

# TurfGrass TRENDS

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## Maximizing Turfgrass Irrigation Efficiency

by William E. Richie, Robert L. Green and Victor A. Gibeault  
*University of California, Riverside*

Fresh water available for human consumption, recreation activities, agricultural production, and industrial uses accounts for only 1% of all water on the earth. The remaining 99% is salt water and polar ice. Water is a particularly precious resource in the arid Southwest where average annual rainfall is approximately 10 inches. This is insufficient for plant needs, such as tall fescue (*Festuca arundinacea*), which comprises 70-80% of the sod industry in the state of California. Tall fescue is also a popular turfgrass species in other regions of the USA. In Riverside, CA, tall fescue requires an average of 46 inches of water annually while a typical warm-season turfgrass requires 35 inches of water each year. As might be expected, plant water needs are greater in the arid West vs. the humid East.

Irrigation is a necessary component of typical landscape maintenance in the Southwest, and is becoming commonplace in landscapes countrywide. The



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# TurfGrass TRENDS

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demand for water is accentuated by growing urbanization, multiple years of drought, and reduced recharge of water supplies (aquifers, mountain snowpack). An example of growing urban demand is that approximately 30% of all water delivered by the Metropolitan Water District of Southern California is applied to landscapes. In response to this, local water districts have published recommendations for efficient landscape water application and some have initiated active conservation programs. One of their conservation goals is to reduce the amount of water being applied to landscapes and thus defer the need for more aqueducts and support facilities.

Turf and landscape managers are finding that acceptable aesthetic standards can be sustained with less water. It is in their best interest to employ irrigation practices that result in water conservation and monetary savings. A fine-tuned irrigation program is essential to maintain the aesthetic quality of turf while using limited water resources wisely. A companion article by Richard Hull (*TurfGrass Trends* 10: 1996) discussed management of turfgrass for minimum water use. This article will focus on managing turf and landscape irrigation practices toward the same end.

## How Much Water Should Be Applied?

The first questions asked about turfgrass irrigation often relate to the quantity of water used, such as, "How much water needs to be applied to maintain acceptable aesthetic quality?" University research over the past two decades has established 80% of ETo, or

reference evapotranspiration, as the recommended irrigation replenishment for cool-season turfgrasses in the Southwest, including tall fescue. This recommendation does not take into account the additional water required to compensate for a lack of irrigation uniformity. With typical irrigation uniformities of 60 to 80%, between 100 and 120% ETo may need to be required to maintain uniform and acceptable tall fescue quality, especially during the hot summers. To replace water used by a warm-season turfgrass, 60% ETo is generally required.

ETo is an estimate of the amount of water used by a healthy 4 to 6 inch-tall stand of cool-season grass. Reference ET values can be obtained from several sources. The California Department of Water Resources maintains the CIMIS (California Irrigation Management Information Service) program to aid irrigation managers. This program uses daily weather data and a modified Penman model to calculate (estimate) ETo values, which are retrieved by a manager using a modem. A similar program (AZMET) is available in Arizona. Managers of large turfgrass areas (golf courses, for example) may also employ Maxicom (RainBird, Azusa, CA) and similar weather-monitoring Penman systems to provide on-site ET-based irrigation programming. (See "The Use of Weather Stations," on page 10, for a golf course superintendent's experience with his weather station.) Historical ETo records in tabular form also are available for locations throughout the United States.

Besides using empirical equations, reference evapotranspiration can also be estimated from pan evaporation and atmometers. Doorenbos and Pruitt (1975) provide a thorough discussion

of ETo and pan evaporation (Epan) using a USDA Class A pan. Listed below (Table 1) are coefficients (Kp) which are used to convert values of Epan to ETo ( $ETo = Epan \times Kp$ ) under different environmental conditions. Simonne et. al. (1992) discuss using containers other than a standard Class A pan for measuring reference evaporation and scheduling irrigation. Qian et. al. (1996) estimated turfgrass evapotranspiration using pan evaporation, atmometers (C and M Meteorological Supply, Colorado Springs, CO), and the empirical Penman-Monteith equation and found that atmometers (Bellani plate) correlated most closely with measured turf ET in relatively humid eastern Kansas. Whatever source is employed to estimate baseline turf water use, the first step to maximizing irrigation efficiency is to know the quantity of water to apply.

