Conservation Strategies for Lawn Irrigation During Drought
A Colorado Experience

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Background:

Colorado experienced its worst drought in recorded history during 2002. Based upon tree ring studies conducted by Hydrosphere in Boulder, Colorado the last drought of this magnitude was 1725 in the Boulder Creek watershed. 2002 was a year of extremes with very low snowpack resulting in very low runoff and streamflows, low precipitation and record hot temperatures. Most Colorado municipalities faced difficult choices to stretch limited water resources focusing on restricting or eliminating lawn irrigation. Many had plans with various actions items that were triggered by reservoir storage levels. However, few if any plans had ever been tested to see if the desired results could be achieved and was complicated by a drought that was worse than anyone had ever experienced or planned for.

In Colorado, the annual demand for water in many municipalities is roughly 55-60% for the indoor or base use and the other 40-45% is for outdoor water use. For the typical single-family residence, a little more than half of the water used is for irrigation of lawns and landscapes.

The most successful conservation programs will place an emphasis on both indoor and outdoor water conservation. Indoor conservation should be practiced by the whole community and can be practiced everyday all year long. Outdoor conservation impacts those who have landscapes to maintain and therefore only a portion of the community is involved. The water saved by indoor conservation efforts becomes available to help meet outdoor needs.

It is suggested that a water provider clearly identify how much water needs to be conserved and what portion of that should be realized by restricting lawn watering. The following conservation strategies for lawn watering come with several options to achieve similar results. *It is highly recommended that local communities consult with members of the green industries to determine the strategy that will work best for local circumstances and needs.* Perhaps none of these suggestions will work just right but can become the catalyst to create other ways and ideas to stretch water resources during difficult times.

Effective landscape water management can use current evapotranspiration rates (ET) to create irrigation schedules on a real time basis, but for planning purposes historical ET is used. The following conservation irrigation strategies could be used when water supplies are insufficient to meet the water requirement of the landscape whether the shortage is caused by drought or is a delivery problem. They are based upon the historical ET calculated using the ASCE / EWRI Standardized Penman-Monteith equation.

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Base information:

The following chart lists how ET information is used to determine the amount of water that needs to be applied to the landscape.

Inches of water per month for Northeastern Colorado

	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
ET_o	4.02	4.95	6.17	6.62	5.51	4.05	2.77	34.09
K_c	.90	.90	.90	.90	.90	.90	.90	.90
PWR	3.62	4.46	5.55	5.96	4.96	3.65	2.49	30.69
Rain	2.06	2.32	1.53	1.29	.99	1.30	.67	10.12
Eff. Rain	2.06	1.16	.77	.65	.50	.65	.34	6.13
IWR	**1.95**	**4.13**	**5.98**	**6.64**	**5.58**	**3.75**	**2.69**	**30.72**
Gal / s.f.	1.2	2.6	3.7	4.1	3.5	2.3	1.7	19.1

Where:

ET_o = Historical Grass Reference evapotranspiration for the growing season of April 1 to October 31

K_c = Crop coefficient for cool season turfgrass mowed at 2.5 to 3.0 inches

PWR = Plant Water Requirement PWR = ET_o x K_c

Rain = Historical rainfall

Eff. Rain = Effective rainfall 100% for April, 50% all other months

IWR = Irrigation water requirement IWR = (PWR – Effective Rain) divided by 80% irrigation efficiency

Effective landscape water management will use current ET to create irrigation schedules on a real time basis, but for planning purposes historical ET is used. The following conservation irrigation strategies could be used when water supplies are insufficient to meet the water requirement of the landscape.
Implementing any of these can have an overall impact upon the landscape depending upon the condition and health of the plants and turfgrass when these strategies are implemented. Continuous deficit irrigation over a long period of time will have debilitating effects on the landscape, but when water resources are scarce, there are only a few alternatives and they mostly have negative impacts on landscapes. **When changes in irrigation management are introduced, changes in other horticultural practices must be implemented at the same time**.

