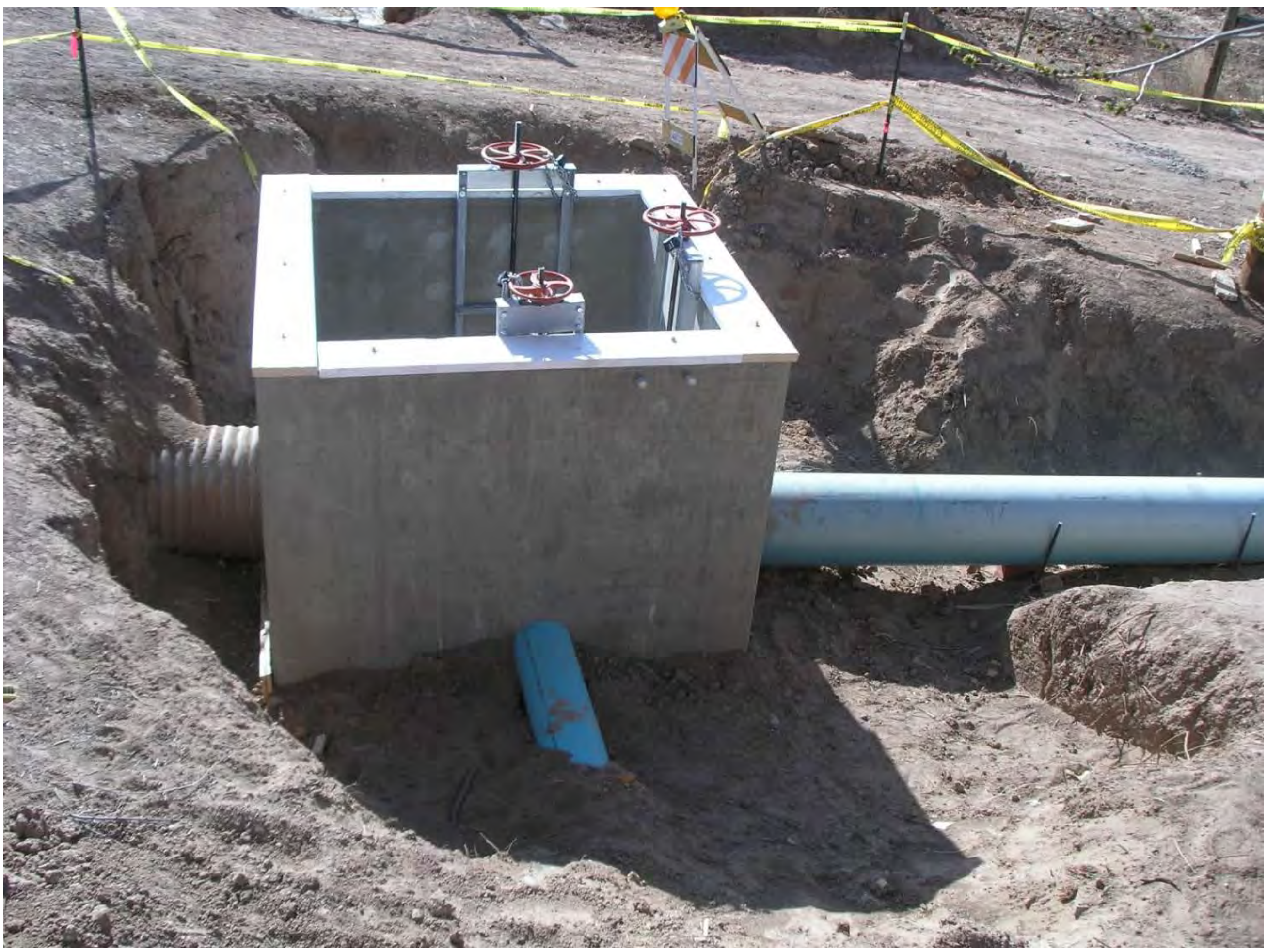
16. A tired but happy work crew!

17. The forms come off

18. Pouring the floor

19. The canal gates go on!

20. Caulkin' it good!



21. Ready for the water!

See Appendix B for detailed drawings of the water control structure

2. Buried pipeline to well house. The surface water flows through the box into a buried 8" pipeline that runs approximately 600' underground into the wellhouse area.

