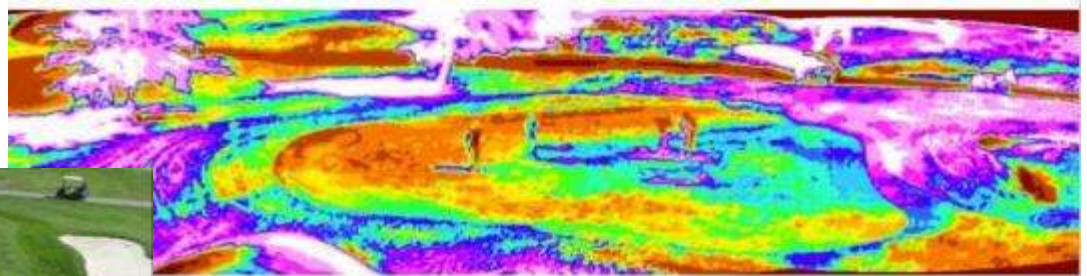


**See it      Manage it**



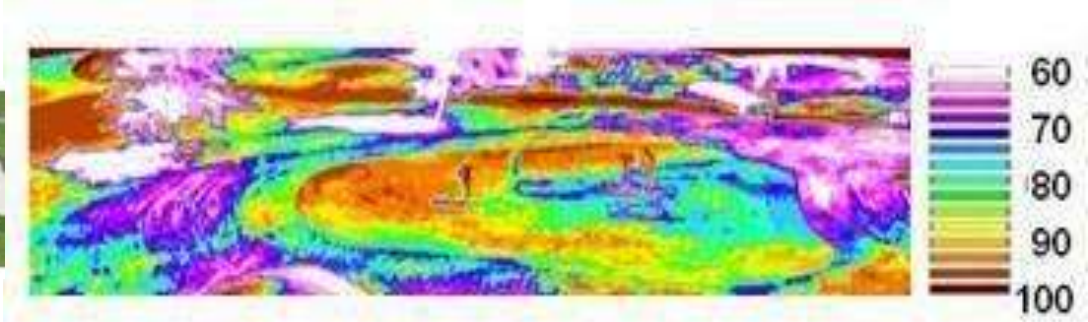
# Hawk-Eye Systems & Turf-Vu® Services

The screenshot displays the ItriCorp Hawk-Eye web interface. At the top, there is a navigation bar with the ItriCorp logo and the text 'Hawk-Eye - Late'. Below this is a search bar and a 'Search Analysis...' button. The main content area shows a grid of images and thermal data for a golf course. The images include aerial views of a golf course, thermal maps showing moisture levels, and a time series of images. A large eye icon is overlaid on the top right of the screenshot. Several circular callouts are overlaid on the screenshot, showing close-ups of the Hawk-Eye sensor mounted on a tree, a person operating the system, and a green tractor with the system mounted on it.

**System Sale - Lease - Rent**



# Canopy Temperature is the Indicator of Turf Grass Health

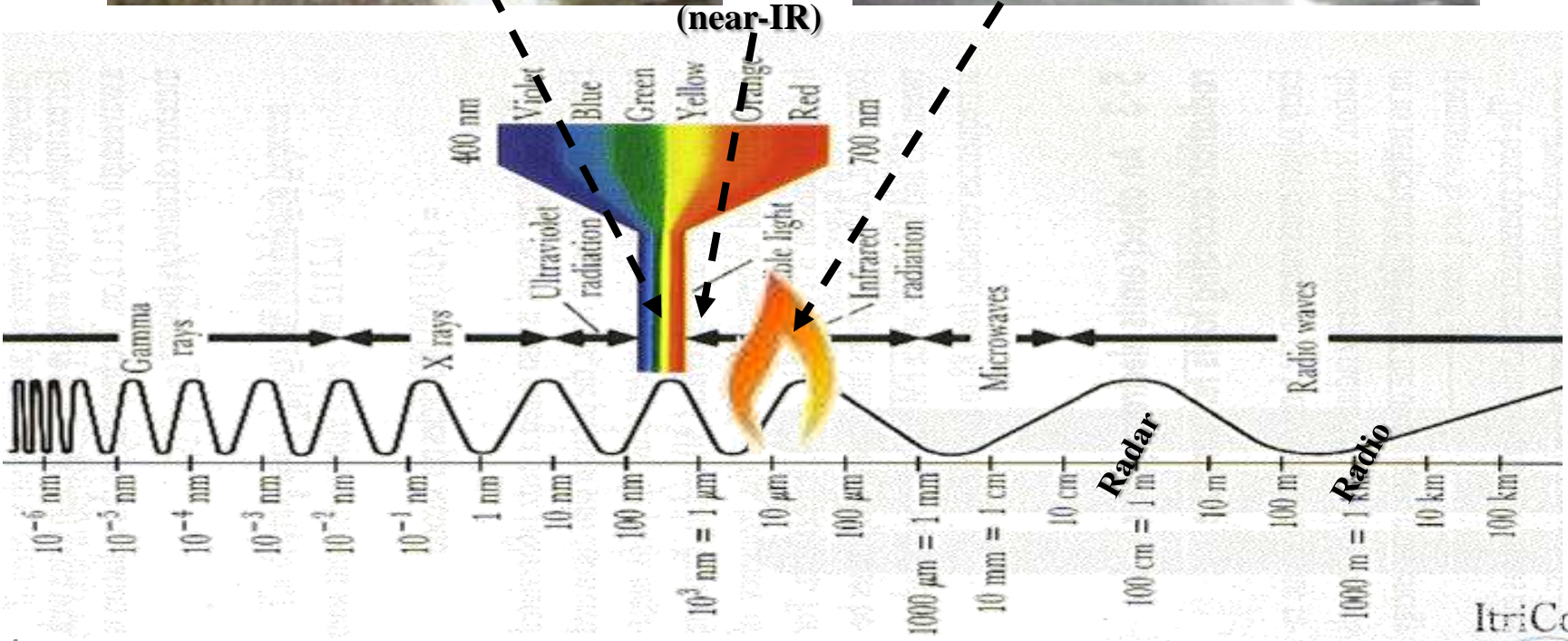
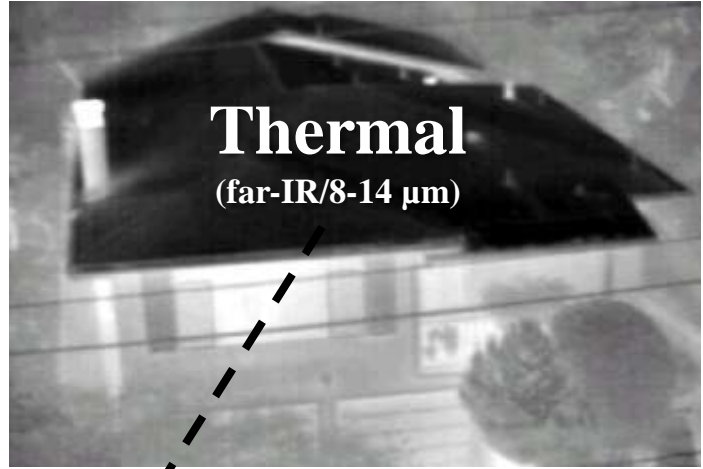


Real-time monitoring of canopy temperatures allows you to quickly identify turf stress

Turf “hot spots” are the result of many factors.  
It is the best indicator of stress.