## University Research Findings

The University of California, Riverside has conducted several precision-irrigation studies on tall fescue during the past 16 years. These studies were made possible primarily through several research grants from the Metropolitan Water District of Southern California. The more recent studies were conducted on precision-irrigation plots in Riverside, and involved irrigating tall fescue at approximately 80% ETo during the summer and fall months. The 80% irrigation system uniformity (see below) of our research plots is probably 25% more-uniform than those of most general turfgrass areas. The summer season is the most difficult time to maintain quality tall fescue at 80% ETo because of the hot dry conditions typical during these

**Table 1. Pan coefficients ( $K_p$ ) for Class A pan in different ground covers and levels of mean relative humidity and 24 hours wind. (Adapted from Doorenbos and Pruitt, 1975)**

<i>Class A Pan</i>		<i>Case A: Pan surrounded by short green crop</i>			<i>Case B: Pan surrounded by dry fallow land</i>		
Mean % Relative Humidity		Low < 40	Medium 40-70	High >70	Low < 40	Medium 40-70	High >70
Wind run (km/day)	Upwind distance of green crop (m)				Upwind distance of dry fallow (m)		
Light <175	0	.55	.65	.75	0	.70	.80
	10	.65	.75	.85	10	.60	.70
	100	.70	.80	.85	100	.55	.65
	1,000	.75	.85	.85	1,000	.45	.55
Moderate 175-425	0	.50	.60	.65	0	.65	.75
	10	.60	.70	.75	10	.55	.65
	100	.65	.75	.80	100	.50	.60
	1,000	.70	.80	.80	1,000	.45	.55
Strong 425-700	0	.45	.50	.60	0	.60	.65
	10	.55	.60	.65	10	.50	.55
	100	.60	.65	.70	100	.45	.50
	1,000	.65	.70	.75	1,000	.40	.45
Very Strong >700	0	.40	.45	.50	0	.50	.60
	10	.45	.55	.60	10	.45	.50
	100	.50	.60	.65	100	.40	.45
	1,000	.55	.60	.65	1,000	.35	.40

*z* For extensive areas of bare-fallow soils and no agricultural development, reduce  $K_{pan}$  values by 20% under hot windy conditions, by 5-10% for moderate wind, temperature and humidity conditions.



months. Research findings from the more recent Riverside studies show that when summer conditions are mild, quality tall fescue can be maintained when irrigated at 80% ETo and managed under the conditions of our research plots.

When summer conditions are more severe, minimally acceptable tall fescue can be maintained when irrigated at 80% ETo and managed under conditions of our research plots. These findings suggest that more irrigation water may be needed during the summer. Future research on tall fescue will be designed using 80% ETo over 12 months. To achieve this, more water may be applied during the summer and less water will be applied during the fall through spring season.

## From Recommendation to Practice

A series of calculations are required to convert recommended quantity of water to an actual run time on an irrigation controller. The first step in this calculation is to determine how many inches of water need to be applied by multiplying ETo by the crop coefficient (Kc) for the turfgrass of interest.

The Kc appropriate for the region of interest and for the time increment desired, such as a month or quarter (irrigation schedules are not usually altered more frequently than this) must be selected. If irrigating tall fescue or other cool-season grasses, Kc = 0.8. A Kc of 0.6 is used for warm-season grasses. Crop ET is then equal to ETo x Kc. The resulting number is then divided by the irrigation system uniformity, or DU, which will be calculated below. This 'depth' of water is converted to an actual run time (minutes) for the period by dividing it by the system delivery rate (inches per hour) and then multiplying by 60.

The final step is to calculate run time (minutes) per irrigation event by dividing run time for the period (month or quarter) by the number of irrigation events for that period. Following is an example calculation for the city of Los Angeles for the month of July.

Historical ETo = 6.2"

Kc = 0.8 (80% ETo for cool-season grass)

DU = 0.6 (60%, typical for many systems)

System Delivery Rate - assume 1.5 inches/hour for an average rotor-type head

$$\frac{ETo \times Kc}{DU} = \frac{6.2" \times 0.8}{0.6} = 8.3 \text{ inches of water}$$

Depth of Water = 8.3 inches water

$$\text{Run time} = \frac{8.3 \text{ inches}}{1.5 \text{ inches per hour}} = 5.54 \text{ hours}$$

$$5.54 \times 60 = 332 \text{ minutes run time for July}$$

Two variables not previously discussed are required for this calculation. These are system uniformity (DU) and system delivery or precipitation rate, which are both calculated by performing a "catch can test." Six or more straight-sided cans (such as tuna cans) are placed in a grid within the irrigated area. The more cans that are used, the better the information derived from the test. After arranging the cans, sprinklers are run for 15 minutes (one quarter of an hour so that hourly precipitation rate is easily calculated by multiplying by 4) after which the depth of water in each can is measured with a ruler. If 15 minutes is not enough time, run sprinklers longer to collect a measurable depth of water and multiply accordingly.

