

SOUTHERN CALIFORNIA GOLF & WATER SUMMIT

August 18, 2022



Unpacking the Facility Toolbox

Geoff Shackelford
Moderator

**Brian
Whitlark**
Senior
Agronomist
USGA

**Dr. Marta
Pudzianowska**
Assistant
Researcher
UC-Riverside

**Dr. Jim
Baird**
Turfgrass
Specialist
UC-Riverside

**Matt
Muhlenbruch**
Director of
Agronomy
Hillcrest CC

**Dr. Matteo
Serena**
Irrigation
Research &
Services
USGA

Multiple Roads Lead to Water Savings

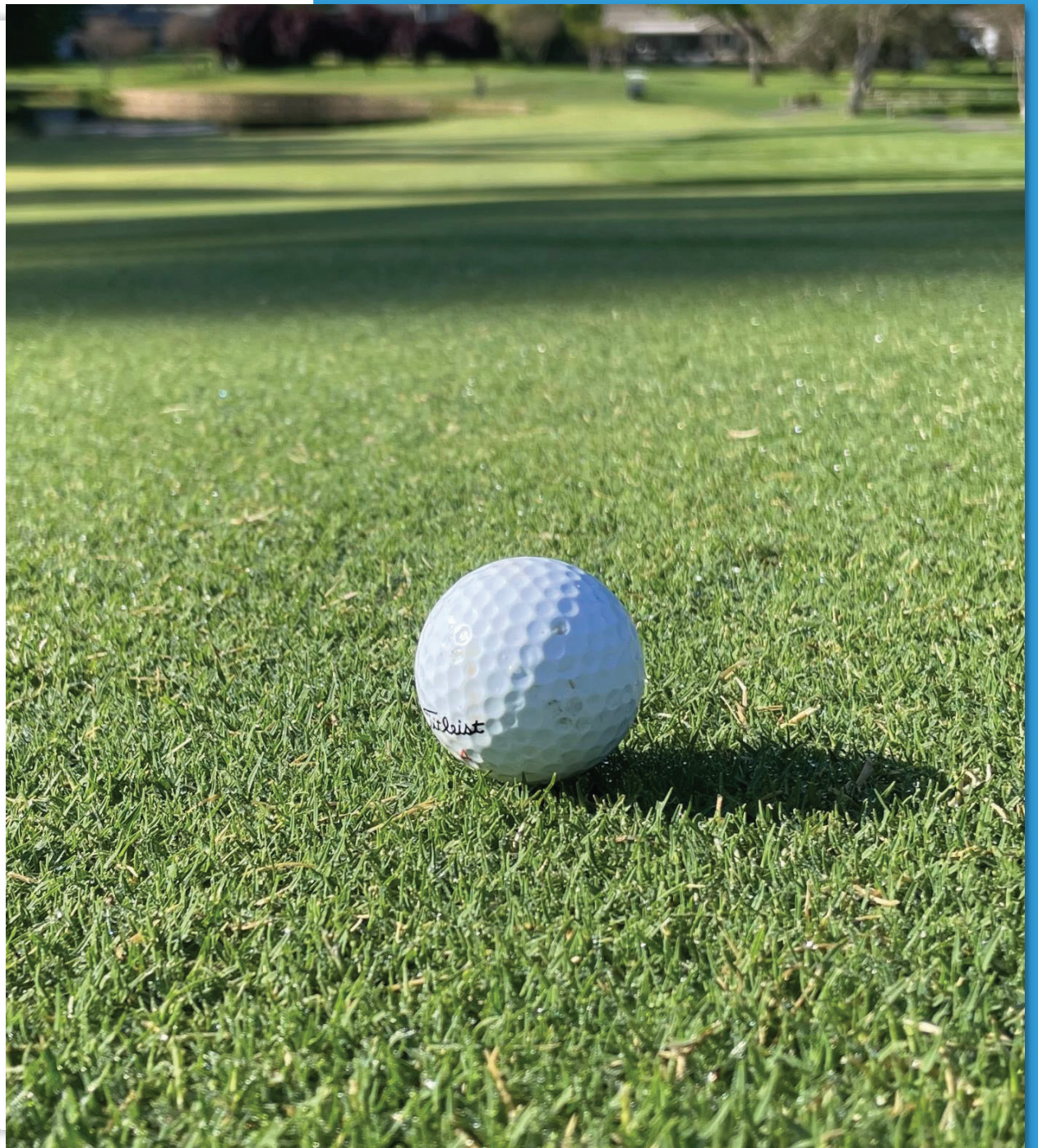
Brian Whitlark,
Senior Consulting Agronomist
USGA

Water Saving Strategies

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT

- Update the irrigation system – 5-8%
- Irrigation maintenance (raise level sprinklers, optimize flow/pressure, replace nozzles) – 5-10%
- Wetting agents/growth regulators – 5-15%
- Eliminate overseeding – 1.5 – 2.0 acre feet per acre
- Change the narrative around golfer expectations - ?
- In-ground soil moisture sensors/portable moisture meters – 10-15%
- Turf reduction – 3-7 acre feet per acre
- In-line subsurface drip irrigation – 50-80%
- Turf conversion: cool season to warm season – 25-30%
- 419 to new hybrid bermudagrass – 10-15%





Brian Whitlark

BWhitlark@usga.org



UCR's New Breeding Selections For Bermuda and Kikuyu

Marta Pudzianowska / UC Riverside

Cool-season vs. Warm-season

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT



Drought resistance comparisons of turfgrasses commonly grown in California

Relative ranking	Cool-season turfgrasses	Warm-season turfgrasses
Superior	--	Bermudagrass Buffalograss
Excellent	--	Seashore paspalum Zoysiagrass
Good	--	Kikuyugrass St. Augustinegrass
Medium	Tall fescue	--
Fair	Perennial ryegrass Creeping bentgrass Kentucky bluegrass Hard fescue Chewing's fescue Red fescue	--
Poor	Annual bluegrass Colonial bentgrass	--
Very poor	Rough bluegrass	--

Source: Harivandi M. A., Baird J., Hartin J., Henry M. and Shaw D. "Managing Turfgrasses during Drought". ANR Publication 8395. August 2009

Cool-season vs. Warm-season

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT



Tall fescue



Bermudagrass



60% ET

UCR Warm-Season Turfgrass Breeding Program

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT



Objectives

Drought/poor water quality tolerance

Reduction/elimination of winter dormancy

Shade tolerance

Tolerance/resistance to pests & diseases

Lower inputs/maintenance

Effectiveness of propagation

UCR Warm-Season Turfgrass Breeding Program

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT



Prof. Adam Lukaszewski • Dr. Jim Baird [@UCRturfgrass](#) • Dr. Marta Pudzianowska [@UCRturbreeding](#) • BSc. Christian Bowman [@csbowman](#)

Bermudagrass

Golf course fairways, roughs & greens/Athletic fields/Lawns

Winter color retention, drought tolerance, salinity tolerance, shade tolerance.

2012

Kikuyugrass

Golf course fairways & roughs/ Athletic fields /Lawns

Lower maintenance, drought tolerance, disease resistance, shade tolerance.

2016

Napa GC Test Plots (2019-2022)