Seeing the “hot spots” can be an early warning of water/disease/pest pressures that should be mitigated before they become expensive and/or unmanageable

# The Hawk-Eye Imaging Spectrum



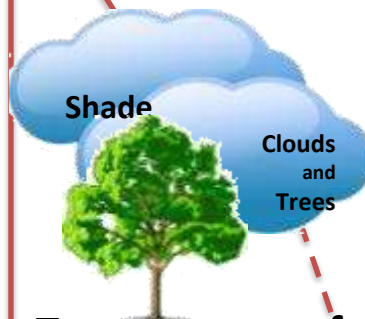
# Turf Grass Energy System @ Day

## Energy Into System

Sunlight Is used in Photosynthesis  
Ambient Air Temperature  
Heat from Respiration

## Weather

Wind  
Temperature  
Humidity  
Precipitation



## Energy out of System

Green Reflected  
Near-IR Scattered by Chlorophyll  
Far-IR (Heat ) Emitted from Plant

## Temperature of the Canopy is a Function of:

### Sunlight

### Air Temperature

Absorbed, Reflected, Scattered, Shaded

### Latent Heat of Vaporization

Cooling effect during Transpiration and Evaporation

## Transpiration

## Transpiration



Healthy Turf

Stressed Turf

Healthy Turf

H<sub>2</sub>O to leaves facilitated by transpiration

H<sub>2</sub>O to leaves facilitated by transpiration





# Hawk-Eye Systems



## Semi-Permanent &/or Mobile

- Thermal camera
- Visual camera
- Camera controllers
- Communications (WiFi & Internet)
- Pan/Tilt Option

## Weather proof

Real time image and  
meteorological data

Data archive w/search tool

Canopy Temperatures

Stress Identification

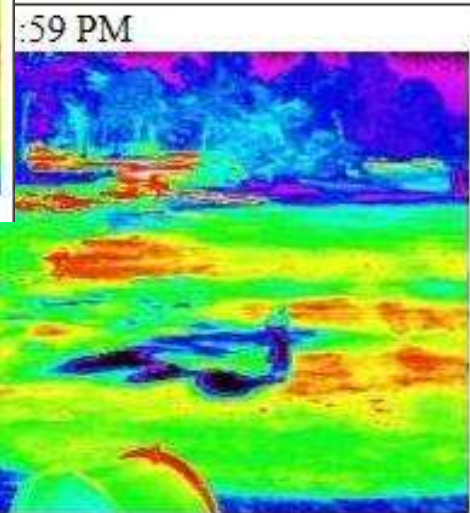
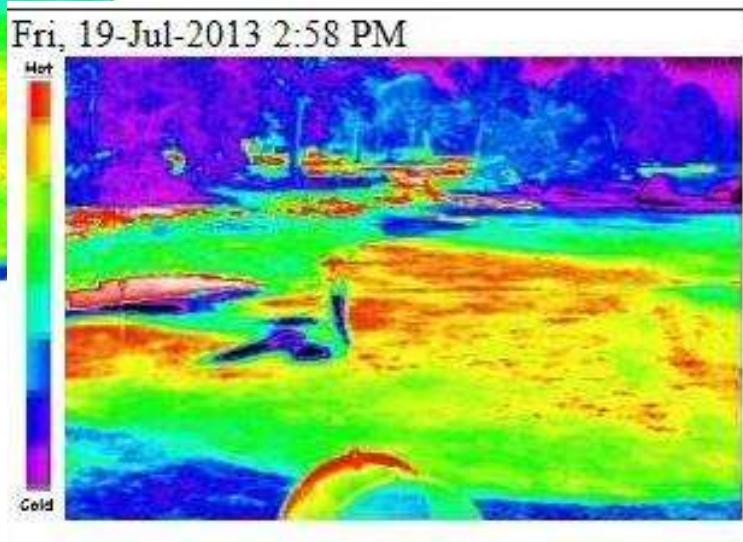
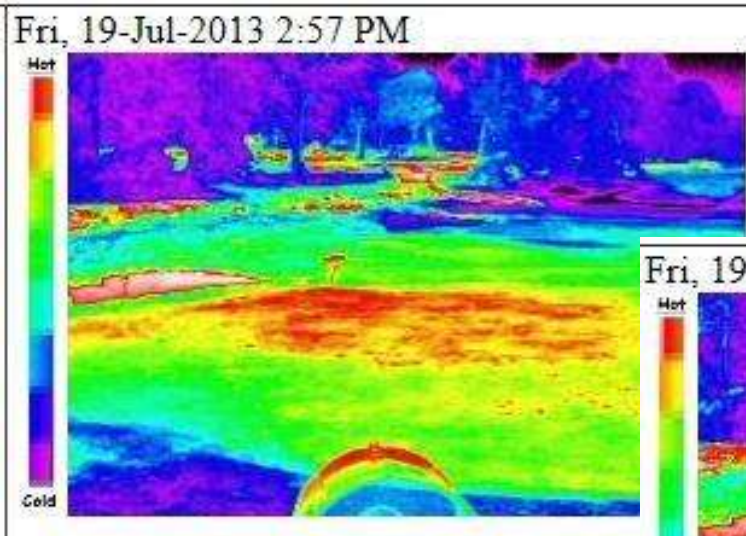
24/7 Live View - via Local WiFi & Internet

# Applying Hawk-Eye

- Managing Syringing
- Managing Irrigation
- Managing Fan Placement & Aim
- Precision Scouting for Stress
  - Pest
  - Disease
  - Shade
  - Traffic
- Precision Application of Treatments
- Preparation of Cultivation Practices
  - Aeration Decision Aid
  - Application of Beneficial Stress (deficit irrigation)
- .....

# Syringing

See exactly where you need it, or not.  
See the result while you are doing it.

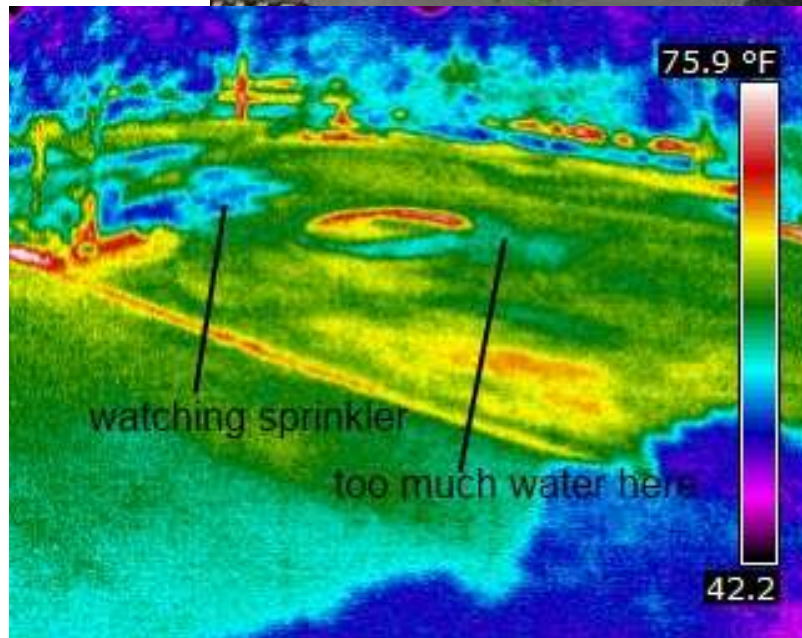


TurfVu Alerts • Survey & Audit Fees (available & in-season) • Irrigation Efficiency Reports • Hawk-Eye Systems (in-season)

