Irrigation audits for sports fields

By Don Savard, CSFM, CGM

Most sports field managers would agree that when the grass is green, life is good! Whether your irrigation system is only a simple hose and sprinkler or an in-ground system equipped with complex technology, the mission is to deliver the right amount of water into the rootzone at the right time. Sports field irrigation management is site specific and the amount of irrigation that your field needs is dependent upon a complex set of variables. These variables include turf species, soil and environmental conditions, amount of use it receives, and how the turf is managed. Also as potable water is becoming a more precious resource, conservation is another concern for the sports field manager. An irrigation audit is a tool used to integrate all of these variables into an irrigation plan that is effective and efficient.

An irrigation audit is a quantitative and qualitative survey of your site that includes your irrigation system's performance, your turf grass's moisture requirements, and your field's soil characteristics. It allows you to make informed decisions to create or modify irrigation schedules to accommodate weather or turf stand health changes. It will likely improve your field's overall quality and possibly save water, time and money. Here's what irrigation audit can do for you:

Show the present condition of your irrigation equipment so that you can make repairs. First find the "as built" construction plans for your irrigation system and confirm that your system components are what was specified and are where they are supposed to be. Note any deviations from the specifications on the "as built." Make sure that you understand how the system works and know how to operate the controllers and the timers. Test every function of your irrigation system and make sure that there are no leaks, and that the components work properly. See that the sprinkler heads are sized appropriately, not clogged and turn correctly. It is likely that you may discover flaws in the system's design, so use this information to take appropriate corrective action.

Measures the performance of your irrigation system. This part of the audit quantifies how much water is flowing out of your system and how long it takes to cover a specific area. Flow rate (expressed in gallons per minute) is a measurement of the volume of the water (or precipitation) coming out of the system. Precipitation rates describe the length of time required to deposit a given depth of water on an area and are normally measured in inches per hour. This information is recorded and will be used elsewhere in the audit.

Show how uniform your irrigation water is being distributed. A goal of effective sports field irrigation is to achieve uniform and consistent coverage. A number of measuring devices or "catch-cans" are positioned in a uniform pattern and the system is operated for a period of time. The precipitate or water that is collected in the catch-can is measured and recorded. This information is used to identify and remediate those wet and dry spot areas of the field that are receiving excessive or insufficient precipitation.

The catch-can devices that you use for capturing precipitation should be uniform and level.

It identifies your site-specific turfgrass water requirements and allows you to customize your program. Your field has specific water requirements that are dictated by the turf species growing in your field. For example, if all growing conditions were equal, perennial ryegrass would still require more water than tall fescue and bermudagrass. Consider the severity of use that your turf is subjected to, the depth of the rootzone as well as environmental stresses such as weather and shade. The level of management that your field receives and the quality expectations of the owners and stakeholders will also factor into your irrigation requirements.

You will discover how quickly your soil is able to absorb water and how fast the water moves through the rootzone. Your field's soil textural and structural characteristics relate to how fast or slow you can irrigate. Do puddles occur during or following an irrigation or rainfall event? A simple physical test performed by a soil-testing laboratory can determine the texture of your soil and be helpful for predicting the soil's water holding capability. Other tests performed in the field can measure the infiltration rate of the water being absorbed by the soil and percolation rate of water moving downward through the soil. All of these tests are part of a comprehensive audit and the information obtained is necessary when establishing an irrigation schedule.

It helps you find out how much water you are losing. After the soil becomes saturated with water following a precipitation event, excess water in the rootzone is pulled downward by gravity through the soil profile. The remaining water is stored in the soil for use by the turf and soon becomes diminished as the turfgrass transpires water vapor and oxygen during photosynthesis. Additionally, some of the water will be lost through evaporation from the plant tissue surfaces and the soil. This combination of moisture losses is evapotranspiration. Evapotrans-piration rates vary seasonally as evaporation and transpiration losses increase during the warmer months and decrease when it is cool. Evapotranspiration can be measured at your site using a specially designed instrument called a lysimeter, but reliable evapotranspiration loss data for your area can also be obtained from your local Cooperative Extension Service.

Think of the soil as a "bank account" for water. The object of supplying irrigation is to make deposits as necessary into this soil "bank account" to avoid becoming overdrawn. But a word of caution here: light, frequent watering to replenish water loss has an adverse effect on turfgrass as it promotes a shallow root system of the turf as well as enabling surface water evaporation from the soil. The deeper the moisture levels in the soil, the lower the daily evaporation rate.

