WaterSense® Draft Specification for Weather-Based Irrigation Controllers Supporting Statement

I. Introduction

Outdoor water use in the United States accounts for more than 7 billion gallons of water each day, mainly for landscape irrigation. As much as half of this water is wasted due to evaporation, wind, or runoff often caused by improper irrigation system design, installation, maintenance or scheduling. In addition to working with irrigation professionals to increase water efficiency outdoors, the U.S. Environmental Protection Agency's (EPA's) WaterSense program is addressing irrigation scheduling by labeling efficient irrigation system control technologies. This draft WaterSense specification for an irrigation product is a significant step toward increasing water efficiency in landscape applications.

WaterSense has developed a draft specification for weather-based irrigation controllers to promote and enhance the market for controllers that create or modify irrigation schedules based on landscape attributes and real-time weather data, applying water only when the landscape needs it. The intent of this specification is to assist consumers in identifying and differentiating products that have been certified to meet EPA's criteria for water efficiency and performance.

II. Current Status of Weather-Based Irrigation Controllers

An estimated 13.5 million irrigation systems are currently installed in residential lawns across the United States[1], and an additional 308,000 new systems are installed each year as a part of new home construction[2]. Of the 13.5 million installed units, industry estimates that less than 10 percent use weather-based controllers to schedule irrigation.

The most common method used to schedule irrigation is a manually programmed clock timer. In these systems, the responsibility of changing the irrigation schedule to meet landscape water needs lies with the homeowner or a hired irrigation professional. Clock timer controllers can be a significant source of wasted water because irrigation schedules are often set to water at the height of the growing season, and the homeowner may not adjust the schedule. For example, plant water requirements decrease in the fall, but many homeowners forget to reset their irrigation schedules to reflect this change. Therefore, a homeowner may be watering in December as if it were July. Weather-based irrigation controllers make these schedule adjustments automatically by tailoring the amount, frequency, and timing of irrigation events based on current weather data and landscape conditions.

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[1] Results from the 2005 Residential Energy Consumption Survey Household Questionnaire. U.S. Department of Energy, Energy Information Office. 2008.
http://www.eia.doe.gov/emeu/recs/recs2005/hc2005_tables/2005recshouseholdquex.pdf

[2] Units sold for new construction figure is based on 906,000 housing starts in 2008 as reported in the U.S. Census Bureau, *Housing Starts*, Construction Reports, Series C-20. Thiry-four percent of homes constructed between 2000 and 2005 had in-ground irrigation (based on the results from the 2005 Residential Energy Consumption Survey Household Questionnaire. U.S. Department of Energy, Energy Information Office. 2008).

Currently, performance standards for weather-based irrigation controllers do not exist, but a voluntary effort called Smart Water Application Technologies™ (SWAT) was initiated in 2002 to test product performance and promote these technologies. This national partnership, consisting of water purveyors, equipment manufacturers, and irrigation practitioners, recognized the need for irrigation technologies that create or adjust irrigation schedules based on plant needs. To identify high-performing products, SWAT developed the first test protocol for climatologically based controllers in 2003, and in 2008 published the eighth draft of the test protocol (http://www.irrigation.org/SWAT/Industry/default.aspx?pg=drafts-controller.htm). Approximately 20 weather-based controllers from 15 manufacturers have been tested to date under this voluntary program. Test results for each of these controllers are available on the SWAT Web site.

III. WaterSense Draft Specification for Weather-Based Irrigation Controllers

Scope

This draft specification addresses weather-based irrigation controllers, including both stand-alone and add-on controllers (collectively referred to as controllers) that utilize current climatological data and some form of evapotranspiration (ET) data as a basis for scheduling irrigation. For purposes of this specification, a stand-alone controller is defined as a product in which weather-based control is an integrated capability. This includes a single controlling device (i.e., the irrigation controller) or the combination of an irrigation controller and plug-in device (i.e., a device manufactured for a specific irrigation controller or brand of controllers) when certified and sold together. An add-on controller is a product that modifies an existing system equipped with a standard clock timer controller to use current climatological data as a basis for controlling the irrigation schedule. For purposes of this specification, add-on controllers are defined as those that communicate with the standard controller through a common wire connection. Add-on controllers are included in this specification because they comprise a substantial portion of the weather-based irrigation controller market. In addition, these devices have been through SWAT testing and performed as well as the stand-alone controllers.

