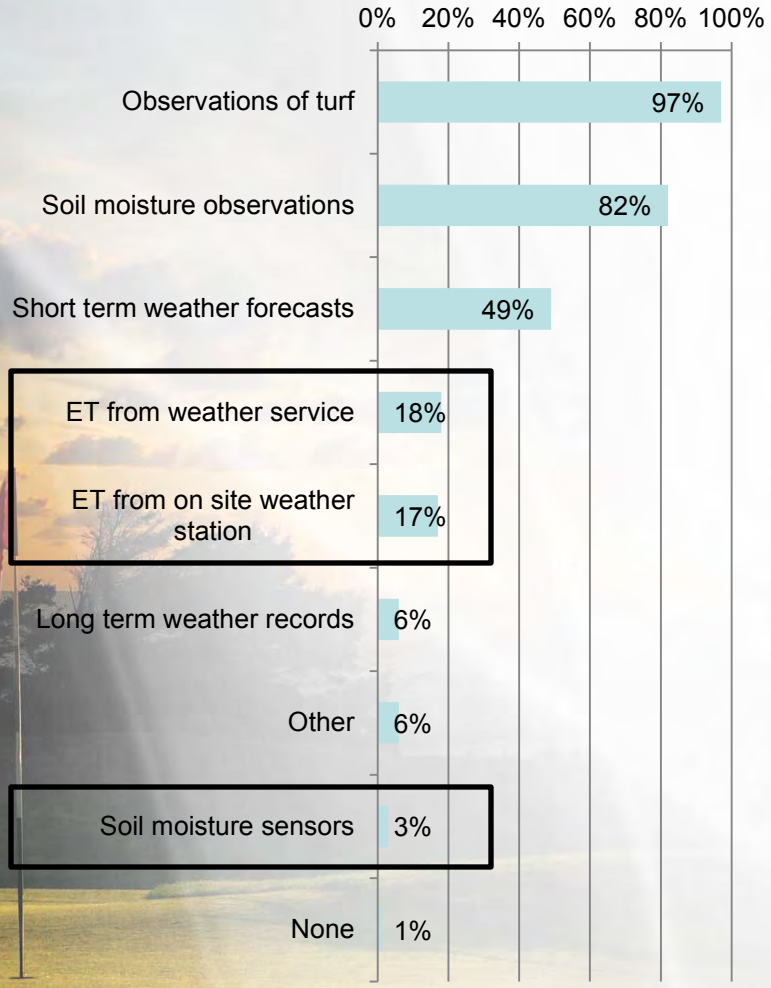
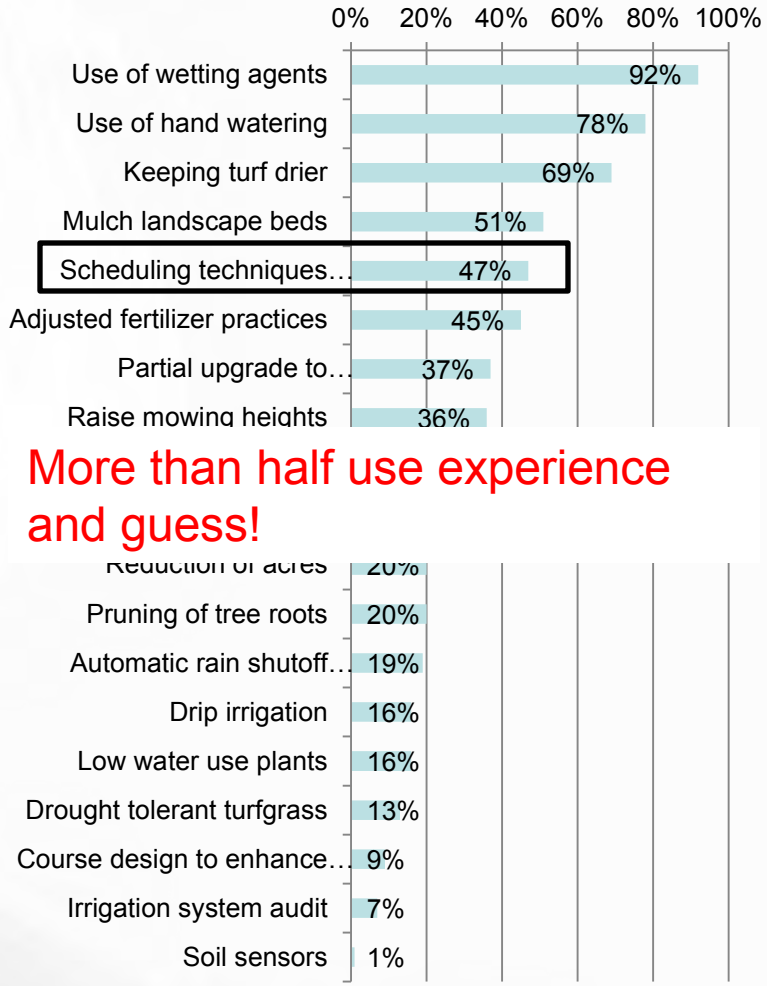
Shifting Watering Decisions from Art to Science

