# Field Optimization of FlowControl Drip Tapes for Superior Performance and Profitability

For presentation at The Irrigation Association Convention, November 2017, Orlando, FL

Inge Bisconer, Technical Marketing and Sales Manager, MBA, CID, CLIA, Toro Ag, El Cajon, CA inge.bisconer@toro.com

Sky Anderson, Product Manager, MBA, Toro Ag, El Cajon, CA sky.anderson@toro.com

Jim Klauzer, Agronomist, Clearwater Supply, Ontario, Oregon jim@cwsupply.com

**Abstract.**

The Toro Company released Flow Control Emitters to the marketplace in 2015, and is now pleased to report published results detailing how commercial agricultural operations in the Americas have optimized FlowControl™ drip tapes to achieve superior performance and profitability in row crop applications.

As noted in IA/ASABE Paper Number 2144972, Flow Control emitters possess a unique flow exponent of 0.3. Flow Control emitters in FlowControl drip tapes deliver superior drip system uniformity when compared to turbulent flow drip tapes and driplines with flow exponents of approximately 0.5. At the same time, unlike pressure-compensating driplines with a flow exponent of 0, the drip system application rate may be adjusted with FlowControl drip tapes by increasing or decreasing system pressure. This feature is especially critical during extreme weather conditions or periods when water deliveries become challenging or altered – both of which are becoming more common. Finally, FlowControl drip tapes are available in more-affordable 5/8-inch 6 mil and 7/8-inch 8 mil wall thickness, and are priced the same regardless of emitter spacing. Since closely spaced emitters are often preferred to achieve superior wetting patterns, the price point helps optimize results without being cost-prohibitive.

Keywords: drip, irrigation, tapes, flow, pressure, emitters, uniformity.

**Introduction:**

This paper reports how well-known growing operations in the Americas optimized irrigation system performance, efficiency and farm profitability using FlowControl drip tapes. These experiences include using FlowControl drip tapes to achieve superior drip system uniformity in both normal and challenging terrain; to achieve superior drip system uniformity in blocks with hilly terrain and long lengths of run, without the expense and logistical complexity of installing extra submains and/or jumpers (small diameter tubes which reduce pressure and flow variation in severe slopes); to increase yield and quality versus ordinary drip tapes; to optimize initial

wetting patterns for near-perfect germination and plant-setting conditions; and to simplify and reduce costs of block designs where water deliveries and/or availability are significantly reduced during critical times of the growing season. In addition, commentary from academia regarding the significant value of FlowControl drip tapes to irrigated agriculture are included, as well as how AquaFlow drip irrigation design software may be used to compare drip system uniformities using FlowControl drip tapes versus ordinary drip tapes.

As noted in IA/ASABE Paper Number 2144972, Flow Control emitters possess a unique flow exponent of 0.3. This results in better irrigation system emission uniformity (EU) when compared to turbulent flow drip tapes and driplines with flow exponents of ~ 0.5 (see Figure 1). When compared to pressure-compensating driplines with a flow exponent of 0, FlowControl drip tapes allow growers to significantly adjust system application rates by increasing or decreasing system pressure (see Figure 2). This feature is especially critical during extreme weather conditions or periods when water deliveries become challenging or altered, both of which are becoming more common.

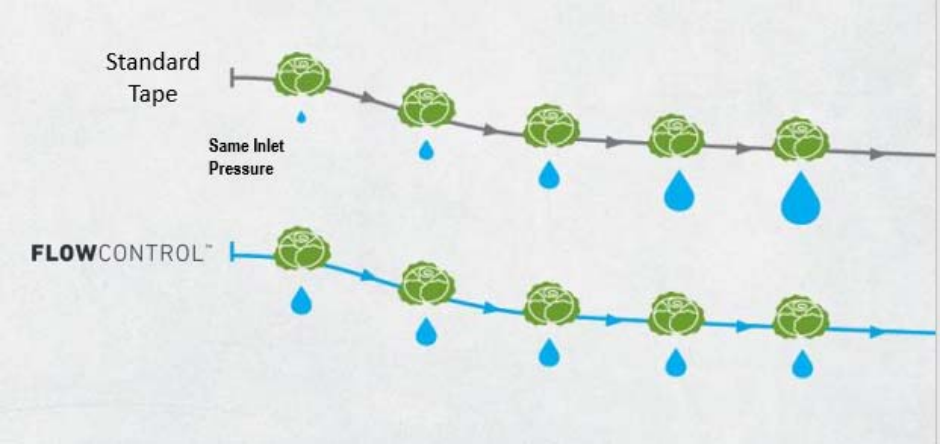



*Figure 1: FlowControl drip tapes, which have a flow exponent of 0.3, provide better uniformity than standard drip tapes, which have a flow exponent of ~0.5.*