This specification applies to controllers that calculate real-time crop evapotranspiration (ETc) based on reference evapotranspiration (ETo) by:

- Using on-site sensor(s) to calculate ETo;
- Using on-site sensor(s) to modify historical ETo;
- Receiving weather data from a real-time remote source to calculate ETo; or
- Receiving direct ETo data from a remote source.

These criteria are based on the SWAT protocol and are intended to include controllers that calculate ETc using on-site sensor(s), controllers that modify historical ETo using on-site sensor(s) [3], and controllers that receive real time weather data to calculate ETc or receive direct ETo data from a remote weather station or network of stations. The scope is intended to match

[3] Because rain sensors do not modify ETc, but interrupt irrigation events based on rainfall, they do not meet this requirement. Controllers must have additional sensors such as temperature or solar radiation to meet this requirement.

the SWAT scope for testing weather-based controllers, but it excludes products that only rely on historical ETo (i.e., do not have any additional sensors to modify historical data).

Soil moisture sensors are not included in the draft specification at this time because there is not an accepted test protocol for such products. SWAT is currently developing a test protocol for soil moisture sensors, and EPA will evaluate their inclusion in the program when that protocol is available.

In accordance with the SWAT protocol, WaterSense is limiting the scope of this draft specification to weather-based irrigation controllers intended for residential or light commercial applications, including home lawns and similar scale light commercial and institutional properties. A review of available products indicated that products with 16 or fewer stations are generally used for this market. SWAT states that its protocol, which forms the basis for this draft WaterSense specification, may not be suitable for testing products used in larger more demanding irrigation systems such as those found in parks and golf courses; therefore, at this time WaterSense is excluding products intended for larger, heavy commercial applications from the specification.

Water Efficiency and Performance Criteria

For weather-based irrigation controllers, the concepts of water efficiency and performance are interrelated and defined by the irrigation controllers' ability to deliver adequate water to meet landscape needs, without overwatering.

Test Protocols

For weather-based irrigation controllers to achieve their water savings potential, it is essential to ensure they are capable of creating or modifying an irrigation schedule that delivers enough water to keep the landscape healthy without overwatering. SWAT's Climatologically Based Controller test protocol measures how well weather-based controllers achieve these goals. This test provides a mechanism to measure both efficiency and performance, which EPA requires before a product can earn the WaterSense label.

In its 2007 Notification of Intent (NOI) to draft a specification for irrigation control technologies, EPA indicated to stakeholders that it was interested in using SWAT's Climatologically Based Controller Protocol (Draft 8) as the foundation for its specification for weather-based irrigation controllers. The protocol is based on input form a wide variety of stakeholders and aligns with the WaterSense requirement for performance-based testing to differentiate products that perform well from those that do not. In the draft specification, WaterSense is moving forward with using the SWAT protocol for performance testing. This protocol is incorporated by reference in this draft WaterSense specification and is independent of the specification itself. The protocol was developed and is maintained by SWAT. Any recommended changes to the SWAT protocol shall be made through SWAT's public comment and revision process.

The decision to use the SWAT protocol is based on stakeholder feedback and additional research conducted over the past two years. In 2007, EPA established four working groups of stakeholders to address questions raised at the NOI public meeting. The Simulated Weather Working Group examined the feasibility of using a weather chamber for product testing, but found this to be too complex and expensive for the purposes of this program. The Performance Measures Working Group was tasked by EPA with identifying performance levels based on the SWAT protocol (Draft 7), but identified some technical issues with that version of the protocol that needed to be resolved. These issues were referred to SWAT and resolved through their comment evaluation process. This resulted in the issuance of Draft 8 of the protocol in September 2008. The Supplementary Features Working Group developed a list of supplementary features a WaterSense labeled controller should contain. The list of features is discussed later in this document. The Multiple Zone Testing Working Group discussed the potential requirement for testing controllers in more than one climate (i.e., dry vs. wet climate). This group recommended that multiple testing facilities in differing climate zones should be available for testing, but products should only be required to be tested at one facility.