It is a desirable practice to allow some of soil water to become depleted before irrigating. This value, called the Management Allowable Depletion (expressed in percent), is the portion of water in the rootzone that plants can use before experiencing stress. Choose an acceptable level of water depletion, that is somewhere below the field capacity of the soil and above the wilting point. Turfgrass develops a more robust root system as it is forced deeper to seek moisture. Consider the concept of heavier, but infrequent irrigation. Just as paying your bank unnecessary banking fees is a waste of money, overwatering your turf causes surplus water to evaporate or move past the saturated rootzone and become wasted.

It gives you the information to make tactical irrigation decisions during rainy periods. For most of us, a gentle rain supplying our fields with adequate soil moisture is a welcome gift from nature. Thunderstorms, however, are often unpredictable as an irrigation event because the storm's precipitation rate is often faster than the soil's infiltration rate resulting in runoff. The information you obtain from your irrigation audit will help you adjust the run time of your system to compensate for any rainfall you receive.

Irrigation audits are not difficult to perform, but may seem confusing and overwhelming for a first time auditor. Fortunately, there are knowledgeable people who are prepared to help you. A Certified Landscape Irrigation Auditor (CLIA) is a trained specialist who can conduct an irrigation audit for you. (Contact the Irrigation Association at www.irrigation.org for a list of Certified Landscape Irrigation Auditors near you).

For more information about irrigation audits or conducting one yourself, the following sources have helpful information:

Puhalla, J., Krans, J., Goatley, M. (1999). Sports Fields: A Manual for Design, Construction and Maintenance, John Wiley and Sons, Inc. ISBN 1-57504-070-0

Choate, R. (1994) Turf Irrigation Manual,

the Complete Guide to Landscape Irrigation Design, Weathermatic Division of TELSCO Industries, Inc. ISBN 0-9635096-0-8

Landry, G., Waltz, C. Water Management for Sports Fields, The University of Georgia, http://commodities.caes.uga.edu/turfgrass/water-conservation/PDF_Files/Article-11.pdf

Thomas, D., Harrison, K., Dukes, M., Seymour, R., Reed, F., Landscape and Turf Irrigation Auditing: A Mobile Laboratory Approach for Small Communities, Cooperative Extension Service, University of Georgia. http://pubs.caes.uga.edu/caespubs/pubs/PDF/B1253.pdf

Landscape Irrigation Audit Procedure: http://aggiehorticulture.tamu.edu/greenhouse/hortgardens/conservation/agentdemo1.pdf

Taylor, G., White, R., Abernathy, S., Smith, D., Athletic Fields and Water Conservation, Texas Agricultural Extension Service, The Texas A&M University System, http://itc.tamu. edu/documents/extension-pubs/B-6088.pdf

Irrigation Association (2007), Recommended Audit Guidelines, http://www.irrigation.org/certification/pdf/AuditGuidelines_FINAL.pdf.

