2005 IA Technical Presentation

By: Wayne E. Eckas, P.E.
Aqua Engineering, Inc.

Kent Lusk
Producer

Title: Case Study: Subsurface Drip Irrigation in Southeastern Colorado

Four years of drought and more restrictive ground water pumping regulations from the State Engineer forced Kent Lusk of Rocky Ford, Colorado to evaluate his current farming operation. The extended drought in the Arkansas River Valley resulted in little or no surface irrigation water. During this same time, the State of Colorado increased the restrictions on the pumping of well water by more closely regulating ground water augmentation plans. Lusk was faced with leaving previously irrigated land fallow, converting irrigated land to dryland, or improving the efficiency and effectiveness of his irrigation practices. As a matter of survival, Kent chose the latter.

Lusk installed his first 66 acres of SDI in 2003. With the help of the Natural Resources Conservation Service (NRCS) Environmental Quality Incentives Program (EQIP) cost share program Lusk has installed an additional 29 acres in 2004, and 33 acres in 2005 with plans to install another 43 acres in the next year or two.

The NRCS EQIP was authorized in the Farm Security and Rural Investment Act of 2002 (Farm Bill) to provide a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals. EQIP offers financial and technical help to assist eligible participants install or implement structural and management practices on eligible agricultural land. EQIP may cost share up to 75 percent of the cost of certain conservation practices. All conservation practices must be planned and implemented per NRCS standards. The local conservation district is responsible for approving the plan.

As Lusk reviewed irrigation options to replace his current flood irrigation system and practices for improved irrigation efficiency, he quickly narrowed in on Subsurface Drip Irrigation (SDI). Since his farm was leveled to accommodate furrow irrigation, and all of the fields were rectangular in shape, SDI fit the best. Overhead irrigation, either through a solid set or center pivot/lateral move system, was ruled out due to the potential mold and fungus problems with melon crops. In addition, the layout of his farm did not work well with the constraints of a center pivot or lateral move system. His farm would have required at least three center pivot/lateral move systems to irrigate most of the 171 acres he is currently irrigating, or planning to irrigate, with SDI. Also, given the variety of crops grown by Lusk, including melons, onions, peppers, tomatoes, corn, alfalfa, beans, and small grains, the SDI system allows for more control of water, and nutrient application, as well as other farming operations.

As Lusk stated "Installing SDI is like buying the farm all over again. It is expensive. The NRCS EQIP program has really helped financially". The NRCS EQIP cost share helped Lusk to install more of his farm acreage under SDI in a shorter time frame than he could have on his own. His total acreage under SDI will be 171, with 105 acres installed with the help of the EQIP program. Lusk applied for EQIP in 2002 and was approved for a 50% cost share per the program that was in place at the time. As part of the Colorado NRCS requirements system design drawings must be developed by a registered Professional Engineer or NRCS Technical Service Provider (TSP) and approved prior to installation.

In addition to water savings, Lusk hoped to realize improved crop yields and quality, reduced fertilizer application, and a reduction in disease and pest problems. He couldn't be more pleased with the results. Water savings has been impressive. For example, 3 to 4 acre-ft of water was required for each acre of melons using flood irrigation. Currently, Lusk is using about 1 acre-ft per acre with the SDI system. Fertilizer applications have been reduced by 30 %. Crop yields have improved by at least 40% across the board. The quality of the produce has also improved, especially the melon crops. Lusk credits the use of SDI, along with plastic mulch, as the reason the number of melons with ground spots or worms has decreased dramatically, while the percentage of No. 1 melons has increased.

Although the results have been outstanding, some concerns were, and still are, in the back of Lusk's mind regarding SDI. His concerns include salt build up in the soil profile and seed germination. To keep the potential salt build up in the soil due to the high TDS water in check, Kent is having soil and water chemisty analysis completed each year to help him develop a management plan. He is also injecting sulfuric acid into the water to lower the pH. Reducing the water pH has also lowered the soil pH which has improved the soil structure.

Lusk has also kept his old gated pipe around, and has installed risers on the SDI system mainline so he can flood irrigate if needed to leach salts beyond the root zone of the crops. So far, neither the salinity or germination has been a problem, but he is keeping a close eye on both. For the most part, germination has not been a problem either. To ensure complete germination for onions, which are very costly to plant, Lusk has flood irrigated after planting to help the onion seeds in the outer edge of the planting beds germinate.

Lusk also indicated that there is a definite "learning curve" with SDI. Due to the small emitter outlets, keeping a handle on filtration and water chemistry is vital to the long term success of the system. Lusk flushes each SDI zone every two to three weeks. Flushing helps him track changes in the appearance of the water being flushed through the system. He also checks the filter and monitors pH daily. This year for example, he began noticing a black precipitate in the flush water. Upon closer inspection, some of the tubing was beginning to plug. He is working with a drip product supplier to change his chemical injection program to solve the plugging problem. Lusk has leaned that water chemistry can change from year to year and you have to continuously monitor the operation of the system to keep small problems from becoming huge. You can't start the system in the spring and walk away, you have to continuously monitor and maintain the system to keep the system working.

