# Notification of Intent to Develop Draft Performance Specifications for Weather- or Sensor-Based Irrigation Control Technologies April 9, 2007

**Introduction**

Outdoor water use accounts for approximately one-third to one-half of all residential water use, and the majority of this water is used for irrigating landscaped areas. To improve the efficiency of landscape irrigation, WaterSense is currently labeling certification programs for irrigation professionals and has begun the specification development process for labeling water-efficient irrigation products.

As a first effort related to irrigation products, WaterSense intends to develop product specifications for irrigation control technologies that use weather- or sensor-based techniques. EPA is holding a meeting on April 19, 2007, as an initial opportunity for interested parties to provide technical input on WaterSense's intended approach. The feedback provided at this meeting, and in anticipated follow-up phone discussions and exchanges with interested participants, will be considered in the development of the draft performance specifications for weather- or sensor-based irrigation control products. Interested parties who are unable to attend the meeting but would like to provide technical input should send their feedback to the WaterSense Helpline at (866) WTR-SENS (987-7367) or e-mail watersense@erg.com.

The specifications will ultimately establish performance criteria to identify and differentiate those technologies that meet criteria for water efficiency and performance. The weather- or sensor-based irrigation control technology product category, as defined by WaterSense, includes those products that establish an irrigation schedule, or modify a predetermined irrigation schedule, based on data input from offsite weather stations or onsite weather stations or sensors. These technologies can save water by tailoring irrigation to meet the specific needs of the landscape and making regular and frequent seasonal adjustments to irrigation schedules.

While WaterSense intends to develop a draft specification for these technologies, several technical points must first be resolved. EPA is seeking input on the topics listed below to aid in developing a draft specification.

**Meeting Discussion Topics**

The technical issues are presented under five primary categories:

- Product Category Name and Scope,
- Potential Specification Performance Requirements,
- Product Testing,
- User Interface Features, and
- Certification Process.

## Product Category Name and Scope

**Weather- or Sensor-Based Irrigation Control Technologies**

WaterSense plans to define the product category, "Weather- or Sensor-Based Irrigation Control Technologies," to include products that establish an irrigation schedule, or modify a predetermined irrigation schedule, based on data input from offsite weather stations or onsite weather stations or sensors. WaterSense anticipates that weather-based irrigation controllers, soil moisture sensors, and possibly others (e.g., rain sensors) will be included within this product category.

Product performance specifications will distinguish technologies in this category in accordance with established testing protocols accepted by the irrigation industry. This product category will include all irrigation control technologies that meet the defined scope and performance specifications. The performance specifications, in terms of water efficiency, will be identical for all products in this category; however, the testing protocol will vary based on the type of control device (e.g., weather-based irrigation controllers, soil moisture sensors, and others).

Under this approach, the product specifications can be updated to include industry accepted testing protocols and new products as they become available. For example, the first version

of the specification for weather- or sensor-based irrigation control technologies might only accommodate the testing and labeling of weather-based irrigation controllers because a generally accepted test protocol currently exists for only these products. When a generally accepted test protocol for soil moisture sensors becomes available, a revised version of the specification can be released to include the test protocol for soil moisture sensors.

Questions for Discussion at Meeting:

- Is this general approach appropriate?
- Is the definition of the intended product category appropriate?
- Are there other irrigation control technologies that WaterSense should consider within the scope of this product category?

**Potential Specification Performance Requirements**

The Irrigation Association (IA) Smart Water Application Technology™ (SWAT™) Committee is developing testing protocols to measure the performance of weather-based irrigation controllers and soil moisture sensors. Several products have been tested according to a draft weather-based irrigation controller protocol while the soil moisture sensor protocol is currently under development.

The SWAT protocol for weather-based irrigation controllers is designed to evaluate how well the controllers use scientific data to irrigate according to a virtual landscape's needs. Each device is initially programmed and calibrated, and is then expected to perform without any human intervention. The test protocol is designed to demonstrate the degree to which the product maintains root zone moisture, based on the assumption that if moisture levels are properly maintained, growth and quality of the landscape will be sustained.

Each device is tested for its performance on six different theoretical zones, which represent different landscape types. The following parameters vary between the zones: soil type, vegetation type, percent slope, and area of the landscape. After initial programming and calibration, the weather-based irrigation controllers are evaluated for how well root zone

moisture is maintained without deficit or overwatering. Each test lasts for at least 30 days, but can extend for a longer period of time to capture fluctuations in weather (rain events). Performance parameters include gross irrigation, direct runoff, soak runoff, effective irrigation, deficit, and surplus. These parameters are used to calculate the measures of performance discussed below. Read full details of the draft protocol.