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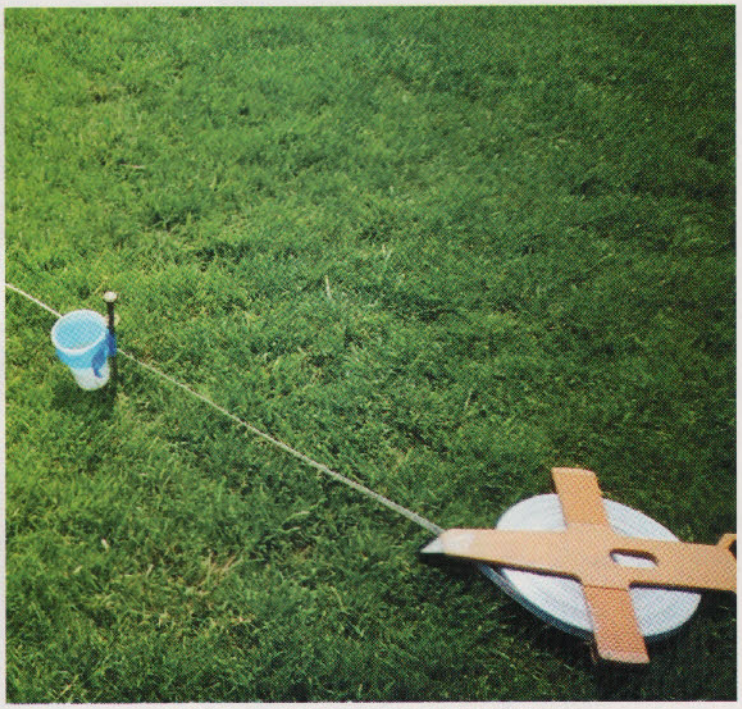
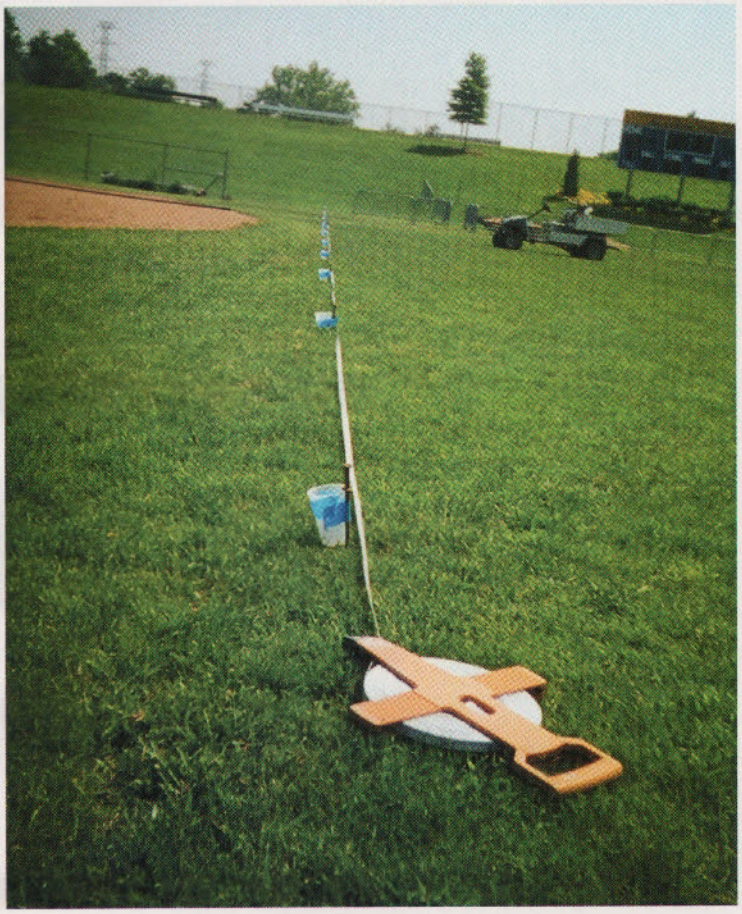


Catch-cans devices may be homemade, but be sure that they are uniform.



Maintain an equal distance between catch-cans for precise measurements.

Here Is How to Conduct a Simple Irrigation Audit

Don Savard, CSFM, CGM

An irrigation audit requires only some time and some very low tech tools (tape measure, catch-can devices, metric graduated cylinder, stopwatch, calculator, notebook and pencil). The audit can be performed with both in-ground and portable above-ground systems. The audit is sequential, meaning that each step provides information necessary for the next step. Choose a clear day with no wind to conduct the audit. You may want to consider a warm day as it is likely you may become wet, so dress accordingly.

The test requires data collection from the field as well as information found on the internet, books and even from the irrigation systems manufacturer. In the field, you will need to **measure the test area** where you will operate the sprinkler. This could be the irrigation zone for an in-ground system or it could be the area that a portable sprinkler would cover. Next, you place catch-can devices in an equally spaced pattern where you will **collect the precipitation** from the sprinkler. The catch-can devices can be store bought or they can be simply a paper cup taped to stake to hold them upright. Just make sure that all of the catch cans are uniform. Run water through the irrigation system for a predetermined amount of time and **measure and record** the amount of water collected in each catch-can.