As a follow up to the climate zone discussions, WaterSense and SWAT both conducted additional research to examine the transferability of results from one climate region to another. SWAT repeated the tests of a signal-based controller previously tested in California using a weather signal from New Jersey and then from Florida. Test results from the three locations were not significantly different. Because only one type of weather-based controller (signal-based) was used in this study, and the same laboratory performed the test, WaterSense conducted additional research at the University of Florida using five weather-based controllers representing three different manufacturer models (two signal-based and one sensor-based) to test both the transferability of results between climates and the repeatability of the test protocol among laboratories. Two controllers of each of the signal-based models were set up, one with and one without a rain sensor. The third model, a sensor-based controller, had a build-in rain sensor. This study evaluated climate impacts on test results and the reproducibility of applying the test protocol at a testing laboratory different than the Center for Irrigation Technology (CIT) laboratory located in Fresno, California. The study indicated the protocol results were both transferable among climate regions and repeatable between laboratories. WaterSense determined, however, that to ensure repeatability of results between laboratories, the protocol instructions required additional detail. WaterSense is currently developing this additional documentation, which should be completed by the end of 2009. It will not impact the requirements contained in the specification, and is intended only to clarify and standardize the test protocol instructions. For more information on the University of Florida research study, please review the final report posted on the WaterSense Web site (http://www.epa.gov/WaterSense/).

Additionally, the University of Florida study indicated that during testing some controllers scheduled irrigation events with unrealistically short runtimes - in some cases, less than 2 minutes. Runtimes of this length may not fill the irrigation system and in the field would not deliver the intended water to the landscape. The current SWAT protocol does not have a minimum runtime, allowing for these unrealistically short runtimes. To address this concern, WaterSense has included a minimum runtime requirement for product testing in the draft specification. All runtimes (irrigation cycles) that occur during the test period must be greater than 3 minutes in duration. Establishing a minimum run time will help ensure that weather-based irrigation controllers schedule irrigation during testing that will mimic realistic schedules found in the field.

Performance Levels

The SWAT protocol establishes the method by which controllers are tested and provides two output measures of performance - irrigation adequacy and irrigation excess. According to the protocol, irrigation adequacy is a measure of how well the plant's or landscape's consumptive water needs are met. Irrigation excess is a measure of water applied in excess of the plant's or landscape's consumptive needs.

The SWAT protocol does not establish specific targets for irrigation adequacy and irrigation excess that define an efficient, high-performing weather-based irrigation controller. Therefore, in its draft specification, WaterSense has set specific performance levels for these output measures. To meet this specification's performance criteria, products must score greater than or equal to 80 percent irrigation adequacy. The 80 percent is based on well documented research that indicates the appearance of warm and cool season turfgrasses do not significantly differ when irrigated between 80 and 100 percent of their specific evapotranspiration rates[4]. In addition, products must score less than or equal to 5 percent irrigation excess. This level allows for a reasonable amount of variation in controller scheduling, but prevents excessive overwatering.

<u>*Supplementary Feature Requirements*</u>

In addition to the performance requirements identified during the NOI phase, water utility stakeholders indicated that weather-based controllers need to have additional features to maintain their performance and intended long-term water savings. As mentioned above, the Supplementary Features Working Group, consisting of utility and manufacturer representatives, met multiple times over of a period of months to produce the list of supplementary features described in Section 4 of the draft specification. Stand-alone and add-on controllers must meet all features listed in Section 4.0 to qualify for the WaterSense label. Following is a brief description for each feature.

- Non-Volatile Memory: Non-volatile memory is required to ensure that information regarding the irrigation program and settings is retained when the power source is lost and no back-up battery is available.

- High Performing Irrigation Controller: The features listed under this requirement, including multiple programming capabilities, multiple start times, percent adjust feature, and variable scheduling, are included to ensure a controller remains a high-performing conservation controller if the product loses real-time weather input or a weather signal.

- Zone-by-Zone Control: Zone-by-zone control is required to successfully manage landscapes that have multiple areas with various watering requirements that need to be managed separately.

[4] 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.

- Ability to Comply with Potential Utility Drought Restrictions: With the increase of utility-imposed watering restrictions, it is important that weather-based controllers are capable of watering efficiently, while complying with these restrictions.