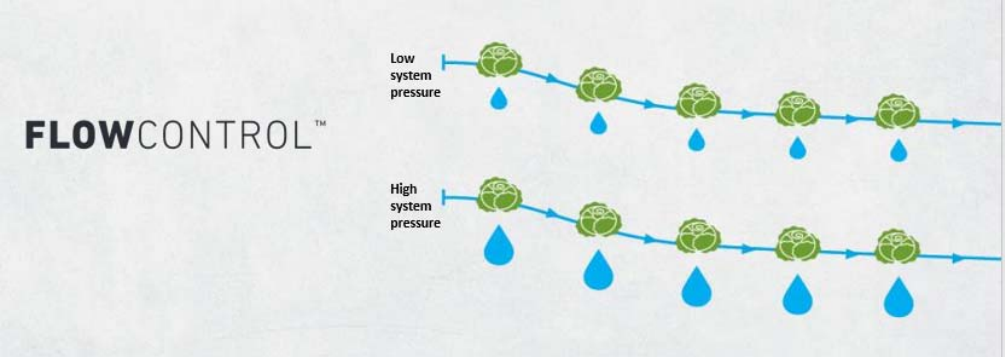



*Figure 2: Unlike pressure-compensating driplines where the application rate is fixed, the application rate of FlowControl drip tapes may be increased or decreased by adjusting pressure. This is important to accommodate changing weather and water availability conditions.*

**Using FlowControl to succeed in challenging terrain**

Irrigating uneven, sloped, or hilly terrain is a challenge because low elevations typically are overwatered and high elevations are underwatered. Uneven water distribution often results in disease and poor crop health, and ultimately, poor crop yield, poor crop uniformity and, in vegetables, poor crop quality. Until recently, challenging terrain was often avoided, was addressed with expensive pressure compensating driplines, extra submains or "jumpers", or poor uniformity was simply accepted. Jumpers refers to the practice of inserting smaller diameter tubes in severely sloped tape runs to reduce excessive pressure gain (see Figure 3 and Figure 4).

*Figure 3: The term "jumpers" refers to the practice of inserting small diameter tubes in tape runs to reduce pressure buildup on extremely sloped terrain. Photo courtesy of Jim Klauzer, Clearwater Supply.*

*Figure 4: The use of jumpers on sloped terrain is labor intensive and results in crop damage where the jumpers are installed. Photo courtesy of Jim Klauzer, Clearwater Supply.*

But each of these responses has severe limitations in view of changing market demands, weather patterns, and resource availability:

1. Avoiding challenging terrain is simply a luxury we can no longer afford since there is intense competition for less challenging terrain for purposes such as housing;
2. Accepting poor drip system uniformity is not only financially undesirable but increasingly illegal due to resulting ground and surface water contamination and subsequent regulatory pressures; and
3. Pressure-compensating driplines are
    a. Cost prohibitive because they are only available in expensive, heavier wall thicknesses, and they are priced by the emitter rather than by the foot, making highly desirable closely-spaced emitters expensive, and
    b. Less flexible because they deliver the same amount of water regardless of pressure, thus the system application rate is fixed and can never be adjusted by increasing or lowering pressure to accommodate heat spells or changes in water supply availability. This is a major drawback because this fixed output does not allow for variable conditions that commonly occur for agricultural growers.

4. Using extra submains and/or jumpers increases initial purchase cost, labor and crop damage, and impedes maintenance flushing.

By using FlowControl drip tapes, these challenges may be better met because:

1. FlowControl, with a flow exponent of 0.3, will always provide better uniformity than ordinary drip tapes with a flow exponent of ~0.5.
2. FlowControl application rates may be increased or decreased by adjusting pressure unlike pressure-compensating driplines.
3. FlowControl is available in a wider range of wall thicknesses than pressure-compensating driplines – including more affordable ⅝-inch 6-mil and ⅞-inch 8-mil
4. FlowControl is a cost effective alternative to using extra submains and/or jumpers.