**80-100% Irrigation Adequacy**

According to the SWAT™ Turf and Landscape Irrigation Equipment Climatologically Based Controllers 7th Draft Testing Protocol (November 2006), 'irrigation adequacy' is a measure of how well the plant's or landscape's consumptive water needs are met.

It is well documented that the appearance of warm and cool season turfgrasses do not significantly differ when irrigated between 80 and 100% of their specific evapotranspiration rates.[1] Therefore, WaterSense anticipates establishing a performance requirement for weather- or sensor-based irrigation control technologies between 80 and 100% irrigation adequacy as defined by the SWAT™ protocol.

Questions for Discussion at Meeting:

- Is this performance requirement appropriate?
- If different values for the range are recommended, please provide supporting rationale.

**Less than 5% Irrigation Scheduling Excess**

According to the SWAT™ Turf and Landscape Irrigation Equipment Climatologically Based Controllers 7th Draft Testing Protocol (November 2006), 'irrigation scheduling excess' reflects water applied in excess of the plant's or landscape's consumptive needs, and is measured as 100 minus the percent scheduling efficiency. The scheduling efficiency reflects how well irrigation cycles avoided direct runoff, soak runoff, and exceeding the root zone working storage capacity.

[1] Beard, 1993; Brauen, 1989; Danielson et al., 1981; Feldhake et al., 1984; Gibeault et. al, 1991; Gibeault et. al, 1985; Meyer and Gibeault, 1986; Minner, 1984; University of California, 2002; and Zazueta et. al, 2000.

The technologies that have completed SWAT™ testing and had their results posted have scored less than 5% irrigation scheduling excess; therefore, WaterSense anticipates establishing a performance requirement that irrigation scheduling excess must be maintained at 5% or less.

Questions for Discussion at Meeting:

- Is this performance requirement appropriate?
- If a different value is recommended, please provide supporting rationale.

Please note that manufacturers that have tested their products and not published the results may confidentially submit the SWAT™ testing results to EPA for consideration in establishing this performance requirement.

## Product Testing

**Testing Requirement: Testing in More Than One Distinct Climate Zone**

WaterSense labeled products must function correctly and realize water savings on a national basis. One technical issue of concern to the WaterSense program in testing weather-based irrigation controllers in a single climate, such as the California central valley, is that the results might not provide representative data on how they will perform in other, more variable climates. To address this concern and evaluate the performance of controllers across a wider spectrum of climate variables, EPA is considering requiring that weather- or sensor-based control technologies be tested and perform satisfactorily in at least two distinct climates.

Questions for Discussion at Meeting:

- Will a requirement to demonstrate successful performance in more than one climate zone adequately address this concern?
- Is testing in two distinct zones sufficient?
- Some products might be designed to only operate in one specific region or type of climate. How should these products be addressed by WaterSense?

Assuming that testing will be required in more than one climate zone for at least some WaterSense labeled products, distinct climate zones will need to be defined for this purpose. EPA has performed a preliminary evaluation of how distinct climate zones might be defined. EPA's preference is to use an existing climate zone scheme that accounts for as many variables that potentially effect plant evapotranspiration as practical, without being unnecessarily complex. Several different climate zone schemes were evaluated for this purpose, including the U.S. Climate Zones for 2003 for Commercial Building Energy Consumption Surveys (CBECS), U.S. Department of Agriculture Plant Hardiness Map, NOAA's Six Regional Climate Centers, the Koppen Climate Classification, the International Code Council's International Energy Conservation Code (IECC) Climate Zones, the Sunset Magazine Garden Climate Zone, the U.S. Average Zone Frost Map, Thornthwaite's Climates of North America analysis[2], and the University of California Cluster Climate Zones. Based on preliminary analysis, WaterSense is considering using an aspect of the IECC Climate Zone map to define distinct climate zones for the purposes of a weather-based irrigation controller test requirement. Under this map, the aspect of interest divides the contiguous United States into three major climate-type zones based on temperature and precipitation. The three major zones are Marine, Dry, and Moist. A map of the zones and underlying definitions are provided in Appendix A of this document.

