Water Management in Gardens & Landscapes

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CENTER FOR LANDSCAPE & URBAN HORTICULTURE <www.ucanr.edu/cluh>

- B.S. & M.S. Horticulture, Ohio State University
- Graduate Studies Soil Science, U.C. Riverside
- 36 years experience - landscape & urban horticulture
  - Education and applied research programs
  - Landscape irrigation mgt., plant water needs, weather-based irrigation control
  - Presentations, workshops, publications, Web

Topics

1) Overview & Resources
2) Evaluating & Maintaining Irrigation Systems
3) Plants and Landscape Water Demand
4) Plant-Soil-Water Interactions
5) Irrigation Schedules, Management, Drip Irr.

Landscape irrigation is the largest use of water in California.

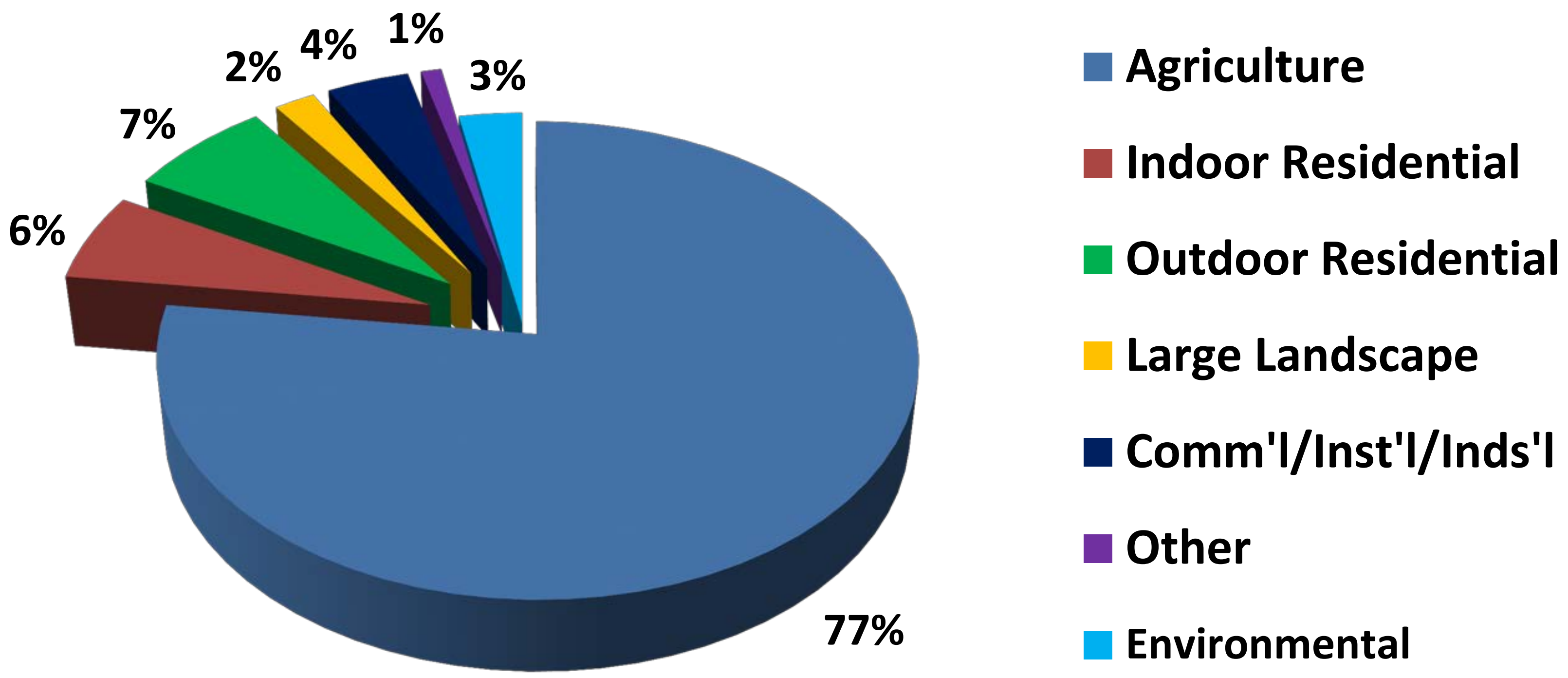
TRUE or FALSE?