The following case studies provide more detail on these benefits:

- **Trevor Hardy, Brookdale Fruit Farm, Hollis, NH** - "We've seen firsthand how FlowControl helps increase yield and quality. Over the past two years, we have tested it and seen it significantly improve our crops' health, especially in challenging terrain. FlowControl delivers a more uniform crop and higher yields in areas that were once impractical to farm. We've even reduced our pre-plant fertilizer costs, thanks to the improved uniform distribution it offers with fertigation. FlowControl's benefits became especially apparent to us this year – during a major drought we were consistently able to achieve uniformity on long irrigated plasticulture rows."

- **Jim Klauzer, Clearwater Supply, Ontario, OR** - "I have never seen such a fine wetting pattern under such conditions (see Figure 5). In the past we would have had to feed the tape from each side into the swale in an attempt to improve the wetting pattern. This would be expensive and labor-intensive to provide bi-directional water application to a single zone. The benefits of eliminating jumpers and improving uniformity with FlowControl in difficult layout and terrain conditions is better yield and quality, lower fertilizer and water costs, lower system cost, elimination of crop damage from jumper installation, and the ability to properly flush the irrigation system which is impossible with the constriction that jumpers create." (See Figures 6 and 7).

*Figure 5: The wetting pattern on severely sloped terrain is near perfect using FlowControl drip tape. Photo courtesy of Jim Klauzer, Clearwater Supply.*

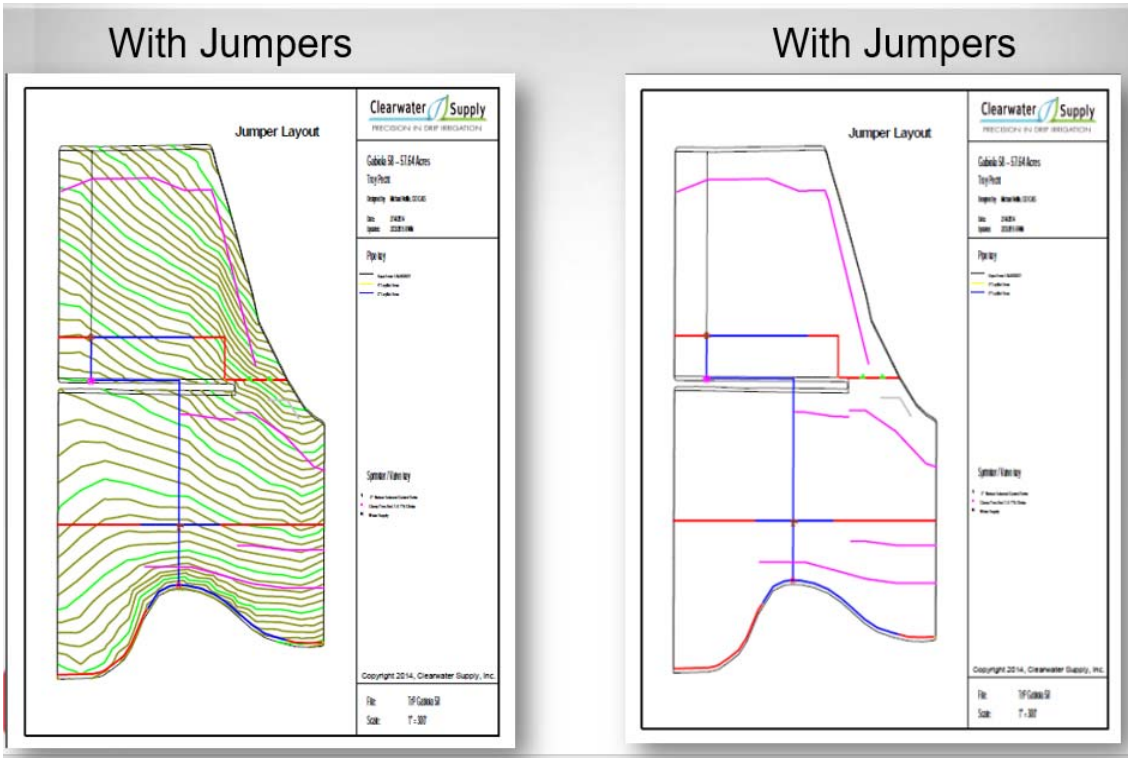



*Figure 6: Topographical map of a field to be irrigated with ordinary drip tape (flow exponent of ~0.5) showing submains in blue and orange, and where jumpers will have to be installed, shown in pink, to reduce pressure buildup on extreme slopes. The use of jumpers significantly increases labor costs, causes field damage, and prevents proper system flushing. Illustration courtesy of Randi Gladwell, Clearwater Supply.*

