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METHODOLOGIES TO IDENTIFY OVER-IRRIGATION IN LANDSCAPES AND INCREASE REBATE PROGRAM EFFECTIVENESS

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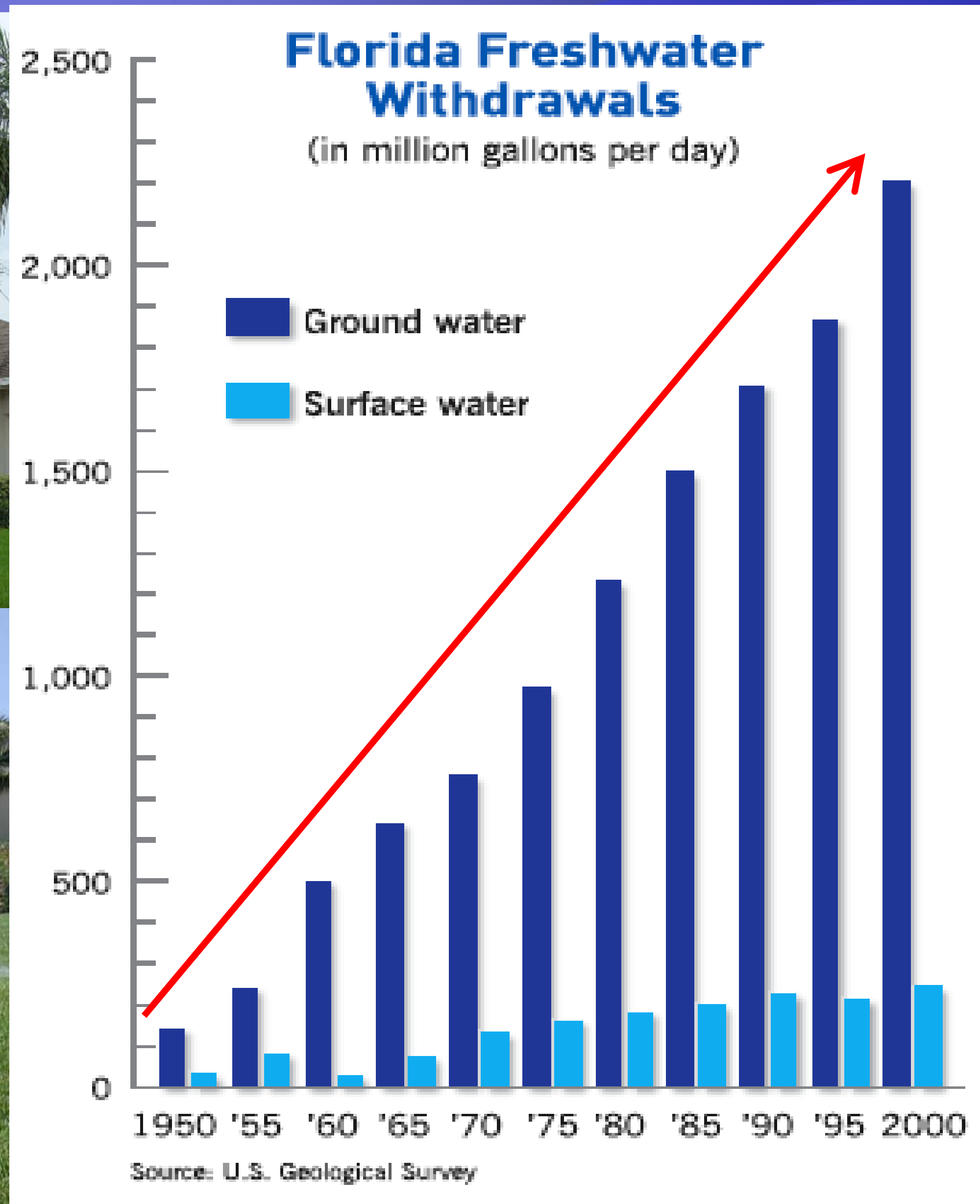
Irrigation is a Standard "Appliance"



Smart Irrigation Controller Irrigation Reduction *Potential*

Method	Location	Irrigation Savings	Weather	Funding agency
Rain sensor	Plots in Gainesville	34%	Normal to rainy	SWFWMD
		15%	Dry	
Soil moisture sensor control	Plots in Gainesville	70-90%	Normal to rainy	SWFWMD
	Plots in Gainesville/Citra	Up to 40%	Dry	
	Homes in Pinellas Co.	65%	Dry (1 d/wk)	SWFWMD
ET controllers	Plots in Hillsborough Co.	Up to 60%	~Normal	Hillsborough Co./FDACS
		Up to 40%	Dry	
	Homes in Hillsborough Co.	???	Dry (ET, variance)	

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Smart Irrigation Controllers Actual Savings

- Research savings potential not realized in the field

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Smart Irrigation Controllers Actual Savings

- CA weather-based controllers evaluation (Mayer et al., 2009)
  - 3,112 controllers evaluated, pre/post with weather adjustment
  - Overall 6.1% savings

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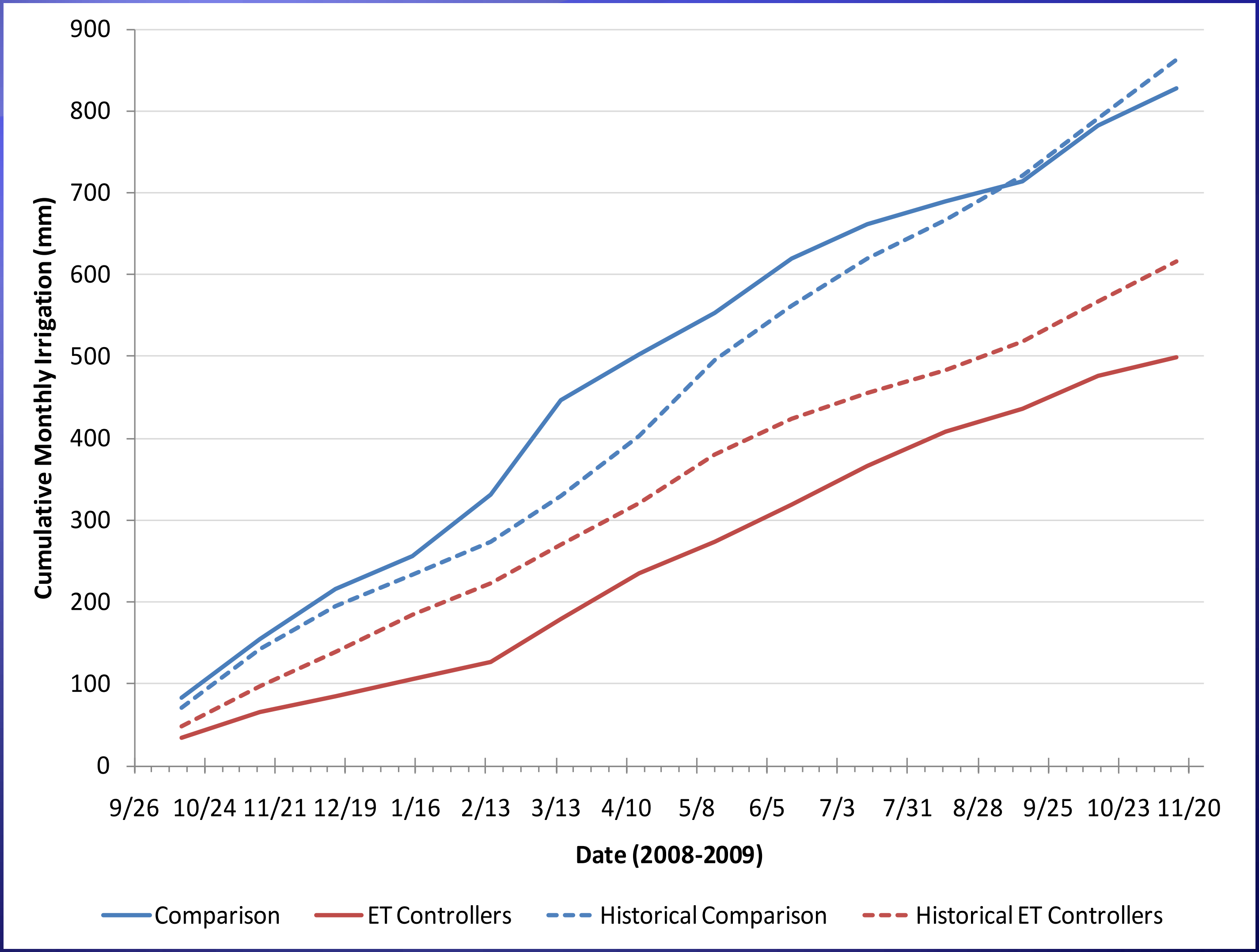
Smart Irrigation Controllers Actual Savings

- CA weather-based controllers evaluation (Mayer et al., 2009)
  - 3,112 controllers evaluated, pre/post with weather adjustment
  - Overall 6.1% savings
  - Sites with a significant reduction, 16.4% savings

