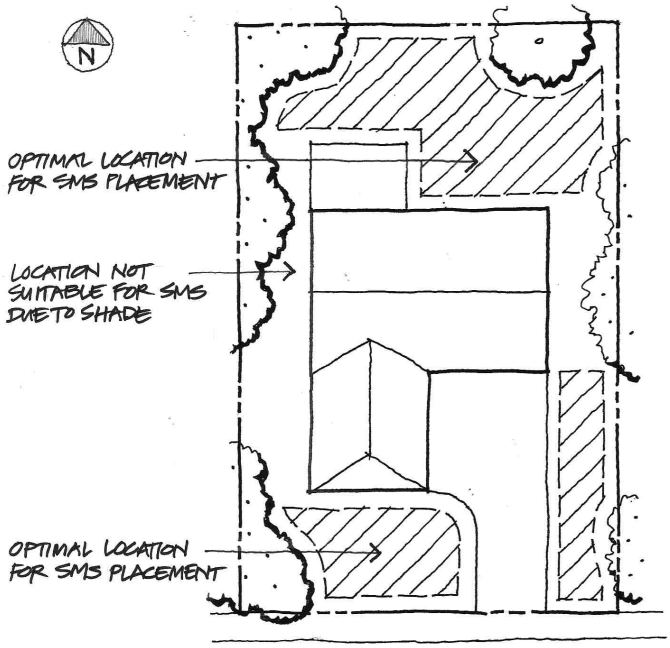
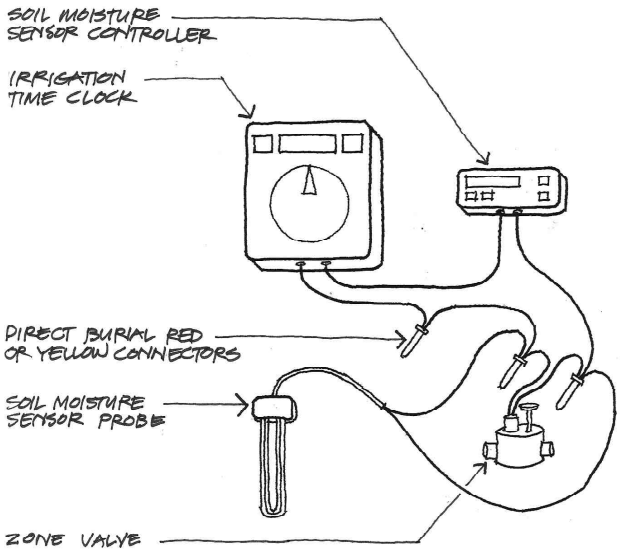
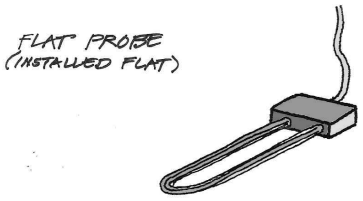
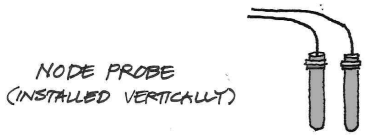
UF UNIVERSITY of FLORIDA
IFAS Extension

Soil Moisture Sensors









(Above left) Layout of irrigated areas showing optimal and unsuitable locations for sensor placement.

(Above right) Components of an installed soil moisture sensor system. Distances between components are not representative of final installation and are meant to illustrate the connections between the sensor, the zone valve, the controller and the irrigation time clock.

(Right) Two types of soil moisture probes used in typical soil moisture sensor systems.

Definition:

The soil moisture sensor (SMS) is a sensor connected to an irrigation system controller that measures soil moisture content in the active root zone before each scheduled irrigation event and bypasses the cycle if soil moisture is above a user-defined set point. Soil moisture sensors, like rain sensors, are considered rain shut off devices, but while rain sensors measure evapotranspiration rates, soil moisture sensors measure real time soil moisture.

Objectives:

Soil moisture sensors (SMSs) measure soil moisture at the root zone and regulate the existing conventional irrigation timer, resulting in considerable water savings when installed and used properly. A customized soil water content threshold is set, allowing for dryer or wetter soil condition. SMSs function similarly to rain sensors by bypassing irrigation events under rainy conditions, but by measuring soil moisture at the root zone they are more effective at minimizing irrigation when plants do not need additional water.

Applications

- New construction
- Retrofits
- Commercial
- Residential communities

Overview:

When connected to conventional irrigation system time clocks, soil-moisture sensors can override scheduled watering events by interrupting the irrigation controller circuit when adequate moisture is detected in the soil. The sensors have user-adjustable moisture content set-points that allow unique watering regimes based on plant species, soil type, and/or seasonal rainfall. Though each device manufacturer uses their own method, all soil-moisture sensors detect the electrical conductivity of the soil and convert it to moisture units.

Water Protection Benefits:

Water conservation implications – University of Florida research shows that SMSs can reduce residential irrigation application by 50%. Water savings have been measured between 5% to 88% over typical timer-based irrigation systems, with 59% average savings in one University of Florida study. In another University of Florida study comparing SMSs to water use with and without a rain sensor, the rain sensor resulted in a 34% reduction in water use while the SMS savings ranged from 69-92% for three of the four SMSs tested. In Florida, approximately 50% of residential water use goes to irrigation, meaning that SMSs can reduce overall residential water use by 25%. Use of soil moisture sensors results in greatest water savings during rainy periods.

