



# WaterSense Draft Specification for Soil Moisture-Based Irrigation Control Technologies

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# Housekeeping

- All attendees are muted to minimize background noise
- Please type questions into the Questions box in the GoToWebinar control panel. We will have a dedicated time for Q&A at the end of each section and at the end of the presentation as time allows
- This PowerPoint presentation and a meeting summary will be posted on the public website
- This meeting is meant to be an open discussion
- All questions, comments, and concerns are welcome

# Agenda

- Background
- Scope
- Performance criteria
- Supplemental capability requirements
- Packaging and product documentation
- Testing configuration and compatibility
- Certification and labeling
- Next steps



# What Is WaterSense?

WaterSense is a voluntary partnership program launched by EPA in 2006 that provides a simple way to identify water-efficient:

- Products
- Programs
- Practices
- Homes

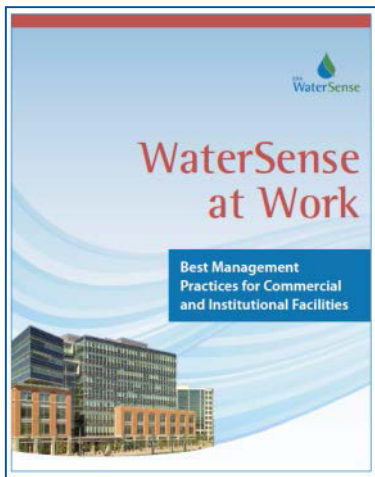


Products are independently certified for water efficiency **and** performance

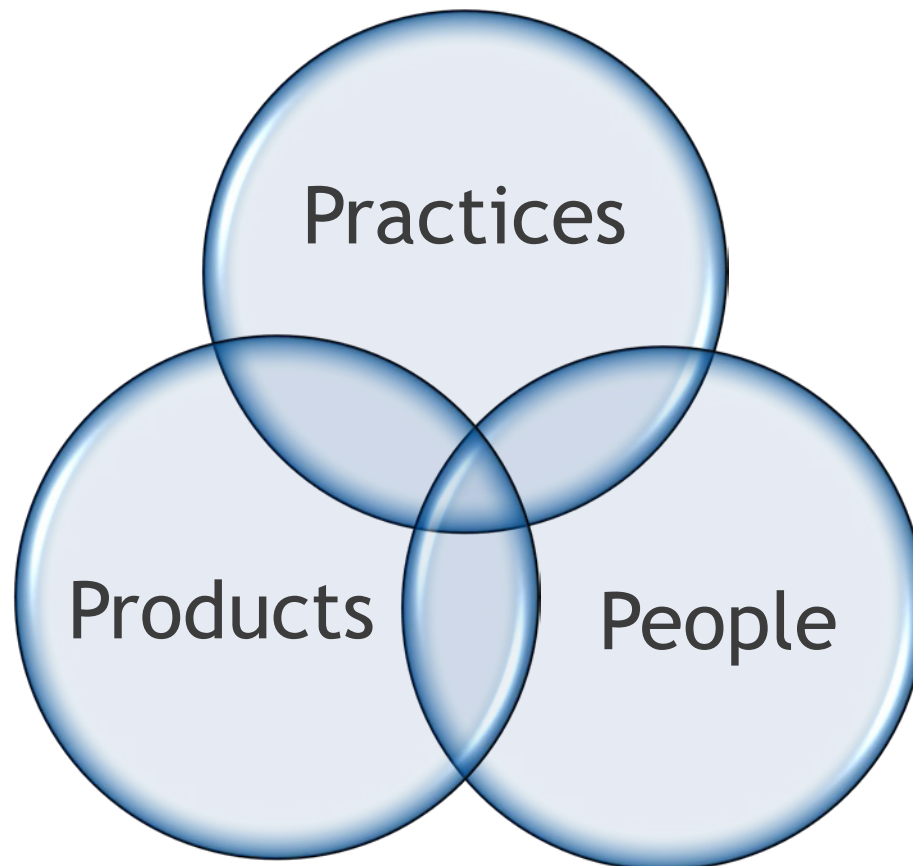


Photo: Judith Chaddock

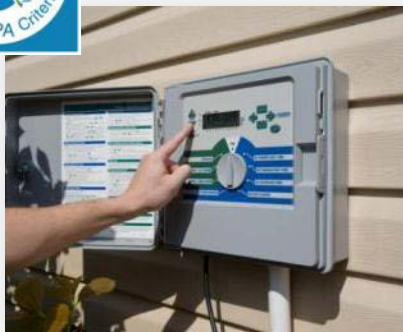
# WaterSense Program Overview



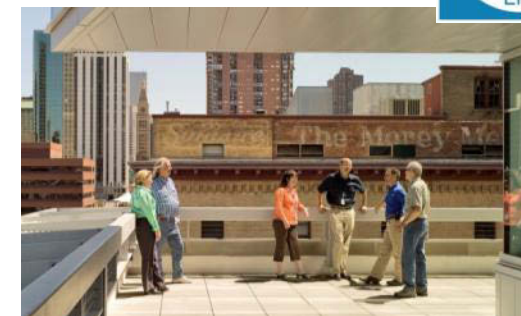
Actions that can be taken to reduce water use—at home, outdoors, and at work



Fixtures and technologies save water



Partners reach users to change behavior



# WaterSense Product Evaluation Factors

WaterSense uses the following factors in determining which products can earn the label. Products must:



- Offer equivalent or superior performance to conventional models
- Be about 20 percent more water-efficient than conventional models
- Realize water savings on a national level
- Provide measurable results
- Achieve water efficiency through several technology options
- Be effectively differentiated by the WaterSense label
- Be tested and independently certified