Some Homes Have Water Savings



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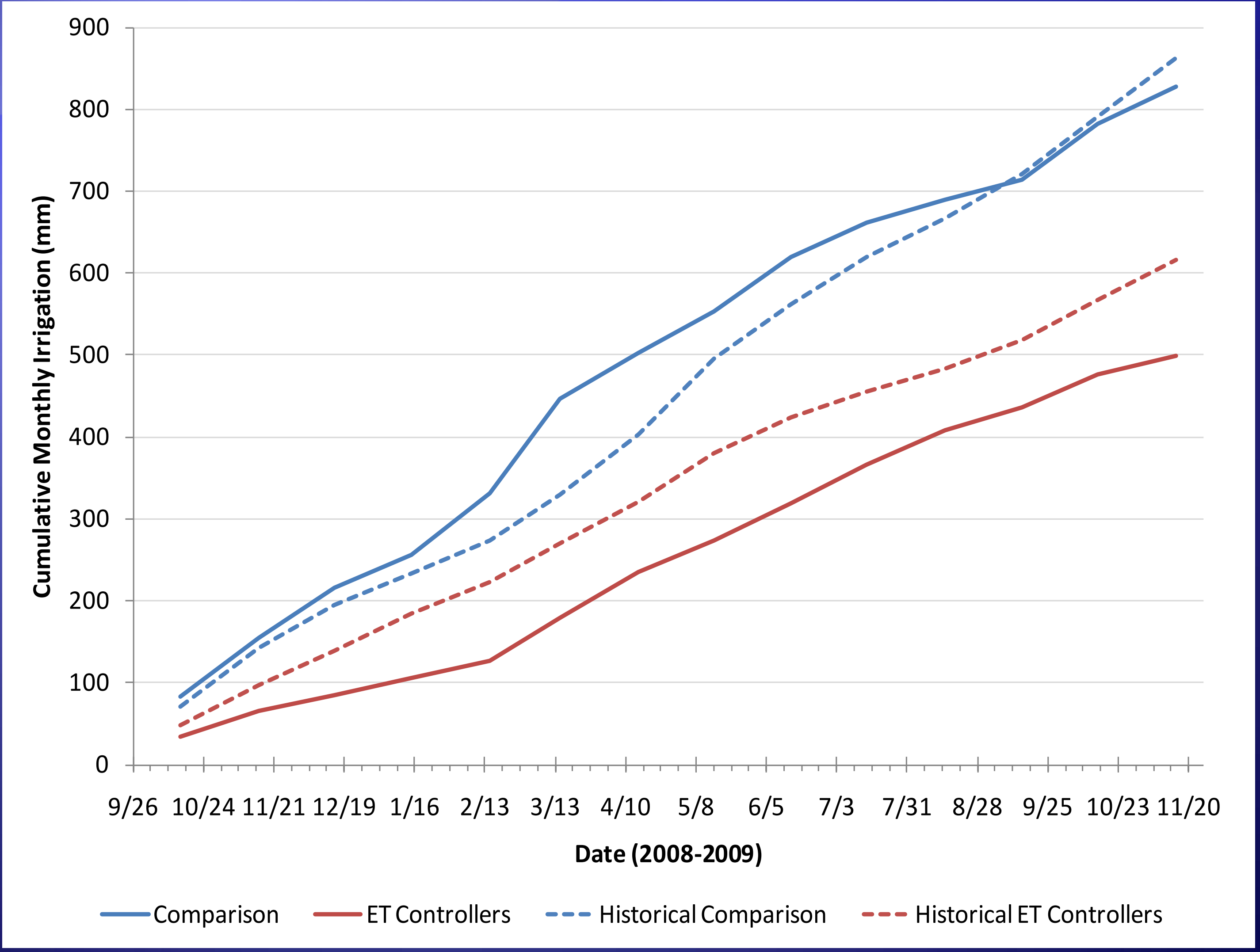

39% savings

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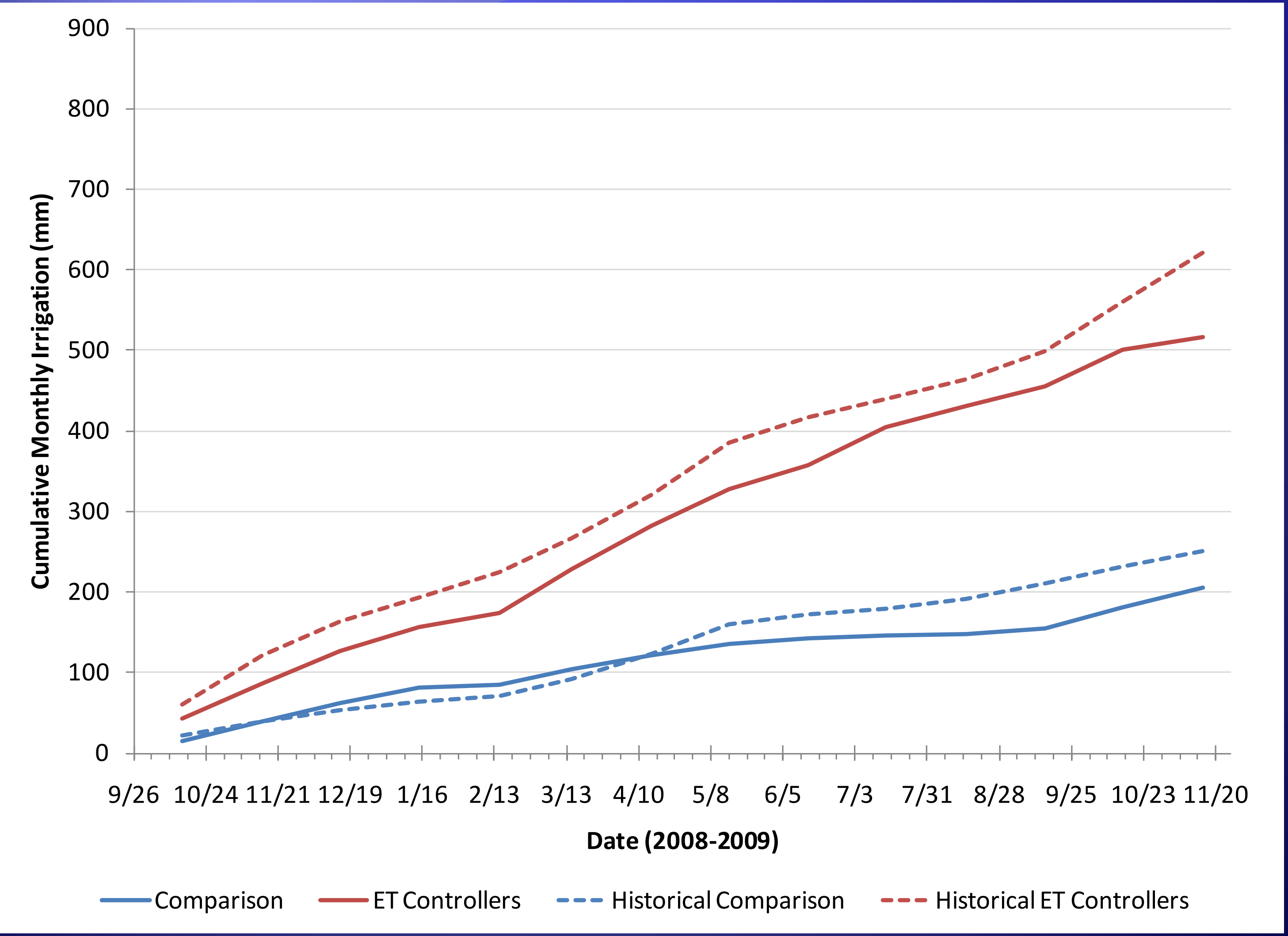
.....And Some Homes Have Increased Usage