Precipitation rate (inches/hour) is the average depth of water collected in all of the cans multiplied by 4. If the average measured depth is .25", then the system precipitation rate would be 1 inch per hour. Alternatively, precipitation rate can be calculated using the following equation, where the value 96.25 converts gallons delivered per minute per square foot to inches per hour:

$$\frac{\text{gpm(one head)} \times 96.25}{\text{head spacing} \times \text{row spacing (ft)}} = \text{precipitation}^*$$

\* precipitation in inches per hour

System distribution uniformity (DU) is determined by calculating the average amount of water

in 25% of the cans that accumulated the least amount of water during the test divided by the mean depth of water in all cans.

Distribution Uniformity is calculated as follows:

$$DU = \frac{\text{Mean of the low quarter (volume or depth)}}{\text{Overall mean (volume or depth)}}$$

Here is an example. A catch can test is performed with 20 cans, spaced 5 feet apart. Measuring the depth of water in each can, the average depth in the 5 lowest cans is found to be 0.22 inch. The average depth of all 20 cans is 0.35 inch. Precipitation rate for this system is  $0.35 \times 4 = 1.4$  inch per hour. DU is  $0.22/0.35 = 0.63$ .

The next step in developing an efficient irrigation program is to calculate run time per irrigation event. This requires knowledge of the number of irrigation events per time period (month or quarter, for example). In the following example it will be assumed that the manager wants to irrigate twice each week (an assumption based on UCR research). Looking at a calendar, this translates into 9 irrigation events for an average month, or 35 irrigation events for a quarter. Total run time for the period needs to be divided by this many irrigation events. Continuing with the preceding example for Los Angeles:

$$\frac{\text{Run time per month (332 minutes)}}{\text{\# irrigation events per month (9)}} = 37 \text{ minutes}$$

37 minutes per irrigation event (Monday, Thursday for example).

This is the amount of time for each irrigation event that will actually be programmed into the irrigation controller to apply 80% Eto.

Why is a twice per week irrigation schedule used in the preceding example? Turfgrass managers are aware that light, frequent irrigation encourages shallow roots and weed growth. Therefore, their recommendation for many years has been to water turf just often enough to avoid visual drought symptoms by deep and infrequent watering (Grau

and Ferguson, 1948; Hagan, 1955). Such infrequent scheduling may conserve water by reducing evaporation associated with irrigation events (Hagan, 1955), discourage weed growth, stimulate deeper rooting, and produce turf better able to withstand drought (Youngner, 1985).

Other recommendations for application frequency are based on replenishing soil moisture to a predetermined desirable level. Such scheduling requires knowledge of the soil's plant available water content and the rate of turf water use. The purpose of recent research at UCR was to find an optimum irrigation frequency for tall fescue in Southern California. Specifically, the objective was to determine if tall fescue performance, when irrigated at 80% crop ET ( $ET_o \times K_c$  for tall fescue  $\times 0.8$ ) in Southern California, could be improved by altering irrigation frequency, cultivar, selection and mowing height.

Results from this study showed advantages to watering tall fescue relatively infrequently (two times per week). Turfgrass color and visual quality, and soil moisture were highest when the turf was irrigated twice per week compared to three or four irrigations per week. Fewer irrigation events may have resulted in less evaporative water loss associated with wet turf and soil and deeper penetration of water into the active root zone resulting in improved plant water status. The bottom line is that the same amount of water applied less frequently results in more water per application and deeper penetration. Deeper water penetration encourages deeper turfgrass rooting and discourages surface rooting of trees and shrubs growing within the turf. Research continues to determine the influence of irrigation frequency on warm-season turf performance.

## Optimizing Irrigation Application: Water Penetration

Regardless of how much irrigation water is applied to tall fescue, or how often it is applied, what is important is that the water must reach the root



**Table 2. Comparison of two irrigation systems.**

	<i>System 1</i>	<i>System 2</i>
Irrigation System Uniformity	80%	50%
Inches water applied	6.2	9.9
Total minutes	248	397
Minutes per run event	28	44
Gallons applied <sup>z</sup>	12400	19850
Cubic feet applied <sup>z</sup>	1662	2660

*<sup>z</sup> Assuming an irrigation system using 50 gallons per minute and a precipitation rate of 1.5 inches per hour.*

zone to be available for uptake by the plant. If the precipitation rate is greater than the soil infiltration rate, runoff will occur. Proper management can ensure maximum water penetration into the soil.

First of all, determine how long sprinklers can run before water begins to pool and run off. Irrigation run times should be shorter than this amount of time. Several sequential 'cycles' may be needed to apply enough water to meet plant needs. The 37 minute run time in the above example may need to be cycled into two 19 minute runs, three 12-13 minute runs or four 9-10 minute runs (allowing soak-in time between runs) to ensure that all water delivered in 37 minutes reaches the root zone. Some irrigation controllers offer cycle repeat features which simplify this operation and preclude the need for multiple start times.