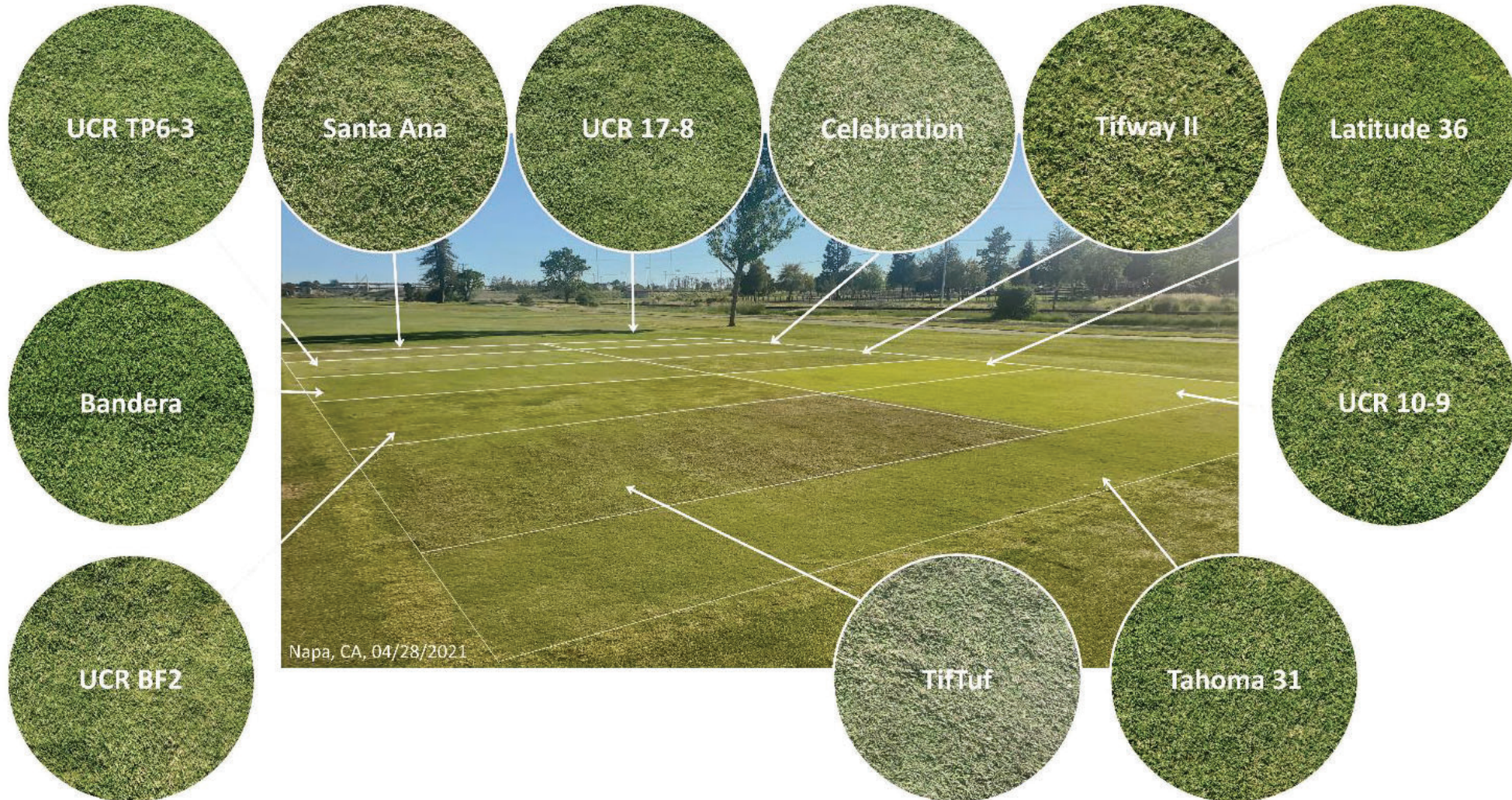
SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT



Napa Golf Course, Napa, CA; 11/24/2020



Napa GC Test Plots (2019-2022)



2019 NTEP – Reduced Irrigation

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT



Monaco Riviera Astro Latitude 36 Tifway Tahoma 31 TifTuf UCR 17-8 UCR TP6-3 UCR 10-9 UCR BF2



Riverside, 09/24/2021

35% ET

2019 NTEP – Reduced Irrigation

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT



TifTuf

Tahoma 31

UCR 10-9

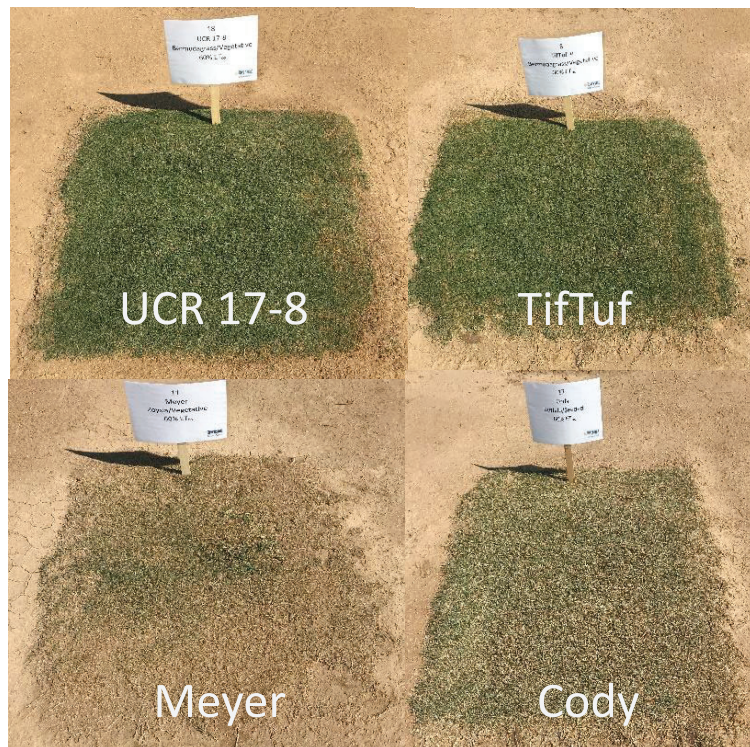
UCR 17-8

2018 USGA/NTEP Warm-season Reduced Irrigation Trial

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT



Bermudagrass



Zoysiagrass Buffalograss

60% ET

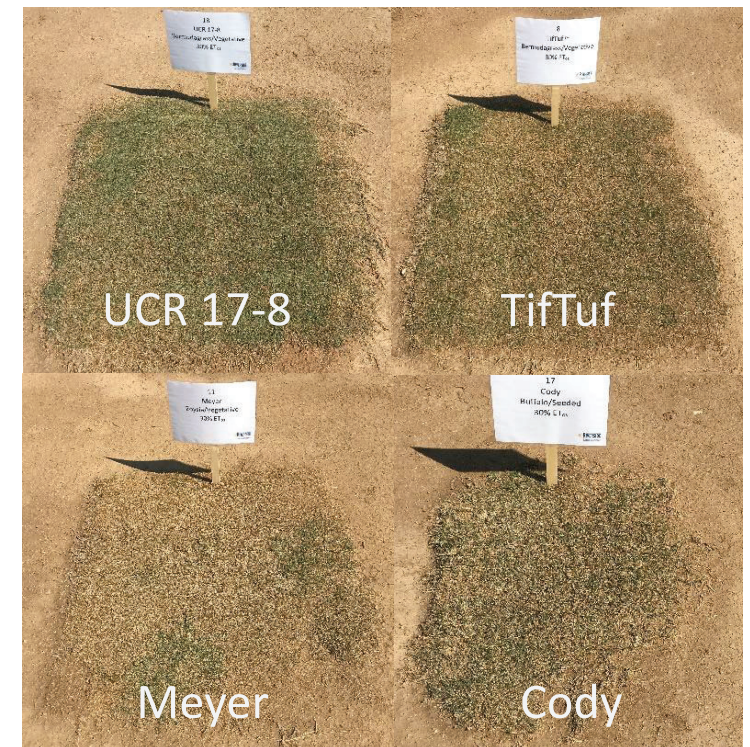
Bermudagrass



Zoysiagrass Buffalograss

45% ET

Bermudagrass



Zoysiagrass Buffalograss

30% ET

UCR Bermudagrass Dry-down Trial (2019-2022)