Survival forced Kent Lusk to review his farming operation. Although he set out to save water, in the end he found saving water can result in many other benefits including increased yields, higher quality crops, lower fertilizer input, and a better overall environment. In short, his family farming operation is healthier and better poised to compete down the road due to the implementation of SDI technology and the help of the NRCS EQIP program.

SYSTEM DESIGN, SPECIFICATION, AND INSTALLATION

A 105 acre SDI was designed under the NRCS EQIP program. The 105 acres to be installed under the NRCS cost share program was designed to properly work with the existing 66 acres installed by Lusk prior to the NRCS involvement.

The 105 acres of crop land to be irrigated is broken into 9 different fields. All of the fields are currently flood irrigated with gated pipe or siphon tubes. The system will be designed with the following mix of crops, 50% vegetables, 20% alfalfa, and the remaining 30% in either dry beans, wheat, soybeans, or a combination of the three.

Water Requirements

The irrigation water requirements for these systems has been estimated using the procedures outlined in Chapter 2, Part 623 of the National Engineering Handbook. More specifically, the SCS Technical Release No. 21 was utilized to estimate the irrigation water requirements.

Assuming the crop mix as noted above, 20% of the land will be planted to alfalfa, 50% to vegetables, and 30% in dry beans, wheat, soybeans, or a combination of the three. The water requirements for dry beans were used in the calculations. The peak season water requirements for dry beans is higher than that calculated for soybeans or wheat so the water requirements for dry beans were used in the table.

Table 1 presents the peak system requirements assuming a normal, or average, rainfall. Average rainfall is assumed to have a probability of occurring 5 out of 10 years. Table 2 presents the irrigation water requirements for a dry year. A dry year is assumed to be the level of rainfall that can be expected 8 out of 10 years. The SCS Technical Release 21 was followed to estimate the dry year rainfall.

TABLE 1 Lusk Farm Estimated Monthy Water Use Normal Year (50% Chance)										
Crop Mixture	**Alfalfa** Acres----->		21	**Vegetables** Acres----->		52.5	**Dry Beans** Acres----->		31.5	**Totals** 105.00 Acres
	Net Irrig/Re In/day	GPM/ Acre	Crop Flow GPM	Net Irrig in/day	GPM/ Acre	Crop Flow GPM	Net Irrig in/day	GPM/ Acre	Crop Flow GPM	System Flow GPM
Month										
March	0.04	0.83	17							17
April	0.08	1.83	38							38
May	0.14	3.26	69	0.02	0.55	29	0.05	1.11	35	132
June	0.25	5.67	119	0.13	2.97	156	0.19	4.37	138	413
July	0.26	5.93	125	0.18	4.07	214	0.26	6.07	191	529 **Peak Flow**
August	0.22	5.10	107	0.16	3.58	188	0.15	3.40	107	402
September	0.15	3.50	73							73
October	0.07	1.64	34							34

TABLE 2 Lusk Farm Estimated Monthy Water Use Dry year (80% Chance)										
Crop Mixture	**Alfalfa** Acres----->		21	**Vegetables** Acres----->		52.5	**Dry Beans** Acres----->		31.5	**Totals** 105.00 Acres
	Net Irrig/Re In/day	GPM/ Acre	Crop Flow GPM	Net Irrig in/day	GPM/ Acre	Crop Flow GPM	Net Irrig in/day	GPM/ Acre	Crop Flow GPM	System Flow GPM
Month										
March	0.04	0.97	20							20
April	0.09	2.02	42							42
May	0.16	3.57	75	0.04	0.82	43	0.06	1.38	43	162
June	0.26	5.95	125	0.14	3.21	168	0.20	4.61	145	439
July	0.28	6.36	134	0.19	4.46	234	0.28	6.46	203	571 **Peak Flow**
August	0.24	5.41	114	0.17	3.88	203	0.16	3.70	117	434
September	0.16	3.66	77							77
October	0.08	1.74	37							37

A flow of 529 gpm will be required to met peak ET demands for the 105 acres of crops assuming normal rain fall and a flow of 571 gpm is required assuming a dry year. These calculations assume that all of the water lost to ET is replaced by the irrigation system each month, and that the soil moisture level is not depleted month to month.

Assuming the existing 66 acres of SDI will have a similar crop mixture, the flow required to irrigated the entire 171 acres of SDI will be 529 gpm + 529 gpm x 66/105 = 861 gpm assuming normal precipitation and 571 + 571 x 66/105 = 929 gpm assuming a dry year. Again, these calculations assume that all of the water lost to ET is replaced by the irrigation system each month, and that the soil moisture level is not depleted month to month.