The second step an irrigator can take to increase water penetration or infiltration is to reduce irrigation system delivery rates. Reducing precipitation rates does not change the rate of soil infiltration, but provides a longer time period for the water to soak into the soil. When possible, this can be accomplished by designing systems with rotor-type heads instead of spray heads. A spray head may demand the same gallonage as a rotor head, but only cover 1/4 the area of the rotor head. Thus

more water is applied per square foot using the spray head. Also using smaller nozzle sizes on rotor heads (which can provide the same coverage radius) will deliver less water per square foot covered. Micro spray systems, some of which adapt to existing spray heads, can also be employed. Consult a professional irrigation supplier to see what is available. Although not a common practice in southern California, core cultivation or aerifying (punching holes in the soil surface) can be performed to increase water infiltration and reduce runoff.

## **Optimizing Irrigation Application: System Uniformity**

Maximizing irrigation system uniformity is one of the most important steps an irrigator can take to optimize irrigation efficiency. Returning to the preceding example of applying 80% July ETo in L.A., a comparison of two systems with different distribution uniformities is instructive:

Notice how much more water must be applied with System 2 to achieve a similar result (9.9 inches vs. 6.2 inches). The less uniform a system is (the lower the DU), the longer the sprinklers will have

to run to produce a uniform turf appearance over the entire irrigated area.

Irrigation system uniformity can be improved in many ways. The first is to ensure that system operating pressure is within the manufacturer's recommended range for the heads being used. Sprinkler heads are often sold with a specification sheet which includes the recommended operating pressure. Manufacturer's catalogues also list optimum operating pressures for specific heads. Higher than optimum pressure causes atomization and loss of fine droplets to wind, not to mention unnecessary wear on system piping and equipment. Lower than optimum pressures cause insufficient interfacing of sprinkler spray patterns, and dry 'donut' areas are the result. Operating pressure can be measured with a gauge affixed to a shradet-type valve on the solenoid valve (pressure regulating valves have these), or installed somewhere in the system. Pressure can also be measured on rotor or impact-type heads with a pitot tube held where water leaves the nozzle.

If system pressure is too high, it can be regulated with an adjustable pressure regulator or a pressure regulating solenoid valve. Pressure regulators are often located after the backflow device and regulate pressure on all systems downstream. (Note: before performing any alterations, an irrigation designer should be consulted. Higher pressures may be required for certain systems downstream, e.g., systems at higher elevations). One can also use a pressure regulating master valve which is actuated by the irrigation controller to supply water to all systems. All systems will therefore be supplied with the same operating pressure from the master valve. Pressure regulating valves can also be installed on each irrigation system. This provides the greatest flexibility by allowing adjustment of each system to an optimum operating pressure. Pressure regulation at the sprinkler head itself is also possible with products now available on the market. Spray head nozzles can be obtained with pressure compensating devices (PCD's) or pressure compensating screens (PCS's) which reduce operating pressure to an ideal range for a specific nozzle and thereby eliminate fogging. One manufacturer also has

recently marketed a pop-up spray head with a built-in stem pressure regulating feature.

System uniformity also can be adversely affected by low operating pressures. Although sometimes more difficult to remedy than high pressure, several steps can be taken to increase a low operating pressure. The first step is to install a booster pump to increase system pressures. This can be a costly remedy and require considerable work. Another solution is to divide large systems into multiple smaller systems, reducing the gallonage demand, and increasing the operating pressure available to each smaller, individual system. This procedure will require the installation of more valves and may be complicated by the need for more wiring and additional controller stations. An easier solution may be to install smaller nozzles on rotor heads. Smaller nozzles can often provide sufficient radius for head-to-head coverage, while reducing the gallonage demand of the system. Finally, irrigation should occur when supply pressure (city water) is at its maximum, usually early morning.

Assuming system operating pressure is within the recommended range, system uniformity often can be improved further. Typically, rotor or impact-type heads provide superior uniformity to spray heads and should be used whenever possible. When using rotor heads, nozzles should be selected carefully to balance precipitation. For example, a rotor head with a 180-degree arc takes twice as long to cover its area as a head with a 90-degree arc. Therefore, a nozzle supplying approximately twice the gallonage of water should be used in the 180° head. A nozzle supplying four times the gallonage should be used in a 360-degree head. More specifically, if a corner head with an arc of 90-degree has a 1.5 gpm nozzle, an adjacent head operating with a 180-degree arc should have a 3.0 gpm nozzle. A full circle head on this system would then need to be equipped with a 6.0 gpm nozzle.

Heads should be checked periodically for vertical alignment to make sure they are as near to vertical as possible (assuming level ground). Head spacing and proper nozzle size should also be monitored to ensure head-to-head coverage. System operating



condition should be checked routinely to ensure that all heads are functioning properly and that there are no clogged nozzles or streams. Finally, irrigation should be performed when wind is at a minimum, such as evening or morning. Early morning is generally recommended to reduce disease occurrence.

