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Irrigation Show 2019 Education Week

Industry Insights

Landscape Track Presentations

IRRIGATION SHOW | Dec. 4-5, 2019
EDUCATION WEEK | Dec. 2-6, 2019
Las Vegas Convention Center
Las Vegas, Nevada

AGRICULTURE
LANDSCAPE
GOLF
NURSERY & FLORICULTURE
SPORTS TURF

Co-located with **NGWA** and **ARCSA.**

Landscape Track – Table of Contents

SWATs and Apps for Water Conservation on Turfgrass

2019 IA Conference
December 3, 2019
Las Vegas, NV

Bernardo Cardenas & Michael Dukes

Agricultural & Biological Engineering Dept.

University of Florida/IFAS

UF UNIVERSITY of FLORIDA

Landscape irrigation

- In SFHs, avg. 50% of total potable water is used for landscape irrigation (DeOreo et al., 2016)
- Waste of water and energy
- May create environmental problems

Over-irrigation

Questions

- Can ***ITAs*** help conserve irrigation water?
- How much water may they save?
- Would those savings have a negative impact on the turfgrass quality?

Objectives

- Compare 9 different ITAs:

  A) To a time-based irrigation schedule

  B) Between them

- Regarding:

  - Irrigation water applied
  - Resulting turf qualities

Materials and Methods

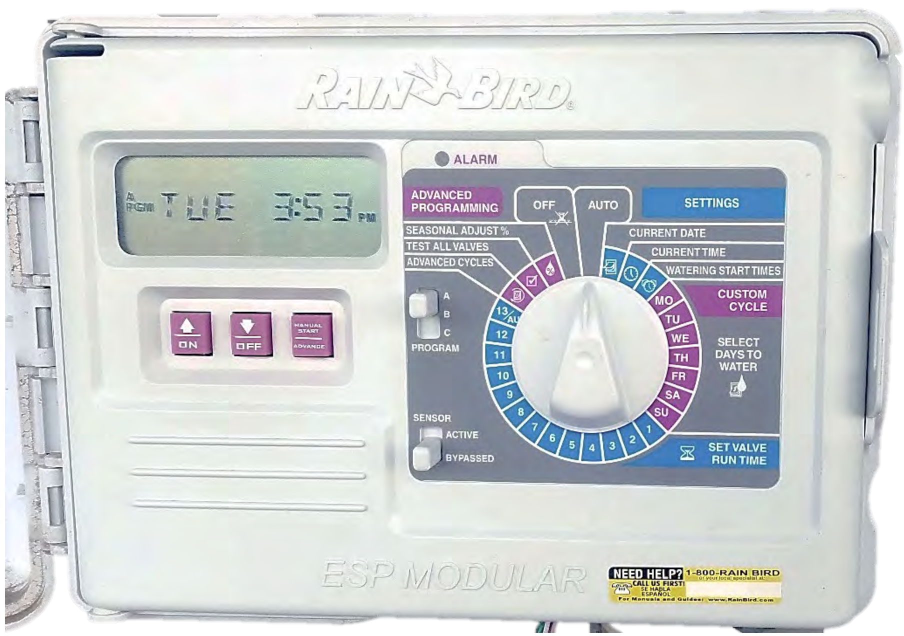
Site and Dates

- 72 Plots at UF campus
- Apr 28 – Oct 25, 2017

Materials and Methods

Treatments

Just timer



Without sensor feedback (WOS)

- Schedule recommended by UF-IFAS
- Based on historical ET
- Changes runtimes monthly

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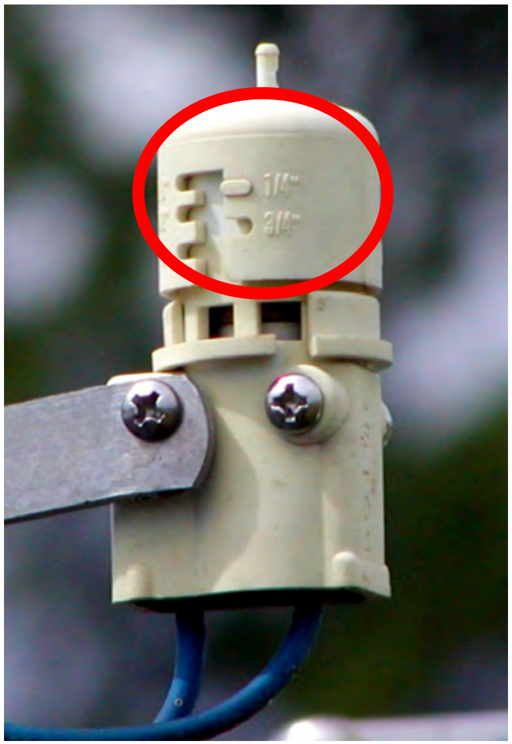
Materials and Methods

Treatments

Timer + rain sensor



Hunter Mini-Clik
(RS)

- With rain sensor (WRS)
- WRS and 60% deficit irrigation (DWRS)

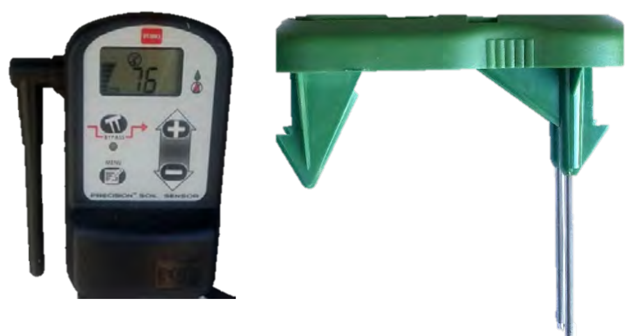
Materials and Methods

Treatments

Timer + soil moisture sensor

Rain Bird SMRT-Y
(RBD)

Baseline S100
(BAS)



Toro Precision SMS
(TOR)

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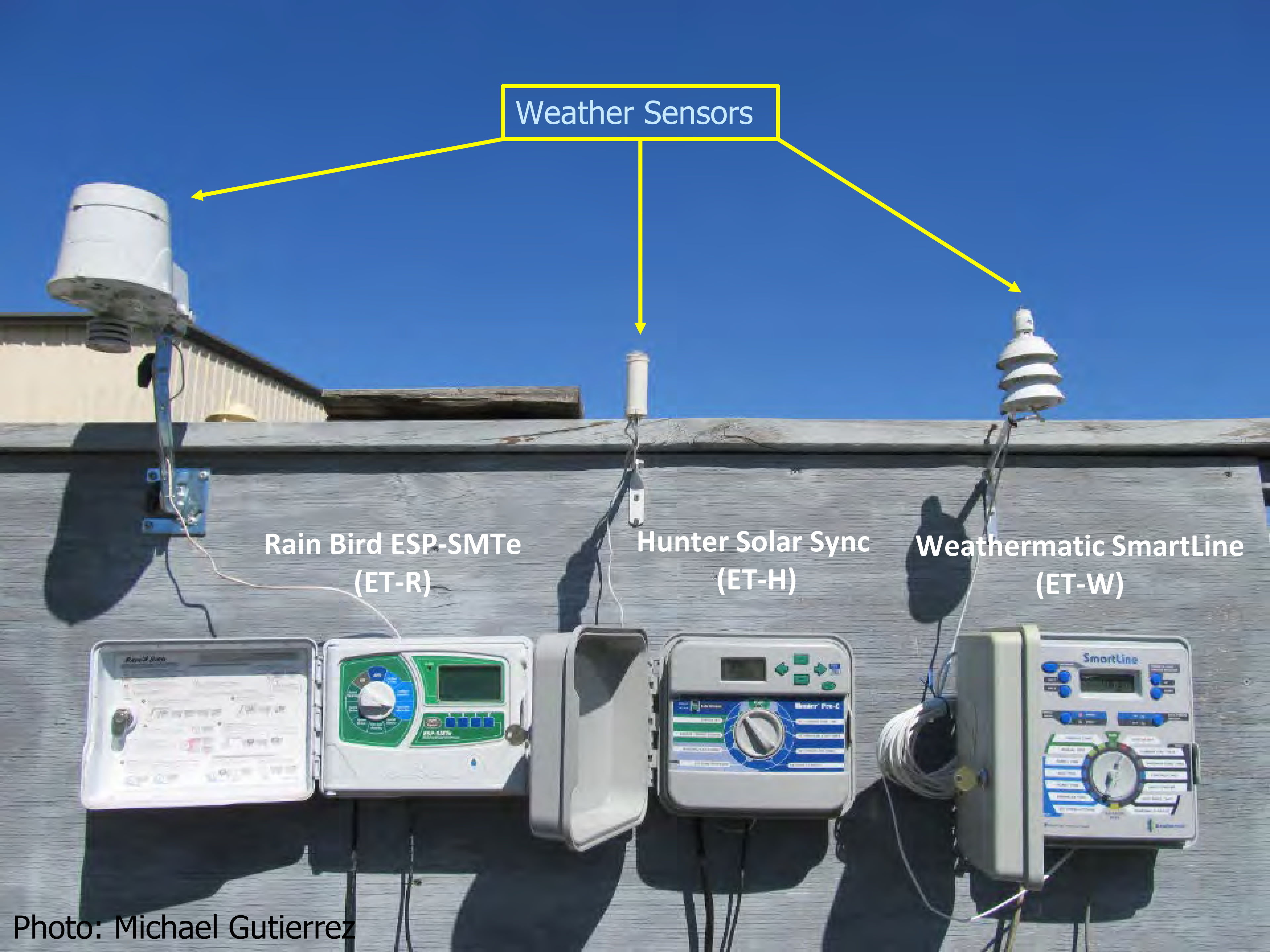
Materials and Methods

Treatments

Evapotranspiration (ET) controllers

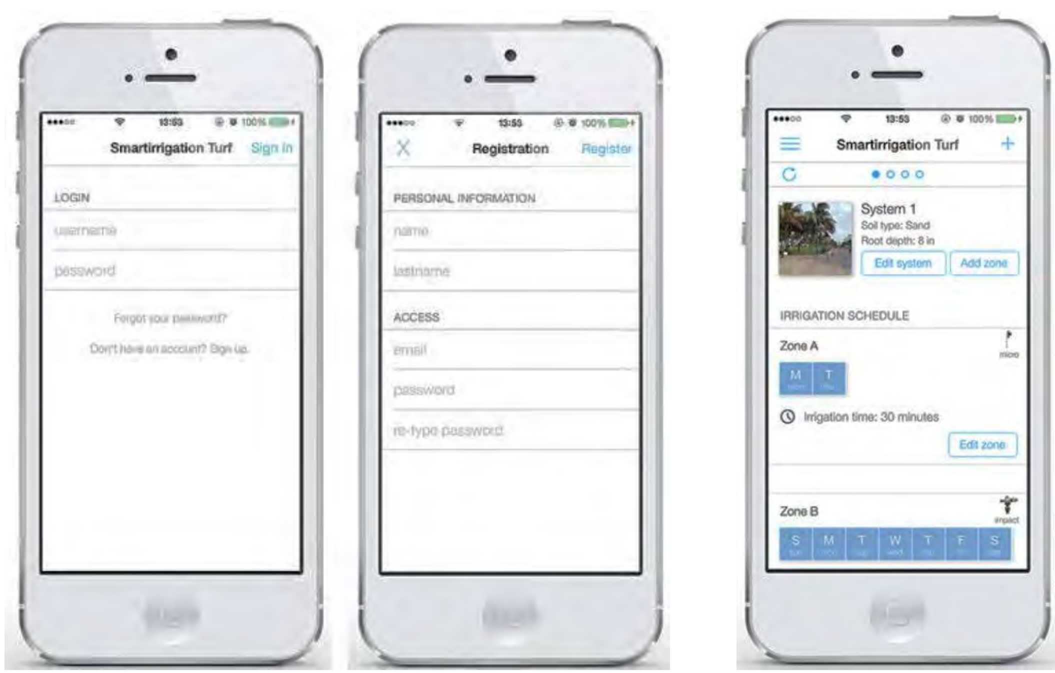

Weather Sensors
Rain Bird ESP-SMTe
(ET-R)
Hunter Solar Sync
(ET-H)
Weathermatic SmartLine
(ET-W)
Photo: Michael Gutierrez

Materials and Methods

Treatments

Smartphone Apps

- Smartirrigation turf app (APP)
- APP with seasonal water conservation (APP-SWC)



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Materials and Methods

Treatments

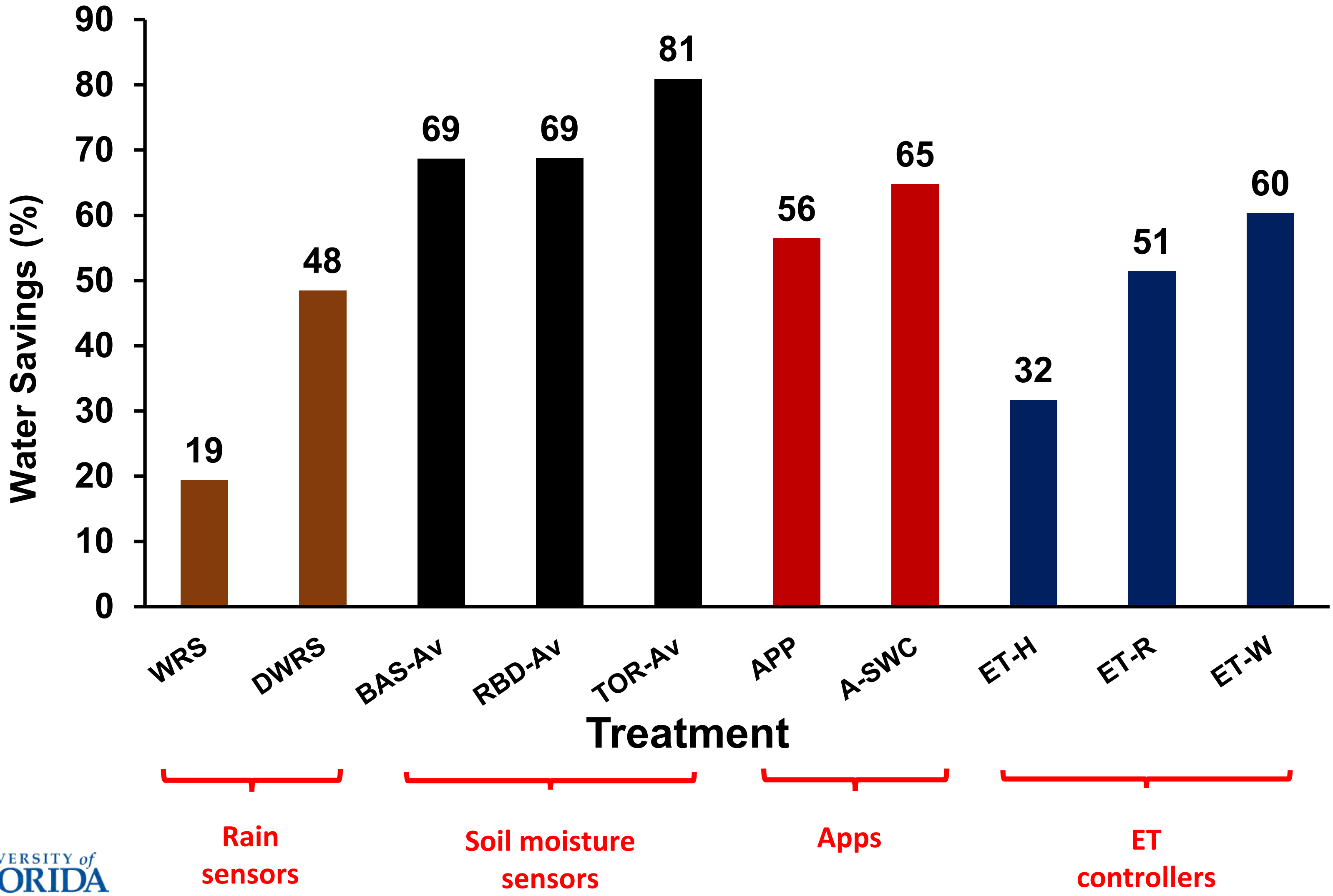
- Non-irrigated plots (NI)

Results
Turf quality

- Record breaking rainfall during June, July and (almost) August
- No turf quality differences between treatments
- Even the non irrigated plots

Results

Water savings compared to WOS



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Results
SMSs

Irrigation cycles that run as programed

Treatment	Morning AND Evening	Morning OR Evening	None
	-------------------	(%)	-------------------
BAS	15	42	43
RBD	20	32	48
TOR	18	10	72

Conclusions

- All **ITAs** applied less water than the comparison WOS treatment
- Water savings SMSs > APPs > ET controllers > RSs
- SMSs bypassed numerous evening cycles as a result of afternoon rain events
- ET-based treatments ➔ results are specific to input settings

Conclusions

- These results demonstrate the ability of **ITAs** to regulate irrigation based on real-time soil moisture/weather conditions, but with different outcomes.

Acknowledgements

- USDA NRCS Conservation Innovation Grant 69-3A75-13-83 for funding
- Ian Hahus, Michael Gutierrez, Conrado de Leon, Pat Rush for their help

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Comparing Weekly Irrigation to Rain Sensor Performance

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Irrigation Technology Program
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Rain Sensors in Texas

* Also referred to as Rain Shutoff Devices
* 2009 State of Texas started requiring rain or moisture shutoff devices on all new automatically controlled irrigation systems
  * Majority of irrigation professionals use rain shutoff devices
* Many irrigation professionals (and homeowners) do not really understand how a rain sensor works
  * Many Question their use in irrigation scheduling

Questions about Rain Sensors

* How do Rain Sensors Operate?
  * How long will they prevent operation of the controller?
* How does Rain Sensor Performance effect weekly irrigation scheduling?
  * Should irrigation professionals create irrigation schedules that assume (average) rainfall?

Rain Sensor Study

Rain Sensors

* Hunter
  * Mini-Click
  * RFC*
  * RainClick
* Orbit 57069N
* Weathermatic 420GLS
* Toro TRS
* Rainbird
  * RSD-BEX
  * WR2-RFC*

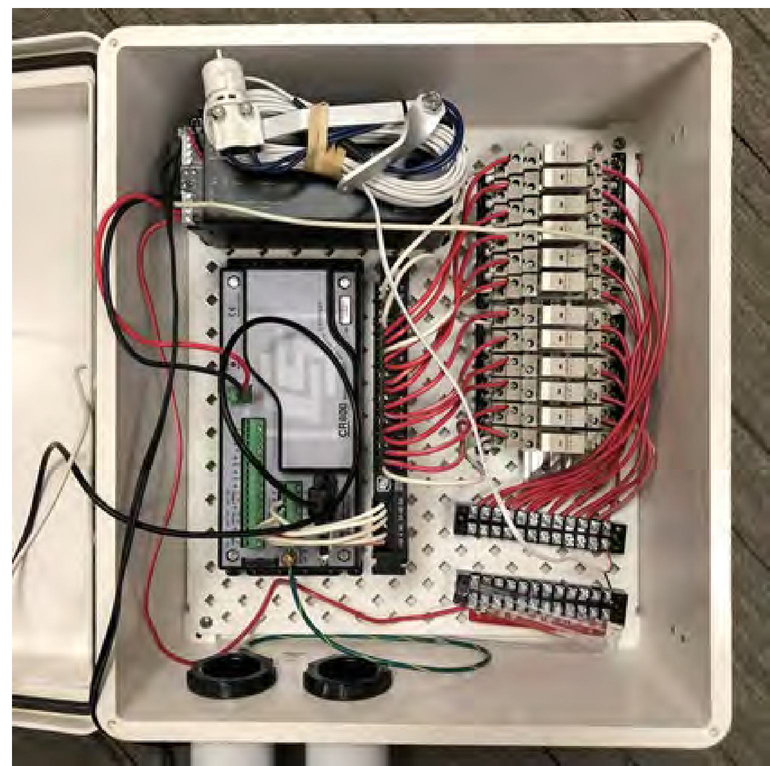


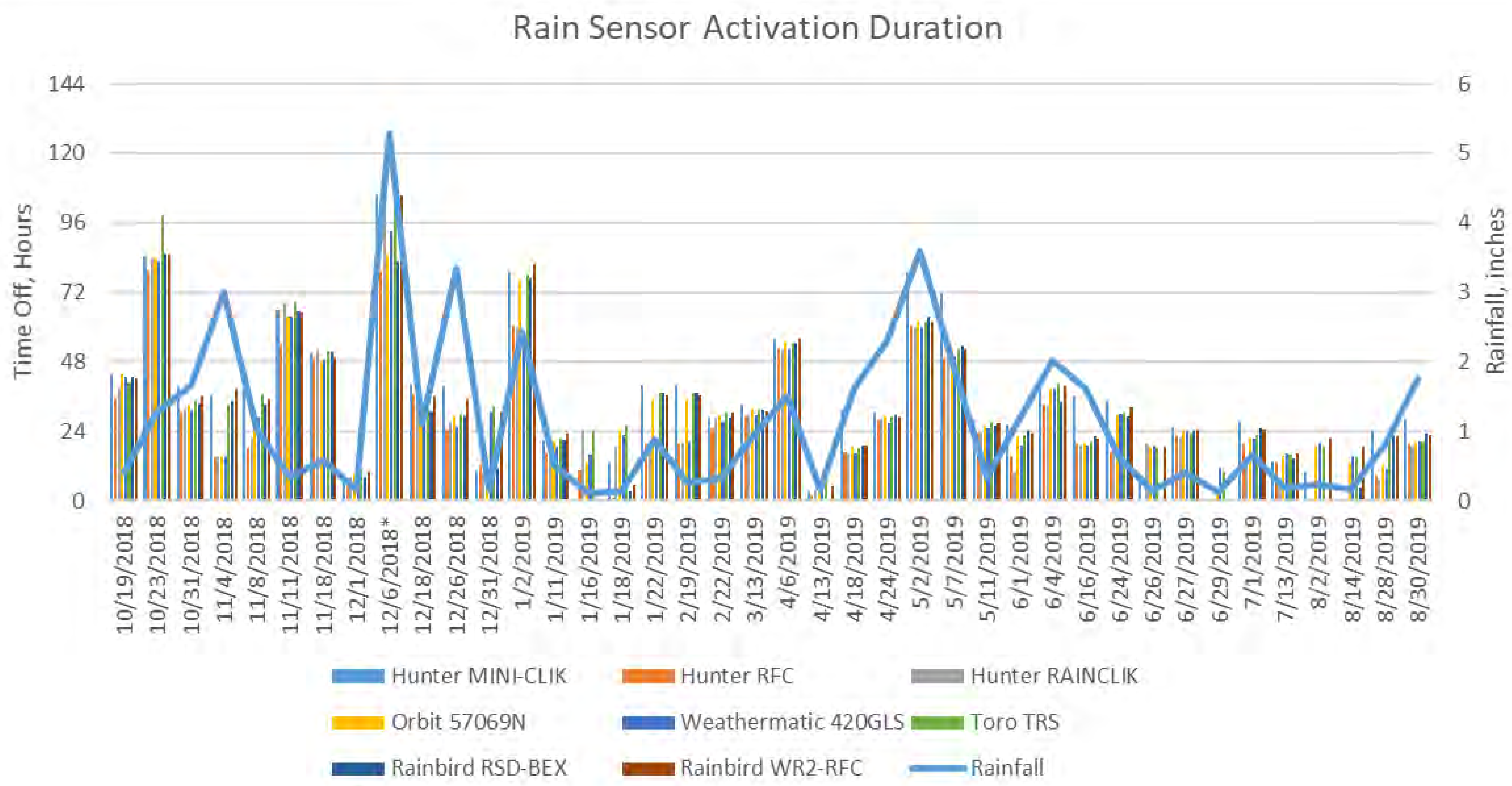




Study Period

- Sensors installed October 2018
- Datalogger recorded timestamp when sensor triggered and "resumed irrigation"
- Sensors installed for minimum threshold, (1/8")
- To Date (9/30/19)
  - 43 Rain Sensor Triggering Events
  - Total Rainfall: 47.79 inches