Using water stored in the crop root zone is a valid management tool to reduce the peak season irrigation requirement for many crops. The use of a Management Allowed Deficit

(MAD) of 50% is typical and will be used to calculate a reduced system flow requirement.

The MAD is based upon the crop rooting depth, and the water holding capacity of the soil. Per the Otero County Soil survey the three main soils at the Lusk farm are:

Kornman & Neesopah (KnA) loam, with a water holding capacity of 1.32 to 2.40 inches per foot of soil.

Olney (OnA) Sandy Clay Loam, with a water holding capacity of 1.32 to 2.16 inches per foot of soil.

Numa (Nma) clay-loam, with a water holding capacity of 1.68 to 2.52 inches per foot of soil.

A conservative water holding capacity of 1.32 inches per foot of soil will be used to calculate peak system flow with a MAD of 50%. Tables 3 and 4 calculate the monthly water requirement and peak system flow assuming a MAD of 50%. Table 3 describes water requirements based upon normal precipitation, and Table 4 assumes a dry year precipitation.

TABLE 3
Lusk Farm
Estimated Monthy Water Use with Management Allowed Deficit Irrigation (MAD)
Normal year (50% Chance)

Crop Mixture	Alfalfa					Vegetables					Dry Beans					Totals
			Acres----->		21			Acres----->		52.5			Acres----->		31.5	105.00 Acres
	Root depth			5 ft		Root depth			3 ft		Root depth			3 ft		
	Water Holding Capacity			1.32 in/ft		Water Holding Capacity			1.32 in/ft		Water Holding Capacity			1.32 in/ft		
	MAD			50 %		MAD			50 %		MAD			50 %		
	Soil Reservoir			3.3 Inches		Soil Reservoir			1.98 Inches		Soil Reservoir			1.98 Inches		
	Maximum Net Irrigation Application, In/day				0.21	Maximum Net Irrigation Application, In/day				0.14	Maximum Net Irrigation Application, In/day				0.2	**System Flow**
	Flow, GPM per Acre				5.15	Flow, GPM per Acre				3.43	Flow, GPM per Acre				4.90	
	Total Crop Flow, GPM				108	Total Crop Flow, GPM				180	Total Crop Flow, GPM				154	443 GPM
	Net Irrig Req'd In/day	Days Irrig Days/mo	Net Irrig Req'd In/Month	Max. Irrig Applied In/Month	Deficiet In/Mo	Net Irrig Req'd In/day	Days Irrig Days/mo	Net Irrig Req'd In/Month	Max. Irrig Applied In/Month	Deficiet In/Mo	Net Irrig Req'd In/day	Days Irrig Days/mo	Net Irrig Req'd In/Month	Max. Irrig Applied In/Month	Deficiet In/Mo	
Month																
March	0.04	20.00	0.72	4.20	0.00											
April	0.08	30.00	2.39	6.30	0.00											
May	0.14	31.00	4.40	6.51	0.00	0.02	15.00	0.36	2.10	0.00	0.05	15.00	0.72	3.00	0.00	
June	0.25	30.00	7.40	6.30	-1.10	0.13	30.00	3.87	4.20	0.00	0.19	30.00	5.70	6.00	0.00	
July	0.26	31.00	8.00	6.51	-1.49	0.18	31.00	5.48	4.34	-1.14	0.26	31.00	8.18	6.20	-1.98	
August	0.22	31.00	6.88	6.51	-0.37	0.16	31.00	4.82	4.34	-0.48	0.15	24.00	3.55	4.80	0.00	
September	0.15	30.00	4.56	6.30	0.00											
October	0.07	13.00	0.93	2.73	0.00											
	Cumulative Deficit Irrigation, Inches--->				-2.95	Cumulative Deficit Irrigation, Inches--->				-1.62	Cumulative Deficit Irrigation, Inches--->				-1.98	

TABLE 4
Lusk Farm
Estimated Monthy Water Use with Management Allowed Deficit Irrigation (MAD)
Dry Year (80% Chance)