The following conservation strategies with accompanying options that could be used to reduce irrigation demand are based on the typical growing season of April 1 to October 31 and assume near normal rainfall. If rain is lacking, the impacts upon the landscape will be even more severe**.** The reduction listed is only for the amount of water reduced that is used for outdoor irrigation. The number in parenthesis is the overall demand reduction based on a typical annual delivery of 60% for indoor usage and 40% for outdoor usage. Water providers should apply their unique demand split (indoor and outdoor usages) to determine potential overall demand reduction.

Conservation Strategy # 1 @10% Landscape irrigation reduction

		Inches	gal/s.f.	Reduction
A)	A 10% reduction in irrigation run times	27.65	17.2	10% (4%)
B)	Irrigation May 1 to Sept 30	26.08	16.2	15% (6%)

A) A voluntary measure without convenient ways to verify if there is compliance.
B) Option B is easier to administrate and verify results. Saves water early & late.

Conservation Strategy # 2 @20% Landscape irrigation reduction

		Inches	gal/s.f.	Reduction
A)	A 20% reduction in irrigation run times	24.58	15.3	20% (8%)
B)	Irrigation Apr 23 to Oct 7 @ 1" per week	24.00	15.0	24% (10%)

A) Hard to verify compliance
B) Option B is easier to administrate. Irrigation schedule remains the same throughout the season. Works well with Twice-A-Week Watering, Quality of the lawn will change over the course of the season looking stressed during the hottest periods.

Conservation Strategy #3 @30% Landscape irrigation reduction

		Inches	gal/s.f.	Reduction
A)	Irrigation May 1 to Sept 30 @ 1" per week	22.00	13.7	28% (12%)
B)	Irrigation May 1 to June 30 @ IR			
	NO IRRIGATION July 1 to July 31			
	Irrigation Aug 1 to Oct 15 @ IR	20.79	13.0	32% (13%)

A) Levels out distribution, less demand early in the irrigation season when reservoirs are lowest, controller times stay constant; grass will change in appearance and quality during growing season. If the results don't materialize see strategy #4, option B.
B) Better for the plants and turf, but irrigation schedules will change frequently to irrigate properly. This is the biggest challenge to get the changes needed to save the water. A 30 day period of no watering will have minimal impact on the turf overall. It has time to be healthy before the restrictions start and enough time afterwards to revive.

Conservation Strategy #4 @40% Landscape Irrigation reduction

		Inches	gal/s.f.	Reduction
A)	Irrigation May 1 to Oct 15 @ .75" per week	18.00	11.2	43% (17%)
B)	Irrigation May 1 to June 30 @ 1" per week			
	NO IRRIGATION July 1 to July 31			
	Irrigation Aug 1 to Oct 15 @ 1" per week	18.00	11.2	43% (17%)
C)	Irrigation Apr 15 to June 15 @ IR			
	NO Irrigation June 15 to Aug 15			
	Irrigation Aug 16 to Oct 31 @ IR	17.33	10.8	44% (18%)

D)	Water diet.	40% (16%)
E)	Water budget	40% (16%)

A) Levels out distribution with less demand in early spring when water supply is uncertain. Controller times are set for the season. Turf will most likely remain in a stressed condition for the entire year. Winter desiccation and death of some lawns the following spring, especially lawns with shallow root systems. Trees and shrubs will not receive sufficient moisture and they will compete with the grass for the moisture.

B) Same base schedule as option A in Conservation Strategy 3 with no watering for the month of July. It has the advantages of option A listed above and could be implemented if the desired reductions were not being achieved in Conservation Strategy 3 using option A. Run times will be consistent throughout the season.

C) Better for the natural growth cycle of the cool season grasses and many trees and shrubs. Healthy lawns and other plants should be able to go 60 days without additional water, but that will be pushing the threshold for many landscapes. Big challenge to communicate effectively the on-off times to water with controller times needed to be changed at least monthly to water to ET. Technology could assist in facilitating customer's need for better irrigation management. Extending irrigation into October will help replenish lost soil moisture and benefit trees and shrubs for the winter months.