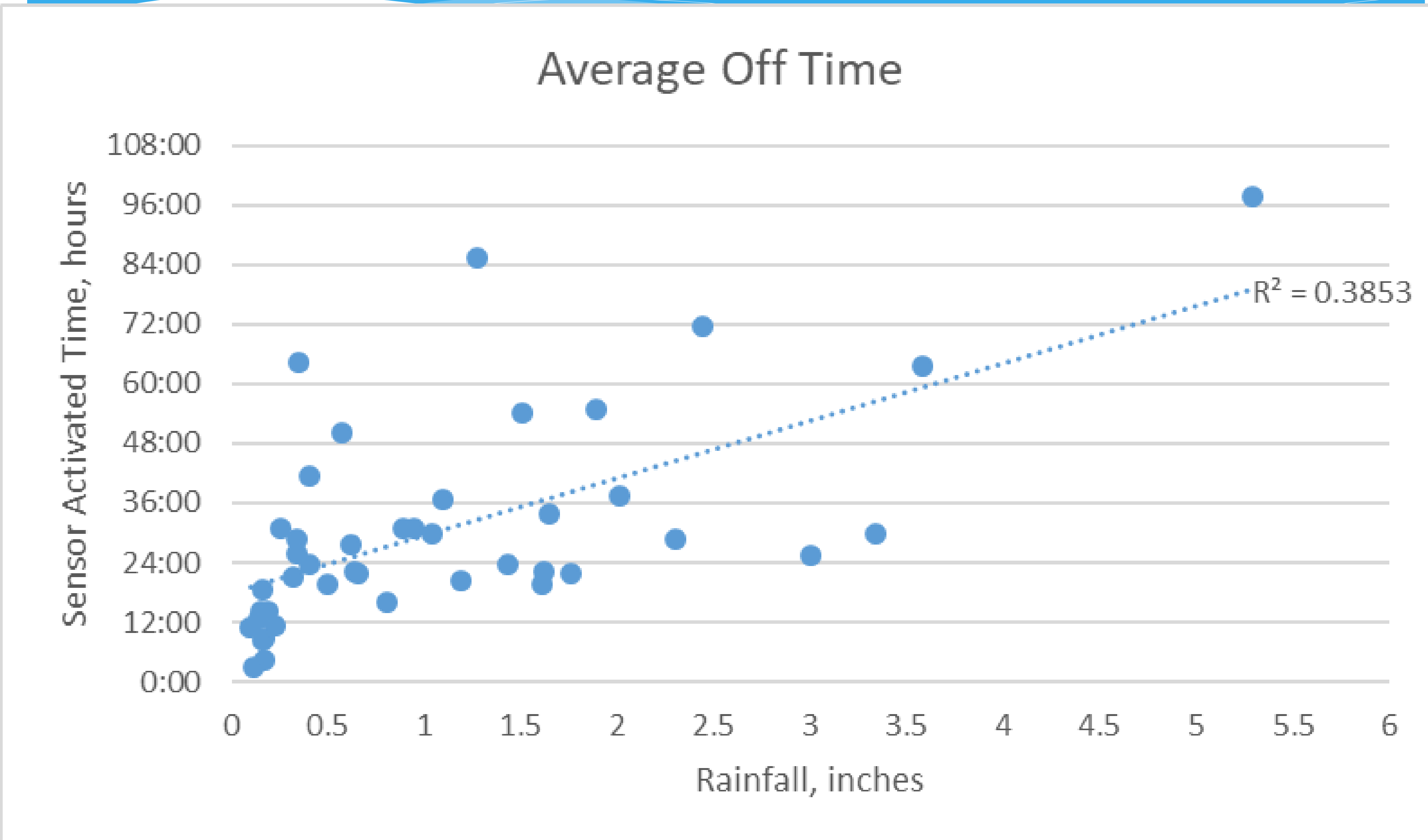




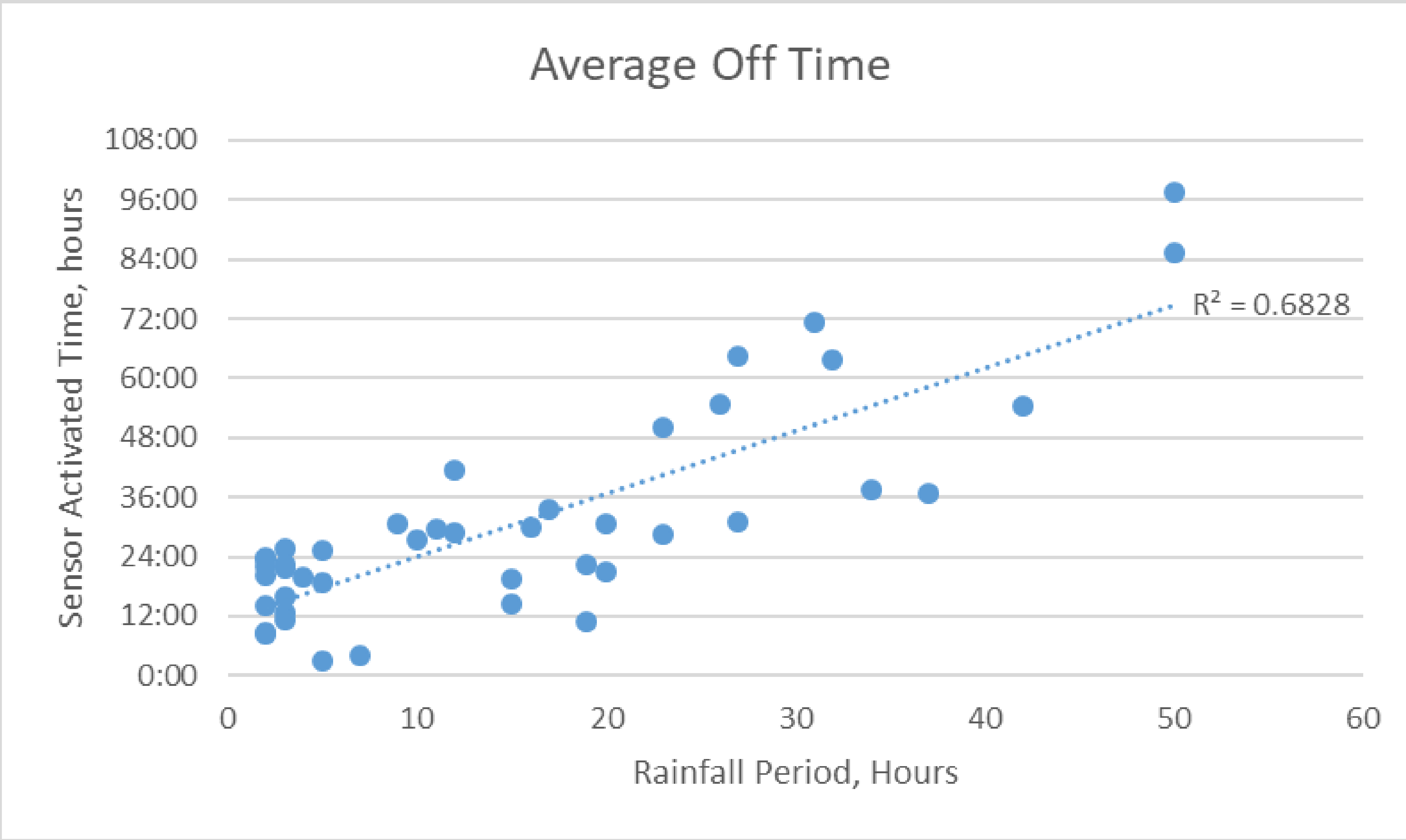
Rain Sensor Activation Duration
Time Off, Hours
Rainfall, inches
144
120
96
72
48
24
0
6
5
4
3
2
1
0
10/19/2018
10/23/2018
10/31/2018
11/4/2018
11/8/2018
11/11/2018
11/18/2018
12/1/2018
12/6/2018*
12/18/2018
12/26/2018
12/31/2018
1/2/2019
1/11/2019
1/16/2019
1/18/2019
1/22/2019
2/19/2019
2/22/2019
3/13/2019
4/6/2019
4/13/2019
4/18/2019
4/24/2019
5/2/2019
5/7/2019
5/11/2019
6/1/2019
6/4/2019
6/16/2019
6/24/2019
6/26/2019
6/27/2019
6/29/2019
7/1/2019
7/13/2019
8/2/2019
8/14/2019
8/28/2019
8/30/2019
Hunter MINI-CLIK
Hunter RFC
Hunter RAINCLIK
Orbit 57069N
Weathermatic 420GLS
Toro TRS
Rainbird RSD-BEX
Rainbird WR2-RFC
Rainfall

Analysis Breakdown

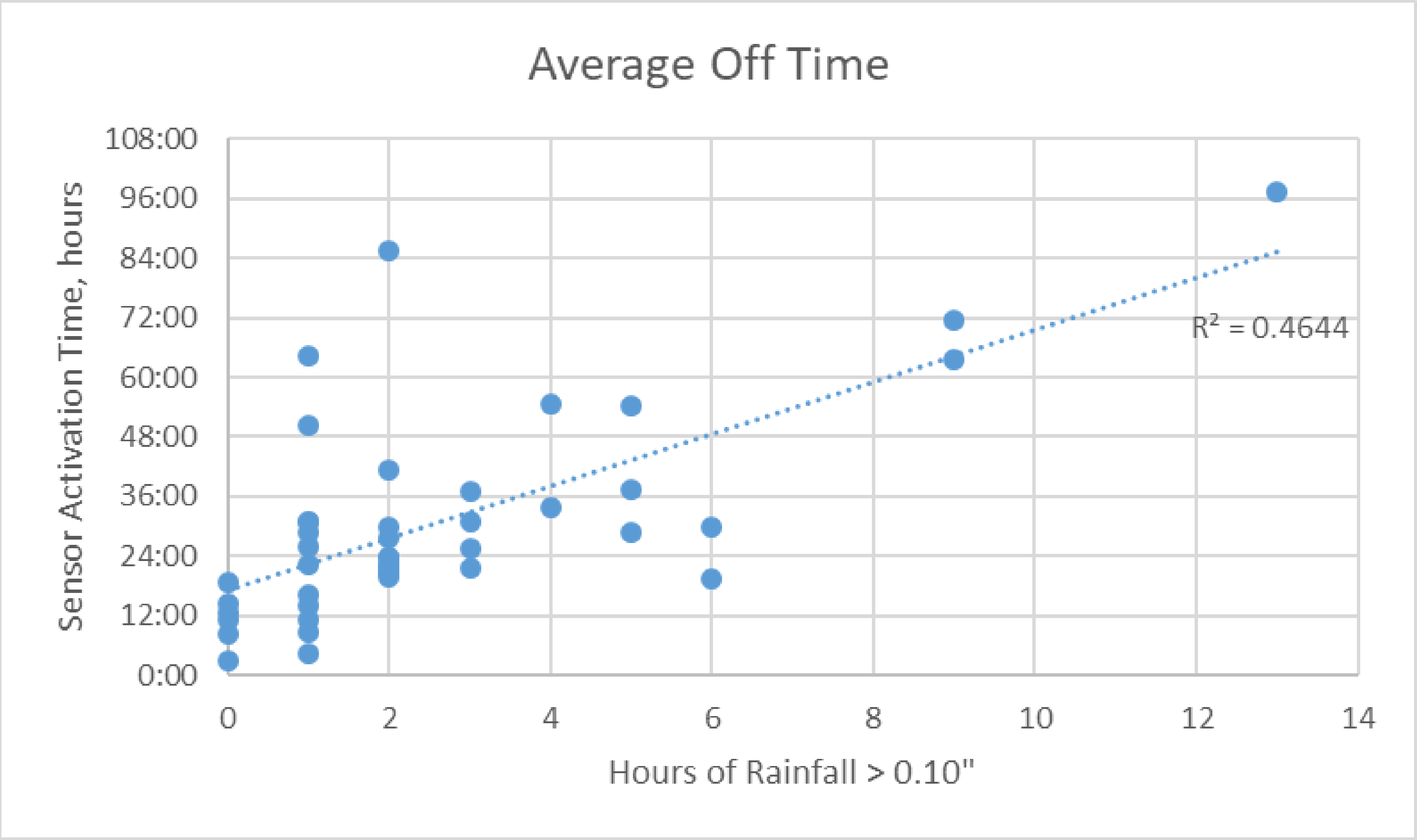
* What effects Sensors “off-time”??
  * Total Rainfall
  * Rainfall Period
    * Time from first rain to last rain recorded
  * Total Rain Time
    * Data logged hours that had rainfall (Actual Rain Time)
  * Rainfall Intensity
    * Average Total Rainfall / Total Rain Time

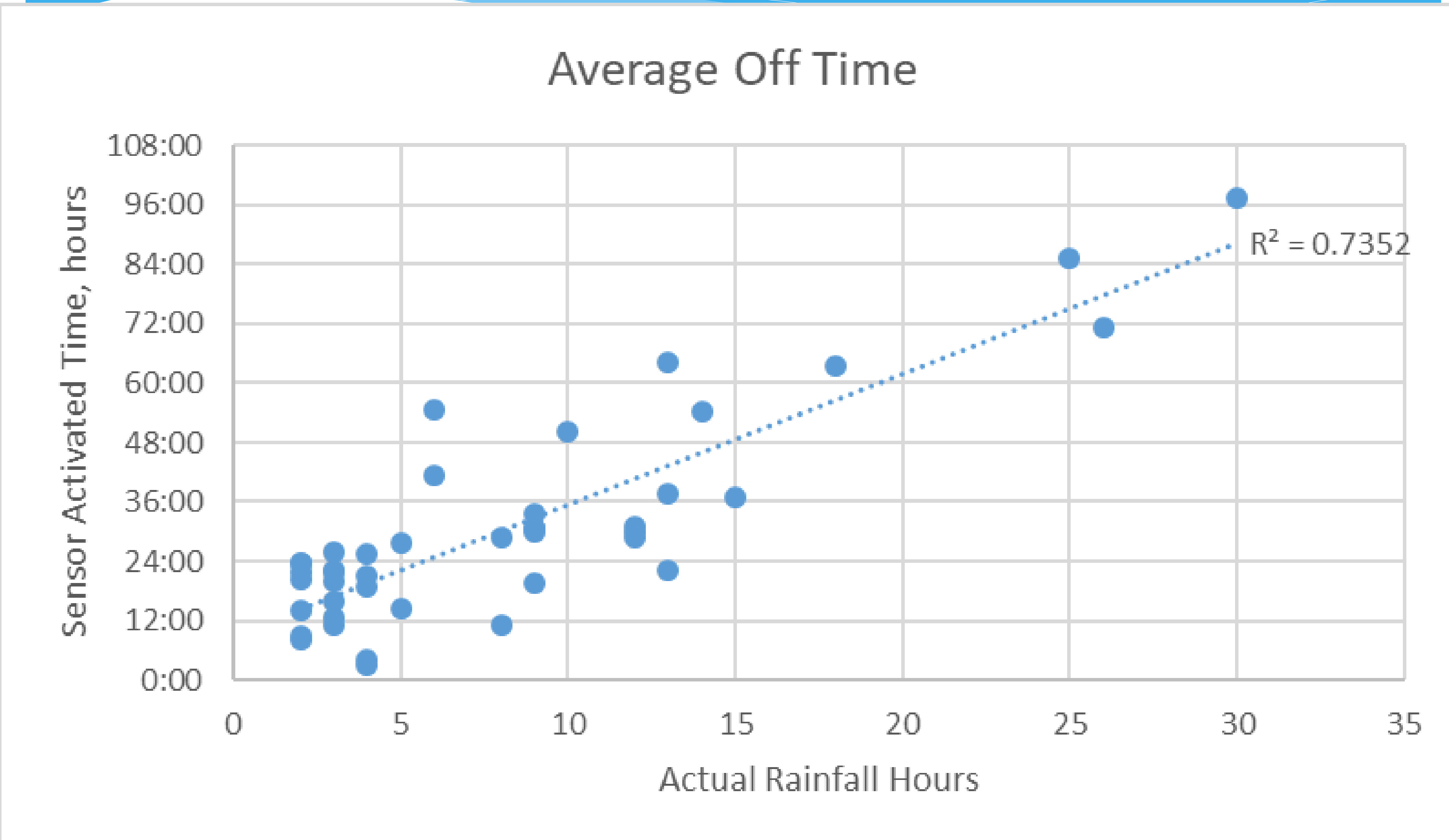


Average Off Time
Sensor Activated Time, hours
108:00
96:00
84:00
72:00
60:00
48:00
36:00
24:00
12:00
0:00
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
Rainfall, inches
$R^2 = 0.3853$



Average Off Time
Sensor Activated Time, hours
108:00
96:00
84:00
72:00
60:00
48:00
36:00
24:00
12:00
0:00
0
10
20
30
40
50
60
Rainfall Period, Hours
R² = 0.6828


Average Off Time
Sensor Activation Time, hours
108:00
96:00
84:00
72:00
60:00
48:00
36:00
24:00
12:00
0:00
0
2
4
6
8
10
12
14
Hours of Rainfall > 0.10"
R² = 0.4644



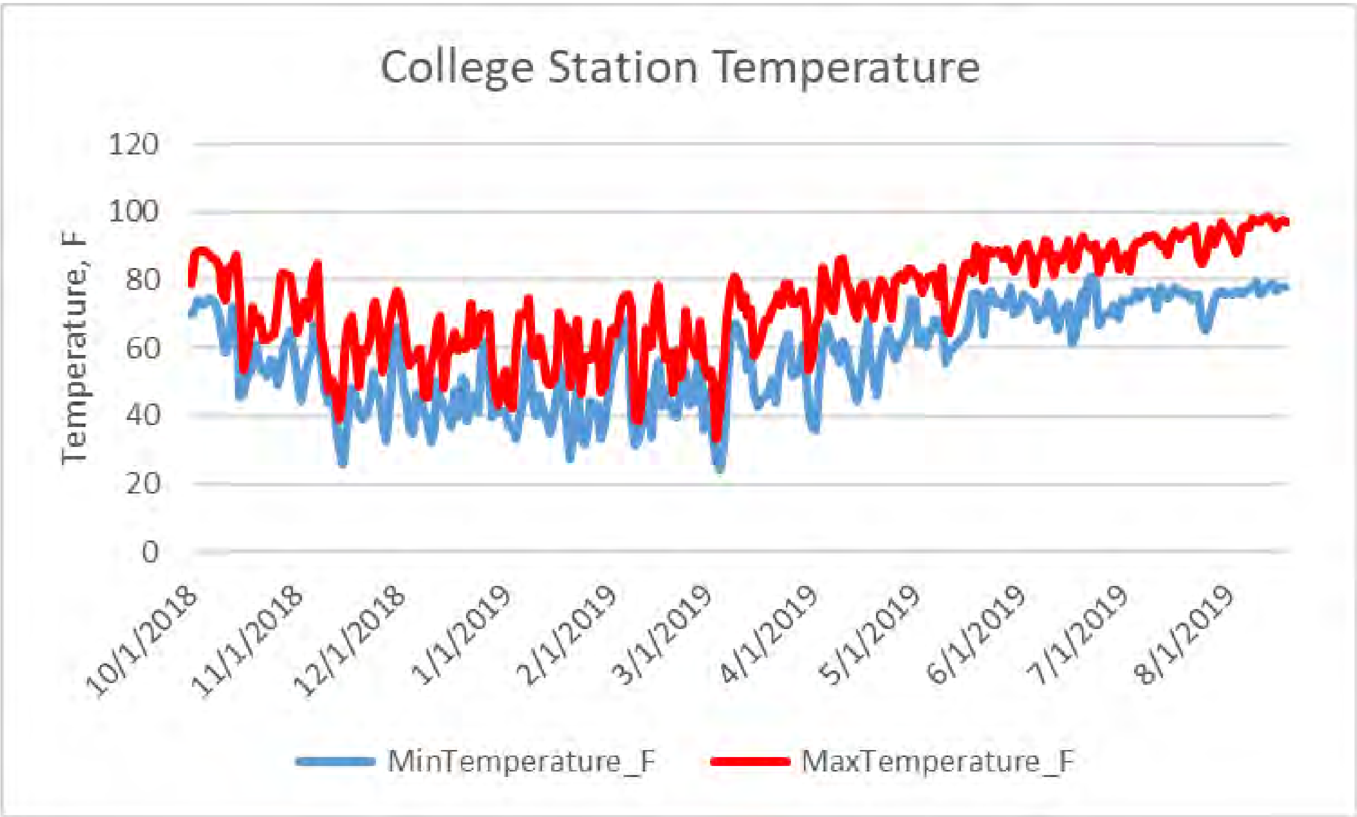
Average Off Time
Sensor Activated Time, hours
108:00
96:00
84:00
72:00
60:00
48:00
36:00
24:00
12:00
0:00
0
5
10
15
20
25
30
35
Actual Rainfall Hours
R^2 = 0.7352

Average Off Time Summary

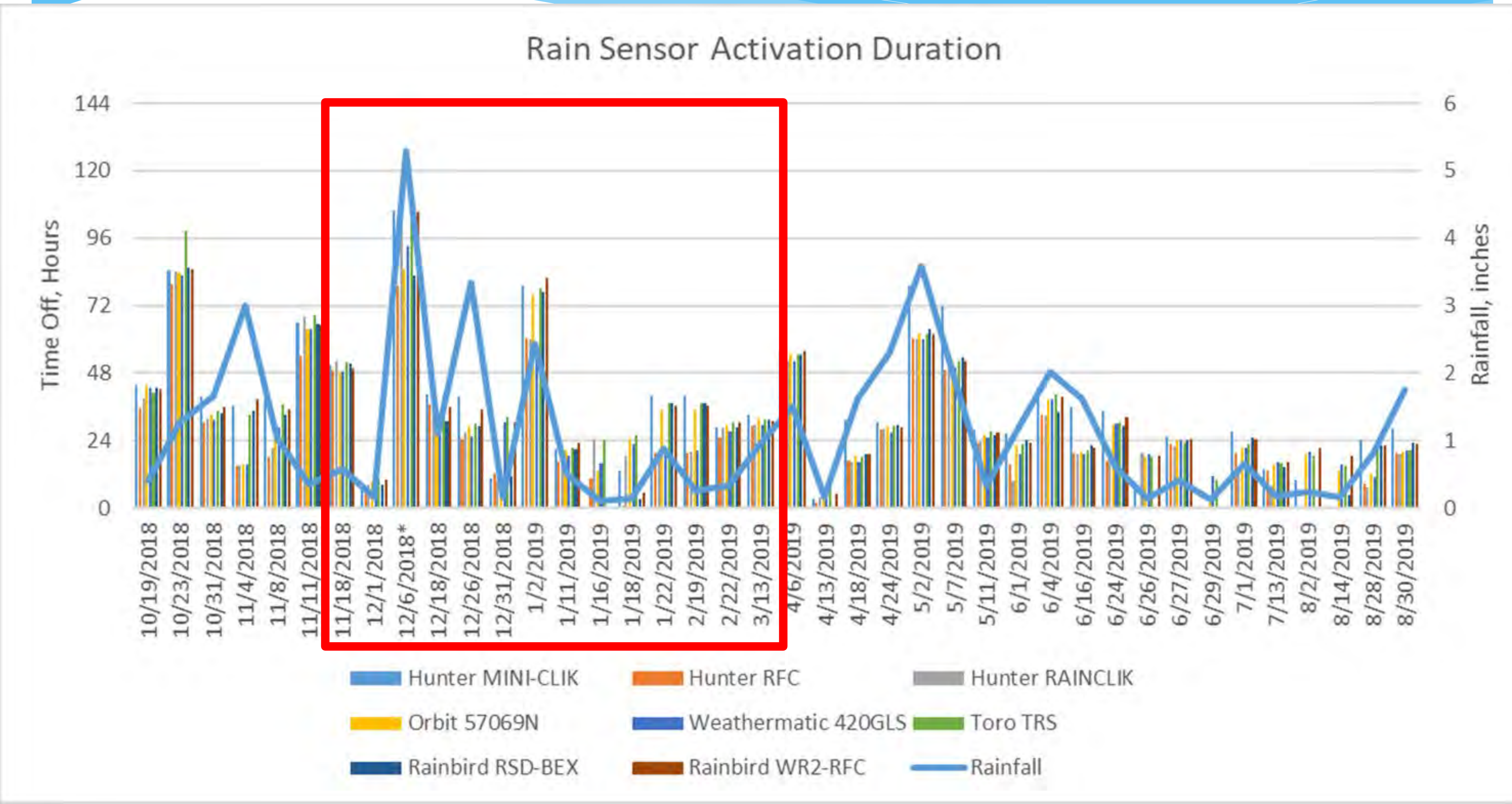
* On Average, “Actual Rainfall Time” had the strongest correlation to sensor triggered period
  * $R^2 = 0.7352$
* On Average, Total Rainfall had the weakest correlation to sensor triggered period
  * $R^2 = 0.3853$