# WaterSense Labeled Products



**Lavatory Faucets**  
Labeled since 2007  
18,000 labeled models



**Weather-Based Irrigation Controllers**  
Labeled since 2011  
800 labeled models



**Tank-Type Toilets**  
Labeled since 2007  
3,900 labeled models



**Flushometer-Valve Toilets**  
Labeled since 2015  
1,500 labeled models



**Flushing Urinals**  
Labeled since 2009  
700 labeled models



**Pre-Rinse Spray Valves**  
**(Recently Sunset)**  
Labeled from 2013 to 2018  
30 previously labeled models



**Showerheads**  
Labeled since 2010  
9,100 labeled models

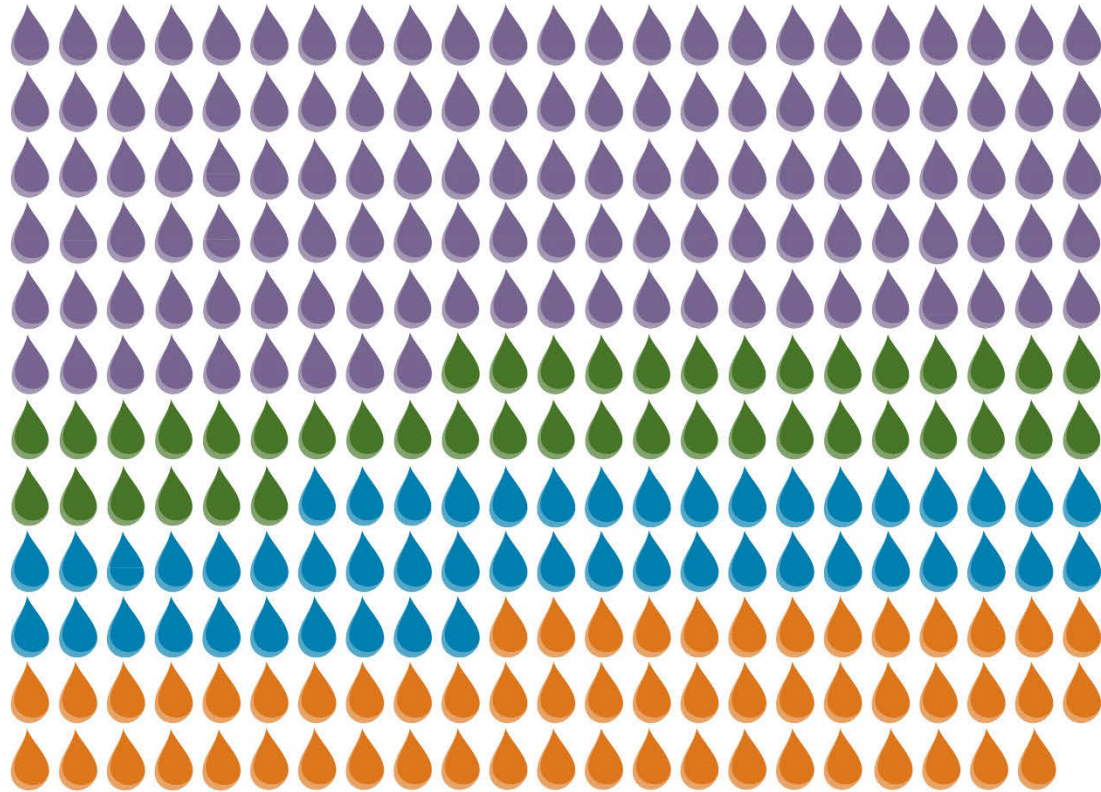


**Spray Sprinkler Bodies**  
Labeled since 2017  
200 labeled models

\*Data as of September 2019

# Accomplishments

**3.4 trillion** gallons of water saved since 2006!



**725 billion** gallons saved in 2018



**saving consumers \$84.2 billion** in water and energy bills



look for



# Questions

look for



# Background

# Soil Moisture-Based Irrigation Control Technologies

- Also referred to as soil moisture sensors (SMSs)
- Save water by inhibiting an irrigation event if the soil is determined to be “wet” enough that the plants don’t need water
- Decision to allow watering is based on actual measurements in the soil
- Threshold to allow or inhibit irrigation is determined by the user, or automatically by the product, as part of the installation process
- While SMSs work in a different way from WBICs, they both provide a means to efficient scheduling compared to a typical clock-timer
- WaterSense is aiming to keep the WBIC and SMS specifications as consistent as possible



Photo courtesy of Hunter Industries, Inc.

# History

- Research and coordination with manufacturers to identify test protocols from 2007 to 2013
- Notice of Intent (NOI) May 2013, specification update 2017
- Working with ASABE X633 committee on a test method
  - Method tests sensors precision and ability to operate after a freeze
  - Two media types, two salinities, three depletions
- Performance testing at the University of Florida completed summer 2019
- Draft ASABE standard released October 18, 2019
- Draft specification released November 7, 2019



# ASABE X633 Standard Committee

- ASABE X633 *Testing Protocol for Landscape Soil Moisture-Based Control Technologies*
- Initiated in 2013
- Tried several different methodologies
- Underwent several rounds of beta testing, then performance testing on the final test method
- Draft standard released October 18, 2019; comments accepted until **December 2, 2019**
- WaterSense references the draft standard definitions and performance test method

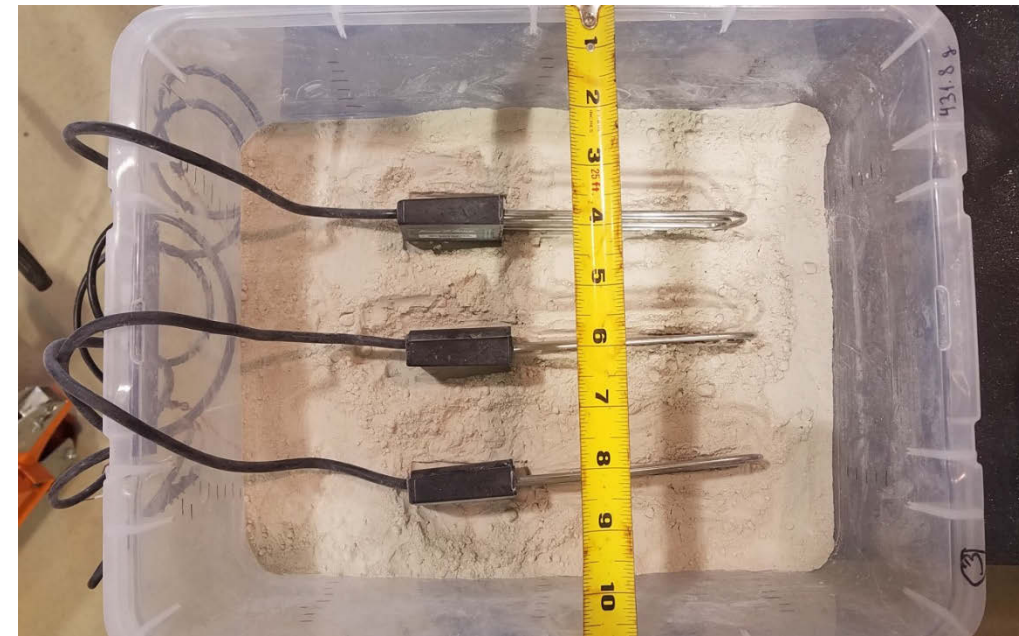


Photo courtesy of Bernard Cardenas, UF/IFAS

# Test Method

- A replicate of three SMSs per manufacturer model are tested
- Examine the SMS's response to changes in soil moisture conditions and ability to consistently enable and disable irrigation events at preset or selected soil water values
- Tested in
  - Three water depletion levels
    - 20, 40, 60 percent
  - Two engineered soils (i.e., media)
    - Moderately coarse
    - Moderately fine
  - Freshwater and saline water
- Freeze Test



Photo courtesy of Bernard Cardenas, UF/IFAS

# Test Method

- Mix air dry media in desired proportions
- Add water for a desired depletion level
- Pack wet soil into test container (in layers)
- Install sensors during packing process
- Pack remaining soil to achieve a volume for target bulk density
- Cover container
- Take readings for irrigation enable and irrigation disable

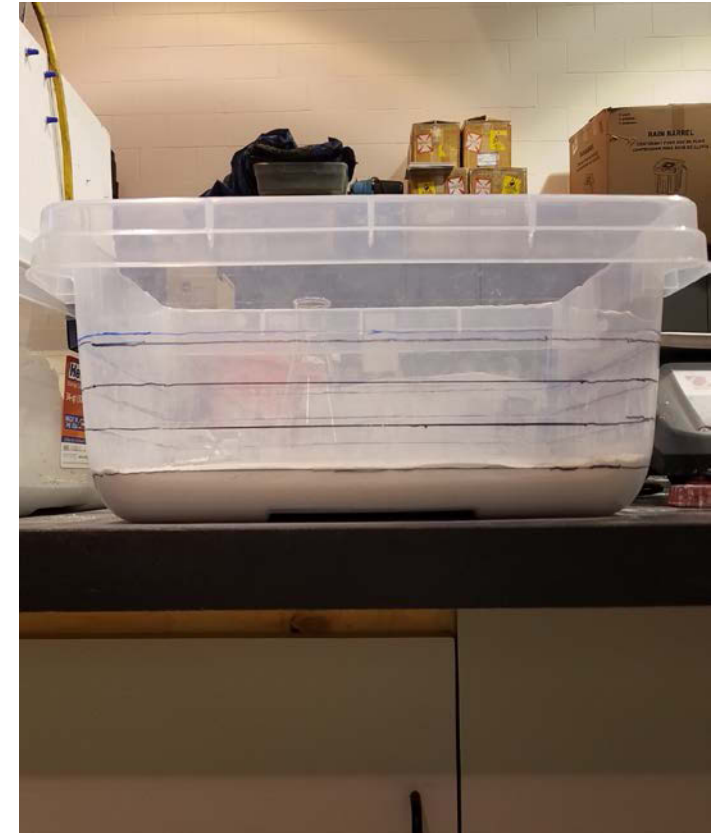


Photo courtesy of Bernard Cardenas, UF/IFAS

# Test Method

- Test Containers – 12 total
- Three replicate sensors in each box (range of 3 to 36 sensors)
- Weight of each container ~ 31 pounds
  - Total weight of media ~ 372 pounds
- Time to prepare three containers for one set of conditions ~ 36 hours (~one week)
  - Total time ~ 3 weeks if media is mixed in batches