Dana R. Lonn, PE
Managing Director CATT
The Toro Company

Water Use and Conservation Practices on US Golf Courses



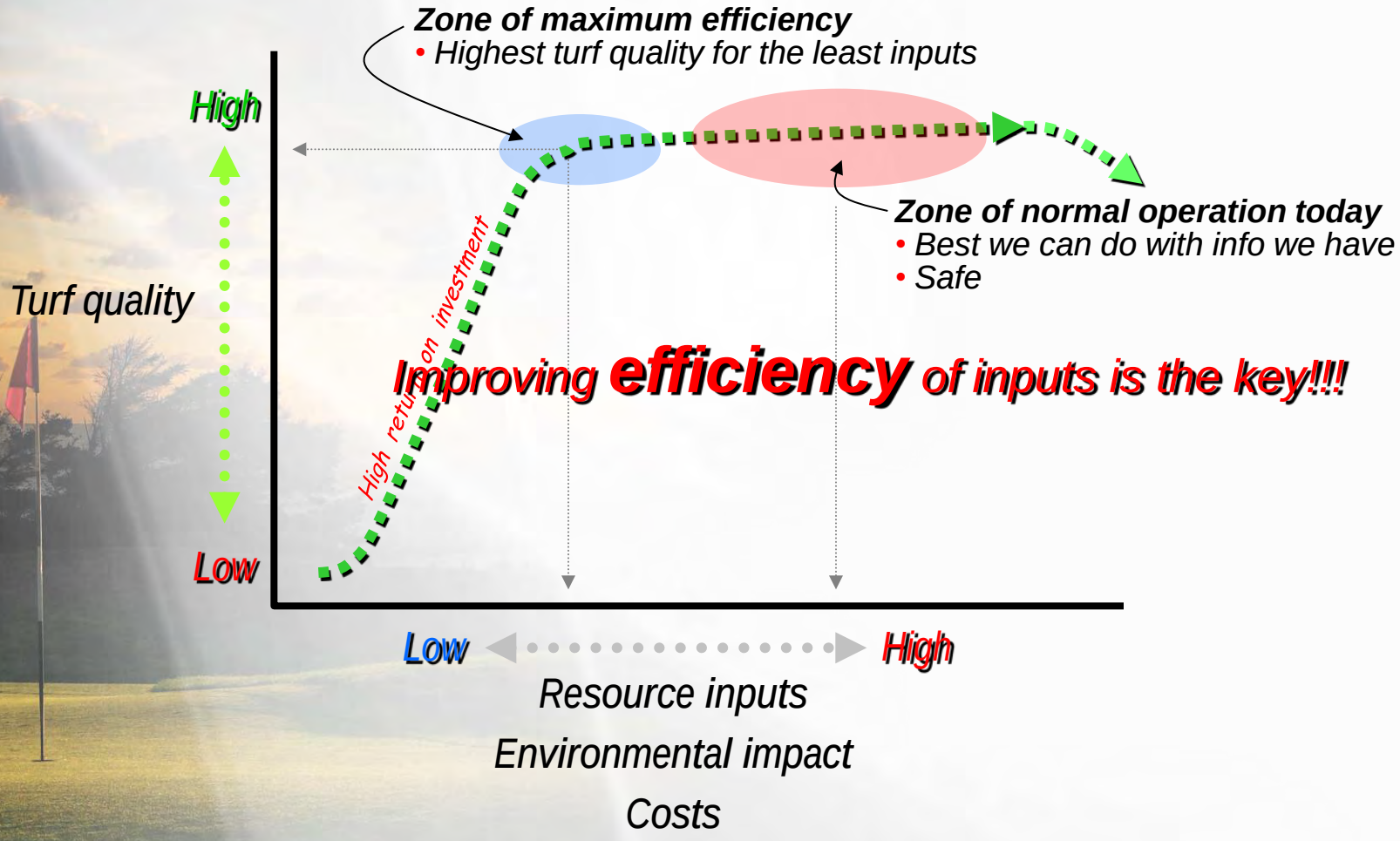


More than half use experience and guess!