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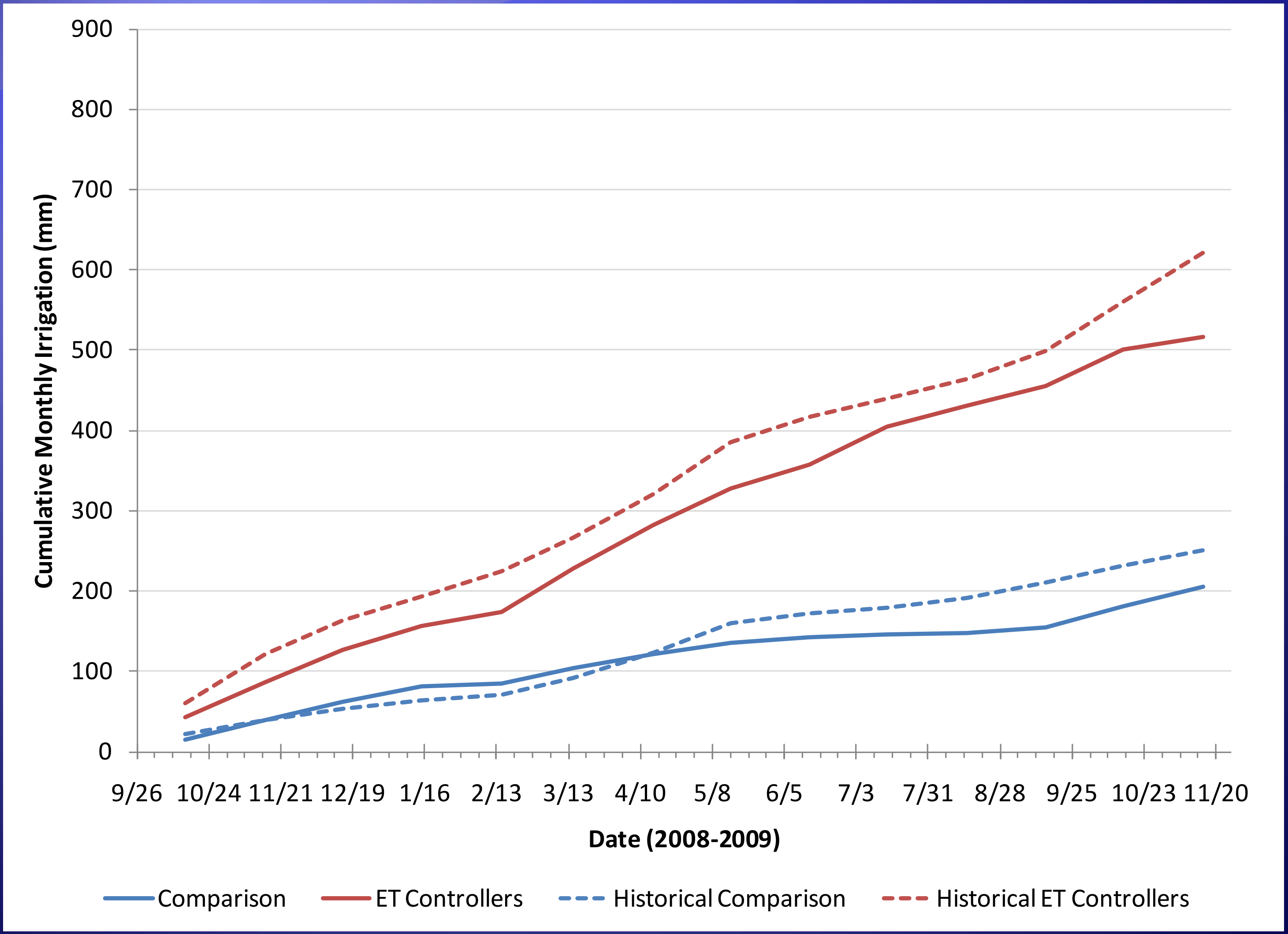

-155% savings

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Introduction

- Irrigation is a large part of potable demand
- Tiered rates often based on one size fits all level, e.g. >15,000 gal/month = (4 inches/6,000 sq ft)
- Conservation efforts comparison
  - Relative (Pre/post)
  - Comparison (Implemented/control)
  - Absolute (theoretical)
- National efforts compared to absolute amounts
  - EPA WaterSense
  - LEED

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Objective

- Determine a methodology to evaluate landscape water use relative to theoretical plant needs

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Soil Water Budget (Balance)

Effective Rainfall (Re)

Irrigation (I)

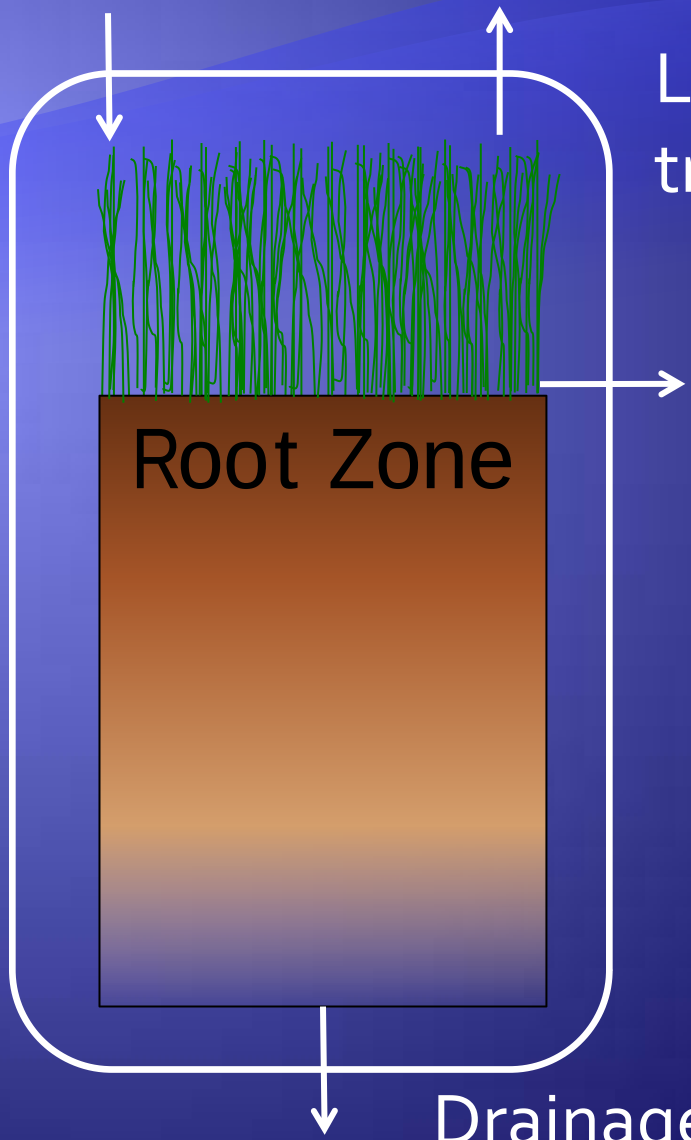
Assume

RO = 0

D = 0

I = ET_L — Re

Landscape Evapo-transpiration (ET_L)



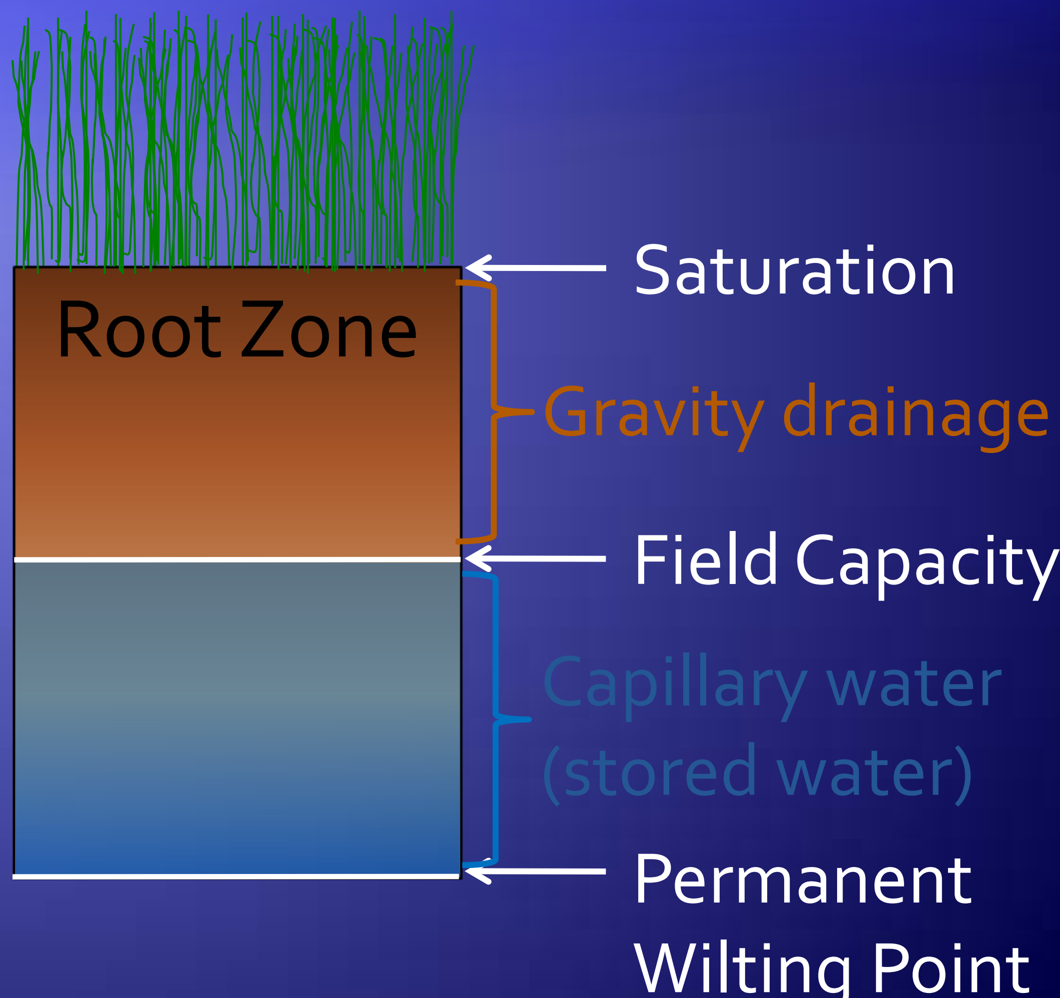
Runoff (R)

Drainage (D)