D) See Item D in Conservation Strategy #5

E) See Item E in Conservation Strategy #5

Conservation Strategy #5 @50% Landscape Irrigation reduction

		Inches	gal/s.f.	Reduction
A)	Irrigation Apr 15 to Oct 15 @ .50" per week	13.00	8.1	58% (23%)
B)	Irrigation May 1 to June 15 @ 1" per week NO Irrigation June 15 to Aug 15 Irrigation Aug 16 to Sep 30 @ 1" per week	13.00	8.1	58% (23%)
C)	Irrigation Apr 15 to May 31 @ IR NO IRRIGATION June 1 to June 30 1" of irrigation for month of July 1" of irrigation for month of Aug Irrigation Sep 1 to Oct 31 @ IR	13.55	8.4	56% (22%)
D)	Water Diet			50% (20%)
E)	Water Budget			50% (20%)

A) Levels out distribution with less demand in early spring when water supply is uncertain. Controller times are set for the season. Turf will be in a mostly stressed condition for the entire year. Winter desiccation and death of lawns and other landscape plants the following spring will be noticed, especially lawns with shallow root systems. Trees and shrubs will not receive sufficient moisture and they will compete with the grass for the moisture. **Once-A-Week watering** would be a better use of the water to encourage deeper soaking of the water into the root zone rather than Twice-A-Week watering of only .25" per watering.

Frequently most lawns will have a higher weed infestation because the weeds can thrive on less water than what the grass needs to effectively compete against weed growth. Additional hand watering of trees and shrubs will affect overall reduction and in older more established neighborhoods almost all of the water would be used for keeping trees alive.

B) Better for the natural growth cycle of the cool season grasses and many trees and shrubs. Healthy lawns and other plants should be able to go 60 days without additional water, but that will be pushing the threshold for many landscapes. Big challenge to communicate effectively the on-off times to water with controller times needed to be changed at least monthly to water to ET. By the end of the growing season the many plants and lawns will have not recovered sufficiently to go through a dry winter. Technology could assist in facilitating customer's need for better irrigation management. Extending irrigation into October will help replenish lost soil moisture and benefit trees and shrubs for the winter months.

C) A variation on option B. Start irrigation earlier in the season at ET rate to help get turf areas healthier and make available more moisture for trees and shrubs. The "no watering" period can be longer with by adding @ .50" of water every other week for the months of July and August. This becomes very confusing to communicate to customers. This amount of water is critical for better survivability of the grass and is not meant to wake it up out of dormancy. A longer period of watering at ET in the fall when ET rates go down will help get lawns, trees and shrubs more water to go into winter dormancy.

D) Water diet sets a percent reduction based on past historical usage. This needs to be communicated if it is on an annual basis or per billing cycle basis. In either case it is difficult for the customer to know how they are doing without an effective way to measure water usage. Water Diets reward poor irrigation mangers that have been water wasters. They could still overuse water even though they are cutting back on past over usage. Good water managers will have stressed looking landscapes when the goal is an across-the-board reduction by percentage. Compliance is usually achieved by imposing surcharges on the amount of water that exceeds the targeted goal or reduction. Water diets are not sensitive to current weather conditions that create the demand for water.

E) Water budgets treat all landscapes fairly by setting a target amount of water to be used based on size of property. Clearly defining the goal of staying within the budget places the responsibility of wise water management upon the property owner. Rain gauges could be used to measure irrigation application and place the burden on each property manager to track his water usage. It takes time and information to establish a fair and equitable water budget for each property. Water budgets work best when coupled with tiered rate structures that will penalize poor water management with higher rates for excess water used or reward those who are able to live within the water budget. Water budgets would hopefully preclude the need for any other type of watering restriction.

Alternative Conservation Strategies or Management Practices

Water Budgeting

Water budgets or allowances, or allotments are terms used interchangeably to determine the amount of water in gallons or CCF to meet the needs of the landscape. Correctly done it should be fair and equitable for each individual property. One of the major advantages is that the water provider can place the burden of responsibly using the water on the water user. It takes considerable effort on the part of the water provider to set up, but so does enforcing watering restrictions. Water budgeting should remain in place always and not be used during times of water shortages.