## Optimizing Irrigation Application: Final Considerations

A few more considerations can help to optimize irrigation application. First, irrigation controllers should be rescheduled as frequently as possible. The above example assumes a monthly reschedule. Time permitting, run times could be changed weekly or biweekly. At the very least, irrigation controllers should be reprogrammed quarterly to compensate for seasonal climatic changes. Water budget or global adjust features on many controllers can simplify rescheduling by allowing the operator to 'dial in' an irrigation level as a percentage of a seasonal maximum. Remote control of irrigation, where programs can be changed via modem or radio, is becoming increasingly popular.

Such features encourage frequent controller updating because irrigation control can be changed and monitored from one's home or office.

An irrigation system should be designed with hydrozones in mind. Water requirements of trees and shrubs differ from those of turf because the former have deeper and more extensive rooting patterns and can be watered more infrequently. Trees, shrubs, and turf constitute different hydrozones and if possible, separate systems should be used for each. Furthermore, shaded areas require less water than sunny areas, so ideally, separately valved systems should be in operation for these two zones. Irrigation on slopes may need to be cycled more frequently than systems on level land and therefore may constitute a unique hydrozone.

The use of rain switches can also prevent irrigation during rain events. Many new controllers have terminals into which a rain switch can easily be installed. Soil moisture sensors, such as Watermark sensors (Irrometer Co., Riverside, CA), also can be used to prevent irrigation when soil moisture is adequate for plant needs. Such sensors operate by opening valve circuits (preventing irrigation) when soil moisture is higher than a preset required level.

### Terms to Know

Crop Coefficient -  $K_c$   
Crop or turfgrass water use,  
turfgrass evapotranspiration -  $ET_{crop}$   
Distribution Uniformity -  $DU$   
Historical  $ET_o$   
Irrigation  
Irrigation Efficiency  
Plant Factor  
Precipitation Rate  
Turfgrass Water Requirement  
Turfgrass Irrigation Requirement  
Reference Evapotranspiration -  $ET_o$   
Water Conservation

### Conclusions

Applying an amount of water which just replenishes turf and landscape water use ( $ET$ ) is a realizable goal which can result in significant water and monetary savings.  $ET$ -based irrigation scheduling seeks to prevent over-irrigation which leads to runoff or leaching into potable water sources. The goal is to irrigate plant materials at a recommended percentage of  $ET_o$  as infrequently as possible. University research has shown that applying 80%  $ET_o$  to tall fescue twice per week can result in improved turfgrass color and visual quality. The irrigator should keep in mind that with longer run times associated with less frequent irrigation, water infiltration becomes a consideration and multiple cycles or lower precipitation rates may need to be



used. Acceptable turf quality can best be maintained when irrigation system uniformity is optimum. Recommendations for improving system uniformity included checking and adjusting operating pressures, selecting appropriate heads and nozzles, checking head alignment and operation, and irrigating at times when wind is minimal. Finally, nothing is more important than personal observation. The turf manager should visually inspect turf areas and irrigation systems on a regular basis (see article by Dave Shaw and Paul Zellman in *Turf Tales* Magazine, Winter, 1996, for an irrigation system walk-through checklist). If dry areas are apparent in spite of proper system operation, controller programs should be adjusted accordingly. With an efficient irrigation system and frequent controller program updates, landscape managers should begin to see improved plant quality with water and monetary savings.

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# Weather Stations Unlock Nature's Secrets

by F. Dan Dinelli, CGCS  
North Shore Country Club

Good golf course superintendents depend greatly on two skills, anticipating problems in advance and responding before they get out of control. Until recently, these skills were based heavily on experience and a collection of personal observations. Today's superintendent has access to information gathering tools that unlock the secrets of nature and provide advance warning to turf and ornamental health problems.

Some stressful conditions are controllable, while others are not. Weather is one of the most difficult factors, beyond human control. Yet, weather can be the greatest influence on turf quality. Consistent, accurate weather predictions cannot even be relied on to plan management practices. With historical and current detailed weather data, insect and disease activity can be predicted. Degree-day accumulations for insect activity and computerized disease models can be used to predict favorable conditions for pests.

A complete weather station with disease model software can do just that. In the spring of 1994, North Shore Country Club purchased what I consider to be a complete weather station made by Metos. It includes 10 sensors, two thermometers (one for air temperature five inches above the turf and one for soil temperature two inches below the turf in our 4th green), a rain gauge to measure rainfall and irrigation water, two leaf wetness sensors, a solarimeter to record solar radiation and day length, and a soil moisture probe located two inches deep in the 4th green. Relative humidity is measured six inches above the turf. Wind speed and direction are sensed and recorded.