Crop Mixture	Alfalfa					Vegetables					Dry Beans					Totals
				Acres----->	21				Acres----->	52.5				Acres----->	31.5	105.00 Acres
	Root depth			5 ft		Root depth			3 ft		Root depth			3 ft		
	Water Holding Capacity			1.32 in/ft		Water Holding Capacity			1.32 in/ft		Water Holding Capacity			1.32 in/ft		
	MAD			50 %		MAD			50 %		MAD			50 %		
	Soil Reservoir			3.3 Inches		Soil Reservoir			1.98 Inches		Soil Reservoir			1.98 Inches		
	Maximum Net Irrigation Application, In/day				0.22	Maximum Net Irrigation Application, In/day				0.15	Maximum Net Irrigation Application, In/day				0.22	System Flow
	Flow, GPM per Acre				5.39	Flow, GPM per Acre				3.68	Flow, GPM per Acre				5.39	
	Total Crop Flow, GPM				113	Total Crop Flow, GPM				193	Total Crop Flow, GPM				170	476 GPM
	Net Irrig Req'd In/day	Days Irrig Days/mo	Net Irrig Req'd In/Month	Max. Irrig Applied In/Month	Deficiet In/Mo	Net Irrig Req'd In/day	Days Irrig Days/mo	Net Irrig Req'd In/Month	Max. Irrig Applied In/Month	Deficiet In/Mo	Net Irrig Req'd In/day	Days Irrig Days/mo	Net Irrig Req'd In/Month	Max. Irrig Applied In/Month	Deficiet In/Mo	
Month																
March	0.04	20.00	0.84	4.40	0.00											
April	0.09	30.00	2.63	6.60	0.00											
May	0.16	31.00	4.82	6.82	0.00	0.04	15.00	0.54	2.25	0.00	0.06	15.00	0.90	3.30	0.00	
June	0.26	30.00	7.76	6.60	-1.16	0.14	30.00	4.18	4.50	0.00	0.20	30.00	6.01	6.60	0.00	
July	0.28	31.00	8.58	6.82	-1.76	0.19	31.00	6.01	4.65	-1.36	0.28	31.00	8.70	6.82	-1.88	
August	0.24	31.00	7.30	6.82	-0.48	0.17	31.00	5.22	4.65	-0.57	0.16	24.00	3.86	5.28	0.00	
September	0.16	30.00	4.77	6.60	0.00											
October	0.08	13.00	0.99	2.86	0.00											
	Cumulative Deficit Irrigation, Inches--->				-3.40	Cumulative Deficit Irrigation, Inches--->				-1.93	Cumulative Deficit Irrigation, Inches--->				-1.88	

Using a MAD of 50%, the required peak season system flow requirement is 443 gpm assuming normal precipitation, and 476 gpm assuming a dry year.

Assuming the existing 66 acres of SDI will have a similar crop mixture, the flow required to irrigated the entire 171 acres of SDI with a MAD of 50 % will be 443 gpm + 443 gpm x 66/105 = 721 gpm assuming normal precipitation and 476 + 476 x 66/105 = 775 gpm assuming a dry year.

Since adequate water is available, either from well water or a combination of well and canal water, it is recommended that the system be designed to provide a flow capacity of 929 gpm as calculated in Table 2. This assumes a dry year, and no deficit irrigation. This is a conservative system flow and will allow for some cropping pattern changes and calculated above.

A pump test was completed by a State of Colorado certified well tester in January of 2004. The produced a flow of 610 gpm, which is less than required flow to meet peak ET, with using a MAD of 50%. Lusk drilled a new replacement well in 2005. This well provides a flow of approximately 900 gpm, which is adequate as described above.

Water Quality

Water samples were sent to a qualified laboratory to test for all of the parameters required by the Colorado NRCS. The water was tested for Nitrogen as Nitrate, Chloride, Sulfate, Carbonate Calcium, Magnesium, Sodium, Potassium, Boron, Hydrogen Sulfide, Irion, Manganese, TSS, TDS, Total Solids, Hardness, Alkalinity, EC, SAR, pH, and a Total Bacteria plate count. In addition to this, a test was run to check for the presence of Iron Bacteria.

Based upon the results of the labor work, the following was noted about the well water. The salinity hazard for the water is medium, which may affect the growth of moderately sensitive crops. Leaching may be required to reduce the build up of salts in the root zone.

The leaching requirement was calculated using and EC for the irrigation water of 1.6, per the water quality testing analysis, and an EC of the soil of 2.4. The soil EC was estimated to be 1.5 x the irrigation water EC. At this level, a 5 percent leaching requirement is required. Assuming an EC of the soil of 1.8, the leaching requirement will be increased to 15 %. The NRCS CO-ENG-20 work sheet was used to determine the leaching requirement.

Based upon the water requirements for the crops planned, the 15% leaching requirement can be met for all months with the exception of July, during peak ET. From time to time, it may be necessary to flood irrigate the fields to help move the salt accumulations thru the soil profile. In all cases, the existing flood irrigation system can be used for this purpose.

The water pH was 7.38, which is within the acceptable pH range of irrigation water of 6.4 to 7.6 of an acceptable pH range.

Iron bacteria were present in the well test. Although the iron level is low, 0.1ppm, it is high enough to support the growth of iron bacteria in the system. The producer operated the system last year with out any problems from the iron bacteria. If a bacterial slime does develop, continuous chlorination is the recommended approach to the control of any bacteria within the system. An injection pump and tank s is recommended for chlorination of the system at the well. If precipitates become a problem from the injection of chlorine, a media filter may also be required. Chlorine should be injected to provide a continuous dosage of 0.5 – 1.5 ppm.