<http://turfvu.com/>



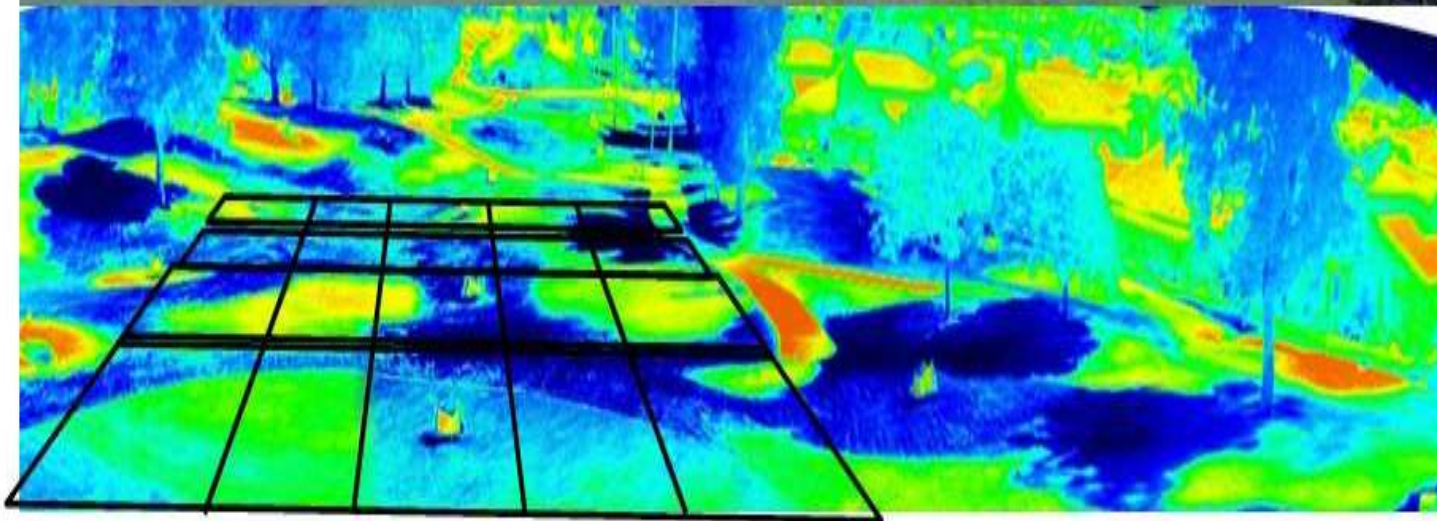
# Managing Irrigation



Myrtle Beach  
10 AM  
10Feb14

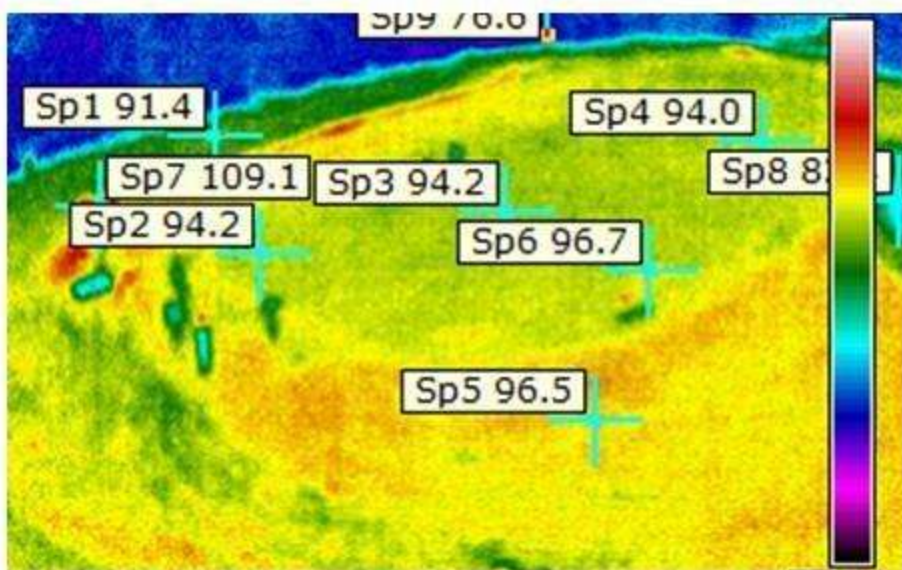
# Irrigation

## “Water Distribution and Uniformity Effectiveness Analysis”

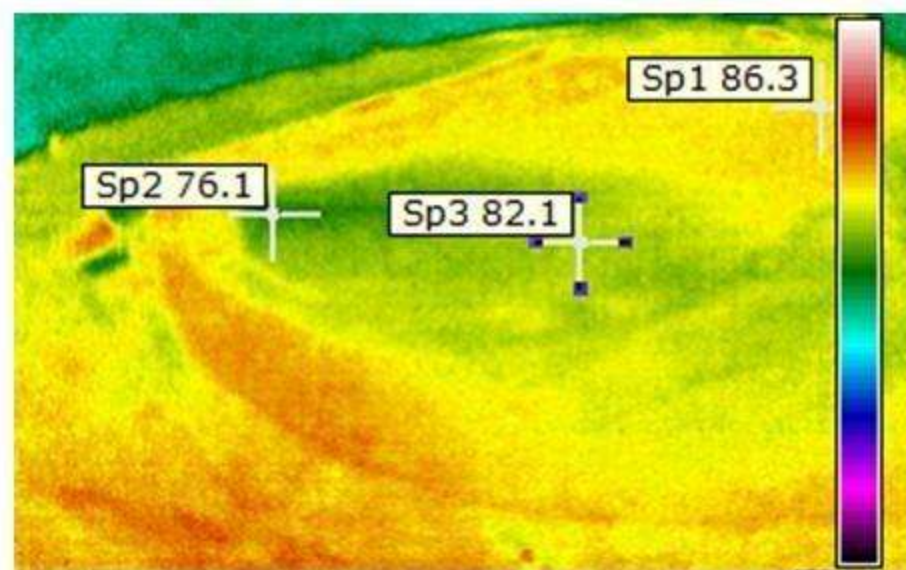




# Managing Fans



Fan Off



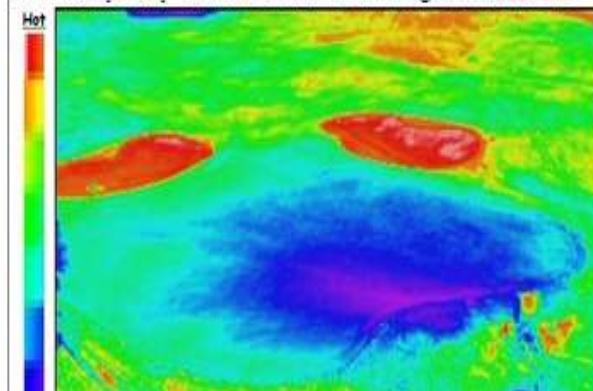
Fan On



## good location & aim

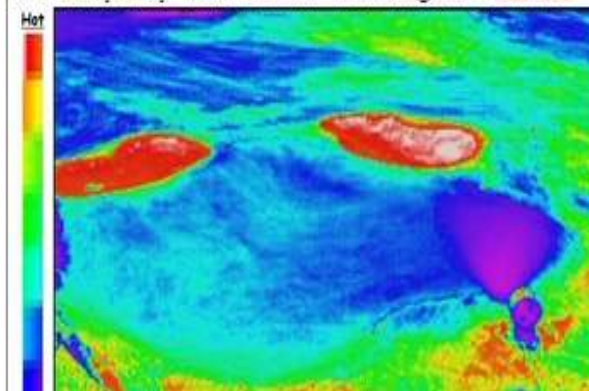
Wed, 21-Aug-2013 1:30 PM

87° F - mostly cloudy - RH: 65% - DP: 74 - SouthEast @ 3 MPH **THI: 152**



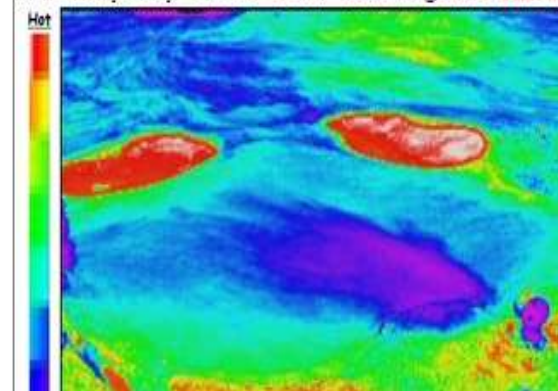
Wed, 21-Aug-2013 1:40 PM

87° F - mostly cloudy - RH: 65% - DP: 74 - SouthEast @ 3 MPH **THI: 152**



Wed, 21-Aug-2013 1:50 PM

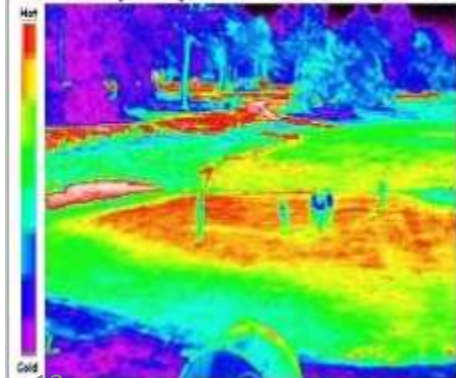
87° F - mostly cloudy - RH: 65% - DP: 74 - SouthEast @ 3 MPH **THI: 15**