Test Media Water Depletion Level (%)	Moderately Coarse Media		Moderately Fine Media	
	Fresh Water	Saline Water	Fresh Water	Saline Water
20	Container 1 000	Container 4 000	Container 7 000	Container 10 000
40	Container 2 000	Container 5 000	Container 8 000	Container 11 000
60	Container 3 000	Container 6 000	Container 9 000	Container 12 000



look for



# Questions

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# WaterSense Draft Specification: Scope

# Scope - Definitions

Defined based on the definitions of the applicable components included in ASABE X633:

- **Soil moisture-based irrigation control technology**—a sensor mechanism and interface device that enables or disables an irrigation event at preset or selected soil water values, commonly known as soil moisture sensors (SMSs)
  - Soil water content sensor controller—measure a property of the soil (e.g., electrical) that is related to soil water content
  - Soil water potential sensor controller—measure a property of the soil (e.g., electrical) that is related to soil water potential

# Scope - Definitions

Defined based on the definitions of the applicable components included in ASABE X633

- **Sensor mechanism**—the portion of the device that contacts the soil and measures physical properties that are related to water content or potential
- **Interface device** – the portion of the device that either enables/disables irrigation events, and/or transmits soil water information to a control system for irrigation decision-making
  - The interface device could be part of an irrigation controller or can be a separate component, either integrated into or separate from the sensor mechanism

# Scope - Definitions

- WaterSense Definitions
  - **Stand-alone controller** – An SMS in which the interface device is integrated into the controller
    - It includes a single controlling device (i.e., the irrigation controller) and the sensor mechanism(s) that provide the soil moisture data
  - **Add-on and plug-in devices** – An SMS in which the interface device is separate from the controller (either a separate component or part of the sensor mechanism)
    - It communicates the sensor mechanism readings to a base controller (typically a clock-timer)
    - Add-ons—designed to work with multiple brands of base controllers
    - Plug-ins—designed to work specifically with one brand of base controllers

# Scope

## Includes

- Products that enable or disable an irrigation event based on reading(s) from soil moisture sensor mechanism(s)
- SMSs for use in residential or commercial landscape applications
- Both wired and wireless technologies
- Stand-alone controllers, add-on devices, and plug-in devices



Photo courtesy of Spiio

# Scope

## Excludes

- On-demand SMSs, which enable irrigation at a lower preset soil moisture level and disable irrigation at an upper preset soil moisture level
- Sensor mechanisms alone (i.e., an interface device is required)
- SMSs intended for use exclusively within agricultural irrigation systems



Photo courtesy of Michael Dukes, UF/IFAS



# Questions and Discussion



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# WaterSense Draft Specification: Performance Criteria

# Performance Testing: University of Florida Study

- Tested four models of SMSs that comprise the majority of the market in accordance with the draft *ASABE X633* test method
- Funded through the ICP via MWD of Southern California
- Data will be available on the ICP website
- Summary report of our analysis is available on the WaterSense website



Photo courtesy of Bernard Cardenas, UF/IFAS

# Performance Testing: University of Florida Study

- Three replicates of each brand tested in two soil media and two salinities at each of the three depletion levels
- 12 total test combinations plus a freeze test per brand
- Results used to establish the performance criteria included in the draft WaterSense specification
- WaterSense identified several modifications that are aimed to simplify and clarify the test for the purpose of the specification

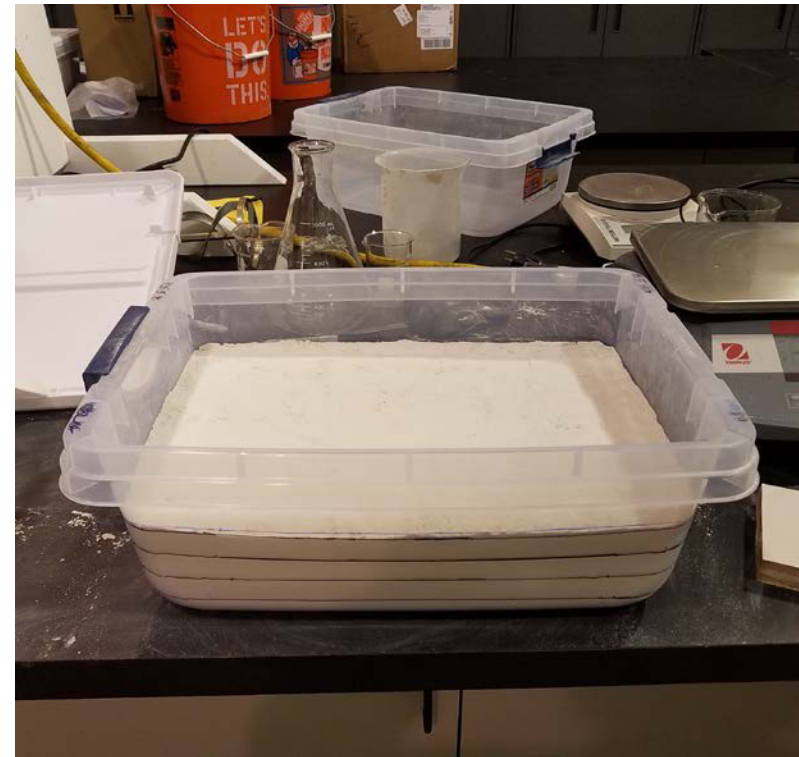


Photo courtesy of Bernard Cardenas, UF/IFAS

# Test Method Modifications

## Engineered Soil Media and Test Water

- No statistical difference between UF test data (coarse vs. fine or freshwater vs. saline water)
- P-value between coarse and fine media was 0.50
- P-value between freshwater and saline water was 0.42
- P-value threshold is typically 0.05 to indicate no difference between two groups of data