System Layout

The 105 acres of crop land to be irrigated with SDI is currently flood irrigated. The 105 acres is broken up into nine different fields. The producer has indicated a preference for each field to be broken up into 5 acre zones. Using 5 acres per zone as a guideline, the 9 fields have been further divided up into 20 zones ranging from 3.7 to 5.7 acres each.

The drip tape will be installed in 60-inch rows to accommodate current farming practices. The drip tape selected has a nominal flow of 0.3 gpm per 100’ at an operating pressure of 10-14 psi. Both 5/8” diameter and 7/8” diameter drip tape will be required depending on field slope, and row length. The tape operating pressure and diameter is specified to provide the minimum emission uniformity of 85% and a minimum flushing velocity of 1.5 ft. /second as required by current NRCS design standards. Refer to the attached drawing showing the layout and individual zone operating pressure, flow, and estimated flow during flushing.

Each zone has an estimated flow ranging from 104 to 149 gpm. All control valves are manually operated, 3-inch butterfly valves. Each valve is opened to provide the desired discharge pressure. A pressure gauge attached to a shrader valve located at each air relief valve just downstream of each control valve is used to measure operating pressure. The system has been designed to accommodate the future installation of automatic control valves.

The supply manifolds are 4-inch PVC CL160 pipe. In general, two control valves are located side by side in the field, thus reducing potential obstructions. The flush manifolds are 3-inch CL160 PVC pipe, with a flush valve located at each end. Air relief valves will be provided at end of each end of the supply manifold and flush manifold. Drain valves will be provided at the low end of each supply manifold and flush manifold.

The mainline is 80 PSI PVC pipe, and ranges from an 8-inch diameter to a 4-inch size. The mainline was sized to provide maximum flexibility in the management of the system. Installation depth is at a minimum of 30 inches. Gate valves are provided to allow isolation of sections of the system to assist in system winterization and maintenance. Manual drains will be provided at low points in the mainline, and air and vacuum relief valves will be located at all high points, tees, and ends.

Filtration And Pump Station

The existing screen filter has adequate capacity for the system. The 6-inch 200 mesh screen filter with a maximum flow capacity of 900 GPM is in place.

Two booster pumps are in place to provide the pressure required to efficiently operate the system. A 300 gpm, and a 600 gpm pump is in place. If one or two laterals are operated, the 300 gpm pump is used, if two to four laterals are operated the 600 gpm pump is operated, and if 5 or 6 laterals are operated both booster pumps must be operating.

The booster pumps have an electric interlock with the chemical injection pumps so that the chemical injection pumps only operate when the booster pump is operating.

Chemigation

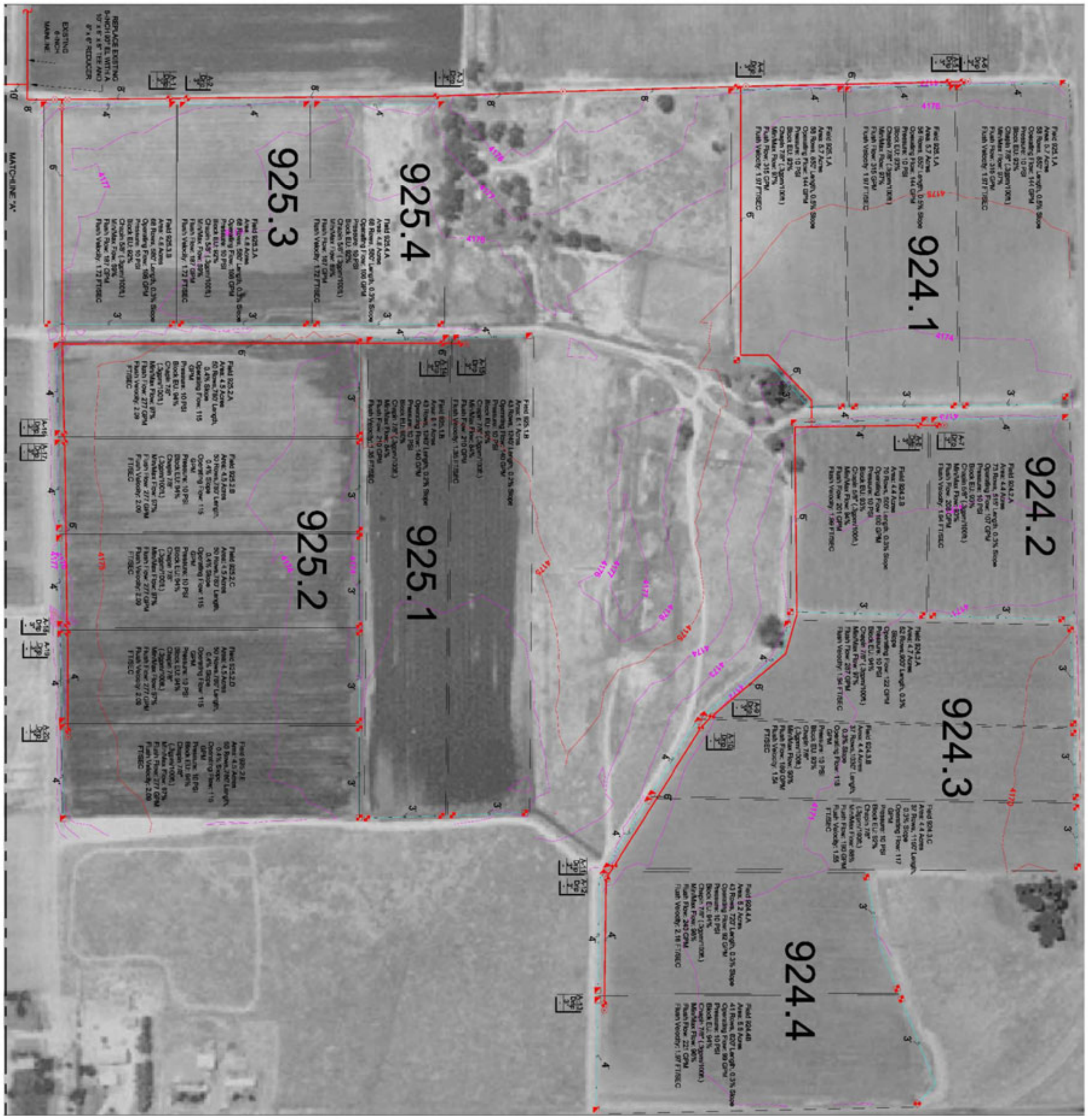
Chemigation is currently in place. The operator must maintain a current chemigation license from the State of Colorado, and the system must conform to all state requirements. A diagram and phone number for more information is attached.