## not so good

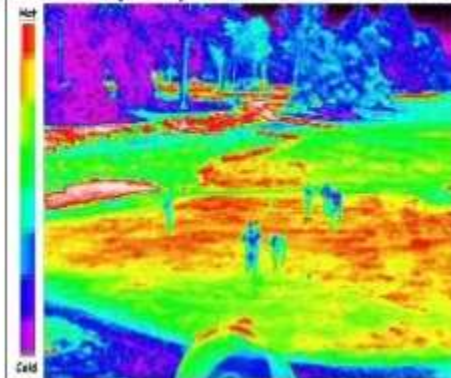
Sun, 21-Jul-2013 2:06 PM

89° F - mostly cloudy - RH: 49% - DP: 68 - SouthSouthwest @ 10 MPH



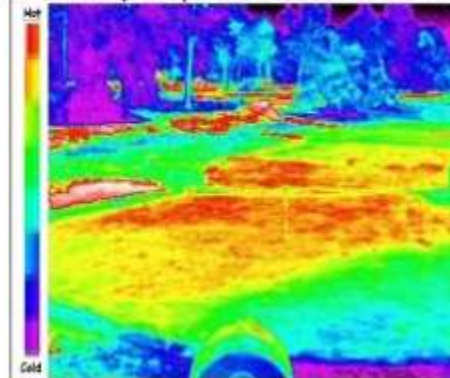
Sun, 21-Jul-2013 2:16 PM

89° F - mostly cloudy - RH: 49% - DP: 68 - SouthSouthwest @ 10 MPH



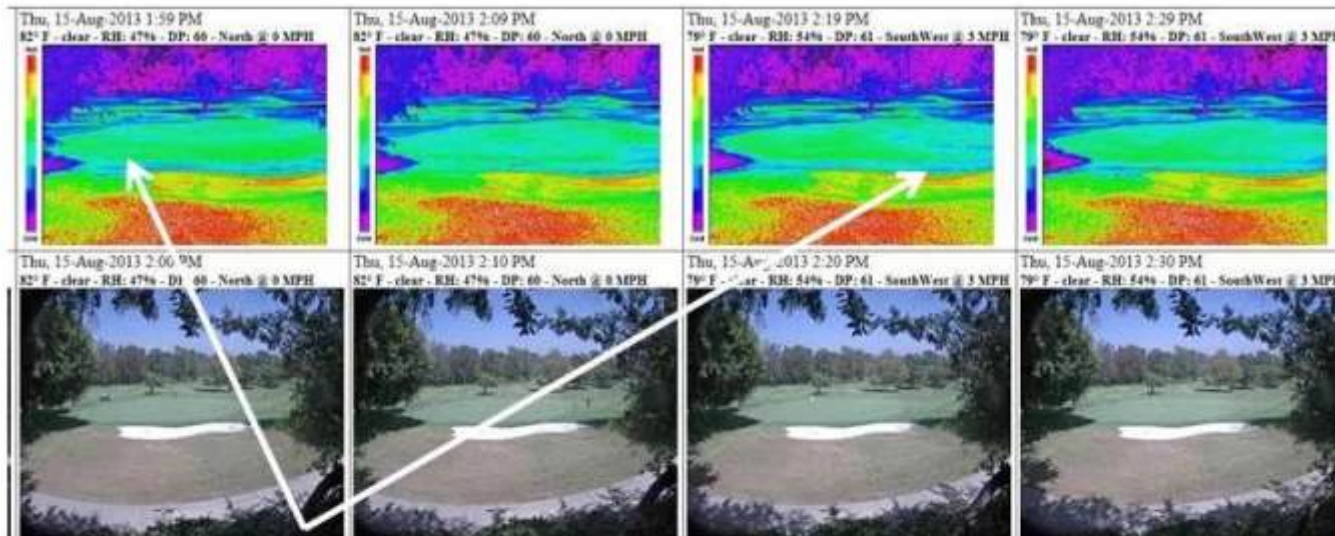
Sun, 21-Jul-2013 2:26 PM

89° F - mostly cloudy - RH: 48% - DP: 67 - SouthSouthwest @ 7 MPH



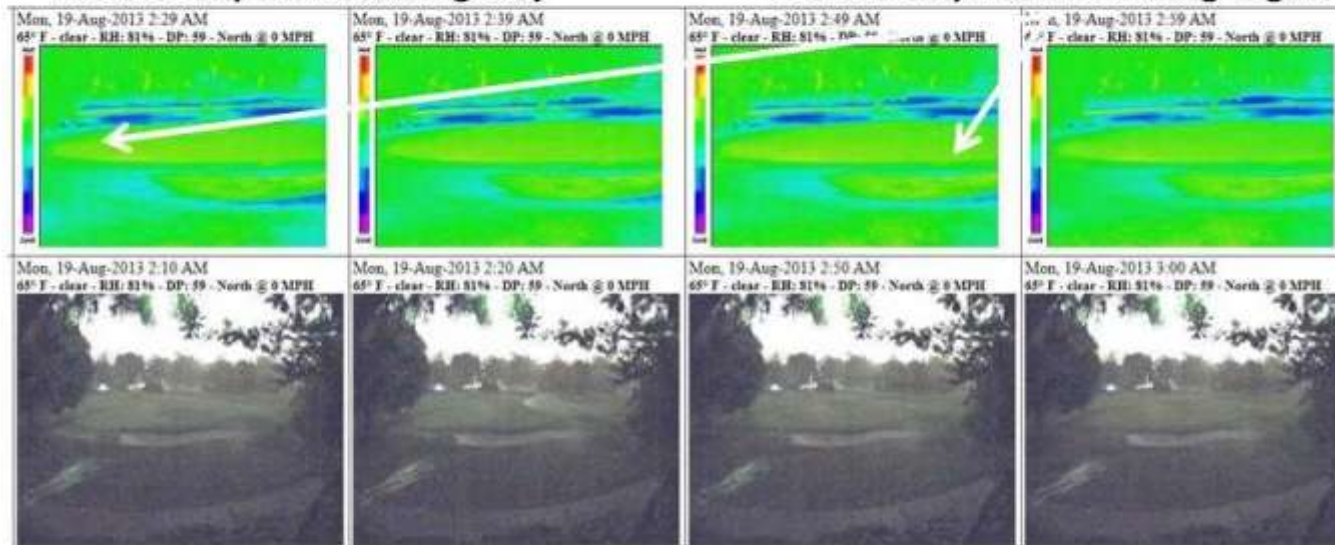
# Stress ID

Accumulation of Stress becomes evident in a persistent time series.