FALSE

Average California Water Use

Statewide Developed Water

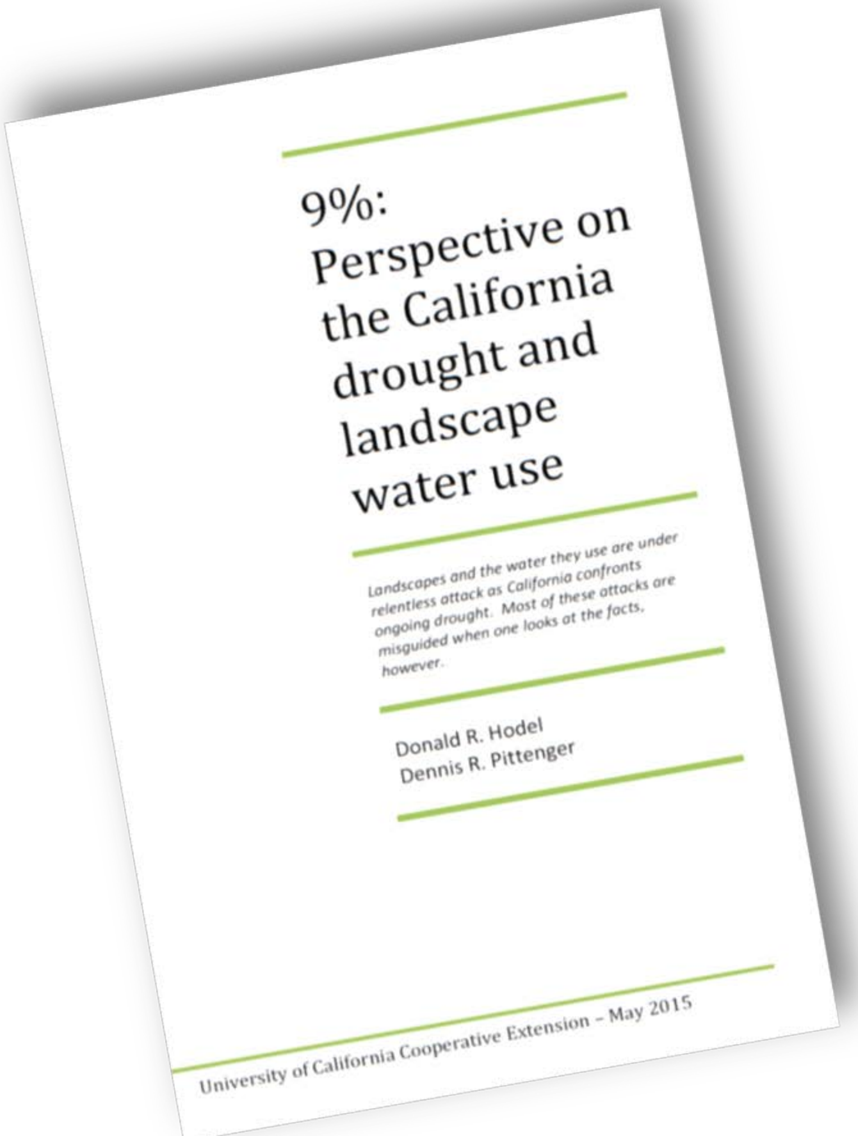
20% Urban – 9% Landscape



Sources: Calif. Dept. Water Resources, 2013 Calif. Water Plan Update Chp. 3.
UCLA Inst. of Env't. and Sustainability, So. Calif. Environ'l. Report Card, Fall 2009.