- Rain Management: Rain shut-off devices are an important component of an efficient irrigation system in many climate regions. Multiple states have mandated the inclusion of these devices by law. Therefore, a WaterSense labeled weather-based controller shall allow for the connection of these devices.

Potential Water Savings

Note: Refer to Appendix A for the assumptions and calculations used to derive these estimates.

Weather-based irrigation controllers have the potential to save significant amounts of water both individually and at the national level. Assuming that a household lawn with a weather-based irrigation controller installed will use 20 percent less water than one with a standard clock timer controller, a household could save 11,600 gallons per year based on an average seasonal outdoor water use of 58,000 gallons per year.

EPA received data from the 2005 Residential Energy Consumption Survey conducted by the Energy Information Administration (EIA) that 13.5 million single family detached homes have automatic irrigation systems, or about 19 percent of all single family detached homes. Assuming that 95 percent of these are candidates for installing a weather-based irrigation controller, 12,800,000 households could be candidates for a weather-based irrigation controller. If all 12.8 million households installed weather-based irrigation controllers, the measure could save nearly 150 billion gallons of water per year nationwide.

Energy savings realized by water utilities will accompany any national water savings. If all candidate households install weather-based irrigation controllers, it could reduce energy consumption of water utilities by 223 million kilowatt-hours of electricity.

Cost Effectiveness

Note: Refer to Appendix A for the assumptions and calculations used to derive these estimates.

The average homeowner installing a WaterSense weather-based controller in place of a standard clock timer controller will realize an accompanying annual water cost savings of $32 due to reduced irrigation water use.

EPA estimates the average cost of a weather-based irrigation controller is approximately $470, based on available market and cost data. Using this estimate, the resulting payback period for installing a weather-based irrigation controller would be approximately 15 years, which is also the assumed product lifetime. The payback period would decrease on properties that use more water than the estimated 58,000 gallons per year.

IV. Certification and Labeling

WaterSense has established an independent third-party product certification process, described on the WaterSense Web site at www.epa.gov/watersense/specs/certification.htm. Under this process, products are certified to conform to applicable WaterSense specifications by accredited third-party licensed certifying bodies (LCBs). WaterSense held a webinar in 2008 to describe the certification system to weather-based controller manufacturers and has taken steps to introduce these manufacturers to WaterSense LCBs. When the final specification is published, manufacturers may submit products for testing and will be authorized to use the WaterSense label in conjunction with certified products.

It is important to recognize that the WaterSense product certification process is independent of ongoing SWAT testing conducted at the Center for Irrigation Technology (CIT) in Fresno, California. Products may still undergo SWAT testing, but in order to earn the WaterSense label, must be tested and certified by a WaterSense LCB in accordance with the WaterSense specification. LCBs will not publish test results or disclose them to WaterSense. The manufacturer will notify WaterSense when a product has met the specification criteria, as indicated by the LCB. Previous SWAT test scores will not factor into the WaterSense product certification process.

Manufacturers are currently permitted to set up their products for SWAT testing at CIT; however, under the WaterSense product certification system, the LCB will be responsible for product set-up based on instruction from the manufacturer. It is anticipated that manufacturers will submit settings to the LCB, which will be programmed into the controller for the test. Further information will be made available as WaterSense works with its LCBs to provide testing for these products.

Regarding add-on controllers, WaterSense is proposing that these devices be tested with one standard irrigation controller, because these devices will connect with all standard controllers in the same way, though a common wire.

V. Additional Issues for Consideration

While weather-based irrigation controllers have been shown to save significant amounts of water - upwards of 50 percent in certain applications - there are numerous outside factors that must be considered and addressed in order to achieve the intended savings. First, it is important to acknowledge that the weather-based irrigation controller is part of the irrigation system and can only perform as intended if the system is properly designed, installed, and maintained. Second, the weather-based irrigation controller must be installed and programmed properly. Third, if the weather-based irrigation controller requires a signal, it must maintain contact with its weather data source to properly schedule irrigation.

WaterSense plans to address these issues with a two-pronged approach using marketing and outreach, as well as our national network of irrigation partners. Marketing and outreach strategies will be used to help consumers and utilities make informed purchasing decisions and necessary irrigation system improvements before installing these technologies. EPA also recommends that purchasers of these products utilize the services of WaterSense irrigation partners who have been certified through a WaterSense labeled program that focuses on water efficiency and weather-based technologies.

