Soil Moisture Monitoring and Irrigation Scheduling

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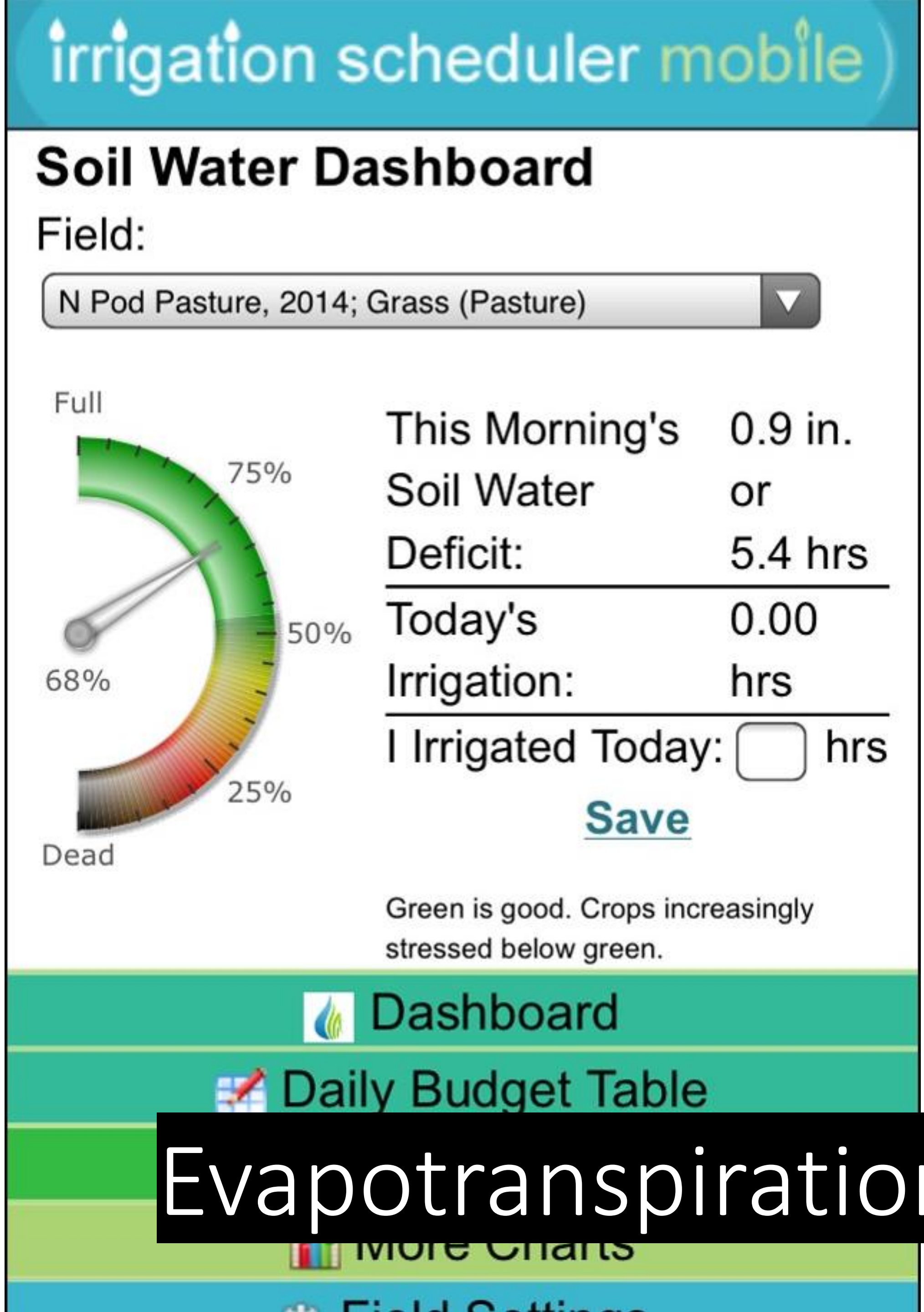
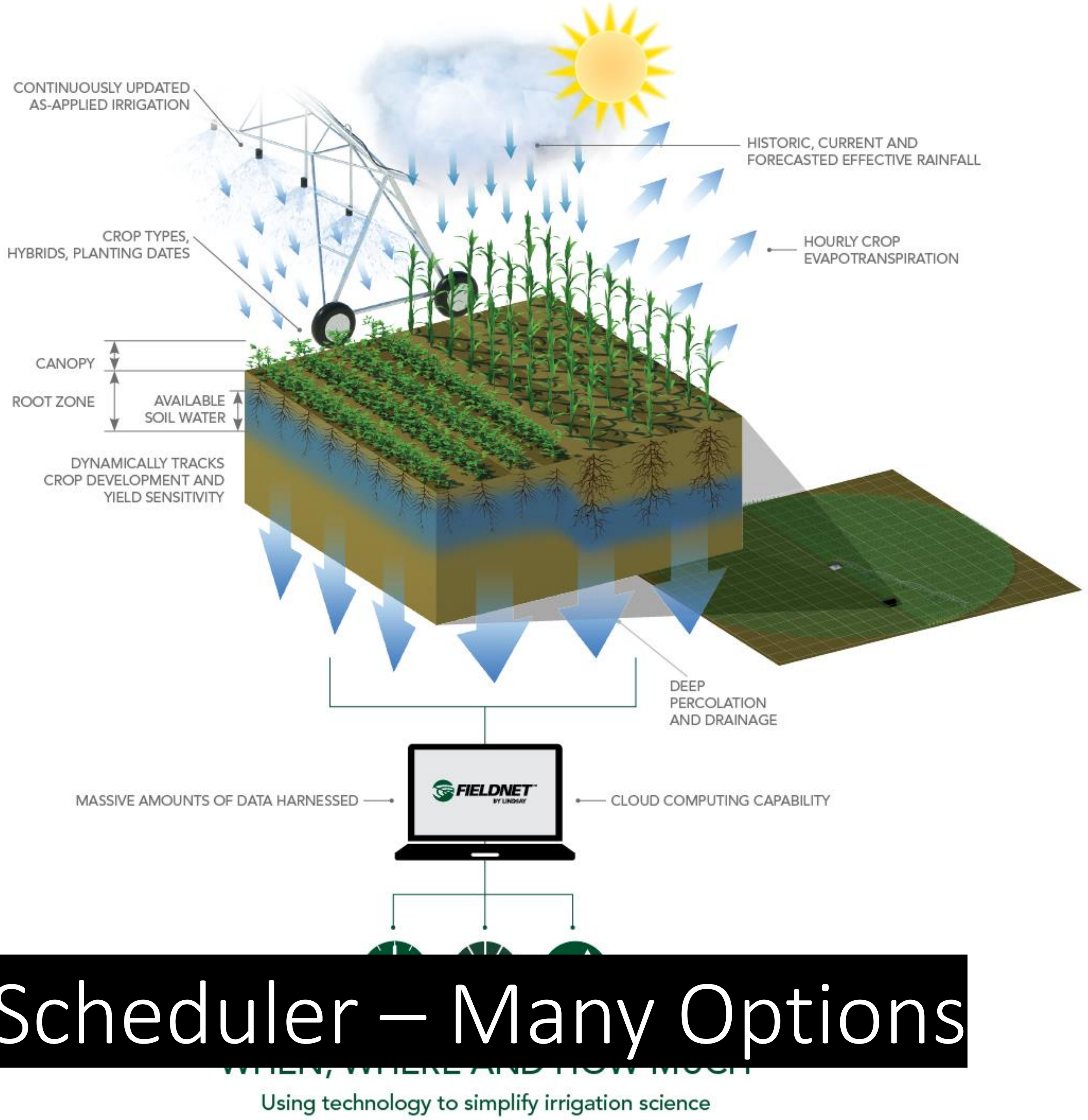
Scheduling Methods

- Predictive Schedule (ET model)
  - Checkbook method using crop water use curves
  - Digital Schedulers – Weather Station
  - Can use weather forecast to predict current status and predict future uses
  - Data relies on accurate application data entry. (garbage in = garbage out)