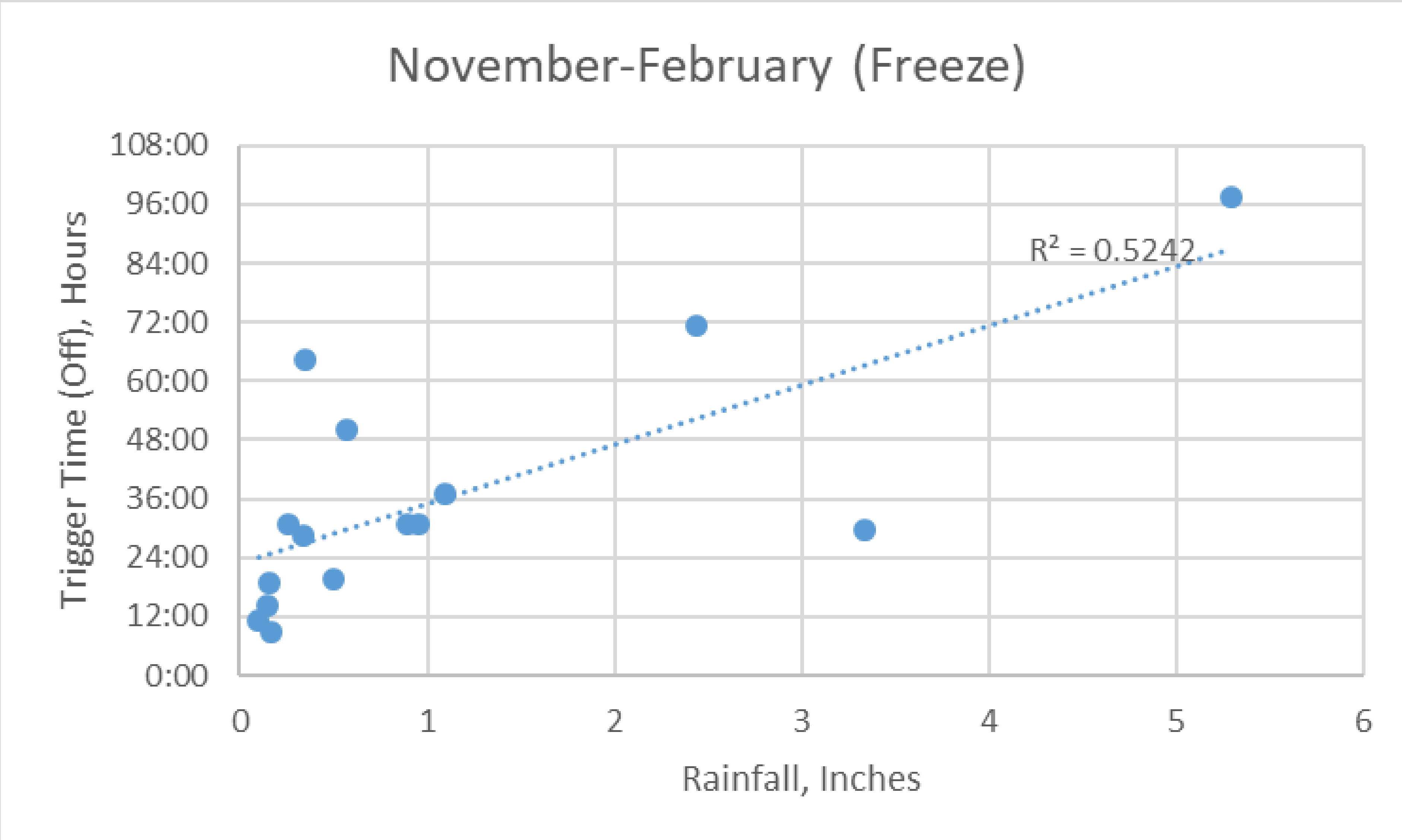
Freezing Effects

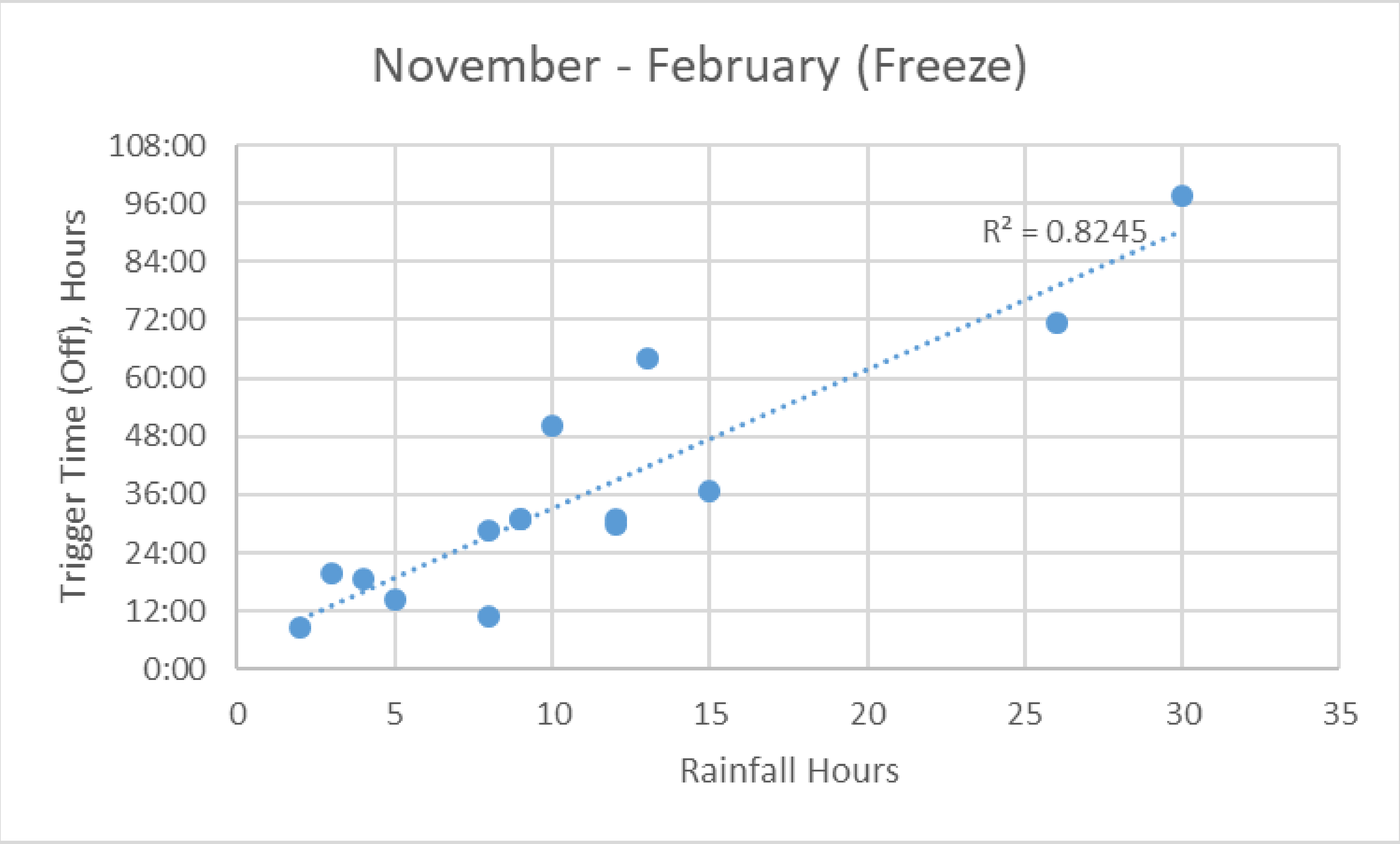
* Multiple Devices included Freeze Sensing
* Freeze Period: 11/12/19 - 3/6/19



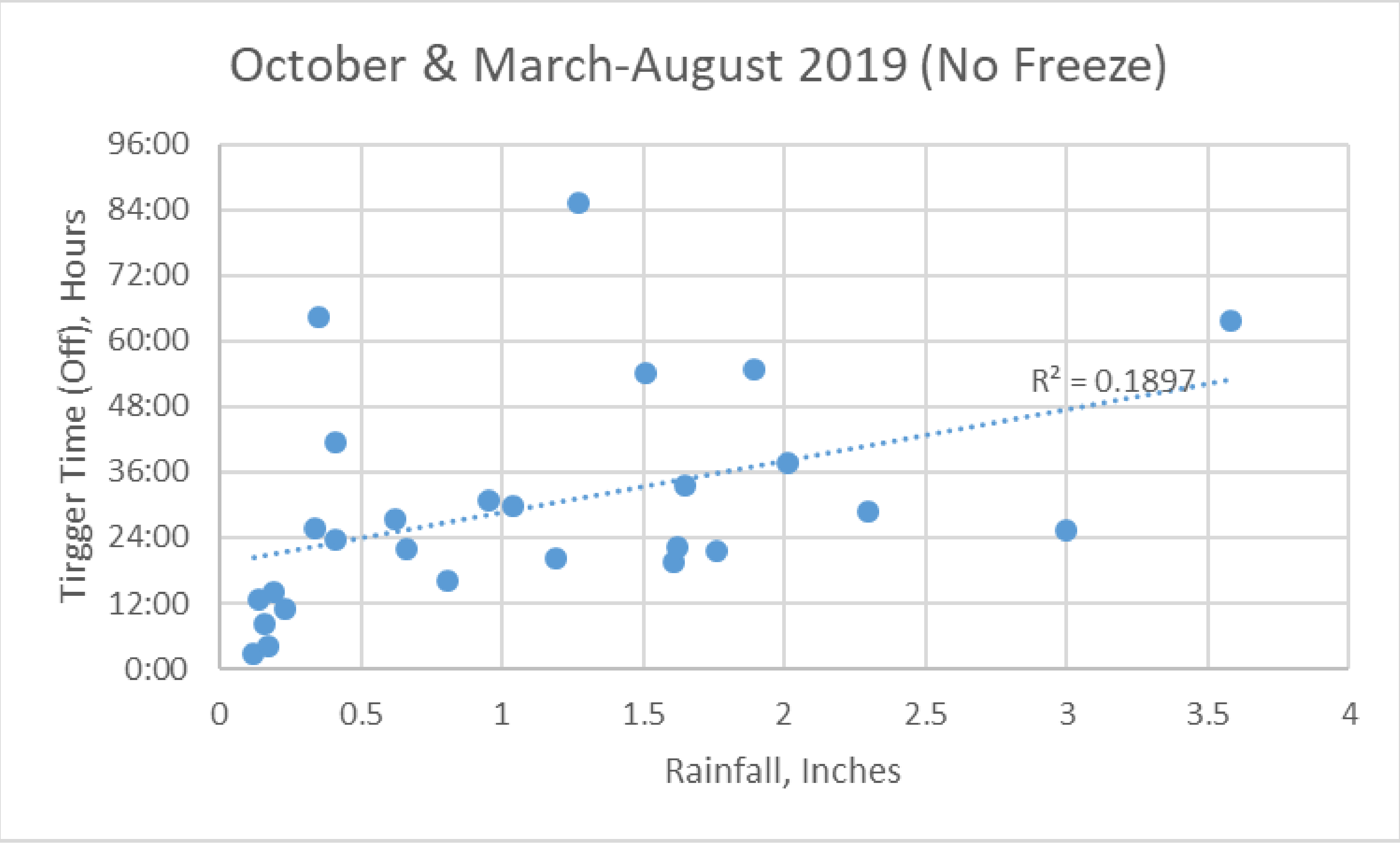
Freeze Range



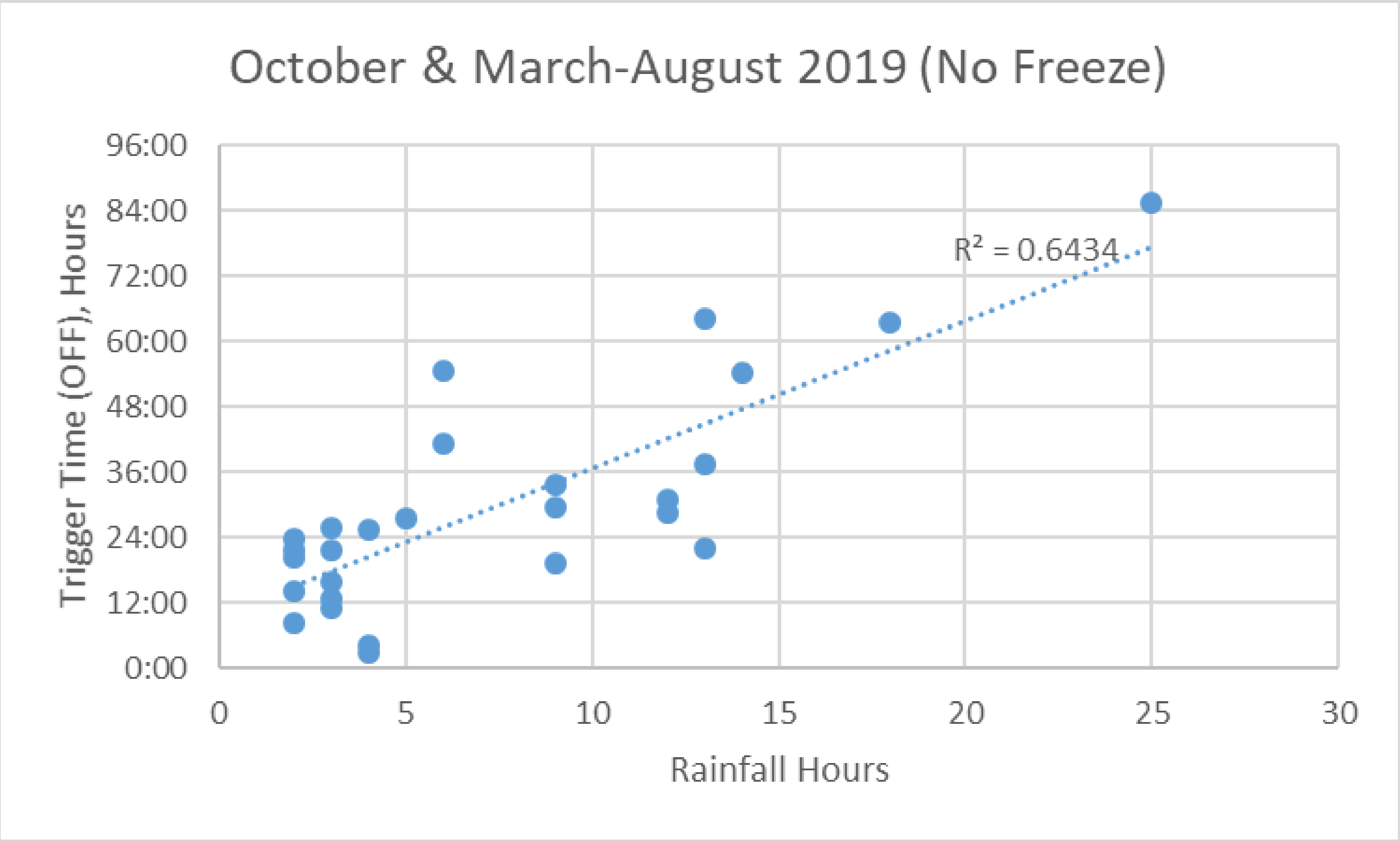

November-February (Freeze)
Trigger Time (Off), Hours
108:00
96:00
84:00
72:00
60:00
48:00
36:00
24:00
12:00
0:00
R² = 0.5242
0
1
2
3
4
5
6
Rainfall, Inches



November - February (Freeze)
108:00
96:00
84:00
72:00
60:00
48:00
36:00
24:00
12:00
0:00
Trigger Time (Off), Hours
0
5
10
15
20
25
30
35
Rainfall Hours
R² = 0.8245



October & March-August 2019 (No Freeze)
Tirgger Time (Off), Hours
96:00
84:00
72:00
60:00
48:00
36:00
24:00
12:00
0:00
0
0.5
1
1.5
2
2.5
3
3.5
4
Rainfall, Inches
R² = 0.1897


October & March-August 2019 (No Freeze)
Trigger Time (OFF), Hours
96:00
84:00
72:00
60:00
48:00
36:00
24:00
12:00
0:00
R² = 0.6434
0
5
10
15
20
25
30
Rainfall Hours

Freeze Vs Non-Freezing Season Summary

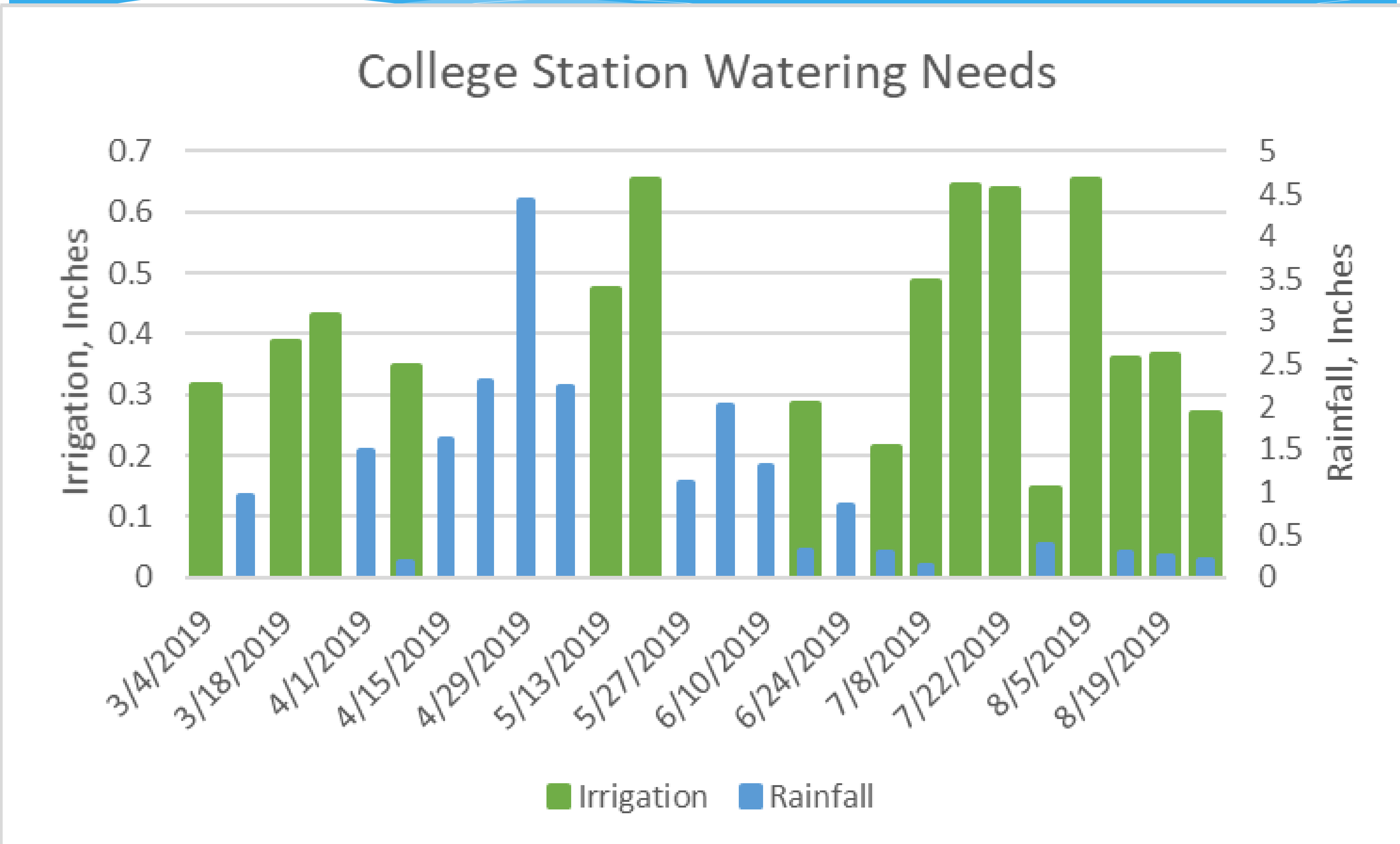
* When comparing the freezing to the non-freezing season, the rainfall time still showed the stronger correlation to off time, compared to total rainfall

	Freeze	No Freeze
Total Rainfall, Inches	0.52	0.19
Rainfall Hours	0.82	0.64

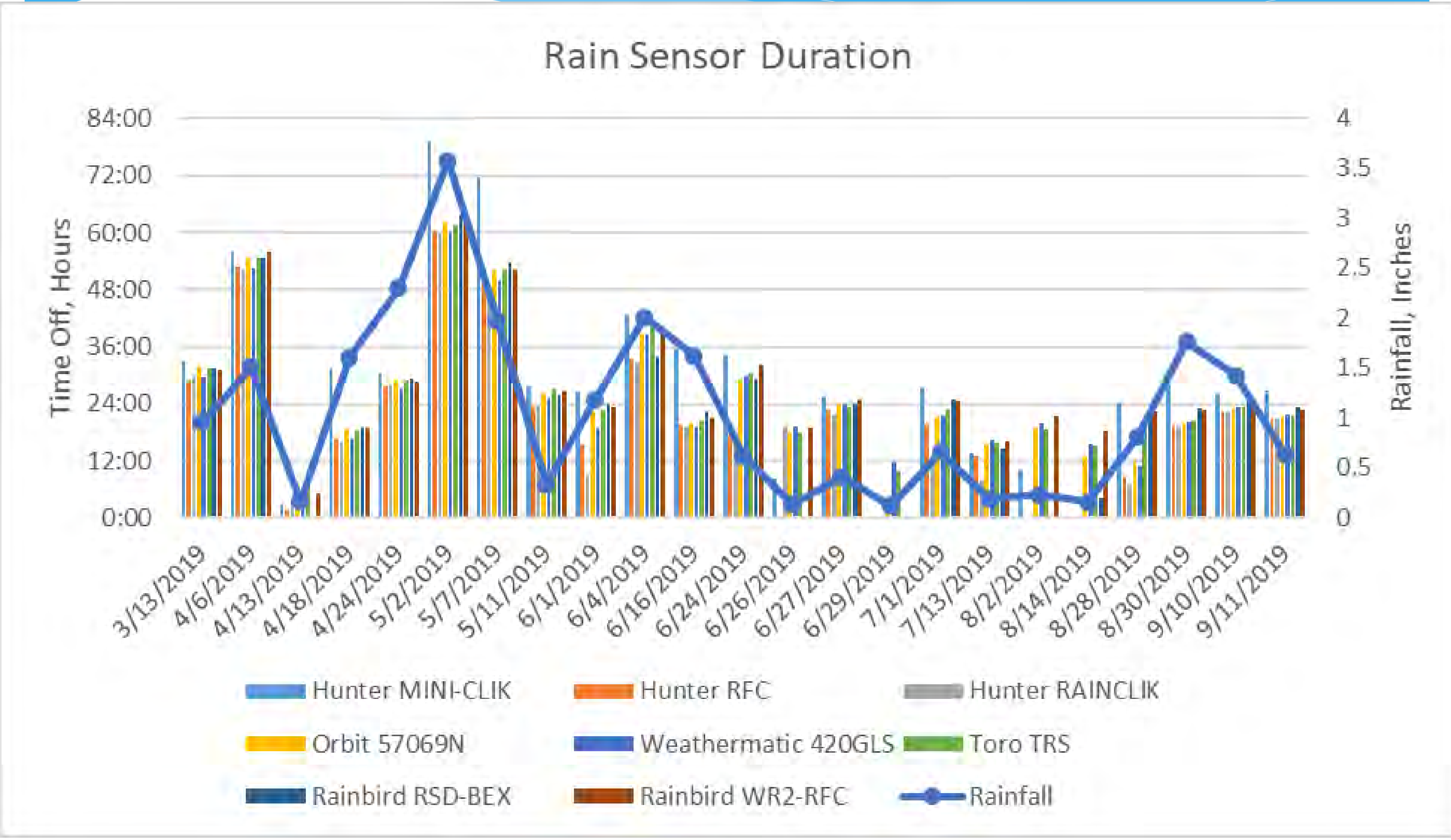
* Normally would expect irrigation to be turned off during the freezing season…

Performance Effects on Scheduling

* Weekly irrigation needs were calculated for a neighborhood in College Station, Texas
  * March – August, 2019
  * 26 Weeks
* Calculations showed that no irrigation was needed for at least 10 weeks due to rainfall
  * Greater than 0.96" of rain per week
* The average sensor performance was compared to the irrigation schedules of 8 random irrigation systems in a single neighborhood
  * Focus on the 10 Rainfall Weeks



College Station Watering Needs
Irrigation, Inches
Rainfall, Inches
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
3/4/2019
3/18/2019
4/1/2019
4/15/2019
4/29/2019
5/13/2019
5/27/2019
6/10/2019
6/24/2019
7/8/2019
7/22/2019
8/5/2019
8/19/2019
Irrigation
Rainfall


Rain Sensor Duration
84:00
72:00
60:00
48:00
36:00
24:00
12:00
0:00
Time Off, Hours
4
3.5
3
2.5
2
1.5
1
0.5
0
Rainfall, Inches
3/13/2019
4/6/2019
4/13/2019
4/18/2019
4/24/2019
5/2/2019
5/7/2019
5/11/2019
6/1/2019
6/4/2019
6/16/2019
6/24/2019
6/26/2019
6/27/2019
6/29/2019
7/1/2019
7/13/2019
8/2/2019
8/14/2019
8/28/2019
8/30/2019
9/10/2019
9/11/2019
Hunter MINI-CLIK
Hunter RFC
Hunter RAINCLIK
Orbit 57069N
Weathermatic 420GLS
Toro TRS
Rainbird RSD-BEX
Rainbird WR2-RFC
Rainfall

Programmed Irrigation Days								
Site #	Start Time	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
31	5:00 AM		■		■		■	
34	6:00 AM	■		■		■		
37	5:30 AM		■		■			■
38	4:00 AM	■				■		
39	5:00 AM	■		■		■		
40	3:00 AM				■			
41	6:30 AM			■		■		
42	5:00 AM			■		■		■

- 8 Residential Sites in 1 Neighborhood were selected
- Controller Settings were documented for:
  - Start Time – All sites had only 1 start time
  - Runtime
  - Watering Days

Comparing Sensor Operation to Rain Events and Daily Irrigations

Ave Sensor Performance - Irrigate That Day?									
Rain Week	Total Rain	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	(Monday)
11-Mar	0.96	Yes	Yes	Yes	**No**	Yes	Yes	Yes	Yes
1-Apr	1.53	Yes	Yes	Yes	Yes	Yes	Yes	**No**	Yes
15-Apr	1.61	Yes	Yes	Yes	**No**	Yes	Yes	Yes	Yes
22-Apr	2.3	Yes	Yes	Yes	**No**	Yes	Yes	Yes	Yes
29-Apr	4.42	Yes	Yes	Yes	**No**	**No**	Yes	Yes	Yes
6-May	2.26	Yes	Yes	**No**	**No**	Yes	Yes	**No**	Yes
27-May	1.19	Yes	Yes	Yes	Yes	Yes	Yes	**No**	Yes
3-Jun	2.01	Yes	Yes	**No**	Yes	Yes	Yes	Yes	Yes
10-Jun	1.3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	**No**
24-Jun	1.03	**No**	**No**	Yes	**No**	**No**	Yes	Yes	Yes