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT

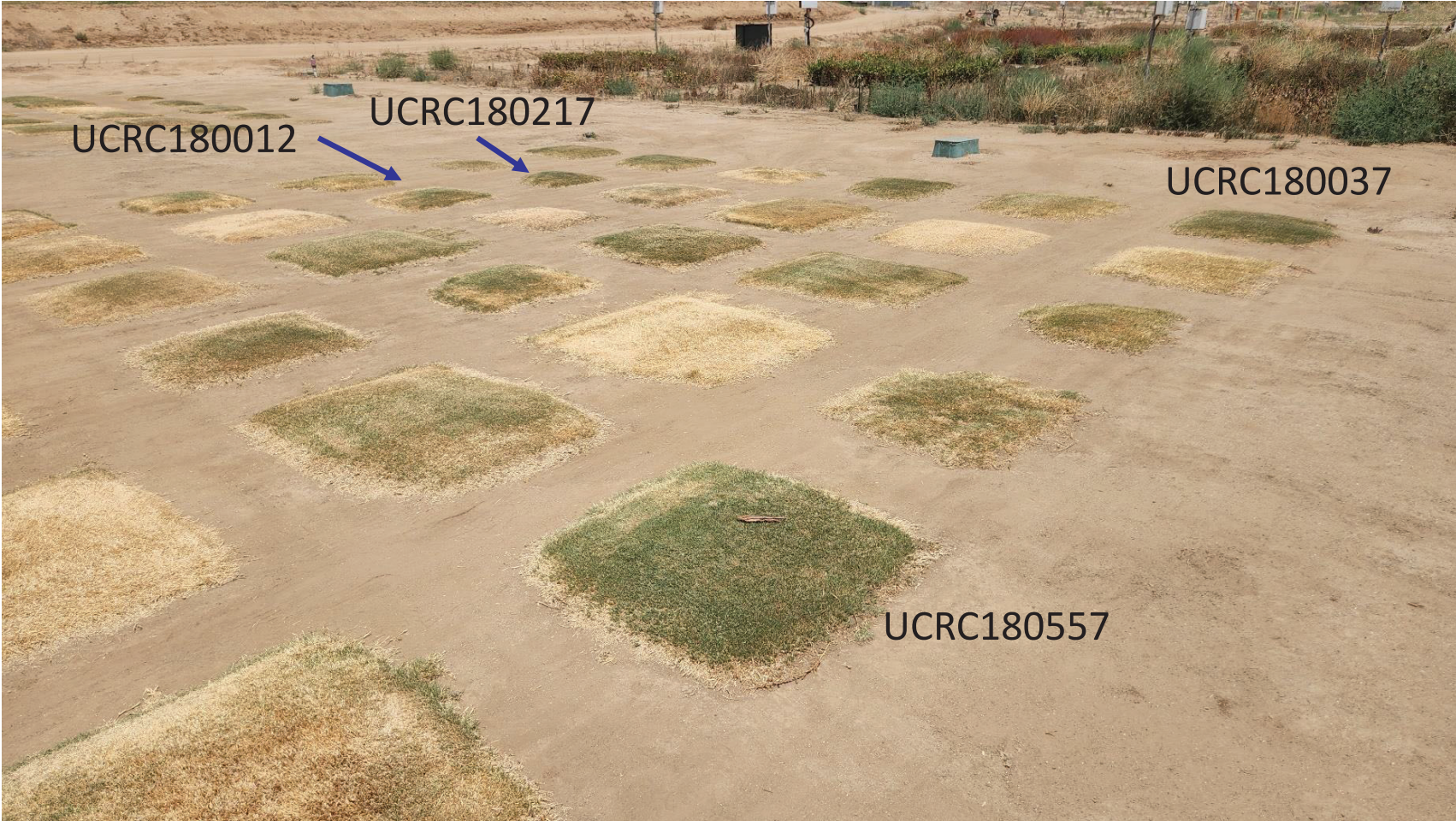


53
days with no
irrigation/rainfall

Riverside, 08/12/2022

UCR Bermudagrass Dry-down Trial (2019-2022)

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT

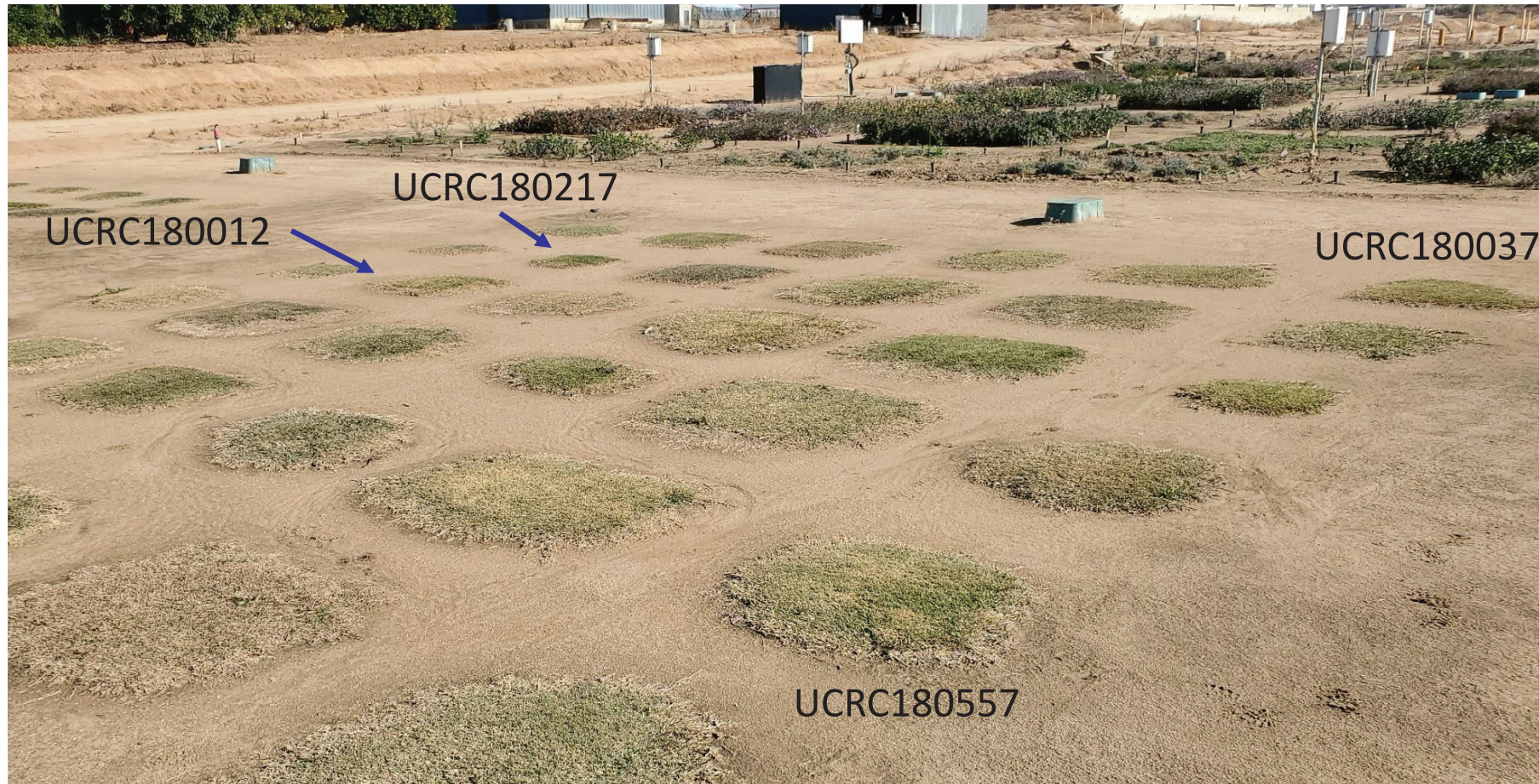


53
days with no
irrigation/rainfall

Riverside, 08/12/2022

UCR Bermudagrass Dry-down Trial (2019-2022)

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT



Riverside, 01/04/2021

UCR Bermudagrass Hybrids

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT

UC RIVERSIDE



Riverside, 02/27/2019

Evaluation of Warm-season Turfgrasses Under Salinity Stress

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT



4.4 dS*m⁻¹

Riverside, 08/14/2021

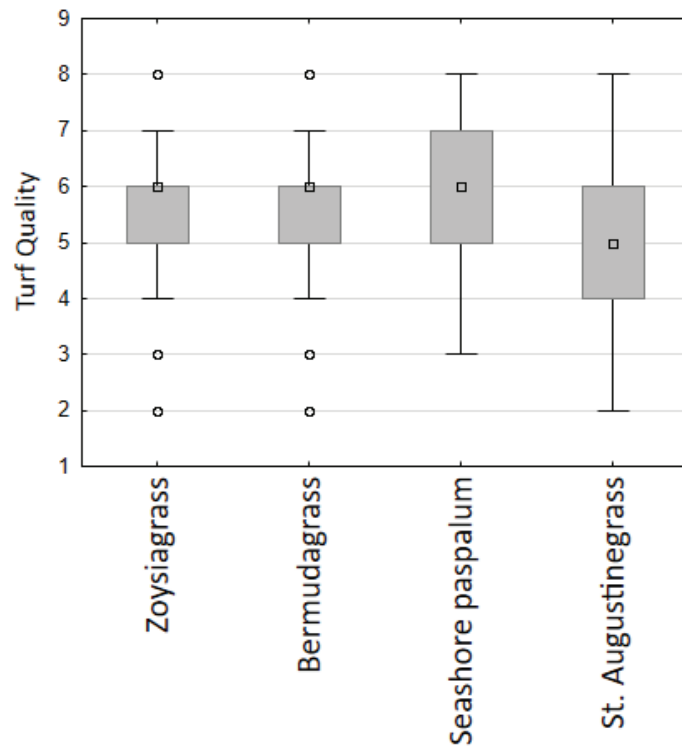
Evaluation of Warm-season Turfgrasses Under Salinity Stress