WaterSense is considering requiring product testing in two of the above mentioned IECC major climate type zones (Marine, Dry, and Moist). Products would need to meet the specification performance requirement in two different zones to be eligible for the WaterSense label.

Meeting Discussion Topic:

WaterSense is seeking feedback on how to best define distinct climate zones if testing in more than one distinct climate zone is required.

[2] Thornthwaite, C.W. 1931. The Climates of North America According to a New Classification. Geographical Review 21(4):633-655.

**Testing Requirement: Weather Station Standards**

Under the SWAT™ protocol, the weather-based irrigation controller performance is evaluated against a nearby weather station that provides reference weather data. The irrigation adequacy and irrigation scheduling excess performance measures are calculated using the reference evapotranspiration (ET) and rain measurements recorded at this weather station. National and state run weather networks across the country have different siting, maintenance, and sensor requirements. The differences in the requirements between the weather networks at the different testing facility locations might be of concern. Currently, SWAT™ protocol testing is conducted at the Center for Irrigation Technology in Fresno, California, which uses reference data from a California Irrigation Management Information System (CIMIS) weather station located approximately one mile from the testing location.

Questions for Discussion at Meeting:

- If testing is conducted at other locations, how should the quality of the reference weather station data be defined?
- When testing weather-based irrigation controllers that have onsite sensors, it is important that the test facility location and reference weather station experience the same weather. Therefore, should there be a maximum allowable distance between the testing facility and the weather station used to generate the reference weather data, or some other means to ensure both locations experience the same weather?

**Testing Requirement: Ensuring the Testing Protocol Mimics Real-World Vendor to End-User Relationships**

The weather- or sensor-based irrigation control technologies should be tested in a manner that is designed to replicate how the technologies will be installed in the field. Therefore, the level and type of manufacturer or vendor input, customized signal processing, or communication with the control device during the test should not differ from what will occur in a standard installation. Several ideas have come forward related to this topic, such as requiring the manufacturer to sign a declaration that its communication with the controller

during the test does not differ from what would occur in a standard installation, or making the manufacturer blind to the exact testing period in some manner.

Meeting Discussion Topic:
WaterSense is seeking input on how to best specify testing requirements so weather-based irrigation controllers are tested under conditions that will replicate real-world performance.

**Test Reproducibility**

The underlying theme associated with many of these issues is the inherent variability of weather between regions and over time. This variation presents certain testing challenges, for example, creating a desire to test in more than one climate, or waiting for certain weather conditions to be achieved before a valid test can be performed. In addition, given this variability, no two weather-based irrigation controllers are tested to the same set of conditions.

This raises the prospect of potentially addressing these issues by testing weather-based irrigation controllers to a standard set of weather conditions. For example, instead of testing controller response to a real-time weather station signal, might controllers be uniformly tested to a set of prerecorded weather data that could be established in advance? The prerecorded data would be selected to test the range of conditions that the weather-based irrigation controller would be expected to perform under.

Questions for Discussion at Meeting:

- Does this idea have merit, and if so, how could it be implemented for signal-based irrigation controllers?
- Could this approach be implemented for weather-based controllers equipped with onsite sensors?

## User Interface Features

How well the weather-based irrigation controller performs will be influenced in part by the design of the user interface. Several issues related to desirable features in a user interface have been identified and EPA seeks additional technical input in this area. Such examples include:

- Technologies with crop coefficients programmed into the weather-based irrigation controller might be accurate for one region of the country, but not appropriate for other regions. Manufacturers should make clear which crop coefficients are used and allow them to be modified by the user in a clear and easily implemented manner.
- Default settings should be water conserving.
- Weather-based irrigation controllers should offer the user the ability to select deficit irrigation, meaning irrigation at less than 100% ET.
- Weather-based irrigation controllers should allow users to comply with time-of-day and day-of-week local watering restrictions.

Meeting Discussion Topic:
WaterSense is seeking input on these features and other user interface issues that must be considered to ensure water savings are sufficient and reliable.

## Certification Process

WaterSense has established a product certification process, described in the WaterSense Program Guidelines. Under this process, products are certified to conform to applicable WaterSense specifications by accredited third-party certification bodies. Certified products are then authorized to carry the WaterSense label. The WaterSense certification process was established to meet the following objectives:

- Provide independent, third-party testing;
- Provide ongoing surveillance of the manufacturing process;
- Avoid being overly burdensome for manufacturers to obtain or EPA to administer; and
- Provide an appropriate level of assurance to customers that the product meets the WaterSense specifications.