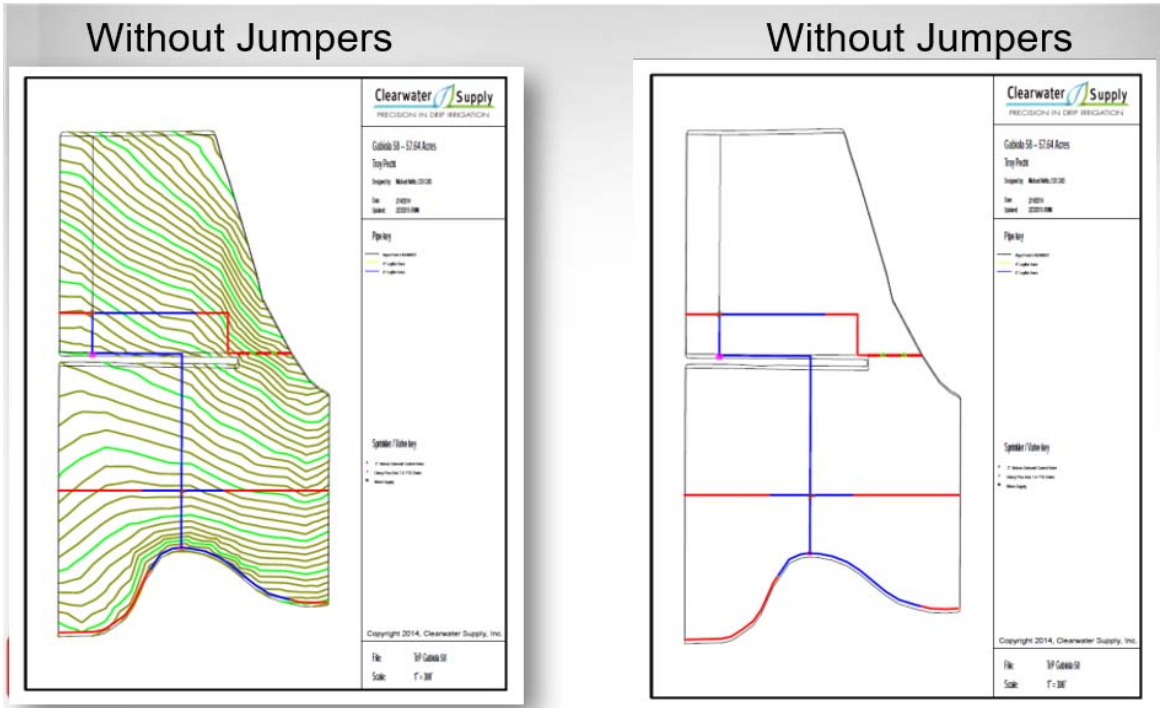



*Figure 7: Topographical map of a field to be irrigated with FlowControl drip tape showing submains in blue and orange. Note that jumpers are not necessary when FlowControl drip tape is used, significantly reducing costs and improving uniformity. Illustration courtesy of Randi Gladwell, Clearwater Supply.*

## Using FlowControl drip tapes to increase uniformity and yields vs. ordinary drip tapes

Ordinary drip tapes stress plants and reduce yield and efficiency by over- or under-watering as pressure changes throughout the field. As a result, water and fertilizer are wasted, and stressed plants reduce yields. Worse yet, challenging terrain isn't farmed at all, or extra expense is incurred installing submains, jumpers or pressure-compensating driplines. FlowControl provides better drip system uniformity than ordinary drip tapes, and is especially beneficial where long lengths of run and/or hilly terrain exist. With better drip system uniformity, improved crop quality and yields are the result.