Less than 40% use any technology to aid scheduling!

Source: GCSAA Golf Course Environmental Profile Volume II
URL: http://www.eifg.org

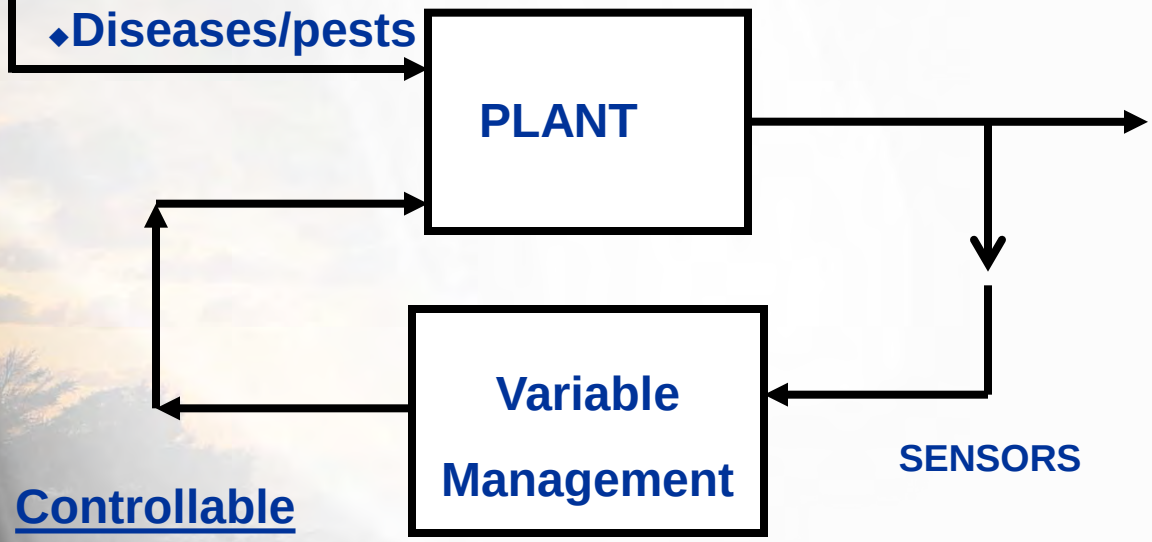
Turf Quality vs. Inputs



Precision Turf Management

Un-Controllable

- Weather
- Soil Type
- Diseases/pests



Optimization Goals

- Water Conservation
- Plant Health
- Playable Surface
- Color

Controllable

- Water
- Nutrients
- Compaction
- Hybrids
- Mowing
- Dethatching
- Pesticides
- Fungicides

Precision Turf Management

*The precise application of inputs based on **site needs**:*
Applying inputs only where they're needed, in the right amounts and at the right time to produce a high quality product.

Efficiency *requires*

- *Water use*
- *Fertilizers*
- *Fuel*
- *Chemicals*
- *Labor*
- *Equipment*
- *Operating budgets*

Precision *requires*

- *Precise application & management of all inputs*

Information *requires*

- *Critical agronomic site conditions*
- ***Equipment** performance*

Sensors & GIS

- *Soil Properties*
  - *Moisture*
  - *Compaction*
  - *Fertility*
  - *Salinity*
- *Turf Performance/Quality*
- *Topography/Relief*
- *Weather*
- *GPS*

Site-specific Irrigation Management
Site-specific Fertility Management
Site-specific Pest Control
Site-specific Cultivation

Complex problem:

Agronomics of water use - ***where, when, how much ???***
- soil conditions • topography • weather • species • season

Technologies - sensors
- sensitivity • reliability • practicality • weather stations

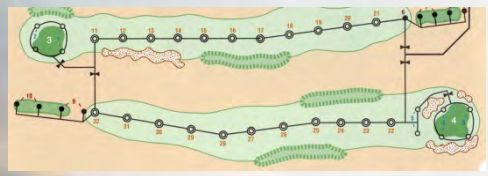
Data interpretation
- diagnostic usefulness

Logistics of data collection
- practicality • GPS/GIS

Data presentation/transfer – visual tools, irrigation control
- usefulness

What is different about these photos?