Based on information from all its sensors, the weather station offers raw weather data, degree-day calculations, evapotranspiration (ET) value, and three disease models (Pythium Blight, Brown

Patch, and Dollar Spot). Spray data can be entered into the program to track the impact of spray decisions on disease activity. The micrologger automatically scans all sensors every 12 minutes, and stores this data for up to a week. Information is downloaded from the micrologger to the personal computer in the office of the grounds department any time. The data is stored on the hard drive and used in the software. One more attribute on the weather station is the solar-powered charging system.

Singularly or collectively, data from these sensors provides information, which improves and, at times justifies, many of our management practices. The station utilizes air temperature, relative humidity, wind speed and solar radiation to calculate evapotranspiration. According to the Penmann formula, ET gives an estimate of water lost by evaporation into the atmosphere and by transpiration from the turf plant. It references ET as inches or millimeters of water loss per 24 hour period.

Soil temperature information has helped us time our first fungicide application better to control summer patch (*Magnaporthe poae*) and Take-all patch (*Gaeumannomyces graminis*). Soil temperature data also indicates the proper timing of pre-emergent herbicide treatments for crabgrass control.

Microbial activity is governed largely by soil temperature and moisture. Nutrient release by some fertilizer carriers is also governed by soil moisture and temperature. With a better understanding of these factors, we can better understand and predict fertilizer activity.

Insect development can be predicted by tracking accumulated heat, expressed as degree days. Our weather station calculates degree days by averaging 120 air temperature measurements for the day. Once the average is obtained, the degree total for the day is this average minus the base temperature. We use a degree base of 50 degrees F. For a day





Dinelli stands next to weather data sensors which recorded exceptionally hot weather that damaged North Shore Country Club's *Poa annua* on greens.

with an average temperature of 59 degrees, the degree days for that day would be 9. This calculation is repeated each day and the result is added to the running total of accumulated degree-day values. Researchers have developed degree-day thresholds for many insects. An article by Rick Brandenburg (*TurfGrass TRENDS* 11: 95) discussed intuitive forecasting of turfgrass insect pests, including degree-day modeling and monitoring equipment and services. Knowing the degree-day value and referencing it to a particular insect's development, the turf manager can focus scouting on a particular insect and target insecticide applications better.

Plants also respond to accumulated heat. Some plants' inclination to flower or set fruit can be predicted with degree-day information. Some weeds share degree-day characteristics with other plants. For example, pre-emergent crabgrass controls should be applied when the Bridal Wreath Spirea (*Spiraea x vanhouttei*) blooms. In this case, the Bridal Wreath Spirea is an indicator plant for the conditions of crabgrass germination. For further information on timing pest management with ornamental plant development, the book "Coincide" by Donald A. Orton is a good reference.

A helpful feature of our weather station is disease model software. The Metos station has three prediction models for turf diseases, -- Pythium Blight (*Pythium aphanidermatum*), Brown Patch (*Rhizoctonia solani*), and Dollar Spot (*Lanzia & Moellerodiscus spp.*). The predictive models are based on information collected from sensors of air temperature, soil temperature, rain or irrigation, relative humidity and length of leaf wetness. They do not account for inoculum pressure, species or cultivar resistance to disease, fertility or future weather (environmental) conditions that could influence disease development. Ultimately, it is the turf manager who makes the decision on disease pressure versus needed controls.

The weather stations has proved to be an important tool in our integrated pest management program. It has helped us fine tune our irrigation needs. It also helped our timing to scout for disease and insect activity. People who may question our management activities can relate to a computer printout. This "scientific" support of what we do is becoming increasingly important.

Considerable work is still needed. More disease models must be constructed. Degree-day models need to be calculated for other pests as well as for beneficial insects. There is a lot of room for "home grown" research based on collected data coupled with field observations. The uses and applications are limited only by your imagination — that's what makes a weather station so exciting!

*F. Dan Dinelli, CGCS, has worked at North Shore Country Club for 21 years. A third generation golf course superintendent, Mr. Dinelli holds degrees in Turfgrass Management from Michigan State University and Horticulture from Harper College.*

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# Irrigation Uniformity: Looking Like A Million \$\$

by Mike Huck

USGA Green Section - Western Region

You are preparing to approach your course officials about replacing that antiquated irrigation system with a new state-of-the-art, computer-controlled model. You are going to ask them to put up a million plus dollars for this system, but what will happen once the system is in the ground? Think about it for a moment. After spending a seven figures they will expect the course to reflect it. Pardon the pun, but they will think the place should immediately look like a million bucks. It is possible that your golfers' expectations may exceed the mechanical limitations of the new system's coverage. If this happens, it could cost you your job!