3. Wellhouse. This metal building houses the filters and related components.

Wellhouse

4. Well. The well has been on the property for over 50 years- as part of this project we rehabilitated the well, updated the motor and added electronic controls. The well pump does not create the pressure for the system- it pumps the water into a concrete "wet well" box similar to the water control box. Pressure for the system is created through a 2nd submersible booster pump located in the wet well. It is important to periodically test the well water to determine the mineral content and solids in the well water. We test the well water once yearly.

Meter used to measure well water

well with piping leading to concrete box "wet well"

well water pumps into one side of the 2 chamber "wet well"

5. Two chamber concrete box "wet well". The wet well is critical to being able to use 2 sources of water. The wet well has 2 chambers. One side is the intake for both water sources. the buried pipeline from the ditch delivers the surface water into one side of the box. Well water also goes into the same side of the box. We can use either surface water or well water. In the chamber that receives the water, we have a "prefilter". This is a Lakos brand fine mesh spinning filter that screens the water as it passes from one side of the box to the other. this pre-filtering is critical to keep out crawdads, debris from the surface water and much of the sand that comes from the well water. See Attachment C for plans of the wetwell.

Concrete two chamber "wet well". Note surface water piping on left. Ditch water enters here and is controlled by a butterfly valve.

6. Lakos brand spinning prefilter. This device is critical to keeping the sand media filters in top working condition. This prefilter screens out large debris and crawdads from the ditch and sand from the well water. It consists of a stainless steel fine mesh that spins around. Inside the screen are water jets that blow the material off the screen as it spins, thus keeping the screen clear. The pre-filter is attached to a pipe that leads from one side of the chamber to the other. Prefiltered water flows into the 2nd chamber where the submersible pump is located. See Attachment D for details on the Lakos spinning screen

Spinner prefilter leading from chamber one to chamber two.

Cleaning the spinner is critical

7. Submersible pump. This is the heart of the drip system. The 26 hp pump sits in the 2nd chamber of the wet well and creates the pressure for the system. It is a 460 volt, 3 phase motor but because of the computer controls, it operates very efficiently and uses very little electricity. It is capable of pumping 700 gallons per minute but we rarely operate the system at higher than 300 gpm. The pump is large and expensive because it is considered a "trash pump" meaning it can pulverize most solid material at intake such as leaves, dirt, debris, etc. It is designed to pump dirty water such as from the ditch or river. Many drip systems operate only off well or city water, but because we needed the capacity for ditch water we went with the heavier pump.

submersible pressure pump being lowered into wet well

Pump sitting in the wet well

8. Sand Media filters. We have three filters each filled with sand and gravel. They are a self cleaning design. When they get clogged, they automatically backflush and wash out all debris. The dirty water goes into a "french drain" adjacent to the wellhouse that serves to water plants that form a 700' long wildlife corridor. See Attachment E

Sand media filters

9. Computer motor controls. Both the well pump and the submersible booster pump are variable speed controlled motors. There is a sensor in the wet well that records the height of the water in the box. As more water is needed the well pump turns faster to keep the level of the water in the box constant. The higher the flow rate, the higher the pump speed. Same is true for the booster pump except the variable is system pressure. The line has a set pressure- 40 psi- and the computer controls the booster pump to maintain this constant pressure, regardless of the flow rate.

Computer motor controls

10. Flow rate meter. This device measures the rate of flow of water passing through the system in gallons per minute (gpm) as well as the total volume of water. This is an important device not only because it allows us to record the water used for a particular crop but as a diagnostic tool for problems in the system. At a given pressure, if the flow rate increases then this indicates a leak. If the flow rate decreases, this indicates a blockage. We can pretty much tell what is going on with the system from inside the wellhouse by looking at the flow rate meter. Highly recommended on any system.

Flow rate meter

11. Zetacore catalytic water treatment unit. This is one of our "secret weapons" and a critical component to operating our system under organic standards. This device creates a dc charge that flows through a set of metal bars that release ions in such a way that they interact with the various minerals in the water, preventing them from precipitating out as a solid. Mineral precipitation is one of the prime causes of emitter plugging and this device keeps the minerals in their liquid state. Not only does this prevent plugging but makes the minerals more available to the plants for uptake. All water flowing through the pipes passes through the Zetacore unit. See Attachment F for further information.