Essentiality of Landscape Water

- Function
- Recreation
- Aesthetics
- Mental Well-being



9%:
Perspective on the California drought and landscape water use

Landscapes and the water they use are under relentless attack as California confronts ongoing drought. Most of these attacks are misguided when one looks at the facts, however.

Donald R. Hodel
Dennis R. Pittenger

University of California Cooperative Extension – May 2015

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Water Management 4

Janet Hartin and Ben Faber

Learning Objectives

Become familiar with the basic concepts of evapotranspiration (ET) and plant water needs.

Develop an understanding of basic concepts of water movement in soil and plant water availability in different soil types.

Learn how to place plants with similar water needs together and irrigate them effectively.

Understand and apply basic principles of irrigation and water management to maintain optimal plant health, reduce water waste, and protect groundwater and surface water quality.

Learn how to manage drought in California landscapes and gardens.

California Master Gardener Handbook 2nd edition

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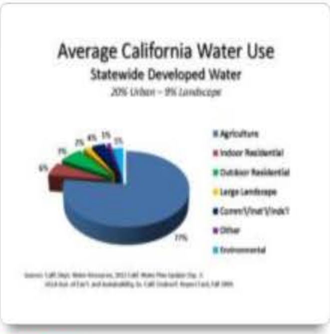
Welcome!

Welcome to the *Center for Landscape and Urban Horticulture (CLUH)*, an information resource of the University of California Cooperative Extension (UC Cooperative Extension). The CLUH supports UC Cooperative Extension educational and applied research programs serving California's environmental horticulture industry. This site features science-based information on:

- landscape water management and conservation.
- urban tree management and selection.
- assistance for home gardeners and consumers of horticultural products and services.



THE 9%: ***Landscape irrigation accounts for just 9% of water use in California, yet landscapes are under relentless attack as California confronts ongoing drought. The facts presented here***

ucanr.edu/sites/UrbanHort

www.cimis.water.ca.gov

Reading A Water Meter

1 sweep = 1 cubic ft.

Leak

100 cubic ft.
= 748 gal.

1 cubic ft.
= 7.48 gal.

Can't manage water if it's use is not measured!!

Useful Equations

Inches = Gallons ÷ (Sq. Ft. × 0.623)

Gallons = Inches × Sq. Ft. × 0.623

1 gal. covers 1 sq. ft. with 1.6 in. of water

1 Billing Unit = 100 cubic ft. = 748 gallons

(1 sweep of meter needle = 7.48 gallons)

$$\textbf{Runtime Minutes} = \frac{\textbf{in. or gal. needed} \times \textbf{60}}{\textbf{in. or gal. applied per hr.} \times \textbf{efficiency}\,\%}$$