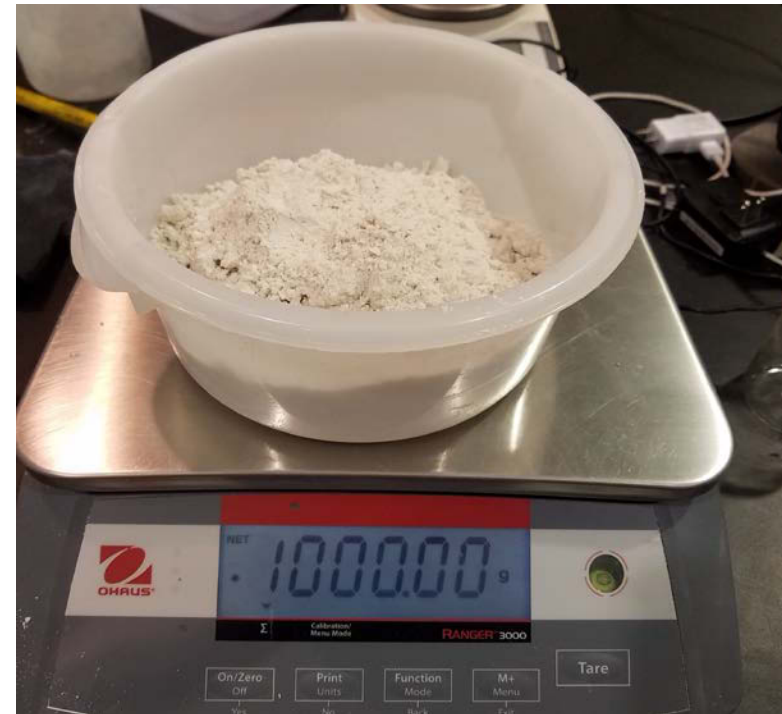


Photo courtesy of Bernard Cardenas, UF/IFAS

# Test Method Modifications

## Engineered Soil Media and Test Water

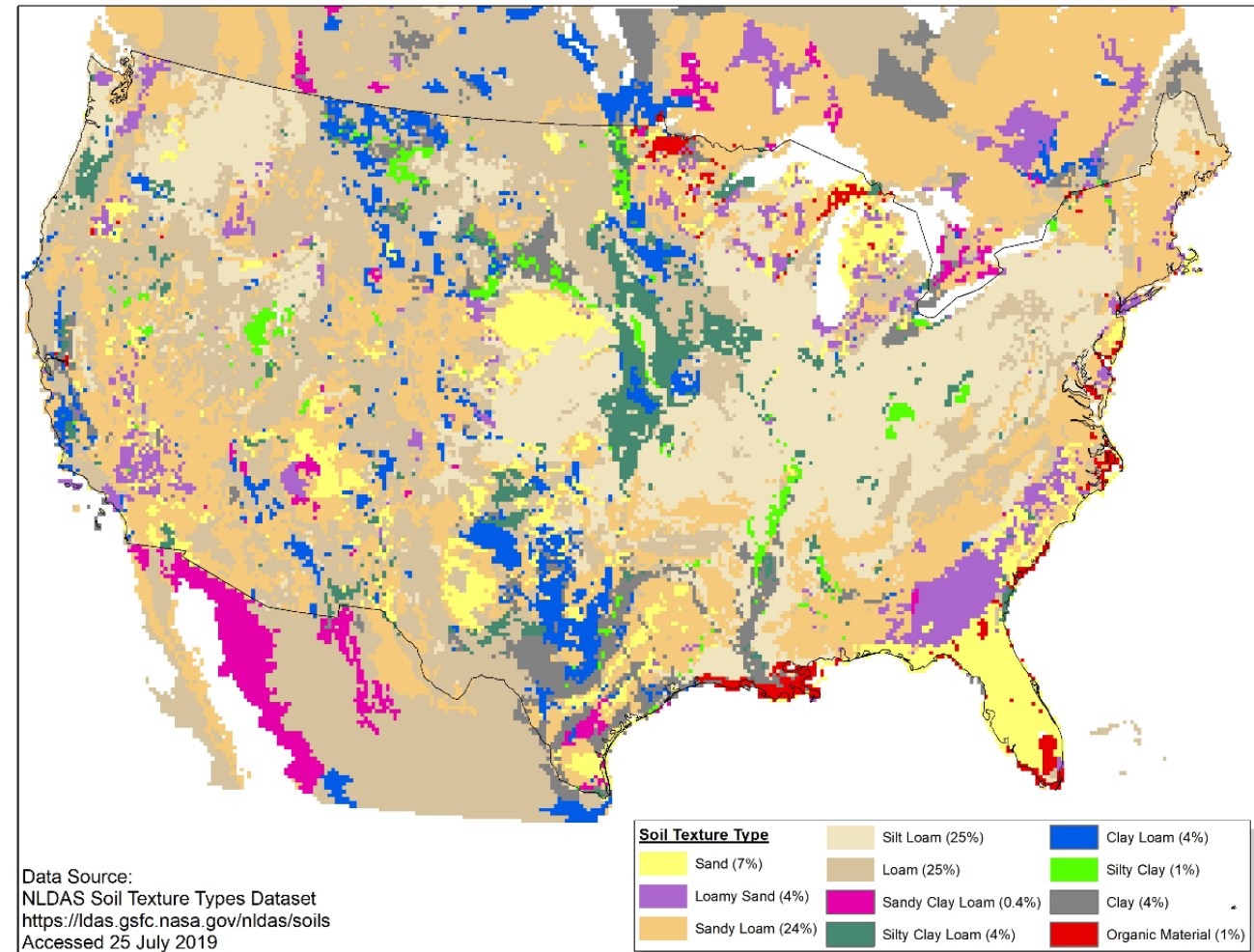
- Specification requires testing only in moderately coarse media and saline water
- Reduces the number of containers from 12 to three
- Reduces labor and waste by ~80 hours and 280 pounds of media

Test Media Water Depletion Level (%)	Moderately Coarse Media		Moderately Fine Media	
	Fresh Water	Saline Water	Fresh Water	Saline Water
20	Container 1 000	Container 4 000	Container 7 000	Container 10 000
40	Container 2 000	Container 5 000	Container 8 000	Container 11 000
60	Container 3 000	Container 6 000	Container 9 000	Container 12 000

# Test Method Modifications

## Engineered Soil Media and Test Water

- Spec to require testing only in the moderately coarse media (representing sandy loam)
  - Sandy loam is the more common soil type across the United States
- Spec to require testing in only saline water (3 dS/m)
  - Users in the past expressed concern over product performance under saline conditions (i.e., reused or reclaimed water)



# Test Method Modifications

## Freeze Test

- Conditions for the freeze test in the ASABE X633 standard are different from WaterSense's proposed modified test conditions
- *ASABE X633* requires the freeze test to be conducted on a specific depletion level, soil medium and salinity (fine media, freshwater)
- WaterSense proposes that the freeze test be conducted on the 40 percent water depletion container using moderately coarse media
- Avoids testing in a new set of soil conditions solely for the purpose of the freeze test
- University of Florida testing demonstrated that neither media type nor salinity had an impact on test results

# Test Method Modifications

## Power Source

- Add-on and plug-in devices shall be connected to a base controller specified by the manufacturer for the performance test
- Addresses potential ambiguity of the power source in the draft ASABE X633 standard
- Provides assurance that the add-on or plug-in devices, when connected to a representative and compatible base controller, can meet the supplemental capability requirements included in Section 3.0 of the draft specification



Photo courtesy of Bernard Cardenas, UF/IFAS



# Performance Criteria

**Function:** Each SMS evaluated shall enable and disable irrigation at each of the three depletion levels.

- Ensures a baseline level of function
- Each SMS must be capable of enabling and disabling irrigation around a soil moisture threshold, as part of the performance test as described in Section 6 of the draft *ASABE X633* standard
- If any of the replicate SMSs do not meet this criterion under any of the test conditions:
  - Stop testing
  - Product does not pass

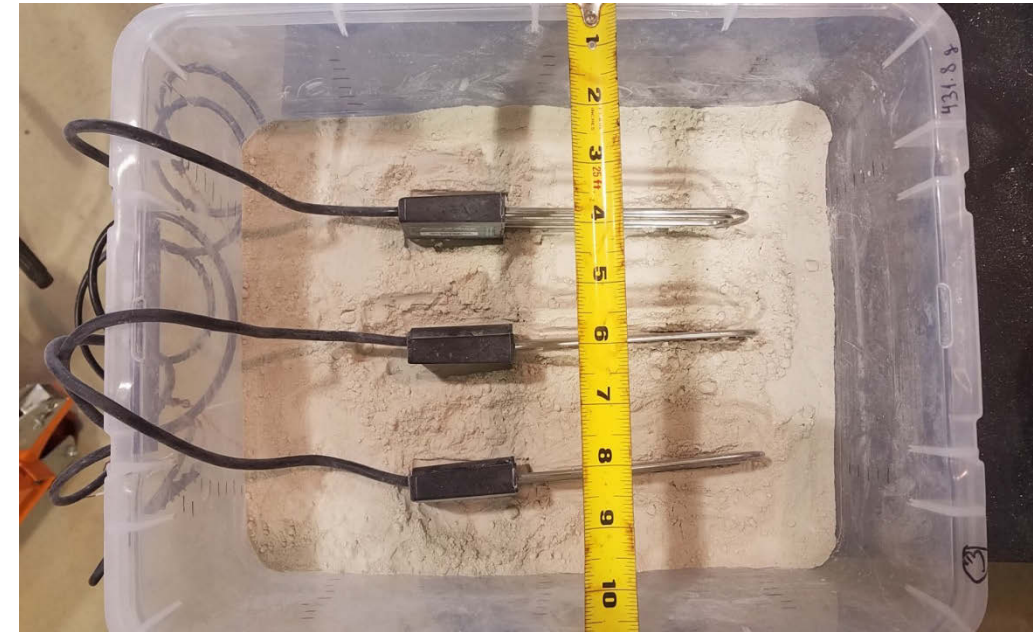


Photo courtesy of Bernard Cardenas, UF/IFAS

# Performance Criteria

**Precision:** The relative average deviation (RAD) of the readings at which the replicate SMSs enable and disable irrigation, when averaged across all three water depletion levels, shall be less than or equal to 10 percent.