	Rain Day

Site Irrigations based on Average Sensor Performance

Site	Total Irrigations	Prevented Irrigations	% Prevented	% Allowed
31	30	5	16.7%	83.3%
34	30	10	33.3%	66.7%
37	30	3	10.0%	90.0%
38	20	9	45.0%	55.0%
39	30	10	33.3%	66.7%
40	10	2	20.0%	80.0%
41	20	7	35.0%	65.0%
42	30	7	23.3%	76.7%
Average			27.1%	72.9%

*10 Week Period

Summary

* The amount of rain has little effect on duration a rain sensor is active
* Analysis suggest irrigation professionals (and homeowners) should anticipate the effects of rainfall when programming controllers
  * Maximize the use of controllers with programmable sensor delay

* There is a need for better rain sensor technology that not only detects rain but also takes credit for rain

Controller Rain Gage-Sensors that have been discontinued by Manufacturers

Contact Information

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979-845-5614

http://itc.tamu.edu
Irrigation Technology Program

Fewer Drinks for the Links

Ariana Wilfley

Drought Management and Conservation Department

Esri Story Map

Quality. Service. Value.®

Fewer Drinks for the Links

Drought Status in California, June 2015

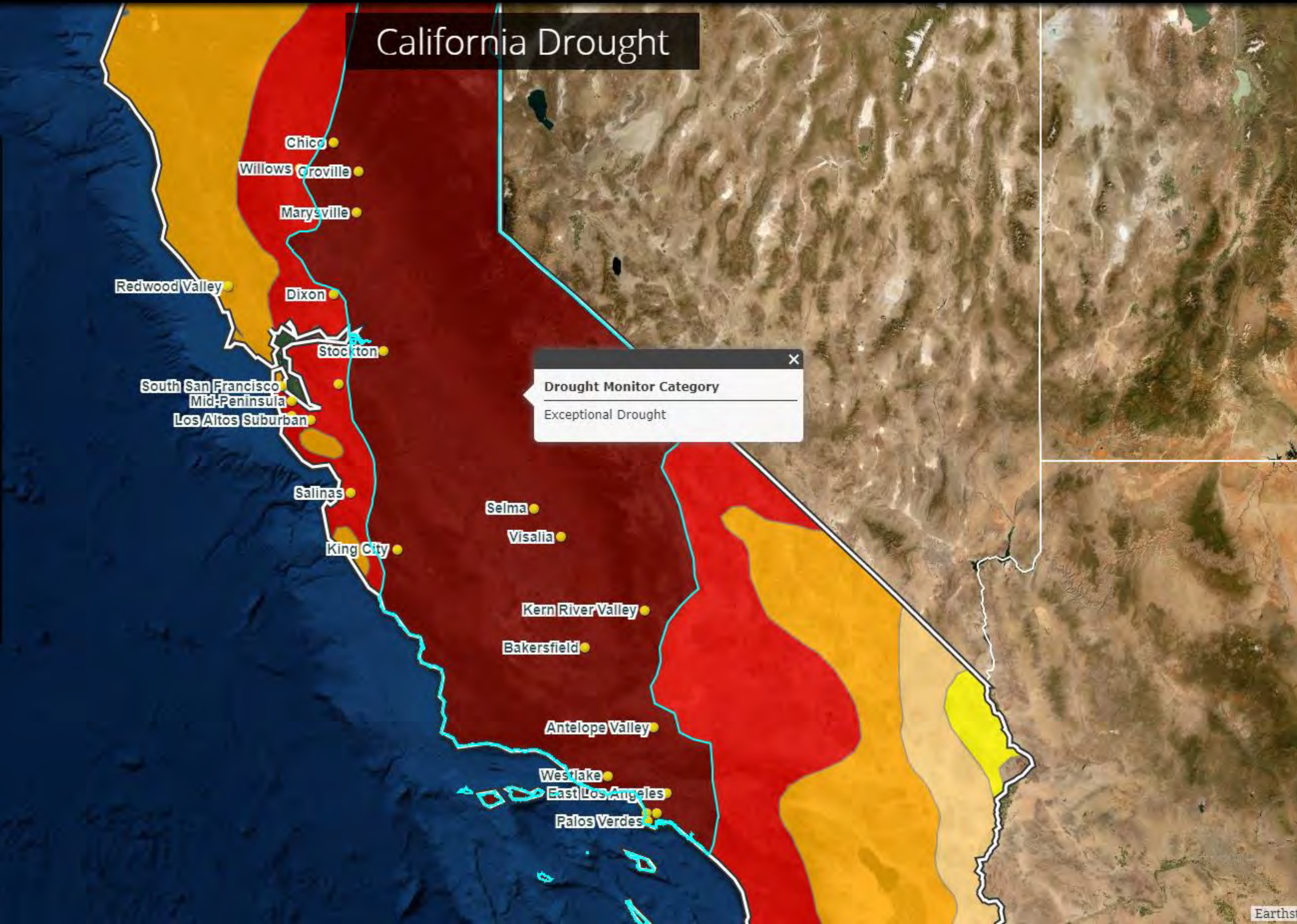
The State Water Resources Control Board set water-use reduction requirements ranging from 8% to 36% for water suppliers to meet this mandate.

Cal Water assembled a dedicated drought team to achieve these targets in our 24 systems. Where Cal Water's Service areas stood in June 2015:

2 **service areas in severe drought conditions**

6 **service areas in extreme drought conditions**

16 **service areas in exceptional drought conditions**



Palos Verdes reduction goal

36%

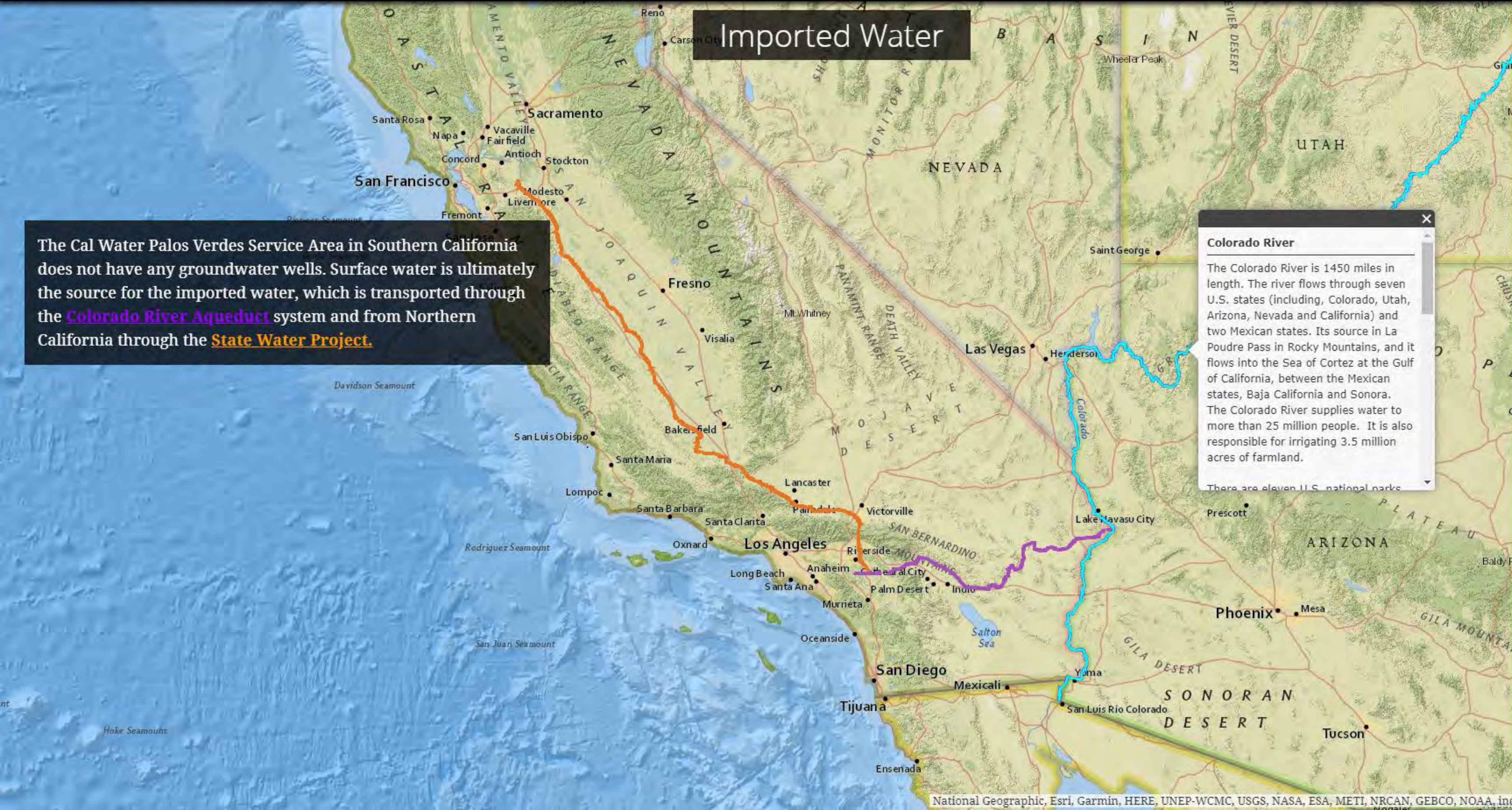
Imported Water

The Cal Water Palos Verdes Service Area in Southern California does not have any groundwater wells. Surface water is ultimately the source for the imported water, which is transported through the Colorado River Aqueduct system and from Northern California through the State Water Project.

Colorado River

The Colorado River is 1450 miles in length. The river flows through seven U.S. states (including, Colorado, Utah, Arizona, Nevada and California) and two Mexican states. Its source in La Poudre Pass in Rocky Mountains, and it flows into the Sea of Cortez at the Gulf of California, between the Mexican states, Baja California and Sonora. The Colorado River supplies water to more than 25 million people. It is also responsible for irrigating 3.5 million acres of farmland.

There are eleven U.S. national parks



Palos Verdes Service Area Historical GPCD

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Fewer Drinks for the Links

Palos Verdes Golf Club

Cal Water, committed to reducing water use for all service areas, partnered with some of our heaviest-using/ highest-consuming customers: **Golf Courses.**

One such golf course, the Palos Verdes Golf Club, has made leaps and bounds in reducing their water consumption. Some golf courses in California had to shut their doors because of the drought, but Palos Verdes Golf Club made many efforts toward water conservation.

Fewer Drinks for the Links

Much can be done at a course to use less water while still making the course playable and maintaining the aesthetic appeal. PVGC has participated in many of Cal Water's Water Conservation incentives, rebates, and upgrades.

Click on the map for details of each water conservation project.

1. Pump Station Upgrade

2. Real-time Monitoring Devices

Orion Cellular Endpoint

3. Biochar Usage


By partnering with Cal Water's Conservation Team, local golf courses can find areas in which turf can be replaced that will *not impact the golf game*.
Let's map where golfers play on the course.

Fewer Drinks for the Links

The Study began by gathering course information: number of holes, type of course, and marking out course features, such as **hole locations**, **water features**, **bunkers**, and **club house**, as control points.

Control points are important for validating the data and were completed with a precision GPS device - the Trimble Geo-7x.

Trimble Geo 7x

Fewer Drinks for the Links

Palos Verdes Golf Club

A golfer places a GPS device into their pocket while they plays on the course. The GPS device maps the golfer's location during the round of golf. This, along with other information collected from the golfer, informs the Course of playable turf areas.

The GPS devices are the size of a flash drive and fit easily into a pocket.

Canmore Sports LogBook GT-740FL GPS Data Logger


Palos Verdes Golf Club
Here is the path of one golfer during his game. He starts at the first hole and moves through to the last hole in just over 4 hours.
Port of Long Beach, USDA FS

Fewer Drinks for the Links

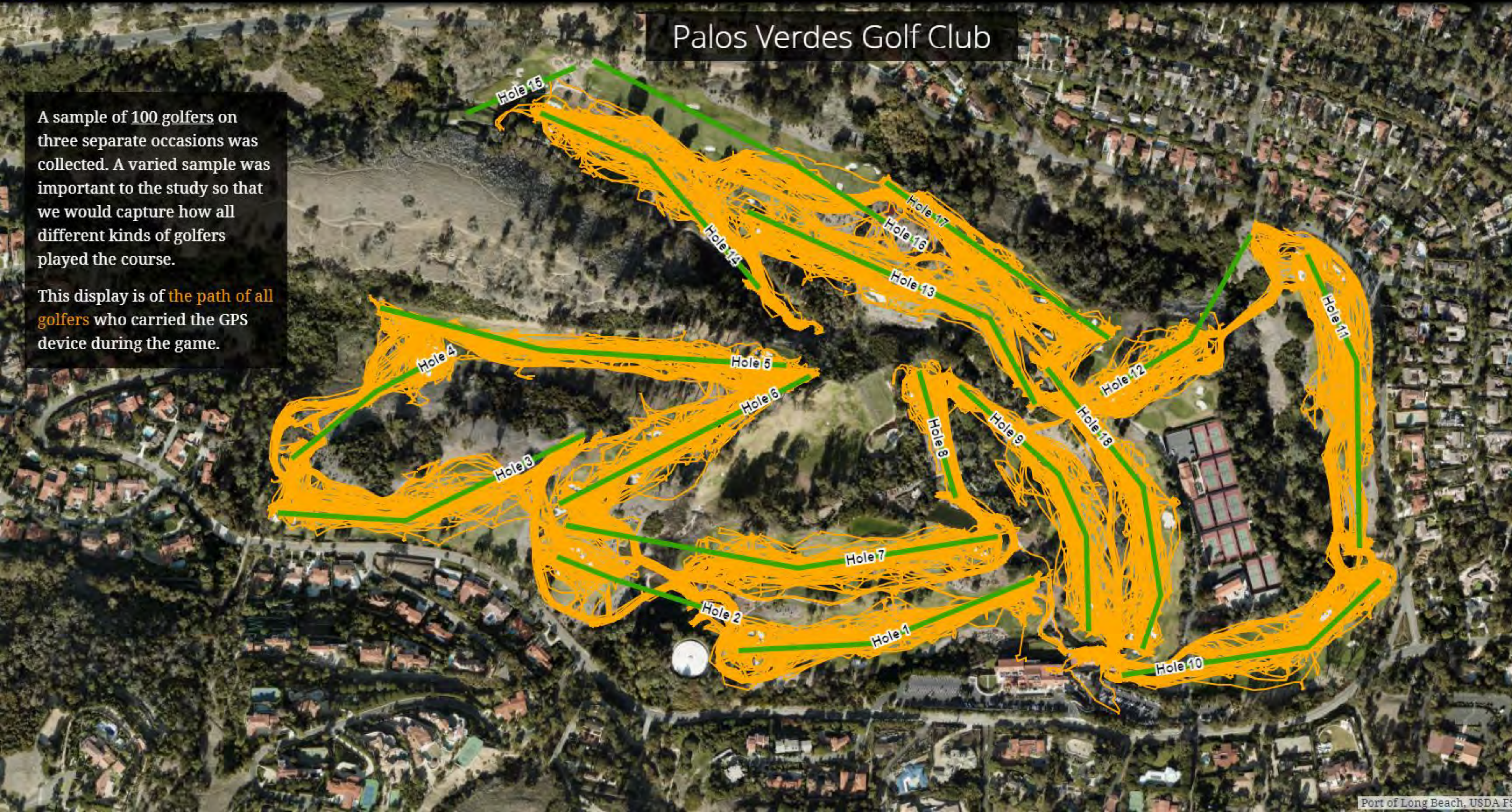
Using the GPS devices, the Course can see how different golfers behave on the course. The amount of the course that is utilized is highly dependent on the method used to get around the course. Here you see the difference between golfers who walked the course vs. golfers who road around in carts.

Fewer Drinks for the Links

Palos Verdes Golf Club

A sample of 100 golfers on three separate occasions was collected. A varied sample was important to the study so that we would capture how all different kinds of golfers played the course.

This display is of the path of all golfers who carried the GPS device during the game.



Take away the places that the golfers traveled on, and you get all of the areas that they *didn't* travel on.

Not all of these areas have an impact on the turf removal guidelines, so we subtract certain categories of land cover, like **trees and large shrubs**, and **impervious surfaces**.

With those categories no longer shown, the areas that remain are those eligible for renovation - **turf**, **bare**, **and sand**.

These areas were given to the golf course to help inform the decision on which turf around the Course to convert.


About Us Find Your District Help Contact Us

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ites Precautionary Boil Water Notice **February 18, 2017** - Hamilton City - Sacramento River Forecast and Road Conditions **February**

Conservation

- Drought Resources
- Report Water Waste
- Local Ordinances
- Conservation Reports
- Rebates and Programs
- Conservation Kits
- H2O Challenge
- Conservation Tips
- Drought-Resistant Plants
- Conservation at Home
- Urban Water Management Plans
- Other Resources

Turf Replacement Rebate Program

Cal Water will pay an incentive of $1.00 per square foot for lawn that is replaced with climate-appropriate, drought-tolerant landscaping. Artificial turf and warm season turf grasses (bermuda grass, St. Augustine, etc.) do not meet program guidelines.

A minimum of 250 square feet of turf must be removed to be eligible for this rebate. For single-family residential customers, the maximum rebate is limited to 1,000 square feet of turf removed ($1,000). For multi-family residential and non-residential customers, the maximum rebate is limited to 10,000 square feet of turf removed ($10,000).

Cal Water will consider applications for turf replaced between January 1 and December 31, 2016, or until rebate funds are depleted, whichever comes first. Applications must be submitted through **Cal Water's Program website**. Paper applications cannot be accepted.

Additional restrictions apply, so be sure to read all program specifications, terms and conditions, and design guidelines for more information.

Cal Water is partnering with our wholesale water provider in areas where a wholesaler program may offer a larger rebate. Customers in our Los Altos district can apply for such rebates by visiting the **Rebates and Programs** page and selecting their district.

California Water Service (Cal Water) takes our responsibility for environmental stewardship seriously. We encourage customers to seek out healthier and more sustainable alternatives for turf replacement than artificial turf. See **Artificial Turf**.

Latest News

Corporate Information

Turf Removal

$1/square foot

1 sqft = 24 gallons/year saved

Fewer Drinks for the Links

Based on the areas found in the GPS Study, the Course redesigned 8 sections of the playable area to incorporate water-efficient and drought-friendly design with zero turf.

Fewer Drinks for the Links

Turf Removed

Hole 4 turf removal from the south side of the Tee, near the pathway from Hole 3's green.

Total amount of turf removed and replaced at Hole 4 is **2,144 square feet**.

After - Tee at Hole 4

Fewer Drinks for the Links

After - near Tee

After - left near path

Together, Cal Water and Palos Verdes Golf Club removed *96,928 square feet of turf!*

This equates to *2,326,272* gallons of water saved per year!

For more information, please visit www.calwater.com

Ariana Wilfley

Water Conservation GIS Analyst

awilfley@calwater.com

The GPS logger study was made possible by the Drought Management and Conservation Department at California Water Service and Pat Gradoville, Director of Course and Grounds at Palos Verdes Golf Club.

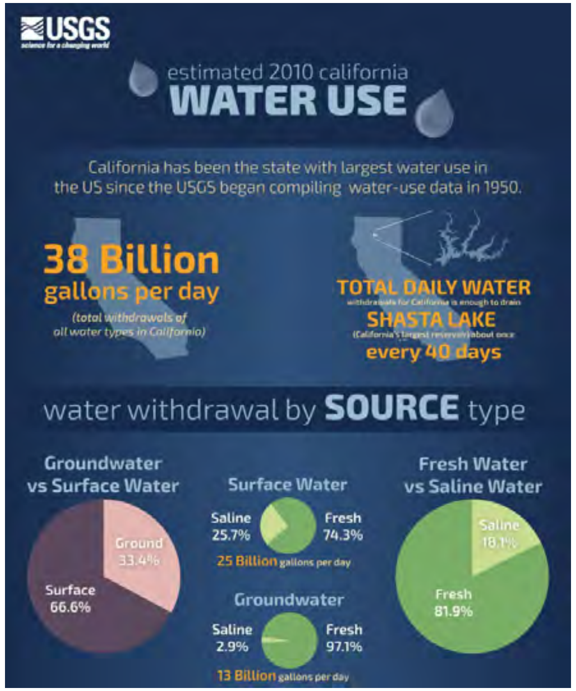
By Mark Nakatsui

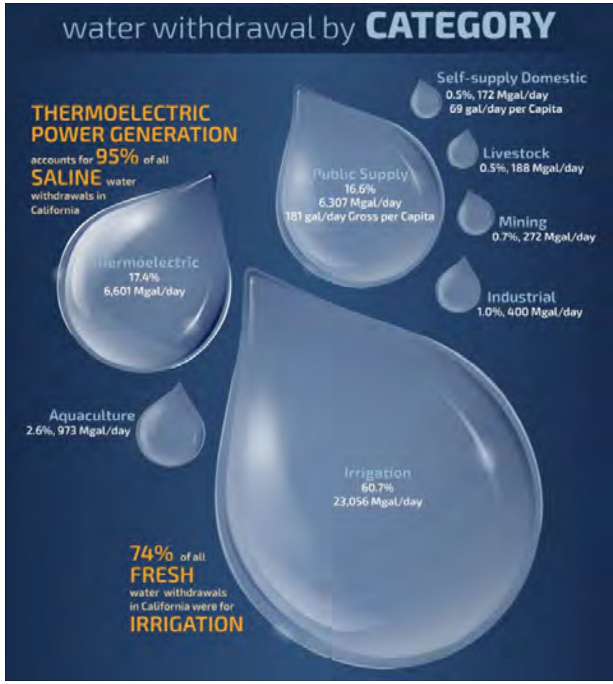
California State Polytechnic University, Pomona, CA 91768

Water Conservation on |Cynodon dactylon (L.)| Fairways

California Drought

- Southern California is in chronic drought conditions
  - On average California uses 38 billion gallons per day
    - Of this we use about 66.6% of it through surface water and about 33.4%
    - Most of the water are used in Central and Southern California Areas.





Golf Courses Struggle to Obtain Water

- Golf Courses in particular have difficult times with obtaining water
  - Water restrictions
  - Poor water quality: Reclaimed water
  - Lowering of the water table
  - Increased price of water

  - A Questions I want to leave with you
    - How can we remedy this problem?

Ways Golf Courses Reduce Water

- Remove the amount of irrigated areas
  - Reducing the amount of water on areas that do not see play on the golf course.
- Use of Water Efficient turfgrasses
  - Examples of more drought tolerant turfgrass species are Bermudagrass, Zoysia, Kikuyu, and St. Augustine.

Ways Golf Courses Reduce Water Continued

- Deficit Irrigation
  - Reducing the amount of water below optimum levels, but still achieving a desired look and play.
  - Only replacing enough water for the turfgrass to grow and survive, to a point where club member would like the playing conditions and appearance of the turfgrass.
- More Efficient Irrigation and Golf Course Design
  - Example is explained by Larry Stole from PACE Turf.
    - He suggests using a 16 inch sand base at the front of a golf course green, and an 8 inch sand base at the back of the green to provide even volumetric water content throughout the green.

Soil Moisture Sensors (SMS)

- Time-domain reflectrometer (TDR)
  - Sends a signal between the probes and measures the time between pulses to determine soil moisture levels.
- Frequency Domain Reflectometry (FDR) Capacitance technology
  - Probes create an electromagnetic signal that radiates in a “sphere of influence.”
  - In this case the meter will measure the difference between the output wave, and the return wave frequency to determine soil moisture.

Description of Proposed Research

- 3 Main Objectives
  1. Analyze the performance of SMS systems to apply less irrigation and result in water saving by bypassing irrigation events when soil moisture is adequate
  2. Evaluate SMS capability to maintain bermudagrass quality.
  3. Compare SMS performances against standard irrigation scheduling.

Installation

- Soil moisture sensors will be installed based on manufacturer's instruction and with their assistance.
- There will be two or more wetting and drying cycles after sensors installation to monitor and ensure proper sensor response before final setting of control points on sensors.

Irrigation/ Turfgrass Plot Treatments

- All treatments will be scheduled once per week with the same amount of irrigation.
- Plots will be individually scheduled once per week.
- Total weekly irrigation run time will be equally divided over five irrigation days per week.

Distribution Uniformity (DU)

- A catch-can test will be conducted to evaluate performance of the irrigation system of each plot to determine DU and precipitation rate.

Maintenance/ Upkeep

- Bermudagrass will be maintained at the heigh of 1/2”
- Mowed twice a week.
- Fertilized using 0.4 lbs N/1000 ft2 per growing month
  - Split the monthly rate into one application every 2 weeks to avoid high and low peaks of shoot growth.