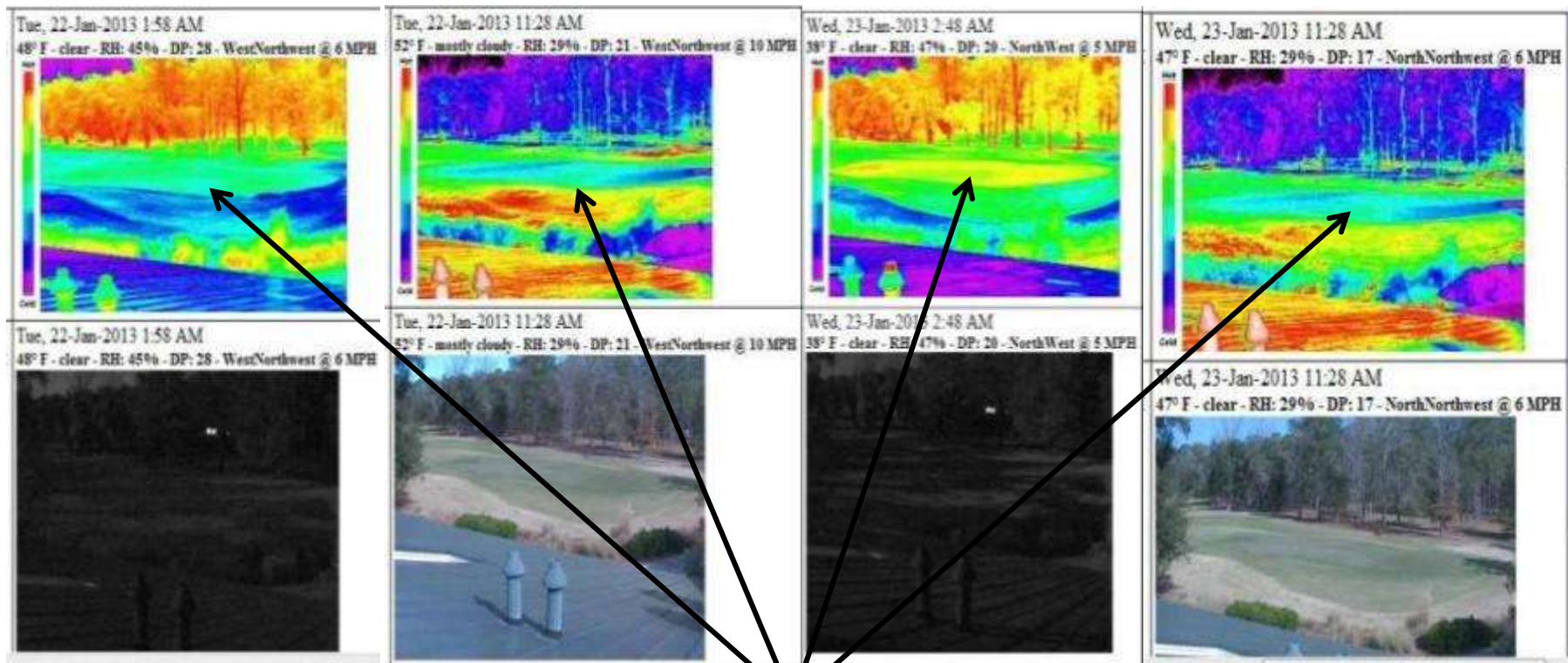
Persistently cooler during day

Persistently warmer during night





# Scouting Pests



**Persistent Pattern**  
Cooler at night  
Warmer during day (sunshine)

**See disease and pest caused stresses, before they are a problem**



# Collaborative Efforts to Find & Test Cultivation Techniques that are Facilitated by Plant Thermography

Research and Classroom Activities at Horry Georgetown Technical College \*

- Study the effects of heat and moisture response on ultradwarf bermuda grasses at different locations under different management practices.
  - Agronomic relationships to be studied include: soil content, i.e. push-up greens versus sand based greens; wetting agent application; plant growth regulator application; liquid versus granular fertilizer application; pigment application.
- Study 419 bermuda grass & synthetic turf sports fields.
  - Study a variety of cultural practices such as irrigation, topdressing, painting, tarps and covers, and crumb rubber applications.
  - Study temperature relationships with regard to turf painting and if thermal imagery can impact paint management application timing and turf vigor.
- Collaborate with North Carolina State to look for correlations in their visual color studies photosynthesis and respiration.
- Collaborate with Clemson Universities turf research center to look at the relationship of heat and moisture stress on turfgrasses varieties with regard to basic cultural activities.

\* Hawk-Eye technology will broaden the experiences of Horry Georgetown's forthcoming turf and landscape professionals.

# Client Access via Web, Real-Time & Archive

<http://itricorp.com/hawkeye/>

Log-On

Turf-Vu® Logon

Account: Greens-Demo  
Password: guest

Keep Connected

Logon

Via: Desk Top  
Ipad or Tablet  
Iphone or Smartphone

Overlays:  
Topography  
Soil Moisture/Temperature

The screenshot displays the Itrix Corp Hawk-Eye web interface. At the top left is the Itrix Corp logo and navigation links like 'Options...', 'Search/Analysis', and 'Logoff'. Below this is a 'Weather Forecast' section with a grid of images and thermal maps. The grid is organized as follows:


- Row 1:** Six panels showing 'Visual' images of a golf course at different times: 4:14 PM, 4:04 PM, 3:54 PM, 3:44 PM, 3:34 PM, and 3:24 PM. Each panel includes weather data (e.g., 54° F, clear, RH: 35%, DP: 27, South @ 8 MPH).
- Row 2:** Six panels showing 'Thermal' maps corresponding to the same times as the visual images above.
- Bottom Left:** A 'Time Series (Reverse)' section showing a 'Movie' of the thermal data over time.

Annotations with arrows point to various features:

- 'Search Archive' points to the 'Search/Analysis' link in the top navigation.
- 'Real Time Weather' points to the 'Weather Forecast' section.
- 'Visual' points to a visual image in the top row.
- 'Thermal' points to a thermal map in the second row.
- 'Current Radar & Weather Forecast (7 day) & Alerts (Disease Pressure and Frost)' points to the bottom right area of the interface.
- 'Movie' points to the 'Time Series (Reverse)' section.

# Current Radar & 7 Day Forecast & Notices


Forecast: [Location View](#) [Graphical View](#) [Table View](#)  
 Location: 7 Miles NNW Bluffton SC  
 Radar: CLX - Charleston, SC



**Forecast**  
 Fri, 25-Apr-2014 08:00  
 Temp: 68 | RH: 87 | WndSpd: 7 | WndDir: 190

**Notices**  
 9pm, Mon, 28-Apr-2014 --> 9am, Tue, 29-Apr-2014: Disease Pressure  
 9pm, Tue, 29-Apr-2014 --> 10am, Wed, 30-Apr-2014: Disease Pressure

OK



Mon, 18-Feb-2013 4:14 PM  
 54° F - over - RH: 80% - DP: 47 - Wind @ 11 MPH  
 << | Play | >>  
 1.0  
 From: Time Grouping: 15 min - Speed: 100

**Augusta - Azalea** - Site Time at Fetch: Fri, 25-Apr-2014 07:23 AM

Weather Forecast	Show Topography	Perform Analysis Across Results	Visual	Thermal
Fri, 25-Apr-2014 07:14 AM 61° F - overcast - RH: 96% - DP: 60 - SouthSoutheast @ 0 MPH <b>THI: 157</b>	Fri, 25-Apr-2014 07:04 AM 61° F - overcast - RH: 96% - DP: 60 - SouthSoutheast @ 0 MPH <b>THI: 157</b>	Fri, 25-Apr-2014 06:54 AM 61° F - overcast - RH: 96% - DP: 60 - SouthSoutheast @ 0 MPH <b>THI: 157</b>	Fri, 25-Apr-2014 06:43 AM 61° F - overcast - RH: 96% - DP: 60 - SouthSoutheast @ 0 MPH <b>THI: 157</b>	Fri, 25-Apr-2014 06:33 AM 61° F - overcast - RH: 96% - DP: 60 - SouthSoutheast @ 0 MPH <b>THI: 157</b>