7 Habits of Highly Effective Irrigators

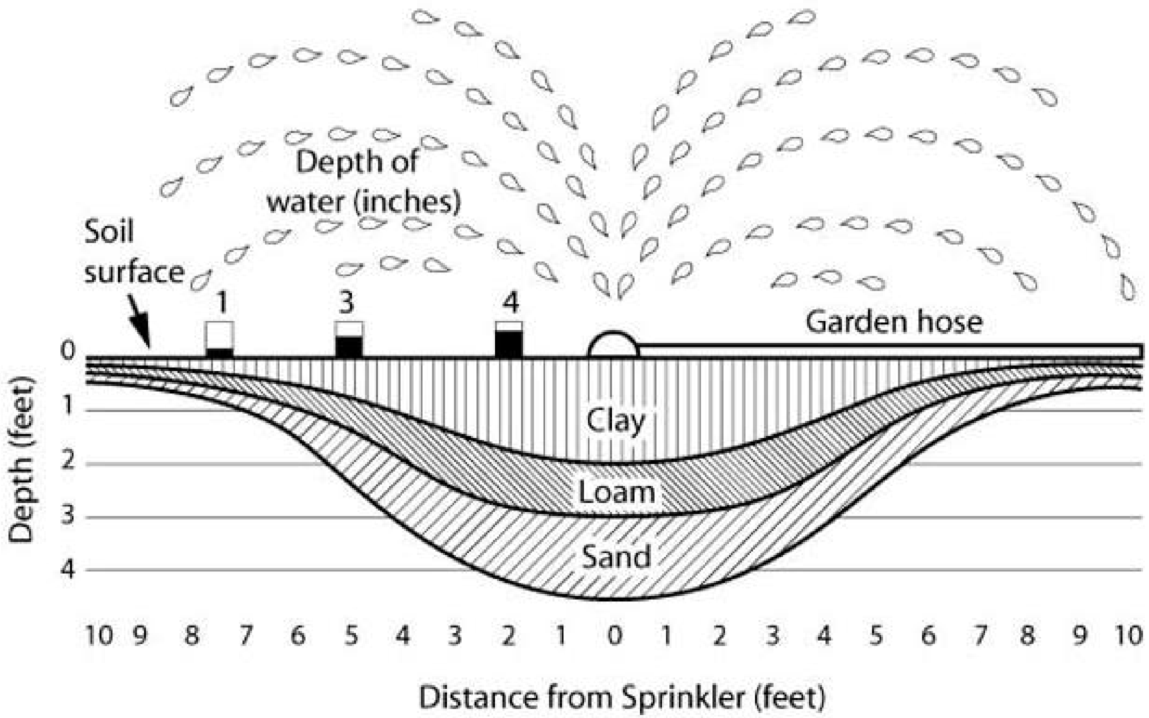
- Apply the right amount of water
- Apply water at the right schedule
- Distribute water as uniformly as possible
- Avoid runoff & deep percolation
- Adjust schedules as conditions require
- Irrigate when wind & evaporation are minimum
- Evaluate hardware and schedules regularly

Irrigation System Performance

The irrigation system should distribute water as uniformly and efficiently as possible

Sprinkler Spacing

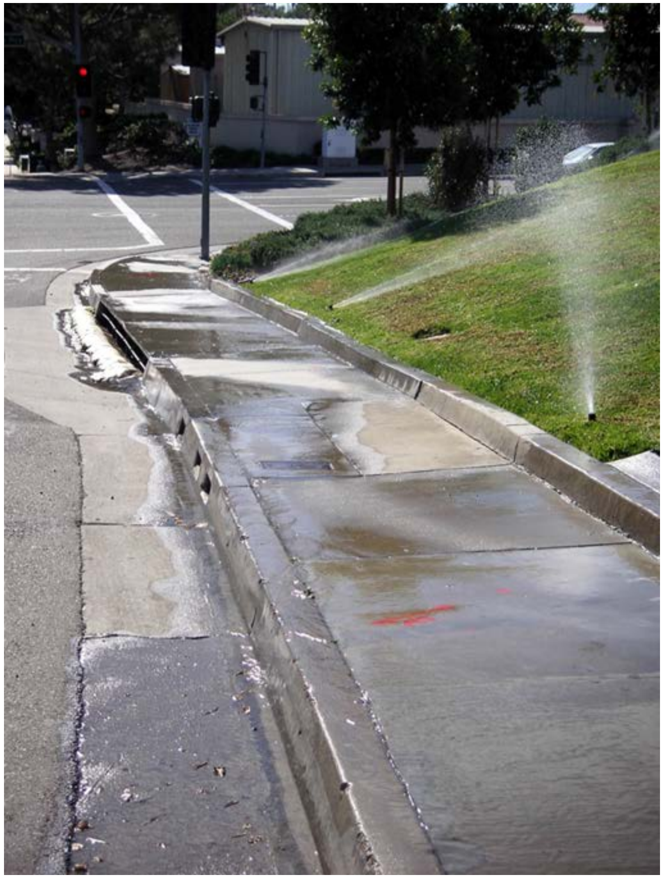
Importance of Head-to-Head Coverage



Irrigation System Performance
Fix Obvious Problems

Avoid Runoff & Overspray

- Cycle and soak – *drip too!!*
- Run irrig. lines across slope
- Reduced precipitation rate heads & emitters