Trade-offs on the size of the irrigation pixel



Fewer Irrigation Heads = Less Pixels

More Irrigation Heads = More Pixels

- Less Control Points
- Cannot put water where you want it
- Poorer distribution uniformity
- Use more water to provide desired grass health
- Lower installation cost
- Higher operational cost

- More Control Points
- Can put water where you want it
- Improved distribution uniformity
- Optimize use of water
- Higher installation cost
- Lower Operational cost

Data from Soil Sensors

F

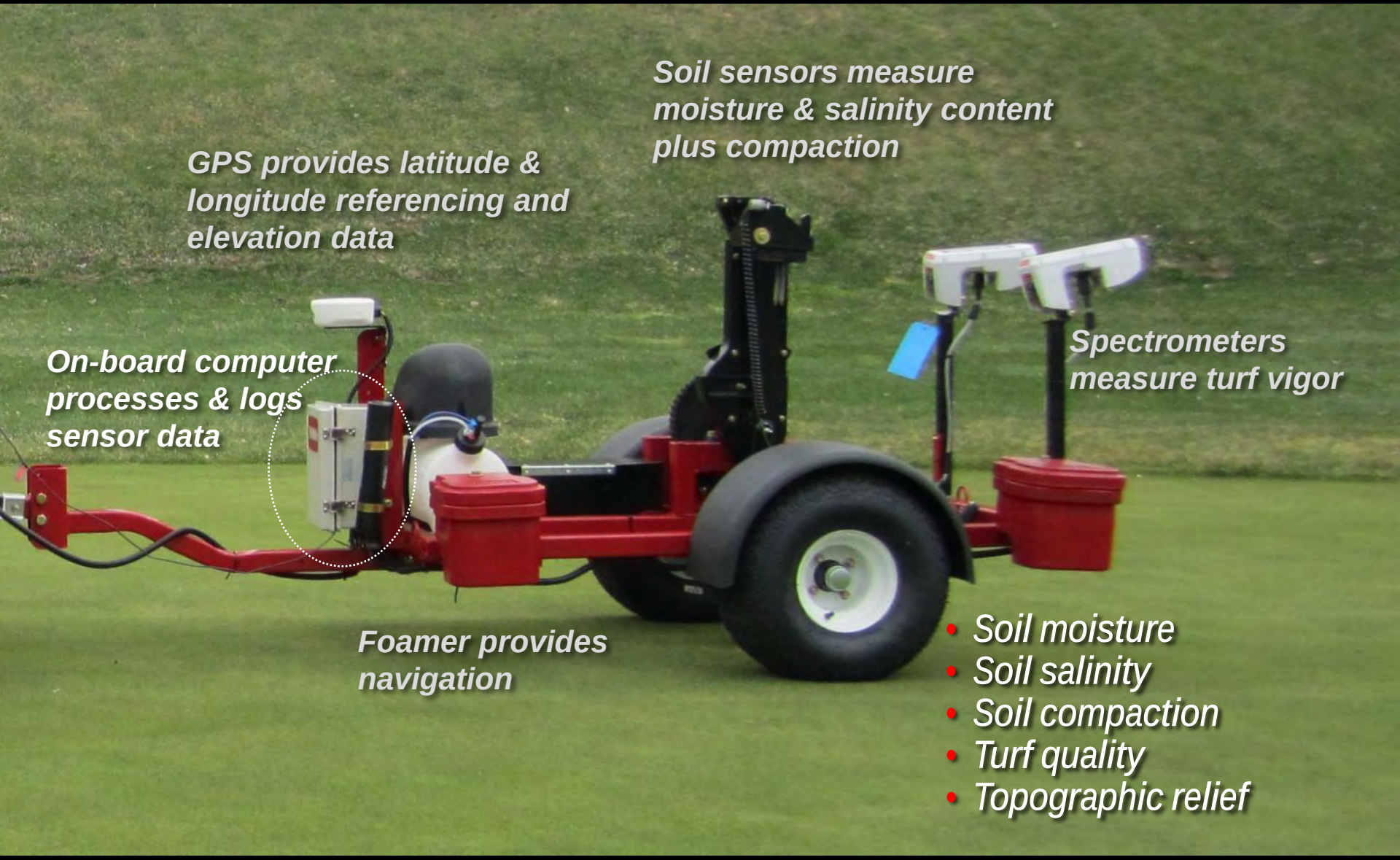
E

H

C

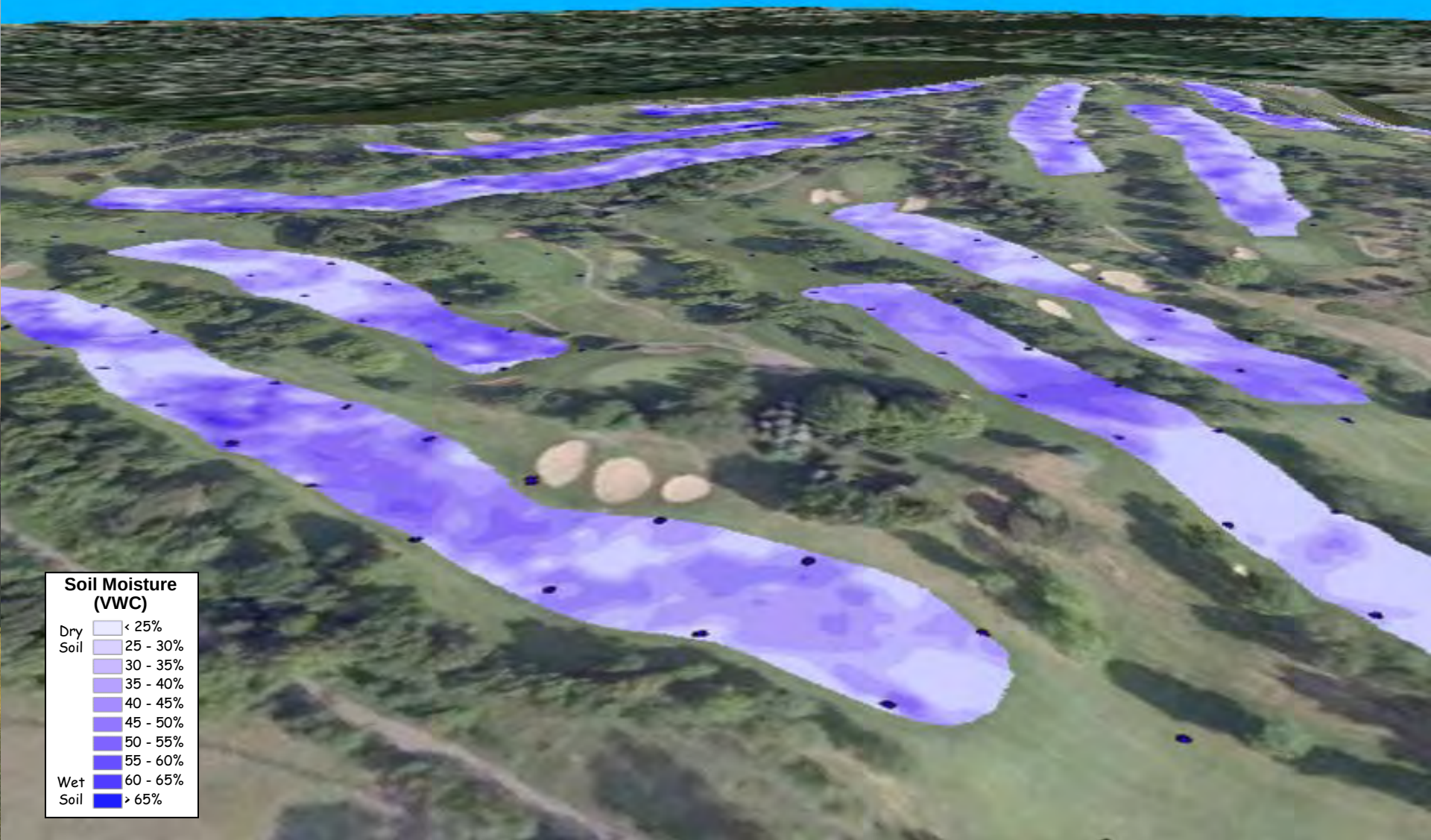
- Allow us to precisely measure soil moisture
- Can calibrate sensors to “empty” and “full”
- Sensors are the most precise method of measuring plant available moisture