- **Bianca Pérez-Lizasuain, Peninsula del Rio, Guayanilla, Puerto Rico** "The principal reason we use FlowControl is because our farm is not flat – a 5% to 10% slope. When we tried normal tape, the uniformity was not good. We tried splitting the lots and preparing the land better, but that didn't work. The only thing that improved our uniformity was moving to FlowControl. When we did, we saw the benefits right away – the irrigation and crop growth was uniform, fertilizer-use was better, and we could get longer runs. Before, our maximum run length was 300 feet. With FlowControl we are running 500 feet, which allowed us to eliminate a submain!"

- **Nolan Masser, Red Hill Farms Inc., Pitman, PA** "We wouldn't have moved to drip irrigation if it weren't for FlowControl. Standard drip tape just couldn't provide the results we needed on the slopes of our rolling and uneven terrain. FlowControl not only gives us the uniformity we need, but we've been able to get longer runs as well. Now we get the performance and the water- and energy-efficiency we need – that's what we like about it."

- **Greg Phillips, Oceano Packing Company, Oceano, CA** "With standard drip tape, we had to use up to 2 extra submains to irrigate the whole field. With FlowControl, we're getting longer runs so we can use just one submain. FlowControl is also giving us better uniformity – even in our steep sloping fields. Standard drip tape would under- or over-irrigate in areas."

- **Manuel Paz, Huntington Farms, Soledad, CA** "We are seeing more yield, and the uniformity improvement is visible. The wetting pattern at the beginning of the row is identical to the pattern at the end of the row. When water is equal from the beginning of the field to the end, this means the crop grows evenly and is higher quality."

## Using FlowControl drip tapes to adjust application rates without sacrificing uniformity

Farmers often wish to adjust the application rate of drip systems to quickly accommodate changing weather conditions and/or water availability. For instance, if a heat spell occurs, farmers may want to increase the application rate and apply the necessary water quicker rather than irrigate longer. Since the application rate of pressure-compensating driplines is fixed, farmers typically sacrifice uniformity and opt for the use of ordinary drip tapes whose application rates may be adjusted with pressure. With FlowControl, the application rate may

be increased or decreased by adjusting system pressure while at the same time providing better uniformity than ordinary drip tapes. In other words, FlowControl provides more uniform delivery of water and fertilizer while maintaining the flexibility to adjust application rates.

- **Jim Klauzer, Clearwater Supply, Ontario, OR** - "Using FlowControl, we have simplified the block designs and irrigation operation in areas where there are variable output wells and/or where there are temporary water restrictions from the ditch source, such as 25% decreases for a month in the summer. Before FlowControl was available, we would design systems to run in 3 sets when the normal 400 GPM was available from the source (Figure 8), and to run in 4 sets when the restricted 300 GPM was available during peak summer months (Figure 9). This design required extra submains, valves and operational complexity. After FlowControl drip tape became available, the system design was simplified (Figure 10) to run in 4 sets at **14 psi** when the normal 400 gpm was available, and to then run in 4 sets at **8 psi** when delivery flows were reduced. Operational time must increase to deliver a comparable amount of water at 8 psi vs. 14 psi, but this design is much simpler and much less costly than a 3-set and 4-set scenario."