- Soil Moisture Sensors
  - Analog sensors - Tensiometers, Watermark, etc
  - Digital instruments - TDR, FDR, TDT aka, FieldScout, Sentek, Crop X, etc
  - Essentially a level gauge for field moisture level
  - Expensive and requires regular analysis to determine trends (time consuming)

Evapotranspiration Scheduler – Many Options





Evapotranspiration Scheduler – Many Options

Delaware Irrigation Management System

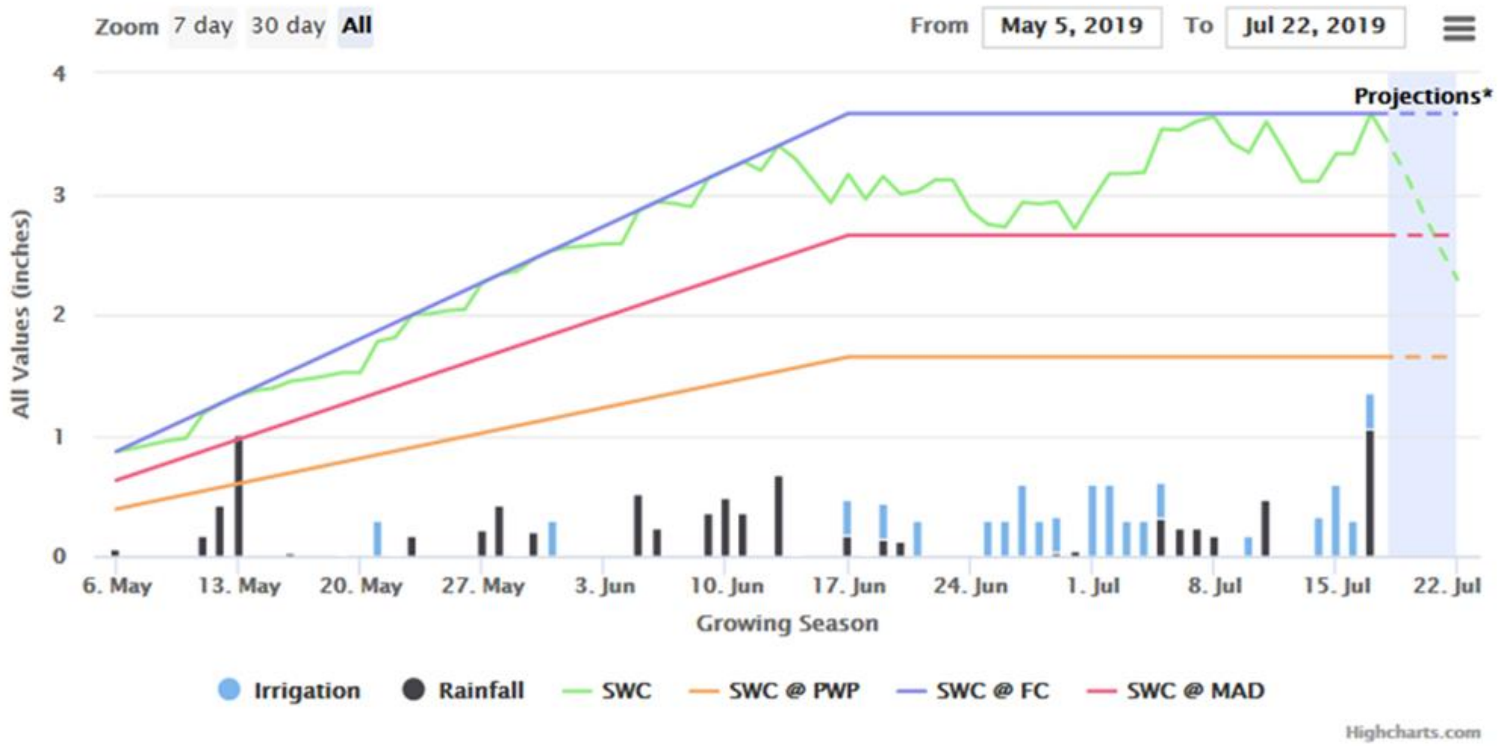
Current View: adkins

Controls

- Field Status
- User Settings
- Enter Data

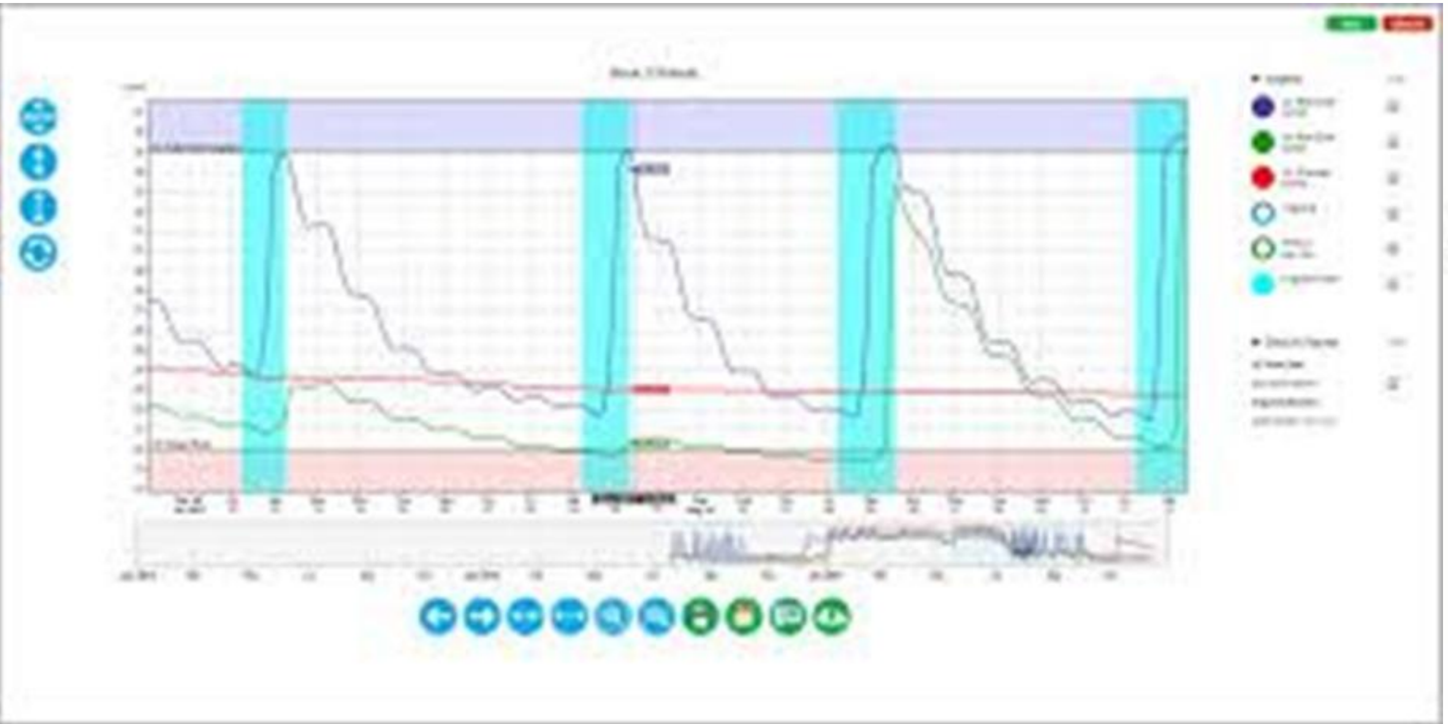
- Add Field
- Replant Field
- Modify Field
- Delete Field