High precision is the goal of X633

- Because the products are installed and calibrated in the field to enable and disable irrigation around a threshold moisture level set by the user, precision, not accuracy, determines whether the products perform and will save water
- EPA is specifying RAD as a performance metric, which assesses whether the three sensors are precise in their irrigation enable/disable readings under each set of conditions (i.e., combination of soil and salinity at each depletion level)

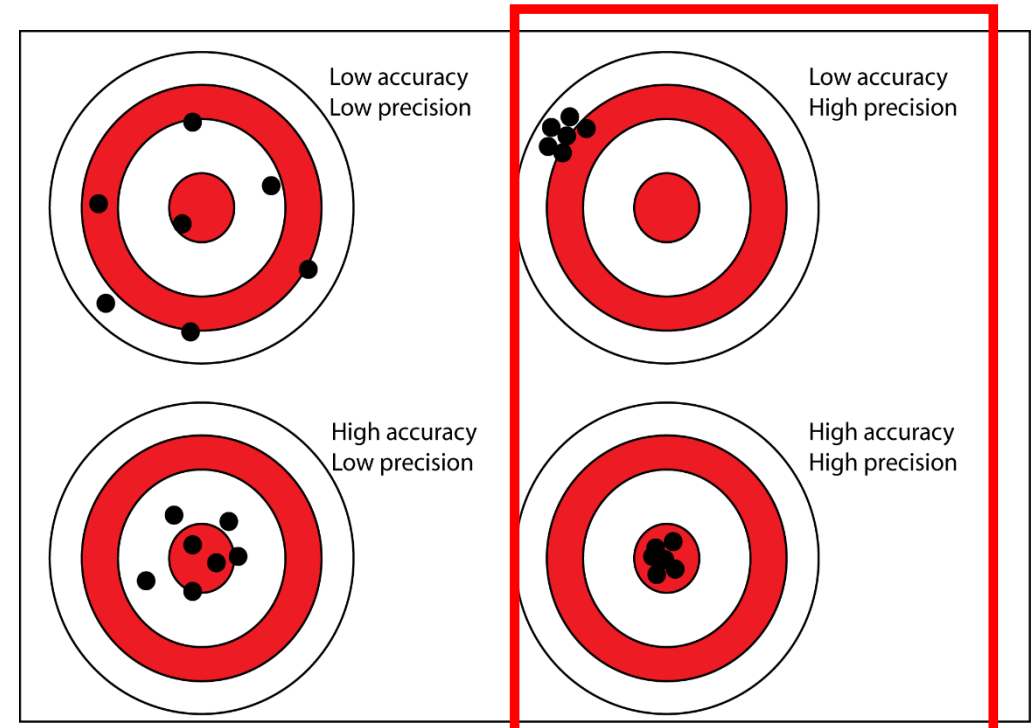


Figure citation: <https://sites.google.com/a/apaches.k12.in.us/mr-evans-science-website/accuracy-vs-precision>.

# Performance Criteria

## Relative average deviation (RAD)

- $Relative\ Avg\ Deviation = \frac{Avg\ Deviation}{\bar{x}}$

Where:

$\bar{x}$  is the mean

- $Avg\ Deviation = \frac{\sum_{i=1}^n |\bar{x} - x_i|}{n}$

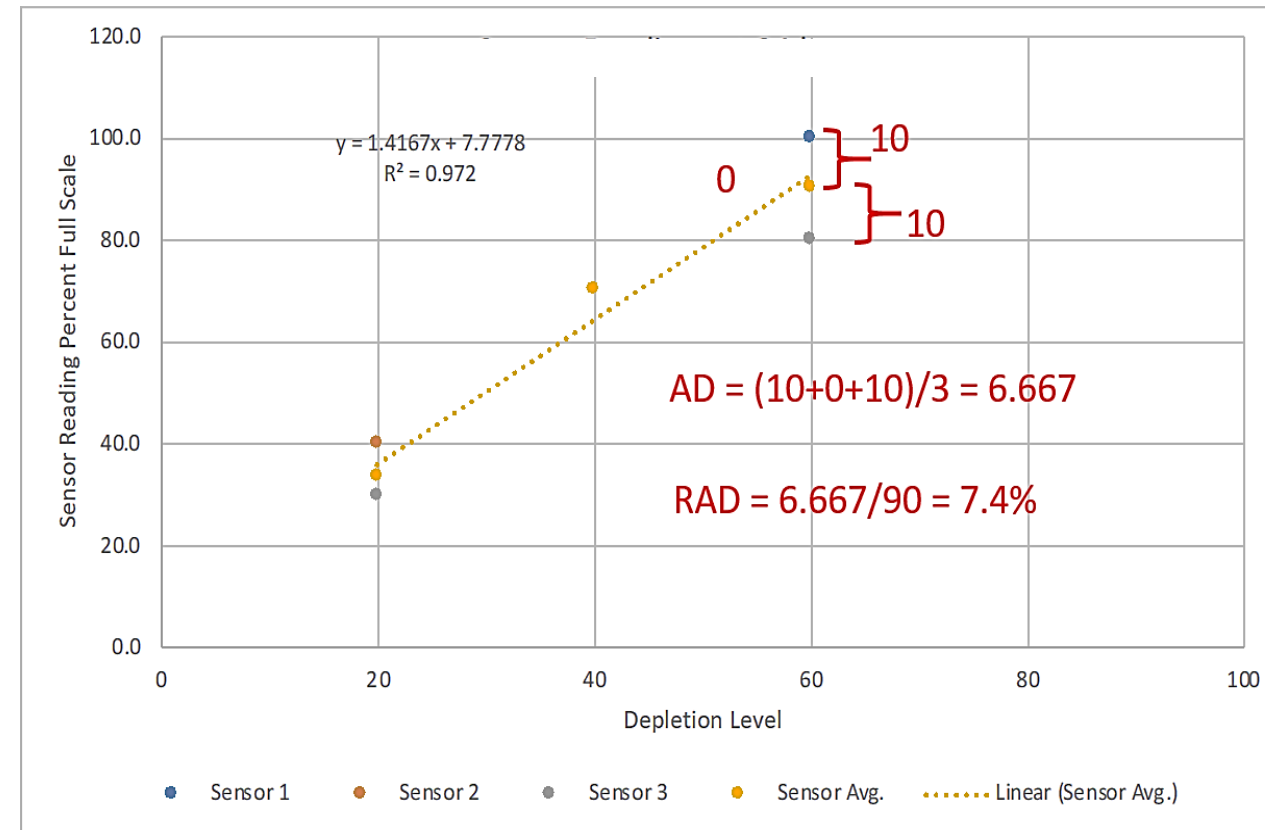
Where:

$\bar{x}$  is the mean

$x_i$  is the observation

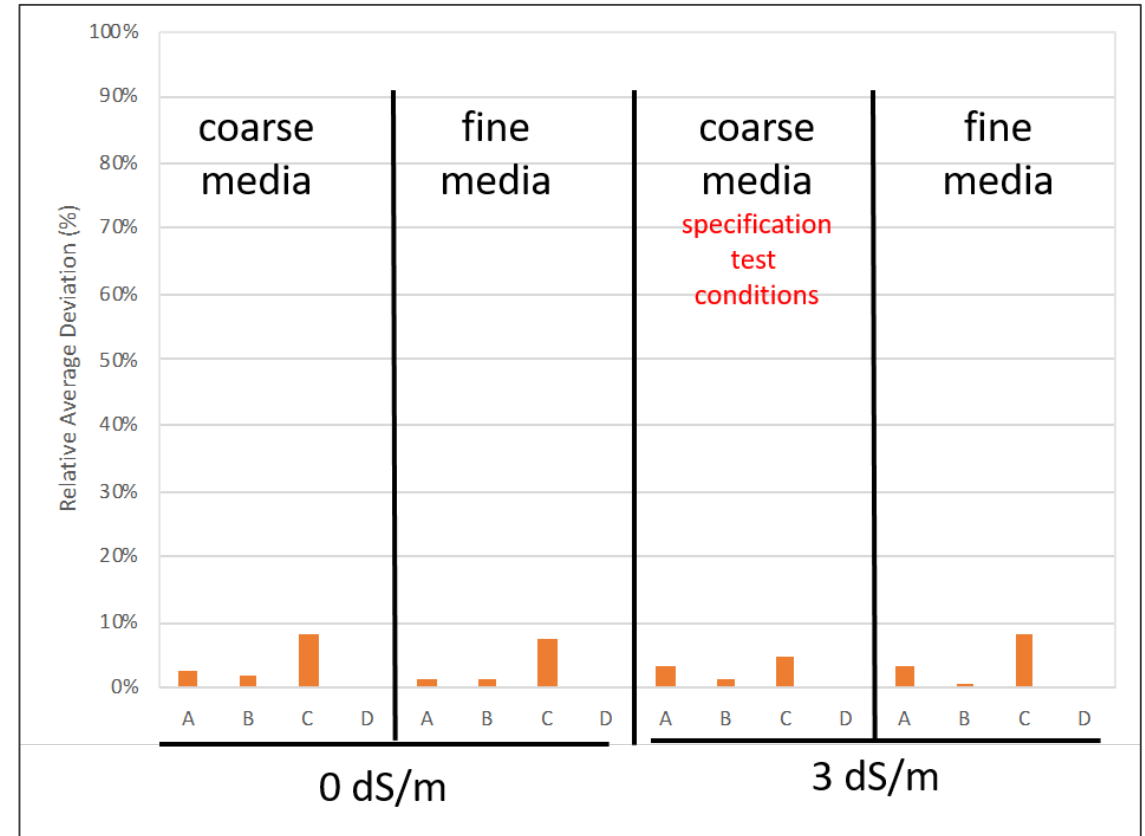
$n$  is the number of observations

- SMSs with a small RAD have high precision and can consistently enable/disable an irrigation event across a variety of conditions at the same preset moisture threshold



# Performance Criteria

- Average RAD of less than 10 percent
- Range of RADs observed in University of Florida performance testing
- Field and plot studies for three models that functioned properly indicate water savings of at least 30 percent
- Draft specification performance threshold includes all products that functioned properly in the University of Florida performance testing

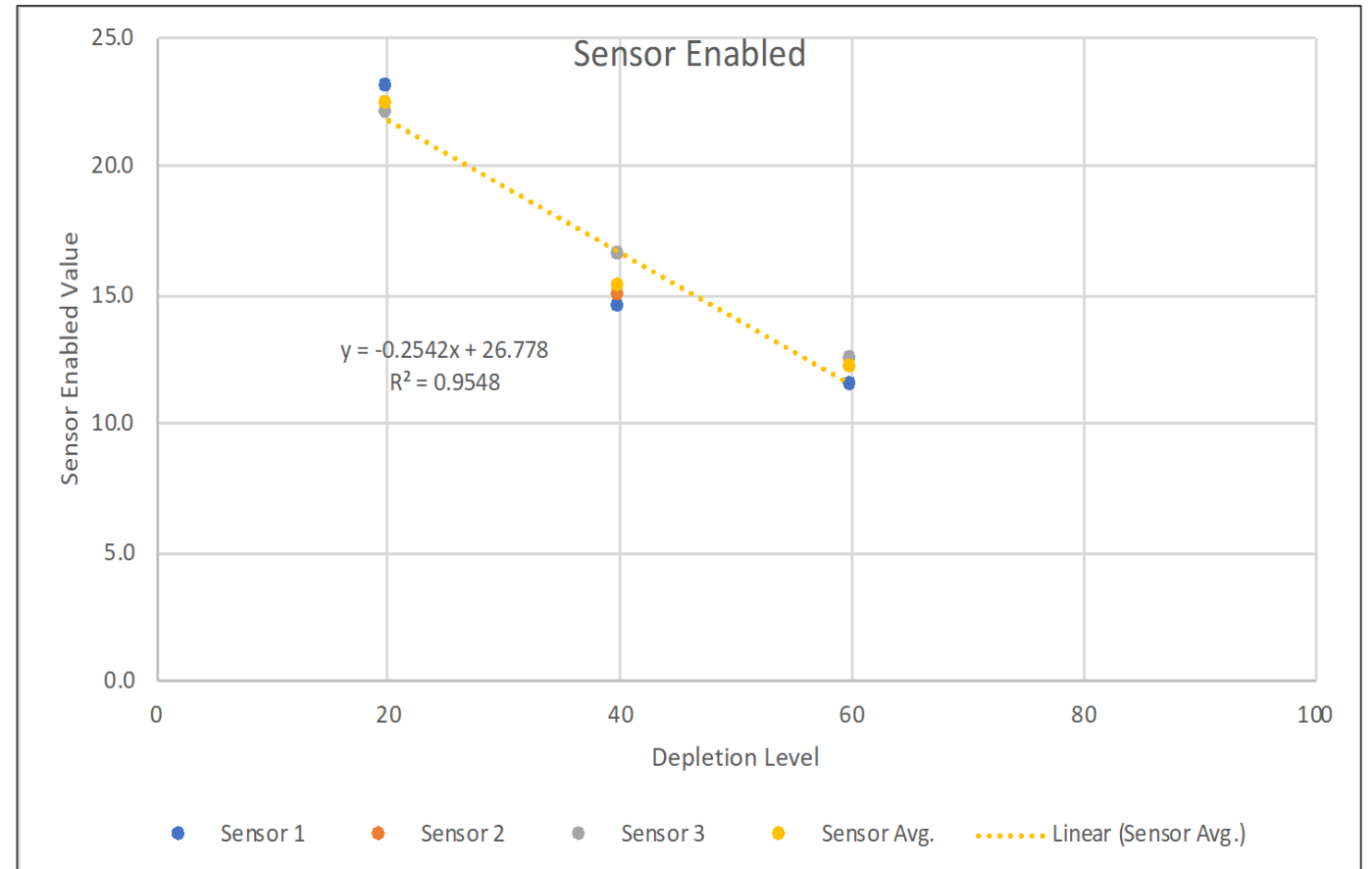


**RAD for Four Brands Included in the University of Florida Performance Tests** (averaged across irrigation enable and irrigation disable readings and across depletion levels)

# Performance Criteria

**Response to change in soil moisture:** The absolute value of the slope of the line generated by plotting irrigation enable/disable readings for all three replicates across all three depletion levels shall be greater than zero when rounded to two significant digits (i.e.,  $\geq 0.01$ ).