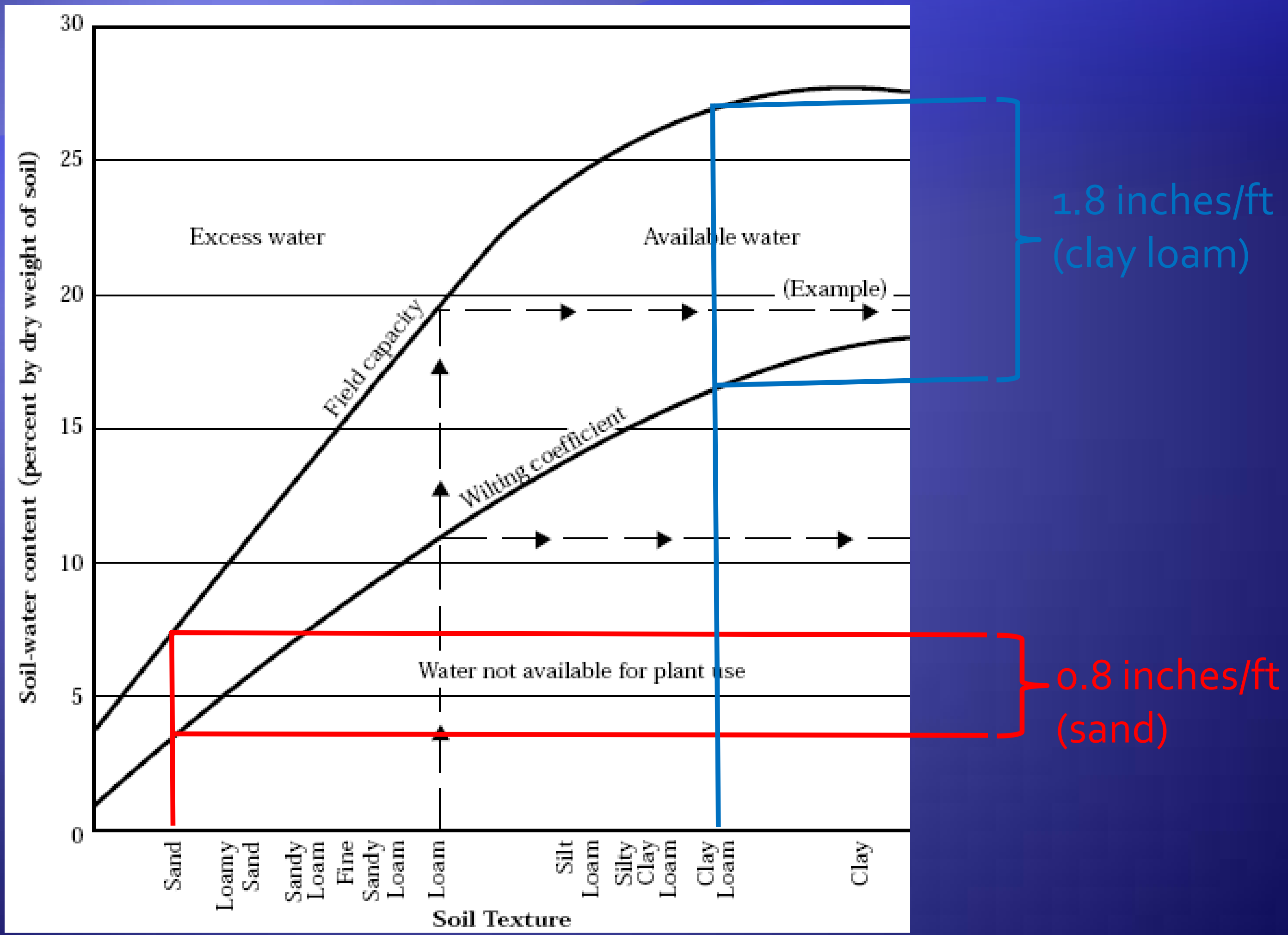
Water Holding Capacity (WHC)

Water holding capacity is a percentage of the total volume that holds water after gravity drainage

WHC = FC — PWP



Water Holding Capacity - Example



NRCS. 1997. Irrigation Water Management, Chapter 9, 21-vi-NEH, September 1997

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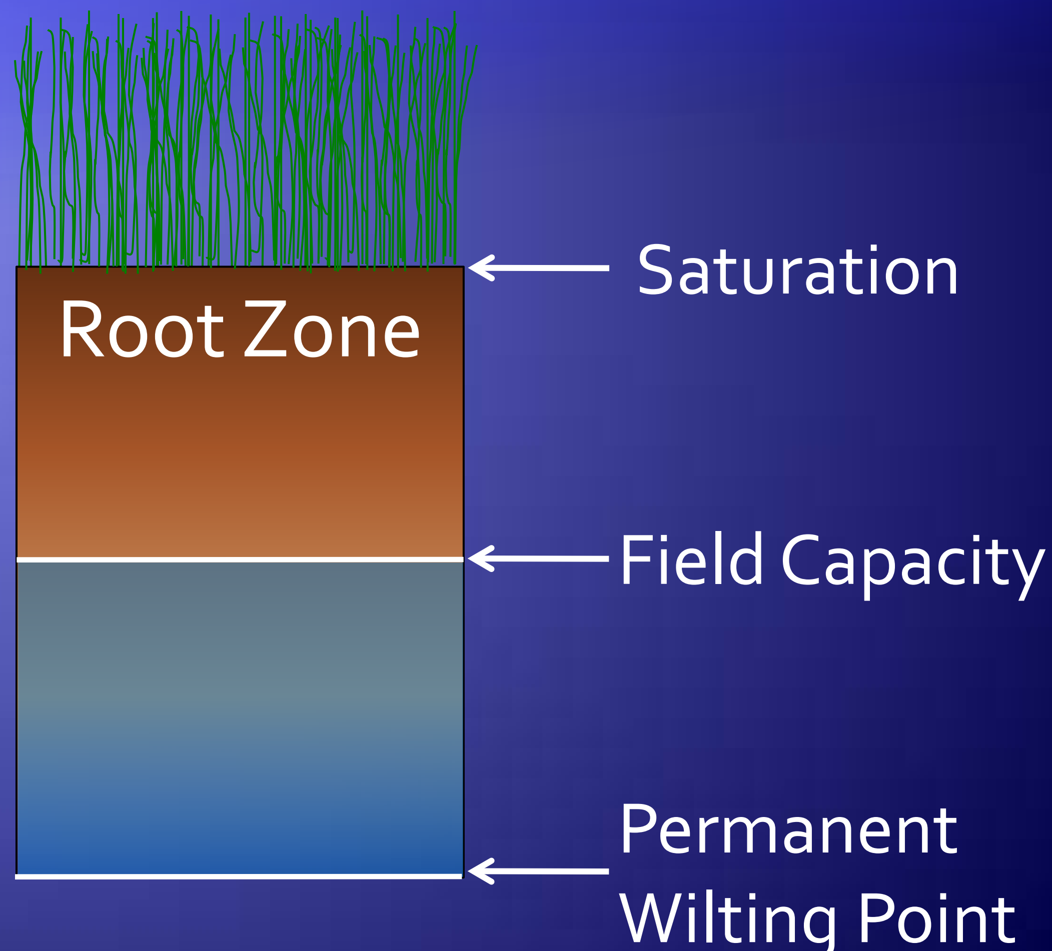
Available Water (AW)

Amount of water (depth) soil can hold in the root zone

$$WHC = FC - PWP$$
$$AW = WHC \times RZ$$



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Available Water (AW) - Example

Fine Sand

FC = 9%

PWP = 3%

WHC = (9-3)