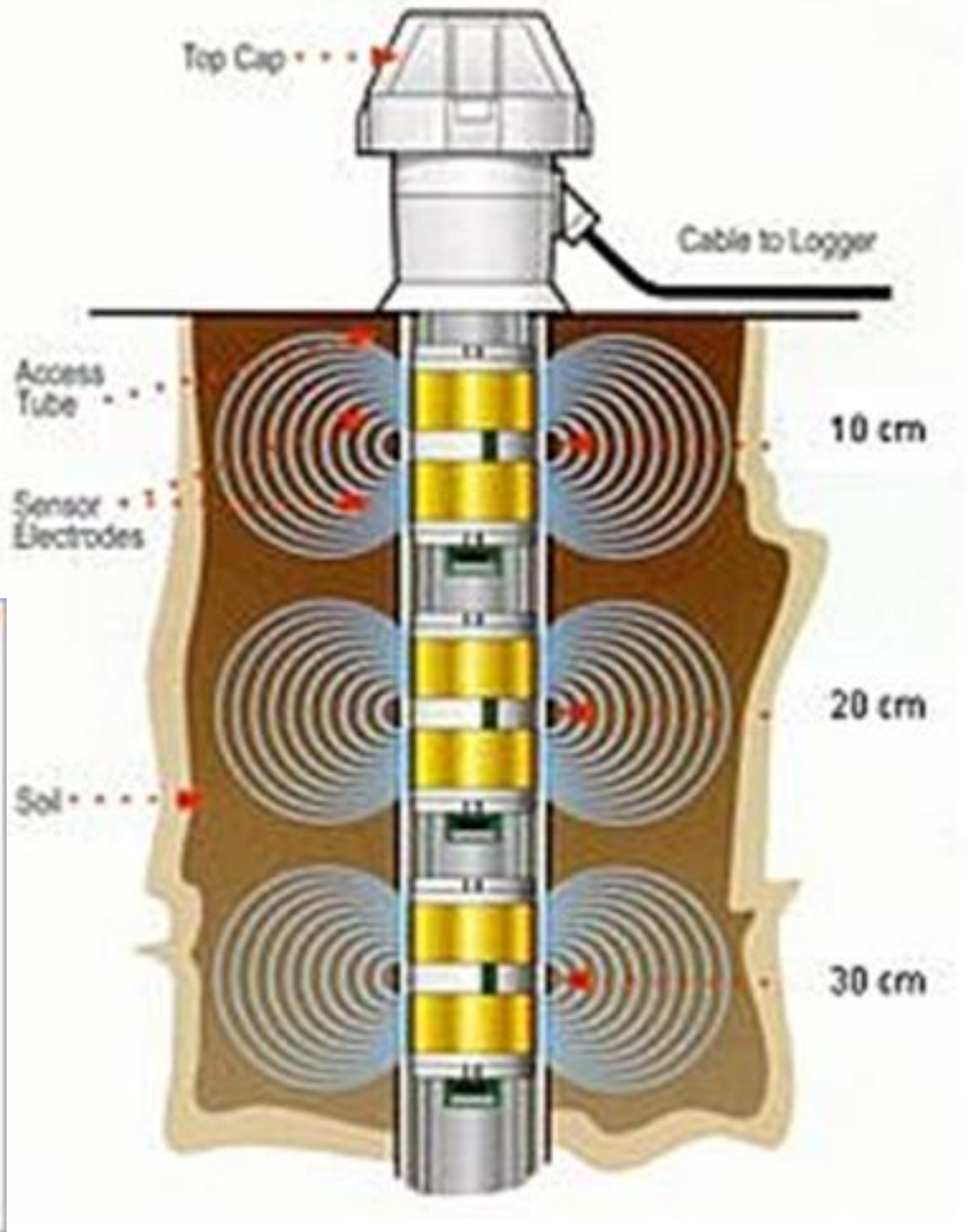
- Logout



Forecast Data	Thursday 7/18	Friday 7/19	Saturday 7/20	Sunday 7/21	Monday 7/22
Chance of Rain	60%	10%	10%	20%	60%
Crop ET*	0.24	0.26	0.32	0.30	0.26
Soil Water Content*	88%	75%	59%	44%	31%

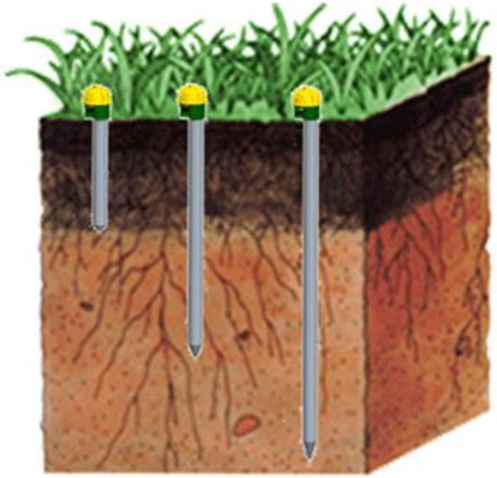
Soil Moisture Sensing






Moisture
Monitor

HydroSense™



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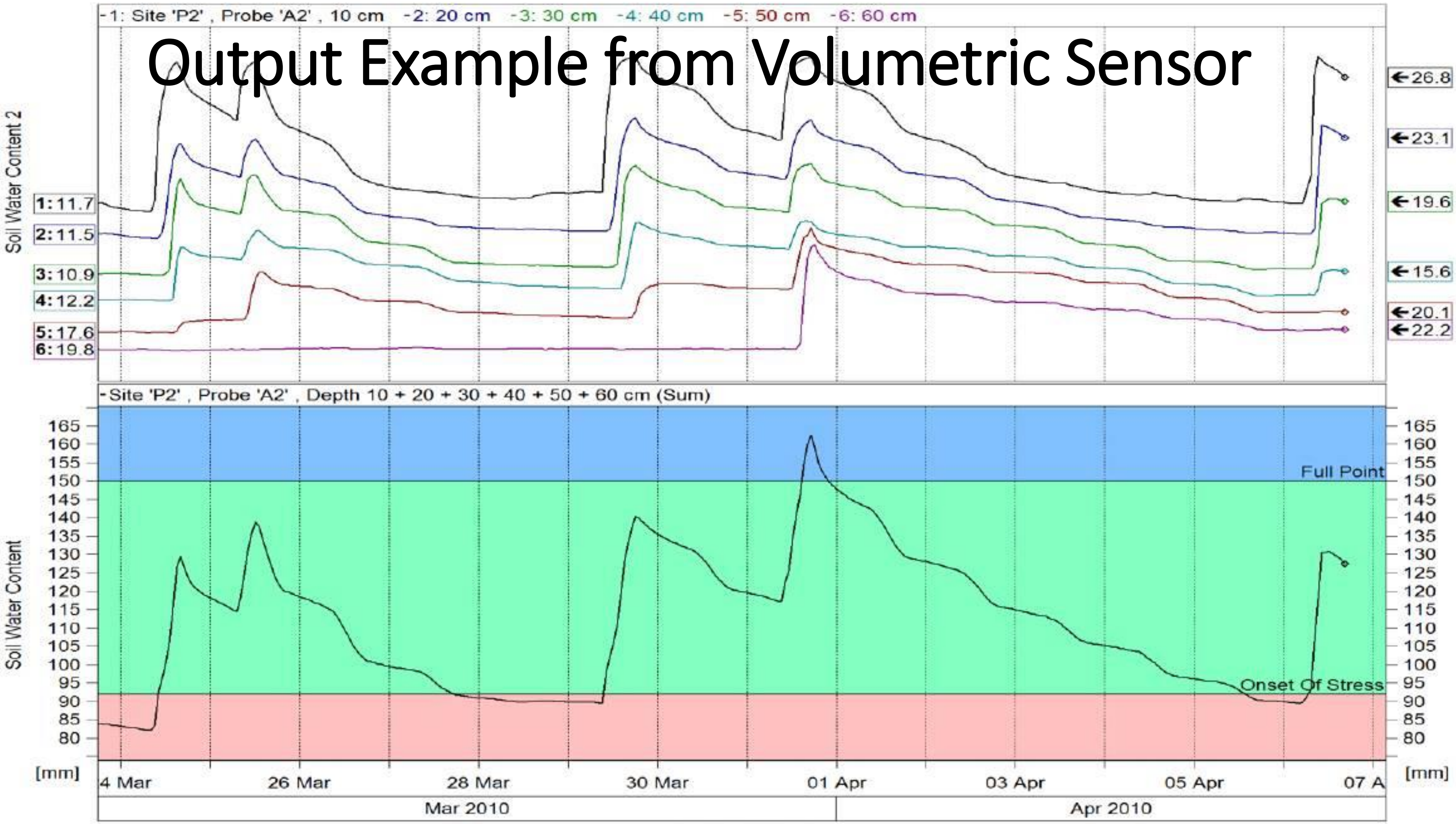
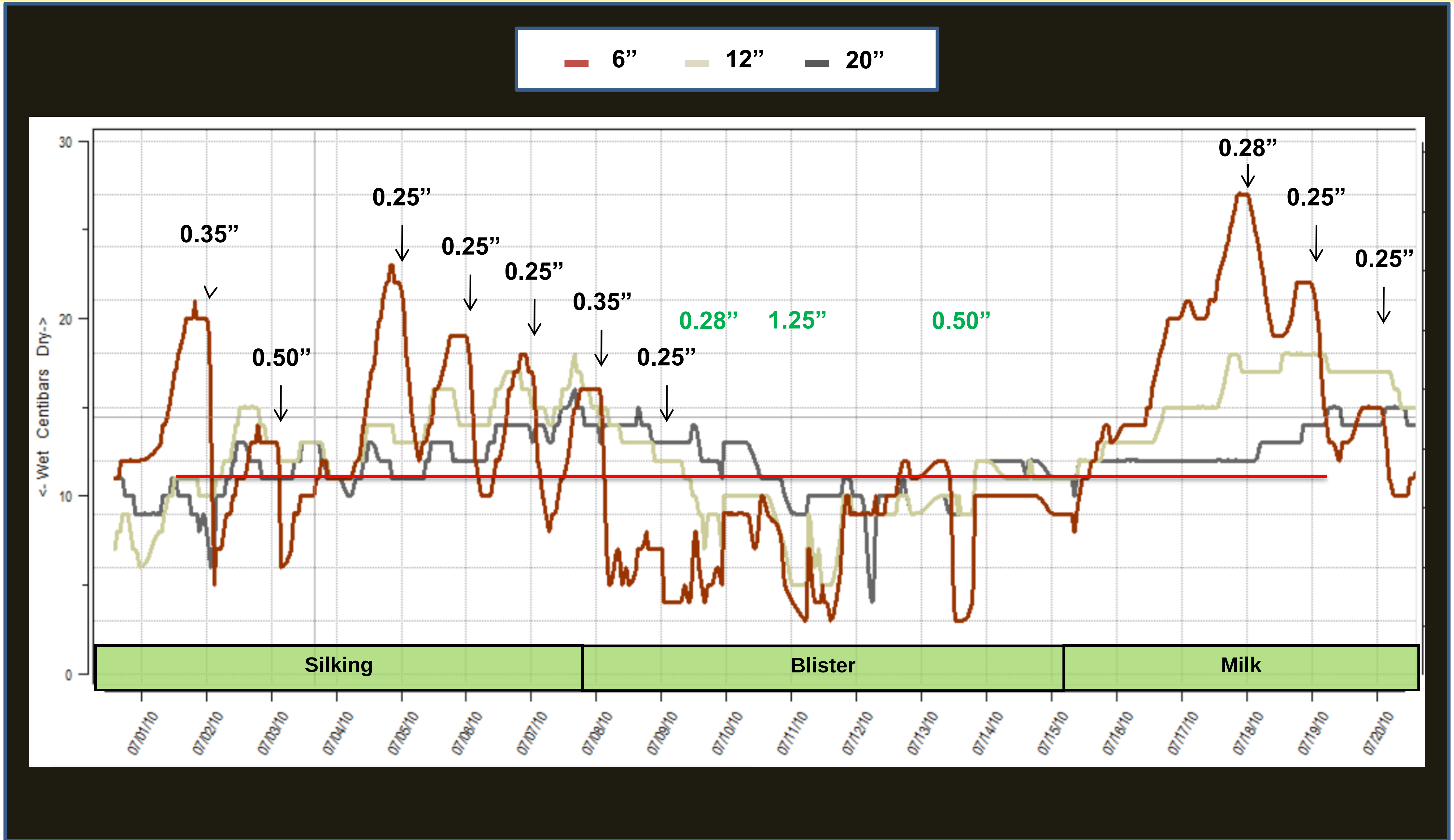
Output Example from Volumetric Sensor