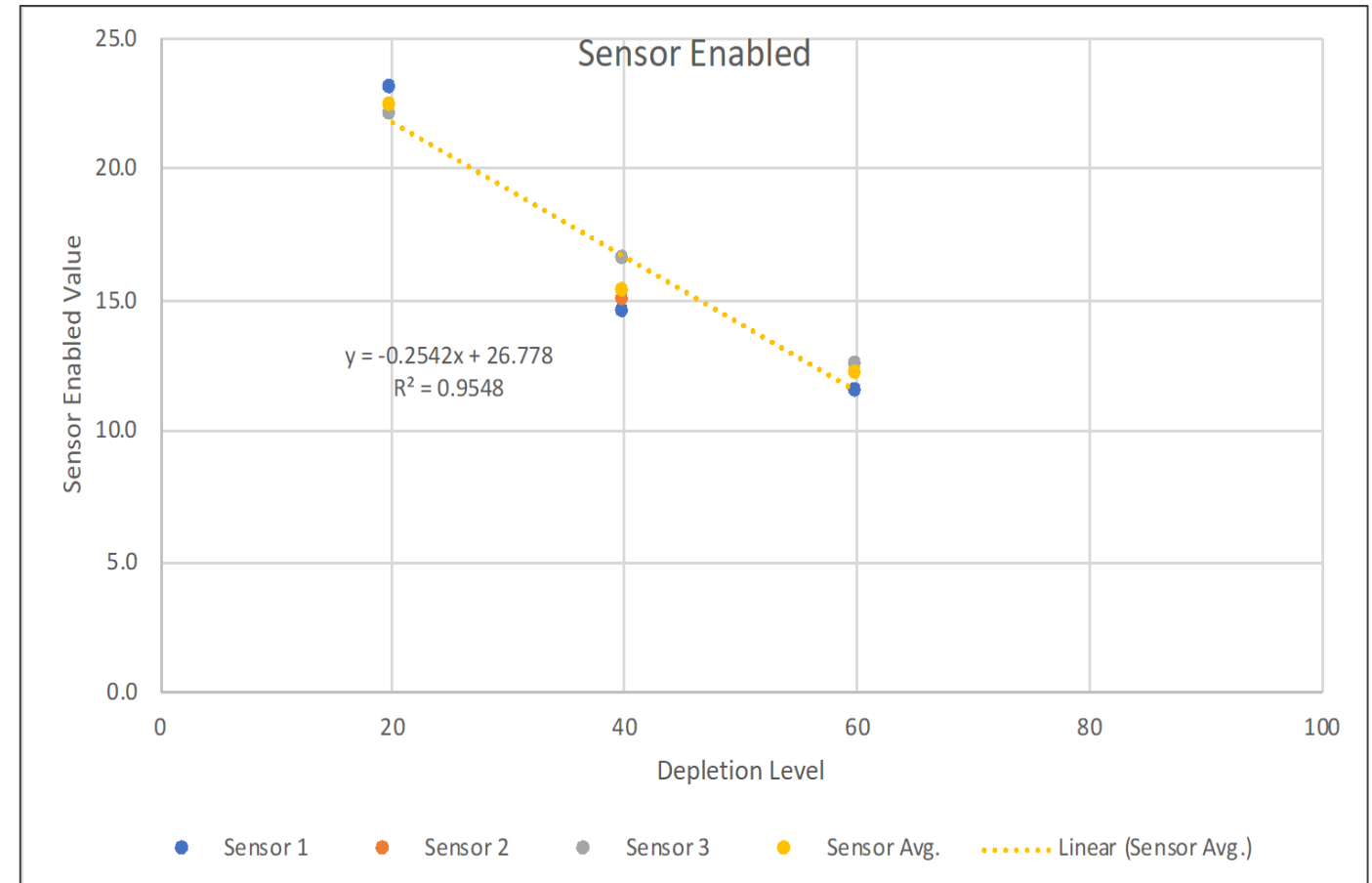
- Products with precise readings might not adequately adjust their readings when the soil moisture changes
- Could affect the point at which the product enables/ disables irrigation



# Performance Criteria

**Response to change in soil moisture:** The absolute value of the slope of the line generated by plotting irrigation enable/disable readings for all three replicates across all three depletion levels shall both be greater than zero when rounded to two significant digits (i.e.,  $\geq 0.01$ ).

- University of Florida results showed absolute values of the slopes ranged from 0.04 to 0.26
- Field and plot studies indicate achievable water savings greater than 30 percent for several products tested
- Where the absolute value of the slope is greater than zero in the laboratory test, products should be able to provide water savings in the field



# Performance Criteria - Freeze

**Function following freeze conditions:** Each SMS evaluated shall enable and disable irrigation after the sensor mechanism is placed in a freezer for three days and thawed to pre-freeze temperature

- Ensures the products function after one freeze-thaw cycle, as specified in Section 7.2 (with modification) of *ASABE X633*
- Only requiring products to continue to enable/disable irrigation after the freeze test
  - Not specifying that products meet a specific RAD threshold
- Products are recommended to be reconditioned every field season
  - Measuring RAD directly after a freeze may not translate to actual field conditions



# Questions and Discussion



look for



# WaterSense Draft Specification: Supplemental Capability Requirements

# Supplemental Capability Requirements

- Ensure consistency with WBIC specification and an equal level of performance
- Initially developed WBIC spec by water utility stakeholders to promote greater long-term water savings
- Working group of utility and manufacturer representatives developed the initial list
- EPA recently reviewed the WBIC specification for possible revision
  - During that process, WaterSense gathered public comments on that specification
  - Stakeholders generally very positive about the supplemental capability requirements and did not request any changes



Photo courtesy of Rachio

# Supplemental Capability Requirements

- Be capable of preserving the contents of the irrigation program and sensor mechanism settings when the power source is lost and without relying on an external battery backup
- Either be capable of independent, zone-specific programming or storing a minimum of three different programs to allow for separate schedules for zones with differing water needs
- Be capable of indicating to the user when it is not receiving sensor mechanism input and is not adjusting irrigation based on soil moisture content in the landscape
- Be capable of interfacing with a rainfall device

# Supplemental Capability Requirements

- Be capable of accommodating watering restrictions
- Include a percent adjust (water budget) feature
- Be capable of reverting to a percent adjust (water budget) feature if the sensor mechanism signal is lost
- Be capable of allowing for a manual operation troubleshooting test cycle and shall automatically return to soil moisture mode within some period of time as designated by the manufacturer, even if the switch is still positioned for manual operation



Photo courtesy of Michael Dukes, UF/IFAS



# Questions and Discussion

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# **WaterSense Draft Specification: Packaging and Product Documentation Requirements**

# Packaging and Documentation

Included to ensure that SMSs packages and documentation promotes water efficiency and performance

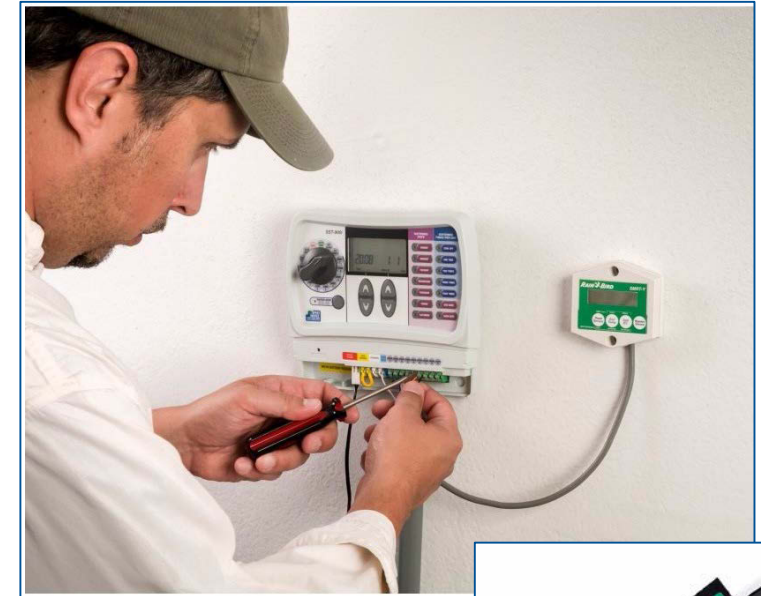
## Stand-alone controllers

- Shall not be packaged nor marked to encourage operation of the controller in standard mode
- Any instruction related to the maintenance of the product shall direct the user on how to return the controller to soil moisture mode

## Add-on and plug-in devices

- Not required to be packaged with compatible base controller(s)
- Documentation shall list each compatible base controller model
- Include statement that the device is only WaterSense labeled when used in combination with a base controller on the provided compatibility list

Photos courtesy of Rain Bird Corporation



look for



# **WaterSense Draft Specification: Testing Configuration and Compatible Base Controller Determination**



# Initial Testing and Compatible Base Controllers

- Product Search Tool will mimic the compatibility listing for WBICs
- Will help purchasers and utilities offering rebates ensure that the specific combination of an add-on or plug-in device and base controller will provide the expected water savings and long-term performance


## WaterSense

### Product Search

WaterSense makes it easy to find and select water-efficient products that can help your wallet and the environment. Just look for products bearing the WaterSense label at your local retailer. Reduce your water use while enjoying exceptional performance with the following WaterSense labeled products. Select a product category below to get started.