EPA recognizes that this type of certification approach is more firmly established in other industry sectors, such as plumbing products, than it is for irrigation products.

Meeting Discussion Topic:
EPA welcomes input on how to implement the product certification process for irrigation products in the most efficient and effective manner possible.

## Other Issues

Are there other issues related to establishing WaterSense specifications for weather- or sensor-based control technologies that warrant further evaluation or consideration that are not addressed in this notification of intent?

## References

Beard, J.B. 1993. The Xeriscaping Concept: What about Turfgrasses. International Turfgrass Society Research Journal 7. R.N. Carrow, N.E. Christians, R.C. Shearman (Eds.) Intertec Publishing Corp., Overland Park, Kansas. P. 87-98.

Brauen, S. 1989. Turfgrass Water Consumption in the Northwest. How Do We Compare to Other Regions? 43rd Northwest Turfgrass Conference, Sheraton-Tacoma Hotel, Tacoma, Washington, September 18-21, 1989.

Danielson, RE, CM Feldhake, and WE Hart. 1981. Urban Lawn Irrigation and Management Practices for Water Saving with Minimum Effect on Lawn Quality. Completion Report to OWRT Project No. H-043-Colo. 120p.

Feldhake, C.M., R.E. Danielson, and J.D. Butler. 1984. Turfgrass Evapotranspiration. II. Responses to Deficit Irrigation. Agronomy Journal. 76, Jan-Feb: 85-89.

Gibeault, V.A., J. Meyer, M.A. Harivandi, M. Henry, and S. Cockerham. Managing Turfgrass during Drought. Cooperative Extension University of California Division of Agriculture and Natural Resources Leaflet 21499.

Gibeault, V.A., J.L Meyer, V.B. Younger, and S.T. Cockerham. 1985. Irrigation of Turfgrass below Replacement of Evapotranspiration as a Means of Water Conservation: Performance of Commonly Used Turfgrasses. P. 340-356. In F. Lemaire (Ed) Proc. 5th Int. Turfgrass Res. Conf., Avignon, France. 1-5 July, 1985. INRA Publ., Versailles, France.

Meyer, J.L. and V.A. Gibeault. 1986. Turfgrass Performance under Reduced Irrigation. Calif. Agric. 40(7,8):19-20.

Minner, D.D. 1984. Cool Season Turfgrass Quality as Related to Evapotranspiration and Drought. PhD. Diss., Colorado State University, Fort Collins.

Thornthwaite, C.W. 1931. The Climates of North America According to a New Classification. Geographical Review 21(4):633-655.