Output Example from Soil Tension Sensor



Challenges

- Predictive Schedule (ET model)
  - **Requires an accurate timer setting chart**
    - 50% of system in DE applying 80% of the irrigation predicted on chart
  - Needs good soil type and growth stage inputs
  - Requires active review to enter irrigation applied

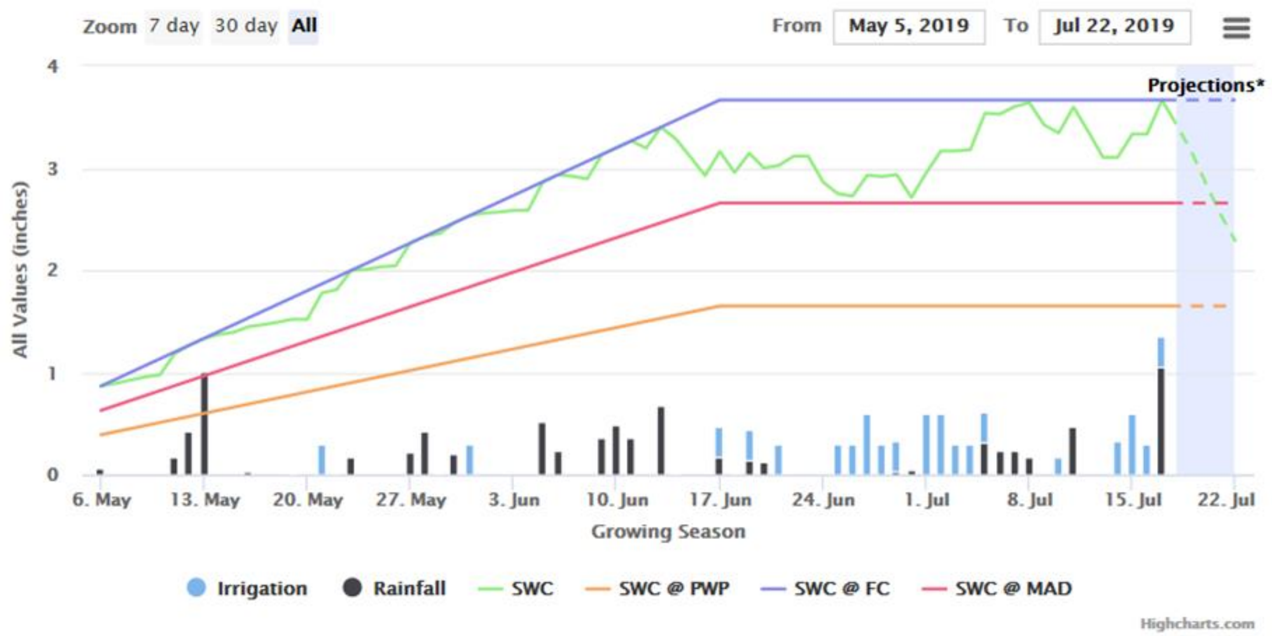
- Soil Moisture Sensors
  - Need multiple sensor stations (3-4) per field to account for soil variability, and system uniformity
  - Need to account for lag time in application
  - Less predictive than ET models
  - Still requires active data review for decision making
  - **DO NOT TRY TO MANAGE MULTIPLE FIELDS WITH 1 PROBE**

Combining Weather Station Data & Sensors

Evapotranspiration Based Scheduling with Sensor Feedback

Date	Crop ET (in)	Rainfall (in)	Irrigation (in)	Soil Water Content (%)	Soil Water Content (in)	Root Zone Deficit (in)
2019/08/27	0.06	0.00	0.00	87.9	3.36	0.24
2019/08/26	0.06	0.00	0.00	90.7	3.42	0.18
2019/08/25	0.09	0.07	0.00	94.0	3.48	0.12
2019/08/24	0.10	0.00	0.00	95.1	3.50	0.10
2019/08/23	0.05	0.70	0.00	100.0	3.60	0.00
2019/08/22	0.14	0.36	0.00	99.7	3.59	0.01
2019/08/21	0.14	0.00	0.00	88.5	3.37	0.23
2019/08/20	0.10	0.01	0.00	95.4	3.51	0.09
2019/08/19	0.13	0.46	0.30	100.0	3.60	0.00
2019/08/18	0.13	0.00	0.00	75.0	3.11	0.49
2019/08/17	0.13	0.00	0.00	81.6	3.24	0.36
2019/08/16	0.13	0.00	0.00	88.0	3.36	0.24
2019/08/15	0.11	0.00	0.00	94.6	3.49	0.11
2019/08/14	0.11	0.71	0.00	100.0	3.60	0.00
2019/08/13	0.09	0.77	0.30	100.0	3.60	0.00
2019/08/12	0.16	0.00	0.30	62.9	2.87	0.73
2019/08/11	0.17	0.00	0.00	59.0	2.79	0.81