Data Collection

- Data Collection will be conducted from May 1st – October 31st, 2018 and 2019.
- Eto precipitation, and other climatic data will be accessed from CIMIS station #78 based
- Data being collected
  - Runtime
  - Irrigation applied
  - Number of irrigation events that are bypassed or allowed
  - Amount of saved applied irrigation
  - Visual turfgrass quality and color ratings
  - Soil water content (VMC %)
  - Soil salinity (EC)

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Autonomous Turfgrass and Groundcover Irrigation Management Using Smart Irrigation Controllers in Southern and Central California

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Smart Irrigation Controllers

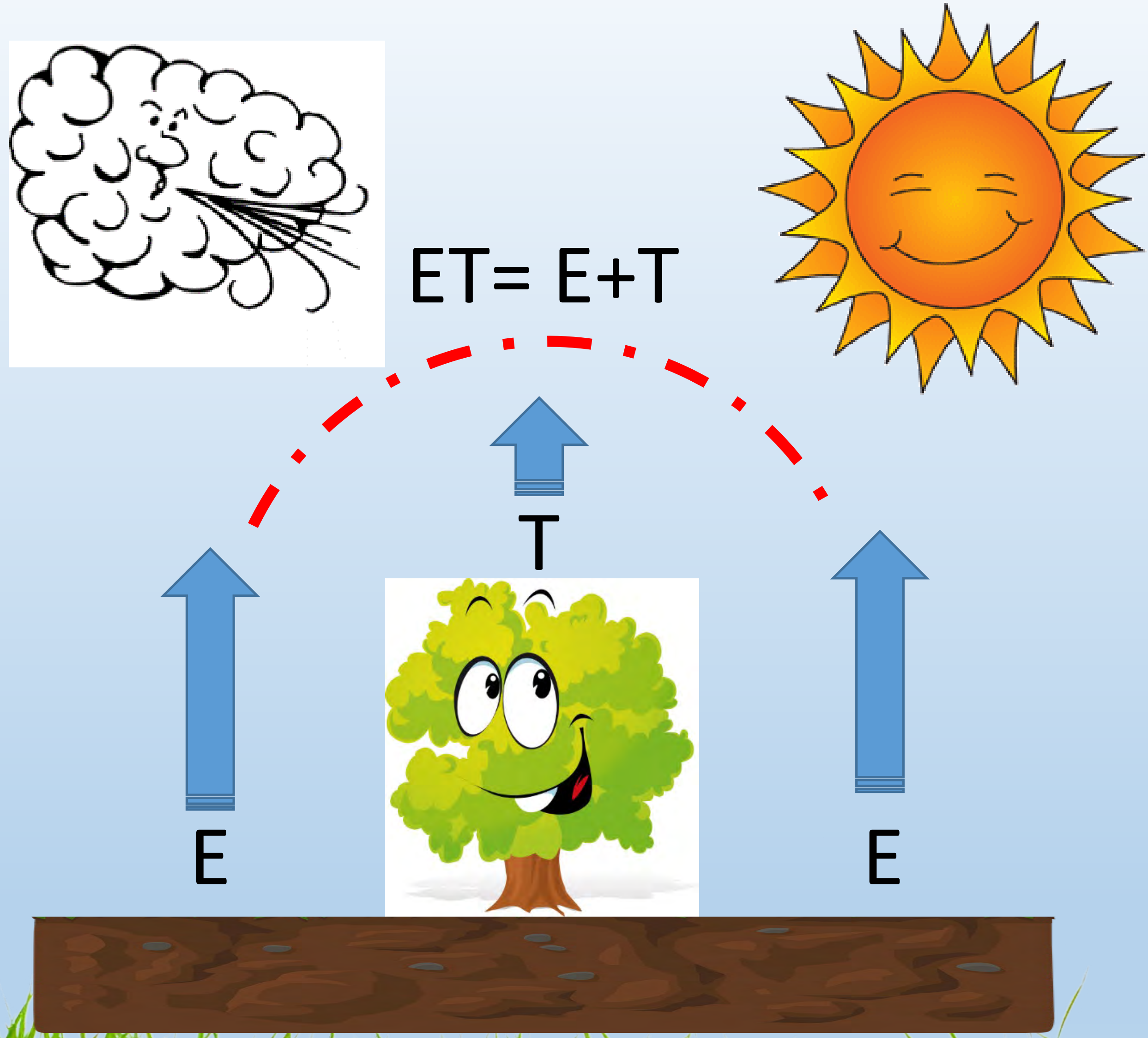
Irrigation association: “*estimate or measure depletion of available plant soil moisture in order to operate an irrigation system*”

Irrigation timer + Sensor

1. Weather based Smart Irrigation Controllers
2. Soil Moisture Sensor based Smart Irrigation Controllers

Photos taken from multiple webpages.

Weather based Smart Controllers



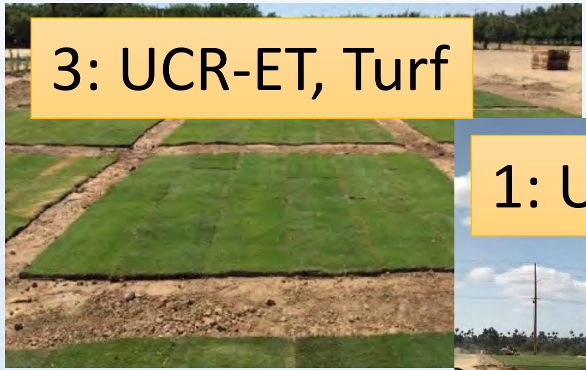
Photos taken from multiple webpages.

Soil Moisture based Smart Controllers

- ✓ Adjust and apply irrigation based on soil moisture data
- ✓ Eliminate the unnecessary irrigation applications




Photos taken from multiple webpages.



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ET, Turf

- 72 plots (12 feet * 12 feet)
- 2-3 feet border between plots
- Tall fescue and Bermudagrass
- 6 irrigation levels: 100% ET – 50% ET
- 2 frequencies: 5 days per week, 3 days per week

ET, Turf

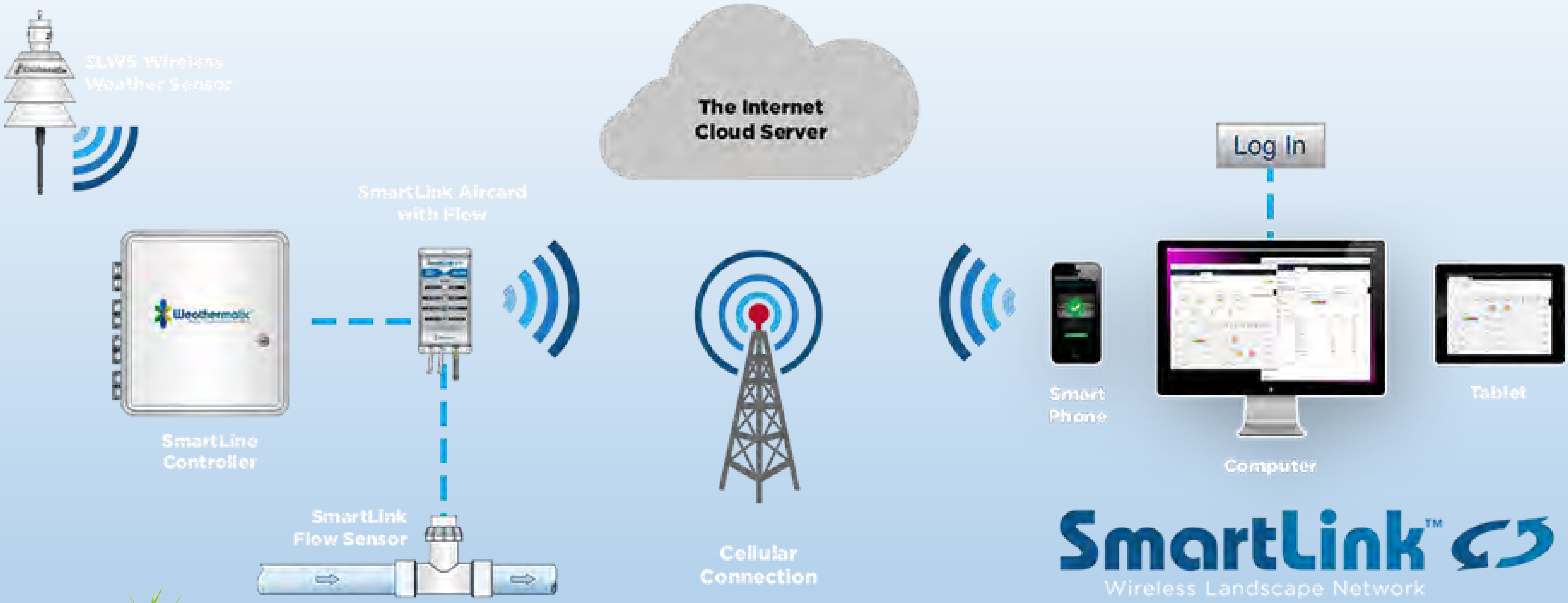
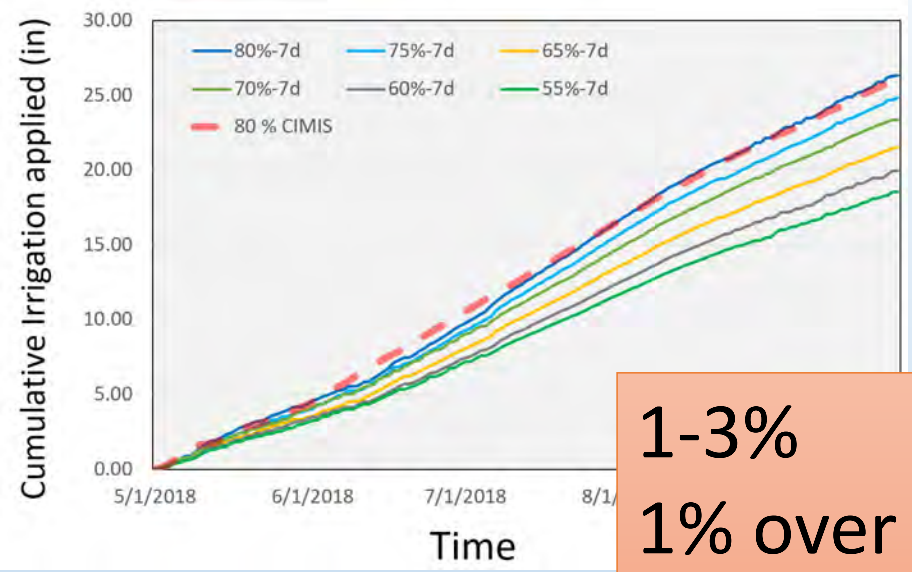


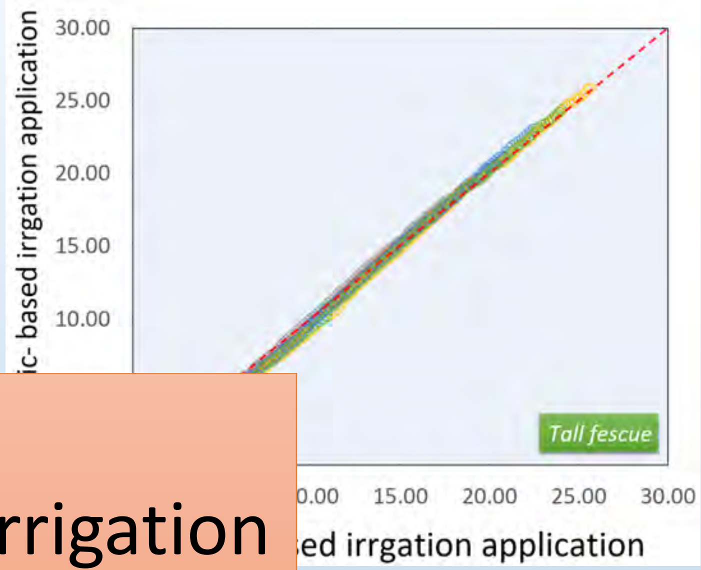
Photo credit: smartlinknetwork.com

ET, Turf

UCR 2018

7 day week^{-1}



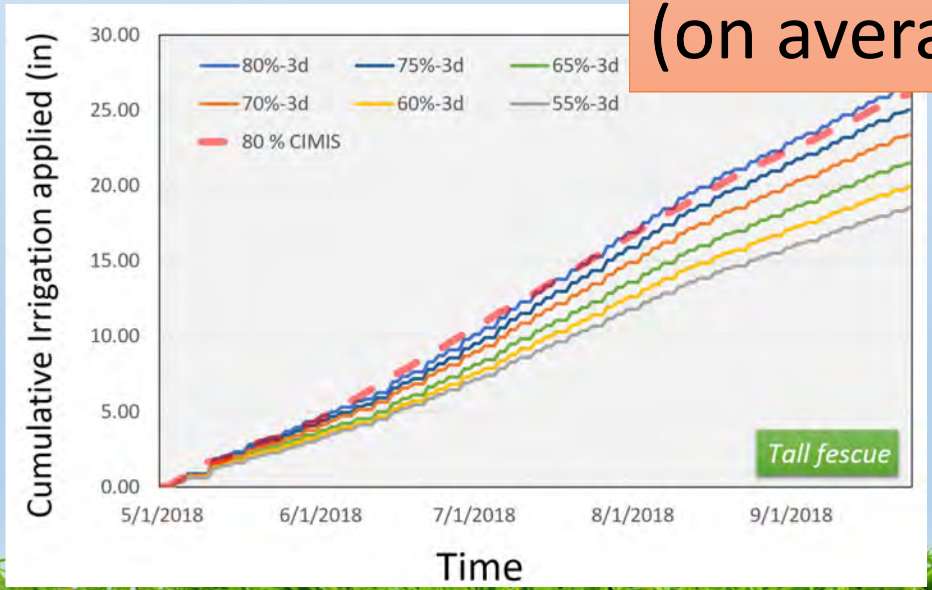


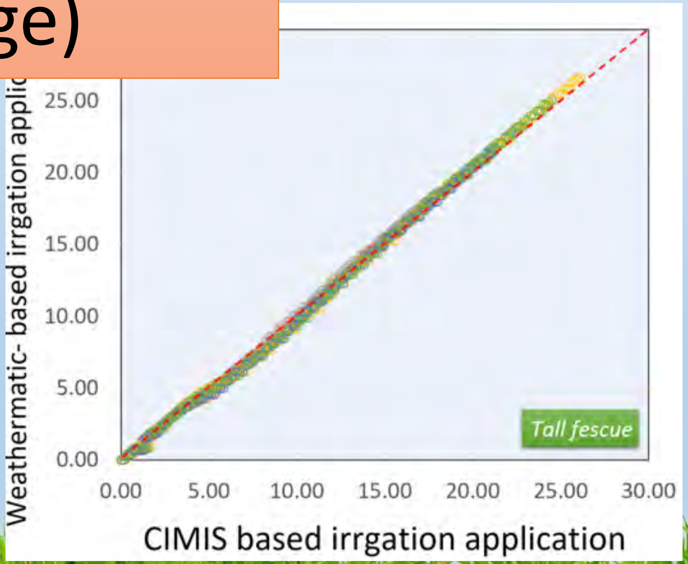
1-3%

1% over irrigation

(on average)

3 day week^{-1}





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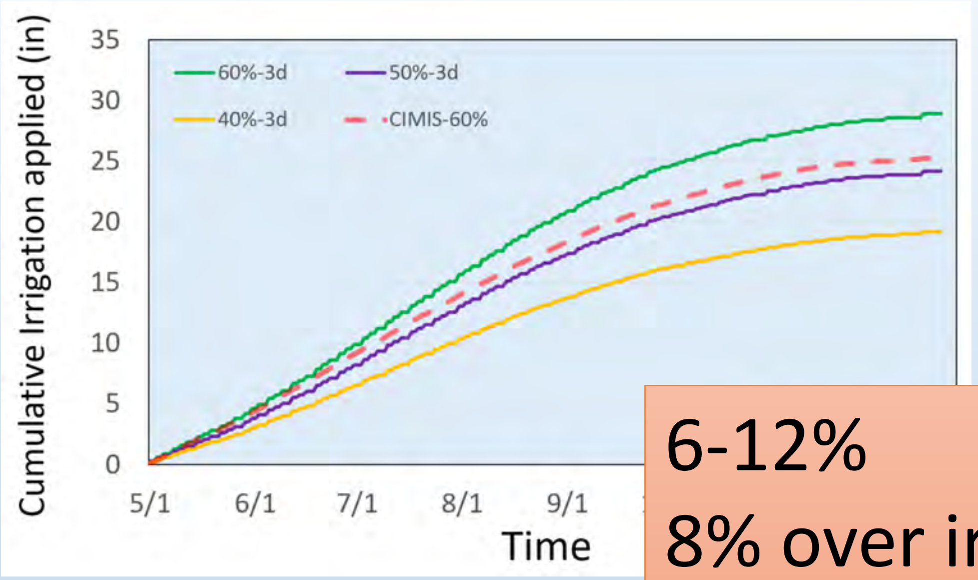
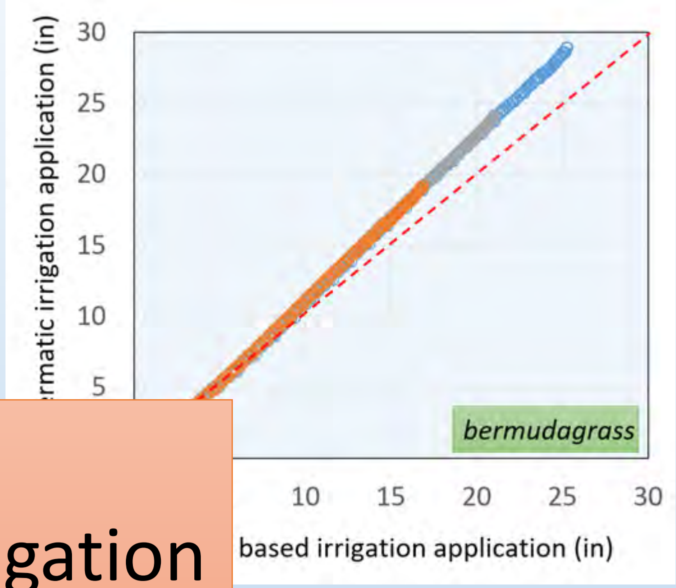
ET, Turf

KARE 2018

3 day week^{-1}

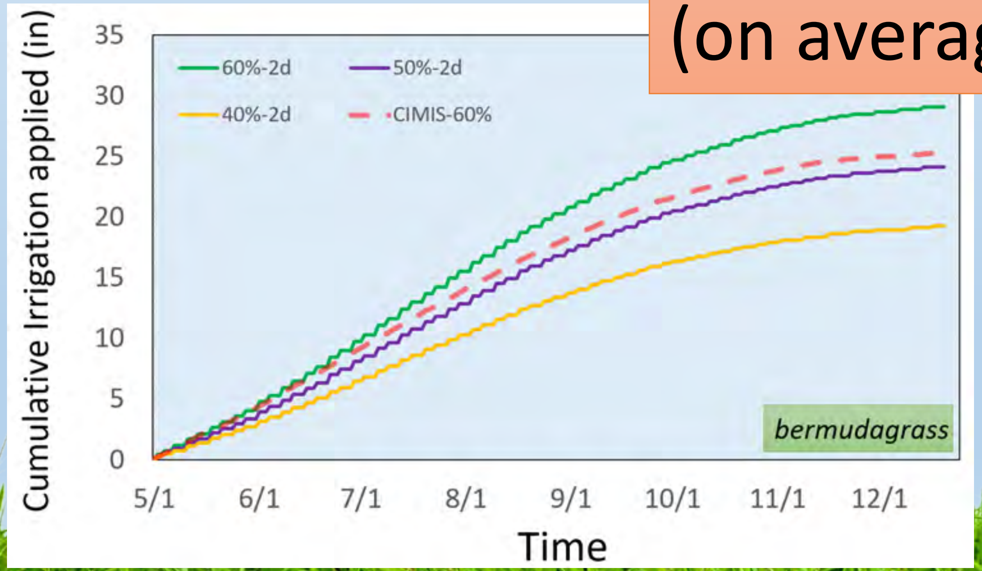


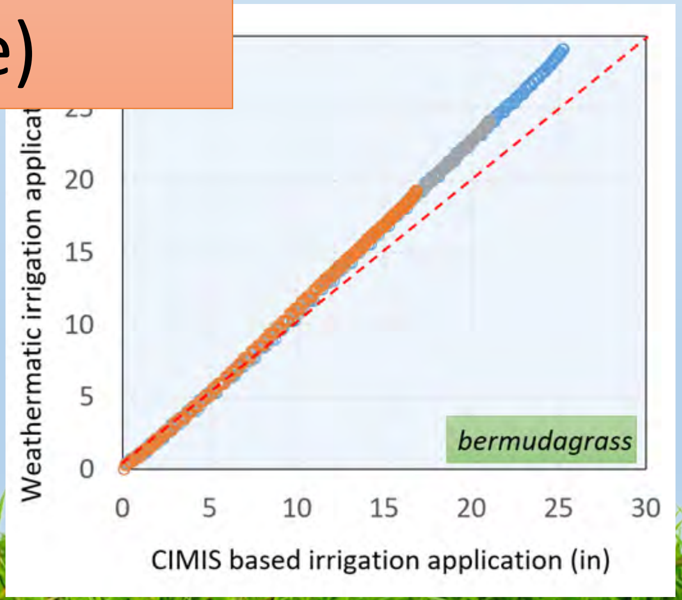


6-12%

8% over irrigation (on average)

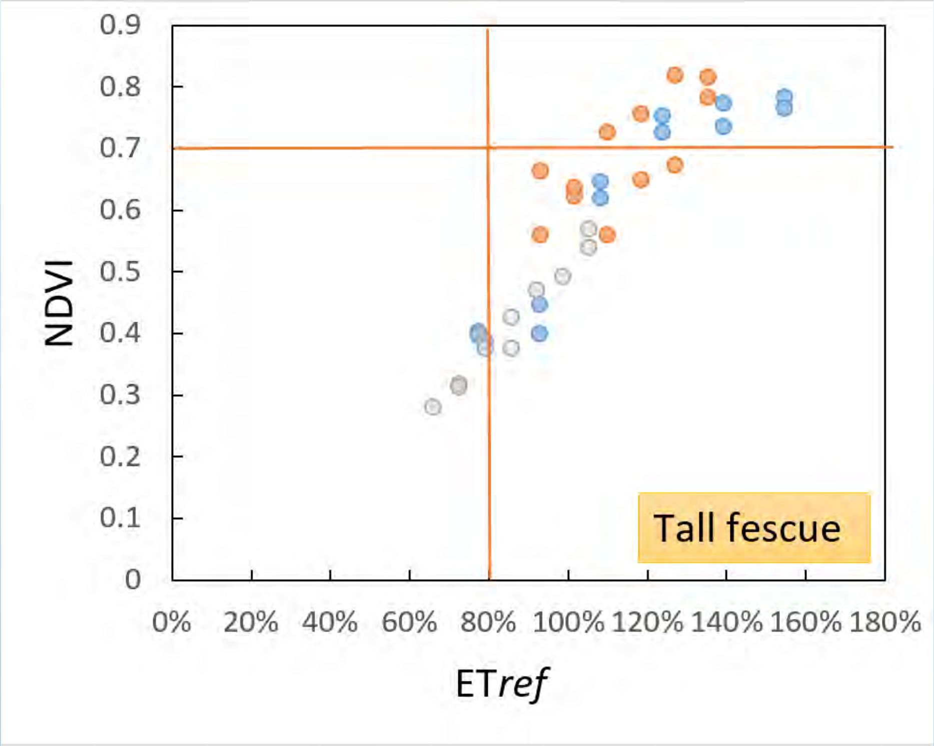
2 day week^{-1}

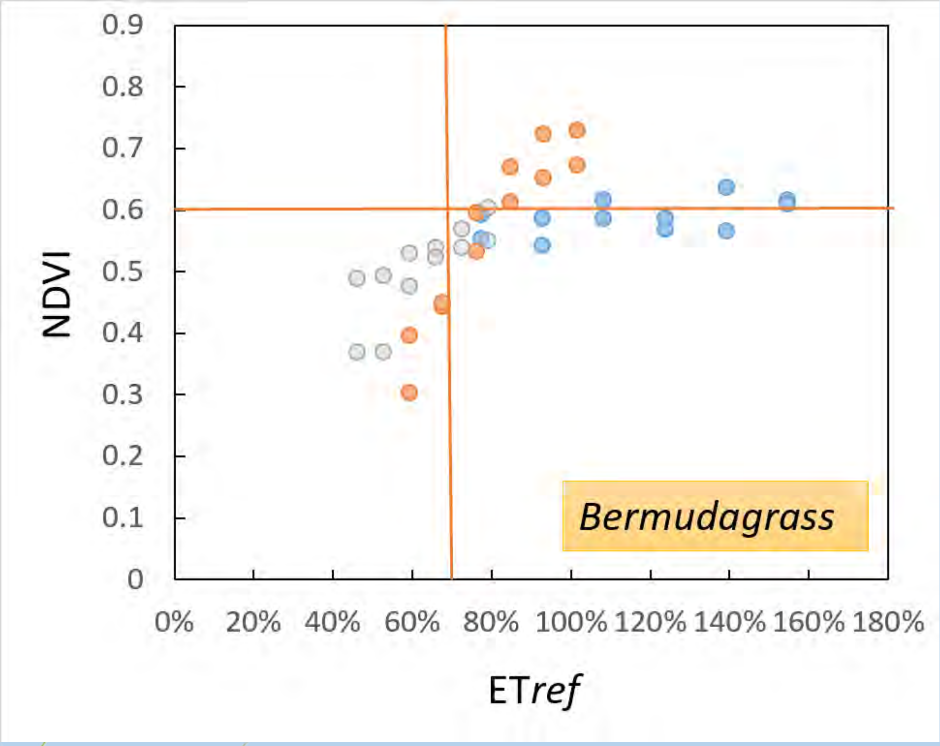




ET, Turf

NDVI (2017, 2018,2019)





SCREC-SMS, Turf

- 48 plots with Warm season (*bermudagrass*)
- Randomized complete block design
- UC ANR South Coast Research and Extension Center, Irvine
- Recycled water for Irrigation