Stormwater implications – The significant reduction in unneeded landscape irrigation translates to reduced runoff. As a result, fewer nutrients from fertilizers and chemicals from pesticides are carried off individual lots and landscaped areas. Additionally, there is a reduction in the overall burden placed on the stormwater conveyance system.

Design Considerations:

SMSs appear to be effective in all soil types. However, there is a range in effectiveness, and uniform performance across soil types should not be assumed. There is no strong variance for application and use of SMSs across soil types in Florida. SMSs can be used regardless of slope in Florida.

A SMS should be placed in a location that is representative of the water requirements in the zone(s) it is controlling. Where there are variations due to shade, topography, etc., the sensor should be placed in the driest location (ie., in full sun, on high elevation points). In larger landscapes, use of multiple sensors is most effective, with one sensor per irrigation zone (hydrozone). If one sensor is used for the entire landscape, it should be placed in a turfgrass hydrozone and in a location where it is most representative of the average water requirements of that zone.

SMSs should be placed at least 5 ft. from any structure, from impervious surfaces, from depressions/swales, from the property line (to avoid overspray from neighboring irrigation systems), and from septic tanks/drainfields, and at least 3 ft. from plant beds. They should also be placed to avoid high moisture areas, and so should be at least 5 ft. from downspouts, overhangs, hose bibs, air conditioning condensate lines, tree canopy drip lines, and shade on the north side of a home. Sensors are installed in the root zone, in undisturbed soil when possible. Refer to the *Field Guide to Soil Moisture Use in Florida* for detailed installation and calibration instructions.

Benefits

- Reduced water consumption
- Can be set to lower and upper thresholds to maintain optimum soil moisture saturation and minimize plant wilting.
- Can contribute to deeper plant root growth, reduced soil runoff/leaching, and less favorable conditions for insects and fungal diseases.

Operations and Maintenance:

The SMS overrides the controller's scheduled irrigation events when they are not needed but it does not control the duration of those events. To achieve maximum water use efficiency, the irrigation run time must be set appropriately on the irrigation controller according to application rate, season, region and plant needs.

If the system is applying excessive amounts of irrigation, an irrigation contractor trained in the installation and operation of soil moisture sensors should be called in for an inspection. If the system is running properly, an annual recalibration is recommended along with an inspection. More frequent recalibration may be needed due to changing plant needs (site changes or termination of establishment period), seasonal weather variation, or if the sensors were placed improperly.

When a landscape maintenance company or homeowner makes fertilization or pesticide applications, they may temporarily turn off the SMS controller to allow a watering-in application. The technician or homeowner must make sure that the SMS controller is turned back on following that event.

HOA or Regulatory Considerations:

Florida Statute 373.62 states that "Any person who purchases and installs an automatic lawn sprinkler system after May 1, 1991, shall install, and must maintain and operate, a rain sensor device or switch that will override the irrigation cycle of the sprinkler system when adequate rainfall has occurred." Soil moisture sensors are considered rain sensor devices.

The SMS reduces water use by having irrigation events determined by soil moisture conditions rather than a predetermined irrigation schedule. However, watering restrictions in many parts of the state limit irrigation to specific days of the week. Be sure to follow local watering restrictions when inputting timer settings.

Credits in Green Building Certification Programs:

- FGBC-Development Standard (A-6 water conserving irrigation in common areas)
- FGBC-Home Standard (W-26 innovative irrigation technology)
- Florida Water Star[SM]
- Florida Yards and Neighborhoods
- LEED for Homes (WE 2.1 high efficiency irrigation system)
- NAHB Model Green Home Building Guidelines (1.3.5 Manage storm water using low-impact development when possible)

Relative Costs:

Relative costs for a SMS system are low compared to the quantity of potable saved over the lifetime of the technology. Materials and installation costs currently, range from $150 to $400. This is likely the simplest, most cost-effective, and socially acceptable water-efficiency LID practice in Florida. Complex landscapes with multiple hydrozones and plant watering needs may require numerous sensors and increase costs. SMSs can often pay for themselves in as little as 12 months or less as a result of water savings (depending on water use fees and residential consumption).

References and Resources:

Baum, Melissa C., Dukes, Michael D., Miller, Grady L. 2005. "Analysis of Residential Irrigation Distribution Uniformity." *Journal of Irrigation and Drainage Engineering*, July/August 2005, 336-341.

Cardenas-Lailhacar, B., M.D. Dukes, and G.L. Miller. 2008. Sensor-based automation of irrigation on bermudagrass, during wet weather conditions. *Journal of Irrigation and Drainage Engineering* 134(2): 120-128.

Dukes, Michael D., Cardenas-Lailhacar, Bernardo, and Miller, Grady L. 2005. "Residential Irrigation Based on Soil Moisture." *Resource*, June/July 2005, 4-6.

Philpot, Brent. 2008. *Field Guide to Soil Moisture Use in Florida*. Produced for the St. Johns River Water Management District by the Program for Resource Efficient Communities, University of Florida. 40 pp.

"Sensors of today...Savings for tomorrow." http://www.igin.com/Irrigation/pageSensorsToday.htm

Soil Moisture Sensor page at the homepage of Dr. Michael Dukes at UF: http://irrigation.ifas.ufl.edu/SMS/publications.htm

Credits

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