USDA Specialty Crop Research Initiative

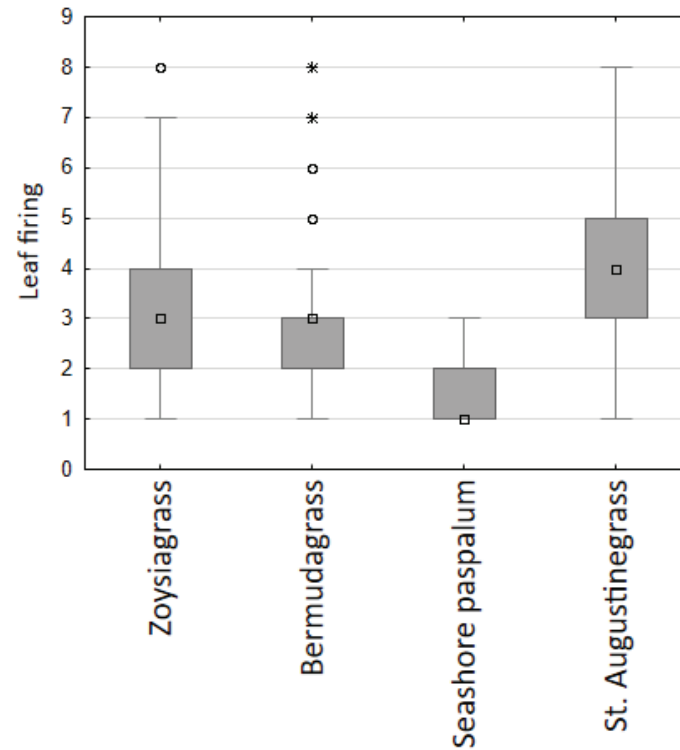
SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT



Turf Quality



Leaf firing



4.4 dS*m⁻¹

- Median
- 25%-75%
- ┆ Non-Outlier Range
- Outliers
- * Extremes

2022 - New studies

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT



Turfgrass and Landscape Research Field Day

Thursday, September 15, 2022

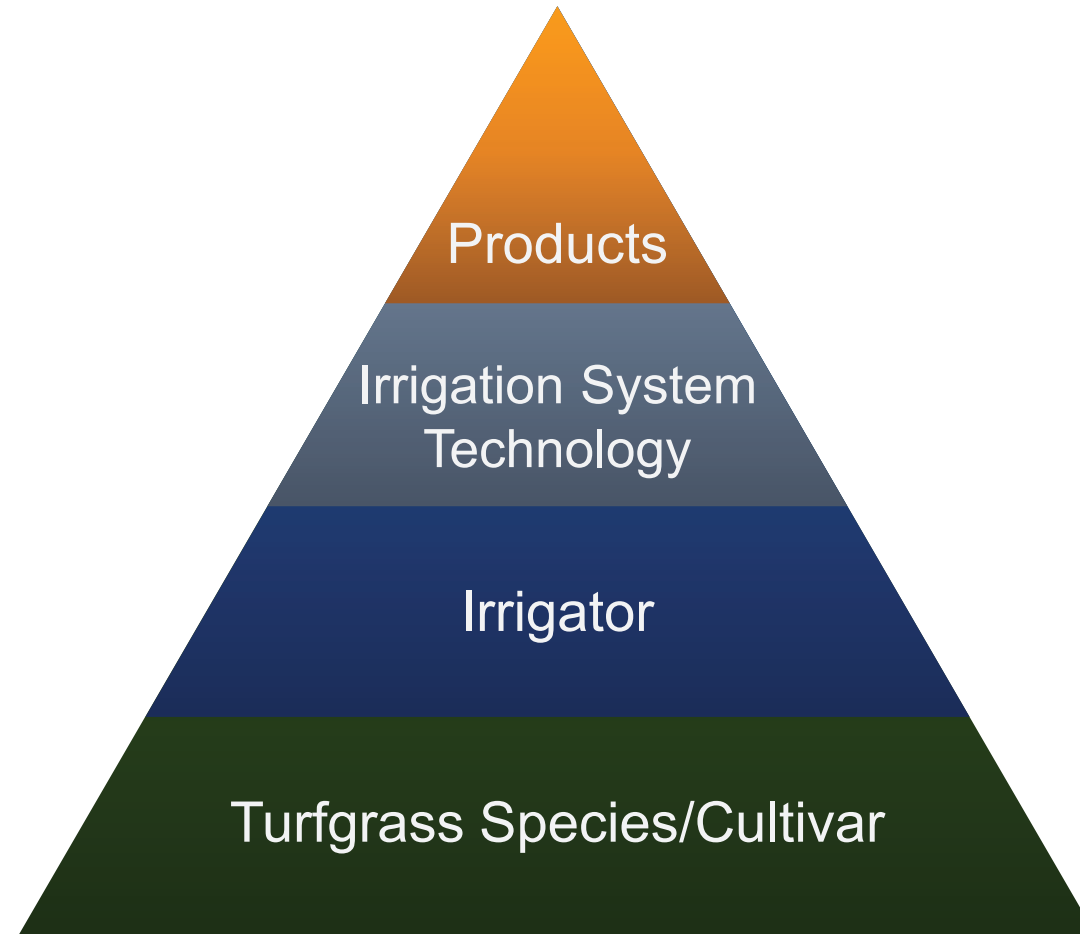


Chemical Options for Drought Alleviation

Jim Baird / UC Riverside

Turfgrass Water Conservation

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT



USGA Green Section Record

This Product Is So Good, It Didn't Need Any Research!

When choosing what's best for your golf course, rely upon scientific research rather than black magic.

by JAMES H. BAIRD, Ph.D.

*"Take any common-place remedy, give it a mysterious origin, advertise it with extravagant claims, and it will be purchased by the [gullible]. At present, the crop of grass-growing [snake oils] appears to be above normal!" – Dr. Charles V. Piper and Dr. Russell A. Oakley, *The Bulletin of the USGA Green Section*, 1922.*

SOME THINGS never change. Thankfully, neither has the commitment from the USGA Green Section and the scientific community to provide information for improving golf turf that is based upon scientific obser-

vation and experimentation. While it is true that science oftentimes seems dull and monotonous, it is factual. On the other hand, how many products, technologies, or services are you currently using that are based solely upon slick pitches from salespeople? Or maybe you've been persuaded by testimonials from leaders of the golf turf management profession. If they use it, it must be good, right? Or could it be that these people employ sound agronomic practices and excel at managerial skills in spite of using products that do nothing to improve their already pristine turf? Perhaps you are from the school of

thought that these products can't hurt anything, so why not use them?

Although using snake oils may not harm your turf, what effects do they have on the professionalism that both you and the golf turf management industry have worked so hard to build? And more to the point, how much of your club's money is being spent on these products, and would you exercise the same blind faith if it were your money?

The primary purpose of this article is to provide the reader with a better understanding of the importance of research and the scientific method in

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT

UC RIVERSIDE

UCR Turfgrass Water Conservation and Salinity Management Research Facility

Salinity Alleviation Study

Sub-Surface Irrigation Study

Linear Gradient Irrigation Study

Line Source Irrigation Study



SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT



Basic Ingredients

- Nitrogen
- Plant Growth Regulator
- Soil Surfactant (Wetting Agent)

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT



Bermudagrass 'Princess 77'