One interesting story about the effectiveness of this device. In 2011 the Zetacore unit developed a pinhole leak at a weld joint, thus necessitating removal of the unit for repair. I was shocked at what I found upon removing the unit. When I looked in one end of the unit- the end where water enters the unit- I could clearly see a large buildup of the type of scale that is common in water systems: calcium carbonate, iron oxide, etc. At the end where water exits the unit, there was no scale at all! Clearly the unit is having an effect on keeping minerals in solution in the water.

Zetacore catalytic water treatment unit

Note buildup of scale at pipe as water enters the Zetacore unit (untreated water)

Mineral scale buildup before water treated by Zetacore unit

Note LACK of scale after water treated by Zetacore

12. Pressure reducing valve. This valve reduces the overall line pressure. In order for the filters to operate correctly the line pressure must be maintained at 40 psi. We use the reducer valve to reduce the pressure to 20 psi going out into the field. See Attachment G

pressure reducing valve- reduces pressure from 40 psi to 20 psi

13. Electric zone valves and control box. Our system has 7 separate growing zones. Conditioned and filtered water flows out of the wellhouse underground to a manifold that feeds each of the 7 zones. Each zone is controlled by an electric valve that can be operated from the wellhouse. These valves also serve to “step down" the pressure from the line pressure of 20 psi to 15 psi, the drip tape pressure.

Zone valve at the head of each zone

Electric zone valve

Zone valve controller- can be fully automated

14. Chemical injector. This is an important component particularly for organic operation. This pump allows you to inject material into the main line. It is used to inject cleaning materials and fertilizers. We inject hydrogen peroxide into the system monthly at a low level as a maintenance and yearly at a high level. We have yet to use the system for fertilization (fertigation) because we are so concerned about emitter plugging. However we intend to eventually use the system for fertigation. See attachment H.

Injector pump- in red, lower right of photo

Injector pump with tank- note blue drum of hydrogen peroxide


Injection port in line


View of the main line in the wellhouse showing flow meter, Zetacore unit and pressure reducing valve

See Attachment I for a schematic drawing of all components in the system

See Attachment J for a general schematic of components in a SDI system

15. Field manifolds. There is one main manifold that runs the length of the field and each zone has a sub-manifold and flush manifold. All lines are buried below the frost line.

Main manifold

flush line


flush line manifold

16. Drip tape. We laid out the drip tape in 7 zones, each zone having either 2 or 3 beds. Each bed consists of 12 rows of drip tape buried at 36" on center. Between each bed is a 10' drive path to allow vehicle access. Each bed is approximately 600' long. We have a total of 18 beds. We used Eurodrip brand drip tape, 7/8" wide, 15 mil thick, high flow rating with emitters spaced every 12". It was buried in the ground using specialty laying equipment using GPS. Lines are absolutely straight and precisely spaced. Tape is buried approximately 6" below grade. See Attachment K for field layout.


12 Rows in a bed separated by a drivepath. One drip tape per row

SECTION III- SYSTEM OPERATION AND MAINTENANCE

Operation of a SDI system is very similar to any drip system. There are a few things one must do different because the drip tape is buried in the ground. And there are a few things different if you are certified organic, but many aspects of running the system are the same. Some of the key lessons we have learned are:

1. Calibrate the system at the beginning of the season with a great deal of accuracy. Establish a desired operating pressure for the drip tape and use a high quality pressure gage to adjust each zone to the desired pressure. We generally operate the tape at 15 psi. Assure that there are no leaks in the system and then record the flow rate for the zone. This becomes the baseline rate and allows you to determine if there is either a leak or a blockage in the system.