***Not* Hydrozoned**

- Trees irrigated with turf
- All 80% ETo

Hydrozoned

- Turf irrigated separately
- Part 50%, part 80% ETo

Micro & Drip Irrigation

Micro

Drip

Micro & Drip Irrigation Features

Micro

- Often low pressure
- Small emitters
- Usually overhead applcn.
- Wet small or large area
- High or low volume
- Can lower evaporation
- Can avoid runoff

Drip

- Low pressure
- Small emitters/Pt. sources
- Can run any time of day
- Wet small area
- Low volume-slow applcn.
- Little evaporation
- Run-off unlikely

Micro & Drip Irrigation Issues

Micro

- Above ground
- On-going system maintenance
- Calculating runtimes and schedules

Drip

- Can be covered/buried
- Out sight – out of mind
- Fertilizing plantings
- Calculating runtimes and schedules

Drip Irrigation Efficiency

- Reduced evaporation
- Runoff reduced or eliminated
- Precisely meet plant water demand
- Wet only a portion of root system to full depth
- Same plant performance with less water
- Better plant performance with same water
- ***Large water savings <u>not</u> guaranteed!!***

Drip System Basic Hardware

- Source connection
- Backflow preventer
  (if not in valve)
- Filter
- Pressure regulator
- Distribution tubing
- Emitters
  - Press. Compensating
  - Match soil & slope

Drip Irrigation

- Soil texture affects wetting pattern
- Wet ≥50% of root area
- Add emitters as plants grow

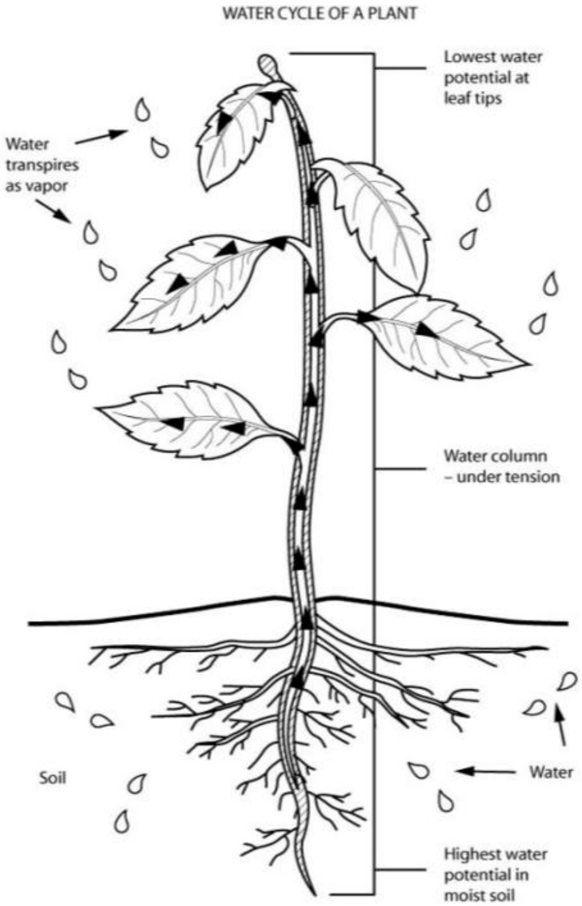
Drip Irrigation System Design

Irrigation System Performance

Effective Irrigation Controllers

- Minimum 3 programs
- Minimum 4 start times
- Interval or day of week option
- Station for each hydrozone
- Rain shutoff
- Global % adjustment