Delaware Irrigation Management System



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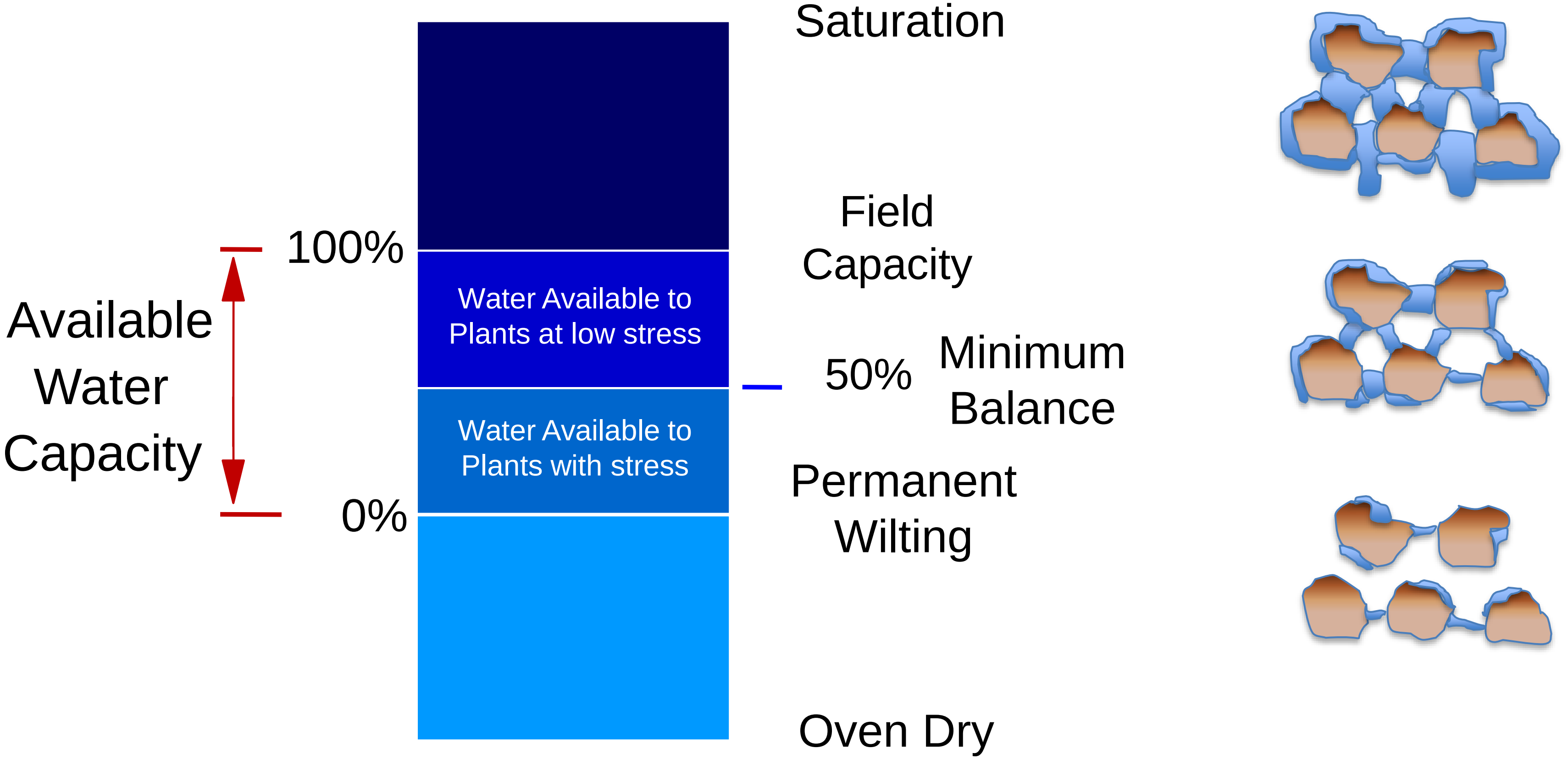
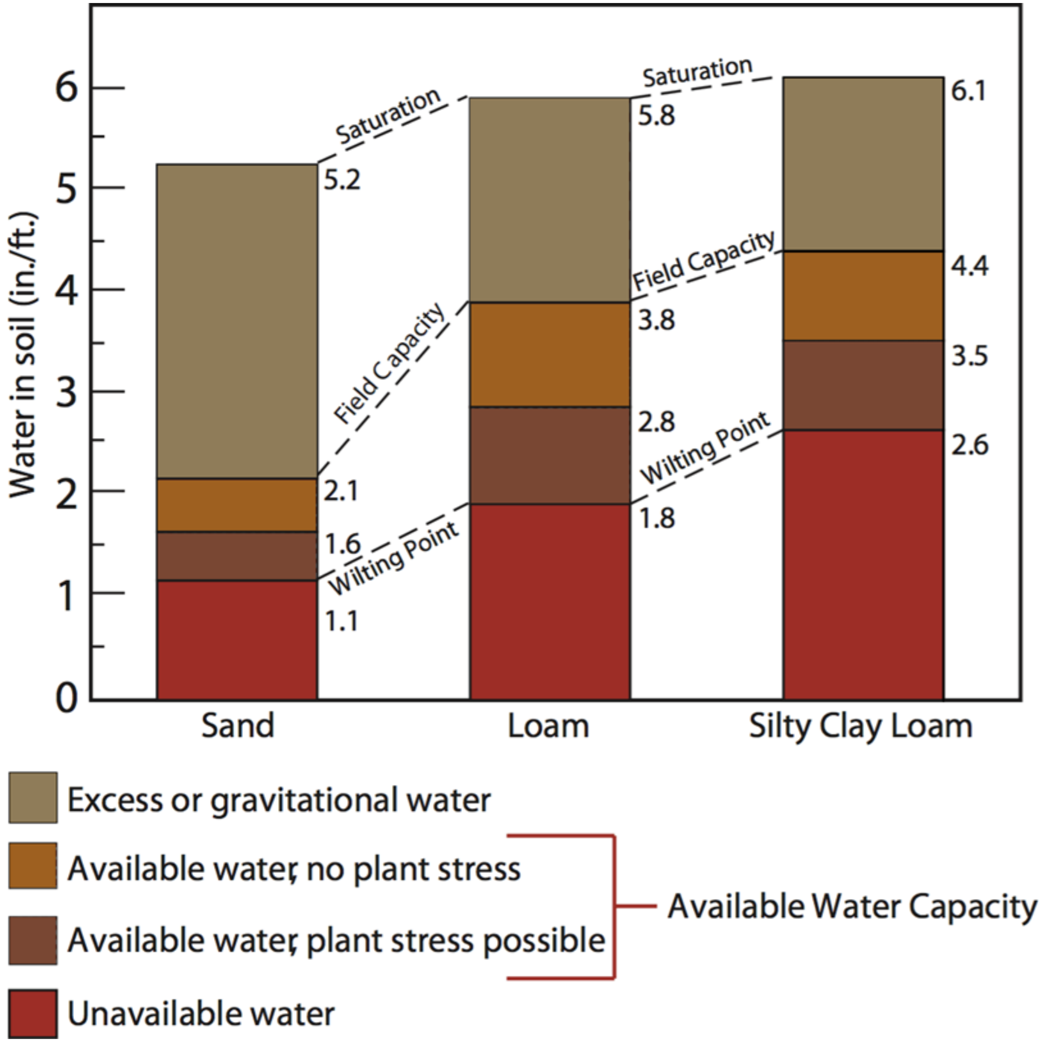
Understanding Soil Moisture Holding Capacity is Important to Determine When and How Much to Apply