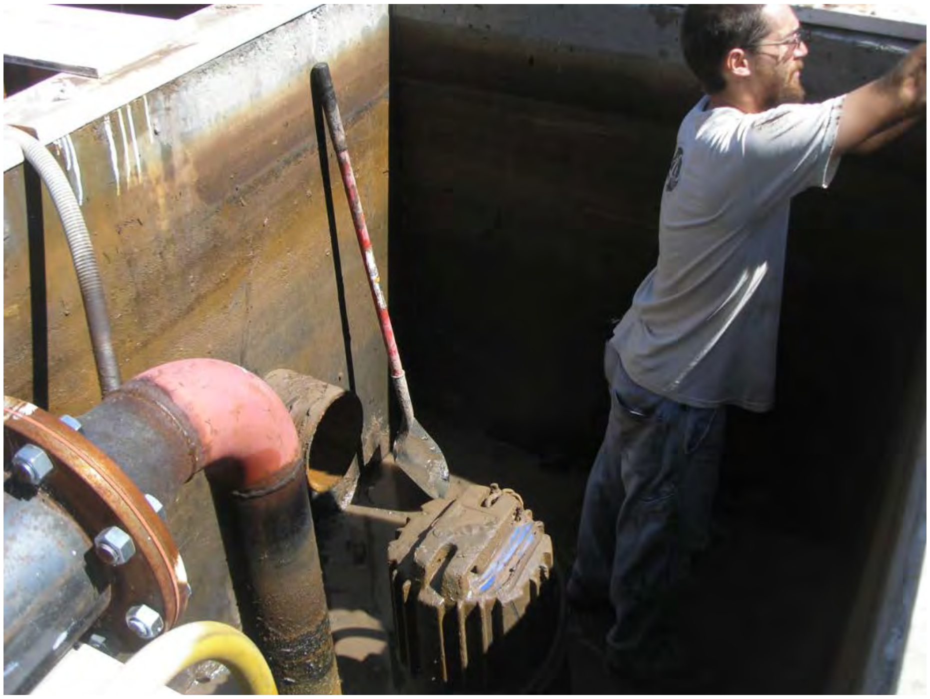
2. Flush the lines with each and every watering event. Each zone has two flush valves at the end of the line and we open these up for at least two minutes every time we turn the system on. The first few seconds will flush out dirty water and then clean water follows. When using surface water from the ditch, a very fine silt makes it through the sand media filters. This silt will flow out through the emitters as long as it does not build up in the system. Flushing accomplishes this.

Checking flush water for particles with a strainer

3.Dont cheap out on the thickness of the tape. If you are using SDI and hope to have the tape in the ground for several years, use at least 13 mil but preferably 15 or even 17 mil. The tape is more expensive but it allows a higher operating and flush pressure. Once a year we crank up the pressure in the lines to 30 psi and flush the lines out at this higher pressure. This flushing moves out pockets of sediment and silt buildup that can remain at the normal operating pressure of 15 psi.

4. Drain out the 2 chamber box. Because of the prefilter spinner that screens out debris from one chamber to the next, the debris level will build up in one side of the box. By draining the box at least monthly during the growing season, we keep the system in good working order.

5. Clean the box regularly. The water collection box builds up debris and is subject to mold and algae growth in the summer. It is important to clean the box periodically, scrubbing the sides of the box, the pump, spinner filter and all components.

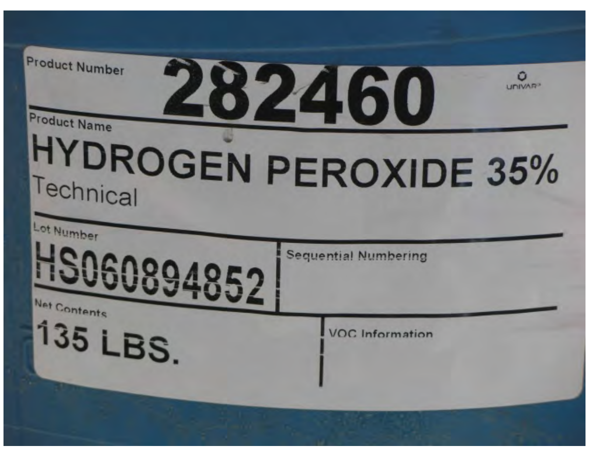


Cleaning out the water collection box

Cleaning the booster pump


Well sand cleaned out from the water collection box

6. Regular flushing with hydrogen peroxide serves several important functions. It clears out any algae buildup at the root zone, it burns out any organic matter such as small roots, it dissolves any organic scale residue. Most well water is high in iron and ours is no exception. There is a particular type if algae that feeds off of iron and creates a red scummy, sticky substance. Hydrogen peroxide is particularly good at clearing this residue out. We use a 35% solution. We have tried a 50% solution but found that handling and storage was too dangerous. See Attachment L for our exact flushing protocol. Also see Attachment M for an excellent hydrogen peroxide injection calculator available from Arapaho Citrus Management.



7. Do not use the system to fertigate. Over the three years we have been operating the system we have not injected any fertilizers or chemicals into the lines. This is due to an overabundance of caution and fear of plugging up the emitters. Instead we rely on traditional organic methods of fertilizing such as foliar feeding, side dressing and cover crops.