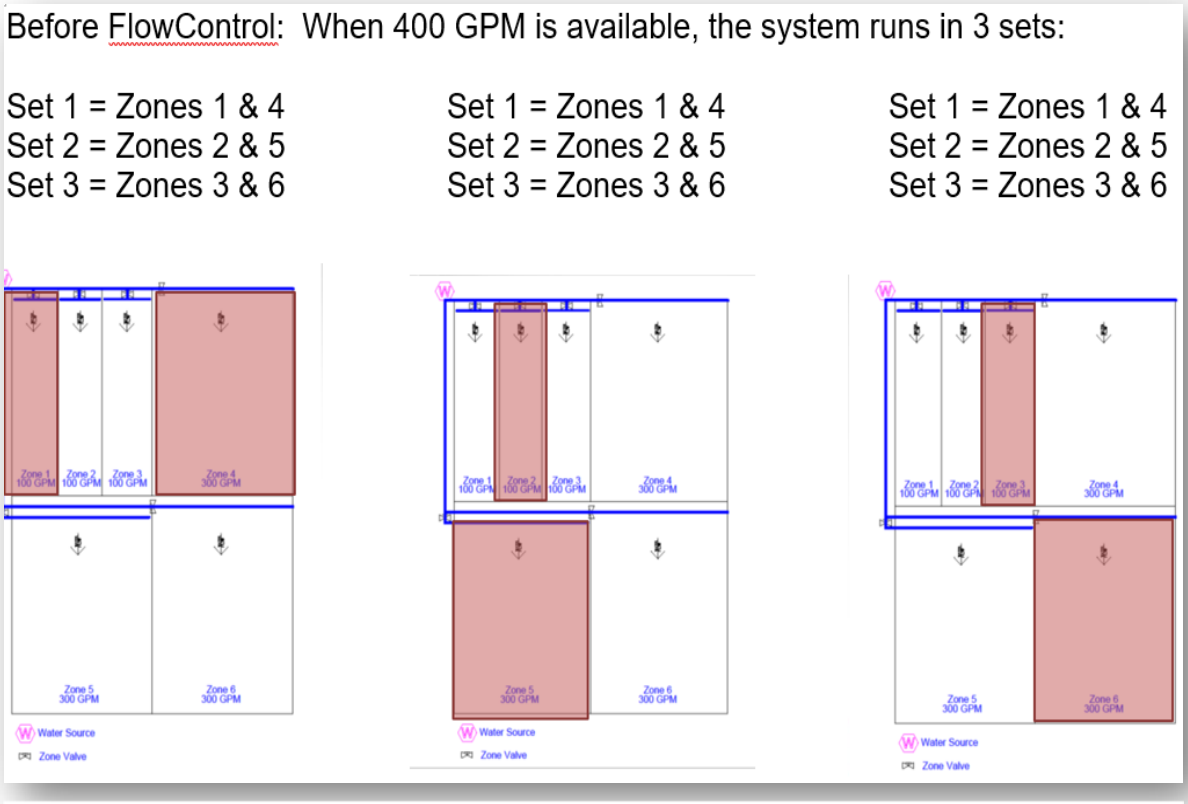



*Figure 8: Before the availability of FlowControl, systems were designed to run in 3 sets when the normal 400 gpm was available from the water source. Illustration courtesy of Randi Gladwell, Clearwater Supply.*

Before FlowControl: When 300 GPM is available, the system runs in 4 sets:

| | | | |
|---|---|---|---|
| Set 1 = Zones 1, 2 & | Set 1 = Zones 1, 2 & | Set 1 = Zones 1, 2 & | Set 1 = Zones 1, 2 & 3 |
| Set 2 = Zone 4 | Set 2 = Zone 4 | Set 2 = Zone 4 | Set 2 = Zone 4 |
| Set 3 = Zone 5 | Set 3 = Zone 5 | Set 3 = Zone 5 | Set 3 = Zone 5 |
| Set 4 = Zone 6 | Set 4 = Zone 6 | Set 4 = Zone 6 | Set 4 = Zone 6 |