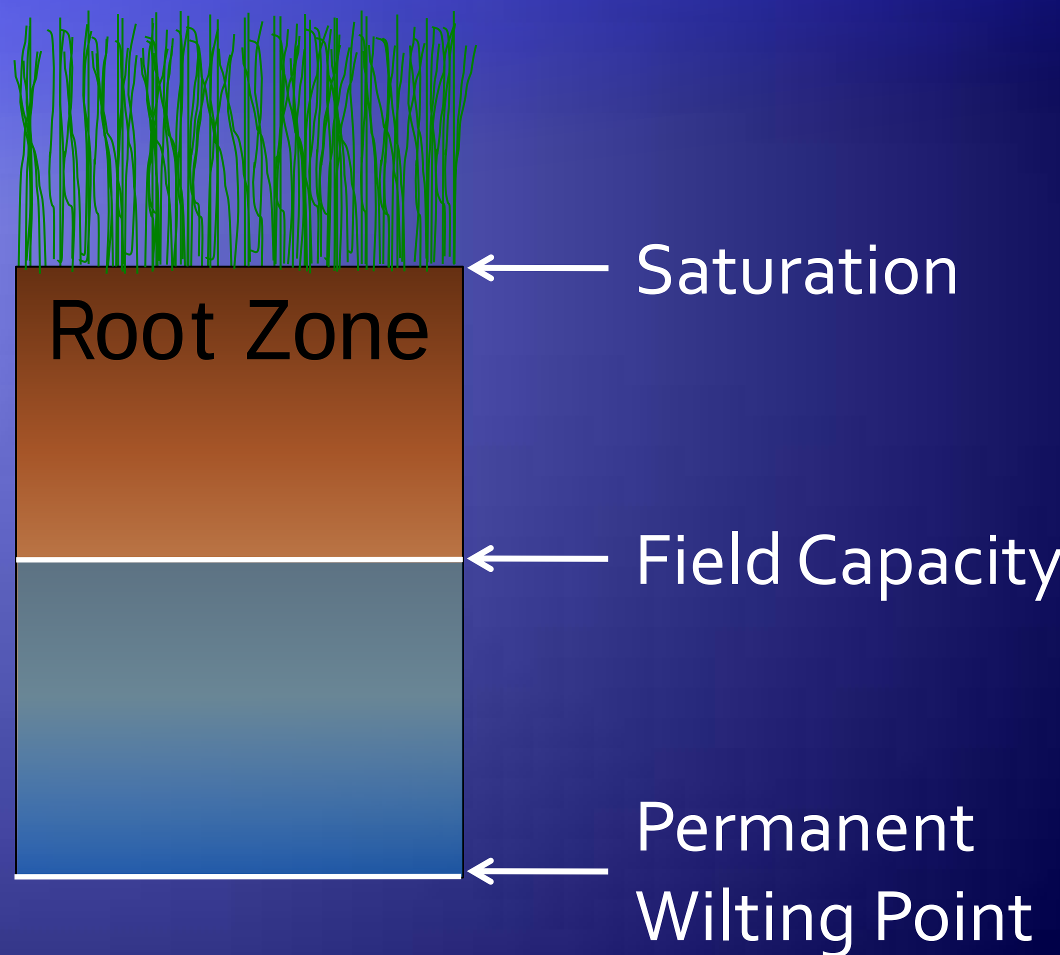
= 6%

Turfgrass

RZ = 12 inches

AW = 0.06 × 12

= <u>0.72 inches</u>

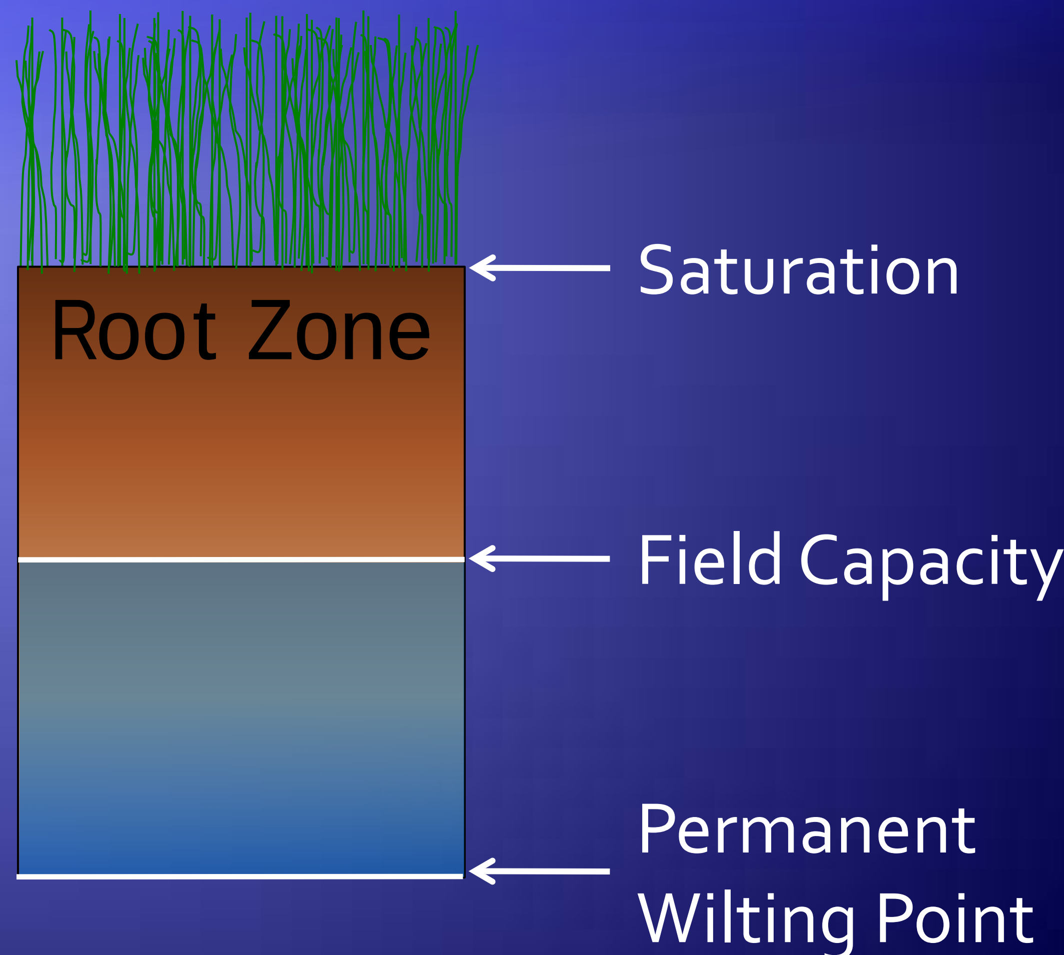


Readily Available Water (RAW)

Removal of all soil water could result in quality decline

MAD = Maximum allowable depletion

RAW = AW × MAD



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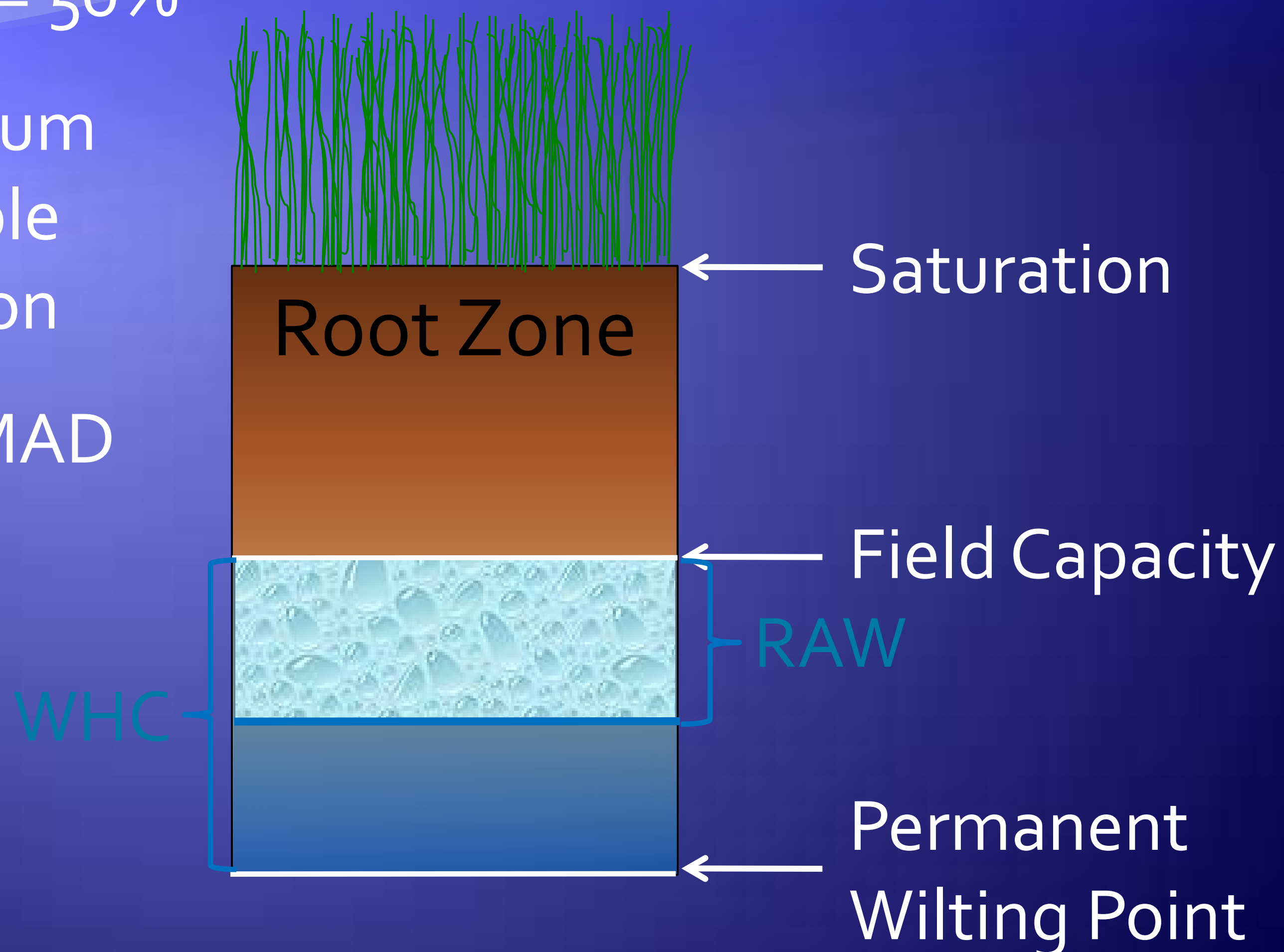
Readily Available Water (RAW)