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT

UC RIVERSIDE

Rep 1
40% ETo
UC Riverside
10-20-2016

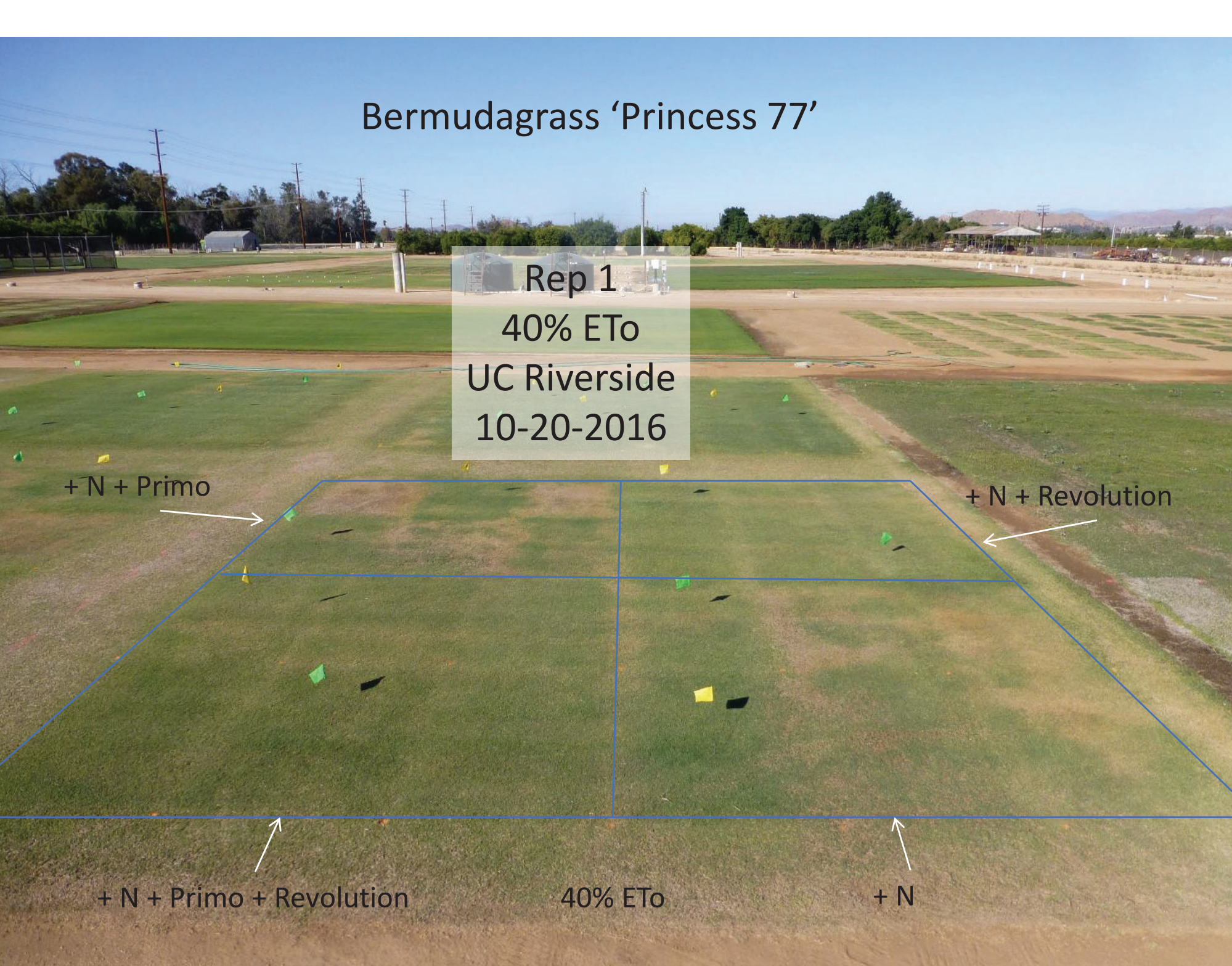
+ N + Primo

+ N + Revolution

+ N + Primo + Revolution

40% ETo

+ N



Soil Surfactant Top Performers

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT



Product	Company	Deficit	Localized Dry Spot
Revolution	Aquatrols	✓	✓
TriCure AD	Mitchell Products	✓	✓
WA-001	JRX Biotechnology	✓	
Passage	Numerator	✓	
Hydro 90	Harrell's		✓
Hydro 90 + Symphony	Harrell's	✓	
Aquimax Turf Lateral	Exacto	✓	
Cascade Plus	Precision Labs	✓	
Vivax	Precision Labs	✓	
ReWet	Simplot		✓
Forte + CounterAct Retain	Simplot	✓	
Forte + Brilliance	Simplot	✓	

Preserve Golf Club 17 July 2013



Control

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT





Preserve Golf Club
17 July 2013

Revolution
6 oz/M

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT



Preserve Golf Club

17 July 2013

TriCure AD
6 oz/M

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT



Other Product Top Performers

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT



Product	Company	Active Ingredient
Daconil Action + Appear II	Syngenta	Acibenzolar + phosphite + pigment
Civitas Turf Defense	Intelligro	Mineral oil + pigment
Nanocarbon	Vulpes Corp.	Nanocarbon
Various	Various	Biostimulants

October 24, 2019

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT





**Daconil Action (3.50 oz/M)
+ Appeal II (6.00 oz/M)**

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT



Conclusions

- Effective commercial products can help save at least 20-25% water.
- Products with pigments can potentially stretch that to 30-40%.
- Future research will continue to evaluate new products/technologies and seek to match the best products with the best grasses.

Turfgrass and Landscape Research Field Day

Thursday, September 15, 2022



Utilizing Modern Tools for Golf Course Irrigation

Matthew Muhlenbruch Hillcrest Country Club

What's in the Toolbox?

- Water Quality
- Irrigation Design
- Toro Precision Sense
- Soil Sensor Network
- Daily Drone Imagery
- Rainbird Weather Station and Cirrus Software

Water Quality

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT



Irrigation Water Contribution per Acre/Foot

SAMPLE : **Hillcrest Country Club - Well Water - AgSource Lab Date: June 4, 2019**

pH: **7.55**

ECw: **1.77**

TDS: **1133**

Adj SAR **5.34**

Constituent:

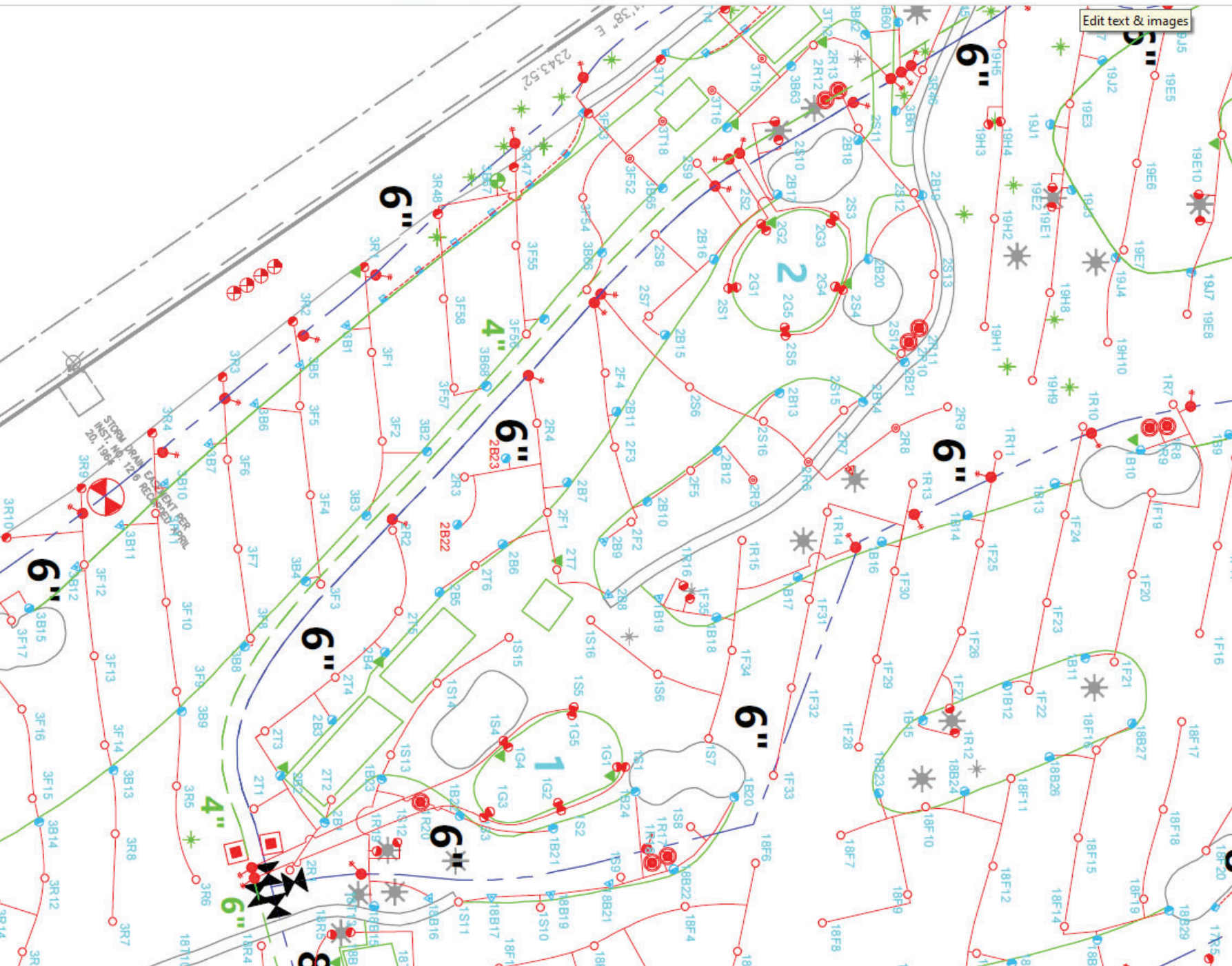
ppm:

X 2.72 =

Pounds Per Acre-Foot

lbs/applied per 1000sf

	Bicarb	Chloride	Sodium	Nitrate	Phosphate	Potassium	Calcium	Magnesium	Sulfate	Boron
ppm:	386.01	278.00	122.46	3.06	0.12	9.69	167.65	75.77	194.25	0.34
X 2.72 =										
<i>Pounds Per Acre-Foot</i>	1049.9	756.2	333.1	8.3	0.3	26.4	456.0	206.1	528.4	0.9
<i>lbs/applied per 1000sf</i>	24.1	17.4	7.6	0.2	0.0	0.6	10.5	4.7	12.1	0.0



System Design

- 2 main lines-Potable water to Greens
- Well water with blending capabilities
- Traditional Spacing for maximum uniformity and coverage
- Supplemental Rough System

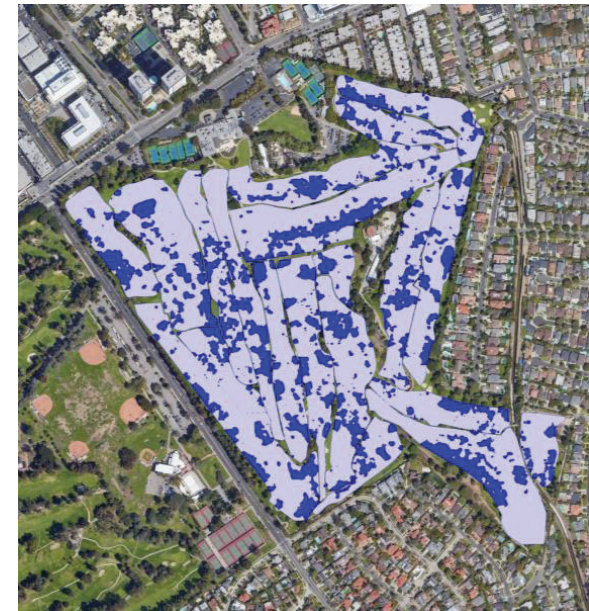
Toro Precision Sense

- Volumetric Water Content
- Compaction
- Salt
- Plant health



Compact – Dry – Wet Maps

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT



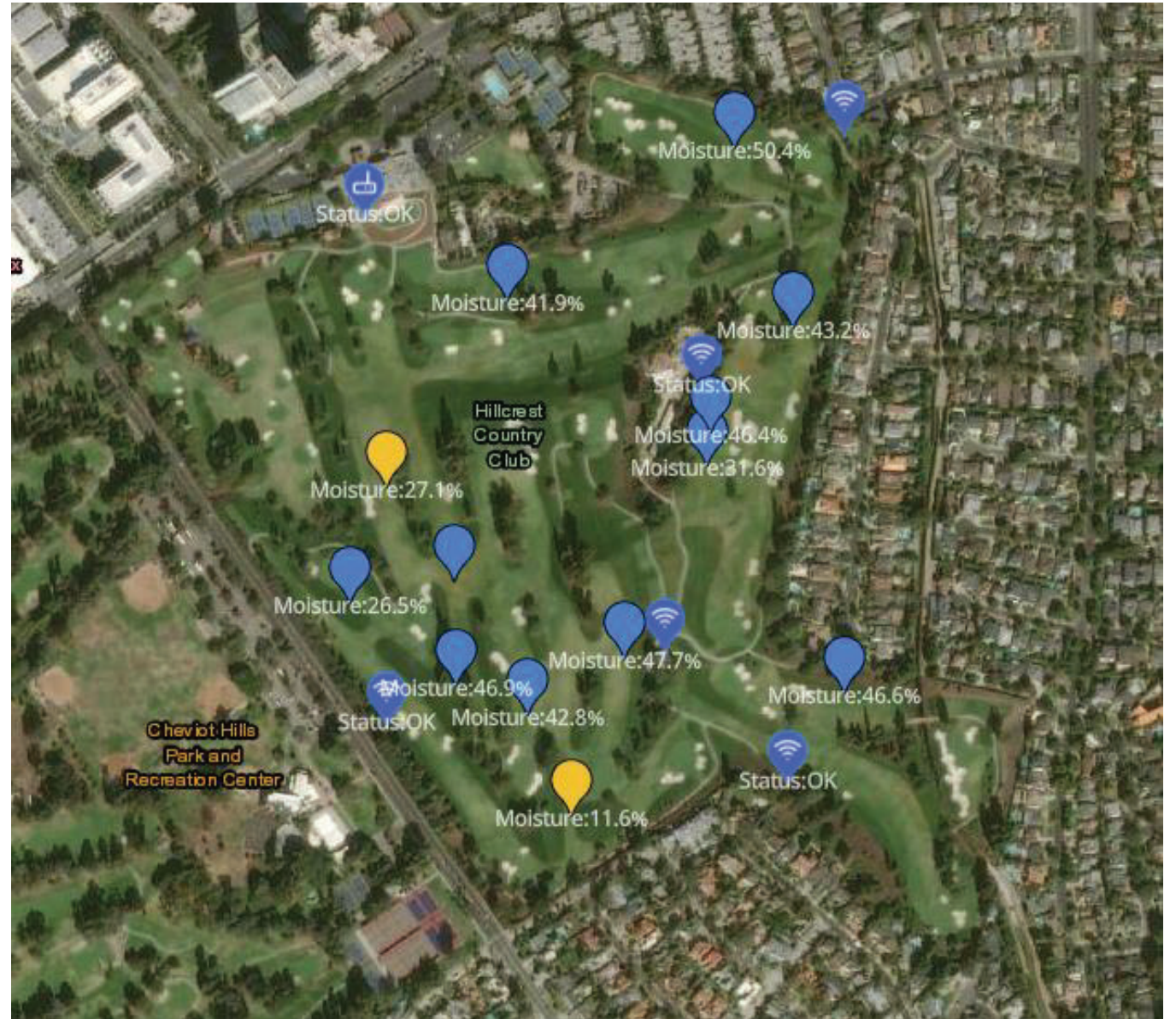
Irrigation Programming

- Front 9 & Back 9
- Dry- Upper Quartile
- Wet-Lower Quartile
- Compact-Upper Quartile
- Average – Remaining Heads