8. Know what is in your water. We perform tests to determine the mineral content of the water and the amount of solids. See Attachment N.

SECTION IV- NO/MINIMAL TILLAGE PRACTICES

For years we have practiced traditional tillage techniques. We would begin every season by discing or shanking the land, then light discs, then rotary tiller and begin with a perfectly even field of brown dirt. We would plant cover crops or cash crops as needed.

With the advent of our drip system we have had to change our tillage practices. We have had to re-tool and are now using implements that until 3 years ago we didn't even know existed. Outlined below are these implements and the function they serve.

1. Roller/Crimper. This implement rolls down a crop and lays it down on the ground by breaking the stalk and killing the plant. Timing is critical with this implement as it is necessary to roll the crop at the proper stage of growth. too early and the crop pops back up and too late the crop goes to seed. The advantage of this is to create a mat of organic matter composed of long strands of crop residue. Into this can be planted seeds or starts. This implement was designed by the Rodale Institute. See Attachment O.

3. No till drill. This implement is designed to cut through heavy ground residue and plant seed. Cutting discs are placed approximately 6" apart and are spring loaded to exert downward pressure adequate to cut through the heaviest stalk or crop residue. A seed chute places the seed precisely in the grove and a follow-on disc covers up and compacts the seed. A 2nd fertilizer box can add fertilizer at the point of planting.

8' wide no-till drill


no-till drill in action

3. Flail chopper. This implement has a hundred rotating "flails" that pulverize the crop residue and lay it down in a perfectly even mat. Whereas a rotary or sickle mower lays the material down in swaths, the flail chopper gives an even distribution of finely chopped residue. We have found that an early spring cover of oats flail chopped then planted with a summer sorghum that is then roller crimped in the fall, provides an excellent organic mulch layer to plant into.

Flail chopper pulverizing a cover crop

Notice how even the residue lays on the ground

4. Lister/Peeler. This implement has 2 sets of off-set discs separated on a tool bar by approximately 3'. The first set of disc "peels" the center of a row back only going a few inches into the ground but enough to uproot the plant. The 2nd set of discs "lists" the row back into shape thus burying the crop residue under the newly re-made row.


lister/peeler remaking 4 rows over buried drip tape


lister/peeler in action

5. Air Seeder. Dan our farmer calls this one "my Italian beauty". This precision implement can plant one seed at a time at a very precise spacing and high accuracy. It operates off a series of discs that pick up one seed by vacuum and lay it down in a grove made by a set of discs. While the downward pressure of the discs cannot match the no-till drill, the pressure is adequate to cut through a light mulch layer.

Two row air seeder

6. Modified corn planter. We modified the wheels on this planter to match or 36" row centers. It is useful for cover crops on lightly mulched ground.

Modified box seeder

7. Howard rotovator narrow tiller. This ancient implement works perfectly for lightly tilling (2"-4" deep) a single 36" row. Works great for incorporating crop residue.


Single row shallow tiller, the "Wonkavator"

8. Modified manure spreader. We changed this implement around to be a good compost spreader.

compost spreader

SECTION V- CHALLENGES AND THE ORGANIC SOLUTION

Note: While the materials and products we use have been approved by our NOP certifying agent, users are advised to seek approval from their NOP certifying agent before use of any materials.

Also note that while we have developed these steps to prevent clogging our SDI lines, these measures will work equally well on surface drip tape.