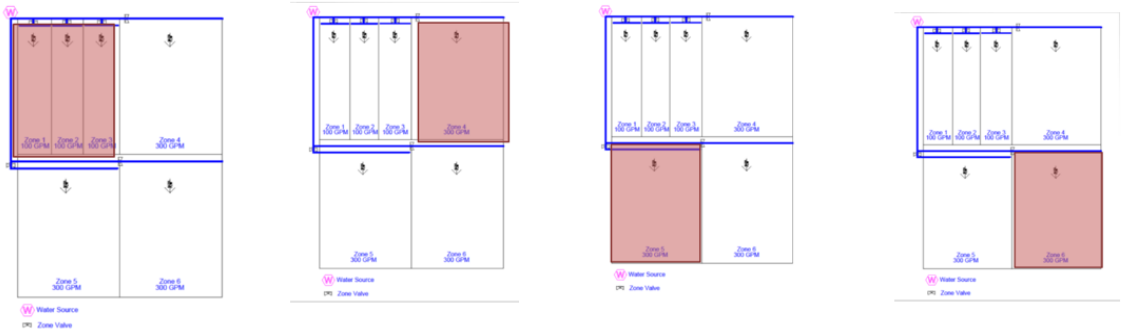
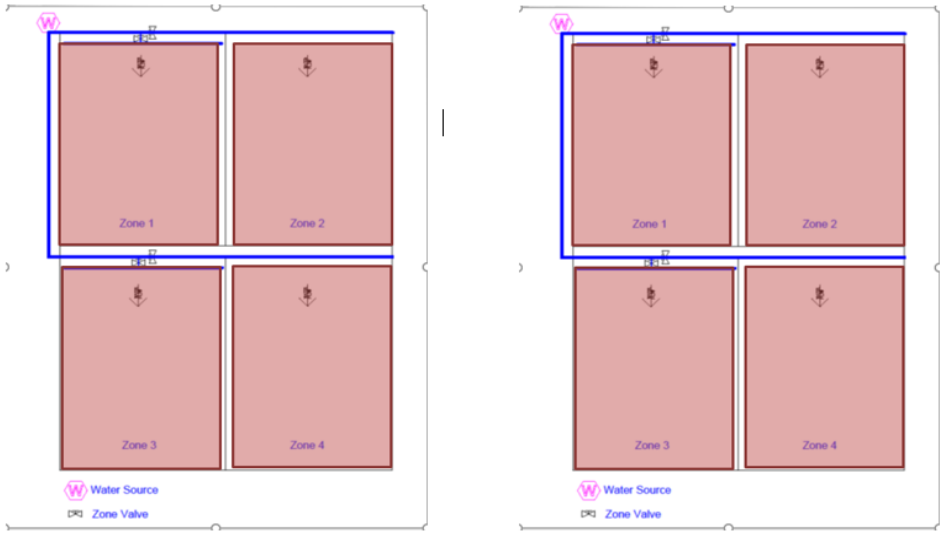


*Figure 9: Before the availability of FlowControl, the system was designed to run in 4 sets when only 300 gpm was available from the water source. Illustration courtesy of Randi Gladwell, Clearwater Supply.*

After FlowControl: When 400 gpm is available, the system runs as 4 sets at 14 psi, and when 300 GPM is available, the system runs as 4 sets at 8 psi.

| As 4 Sets at 14 PSI | As 4 Sets at 8 PSI |
|---|---|
| Set 1 = Zone 1 – 400 gpm | Set 1 = Zone 1 – 316 gpm |
| Set 2 = Zone 2 – 400 gpm | Set 2 = Zone 2 – 316 gpm |
| Set 3 = Zone 3 – 400 gpm | Set 3 = Zone 3 – 316 gpm |
| Set 4 = Zone 4 – 400 gpm | Set 4 = Zone 4 – 316 gpm |




Note: Operational Time must increase to deliver comparable amount of water as 14 PSI

*Figure 10: After FlowControl drip tapes became available, the system design was simplified to run in 4 sets at 14 psi when the normal 400 gpm was available and to run in 4 sets at 8 psi when flows were reduced. Operational time must increase to deliver comparable amount of water as 14 psi, but this is simpler and less costly than a 3-set and 4-set scenario. Illustration courtesy of Randi Gladwell, Clearwater Supply.*

- **Daniele Zaccaria Agricultural Water Management Specialist, University of California, Davis** "FlowControl is an important new technology to provide a uniform application of water. The possibility of adjusting the flow with innovative drip tapes is an important feature that could contribute to increased capacity and flexibility of micro-irrigation systems."

## Using AquaFlow drip irrigation design software to evaluate potential drip system uniformity

Toro's free drip irrigation design software, AquaFlow, allows users to compare different drip laterals against one another while all other design parameters remain constant. AquaFlow's report includes the single lateral and block emission uniformity (EU) and a color-coded Uniformity Map to help illustrate how each lateral choice performs. In this map, the fewer colors displayed indicate higher drip system uniformity. In the example shown below (see Figure 11), FlowControl, with a flow exponent of 0.3, increases drip system uniformity by 5.0% compared to ordinary drip tapes with flow exponents of ~0.5. As a result, the FlowControl drip system will apply water and fertilizer more evenly and require less over-irrigation to mask dis-uniformity.