“PS 6000” Data Collection Vehicle



Soil moisture variation & Topographic relief

Measured by TDR & GPS elevation

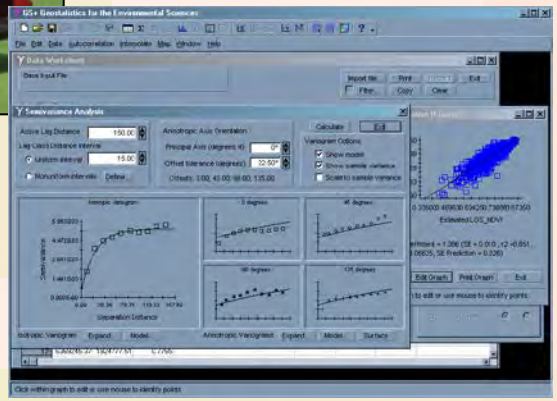


Data collection & analysis process

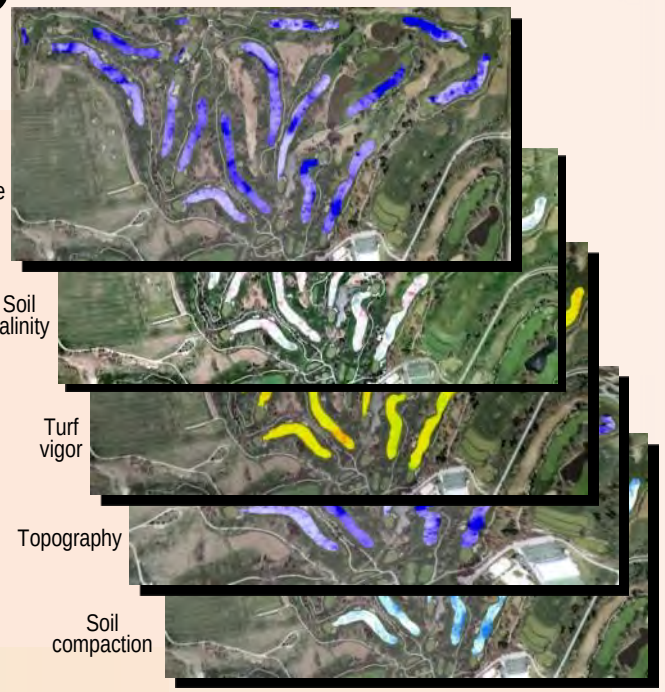
1 Data collection
On-site – Distributor or customer

Data transmitted electronically to Toro

2 GIS ArcView processing & analysis

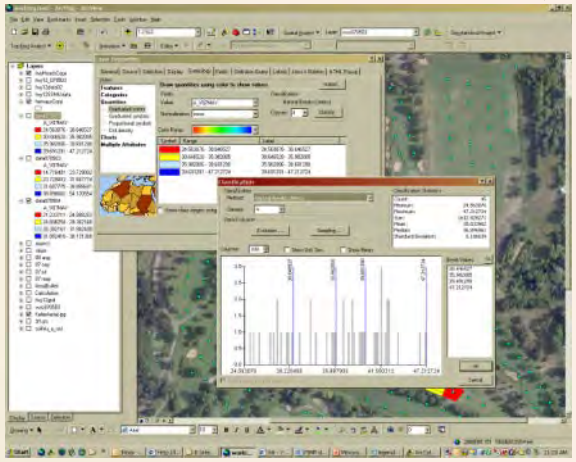


3 Primary Data Products (Google Earth format)



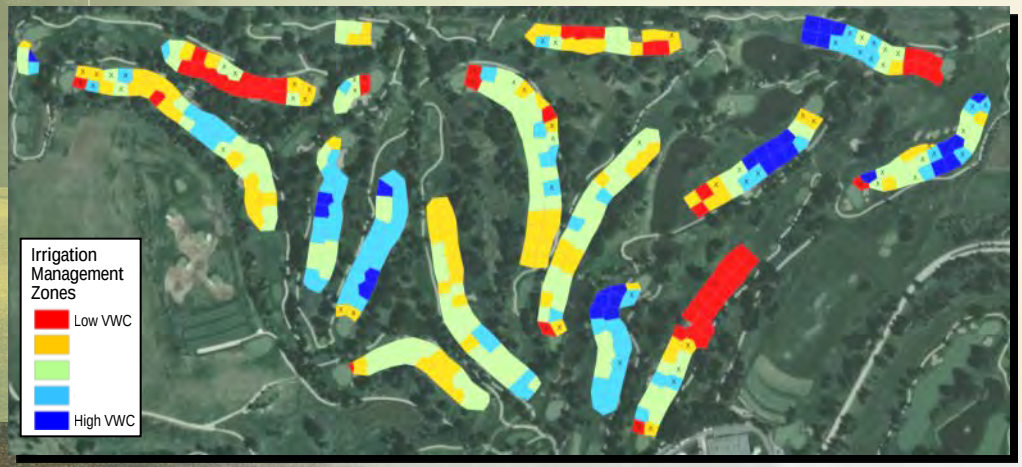
Analysis products delivered to consultant & customer electronically