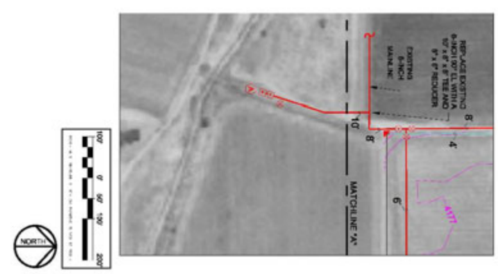
The producer currently injects acid into the system to reduce the pH of the water. He currently uses a pH test kit to adjust the injection rate of the acid to maintain the desired water pH.

The two other chemical injection pumps are for fertilizer. These pumps are adjusted to provide the desired application of fertilizer.

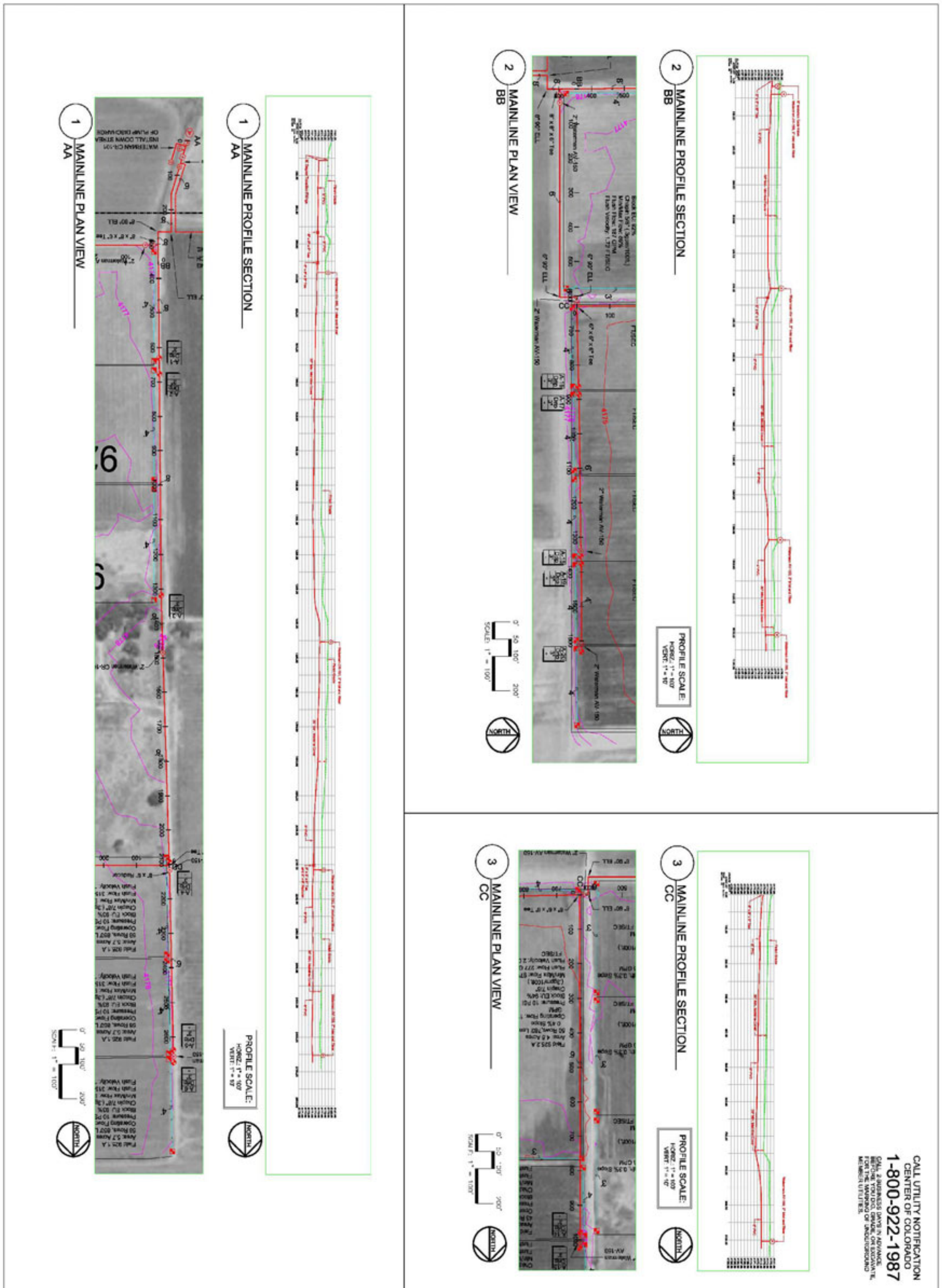
Design Drawings

The following are samples of the drawings developed for the SDI system installed at Lusks farm.

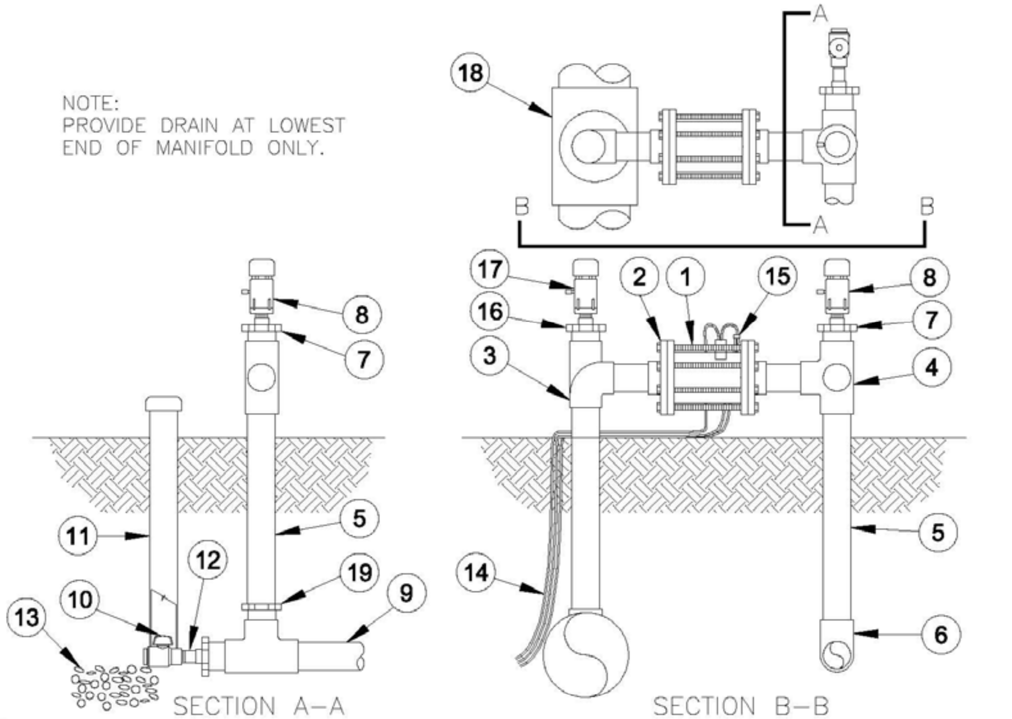




SHEET SD1	Aqua Engineering, Inc.	Kent Lusk Farm Sub Surface Drip Irrigation Layout Otero, Colorado	