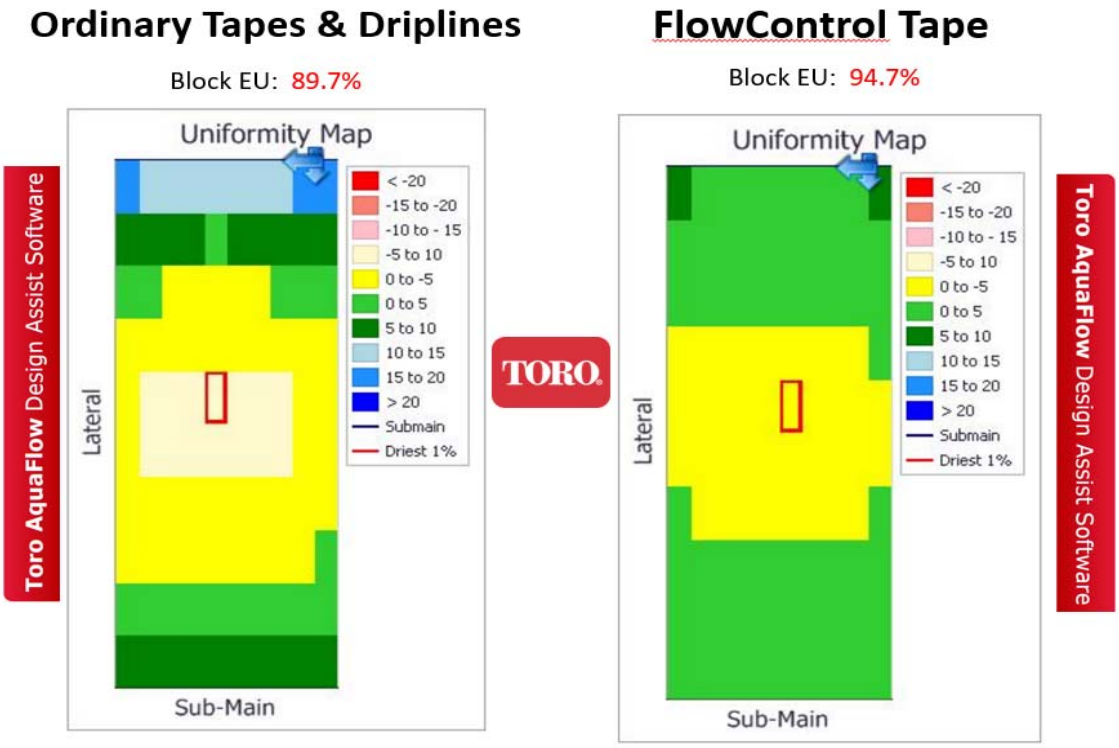



*Figure 11: AquaFlow uniformity map showing superior drip system uniformity using FlowControl drip tape with a flow exponent of 0.3 compared to ordinary drip tapes and driplines with flow exponents of ~0.5.*

## Summary of FlowControl advantages

There are three major advantages to using FlowControl drip tapes. First, FlowControl drip tapes will always provide higher drip system uniformity when compared to ordinary drip tapes because FlowControl has a flow exponent of 0.3. Higher drip system uniformity typically leads to better profitability and resource-use efficiency. FlowControl can help achieve higher drip system uniformity under normal conditions of flat terrain and/or short lengths of run as well as challenging conditions, such as hilly terrain and/or long lengths of run. Specific case studies report that, with FlowControl, costly and cumbersome submains and jumpers are eliminated, wetting patterns are improved, yield and quality is increased, and water, fertilizer, labor and energy input costs are reduced.

Second, FlowControl drip tapes maintain the flexibility to change the drip system application rate by adjusting pressure, unlike pressure-compensating driplines where the drip system application rate is fixed. Case studies report that this feature helps simplify designs, purchase price and operational complexity, especially when weather or water availability conditions change. As a result, flexibility is maintained without sacrificing drip system uniformity.

Third, FlowControl drip tapes are available in a wider range of wall thicknesses than pressure-compensating driplines, including more affordable ⅝-inch 6-mil and ⅞-inch 8-mil. In addition, unlike driplines, FlowControl drip tapes are sold at the same price regardless of emitter spacing, from 6 – 24 inches. Since closely spaced emitters are often preferred to achieve superior wetting patterns, this feature helps optimize results without paying a premium.

## References


The Toro Company: **Grower Reviews from The Field**
https://cdn2.toro.com/en/-/media/Files/Toro/Agriculture/drip-tape-and-dripline/ALT253_FlowControl_Testimonial_ENG_web.ashx

The Toro Company: ***AquaFlow Drip Irrigation Design Software***
http://driptips.toro.com/design-tools/drip-design-software/