Education instead of restrictions

This will focus on conservation education with voluntary efforts by people to reduce water usage both indoors and outdoors. Target amounts of water should be suggested that would focus on small changes in lifestyle or to invest in water saving appliances and technology to aid or facilitate in conserving water.

The overall goal of water savings needed by the utility from the community could be stated with specific suggestions such as the number of gallons per day per person for indoor use or amount of water per week to be applied to the lawn. Restrictions should become guidelines to help minimize peak loads on the distribution system. Keeping the public informed on a very regular basis on how well they are doing with the water resources should improve performance by increasing awareness. This strategy works well with the watering budgeting concept to put the burden of responsible water usage on the user.

Prioritizing the Landscape

This concept involves making a management plan that looks at what parts of the landscape are most important and needs the water and what parts of the landscape can be put into a low-maintenance mode and use the water on the higher priority parts. Sometimes the water is taken from one project and applied to another because of its importance or use. Parks departments or school districts are good examples of looking at all of the opportunities there are and maximizing the water resources for the greatest benefit. This strategy can be combined with any of the above conservation strategies to reduce overall demand for water on the system and allows the manager to make the best decision on how to use the resources instead of the water provider.

Restrictions

The water provider with the hopes of reducing water usage puts restrictions into place, but frequently usage goes up. Restrictions as to which days to water and / or hours to irrigate perhaps help with distribution issues, but they seldom change habits or behavior. Restrictions that are coupled with very strict recommendations for irrigation can achieve the desired goals, but money and time are spent in enforcement. Hoarding & Splurging describes a likely behavior that can occur as people will go into a “panic” mode applying more water than they should going into a “dry” period

and then into a “greedy” mode by over-watering when irrigation resumes after the dry down period. This behavior reduces the overall effectiveness of this strategy concept. Each of these scenarios will have an impact on the water provider’s ability to deliver water effectively because of the high demands that will be placed upon the treatment and distribution system.

If restrictions are used, then the following strategy is recommended to achieve results. With any of the restrictions, horticultural considerations are mostly ignored.

Run Times Per Zone

A big debate over how to enforce the watering restrictions comes with a specified number of hours to irrigate or time limits per zone. A specified number of hours is equal for everyone, but does not address needs. Large properties get the same number of hours as little properties. Little properties can probably get by on the number of hours stated, but large property managers are frustrated with insufficient time to water all of their property. By setting a time limit per zone based upon the type of sprinkler head, properties are treated more fairly but there will still be discrepancies because many sprinkler zones will be different than the average used to determine the suggested run times. Because of the variability in individual sprinkler systems and how they perform, the water providers takes on a role of being landscape water manager in addition to water provider.

As a general rule of thumb, sprinkler heads that are fixed spray, meaning they don’t have any rotating or moving parts when the water is being sprayed out apply water at a rate of 1.5” per hour. Sprinkler heads that have moving or rotating parts when the water is coming out have an application rate or precipitation rate of one-half (.50”) inch per hour. One of the biggest mysteries for most people is to know how many minutes to set the sprinkler for to apply a target amount of water. For most landscapes, a half-inch application of water works well. It is a sufficient amount of water for soaking deeply into the root zone. It may need to be divided into a couple of applications on the same watering day to minimize runoff and to improve the infiltration into the soil. To apply a quarter inch of water would require a run time of 10 minutes for spray heads and 30 minutes for rotor-type sprinkler heads. A half-inch application would then require two start times. With twice a week watering two start times per irrigation day would apply one inch of water for the week.

Summary:

When communities face water shortages, creating a plan with input from green industry leaders can achieve positive results for water savings. The strategies presented can sometimes be combined or they can be a catalyst for creating new strategies that might even be better. There is not one perfect plan for every community because of all the many variables of where the water comes from, who has rights to it, and how it gets delivered. In the end, the best strategy is to allow water purveyors to do what they do best and that is deliver water. Allow customers to manage the water and make them accountable for using it wisely.