**Related Links**

- [WaterSense Products Section](#)
- [WaterSense Home](#)
- [Rebate Finder](#)

 Download a full list of WaterSense labeled product models that includes efficiency information



# Initial Testing Configuration

Allows for consistency with WBIC specification and serves as the basis for determining base controller compatibility, which allows for the retention of all supplemental capability requirements

- Manufacturer shall specify a base controller model with which the add-on or plug-in device shall be connected and tested
- Together, the unit shall be capable of meeting the requirements of the specification, including the supplemental capability requirements specified in Section 3.0

# Compatible Base Controller Determination

Allows for consistency with WBIC specification and serves as the basis for determining base controller compatibility, which allows for the retention of all supplemental capability requirements

- Additional compatible base controller models can be identified
- The add-on or plug-in device is not required to be tested with the additional base controllers determined to be compatible
- Any compatible base controllers shall communicate with the interface device in the same way as the base controller with which the add-on or plug-in device was tested (e.g., common wire interrupt)
- Together as a unit, they must meet the requirements of the specification, including the supplemental capability requirements



# Questions and Discussion

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# WaterSense Draft Specification: Certification and Labeling

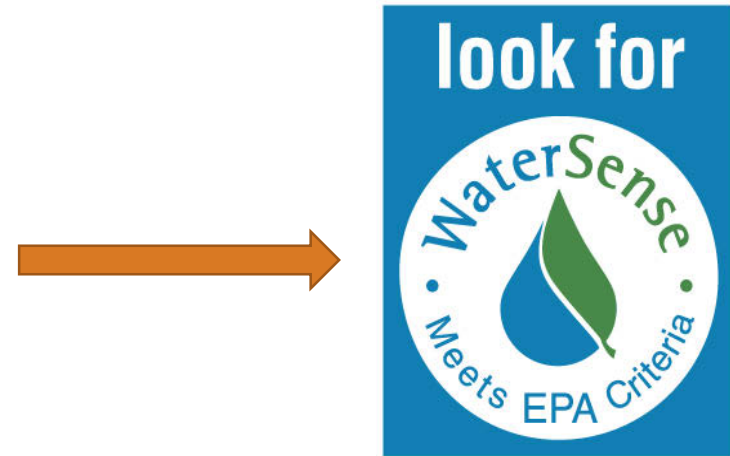
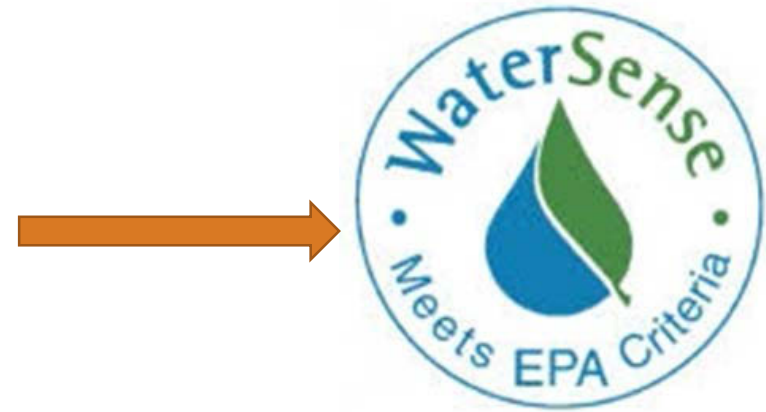
# Certification

- Partnership
  - SMS manufacturers must have signed WaterSense partnership agreement with EPA
- Conformity assessment
  - Conformance to the specification must be certified by a licensed certifying body accredited in accordance with the *WaterSense Product Certification System*
- Sampling
  - Shall be sampled and selected for testing in accordance with Section 5.1 of *ASABE S633*
  - Each test shall consist of three SMSs per manufacturer model randomly selected from a lot of at least 10 items supplied by the manufacturer



# Labeling

- Add-on and plug-in devices
  - Devices certified to meet the spec may bear the WaterSense label
  - Product documentation shall indicate that the add-on or plug-in device is only WaterSense labeled when used in combination with the base controller(s) listed in product documentation
- Base Controllers
  - Base controllers with which the add-on or plug-in devices are tested and/or determined to be compatible shall **not** bear the WaterSense label
  - Base controllers that are tested, or determined to be compatible, with a labeled add-on or plug-in device may bear the promotional label



“Look for the WaterSense labeled [plug-in or add-on device] to improve the water efficiency capabilities of this controller”



# Product Notification Template

- Used by LCBs to report certified products to WaterSense
- Populates the product registry on WaterSense website
- Includes product attributes that will be helpful to consumers
  - Sensor mechanism capacity (number of sensor mechanisms a product can communicate with)
  - Station or zone capacity (applies to stand-alone controllers only)
  - Connection type (i.e., wired or wireless)

**WaterSense® Labeled Soil Moisture Sensors Notification Template**

*Please read these instructions carefully and in their entirety. Understanding these steps will reduce errors and ensure the notification process works smoothly.*

		Version	
1			
2		Draft	
33	<ul style="list-style-type: none"> <li>• <b>Model Name:</b> This field must be completed if the product has a model name (this also refers to Series or Collection names). The model name must match the information on the certification listing and the information that appears to the consumer on the product packaging or online.</li> </ul>	Displayed	Displayed →
	<ul style="list-style-type: none"> <li>• <b>Model Number:</b> All model numbers must match the information on the certification listing and the information that appears to the consumer on the product packaging or online at the point of purchase.</li> </ul> <p><b>Product Families and Base Model Numbers:</b> Families of products demonstrate the same efficiency and performance, but may have variations in any non-performance related attributes (e.g., number of stations or zones). For a family of products that has a common base model number, provide in separate rows the base model number for each family. For a family of products with several unique model numbers, provide all unique model numbers a consumer would see at the point of purchase.</p> <p><b>Placeholders for Base Model Numbers:</b> For base model numbers, include any placeholders, such as "*" or X, that the manufacturer uses to represent prefixes or suffixes that denote any attribute that does not affect performance. A key or legend must be included on the certification listing to indicate all possible prefixes/suffixes that the placeholders stand for and what the prefixes/suffixes mean.</p>	Displayed	Displayed →
34	<ul style="list-style-type: none"> <li>• <b>Sensor Mechanism Capacity:</b> Indicate the maximum number of sensor mechanisms the product is capable of serving.</li> </ul>	Displayed	Displayed →
35	<ul style="list-style-type: none"> <li>• <b>Station or Zone Capacity:</b> If the product is a stand-alone controller, indicate the maximum number of stations or zones it is capable of serving.</li> </ul>	Displayed	Displayed →
36	<ul style="list-style-type: none"> <li>• <b>Connection Type:</b> Indicate whether the sensor mechanism is hardwired to the interface device (wired) or communicates wirelessly with the interface device (wireless).</li> </ul>	Displayed	Displayed →
37	<ul style="list-style-type: none"> <li>• <b>Notes:</b> Information the licensed certifying body deems relevant to EPA to explain unique issues or changes concerning the model's listing.</li> </ul>	Not Displayed	Not Displayed →

Instructions | Product Data | Base Controllers | Paired Controllers & Devices





# Questions and Discussion

# Next Steps

- Pertinent information and comments on the draft specification can be submitted to [watersense-products@erg.com](mailto:watersense-products@erg.com)
- Deadline to submit comments to WaterSense: **January 10, 2020**
- WaterSense will summarize information collected and issue a comment compilation
- To request a copy of the ASABE X633 draft standard, contact ASABE (contact information on the WaterSense website) and mention WaterSense
- Deadline to submit comments to ASABE: **December 2, 2019**
- WaterSense will hold a session at the Irrigation Association Show in Las Vegas, Nevada, December 5, 2019, at 10:00 a.m. Pacific Time and will have a table in the IA Resource Center in the exhibit hall
- WaterSense will review all comments and work toward publishing a final specification (anticipated in summer 2020)

# Contact Us



SMS Specification Webpage:

<https://www.epa.gov/watersense/soil-moisture-based-control-technologies>

General E-mail: [watersense@epa.gov](mailto:watersense@epa.gov)

Comment Submission E-mail: [watersense-products@erg.com](mailto:watersense-products@erg.com)

Website: [www.epa.gov/watersense](http://www.epa.gov/watersense)

Helpline: (866) WTR-SENS (987-7367)