Additionally, it is important to acknowledge that weather-based controllers are designed to deliver a targeted amount of water required by the landscape (usually 100 percent of ETo). In some areas of the country where water conservation is promoted, consumers are practicing deficit irrigation, which is watering at less than 100 percent of ETo. If a weather-based controller is installed on a landscape where the user was previously deficit watering and the newly installed weather-based controller is programmed to water at 100 percent of ETo, the water use in that landscape may increase as a result of the controller. This phenomenon was demonstrated in the recent evaluation of a weather-based irrigation controller program in California (Aquacraft 2009), where many of the homes increased water use after installation. The report suggested that this increase was due to previous good watering habits and can be avoided by programming the controller to water under ETo. Irrigation professionals with experience in these technologies will be able to address this issue in the field. While it is true that these technologies can save water at any property if programmed correctly, the report also provides an important lesson to utilities indicating that rebate or giveaway programs should target high water users first to achieve the greatest savings.

VI. Request for Comments and Data

At this time WaterSense is interested in receiving comments on any and all aspects of the proposed draft specification. Comments should be submitted to WaterSense in writing at watersense-products@erg.com.

VII. References

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Appendix A: Calculations and Key Assumptions

Potential Water Savings

Assumptions:

- A study of 14 cities and more than 1,200 homes stated that average outdoor usage is approximately 58,000 gallons annually.[5]
- 13,500,000 detached single family homes have automatic irrigation systems.[6]
- 95 percent of irrigation systems are candidates for replacement.[7]
- Large-scale, long-term studies have shown that on average, weather-based irrigation controllers have the potential to save at least 20 percent of applied irrigation water.[8]

Calculation 1. Annual Individual Water Savings From Installing a Weather-based Irrigation Controller
(58,000 gallons/year) x (20% reduction) = 11,600 gallons/year

Calculation 2. Number of Candidates for Installation
(13,500,000 households with irrigation systems) x (95%) = 12,825,000 candidates for installation

Calculation 3. Annual National Water Savings
(12,825,000 households) x (11,600 gallons/year) = 148.8 billion gallons/year

Potential Energy Saving

Assumptions:

- 1,500 kWh required to deliver 1,000,000 gallons to residences from public supply.[9]

Calculation 4. Energy Savings Realized by Water Utilities
(148.8 billion gallons/year) x (1,500 kWh of electricity/ 1,000,000 gallons of water) = 223.2 million kWh of electricity

Cost Effectiveness Calculations

Assumptions:

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[5] Mayer, Peter W. and William B. DeOreo. Residential End Uses of Water. Aquacraft, Inc. Water Engineering and Management. American Water Works Association. 1998. Table 5.14
[6] Residential Energy Consumption Survey, 2005.
[7] Program assumption based on market research
[8] AquaConserve, 2002; Aquacraft, Inc., 2003; Carlos et al., 2001; Devitt, 2008; IRWD, 2001; LADWP, 2004; Mayer, 2009; MWDOC, 2004; Santa Barbara County Water District, 2003; Saving Water Partnership, 2003; University of Arizona, 2006
[9] Goldstein, R. & W. Smith. 2002. Water & Sustainability Volume 4: U.S. Electricity Consumption for Water Treatment & Supply – the Next Half Century. Electric Power Research Institute, March 2002. Table 1-2

- $2.72 per kilo-gallon of water (marginal cost)[10]
- 15 year product lifetime for weather-based irrigation controllers.[11]

Calculation 5. Estimated Annual Water Cost Savings From Installing a Weather-based Irrigation Controller

(11,600 gallons/year) x ($2.72/Kgal) = $31.55

Calculation 6. Estimated Payback Period for Capital Cost of a Weather-based Irrigation Controller

($470) ÷ ($31.55/year) = 15 years

Unit Abbreviations:
gal = gallon
kgal = kilo-gallons
kWh = kilowatt-hour

[10] Raftelis Financial Consulting. Water and Wastewater Rate Survey. American Water Works Association. 2006.
[11] Program assumption based on market research