4 GIS application analysis



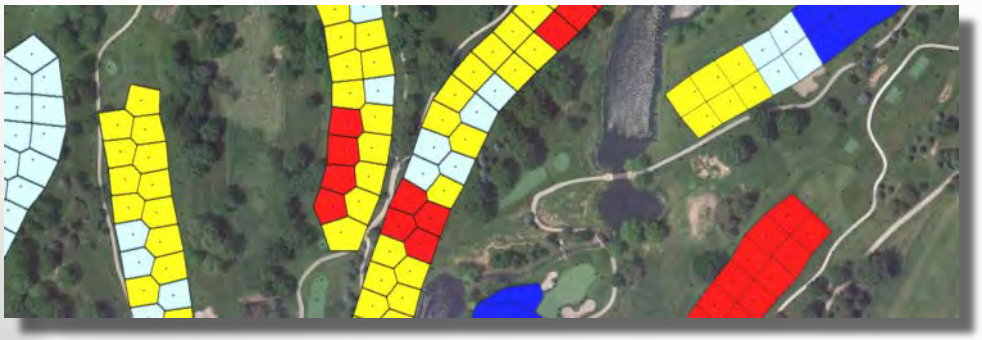
5 Application Data Products & Implementation
On-site – consultant

- *Irrigation management zones defined*
- *Soil moisture sensor placement*
- *Irrigation control customization*