Assume MAD = 50%

MAD = Maximum allowable depletion

RAW = AW × MAD



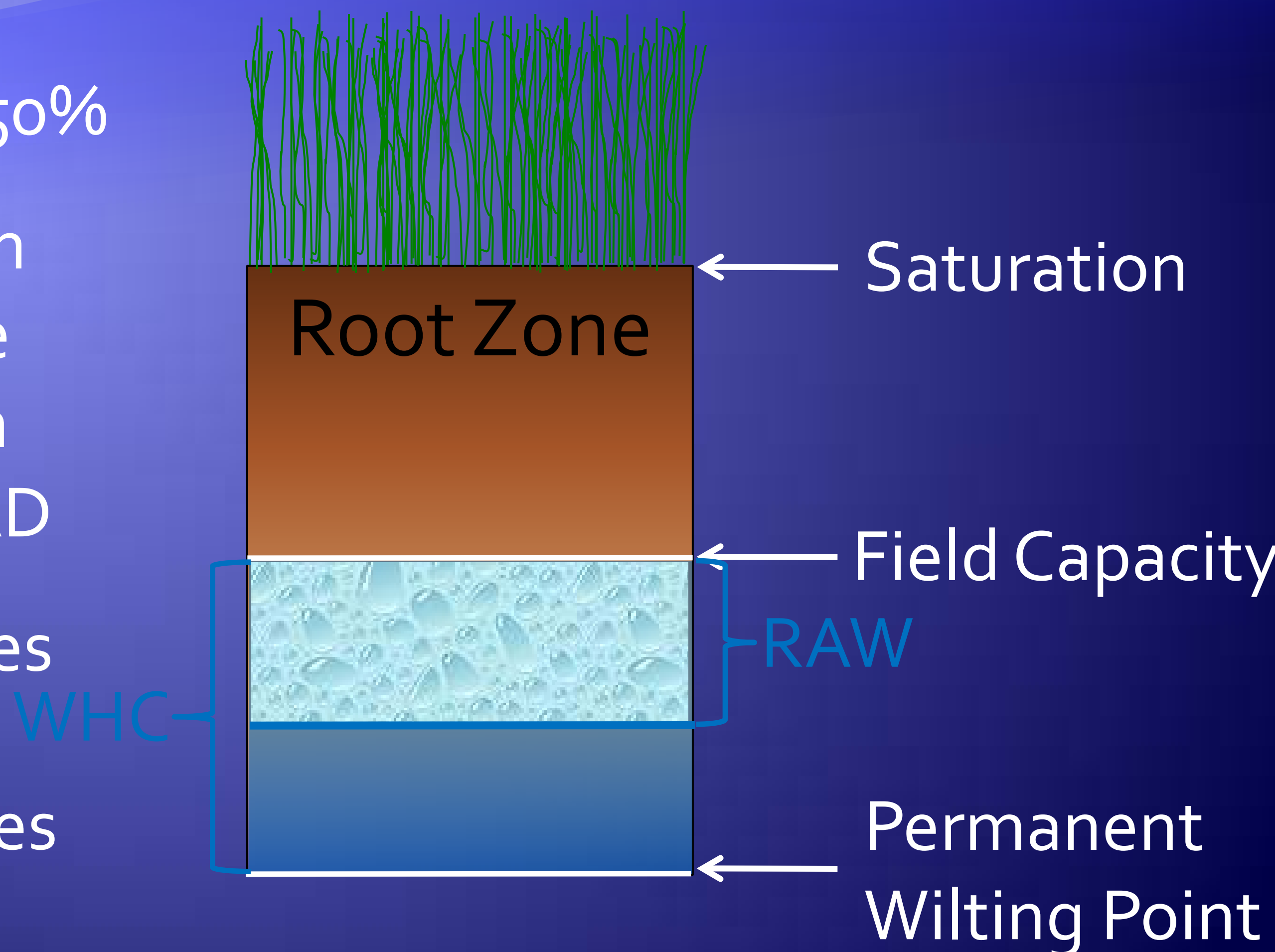
Readily Available Water (RAW) - Example

Assume MAD = 50%

MAD = Maximum allowable depletion

RAW = AW × MAD

RAW = 0.72 inches × 0.5
= 0.36 inches



Data Required for Irrig. Req. Est.

- Irrig. Req. Estimate
  - Weather data to compute reference ET (ETo)
  - Landscape coefficient(s) to adjust ETo to ET_L
  - Effective rainfall estimate
  - Irrig. Efficiency

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Reference Evapotranspiration, ETo

- Daily estimate
  - Tmin, Tmax, RHmin, RHmax, U2, Rs
- Available via some weather networks
  - CIMIS, FAWN, MESONET, etc.
- Preferred method: ASCE-EWRI Standardized Evapotranspiration

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Landscape Coefficient, K_L

- K_L = composite K_c of landscape plants
- Turfgrass K_c readily available
- Revised IA, "Irrigation" book
- WUCOLS

Effective Rainfall, Re

- Depends on:
  - Plant root zone
  - Rain intensity/soil infiltration rate
  - Soil water holding capacity
- Daily water balance → Gives Re
- Typically 25% - 35% shallow rooted plants

Irrigation Efficiency, Eff

- Depends on:
  - Irrigation system design & maint., i.e. uniformity
  - Management, when irrigation is applied

Irrigation Requirement

- $K_L = (K_{c1}*A_1)+(K_{c2}*A_2)+(K_{c...}*A_{...})/(A_1+A_2+A_{...})$
- $ET_L = K_L*ETo$
- Net Irrig Req = ET_L – Re
- Gross Irrig Req = Net Irrig Req/Eff

Data Required Irrig. Use

- Irrig. Use Estimate
  - Monthly gross (indoor + outdoor) use
  - Estimate indoor use
  - Irrigated area

Estimation of Indoor Use

- Per capita (69 gal/person/d)
  - Acceptable for averages over large populations
  - Substantial error in small datasets
- Minimum month
  - Acceptable in freezing climates
  - Considerable error in warm climates (year round irrigation)

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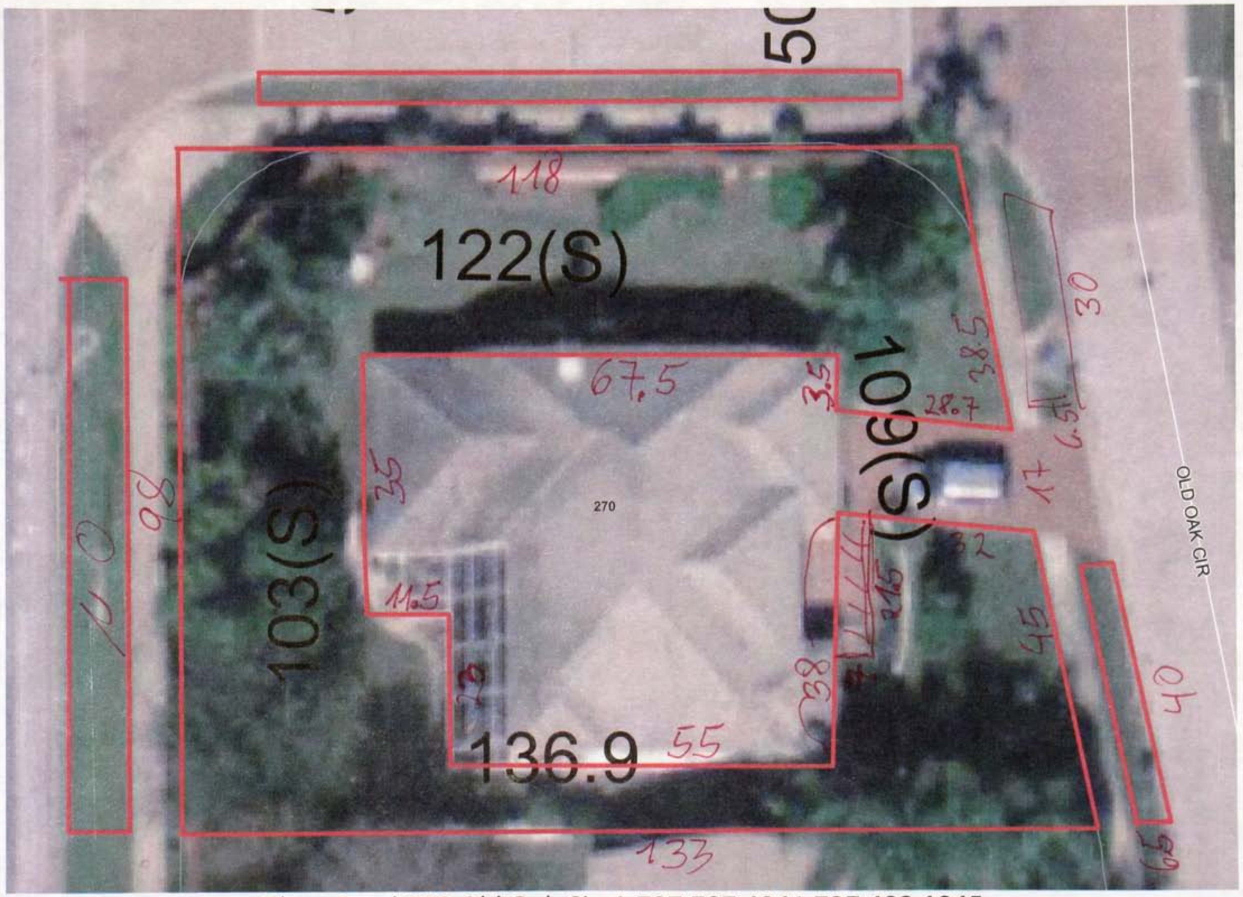
Determine Irrigated Area