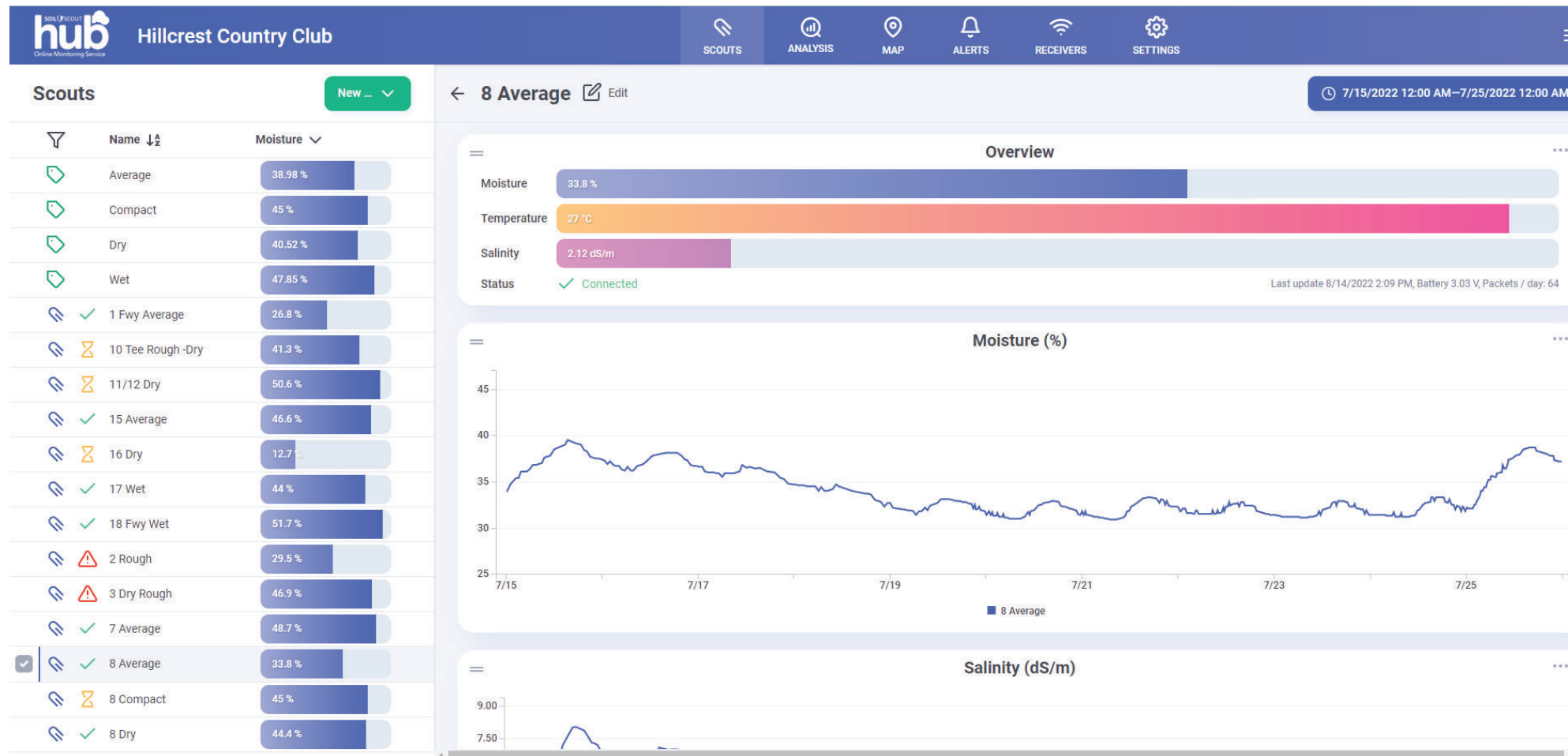
Moisture Sensor Network

- 12- Soil Scout Moisture Sensors
- 1-2 Sensors per Primary Irrigation Program



Sensor Data

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT



Weather Station Data

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT

Daily Climatic Data

Hillcrest Country Club

Date	Min Temp (F)	Max Temp (F)	Relative Humidity (%)	Solar Radiation (langleys)	Wind Run (mi./d)	Rainfall (inches)	ETo (in./d)
7/15/2022	61.92	70.54	96.60	586.903	85.68	0.08	0.16
7/16/2022	61.65	72.86	97.90	591.676	81.36	0.00	0.17
7/17/2022	62.03	87.53	97.60	576.349	91.92	0.00	0.21
7/18/2022	64.96	79.79	91.90	590.122	102.00	0.00	0.19
7/19/2022	61.79	76.80	96.40	605.510	84.72	0.04	0.18
7/20/2022	62.37	79.05	97.90	574.471	77.28	0.08	0.17
7/21/2022	61.68	77.83	90.10	568.920	78.24	0.07	0.18
7/22/2022	61.77	75.45	96.10	551.174	69.60	0.00	0.16
7/23/2022	63.38	74.61	85.50	528.650	77.04	0.06	0.17
7/24/2022	63.83	74.79	91.30	482.019	70.56	0.09	0.15
7/25/2022	62.85	73.63	87.70	543.893	75.12	0.00	0.17
Total	688.23	842.88	1,029.00	6,199.69	893.52	0.42	1.91
Minimum	61.65	70.54	85.50	482.02	69.60	0.00	0.15
Maximum	64.96	87.53	97.90	605.51	102.00	0.09	0.21
Average	62.57	76.63	93.55	563.61	81.23	0.04	0.17

Thermal Drone Image & Sensors

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT



Practical Application

- ✓ Check weather Forecast
- ✓ Run Current Day Weather Station Report
- ✓ Read Moisture Sensors per Program
- ✓ View Daily Drone Image
- ✓ Set Nightly Irrigation

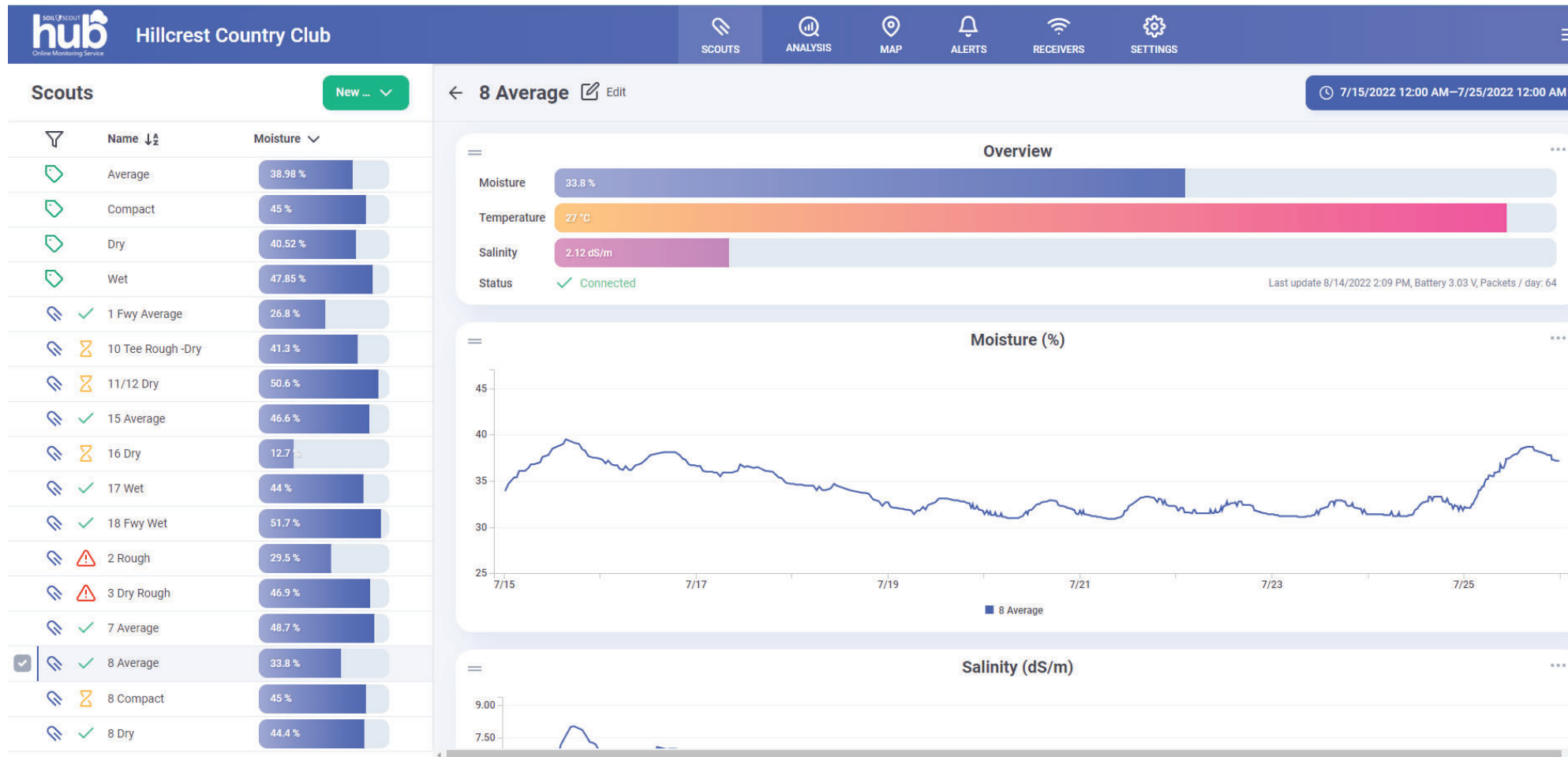
10 Day Snapshot

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT

#8 Average Sensor			
Date	ET	APP Rate (in)	VWM %
7/15/2022	.16	.4	39.5
7/16/2022	.17	0	36.7
7/17/2022	.21	0	35.5
7/18/2022	.19	0	34.0
7/19/2022	.18	.2	33.1
7/20/2022	.17	.15	32.8
7/21/2022	.18	.2	33.2
7/22/2022	.16	0	32.8
7/23/2022	.17	.2	32.9
7/24/2022	.15	.15	32.8
07/25/2022	.17	.4	38.7
Total	1.91	1.7	

#8 Sensor Data

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT



Thermal Drone Image-July 25

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT



Thermal Drone Image-July 26

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT

The screenshot displays the TurfCloud web application interface. At the top, the browser address bar shows the URL greensight.turfcloud.com/map. The application header includes the TurfCloud logo, navigation tabs for MAP, SCHEDULE, and PEOPLE, and a location selector for Hillcrest Country C... with a user profile icon and the Greensight logo.

The main content area features a central map of a golf course. A semi-transparent overlay on the map indicates the date "Tuesday, July 26, 2022". The map is overlaid with a thermal image showing temperature variations across the course, with colors ranging from blue (cooler) to red (warmer). Various data points are scattered across the map, including sensor locations and drone image capture points.