The unfortunate fact is that even the most efficient irrigation systems are not that great. Based on results of field irrigation audits conducted throughout California by the California State Polytechnic University Irrigation Training and Research Center, a distribution uniformity (DU) of 85% is considered excellent. This means that even the best of systems begin with between 15-20% inefficiency. As age, wear and tear take place, things only get worse. Now, imagine how bad it can get if corners are cut during the initial design!

Even an excellent design can produce poor end results if the application profile of the sprinkler is not good. Each sprinkler model and nozzle possesses a different and unique application profile pattern. In turn, some profiles perform better than others. A good way to avoid disaster is to

analyze sprinkler and nozzle application patterns before you make a final product selection. In other words, know what you are buying.

How does one analyze a profile? Profile analysis can be accomplished at the laboratory of the Center For Irrigation Technology (CIT), California State University Fresno, (209)-278-2066. After the profile data are collected, CIT's computer allows irrigation coverage to be simulated in a two dimensional graphic called a densogram. In the process you learn which sprinkler and/or nozzle combination will deliver the most uniform coverage at your specified spacings.

Visualizing what the accumulation of water will look like when profiles are overlapped can be difficult. This is where the densogram enters the picture. The densogram demonstrates wet and dry areas of an overlapped profile by light and dark areas in the pattern.

In addition to the graphics, the software also calculates a scheduling coefficient (SC). The SC is a run time multiplier that compares the driest 5% area of the overlapped patterns. On a golf course no one wants a swamp, so we end up living with dry spots instead.

Therefore, if you want the finished product to look like a million bucks, it would be wise to test several sprinkler brands and nozzle combinations before you purchase. This can give you greater confidence that your golfers are getting the best possible system that money can buy and that you get to keep your job after it is operational.

## Relative System Performance and Distribution Uniformity (%)

Excellent	85% or greater
Very Good	80%
Good	75%
Fair	70%
Poor	65% or less

*Mike Huck is an agronomist in the USGA's Western Region office. He provides turf advisory surfaces for Colorado, Nevada, Arizona, Utah and parts of California. He earned a degree in Ornamental Horticulture with a specialty in turfgrass from the California State Polytechnic University.*



# The Intricacies of an Irrigation Maintenance Budget

*by Erik Christiansen  
EC Design Group, Ltd.*

The most frequently asked questions when becoming involved with an irrigation project design or feasibility study are what kind of maintenance is required with the system and how to budget this expense. My answers to these questions are very general, because it is difficult to answer them simply in terms of equipment. Yes, maintenance on most irrigation systems requires an obvious outlay for parts to replace or repair sprinklers (pipe fittings, wire splice kits, valve assemblies, etc.), but this article will focus on the sometimes hidden costs involved in modernizing your irrigation system.

Today's systems are often extremely complex and are sold on the premise that they can make the superintendent's life much easier. The latter is both true and false. For the record, I am a fan of technology, and these systems can truly give the superintendent the tools to be a better water manager. Modern irrigation systems have the ability to perform much more accurate, efficient and controlled watering than ever before, but luxury has a price. Variable frequency drive pump stations, computerized central control packages, weather stations, and the use of radio frequency signals instead of wire are all mainstreamed advances requiring additional attention.

In setting up an irrigation budget and/or maintenance schedule properly, you need to consider the five major irrigation components and related services: water source/pump station, piping, sprinklers, valves and controllers. The first and maybe the most important components are the water source and pump station. In the case of potable water source, you also need to consider the backflow preventer. For irrigation systems using municipal or potable water, yearly certification of

your backflow preventer is required. You should always check local and state codes because maintenance must be performed by a certified backflow device tester and requires a certification fee.

## Water Source

System water tests from your water source should be performed at the start of the season. It is always a good idea to test your water source during peak operation as well. Relatively inexpensive tests can measure salt content, sodium hazards, water pH, toxic-ions and bicarbonates. In addition, some tests can provide information about suspended solids in water. These tests tell the superintendent many things about the water source and what may be happening to water quality. Water tests can be done very easily by taking a water sample from one foot below the water's surface in ponds or directly from the irrigation system after it has been running a minimum of 30-40 minutes. Since the average Midwest golf course applies over 30 million gallons of water—considerably more in arid regions—in a season. It is nice to know not only how your water source will directly affect your system, but also what agronomic issues could be faced.

## Pump Station

The pump station should have high quality water in adequate amounts to perform its operating schedule. It should run automatically with properly functioning controls to prevent air and water hammer. Occasionally listen to the pump. You should be able to hear cavitation, bearing problems, and air and water hammer. Early detection can save a lot of aggravation. Spring start-up, in-season maintenance and winterization are important, and most pump station manufacturers offer a pump station service that may be worth your serious consideration.

