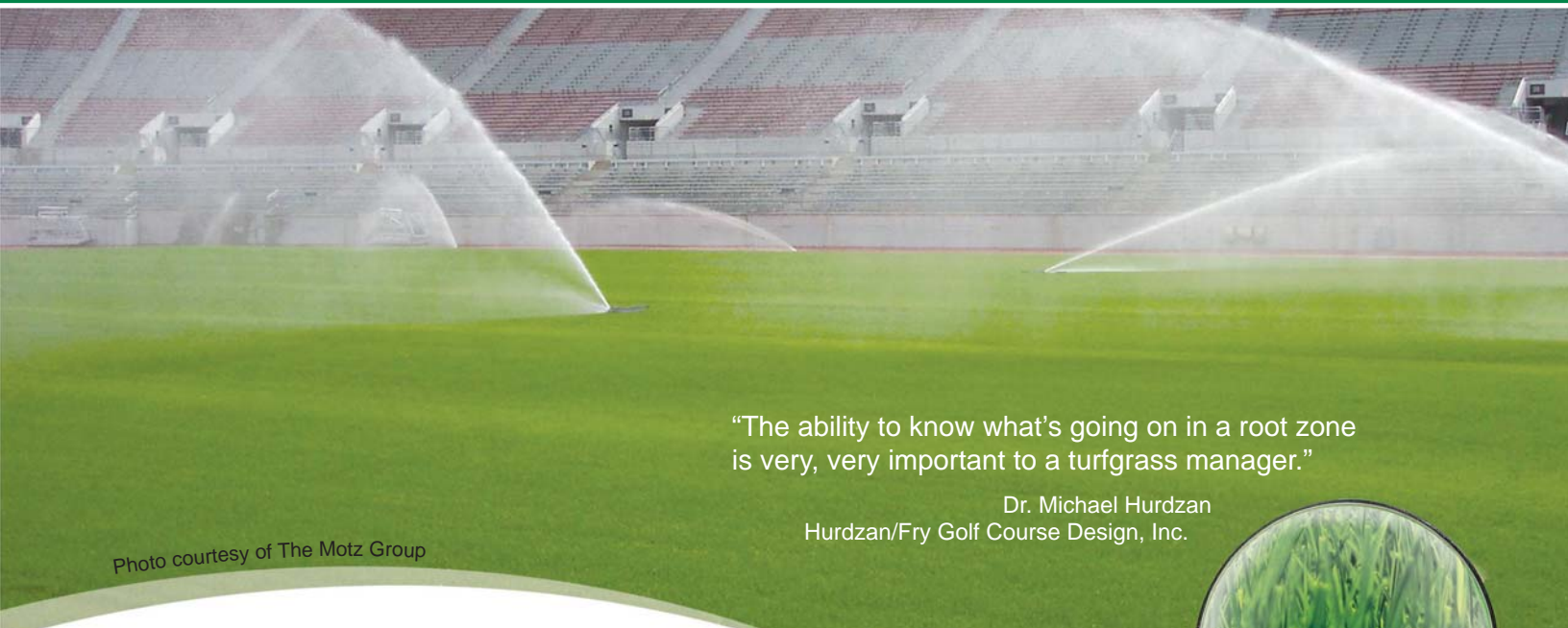


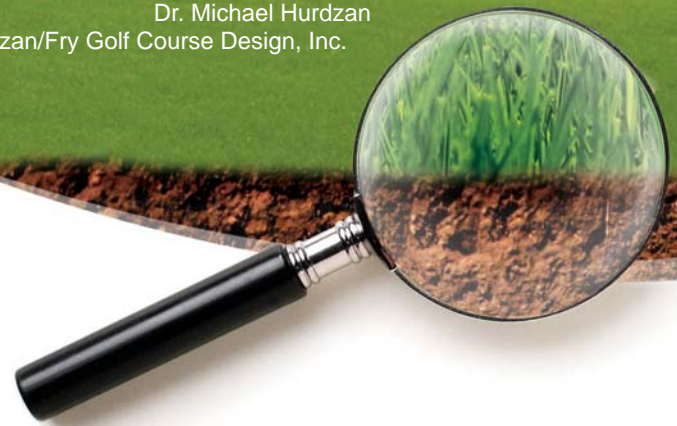
Irrigation and Soil Moisture Solutions



"The ability to know what's going on in a root zone is very, very important to a turfgrass manager."

Dr. Michael Hurdzan
Hurdzan/Fry Golf Course Design, Inc.