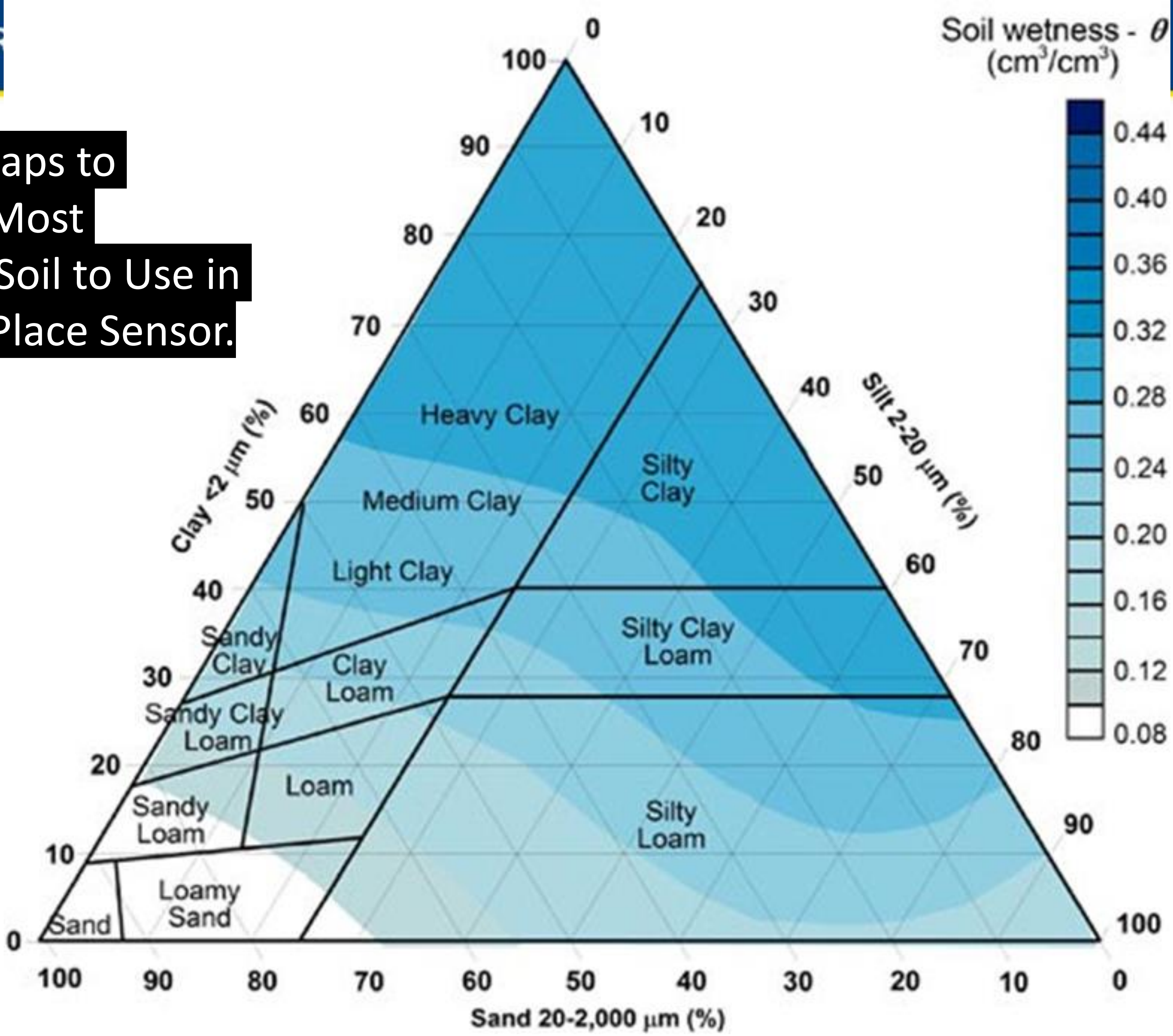
Soil Water Reservoir



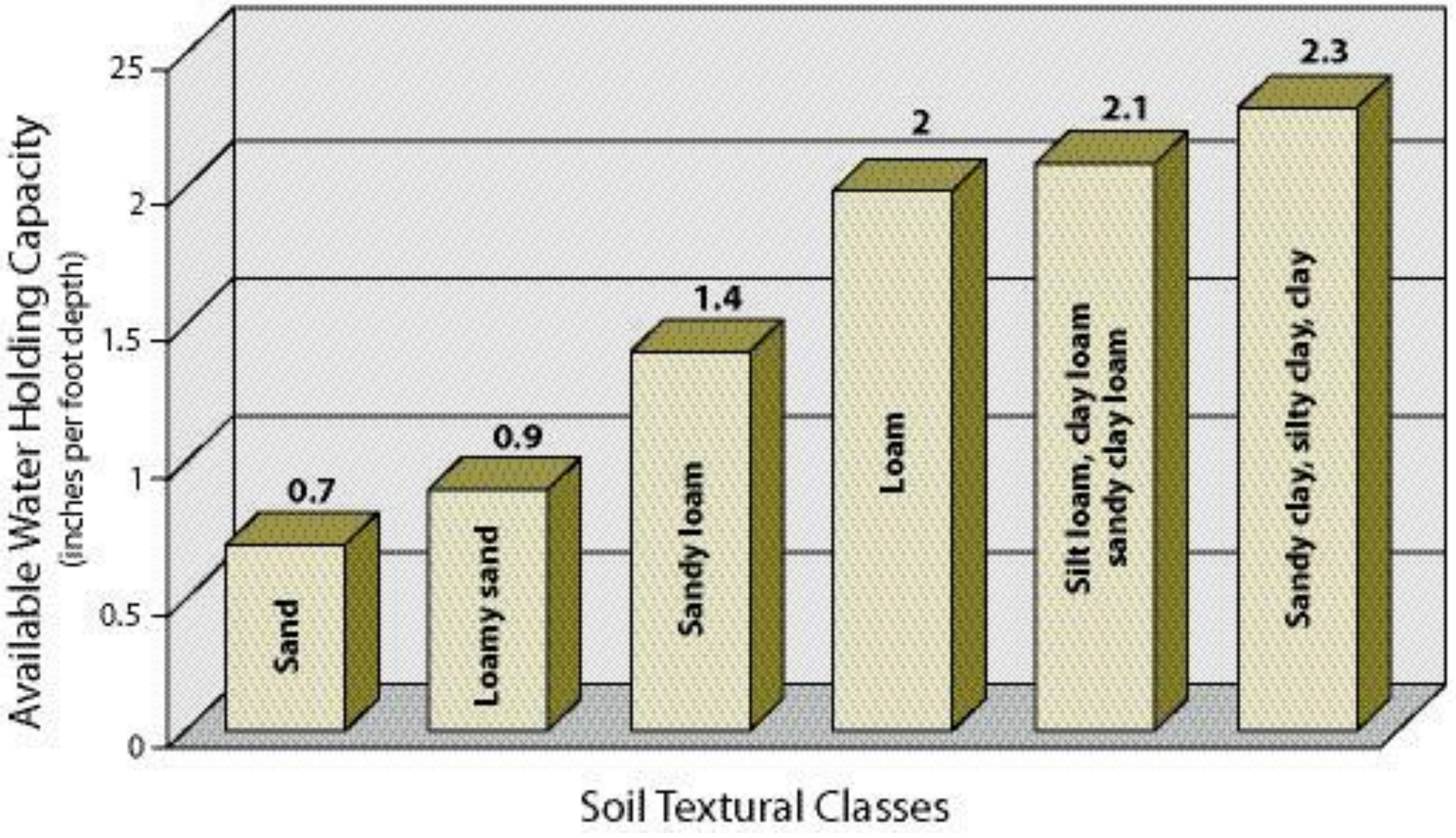
Water-Holding Capacity of Soil
Effect of Soil Texture



Use Field Soil Maps to Determine the Most Representative Soil to Use in ET model or to Place Sensor.