## Pipe

The second major component is the irrigation piping network that carries water from the water source throughout the system. Frost heave, bad glue joints, tree spades, tree root feeders or anything digging deeper than 18" can ultimately cause a problem. Having enough repair couplings on hand to fix any size pipe on your golf course is a good idea. The same is true for common fittings that could be used for future expansions and/or repair. Make sure when selecting a cement to use for potential repairs that you choose the proper primer and cement for the size of pipe you are repairing and temperature you're working on. As an irrigation consultant, I prefer ductile iron fittings instead of glued schedule 40 fittings because of their durability. But some glue fittings are necessary in all repairs.

## Sprinkler Heads

The third component is the actual sprinkler heads. Just as important as having extra sprinklers and sprinkler parts on hand for emergency repair is spending the time to inspect sprinkler operation and coverage. Some of the turf issues on your greens, tees and fairways could be caused by improper coverage. As designers, we are continually concerned with matching precipitation of sprinkler heads. Older systems tend to get dirt and debris in the nozzles that could alter the gallons per minute (GPM) output of the sprinkler and change the precipitation rate, causing dry spots and hydrophobic conditions. These older systems are usually expanded over time which also can affect operation pressure, changing precipitation rates. Catch dishes can be used for analyzing precipitation rates (R factors) on your course. It is a good idea to stock sprinkler heads in order to repair your system quickly. Valve assemblies, solenoids, nozzles, drive assemblies and bodies are also handy to have available to maintain or fix a problem. When budgeting irrigation expenses, you should consider time spent checking and observing your system to make sure everything is

working properly. Weekly system checks can help prevent problems caused by non rotating heads or clogged nozzles.

## Valves

Valves are the fourth component, both block valves and isolation valves for the main line. Although block valve systems are becoming less popular and are being replaced by electric valve-in-head systems for more flexibility, there are still a lot of block systems in the field. Block valves require solenoid maintenance, diaphragm assemblies and, in some cases, valve bodies. These, along with time spent to repair them, need to be considered when setting up an irrigation budget.

## Controllers

The fifth and final components are the satellite controllers and the central system. Field satellites can be affected by lightning, so you need to stock a lot of fuses and check your lightning rod connections. The central controller (if you have one) is something a superintendent uses almost every watering day, but may be susceptible to software and hardware issues. Different manufacturers offer different service programs to help update hardware and support any software issue you may have.

By carefully considering these five, major irrigation components and the time spent and outside services required to keep your system operating properly, you not only will have a more efficient, trouble-free irrigation system, but you also should be able to predict an accurate annual irrigation budget.

*Erik Christiansen is president of EC Design Group, Ltd., an irrigation consulting firm specializing in golf course, athletic field and large commercial irrigation feasibility studies and design. EC Design Group, Ltd. P.O. Box 65036, West Des Moines, IA 50265, Tel.(515)225-6365, FAX (515) 225-6366.*



# Changing of the Guard



To All *TurfGrass TRENDS* Readers and Friends,

You are holding in your hands the first issue of *TurfGrass TRENDS* published by Advanstar Communications. While it may not look any different than your last, there are two differences worth noting.

1. As a large communications company with more than 60 business magazines and professional journals, 80 exhibitions and conferences and a diverse array of database, direct marketing and reference products, we have the resources and publishing talent to help TGT grow.

2. *TurfGrass TRENDS* now joins *Landscape Management* and *Pest Control* magazines as a part of our Green Group. As market leaders in their respective markets, the shared resources of this group will create new opportunities for TGT and add greater reader value.

Our intent is to help *TurfGrass TRENDS* continue to improve as a central information source on technical and research information on turf management issues for all turf managers, no matter where you work or reside. To do that, we will be enlisting your support and working very closely with our editorial and advisory boards.

Please let us know what you think. Your ideas and comments are important to us. Be sure to note our

new telephone number, e-mail and mailing address. They appear throughout this issue and can be found easily on page 2.

We will continue to provide the highest quality of information that you came to expect from Maria Haber, the previous publisher. She and her Editorial Board, comprised of Dr. Richard J. Hull, Dr. Eric B. Nelson and Dr. Michael G. Villani, set the highest standards. We will work closely with this Editorial Board to meet the mission of *TurfGrass TRENDS*.

We congratulate Maria Haber on her successful and creative vision in developing *TurfGrass TRENDS*, and thank her for her continued help and friendship as we welcome *TurfGrass TRENDS* into Advanstar. Maria will devote her time to her other endeavors, but will be available to us on a consulting basis.

Thank you for your continuing support of *TurfGrass TRENDS*. I pledge that we will maintain the same high quality you have come to expect.

John D. Payne  
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