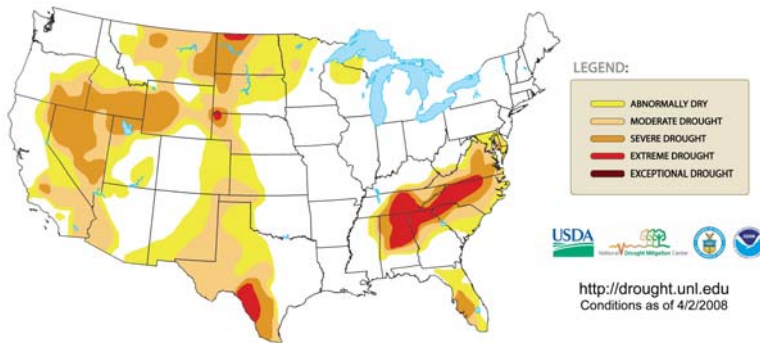
Photo courtesy of The Motz Group



Intelligent Irrigation What is your root zone telling you?

The current drought conditions across the country, brought on by past years of below-average precipitation, will certainly dictate continued irrigation restrictions. Efficient irrigation is one of the most important aspects of proper turf management. It is essential that managers know their water requirements, application rates and the problem spots of their irrigation systems.

Proper irrigation produces strong root zones and the highest turf quality. Improper irrigation can increase water consumption, soil erosion, disease pressure and lead to a loss of vital nutrients in the root zone. All of these factors contribute to higher maintenance costs for the property owner and cause headaches for the turf manager.



**INTELLIGENT IRRIGATION
BEGINS WITH THE
RIGHT DATA** 

CURRENT NATIONAL DROUGHT CONDITIONS

The ability to anticipate and efficiently prepare for future drought conditions is essential. Detecting soil moisture problems farther in advance with greater accuracy and improved geo-referenced detail will be the crucial factor in making irrigation management decisions.

Irrigation System Data: *Fast, Easy, and Accurate!*

Leading the way with



When precision irrigation decisions count, the Field Scout® TDR 300 is your tool to eliminate the guesswork!

Based on proven time-domain measurement technology, these portable units accurately measure soil moisture across the full range of soil moisture conditions. The Field Scout TDR 300 Soil Moisture Meter gives you the flexibility to measure the soil moisture content directly, anywhere in the field. With the internal data logger connected to a user-supplied GPS receiver, The TDR 300 captures geo-referenced data that can be readily imported into our spatial mapping software for full analysis over the Internet.

1) Measure ▶

Connect the TDR 300 to an active GPS receiver. Start collecting your data points along the boundary of the site at 5-step intervals. Once the boundary is set, sample the interior following a grid pattern.

2) Process Your Data ▶

The TDR 300 connects directly to your PC via the data port on the meter. Field Scout software allows you to download your collected data.



SpecMaps™ ProTurf



SpecMaps™ web-based software provides a simple tool for turning your TDR 300 measurements into a 2-dimensional color map of soil moisture variability. The location and relative magnitude of wet and dry spots becomes immediately apparent. SpecMaps also displays statistical information about your landscape, fairway, or golf green, including a histogram for another quick assessment of how uniformly moisture is distributed across the field.

3) Analyze Your Results ▶

Log onto the SpecMaps website. Upload your stored data file and name your map for easy future reference.

Plot your data points alone or create a 2-dimensional contour map

The chart consists of the contour or the data point map. This map is accompanied by a legend that relates the colors in the map to the soil moisture values. See exactly where your site is being over watered or is in need of irrigation with a few clicks of your mouse!

Sprinkler head locations - NEW in SpecMaps ProTurf

You can now plot the location and radius of throw of each sprinkler head. This allows comparison of the soil moisture variability to the expected water application pattern.

Distribution uniformity - NEW in SpecMaps ProTurf

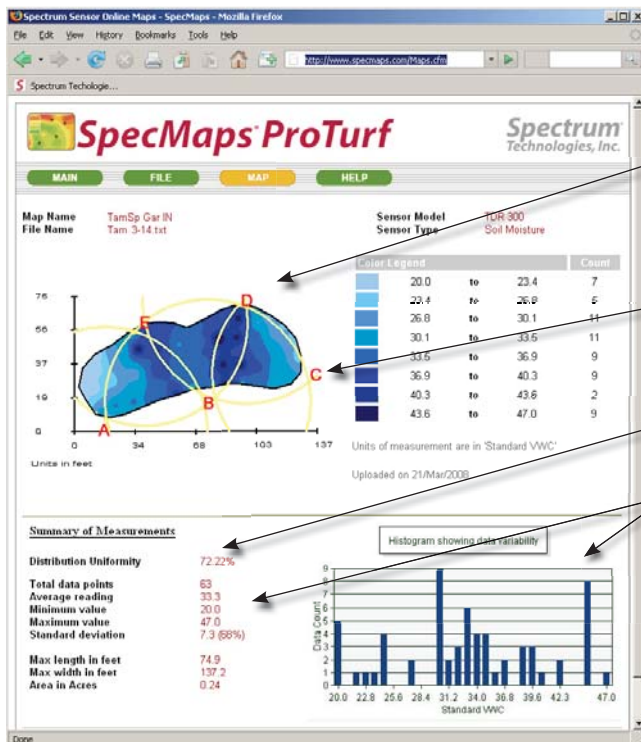
Automatically computes the lower quartile distribution uniformity.