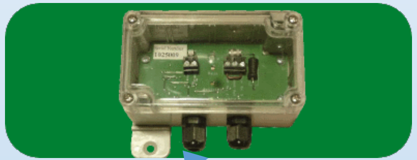
Treatment	Lower limit	Upper limit	Watering days
1	75%FC	FC	3days/week
2	65%FC	FC	
3	65%FC	FC-10%	
4	55%FC	FC	
5	55%FC	FC-20%	
6	75%FC	FC+10%	
7	75%FC	FC	7days/week
8	65%FC	FC	
9	65%FC	FC-10%	
10	55%FC	FC	
11	55%FC	FC-20%	
12	75%FC	FC+10%	

SCREC-SMS, Turf

Acclima CS3500 2-Wire Controller
Zone Decoder

Ethernet Adapter

Rain-Freeze Switch



Hydrometer Integrated Flowmeter

2 Wire TDT senosor

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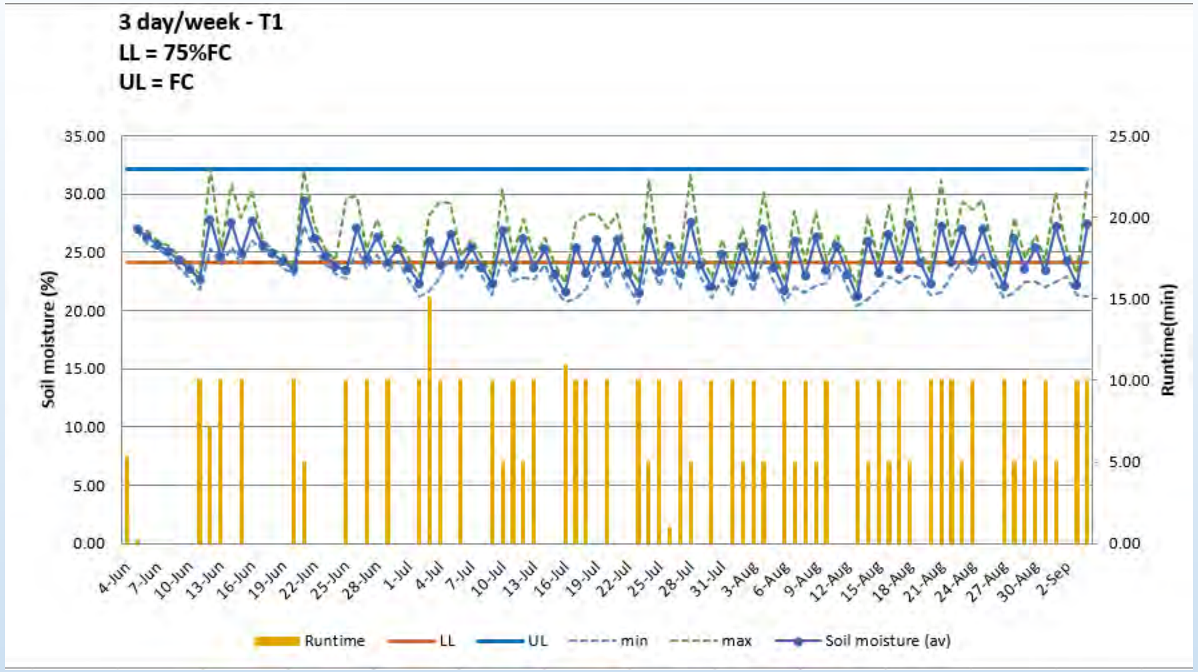
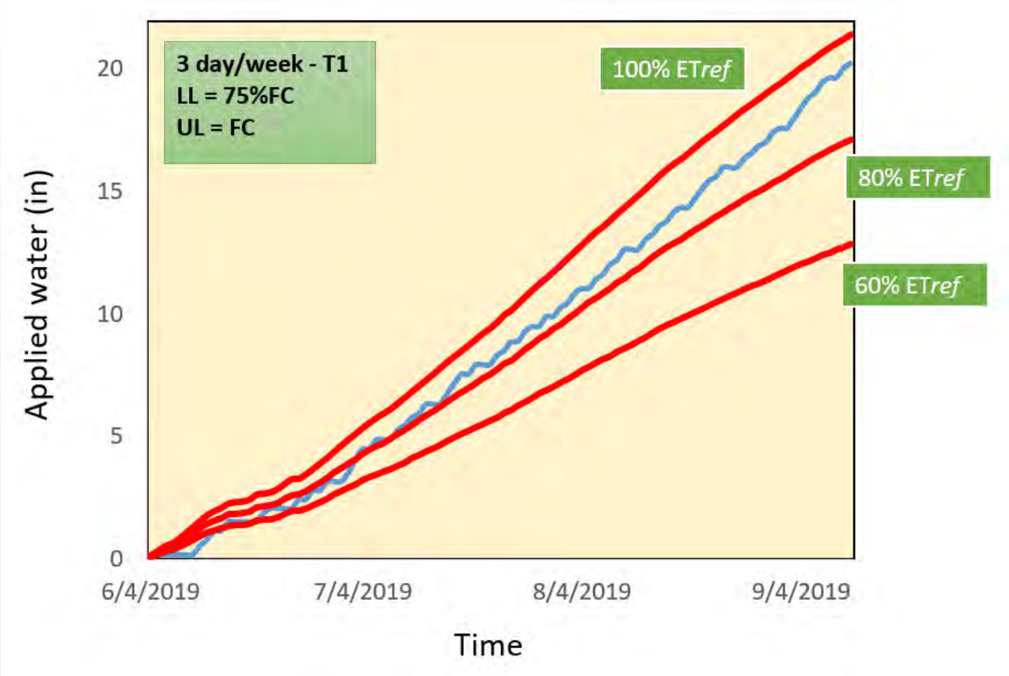
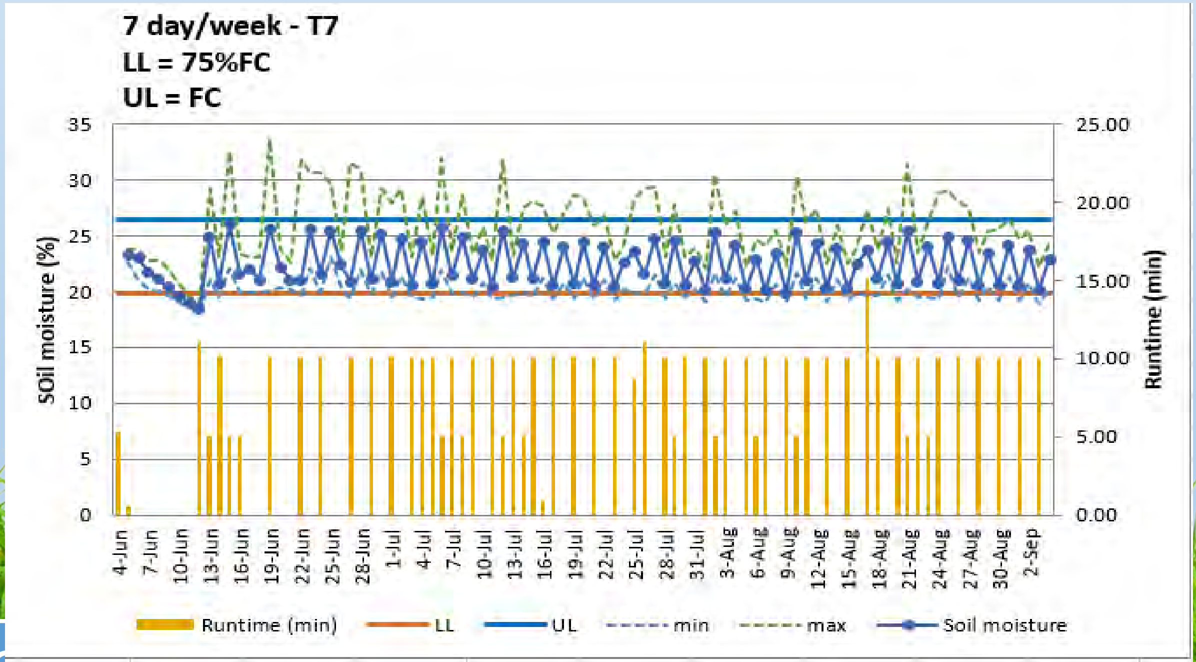
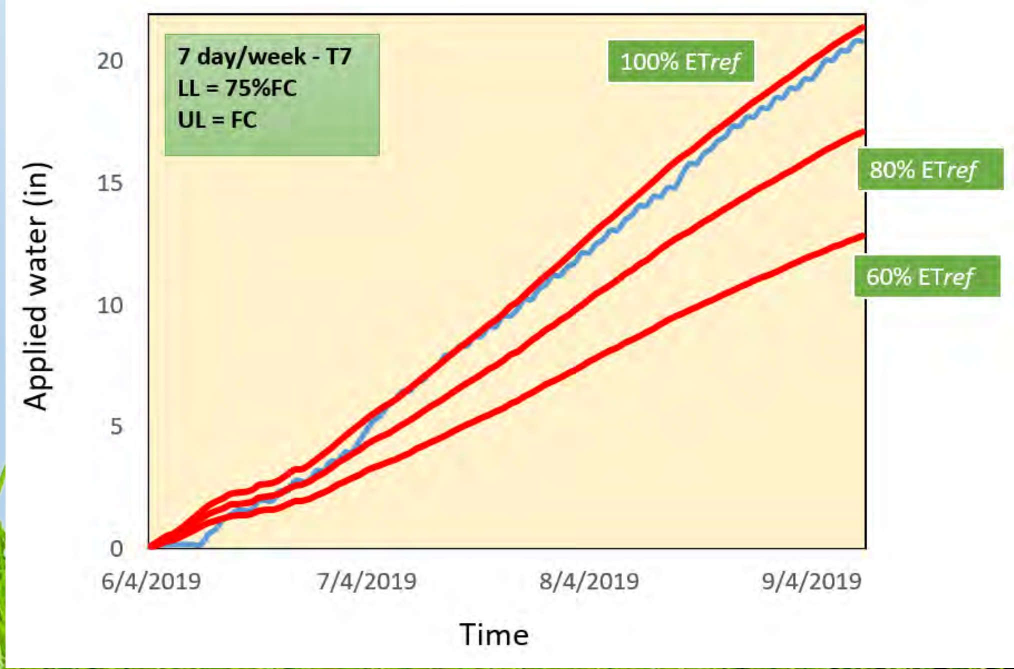
Photo credit: acclima.com

Nevada









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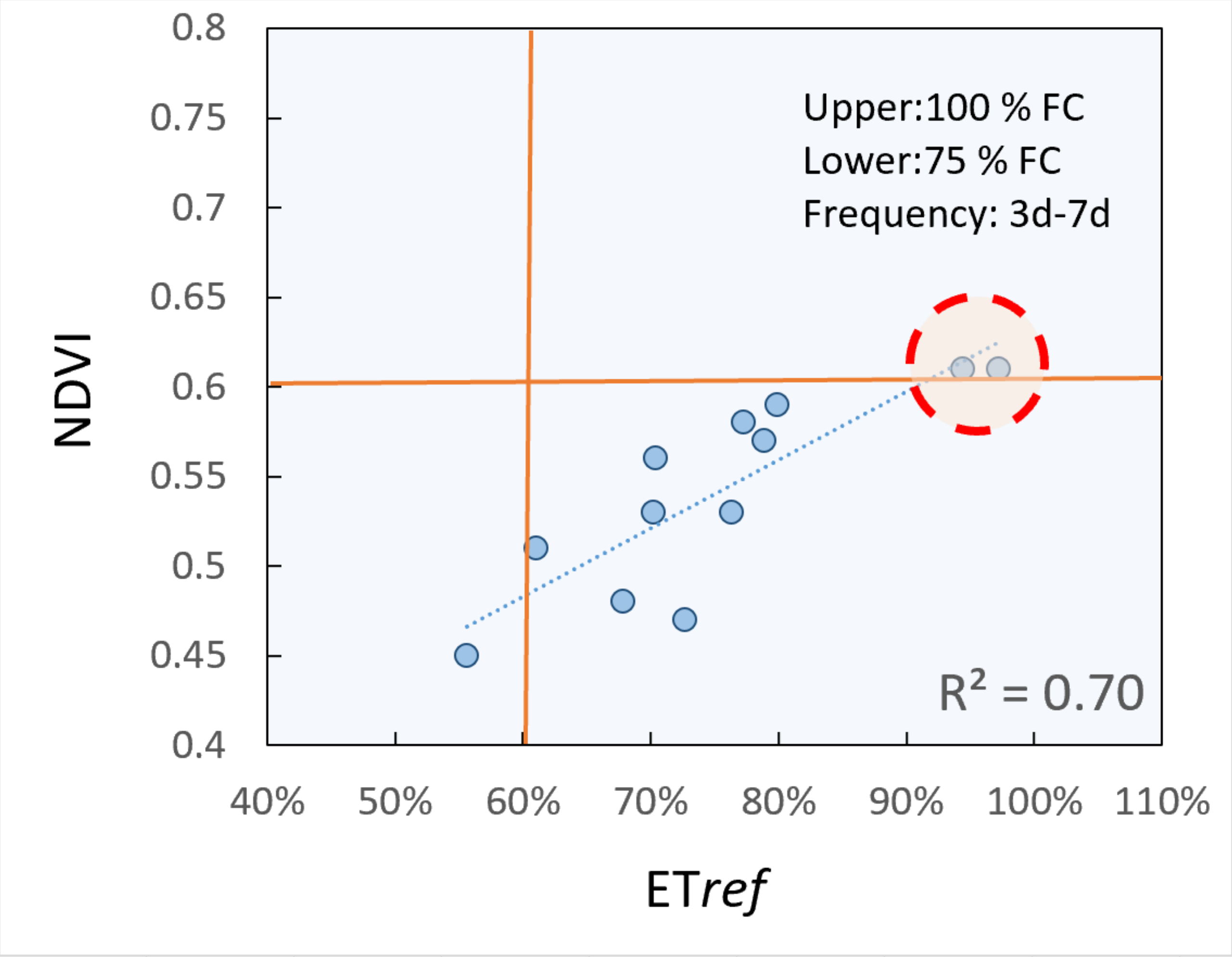
SCREC-SMS, Turf

9/13/2019 (~100 days after initiation of the project)



UCR-SMS, Turf

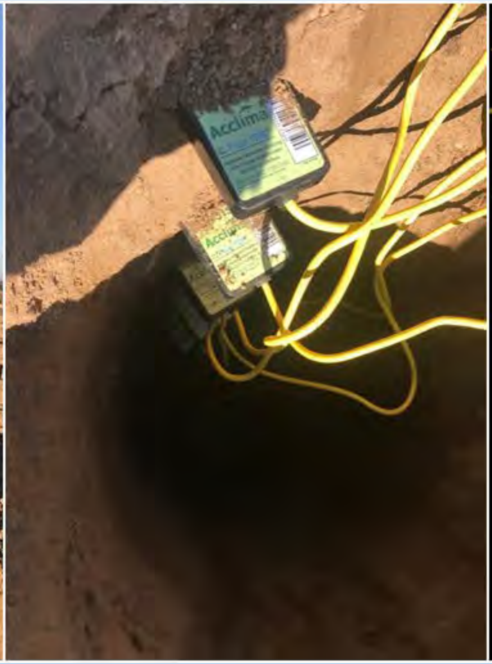
Photo credit: smartlinknetwork.com

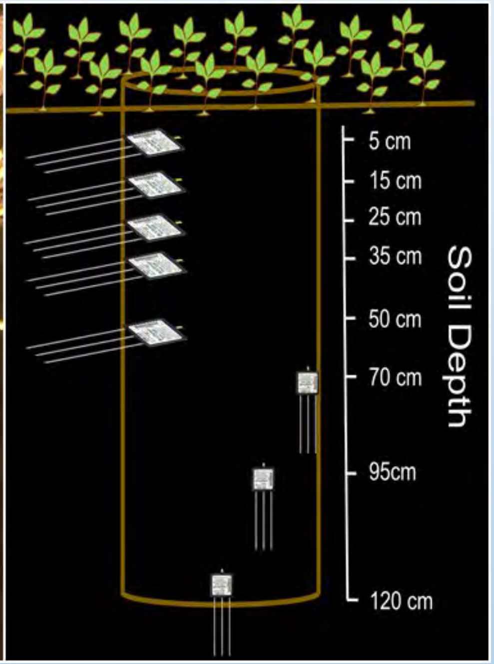
Groundcover irrigation study

- Twelve landscape species
- Four irrigation treatments
- Three replications
- Randomized complete block design

Groundcover irrigation study

- Comprehensive network of time domain reflectometer sensors (TDR; 288 sensors in total)





Groundcover irrigation study

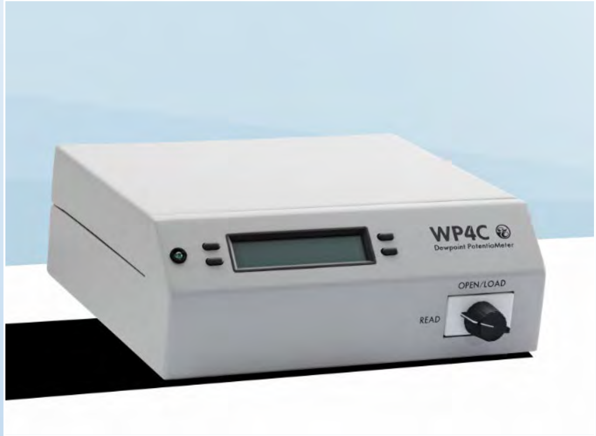
- Handheld tools

a) NDVI

b) Canopy temperature

c) Stomatal conductance

d) Leaf area index

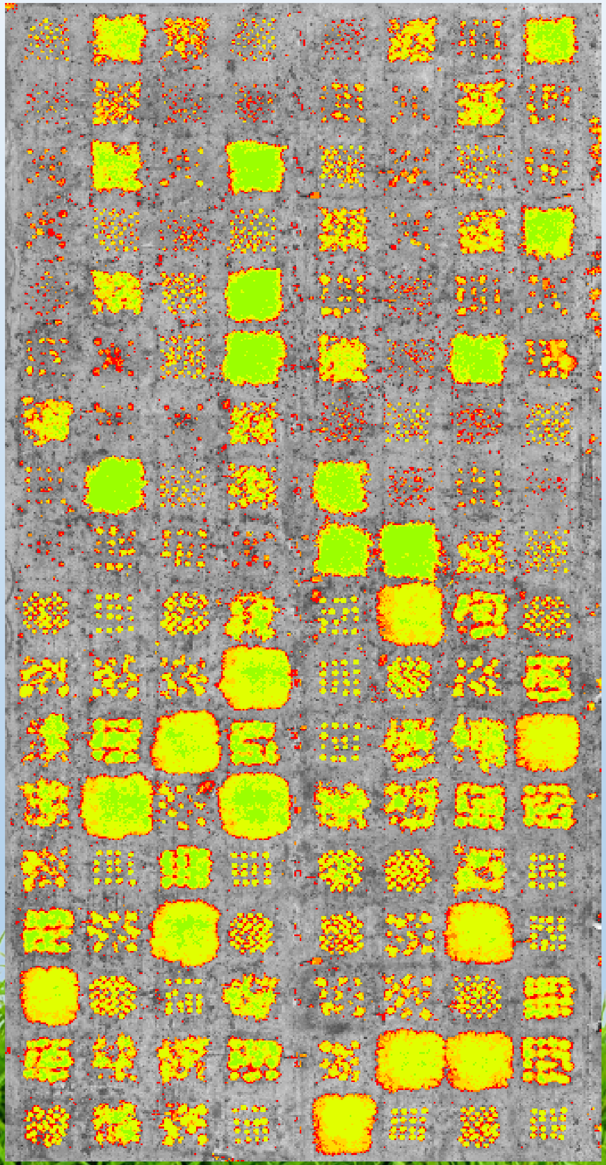


e) Leaf water potential

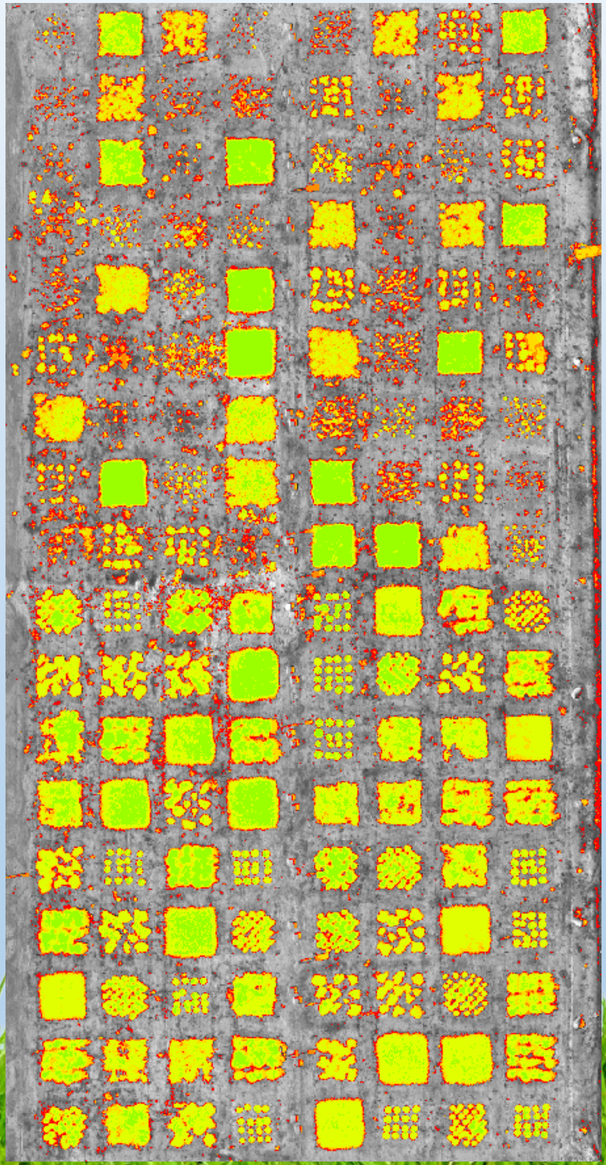
- Aerial images

f) Multispectral & thermal remote sensing images

Groundcover irrigation study



07-16-2019



08-21-2019

Legend:
NDVI Values

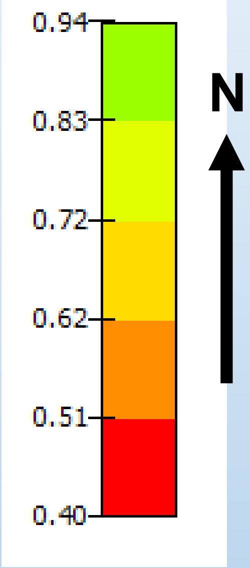


Fig: Lonicera japonica

Fig: Frankenia thymifolia

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Fundamentals of the Smart Water Triangle, Tuesday, Dec. 3rd 2019

Presented by, Rich Miller, CLIA, CIC.

Qualify your customer

- Ask questions. Be in control.
- Who, what, when, where, why, how.
- Know your customer.
- Know your solution.
- Engage them in your solution.

System Controls, Flow requirements and Soil texture

- Gather enough site information in order to create a design
- Design flow
- Output options
- Take a soil sample
- What is the texture and PH
- What is the water chemistry

Add on to ET Controllers

- Explain ET based
- Explain Soil sensor based
- Think beyond the rain switch
- Weather Underground

Be different by connecting your solutions to customers needs

Central controls

Avoid service calls

What they can’t see won’t affect system hydraulics.

TRUE or

FALSE


Irrigation Choice Awards

Irrigation system with
automated shut down function

Right Head Right Place.
Design.
Adjustment or nozzle.

“Be a company that follows best practices and executes.”