The Ability to Store Water is Highly Dependent on Soil Type



Available Water Holding Capacity Based on Soil Texture

Soil Texture		Available Water Holding Capacity (inch of water / inch of soil)
Coarse Sand		0.02 - 0.06
Fine Sand		0.04 - 0.09
Loamy Sand	**(0.09 x 18”) = 1.44”**	0.06 - 0.12
Sandy Loam	**(0.13 x 18”) = 2.34”**	0.11 - 0.15
Loam and Silt Loam	**(0.2 x 18”) = 3.6”**	0.17 - 0.23

Soil Intake Rates

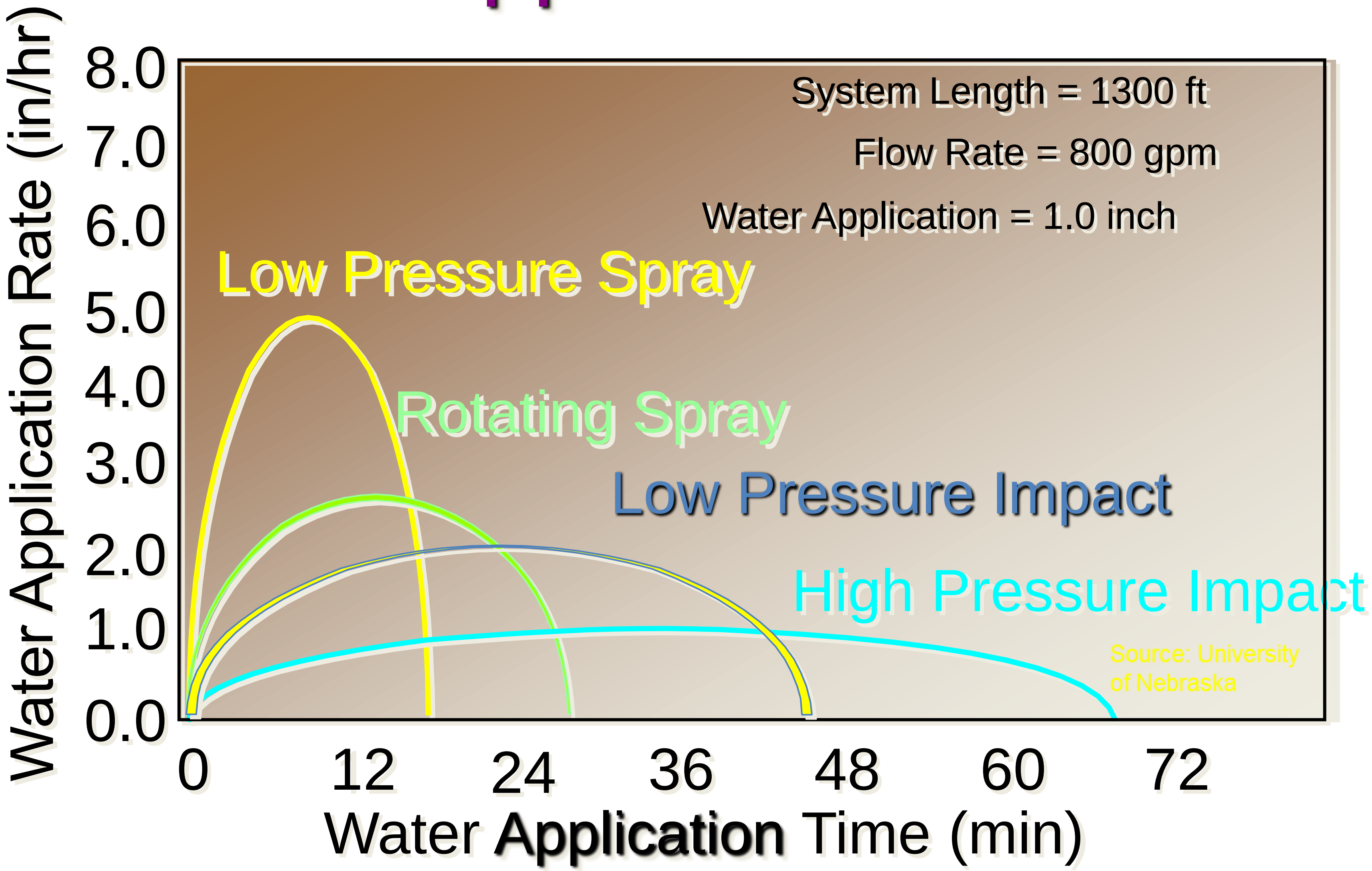
Affected by:

- Soil Type
- Tillage
- Residue
- Crusting
- Organic Matter
- Plant Structure

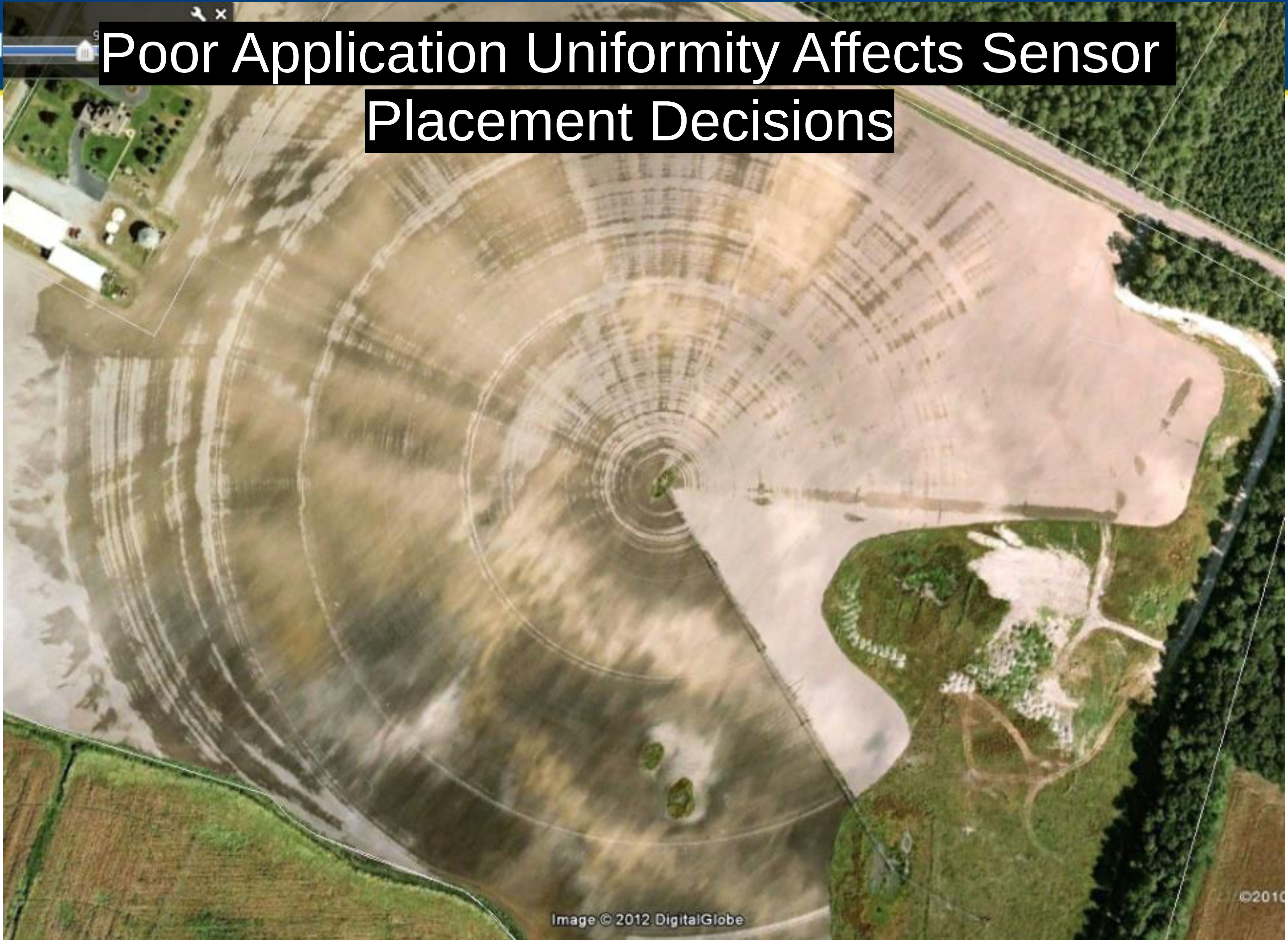
Basic Intake Rates for Bare Soils*	
Sand	0.6
Loamy Sand	0.5
Sandy Loam	0.4
Loam	0.35
Clay Loam	0.2
Silty Clay	0.15
Clay	0.1
* Units are inches per hour	