Challenge/Problem	Solution (consistent with NOP standards)
Emitter clogging due to:	
-Sand	Most well water has a high percentage of sand. Design the system to use either a fine mesh prefilter such as the Lakos spinner screen or a centrifugal sand separator
- Calcium carbonate precipitates	This is the most common cause of emitter clogging and is evidenced by a white "scale" in the lines and emitters. The Zetacore unit has proven effective in eliminating all types of scale. However, the traditional treatment is to lower the ph of the water by using acid to less than 7.0. NOP standards do allow the use of Acetic acid for this purpose. See Attachment P for information on food grade 100% acetic acid.
- iron and manganese precipitates	Iron and manganese will precipitate out as solids at a wide ph range (ph 4.0-9.5) so acidifying the water has little effect. The Zetacore unit however, has proven effective in keeping the iron and manganese in solution in the water. We have seen no iron or manganese precipitates in our lines.
- iron bacteria slime	This has been an issue for us. There are certain strains of bacteria that eat iron and develop long strands of slimy filaments. These form a sort of glue that can clog emitters. the Zetacore does not prevent the bacteria from forming the slime. the most effective prevention of this is use of hydrogen peroxide. Because we have a 2 chamber concrete box, we are able to add hydrogen peroxide via a dripper system. This is a continuous low dosage feed of hydrogen peroxide that keeps the iron algae at bay. Periodic flushing with hydrogen peroxide also cleans the lines.
- large particles from surface (ditch) water	Both ditch and well water enter the system through one side of the two chamber box. Water is screened through a fine mesh Lakos brand spinner filter and this screens out large particles. Any remaining particles are screened out through the sand media filters. The sand media filters are set to automatically backflush when they become clogged, but during the growing season we backflush more often than is required, to keep the sand filters clean. ALSO- important tip: there is a gate valve that controls the rate of backflush water. Instruction manuals for the sand media filters instruct you to set this valve at the

Emitter clogging due to: - large particles (cont)	point where the sand media in the tank is raised up during backflush but is not washed out. However, we have set the gate valve to wash out a slight amount of sand with every backflush. This assures complete flushing of the system, but does require us to monitor the sand level in the filters. We replace missing sand monthly. (sand is cheap)
- fine silt	Neither the Lakos spinner filter nor the sand media filters can screen out the very fine silt that is in the surface (ditch) water. This silt appears as a very fine brownish powder that has the consistency of talcum powder. The silt is fine enough to pass through the emitters, but if allowed to build up could cause problems. Flushing for 2 minutes each time you irrigate eliminates this problem. Also note that one solution to the problem of both fine and large particulate matter is a settling pond. We do not have the space for this, however we have seen applications where surface water is allowed to settle in a large pond and the intake water for the sand media filters is siphoned off the top. This works well but also brings with it the possibility of algae growth in the pond water.
Emitter clogging due to soil ingestion from vacuum pressure.	In all drip systems, when the drip lines deflate at the end of an irrigation cycle, a vacuum is created in the lines as the water seeps out the emitters. This vacuum can suck mud back into the emitters. One-way air intake valves at every point are the solution. These should be placed at all high points in the system and be installed on the main line, manifolds and submanifolds. These allow air to come in behind the escaping water, eliminating the suction effect.
Emitter clogging due to growth of algae and bacteria at the emitter zone.	Systems that routinely inject fertilizer create nutrient rich zones at the emitters. These zones are not only good for the growing plants but also fungus, algae, bacteria and other microscopic organisms. These organisms create slime that can plug the emitters. To date (three years operation) we have not injected any fertilizers into the system. We have relied on traditional organic methods of fertilizing such as side dressing and foliar feeding. We are however, inching closer to fertigation as we further refine our flushing and maintenance procedures using hydrogen peroxide. Fertigation is one of the main benefits of a drip system, but should be approached with caution. Before injecting any fertilizer into the system, jar tests should be completed. This involves mixing the fertilizer with both surface water and well water (in separate tests). Besides particulate matter in the fertilizer that can clog emitters, fertilizers can react with minerals in your water, causing unanticipated precipitates. There are also differing opinions on where fertilizers should be injected into the system. Some