Olaya Sund 270 Old Oak Cir. A 727 787 4241 727 492 1945

Hillsborough County Results

- Annual rainfall
  - 48.4″
- Annual ET
  - ETo = 47.8″
  - K_L=0.8 = 32.7″ (Gr. Irrig Req, 25.8″)
  - K_L=0.6 = 20.7″ (Gr. Irrig Req, 10.8″)
- Avg. irrig. = 43″/yr
  - Not including non-irrigators

Gross req. assumes 80% irrigation efficiency, 25% Re

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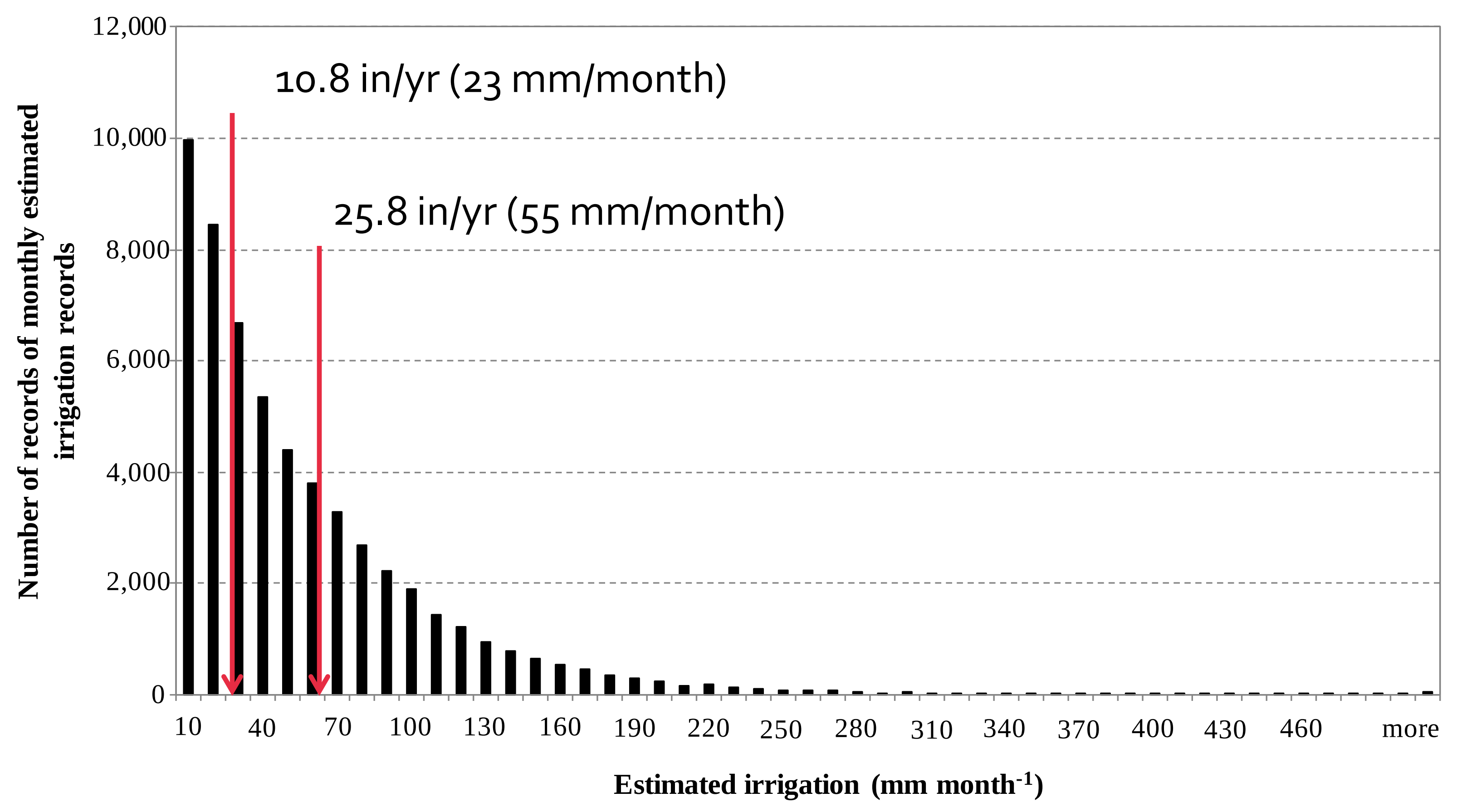
Monthly Irrigation Records Distribution, Hillsborough County



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Hillsborough County Results

- 21 signal based ET controllers
- 17 comparison homes

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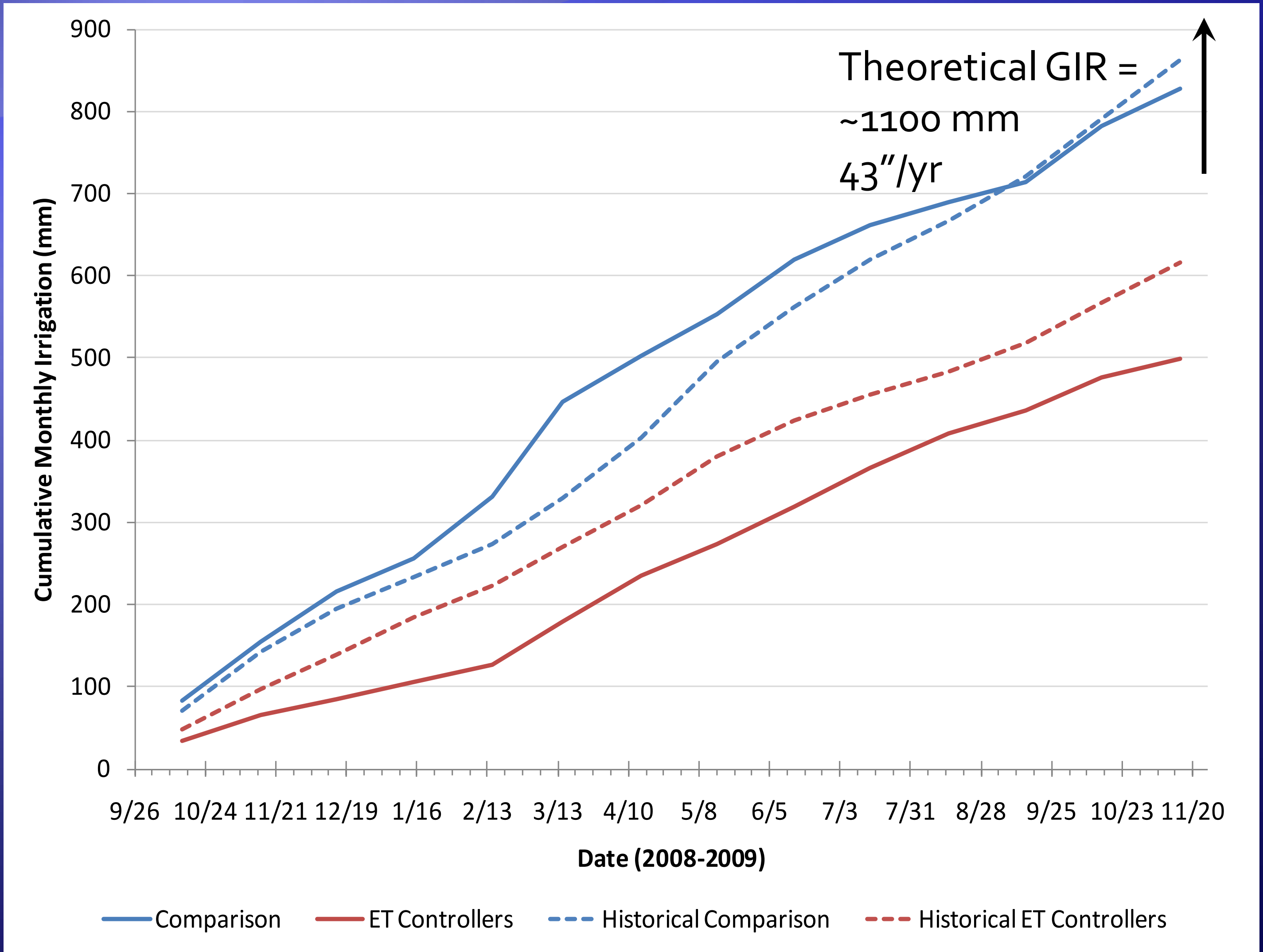
Some Homes Have Water Savings