Proper design
Flow sensor/ master valves
Pressure regulation
Right head right place
Matched precipitation

Soil texture is not a factor to consider

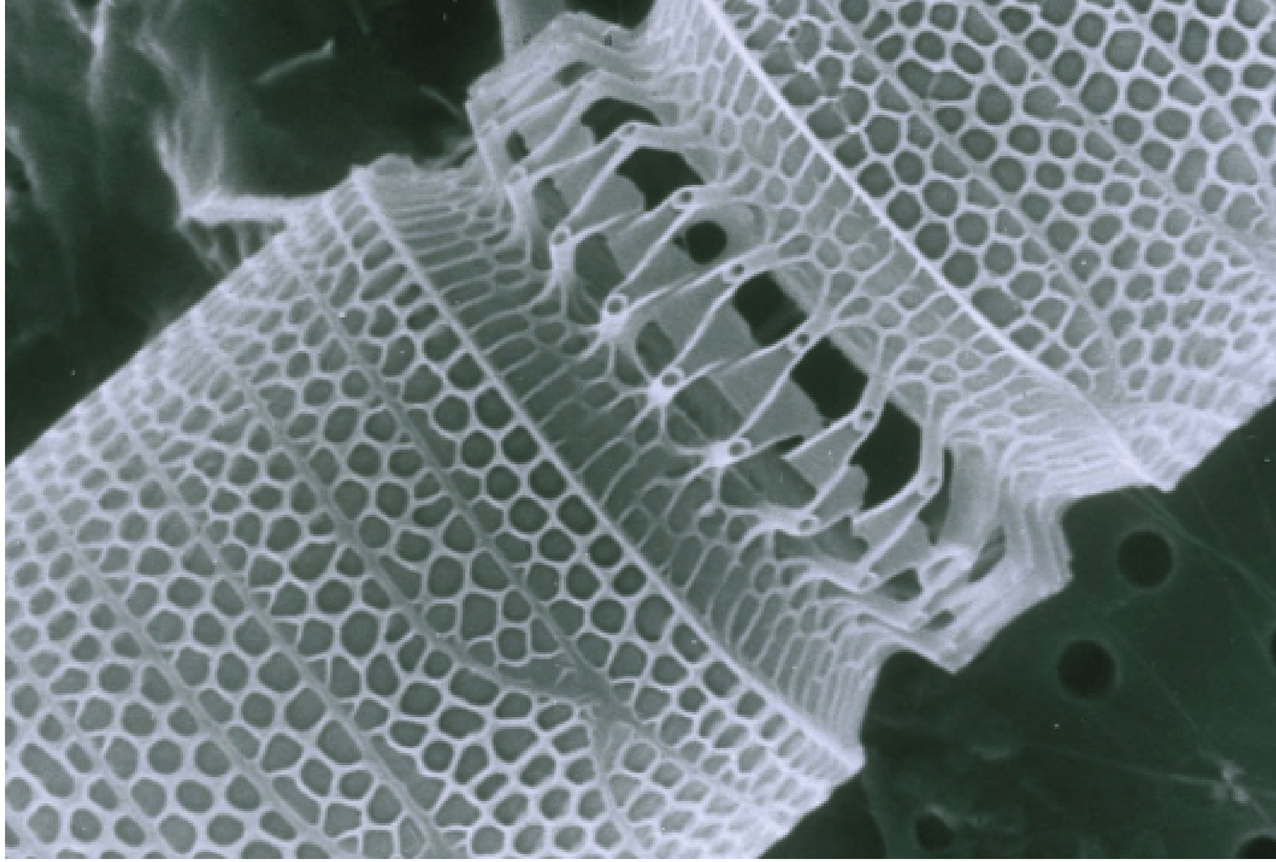
TRUE or

FALSE

Infiltration, run-off
Plant available water

FINE, not fine!

COARSE, of course!



Amendments for water conservation in-organics vs organics.

Add pore space to the soil texture

- Organics continue to break down
- In-organics generally remain
- In-organics such as DE do not break down and are around 80% porous.

Respond to all Factors

- Think beyond the rain switch
- Design for conservation
- Know the soil texture
- Know your solution
- Controler options and types
- Be the professional
- Become IA Certified

Contact information

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727.272.0344

www.AuditH2o.com

www.H2oAxis.com

www.irrigation.org

Designing and Building Landscapes Using Only Rainwater

Darrel McMaster

- Owner of Sustainable Homes Inc.
- Past President Texas Rain Catchment Association
- ARCSA Member
- Certified Green Professional
- Task Group Member National Green Building Standard
- Member of NAHB Sustainability Committee

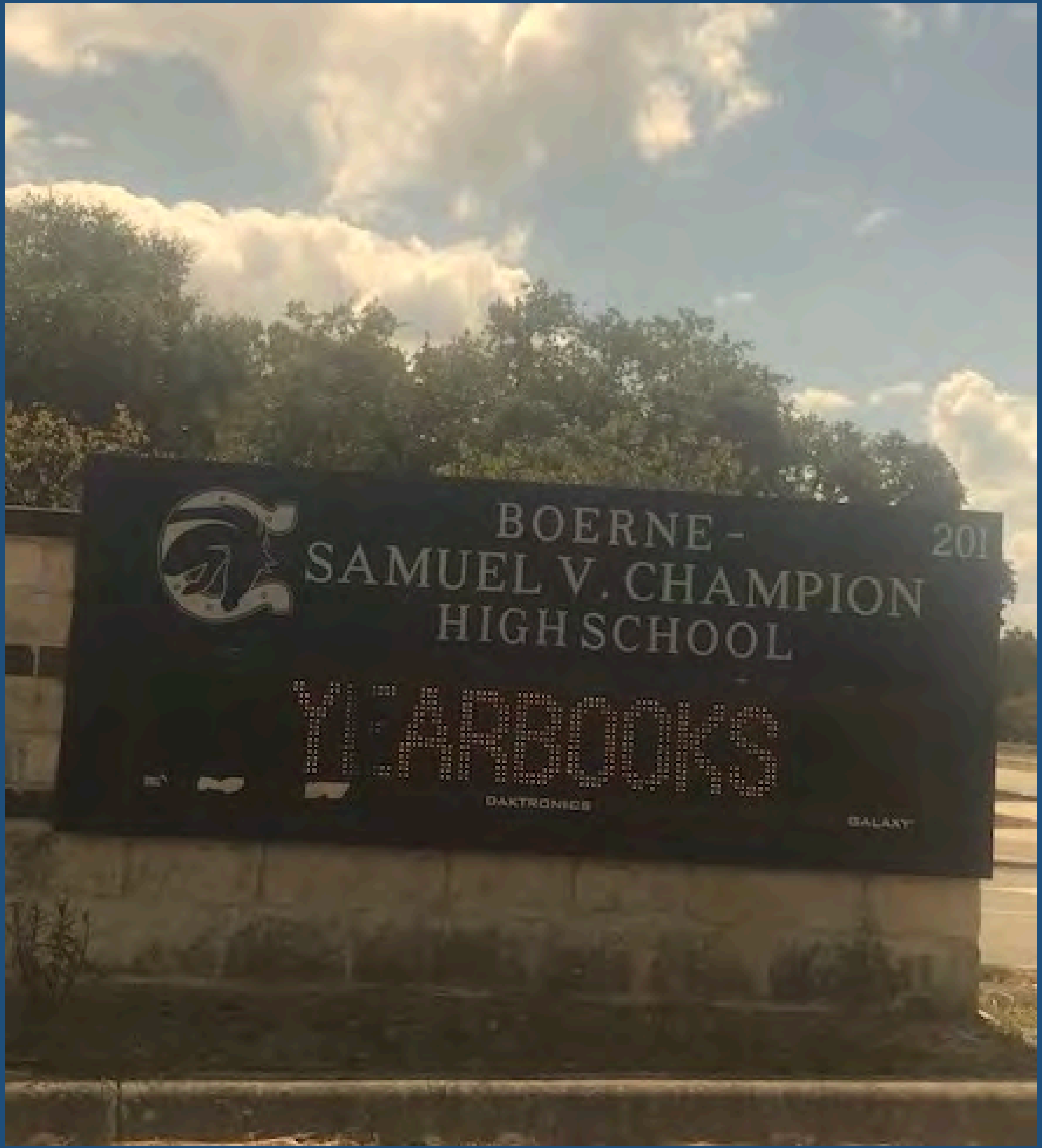
We have over 100 homes that run exclusively on Harvested Rainwater


NON-POTABLE RAINWATER


POTABLE RAINWATER
POTABLE RAINWATER

San Antonio Food Bank 2011
Storage 130,000 Gallons
Collection Area 100,000 Sq. Ft.

San Antonio Food Bank Today
460,000 Gallons
Collection Area 200,000 Sq. Ft


BOERNE -
SAMUEL V. CHAMPION
HIGH SCHOOL
YEARBOOKS
DAKTRONICS
GALAXY

300,000 Sq. Ft Roof
5 Acres of Parking
They collect from the roof, the HVAC condensate and the parking lot.
Storage is a concrete pipe 8’ x 8’ x ¾ of a mile long

1,800,000 gallons of Storage

Irrigation Industry

YOU DON'T KNOW IT BUT YOU HAVE A TARET ON YOUR BACK!

Cities
Counties
States
EPA

- Are Coming After You

How to Make Rainwater work for you

- What are the codes in your area?
- What are your water requirements?
- What is the project collection capability?
- What filtration or sanitation system will work for your application?
- Tank Types.
- How to sell Rainwater.

What are the codes in your area?

1. Is it allowed in your State, County, City?
2. Are there restrictions for Rainwater use
3. What Purification systems do you need?
4. Can you mix Harvested Rainwater with Storm Water?

What are Your water requirement (Demands)?

1. Do you have an estimated annual water use (Plants, Turf…)
2. Type of Irrigation Used
3. Type of Plants Used (Native – Drought Tolerant

What is your project collection capability

1. What is the annual rainfall in your area (100 yr. average)
2. What is the collection area of your project?

How to Calculate Water Capture

Example –

SA Food Bank – 100,000 Sq. FT divided by 1000 = 100
100 x 600 = 60,000 gallons of rain
In our area in Texas we get 30" annually = **1,800,000** gallons per year

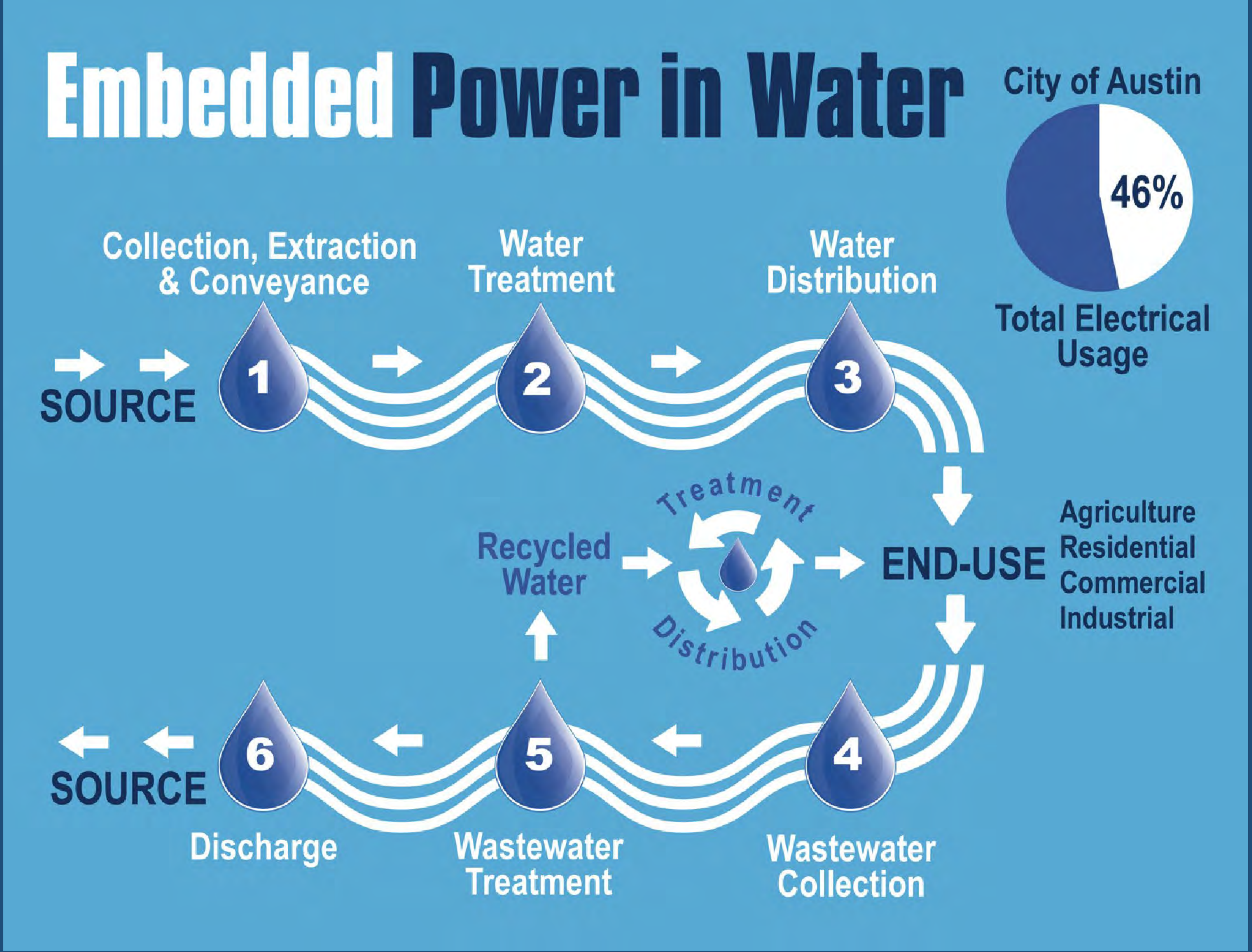
What filtration or sanitation system will work for your application?

- Does Water have to made to Potable Water Standard?
- Can you use a Re-used or Reclaimed Water Standard?

Tank Types

Above Ground Tanks
Underground Tanks

How to sell Rainwater.


Embedded Power in Water
City of Austin
46%
Total Electrical Usage
Collection, Extraction & Conveyance
Water Treatment
Water Distribution
SOURCE
1
2
3
Treatment
Recycled Water
END-USE
Agriculture
Residential
Commercial
Industrial
Distribution
6
5
4
SOURCE
Discharge
Wastewater Treatment
Wastewater Collection

Harvey and Harriet Homeowner

Harvey and Harriet Homeowner

* Distribution Loss From Plant 10% -15%

Harvey and Harriet Homeowner

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*Efficiency of Power Plant   Nuclear- Coal- Natural Gas 15%-35%

Harvey and Harriet Homeowner

* Distribution Loss From Plant 10% -15%
*Efficiency of Power Plant Nuclear- Coal- Natural Gas 15%-35%
*To get homeowners 2000 kWh we need to generate 2500 kWh

Harvey and Harriet Homeowner

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*To get homeowners 2000 kWh we need to generate 2500 kWh

*Virgina Water Research Center
says it takes 25 gallons of water to produce 1 kWh of power

Harvey and Harriet Homeowner

* Distribution Loss From Plant 10% -15%
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*To get homeowners 2000 kWh we need to generate 2500 kWh
*Virgina Water Research Center
  says it takes 25 gallons of water to produce 1 kWh of power
*If we do the math we need to generate 2500 kWh of power for the homeowners
  but we need to use 62,500 gallons to do that

Contact Information – Darrel McMaster

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sustainablehomes@gvtc.com

Green Building
Solutions INC

Greenbsi@yahoo.com

Rainwater BMPs: Plants, Soil, Irrigation & Regulation

Russell Ackerman, CLIA-D, SITES AP

Sustainability Analyst, City of Santa Monica

Irrigation Show December 4, 2019

Rainwater Best Management Practices

- Rain Gardens
- Bioretention areas
- Green Roofs

- Dry Wells
- Permeable Pavement
- Infiltration Pits
- Rain Barrels
- Cisterns
- Downspout filters
- Constructed Wetlands

Regulatory Standards, Guidelines, Codes, Statutes

- International Association of Plumbing and Mechanical Officials, IAPMO, *Water Efficiency and Sanitation Standard* (WE Stand), http://www.iapmo.org/, chapters on rainwater and stormwater (alternate onsite water) standards
  - Provides standards for the construction, alteration and repair of nonpotable rainwater catchment systems
  - Reference table for testing, inspection and maintenance frequency
  - Cross-connection
  - Minimum Water quality standards
- International Codes Council, ICC, https://www.iccsafe.org/, should have recently passed a rainwater collection and use standard
  - Plumbing standards trade groups that oversee plumbing code practices. Covers separate states than IAPMO.
  - Different approval processes for new plumbing standards. IAPMO has its basic rainwater/stormwater standards in place. ICC is developing their standards.

Regulatory Standards, Guidelines, Codes, Statutes

- National Pollutant Discharge Elimination System (NPDES), requirements via a NPDES Permit for treating rainwater and stormwater flowing in the public right-of-way, and dry weather runoff.
- Requirements vary around the country, by state; check with one's local, regional or state water board.
- In Southern California, this Permit requires rainwater and stormwater collection, treatment and onsite use for non-potable uses. https://www.epa.gov/npdes

Regulatory Standards, Guidelines, Codes, Statutes

- Water Infrastructure Improvement Act (H.R. 7279), legislation to H.R. 7279
  - This bill amends the Federal Water Pollution Control Act (commonly known as the Clean Water Act) to allow municipalities to develop a plan that integrates wastewater and stormwater management.
  - Codifies a concept from the Obama administration known as "Integrated Planning," which can assist communities with meeting their requirements under the Clean Water Act while maintaining their obligation to achieve improvements in local water quality. EPA's Integrated Planning framework provides communities with a voluntary opportunity to prioritize local clean water investments with the greatest benefit to human health and the environment.
  - The legislation builds on a recent provision that authorized $450 million in stormwater municipal grants to plan, design, and construct stormwater, water recycling, and sewer overflow projects
  - https://www.congress.gov/bill/115th-congress/house-bill/7279
  - https://news.wef.org/water-infrastructure-improvement-act-incorporates-integrated-planning-into-legislation/

Regulatory Standards, Guidelines, Codes, Statutes

- ANSI/ASPE/ARCSA *Rainwater Harvesting Standard 63*, https://www.ansi.org/
- ANSI/ASPE/ARCSA *Stormwater Harvesting Standard 78*, https://www.ansi.org/
- NSF International, standard 350 for alternate water use, http://www.nsf.org/search/search-results/search?keywords=350&XID=b538784f82b832085f0601ea2ec6458ec95f6879&x=0&y=0
- U.S. EPA, *draft National Water Reuse Action Plan*, https://www.epa.gov/waterreuse/water-reuse-action-plan
- Water Environment & Reuse Foundation (WERF), *Final Report, Risk-Based Framework for the Development of Public Health Guidance for Decentralized Non-Potable Water Systems*, https://watereuse.org/; https://watereuse.org/educate/national-blue-ribbon-commission-for-onsite-non-potable-water-systems/
- HarvestH2O, section on rainwater regulations and statutes around the nation, http://www.harvesth2o.com/statues_regulations.shtml
- Los Angeles County Department of Public Health, *Guidelines for Harvesting Rainwater, Stormwater, & Urban Runoff for Outdoor Non-Potable Uses (Matrix 2.0)*, standards for alternate water uses, http://publichealth.lacounty.gov/eh/docs/ep_cross_con_AltWaterSourcesGuideline.pdf

California Law

- ***Statewide Construction Storm Water General Permit*: Stormwater from construction projects that disturb one or more acres of soil, or that disturb less than one acre but are part of a larger common plan of development,** are required to obtain coverage under the statewide General Permit for Discharges of Storm Water Associated with Construction Activity (also referred to as the Construction General Permit or CGP).
- The CGP regulates construction stormwater based on project-specific overall risk. The CGP requires temporary and post-construction best management practices and measures to prevent erosion and reduce sediment and pollutants in discharges from construction sites.

California Law

- ***Statewide Industrial Storm Water General Program***: Industries with stormwater from industrial activity areas are regulated by the Statewide Industrial General Permit.
- The Industrial General Permit requires industry owners to implement the best technology available to reduce pollutants in their stormwater discharges.
- In addition, industrial stormwater dischargers are required to develop a stormwater pollution prevention plan and monitor it in accordance with regulatory levels specified in the statewide permit.
- The Statewide Industrial General Permit regulates over 10,000 industries in California.

California Law

- *2019 California Green Building Standards Code, Title 24, Part 11*
- CHAPTER 4 - RESIDENTIAL MANDATORY MEASURES 4.106.2
- Projects less than 1 acre of soil
  - Retention basins
  - Filter or wattle
  - Compliance with a local ordinance

California Law

- *2019 California Green Building Standards Code, Title 24, Part 11*
- CHAPTER 5 - NONRESIDENTIAL MANDATORY MEASURES   5.106.1
- Projects less than 1 acre of soil
  - Compliance with a local ordinance
  - Best Management Practices (BMP's) (construct in dry weather; preservation of natural features; drainage swales; mulching; hydroseeding; slope erosion control; protect storm drain inlets; perimeter silt fence; sediment trap; stabilized exits; wind erosion control)
  - Good housekeeping BMP's to manage construction equipment, discharges and wastes (dewatering; material handling and waste mngt; stockpile mngt; manage washout areas; control fueling to staging area; off-site cleaning of equipment; spill prevention and control)

California Law

Title 23 Chp 2.7 Model Water Efficient Landscape Ordinance

- Water budget calculations
  - Maximum Applied Water Allowance (MAWA)
  - Stormwater features are not classified as 'special landscape areas'
- Soil Preparation, Mulch and Amendments
  - Required mulching, friable soils, slope stabilization
- Irrigation
  - In mulched planting areas, low volume irrigation is required as defined by ANSI standard, ASABE/ICC 802-2014. "Landscape Irrigation Sprinkler and Emitter Standard"
- Grading Plan
  - Designed to minimize soil erosion, runoff, and water waste

California Law

Title 23 Chp 2.7 Model Water Efficient Landscape Ordinance

- Strongly <u>recommends</u> that landscape areas be designed for capture and infiltration capacity that is sufficient to prevent runoff from impervious surfaces (i.e. roof and paved areas) from either:
  - the one inch, 24-hour rain event or (2) the 85th percentile, 24-hour rain event,
  - and/or additional capacity as required by any applicable local, regional, state or federal regulation

California Law

Title 23 Chp 2.7 Model Water Efficient Landscape Ordinance

- It is recommended that rainwater (stormwater) projects incorporate any of the following elements:
  - Grade impervious surfaces, such as driveways, during construction to drain to vegetated areas.
  - Minimize the area of impervious surfaces such as paved areas, roof and concrete driveways.
  - Incorporate pervious or porous surfaces (e.g., gravel, permeable pavers or blocks, pervious or porous concrete) that minimize runoff.
  - Direct runoff from paved surfaces and roof areas into planting beds or landscaped areas to maximize site water collection and use.
  - Incorporate rain and rock gardens, cisterns, and other rain harvesting or catchment systems.
  - Incorporate infiltration beds, swales, basins and drywells to collect rainwater and dry weather runoff and increase percolation into the soil.
  - Consider constructed wetlands and ponds that retain water, equalize excess flow, and filter pollutants.

Local Ordinance (Santa Monica)

City's Water Efficient Landscape and Irrigation Standards

Use of an approved and treated alternative water source such as rainwater exempts designer from:

- Plant size restrictions (i.e., amount of turfgrass, high water using plants)
- The overhead irrigation ban for green roofs (may use sprinklers)
- Surface area size restrictions on water features (waterfall, fountains)

Elements: Plant Selection

- Rain gardens:
  - The plants in the ponding area, which is the lowest lying part of the garden, will remain saturated for days at a time. Because of this, install plants that can tolerate “wet-feet” in the ponding area.
  - Other plants need to tolerate drier conditions found on the berm.
  - drought-tolerant species that are adapted to periodic wet conditions may be used as well.
- In most cases, seed is not the preferred method for plant establishment in a bioretention cell. The fluctuating water levels make it difficult for the seed to readily establish, and the random nature of seeding may result in an undesirable plant layout for some situations.
- Instead, it is strongly recommended that containerized live plants be utilized: plugs or 1-gallon for herbaceous plants, 1- to 5-gallon for shrubs, and 5-gallon to 24-inch box for trees. Plant spacing depends on mature plant size and desired density of plant cover.

Elements: Plant Selection

- Trees to use in or near a California rain garden:
  - *Acer rubrum*, Red Maple
  - *Populus tremuloides*, Quaking Aspen
  - *Chilopsis linearis* ‘Art’s Seedless’, Desert Willow
  - *Platanus racemosa*, Western Sycamore
  - *Agonis flexuosa*, Peppermint Tree
  - *Corylus cornuta* var. *californica*, Western Hazelnut

Elements: Plant Selection

- Trees to use in or near a California rain garden:
  - *Acer rubrum*, Red Maple
- Water Use Classification of Landscape Species IV classifies this as a high water using plant for Southern Coastal California
- CA's Model Water-Efficient Landscape Ordinance Maximum Applied Water Allowance may be impacted

Elements: Plant Selection

- Green roofs (extensive):
  - Native or adapted species tolerant of extreme climate conditions (e.g., heat, drought, wind);
  - Low-growing, with a range of growth forms (e.g., spreading evergreen shrubs or subshrubs, succulents, perennials, self-seeding annuals);
  - Possessive of a shallow root system without the chance of developing a deep taproot;
  - Long lived or self-propagating, with low maintenance and fertilizer needs.
  - Plants must be low and hardy, typically alpine, dryland, or indigenous. The plants are often watered only until they are fully established, and after the first year or two, maintenance typically consists of two visits a year for weeding of invasive species, drainage, and membrane inspections.
  - A variety of species and growth forms may be considered for a single roof project to ensure survival and plant growth. In addition, because many perennials and annuals are dormant during part or all of the rainy season, evergreen and cool-season plants should be included to help with rainfall interception and evapotranspiration during the seasons when rains typically occur.