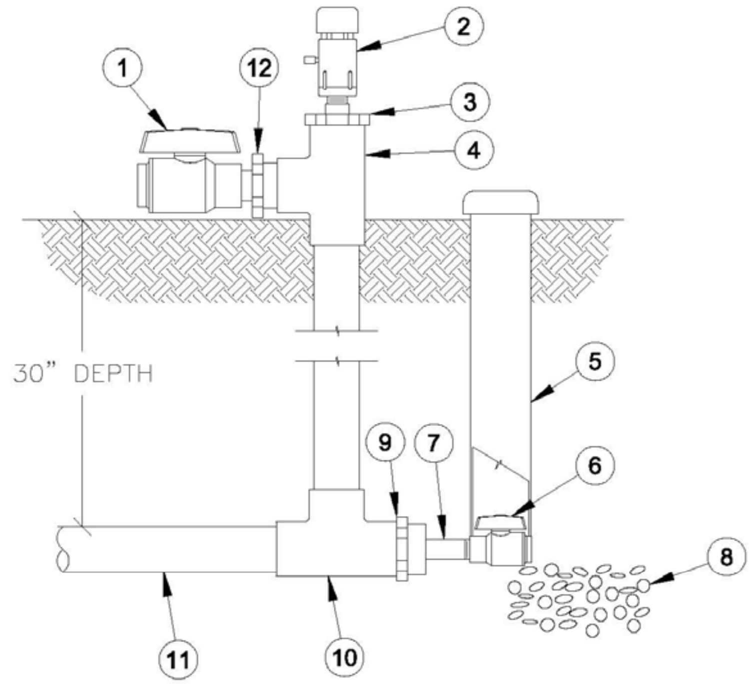


SHEET **SD2**	Aqua Engineering, Inc.	Kent Lusk Farm Mainline Plan and Profile Otero, Colorado	DESIGNED BY: WEE DRAWN BY: WJW CHECKED BY: WEE REVISIONS:



1. WAFER STYLE CONTROL VALVE: NELSON 800 SERIES
2. PVC SCH 80 FLANGE SOLVENT WELD
3. PVC SCHEDULE 40 90° ELL OR TEE IF AIR VACUUM RELIEF VALVE IS REQUIRED ON MAINLINE
4. PVC SCH 40 TEE
5. PVC CL 160 PIPE, SIZE TO MATCH CONTROL VALVE SIZE
6. PVC SCH 40 TEE OR ELL, SIZE TO MATCH MANIFOLD. PROVIDE REDUCING TEE OR ELL IF NEEDED
7. PVC REDUCING BUSHING WITH 1–INCH FEMALE THREADS
8. AIR VACUUM RELIEF VALVE WITH SCHRADER VALVE: AG PRODUCTS APVV–1
9. SUPPLY MANIFOLD
10. 1–INCH PVC SCH 40 BALL VALVE
11. 3–INCH PVC SLEEVE WITH CAP
12. 1–INCH DIAMETER PVC SCH 80 NIPPLE
13. GRAVEL SUMP
14. CONTROL AND COMMON WIRE
15. WATER PROOF CONNECTOR
16. PVC SCH 40 REDUCER BUSHING WITH 2–INCH OUTLET AND 2–INCH PVC SCH 80 THREADED NIPPLE
17. AIR AND VACUUM RELIEF VALVE. SEE PLANS.
18. PVC 80 PSI TEE OR ELL. OUTLET TO MATCH VALVE SIZE.
19. PVC REDUCER BUSHING, SIZE TO MATCH MANIFOLD AND CONTROL VALVE

DATE: 04–20–04	Aqua Engineering, Inc.	SDI CONTROL VALVE ASSEMBLY	DESIGNED: WEE
SHEET: **Lusk-2**	Irrigation System Design, Water Management, and Water Feature Engineering 4803 Innovation Drive Fort Collins, Colorado 80525 Phone (970) 229–9668, FAX (970) 229–3855		DRAWN: CAM CHECKED: WEE REVISION:



1. FLUSH VALVE: 2-INCH SIZE
2. AIR VACUUM RELIEF VALVE WITH SCHRADER VALVE: AGRICULTURAL PRODUCTS APVV-1
3. PVC SCH 40 BUSHING: SIZE TO MATCH PVC SCH 40 TEE WITH 1-INCH FPT FOR AIR VACUUM RELIEF VALVE
4. PVC SCH 40 TEE: SIZE TO MATCH MANIFOLD PIPE
5. 3-INCH PVC PIPE WITH CAP
6. PVC SCH 40 BALL VALVE: SIZE 1-INCH
7. 1-INCH PVC SCH 80 NIPPLE
8. SUMP OF 3.0 CUBIC FEET OF 3/4-INCH WASHED GRAVEL
9. PVC SCH 40 BUSHING: 3-INCH SPIG x 1-INCH FPT
10. SCH 40 PVC TEE
11. PVC CL 160 PIPE: SIZE PER PLANS
12. REDUCER BUSHING, SIZE TO MATCH TEE WITH 2-INCH FPT

NOTE:
INSTALL DRAIN AT LOW END OF MANIFOLD ONLY. DRAIN VALVE IS NOT REQUIRED AT EACH END.

DATE: 04-20-04	Aqua Engineering, Inc. Irrigation System Design, Water Management, and Water Feature Engineering. 4803 Innovation Drive, Fort Collins, Colorado 80525, Phone (970) 229-9668, FAX (970) 226-3855	MANIFOLD FLUSH VALVE ASSEMBLY (SUPPLY AND FLUSH)	DESIGNED: WEE DRAWN: CAM CHECKED: WEE REVISION:
SHEET: **Lusk-3**			