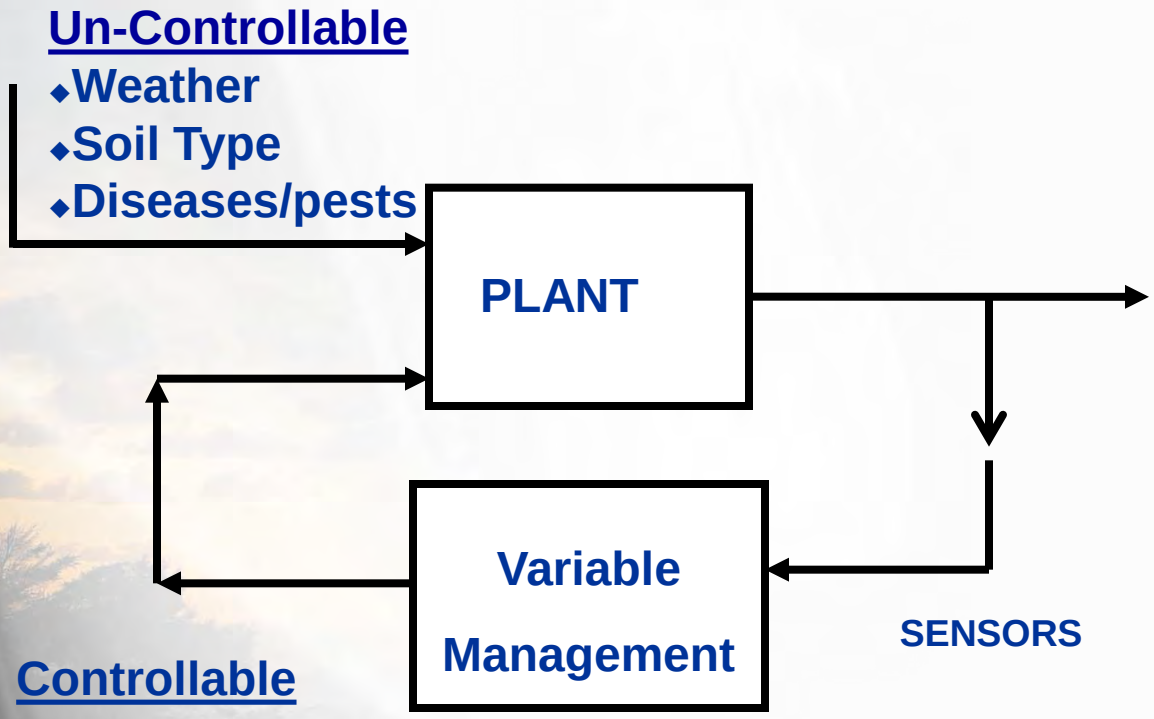


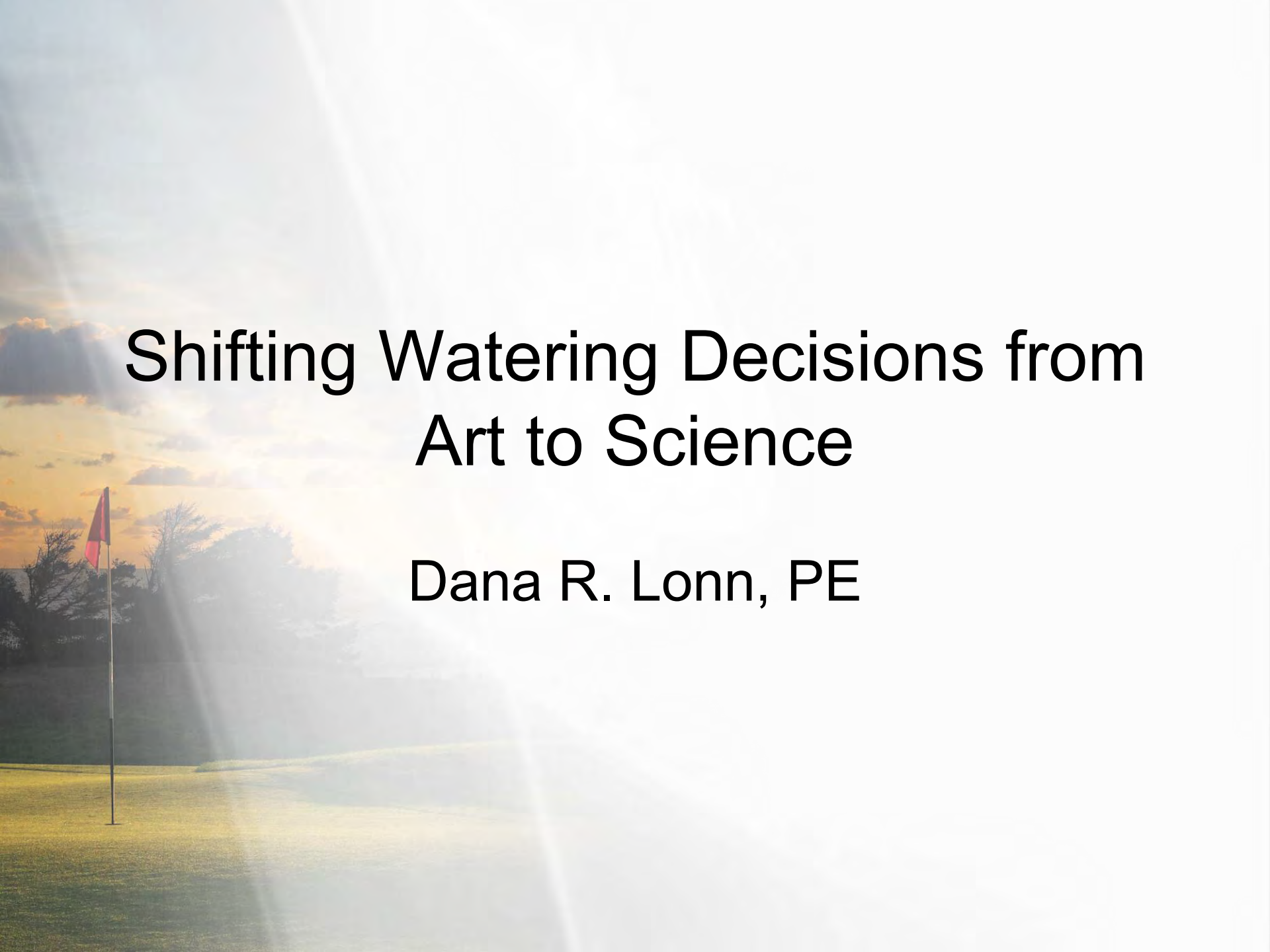
Irrigation Management Zones for Precision Watering

- *Site data is used to define and divide the golf course into distinct "irrigation management zones."*
- *All areas within each zone require similar irrigation treatments because of similar soil & site conditions.*
- *Each sprinkler head is assigned to a management zone. Irrigation is then programmed by zones.*
- *In-ground sensors monitor soil moisture continuously for regular irrigation decision-making.*



Precision Turf Management





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