	manufacturers recommend injecting before the sand media filters. This allows the sand media to filter out any reactions, but also increases the organic matter in the filters. Others recommend injecting after the filters, but this involves the chance of sending particulate precipitates down the line. We are leaning towards injecting after the sand media filters and after the Zetacore water treatment unit, as the Zetacore minimizes particulate precipitation.
Root intrusion	Root intrusion occurs when very fine roots grow into the emitters, seeking water. Avoid crops such as celery that create very fine roots. Also use an emitter design that is anti-root intrusion. (check with the tape manufacturer). Also once a crop is growing maintain adequate watering to prevent roots from searching for water. We have found that our annual high concentration hydrogen peroxide flush flushes out small hair roots. Also cranking up the flush pressure to 30 psi in the drip tape flushes out roots.
Tape damage by gophers	OK, this is a big one and we have not found any real solution, other than repairing lines. Gophers burrow from point A to point B and chew anything in their way. (they do not chew the tape to get water). We have tried a variety of traps, prevention (castor beans, vibrating fans) and scare tactics- nothing works. We cannot use toxic chemicals or poisons under NOP, so... we just live with them. We are now trying a new approach- installing several owl boxes in the hope of creating habitat for gopher predators. but in the meantime, grab the ole repair bucket...
Incorrect tape injection	The process of injecting the tape at the initial installation is critical. Use experienced personnel and high quality equipment. Injection should not be a place to cut corners. You definitely need to inject with GPS technology to assure accurate placement. Also note that all buried drip tape should be laid with the emitters face up. During injection, it is easy for the tape to become twisted and a section is injected emitter down.
Proper system design	Flow rate, tape size, emitter spacing, emitter rating, tape thickness, run distance, tape operating pressure, depth of placement, slope of land, manifold length, zone size- all these are factors in assuring a working system and must be calculated ahead of time. Work with a design professional to run the numbers to assure success. Often the tape distributor can provide this service. There are three main tape suppliers- EuroDrip, Netafim and T-Tape. Research each one and make an informed decision.
Seed germination	This is a major issue and one that needs to be carefully considered. What crops will you be growing? What is your soil type? Are you hand or tractor scale? We intentionally placed our tape rather shallow (6"-8" below grade) to facilitate the

	germination of small cover crop seed such as clover and sorghum/sudan. We also went with a shallower injection because our soil tends to be sandy. On sandy soil, water leaches down faster than it wicks up, so the distance the water must travel at germination can't be too far. On higher clay soils that support upwards wicking of water, a deeper tape injection is possible. At initial germination of a cover crop seed, we generally let the system run 12-24 hours. The soil is thoroughly soaked at this point. Most of our vegetable crops are transplants, so the issue of germination is not as critical. We also supplement water when transplanting starts (we fill the transplant hole with water from a tank)
Insect damage to tape	This has not been an issue for us- usually affects surface tape.
Tape damage by tillage practices	This has been an issue- we have chopped thru, dug up, severed, made holes in, squashed, twisted, hit with shovels and in a dozen more creative ways managed to damage the tape. Lesson learned: outfit your tractors with GPS technology and perform the majority of your no/minimal tillage operations with GPS. Otherwise just get used to fixing leaks...

The Top Thirteen Tips for operating a SDI system under organic certification:

1. Installing SDI requires you to practice no/minimal tillage techniques. Be prepared to retool and rethink how you do all your tillage.

2. Have GPS on your tractors. Although we injected the tape in the ground using GPS technology, our tractors are not outfitted with GPS. We thought we could easily track the location of the drip tape by eye, using the mounded up rows as a guide. This has proven harder than we expected, particularly when the zones have thick cover crops.

3. Install a Zetacore catalytic water treatment device to prevent scale.

4. Regularly use hydrogen peroxide to clean your drip and system lines.

5. Do not use the system to inject fertilizers. Use alternate organic methods for fertilization.

6. Flush the lines at the ends with every watering event.

7. In the height of the season, when iron algae is prevalent, pour hydrogen peroxide into your water containment box, or use a dripper.

8. Install a prefilter or sand extractor before the sand media filters.

9. Use 15-17 mil tape so you can flush periodically at high pressures.

10. Write a detailed Maintenance Schedule and stick to it- regular maintenance is key.

11. Use acetic acid to lower the ph of the water.

12. Routinely test your water and soil so you know what you are dealing with.

13. Backflush at a high flow rate, washing out a small amount of sand each time. Keep an eye on sand levels (in the sand media filters) and replace as necessary.

CONCLUSIONS

We have operated our 16 acre subsurface drip system for 3 growing seasons under NOP organic standards and have had great success. We have had no plugging of the emitters to date and no major problems with the system. The greater challenge has been to modify our tillage practices to not damage the buried drip tape. We are now an "organic no-till" operation and this has already resulted in dramatically improved soil. We are currently working with the USDA to measure the effects of no-till and to date results are encouraging. Our "active carbon" component in the soil has doubled over the 3 years we have been doing this.

The biggest challenge is not having GPS technology on our tractors and the consequent repairs we must make when we damage the drip lines. But we are learning...

For further information contact Minor Morgan at (505) 379-1640.

Rio Grande Community Farm farms 50 acres of public land "for the public benefit" on land managed by the Open Space Division of the Parks and Recreation Department of the City of Albuquerque. Visit www.riograndefarm.org for information about our non-profit farm

Report prepared 11/1/2012 by Minor Morgan.