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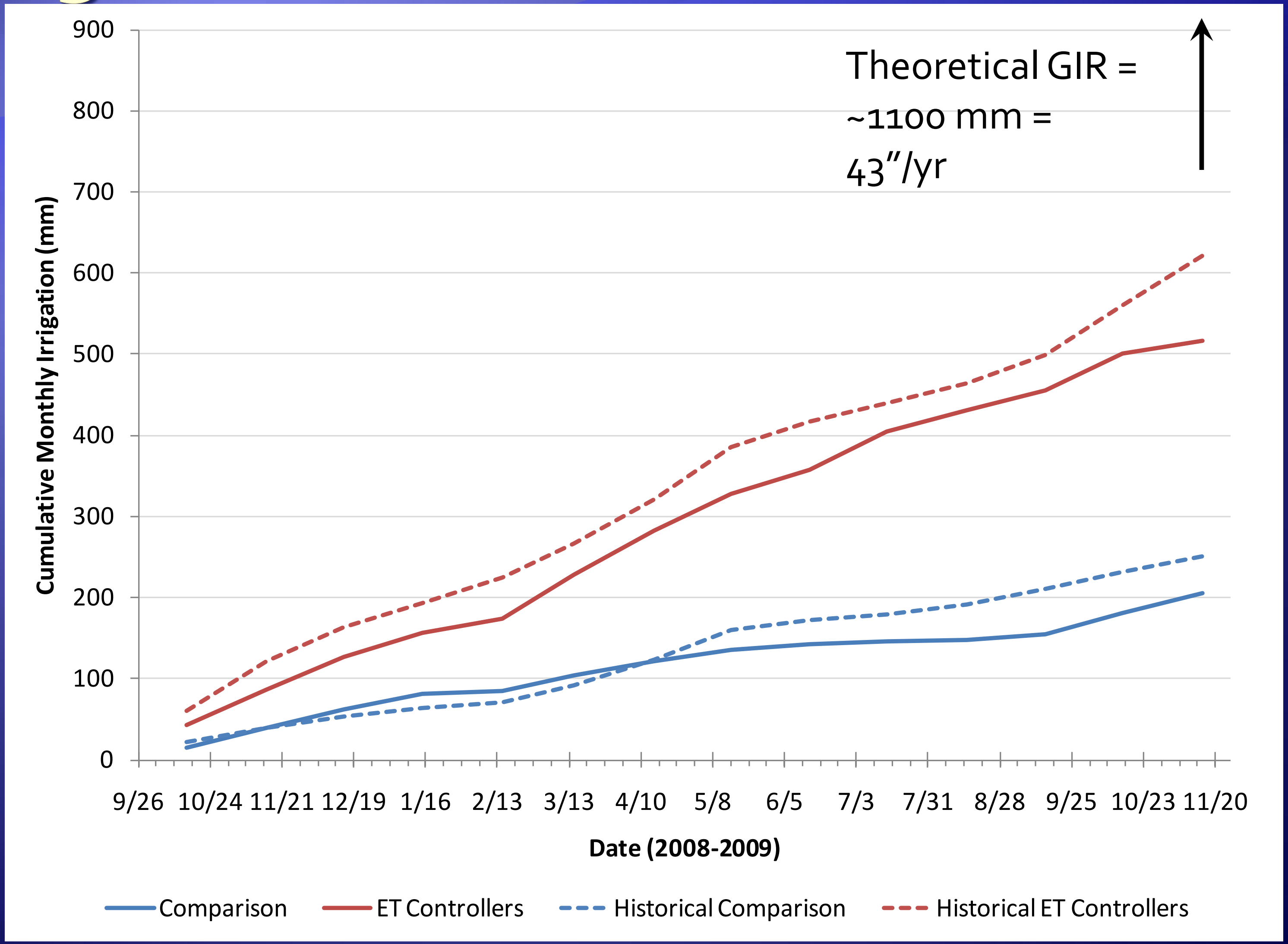
.....And Some Homes Have Increased Usage



Hillsborough County Historical Irrigation & an ET Controller

- Annual irrigation impact of ET controller
  - Increase usage, <20"/yr 80 kgal/yr*
  - No change, 20"/yr – 25"/yr
  - Reduce usage, >25"/yr 99 kgal/yr

*Assumes 6,000 ft^2 irrigated & 5 kgal/yr indoor use

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OCU Project Summary

- Identify 160 cooperating properties
  - 80 → SMS irrigation controllers
    - 40 → Set and forget
    - 40 → Setup follow-up
  - 80 → ET irrigation controllers
    - 40 → Set and forget
    - 40 → Setup follow-up

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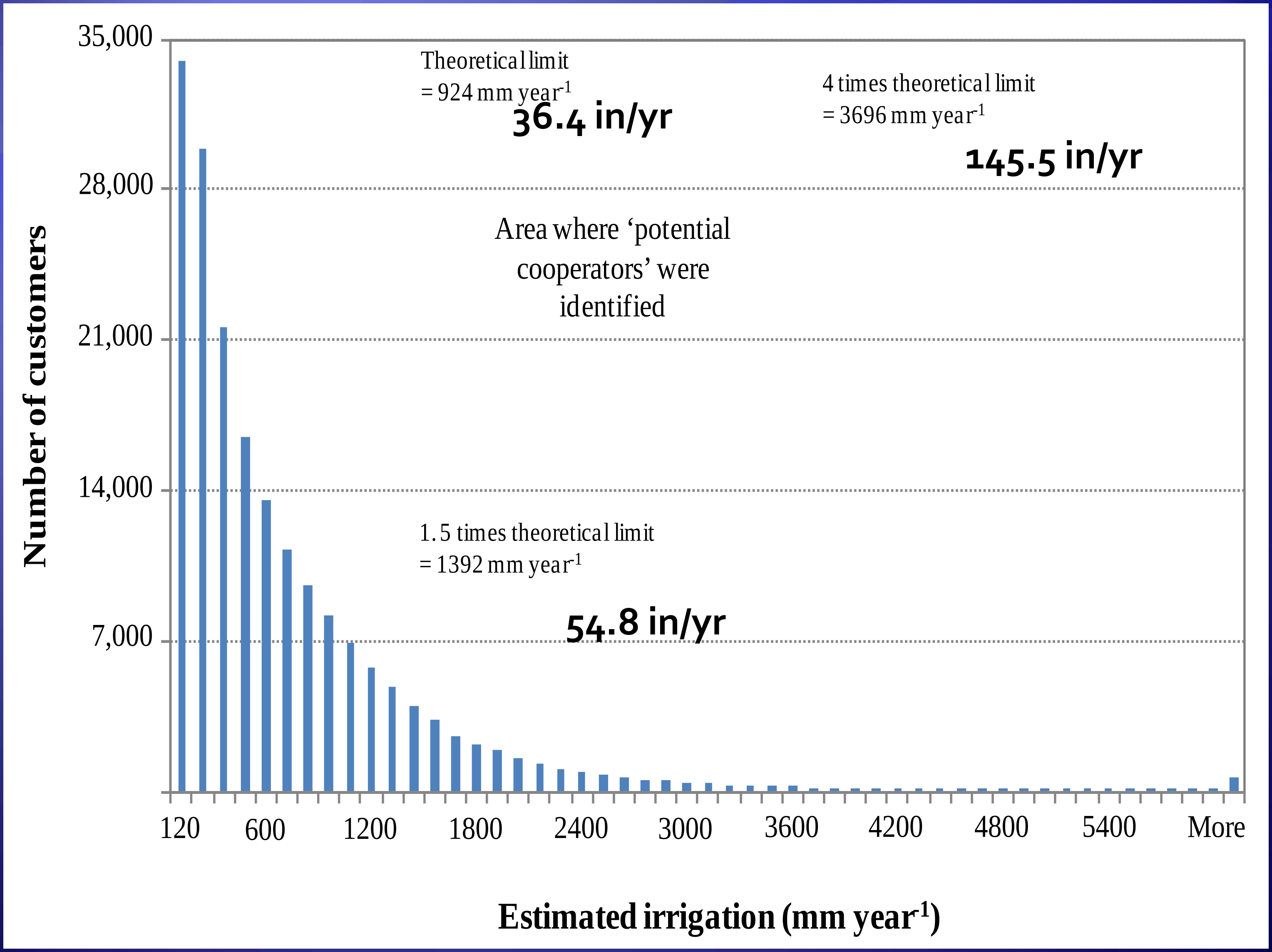
Orange County Utilities - Example

- Determine irrigation profile of OCU single family home customers for Smart Controller pilot
  - 2003-2008 monthly data
  - 7.5 million potable meter records

OCU Customer Irrig. Distribution



OCU "High" Irrigators Identification

- Avg. Irrigation (all homes), 39 – 101 mm/month (18.4"/yr – 47.7"/yr)
- Irrigation exceeded theoretical limit at least 3 months each year, 2006-08
- ~7,500 "high" irrigators identified

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Summary

- Methodology allows targeting high irrigation customers based on absolute plant water requirements
- These sites with smart controllers should result in significant “real” water conservation
- Methodology could be implemented into utility billing systems

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Questions?

- mddukes@ufl.edu
- http://abe.ufl.edu/mdukes/

- Funding partners
  - Orange County Utilities
  - Water Research Foundation
  - South Florida Water Management District
  - St. Johns River Water Management District
  - Pinellas Anclote Basin Board, SWFWMD
  - Tampa Bay Water
  - Florida Dept. Ag. and Consumer Services
  - Florida Nursery Growers & Landscape Association
  - Florida Turfgrass Association
  - Hillsborough County Water Dept.

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