# Archive

### Site Selection

Site	Min Date-Time	Max Date-Time	Timezone
<input checked="" type="radio"/> Ag - GreensDemo	Mon, 14-Jan-2013 07:27 AM	Mon, 18-Feb-2013 4:14 PM	US Eastern

### Image Selection (Date/Time is relative to the Site timezone)

Image Type:  Thermal -  Visual

Date Range: Min Mon, 14-Jan-2013 - Max Mon, 18-Feb-2013

On  Between  Through

30-Jan-2013 and 06-Feb-2013

Time Range: Closest (after) or Between: (12am - midnight, 12pm - noon)

2:00  AM  PM and 4:00  AM  PM

### [-] Weather Selection

Temperature (F) at or between  and

Sky:  clear  mostly clear  partly cloudy  mostly cloudy  overcast  obscured

Relative Humidity (%) at or between  and

Dew Point (F) at or between  and

TH-Index at or between  and  --  Positive Dew Indicator

Wind Speed (MPH) at or between  and

Wind Direction:  North  East  South  West  Variable

Search

All Images Sized to 30% of original

Ag - GreensDemo -- Site Time at Fetch: Wed, 12-Feb-2014 1:48 PM Perform Analysis Across Results on  Thermal  Visual

<p>Wed, 30-Jan-2013 2:05 PM 73° F - mostly cloudy - RH: 68% - DP: 62 - South @ 20 MPH</p>	<p>Wed, 30-Jan-2013 2:18 PM 73° F - mostly cloudy - RH: 68% - DP: 62 - South @ 20 MPH</p>	<p>Wed, 30-Jan-2013 2:28 PM 74° F - mostly cloudy - RH: 63% - DP: 61 - South @ 23 MPH</p>	<p>Wed, 30-Jan-2013 2:38 PM 74° F - mostly cloudy - RH: 63% - DP: 61 - South @ 23 MPH</p>	<p>Wed, 30-Jan-2013 2:48 PM 74° F - mostly cloudy - RH: 63%</p>
<p>Wed, 30-Jan-2013 2:05 PM 73° F - mostly cloudy - RH: 68% - DP: 62 - South @ 20 MPH</p>	<p>Wed, 30-Jan-2013 2:18 PM 73° F - mostly cloudy - RH: 68% - DP: 62 - South @ 20 MPH</p>	<p>Wed, 30-Jan-2013 2:28 PM 74° F - mostly cloudy - RH: 63% - DP: 61 - South @ 23 MPH</p>	<p>Wed, 30-Jan-2013 2:38 PM 74° F - mostly cloudy - RH: 63% - DP: 61 - South @ 23 MPH</p>	<p>Wed, 30-Jan-2013 2:48 PM 74° F - mostly cloudy - RH: 63%</p>

### Time Series

Wed, 30-Jan-2013 2:48 PM  
74° F - mostly cloudy - RH: 63% - DP: 61 - South @ 23 MPH

1/96

Frames: Time Changing: 18 min - Speed: 1 Sec

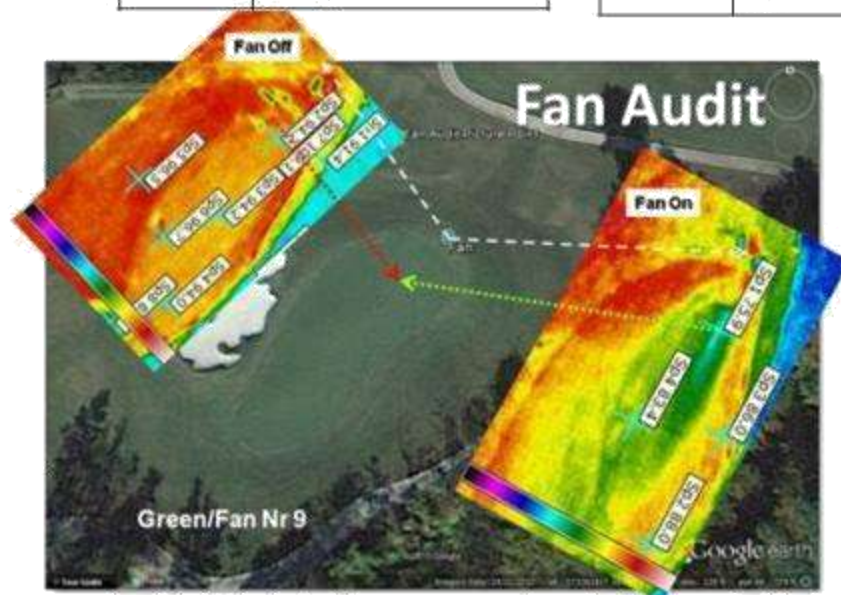
# Turf-Vu® Services

# Positioning and Aiming Fans

Fan Off - Canopy Temperatures	
Time	1110
10min Average Canopy Temp	94° F
Max	96° F
Min	93° F
% Homogeneous	95%
Sky Cover	none
Brightness	4
Notes	Bentgrass is hot

Fan On - Canopy Temperatures	
Time	1140
10min Average Canopy Temp	86° F
Max	88° F
Min	76° F
% Homogeneous	60%
Sky Cover	none
Brightness	4
Notes	Fan cools entire green OK

**Turf-Vu® Fan Audit**  
Prepared for: # 9

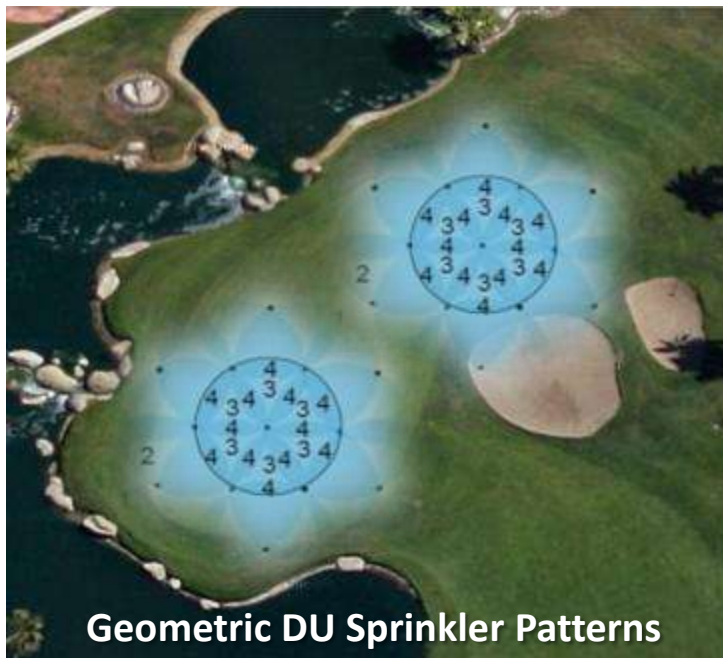


Weather	
Date/Time	14 Aug 13 / 1100
Wind Speed/Direction	light / variable
Air Temperature	87° F
Relative Humidity	68%
Sky Cover	Scattered
Daylight Brightness (1-4)	4
Notes	occasional cloud drifts overhead and slightly decreases brightness to 3