Irrigation Rates Should be Lower than Soil Intake Rate to Ensure Irrigation Stays on Target Area

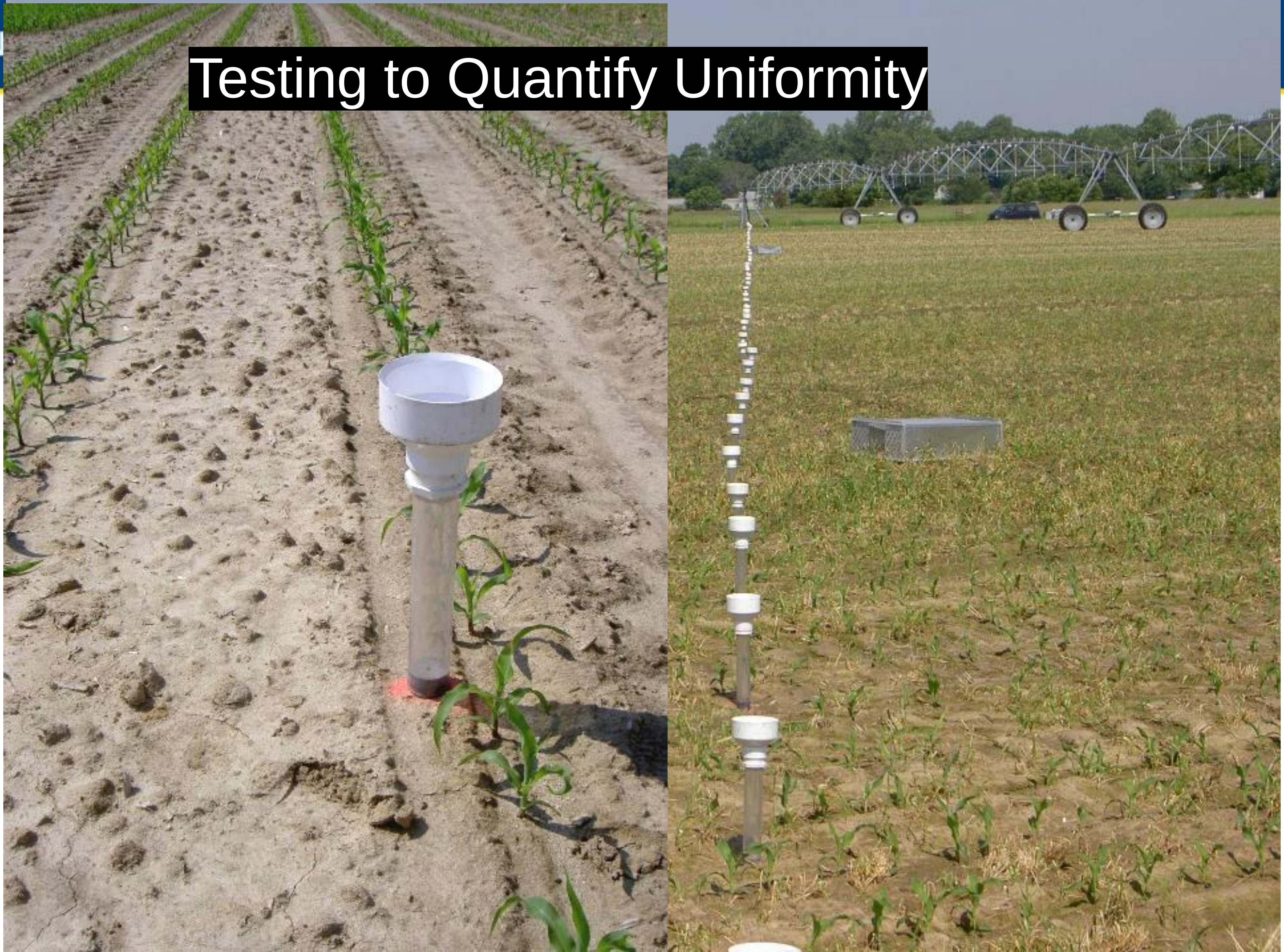
Peak Application Rates



Poor Application Uniformity Affects Sensor Placement Decisions



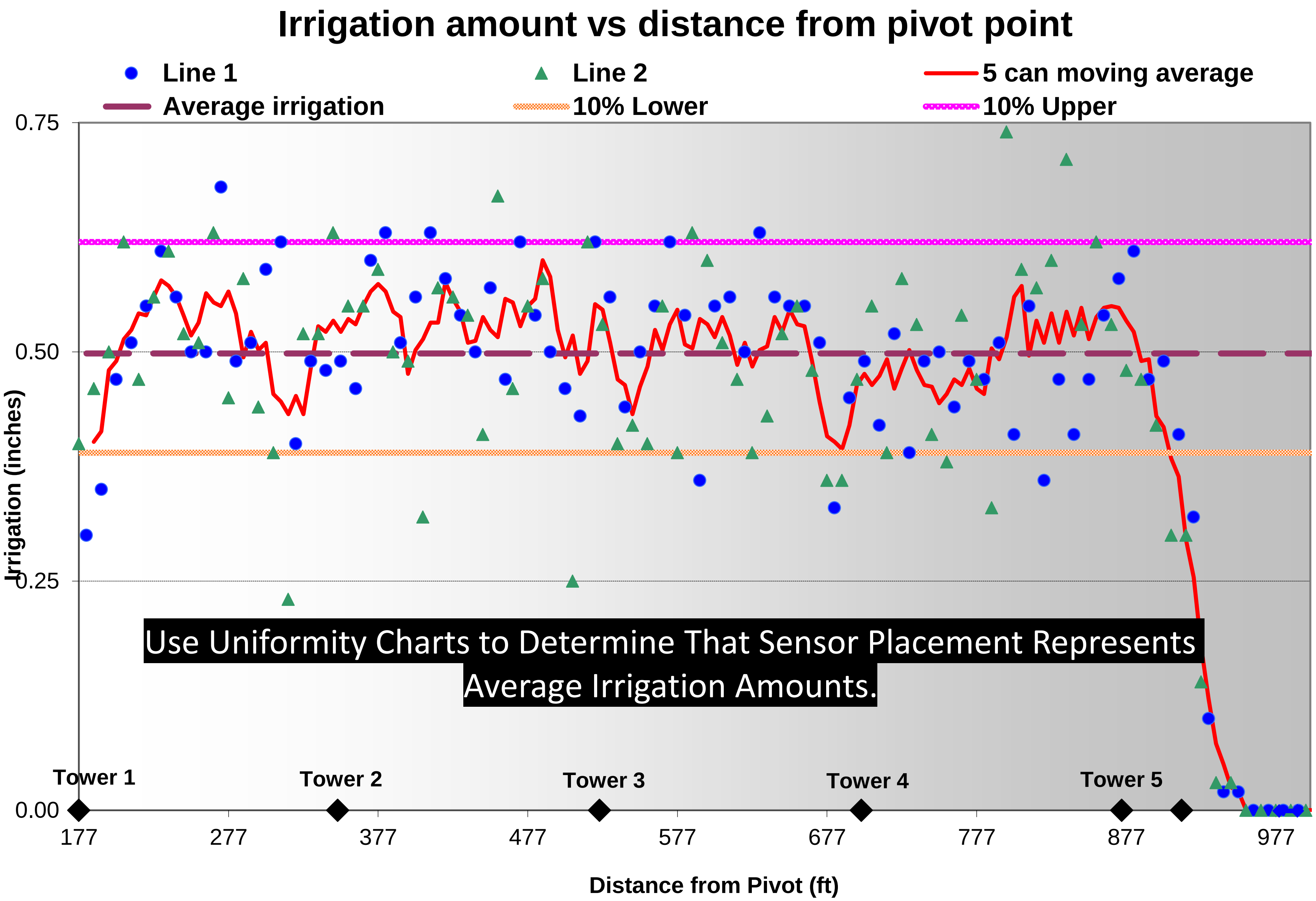
Testing to Quantify Uniformity



Testing to Quantify Uniformity

Average Application Uniformity

Across 903 DE Center Pivots = 83% Avg CU



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