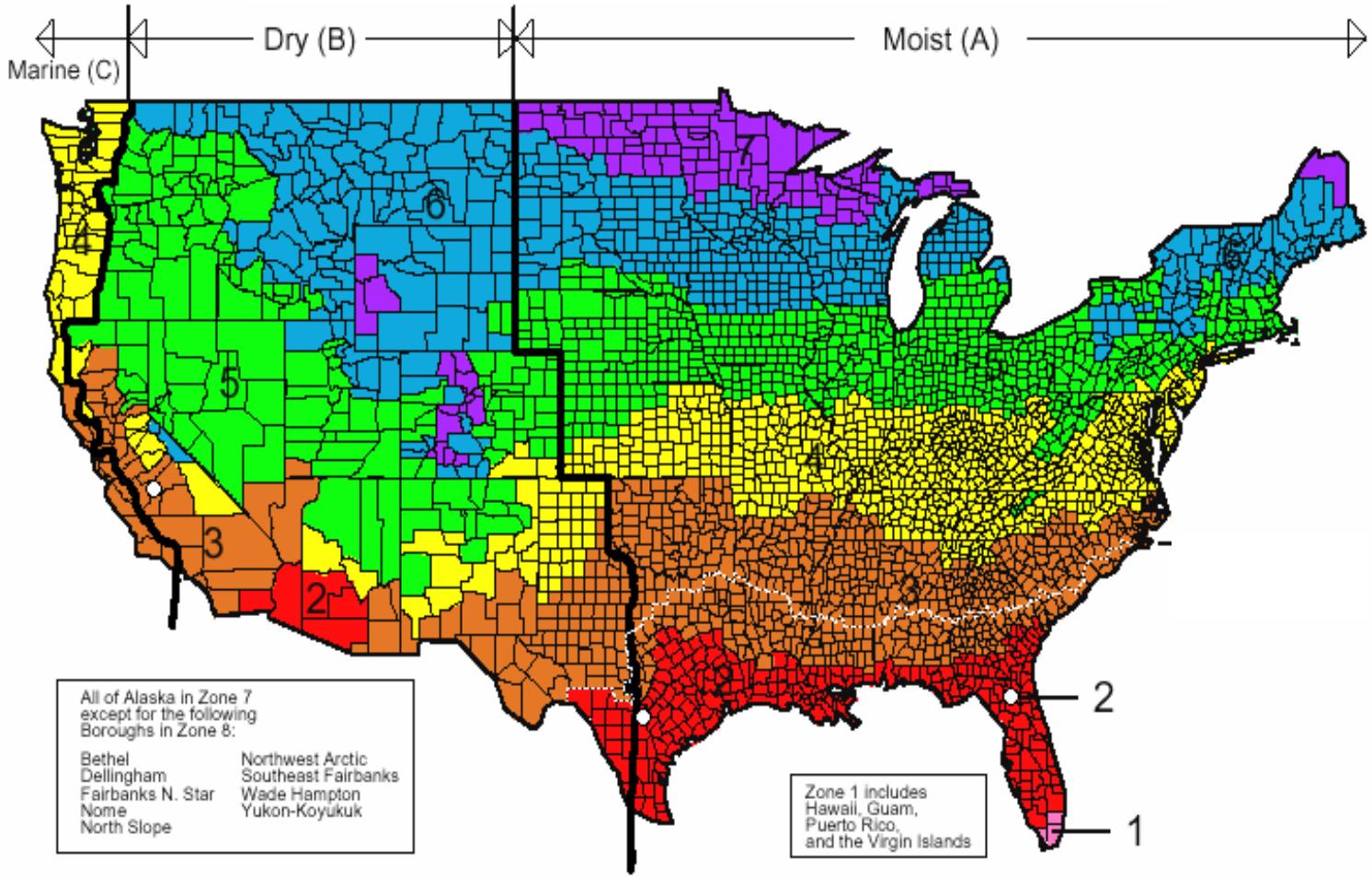
University of California, Riverside Turfgrass Research Program Newsletter, January 2002. Buffalograss and Zoysiagrass: Hot Picks for Functional, Low Input Sites.

Zazueta, F.S., G.L. Miller, and W. Zhang. 2000. Reduced Irrigation of St. Augustinegrass Turfgrass in the Tampa Bay Area. University of Florida Extension Institute of Food and Agricultural Sciences AE-264.

# Appendix A

EPA WaterSense

## Map of the Department of Energy's Proposed Climate Zones



# Climate Zone Definitions (Moisture) for IECC Classification

**A. Major Climate Type Definitions**[1]

**I. Marine (C) Definition**—Locations meeting the following criteria:

- mean temperature of coldest month between –3°C (27°F) and 18°C (65°F)[2] AND
- warmest month mean < 22°C (72°F)[3] AND
- at least four months with mean temperatures over 10°C (50°F)[4] AND
- dry season in summer.[5] The dry season in summer criterion is met when the month with the heaviest rainfall in the colder season has at least three times as much precipitation as the month in the warmer season with the least precipitation. The colder season is October, November, December, January, February, and March in the Northern Hemisphere and April, May, June, July, August, and September in the Southern Hemisphere. All other months are considered the warmer season, in their respective hemispheres.

**II. Dry (B) Definition (SI)**—Locations meeting the following criteria:

Not marine and

$P_{cm} < 2.0 \times (T_C + 7)$

where:

$P_{cm}$ = annual precipitation in cm

$T_C$ = annual mean temperature in degrees Celsius

**II. Dry (B) Definition (I-P)**—Locations meeting the following criteria:

Not marine and

$P_{in} < 0.44 \times (T_F - 19.5)$

where:

$P_{in}$ = annual precipitation in inches

$T_F$ = annual mean temperature in degrees Fahrenheit

**III. Humid (A) Definition (SI)**—Locations meeting the following criteria:

Not marine and

$P_{cm} \geq 2.0 \times (T_C + 7)$

**III. Humid (A) Definition (I-P)**—Locations meeting the following criteria:

Not marine and

$P_{in} \geq 0.44 \times (T_F - 19.5)$