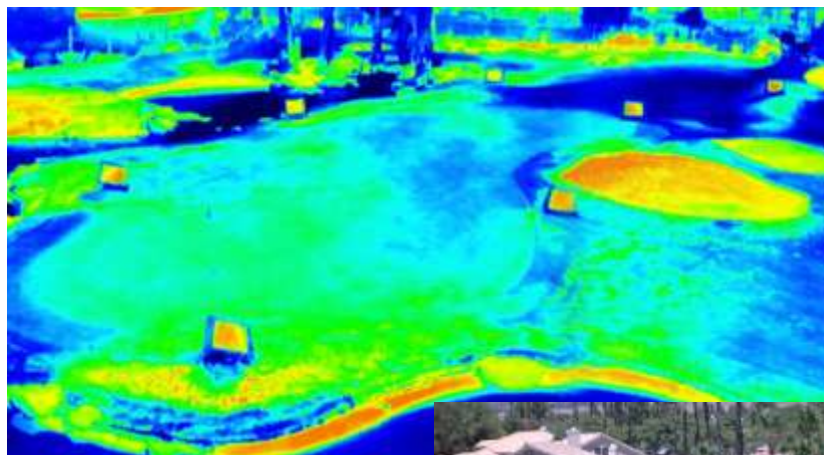
# Turf-Vu® Service

# Irrigation Effectiveness Audit



Geometric DU Sprinkler Patterns

Augmented with



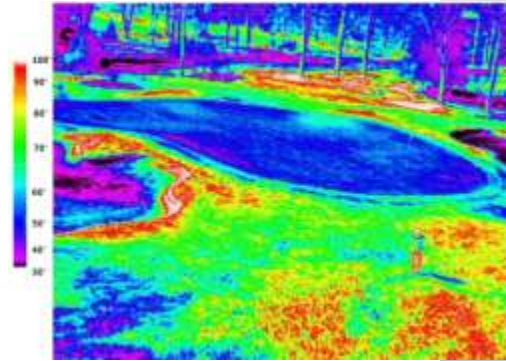
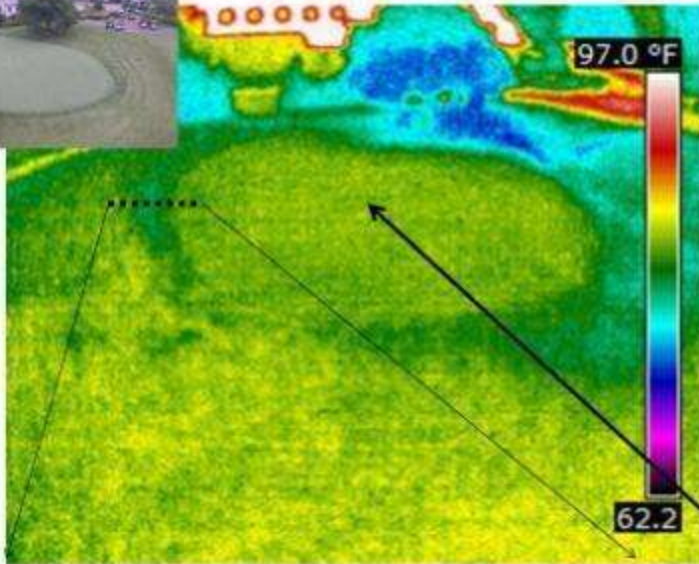
## Seeing What the Turf Says about the Irrigation



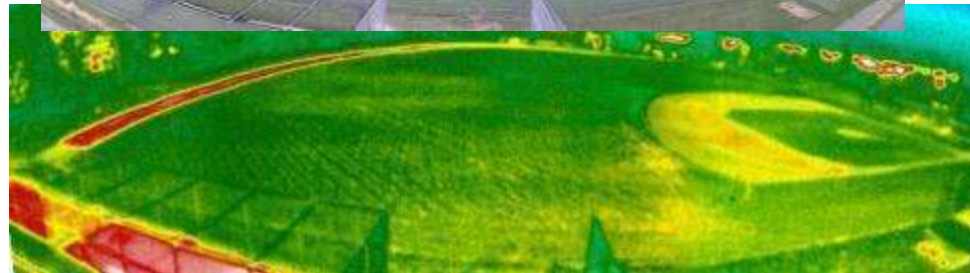
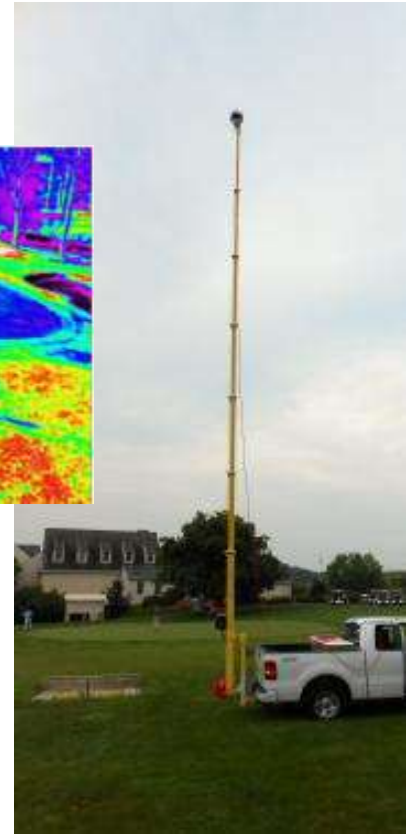
### Putting Water on Effectively

There are no boundaries when enthusiasm and excitement are applied to the task at hand.

# Special Projects and Studies



		29.2	35.5	39.5	27.2	42.4	40.9	28.2	34.6	29.7	29.7	21.8
45.4	34.6	43.6	46.8	55.7	54.7	65.5	63.5	62.1	46.3	40.0	40.5	31.1



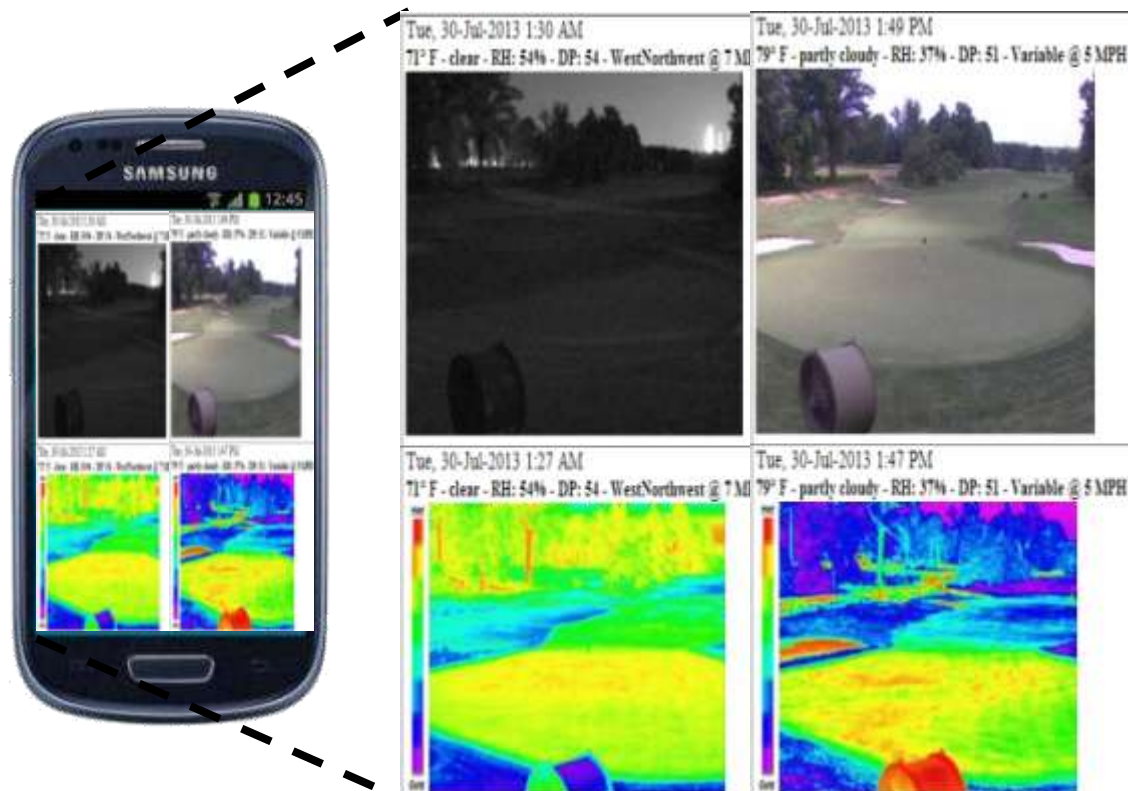


# Turf-Vu® Service

## Stress Monitoring - ID Notices and Alerts

### Text Messages

Persistent area of warmer nighttime and daytime temperatures near right front bunker seen over past several days