You will need to find out the volume of water coming out of your sprinklers in gallons per minute. This can be determined with a flow metering device, or manufacturer's technical data for the system. This information will help you find gross and net precipitation. **Gross precipitation** is the water that sprays out of the sprinkler nozzle.

$$\text{Gross Precipitation Rate in inches per hour} = \frac{96.3 \times \text{gallons per minute from the sprinkler nozzle}}{\text{area being irrigated in square feet}}$$

(96.3 is mathematical constant used as a multiplier)

Net precipitation is the amount of water collected in the catch cans. Find the area of the catch-can opening. To measure the area of a circle that is the opening, use the formula:

$$\text{Net Precipitation Rate} = \frac{\text{average catch volume in millimeters} \times 3.66}{\text{test run time in minutes} \times (\text{catch device area sq. inches})\ (16.5)}$$

This device measures the rate of water percolating through the soil profile.

(3.66 And 16.5 are mathematical constants used as multipliers)

After measuring the amount of water in each catch can, determine the uniformity of distribution of the sprinklers. This will show how well the sprinklers distributed the water evenly over the test area.

$$\text{Lower quarter distribution uniformity} = \frac{\text{average of the lower quarter of 25\% of the devices in millimeters}}{\text{average of all catch-can devices}} \times 100$$

Next determine the average water holding capacity of your soil. Different soil textures have different water holding capacities depending on soil pore space. Sandy soils have large pore spaces between the soil particles, silt loams and clays have minute pore spaces. While sandy soils with their large pore spaces can absorb volumes of water quickly, they also drain quickly. The soils such as silt loam and clays hold their moisture much longer. In Table 1, soil type is silt loam.

Following that, the next step was to find out how much water the turf needed and was using and figure out the irrigation volume and frequency. A turf grass plant is more than 90% water and requires a different amount of water than a shade tree. Evapotranspiration, the process where available water in the soil evaporates into the atmosphere and transpiration the process where a plant gives off water vapor and Oxygen as a byproduct of photosynthesis, is higher during the warmer parts of the year than other times. So, transpiration rates vary every month.

SOIL TEXTURE	INCHES OF WATER STORED PER INCH OF SOIL
Coarse sand	0.02 to 0.06
Fine sand	0.04 to 0.09
Loamy Sand	0.06 to 0.12
Sandy loam	0.11 to 0.15
Fine sandy loam	0.14 to 0.18
Loam and silt loam	0.17 to 0.23
Clay loam and silty clay loam	0.14 to 0.21
Silty clay and clay	0.13 to 0.18

(multiply by 12 to get inches of water per foot of soil)

Table 1. Courtesy of Delaware Cooperative Extension

Table 2. The Monthly Potential Evapotranspiration (PET) values for Delaware. (For daily PET values divide by 30)

The values in Table 2 are averages for Delaware and can vary slightly from year to year. As you can see from the table above, the

	PET *(inches)*	Month	PET *(inches)*
JAN	0.00	JULY	6.10
FEB	0.00	AUG	5.31
MAR	0.62	SEPT	3.74
APR	2.00	OCT	2.02
MAY	3.72	NOV	0.75
JUNE	5.25	DEC	0.00

Table 2. Courtesy of Delaware Cooperative Extension

PET values vary by month. If you can measure the ET at your site, you can become very precise.

The Crop Coefficient is a water requirement scale of different types of plant materials relative to the water requirements of other plants and is used as a multiplier in irrigation audit equations.

Table 3. Water Requirement Crop Coefficient (--) for Sports Turf and Other Common Plants:

Using the information from your data collection as well as from the preceding tables, find the irrigation frequency using the following formula:

$$\textit{Irrigation frequency} = \frac{\textit{average water holding capacity} \times \textit{root depth} \times \textit{management allowable depletion}}{\textit{potential evapotranspiration} \times \textit{crop coefficient}}$$

VEGETATION TYPE	COEFFICIENT (–)
Mature trees	0.80
Shrubs (taller than 4 ft.)	0.70
Shrubs (shorter than 4 ft.)	1.00
Warm season turf	0.50-0.70
Cool season turf	0.60-0.80

Table 3. Puhalla, J; Krans, J; Goatly, M; Sports Fields- A Manual for Design, Construction and Maintenance; John Wiley & Sons Inc.

Find the run time frequency using the following formula:

$$\textit{Run time} = \frac{60 \times \textit{irrigation frequency} \times \textit{potential evapotranspiration} \times \textit{crop coefficient}}{\textit{net precipitation rate} \times \textit{irrigation application efficiency}}$$