Elements: Soil Selection

Typical Bioretention Soil Medium (BSM) Specs

- 50% Sand (Conforms to ASTM C33 Fine Aggregate)
- 20% Organic Material (Compost or shredded hardwood mulch)
- 30% Topsoil
  - Sand (2.0 – 0.050 mm) 50 – 85% by weight
  - Silt (0.050 – 0.002 mm) 0 – 50% by weight
  - Clay (less than 0.002 mm) 10 – 20% by weight1
  - Organic Matter 1.5 – 10% by weight
  - pH 5.5 – 7.5 (NOTE: pH can be corrected w/soil amendments if outside acceptable range)
  - Magnesium Minimum 32 ppm (NOTE: magnesium sulfatecan be added to increase Mg)
  - Phosphorus (Phosphate - P2O5) Not to exceed 69 ppm / P-index should be less than 25
  - Potassium (K2O) Minimum 78 ppm (NOTE: potash can be added to increase K)
  - Soluble Salts Not to exceed 500 ppm
    - Source: The Low Impact Development Center, Inc., 2003
- **Engineered soil media meeting the specification described above can be expected to have infiltration rates ranging from 25 – 130 in/hr (Hsieh and Davis, 2005).**

Elements: Soil Selection

- Green roof (extensive – most common for Rainwater BMPs)
  - The growing medium is typically made up of a mineral-based mixture of sand; gravel; crushed brick; straw, lightweight expanded slate, clay, or shale aggregate; volcanic rock; pumice stone; scoria; zeolite; diatomaceous earth; perlite; or rock wool.
  - Organic matter may also be added, such as composted sawdust, wood, grass, leaves, clippings, agricultural waste, worm castings, peat or peat moss, or manure
  - The growing medium on extensive green roofs varies in depth between 2–6" with a weight increase of between 12–35 lb/sf when fully saturated or at “maximum density”.
  - Extensive green roof wet weight is approximately 6 to 7 pounds per square foot per inch of depth.
  - **FLL Guidelines for the Planning, Construction and Maintenance of Green Roofing**; The Green Roofing guideline sets clear limits on the content of organic matter, structural and bedding stability, water permeability, maximum water capacity, air content, pH-value, salt and nutrient content and more.

Elements: Soil Selection

- CA MWELO soil requirements:
  - 4 cubic yards of compost per thousand square feet to depth of 6 inches (about 22%)
    - Friable soils
    - Typical Biorention soil specs requires a minimum 20% compost
    - Howe do we rectify with most green roof soil specs?
  - 3 inches of recycled organic mulch required on exposed soil surfaces
    - How do we address wood chip mulch applications in rainwater bmps that wash away in heavy rains clogging the outlet pipes?

Elements: Irrigation

- Bioretention cells
  - Will require supplemental irrigation during the first 2-3 years after planting. Drought tolerant species may need little additional water after this period, except during prolonged drought, when supplemental irrigation may become necessary for plant survival.
  - Verify that the maintenance plan includes a watering schedule for the establishment period and in times of extreme drought after plants have been established.
- Rain Garden plants that do not receive regular rain in the first two to three years will need supplemental irrigation
- Green roofs irrigation recommendations from the California Stormwater Quality Association
  - When needed, *subsurface irrigation* should be used to minimize evaporative losses
  - Install a *sub-surface irrigation capillary matting* and supply lines according to design
  - In the arid southwest, regular to *periodic irrigation will likely be required*.

Elements: Irrigation

- Green roofs
  - Factors such as climate and type of plants selected determine the need for permanent irrigation. Most extensive green roofs are designed to function without an irrigation system after an initial start-up period of one to two years.
  - Built-in irrigation systems are more common in Southern California and the Southwest
  - There are a wide variety of irrigation systems:
    - overhead or spray
    - surface or near-surface drip irrigation
    - capillary irrigation
    - base drip
    - trickle irrigation
    - water retention mats

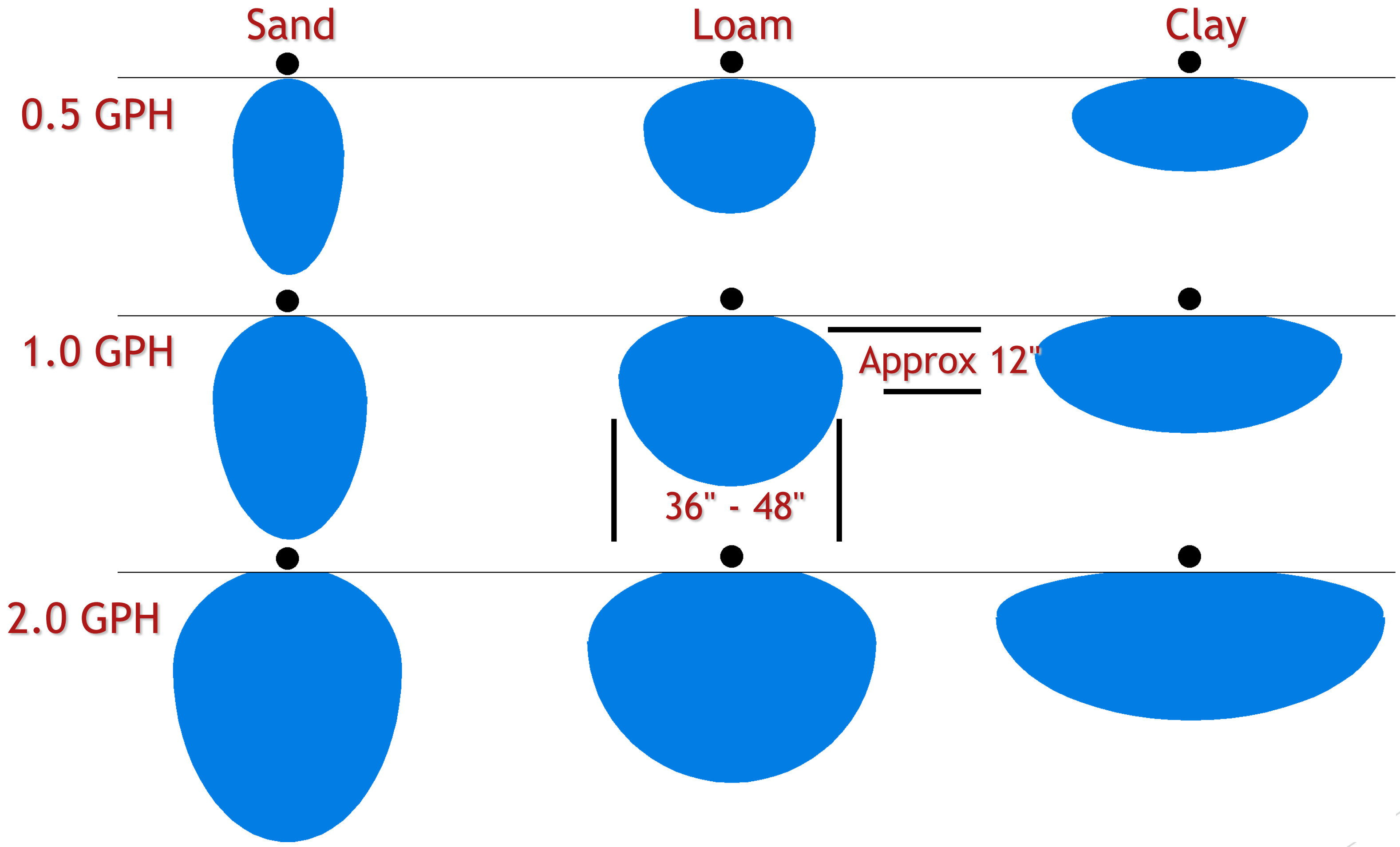
Elements: Irrigation

- Challenges of engineered spaces with drainage infrastructure and specific soil blends that promote high percolation
- Some irrigation manufacturers recommend overhead irrigation for green roofs:
  - Overhead irrigation may deliver greater distribution uniformity over a designed retention area
  - Allows for flexibility as the space changes; soil movement, build-up of organic matter, maintenance of drainage feature.
  - Inline or online micro systems have been tried on green roofs but often fail (not the product the landscape). The high percolation soils fail to move water horizontally with micro drip application and plants suffer in dry periods as a result. Also, the driplines may become damaged during flooding or maintenance practices.

Elements: Irrigation

- Comparison of irrigation efficiency and plant health of overhead, drip, and sub-irrigation for extensive green roofs
  - D. Bradley Rowe*, Matthew R. Kolp, Sarah E. Greer, Kristin L. Getter Michigan State University, Department of Horticulture, A212 Plant and Soil Sciences Building, East Lansing, MI, United States
  - **"Because green roof substrates tend to be coarse to allow adequate drainage, water does not move laterally to a great extent as it would in finer substrates. For this reason, drip and sub-irrigation may not be the most efficient irrigation methods."**

Wetting Patterns for Drippers in Idealized Soil Types



Elements: Irrigation

- CA MWELO Irrigation Requirements
  - In mulched planting areas, low volume irrigation is required as defined by ANSI standard, ASABE/ICC 802-2014. "Landscape Irrigation Sprinkler and Emitter Standard"
  - Should this apply to green roof areas or biorentation areas?

Elements: Irrigation

- Green Roof Irrigation options
  - Square nozzles
  - Low angle low trajectory nozzles
  - Fleece wrapped dripline products
  - Multi-Stream Multi-Trajectory Nozzles
  - Micro-Sprays

Elements: Irrigation

- Irrigation controller
  - Needs to be flexible to accommodate the high infiltration rates of the soil
  - Multiple cycle and soaks
  - Soil moisture sensors preferred with weather-based sensors; must be careful when installing a soil moisture sensor in highly coarse media like green roof soil mixes

Stormwater BMP Resources

- California Stormwater Quality Association
  - https://www.casqa.org/resources/california-lid-gi
  - **Low Impact Development Manual for Southern California** https://www.casqa.org/sites/default/files/downloads/socallid-manual-final-040910.pdf

- Green Roof Design and Construction https://www.greenroofs.org/
- http://www.greenrooftechnology.com/fll-green-roof-guideline

- Santa Monica Rain Harvest Rebate Guide and Program https://www.smgov.net/Departments/OSE/Rebates/Rain_Harvest_Rebate.aspx

2019 IRRIGATION ASSOCIATION SHOW

Subsurface Irrigation Solutions: Forced vs. Responsive

December 5, 2019

11:40 a.m.-12:40 p.m.


Presented by:
Responsive Drip Irrigation
and their Guests

Comparison: Drip Irrigation vs. Plant Responsive Irrigation

- Drip irrigation systems (SDI & SSDI) deliver a set volume of water during cycled intervals regulated by a timer, electronic controller, or manual valves.

- Plant responsive irrigation systems release water & nutrients in response to plant root signals.

Current Technology

- Sophistication
- System cost
- Design and installation
- Efficiency
- System issues

RDI RESPONSIVE DRIP IRRIGATION

Sophistication

Costs

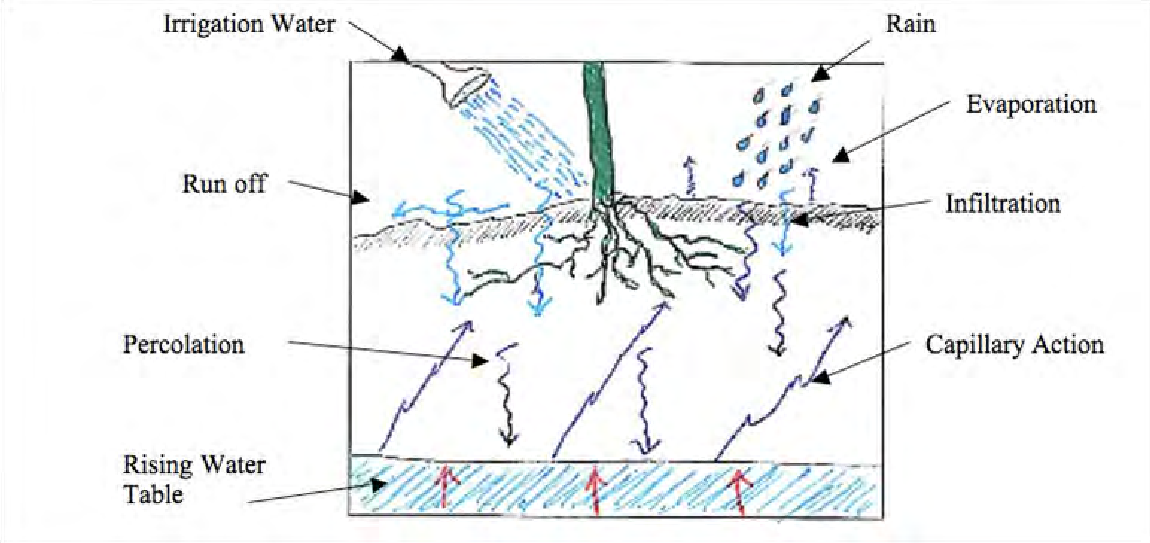
- System installation
- Water
- Fertilizer(s)
- Amendment(s)
- Energy
- Maintenance

Drip Irrigation System Issues

- Improper Design & Installation
- System Clogging
- Soil Percolation/Salt Leaching
- Repairs
- Mechanical Failure
- Variable Efficiency

RDI RESPONSIVE DRIP IRRIGATION

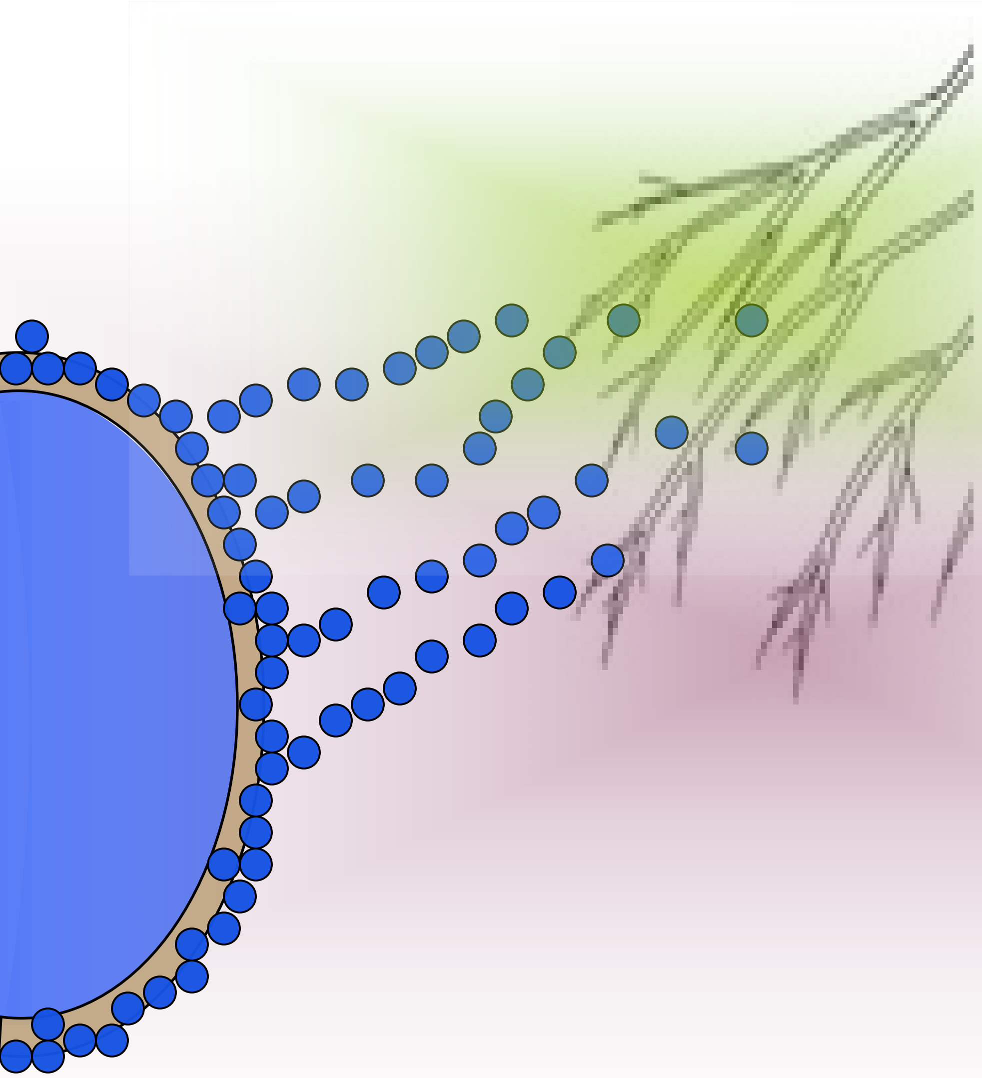
Salt Leaching



- Movement of Minerals
- Reduction of Plant Growth
- The Cycle
- Water Table
- Major Concern of Growers in US
- Low Flow
- Low Percolation

What Does Plant Responsive Mean?

- A plant responsive irrigation system uses "organic chemistry" to release water/nutrients when triggered by plant root signals, which reduces plant stress, thereby producing optimal plant performance in lawn & landscape or agricultural applications.



- Loosely held water molecules
- Breaking the surface tension bond
- Traveling water molecules
- Absorption

System Comparisons

	Responsive	***Surface Drip***	***Sub Surface Drip***
Cost	Moderate	Moderate	Moderate
Design & Installation	Easy	Moderate	Moderate
Maintenance	Low	Moderate	Moderate
Maintenance Cost	Low	Moderate	Moderate
Operation	Easy	Moderate	Moderate
Run Off	None	High/Moderate	None
Evaporation	Minimum/None	Moderate	Minimum/Moderate
Percolation	Low	High	Moderate
Disease Level	Low	Moderate	Low/Moderate
Fertilizer Use	Minimal	High	Moderate/High
Clogging	None	High	High
Salt Leaching	Very Low	High	High
Overall Performance	Very High	Moderate	Moderate/High
Water Conservation	Very High	Moderate/High	High

Benefits of Responsive Irrigation systems versus Drip Irrigation

- Superior water efficiency
- Less fertilizer & amendments
- Simple design & installation
- Fewer components
- Same or lower system costs
- Minimal maintenance
- Eliminates root intrusion
- Reduces weed growth
- Performs well with various water & soil types
- Eliminates run-off and fertilizer leaching into water source
- Low pressure

RDI RESPONSIVE DRIP IRRIGATION

GrowStream

Responsive Drip Irrigation
6404 Manatee Ave W
Suite N
Bradenton, FL 34209
941.792.9788
info@responsivedrip.com
www.responsivedrip.com

Q&A and Discussion

Lighting Design

Beyond the Basics

AOLP
Association of Outdoor Lighting Professionals

Association of Outdoor Lighting Professionals

AOLP Presenters

- Andy Thomas, CLVLT, COLD
  - Viewpoint Lighting, Sacramento CA
- Michael Sestak, CLVLT, COLD
  - Sestak Lighting Design, Sacramento CA
- Dave Bilik
  - Twilight Designs, Las Vegas NV

AOLP
Association of Outdoor Lighting Professionals

Purpose of Lighting

Fundamentals of Lighting Design

- Safety
- Security
- Function/Task
- Beauty - Lighted Objects
- Art - Light Fixtures

AOLP
Association of Outdoor Lighting Professionals

Fundamentals of Lighting Design

Basic Lighting Methods

- Uplighting/Highlighting
- Downlighting
  - Pathlighting
- Silhouetting
- Shadowing
- Grazing
- Mirror Lighting

Tim Ryan - Lighthouse

Association of Outdoor Lighting Professionals

Landscape Lighting Guidelines

Fundamentals of Installation

AOLP

Association of Outdoor Lighting Professionals

Outdoor Lighting Standards and Guidelines

January 2012 — Low Voltage Outdoor Lighting Systems

Table of Contents

Going Beyond the Basics

Advanced Lighting Methods and Techniques

- Tree/Structure Downlighting
- Market Lighting
- Fixture Conversions
- Core Drilling
- Tape/Rope Lighting
- RGB/RGBW Color
- Custom Fixture Design
- Controls

Tree Lighting

Market Lighting

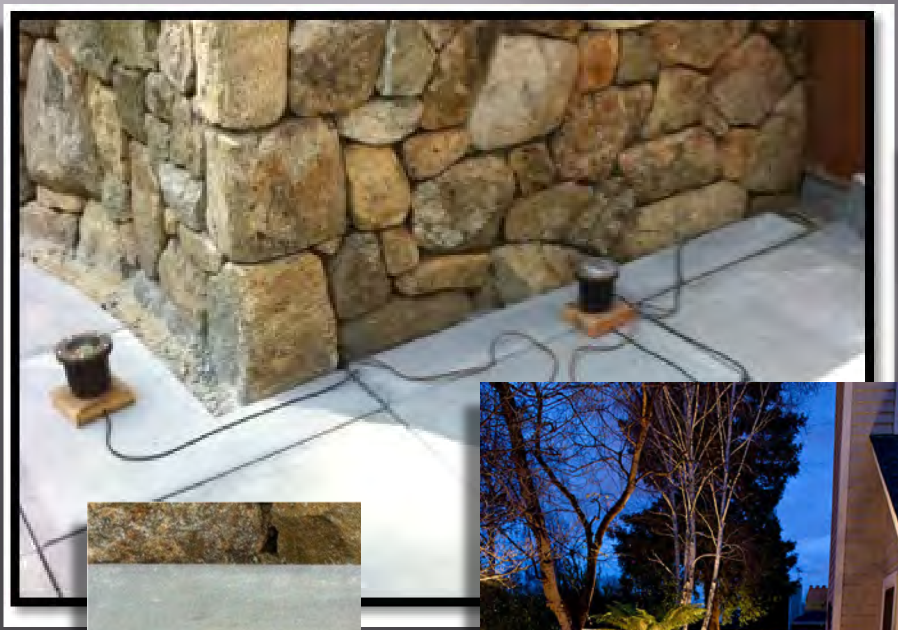
Matt Carli - Moonlighting

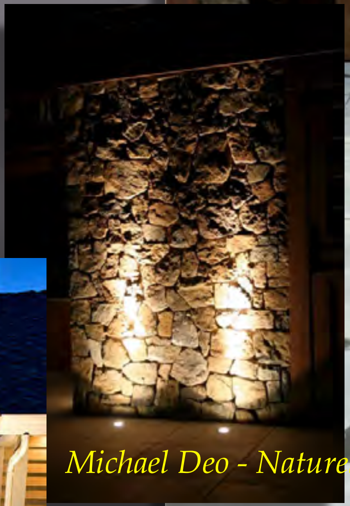
Sestak Lighting Design

Andy Thomas - Viewpoint Lighting

Fixture Conversions

Core Drilling



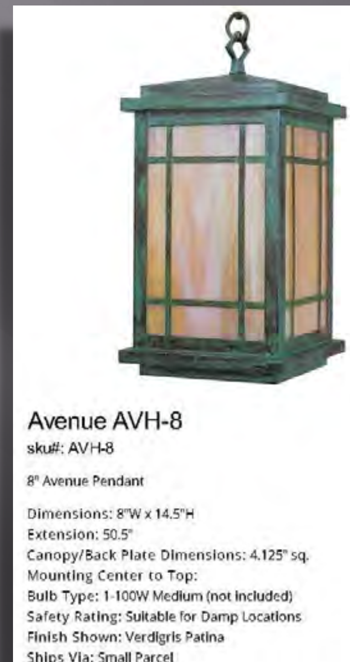


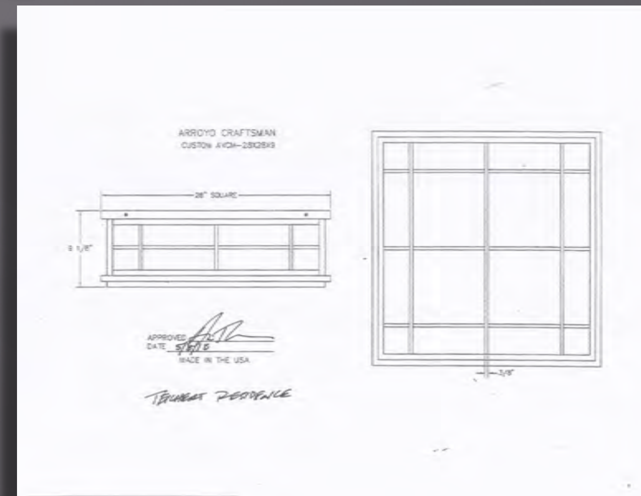
Tape/Rope Lighting

Colored Light

Custom Design

Sestak Lighting Design

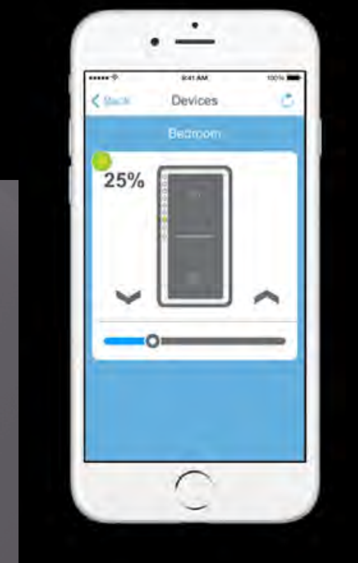




Andy Thomas - Viewpoint Lighting

Control Systems

- Control4
- Lutron
- Crestron
- Insteon
- Many, Many More



Design Strategies

Methods of Design and Presentation

- Evening Demonstrations
- Pen and Paper
- AutoCAD/Computer graphics
- Photo-Based Lighting Concept
  - General Graphic Apps
  - Proprietary Software Programs/Apps

AOLP
Association of Outdoor Lighting Professionals

Paradigm Shift

From Landscape Contractor to Lighting Designer

- Pricing Strategies
  - Consultation and design time
  - Pitch a vision, not components
  - Sell a lifestyle, not light fixtures

- Presentation Methods
  - Getting the idea across
  - From demo to dinner table
  - Portfolio and samples
  - The "Language of Lighting"

Paradigm Shift

From Landscape Contractor to Lighting Designer

- The more you know, the more you can sell
  - Education
  - Certifications

- Night Adjustments are crucial!

Resources

- Association of Outdoor Lighting Professionals
  - AOLPOnline.org
  - Certified Low Voltage Lighting Technician (CLVLT)
  - Certified Outdoor Lighting Designer (COLD)
  - Awards Program

- Illuminating Engineering Society of North America (IESNA)

- International Landscape Lighting Initiative

- Manufacturer/Distributor Training

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- Lighthouse