# Your On-Line Demo

<http://itricorp.com/hawkeye>

Account: **Greens-Demo**

Password: **guest**

# Client “Stories”

- Fans
  - From one to two fans
  - Stopped fan use at night & during day when not needed (windy & cloudy)
- Water
  - Changed irrigation timing and amounts
  - Improved drainage in specific locations
  - Drove decisions to syringe or irrigate
  - Remodel Irrigation System to improve effectiveness (proof of need to membership)
- Early jump on nematode pressure – spot treatment vs broadcast
- Found and ‘re-routed’ walk-off spots before damage
- Aeration and over seeding to get ahead of thin spot in fairway with change in maintenance traffic pattern
- Prepared scouting and work plan to mitigate summer stresses
- Guided management of other systems (sub-green hydronics) and cultivation practices (topdressing, aeration, amendments)

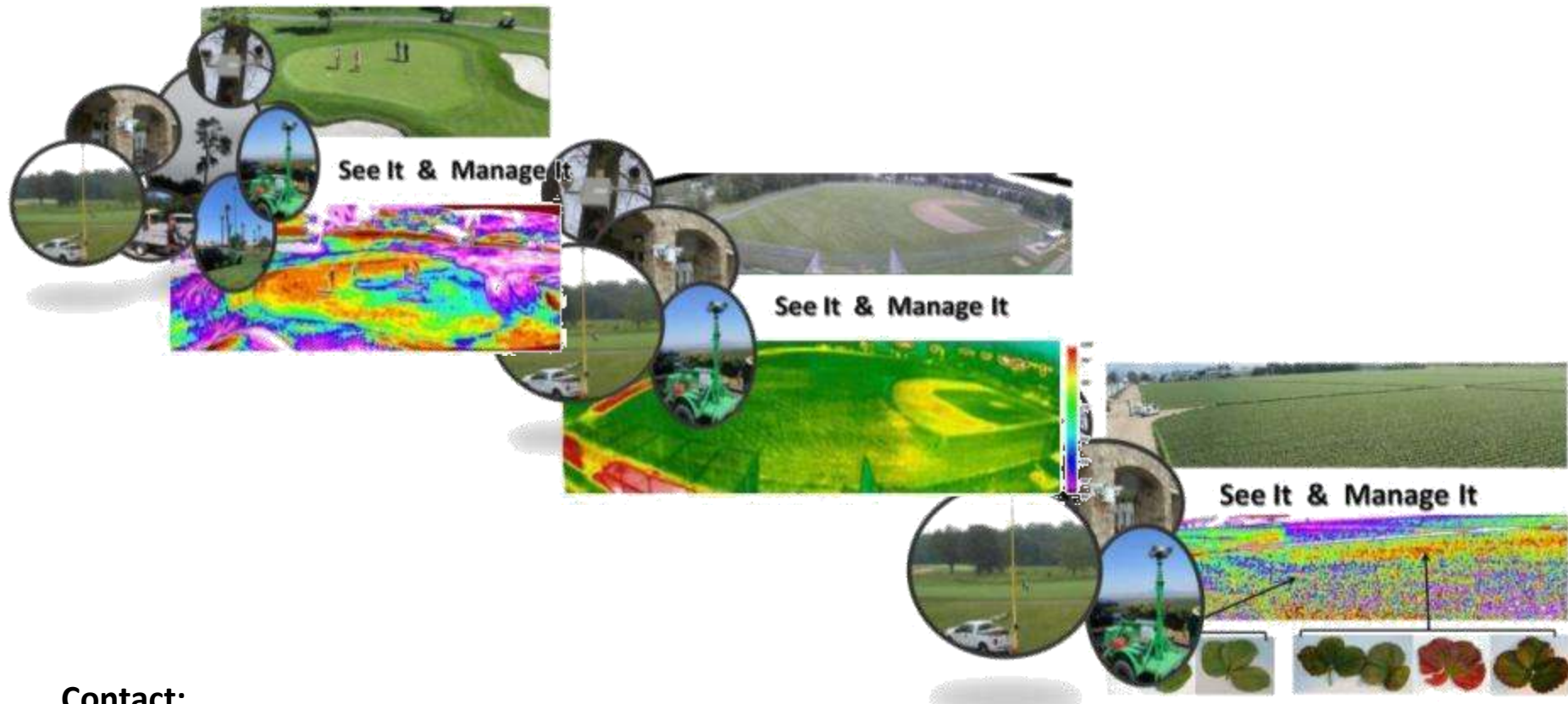
# Selling Hawk-Eye

Sale - Lease - Rent

- **Sale - Lease - Rent**
  - **1, 2, or 3 year Financing Available**  
Partner – Univest Capital
- **Operations & Maintenance Training at Install**
- **Image Analysis Support Available**



# **HAWK-EYE THERMAL IMAGING SYSTEM & SERVICES**



**Contact:**

**Jim Etro**

[jim.etro@itricorp.com](mailto:jim.etro@itricorp.com)

703-489-8507

 **Turf-Vu**<sup>®</sup>  
Beautifully Healthy Turf!  
A Division of ItriCorp - No Boundaries

&

 **Crop-Vu**  
The Future of Crop Management  
A Division of ItriCorp - No Boundaries

are divisions of **ItriCorp**



# Hawk-Eye Price List

@ Hawk-Eye Systems are made to meet your agricultural thermal imaging needs with the geometry and area to be imaged considered when selecting the imager's pixel count and Field of View

Typical Semi-Permanent Hawk-Eye@	\$14,172	Purchase Price Thermal - 320X240 pixels, 28°FOV (Applicable State and Local sales taxes not included) Travel & per diem added when required			
Web Enabled DATA & DB Access Fee	\$160/month				
Hawk-Eye Rental Price	One Week Rental	12 mo*	24 mo*	36 mo*	
Hawk-Eye System w/web&DB	\$ 960	\$ 1,460	\$ 850	\$ 662	
Hawk-Eye System Analysis Notices&Alerts		\$ 3,460	\$ 2,850	\$ 2,662	
Installation and Training (1 Day)	\$ 1,165 + travel and per diem				

\* 12, 24, & 36 month rental to own prices are estimates. Actual rates are subject to the terms and conditions of [Univest Capital](#)

Typical Pan/Tilt Hawk-Eye@	\$ 23,325	Purchase Price Thermal - 320X240 pixels, 28°FOV (Applicable State and Local sales taxes not included) Travel & per diem added when required			
With Mobile/Trailer	\$ 43,564				
Rental Hawk-Eye w/trailer	One Week Rental	12 mo*	24 mo*	36 mo*	
	\$ 2,900	\$ 4,100/mo	\$ 2,300/mo	\$ 1,700/mo	
Installation and Training (1 Day)	\$ 1,165 + travel and per diem				

# Services Price List

## Turf-Vu<sup>®</sup> Services

<b>Irrigation Auditing</b>	<b>\$ 5,500 for up two holes</b> Additional holes = TBD + travel and perdiem
<b>Fan Auditing</b>	<b>\$ 250/Green</b> + travel and perdiem
<b>Special Studies</b> <b>Image Analysis and Interpretation Support</b>	<b>\$145/hour</b> + travel and perdiem (if needed)