The measurement summary

Includes basic statistical information about the data set as well as a histogram for visualizing the complete soil moisture data range.

The new process is designed to be fast, easy, and accurate. No need for tedious set-up, testing, and re-testing for your results. Get your answers on the spot with true root zone moisture information. You are able to see the complete picture of your turf's irrigation profile in full color and without the need of tiny cups or hand-drawn charts.

Your irrigation audit, **simplified...by Spectrum Technologies.**



Cutting Edge Technology...



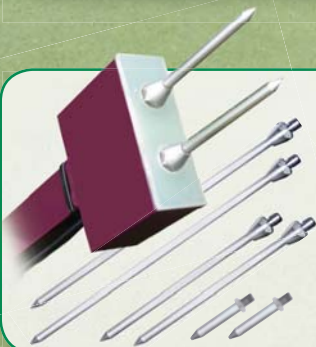
The Garmin GPS 72 & 76

WAAS-enabled for accuracy to within 10 feet (3 meters). The unit is waterproof, rugged and field-ready. The GPS 72 & 76 run for 16 hours on just two AA batteries. (Other GPS units may achieve submeter accuracy) Approx. \$120.00 - \$180.00



Volumetric Water Content (VWC) Mode

Converts a measured electrical signal into percent soil moisture content using an equation valid over a wide range of soils. The LCD screen on the TDR 300 displays the current measurement, the number of measurements taken, and the average of your readings on the spot.



The TDR 300 Soil Moisture Probe Rods

Come in depth measurements of 1.5, 3, 4.8 or 8-inch (3.8, 7.5, 12 or 20-cm) to suit the desired depth measurement. These sturdy, stainless-steel rods can be changed out while testing in the field and gives the user several options to test the soil's moisture content based on the measuring requirements.



SpecMaps Web-Based Software

Allows you to easily upload geo-referenced data files from your TDR 300 meter. Statistical interpolation is used to create charts that give you and your clients an instant visual picture of the spatial variability of soil moisture across the landscape.

"An essential component of precision turfgrass management is 'site-specific management'; and this will be an increasingly important component of soil/water management and sustainability in turfgrass."

Dr. Robert Carrow
University of Georgia, Dept. of Crop and Soil Sciences

Comparison of Irrigation Data Collection Methods

west Traditional Method



Limitations of a traditional irrigation audit:

The traditional process of collecting irrigation data is time consuming: setting up catch cans, drawing out diagrams, and waiting for the watering cycle to be completed. Re-testing areas and going through the whole process again is tedious and not very flexible. Lastly, the traditional audit only measures the water applied but gives no information from the root zone.

The spatial distribution efficiency of a sprinkler system can be checked for uniformity by means of surface collection vessels. However, this does not indicate how the moisture distributes itself in the soil (or, indeed, if it infiltrates at all). Without the information from the root zone, the data is not accurate in showing the full picture of the soil moisture profile.

See the charts below to compare the two methods of data collection

	Traditional Audit	TDR 300 / SpecMaps System
Measures water delivery at the turf level	✓	
Measures water delivery at the root zone level		✓
Irrigation system needs to be running when conducting tests	✓	
Pre-testing set up and post-testing clean up	✓	
Spot testing while walking the site		✓
Measurable water retention of soil throughout the site		✓
Geo-referenced GPS information		✓
Exportable data for analysis		✓
Automated visual analysis of data		✓
Access to data over the Internet		✓
Data stored and backed up on secure server		✓

A study out of Colorado (Mecham, 2001) demonstrated that the lower quartile distribution uniformity (DU_{LQ}) measured by catch cans does not always reflect how moisture is distributed in the soil (columns B and D). The amount of water applied to the turf was determined by either evapotranspiration (ET) or by buried soil moisture sensors. The difference between the two uniformity coefficients is due to the fact that water redistributes itself once it enters the soil profile. Therefore, computing irrigation requirements based on catch-can uniformity can lead to excess water being applied to the soil as can be seen by the corresponding calculated irrigation requirement (columns C and E).

Comparing similar sprinkler zones, same soil type, different data collection methods:

A: Irrigation Schedule	CATCH CANS		SOIL MOISTURE	
	B: DU_{LQ}	C: Irrigation Requirement	D: DU_{LQ}	E: Irrigation Requirement
Daily over-watering	72%	1.39"	93%	1.07"
Twice per week @ ET	68%	1.47"	87%	1.15"
Daily @ > ET	73%	1.43"	90%	1.20"
Daily @ < ET	55%	1.37"	77%	1.11"
Soil Moisture Sensor	70%	1.82"	83%	1.30"

Mecham, Brent. 2001. Distribution Uniformity Results Comparing Catch-Can Tests and Soil Moisture Sensor Measurements in Turfgrass Irrigation. Proceedings, Irrigation Association's 2001 International Irrigation Show, San Antonio, TX, Nov. 2001, pp. 133-139

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