On the left side, there is a calendar for July 2022. The 26th is highlighted in red, indicating the selected date. Below the calendar, there are legend items: a red circle for "Today's date", a grey circle for "Soil sensor data", an orange circle for "Selected date", and a white circle for "Drone image taken". There are also checkboxes for "Robotic mowers" (set to "Live only") and "Soil sensor". A prominent orange button labeled "SHOW ALL SOIL SENSOR INFORMATION" is visible. Below this, there is a section for "See all soil moisture data on map" with radio button options for "Sensor location", "Moisture", "Temperature", and "Salinity".

On the right side, there are "Base maps" options: Satellite, High resolution, Turf health, and Thermal. Below this is a "Calibrate Thermal Map" dropdown menu. At the bottom right of the map, there are standard map navigation controls: a location pin, a plus sign for zoom in, and a minus sign for zoom out.

The bottom of the interface shows a taskbar with two open files: "FieldScoutSessionE...csv" and "Tor Precision Sense.jif". A "Show all" button is located at the bottom right of the taskbar.

Thermal Drone Image-July 27

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT



Thermal Drone Image-July 28

SOUTHERN CALIFORNIA
GOLF & WATER SUMMIT

The screenshot displays the TURFCLOUD web application interface. At the top, there are navigation tabs for MAP, SCHEDULE, and PEOPLE. The current location is identified as Hillcrest Country C... and the user is logged in as GREENSIGHT.

On the left side, there is a calendar for JULY 2022. The date Thursday, July 28, 2022, is selected. Below the calendar, there are checkboxes for "Today's date" (selected), "Selected date", "Soil sensor data", and "Drone image taken".

The main map area shows a thermal drone image of a golf course. The map is overlaid with a color-coded thermal image, with a legend on the right side. The legend includes "Base maps" (Satellite, High resolution, Turf health, Thermal) and "Calibrate Thermal Map".

At the bottom left, there are checkboxes for "Robotic mowers" (with "Live only" selected) and "Soil sensor". A button labeled "SHOW ALL SOIL SENSOR INFORMATION" is visible. Below this, there is a section for "See all soil moisture data on map" with radio buttons for "Sensor location", "Moisture", "Temperature", and "Salinity".

What's next?

- Building predictable Irrigation Models based on data
- Integrating 3rd party Apps with Irrigation Central Computer
- Save Water
- Sleep Better!!

Invisible Irrigation: A Story of Sub-Surface Drip

Matteo Serena, Ph.D.

Senior Manager, Irrigation Research and Services
USGA

History of Drip Irrigation

- **Ancient China (1st century BC):** Clay pots filled with water
- **“Modern Drip”:** Developed in Germany around 1860 (Clay pipe) and used in combination with drainage
- **Perforated Pipe:** Started in 1920
- **Plastic Drip:** Started in Australia in 1950; later developed into Netafim (1964)
- **Farming:** Begun in Australia, North and South America in 1960
- **Commercial Landscaping:** Application started in 1980

System Design

- Filter and pressure regulator
- Air release valve and automatic flush valve (check manufacturers for requirement)
- Manual flush valve
- Drip tubing material
 - Manufacturer/brand
 - Delivery rate
 - Spacing
 - Depth



Picture courtesy Dr. Elena Sevostianova

Does It Work on a Golf Course?

Long-term project started in 2016 at
The Club at Las Campanas in Santa Fe, N.M.

- Bentgrass
- Sand capped 6"
- 12 tees retrofitted with SDI:
 - Toro DL2000®
 - Rain Bird XFS (Copper Shield®)
 - Netafim Techline® HCVXR
 - Hunter Eco-Mat®
- 2 Control sprinkler irrigated



Installation



- Spacing: 12"
- Depth: 6"
- Filter, Pressure regulator, air release, and automatic flush valve
- 1" header, 1/2" drip tubing
- Water meter for measuring water savings
- Trenched directly into the turf
- Sod removal, trenched, sod replacement
- Old sprinkler system left in place



Knowledge Gained

June 2016:
Trenched directly (A) vs. sod removal (B)



November 2016:
Trenched directly (A) vs. sod removal (B)



Additional Knowledge Gained

Trees will compete for water, root pruning necessary



If an inexperienced crew is left unattended, drip lines can be installed deeper than recommended

Small filters can clog fast, especially when using poor quality water



Manual controllers are time-consuming, and crew (or golfers) can "accidentally" adjust time

Success!

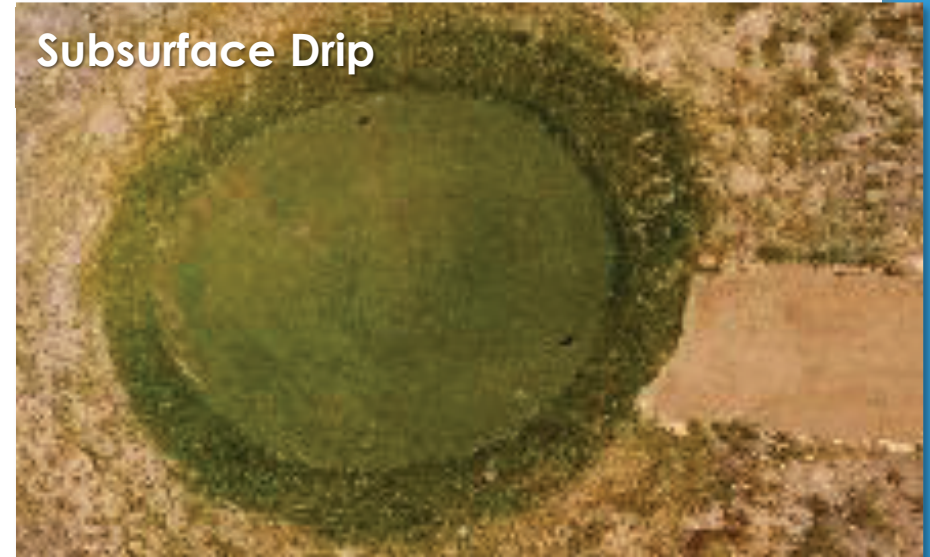
- No visible differences compared to overhead irrigation
- Water use was substantially reduced (50-80%)
- Significant reduction in out-of-play vegetation management (no overspray)
- Less incidence of disease (\$ spot)
- Fewer germination of weeds (poa annua)
- Less soil compaction
- Can irrigate anytime even during play



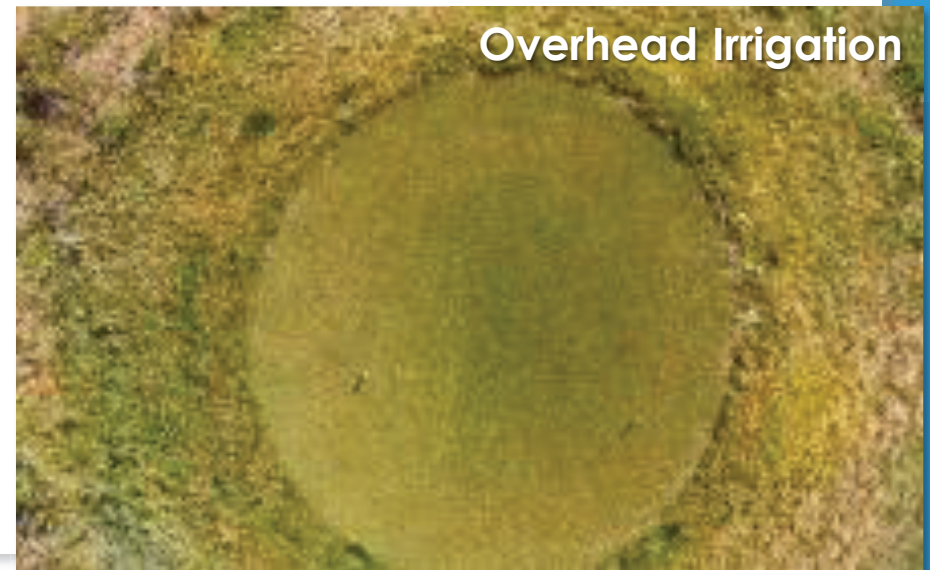
Additional Information

- Cost
- Aerification
- Clogging
- What's next
- Larger areas

Subsurface Drip



Overhead Irrigation



Matteo Serena

MSerena@usga.org



Unpacking the Facility Toolbox

Geoff Shackelford
Moderator

**Brian
Whitlark**
Senior
Agronomist
USGA



**Dr. Marta
Pudzianowska**
Assistant
Researcher
UC-Riverside



**Dr. Jim
Baird**
Turfgrass
Specialist
UC-Riverside



**Matt
Muhlenbruch**
Director of
Agronomy
Hillcrest CC



**Dr. Matteo
Serena**
Irrigation
Research &
Services
USGA