Why & How Plants Use Water



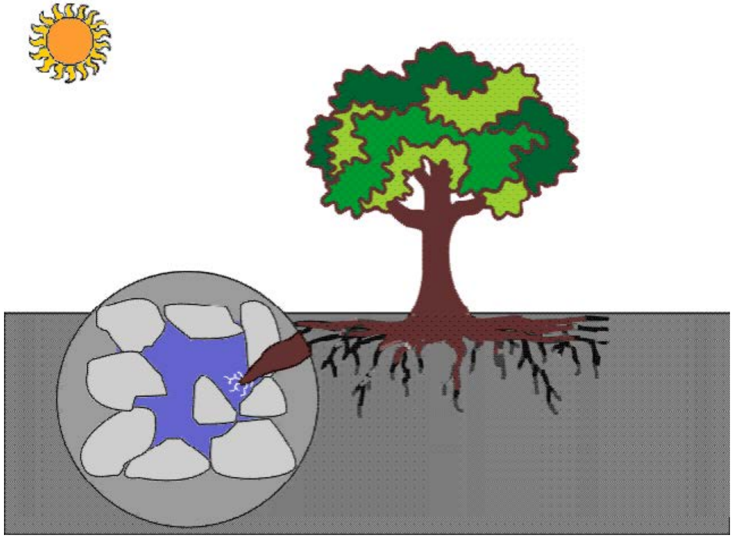
- ***Water loss is essential!!***
- Maintain structure
- Photosynthesis & physiological processes
- Cooling (transpiration)
- Transports minerals & nutrients

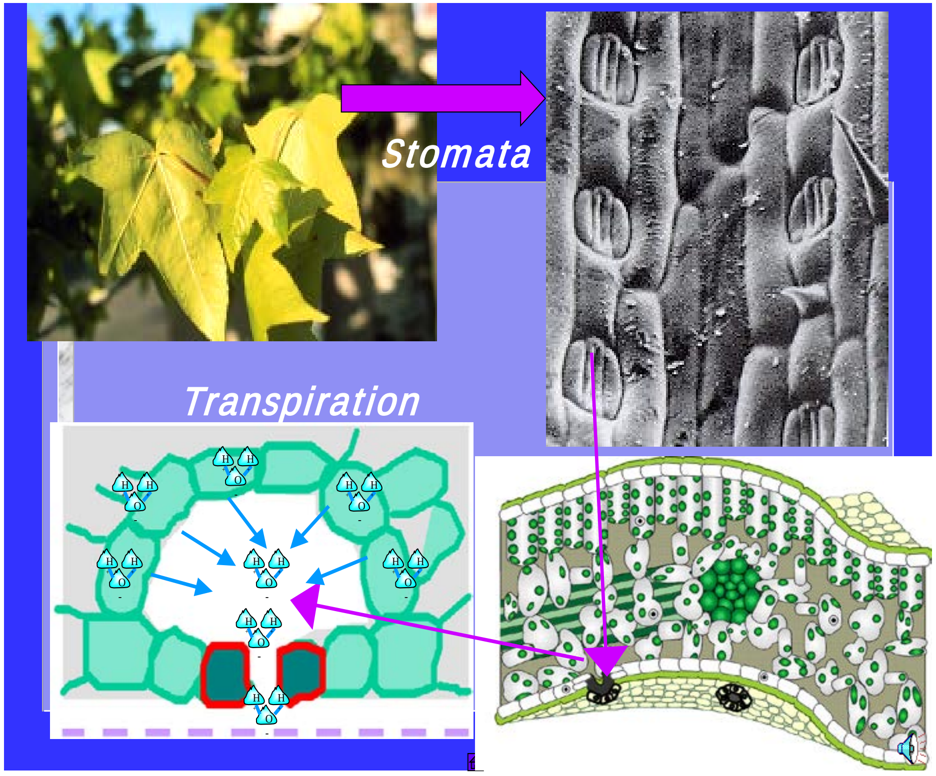
Why & How Plants Use Water

- SPAC:

Soil Plant Air Continuum

- Creates pull or tension





Evapotranspiration (ET)

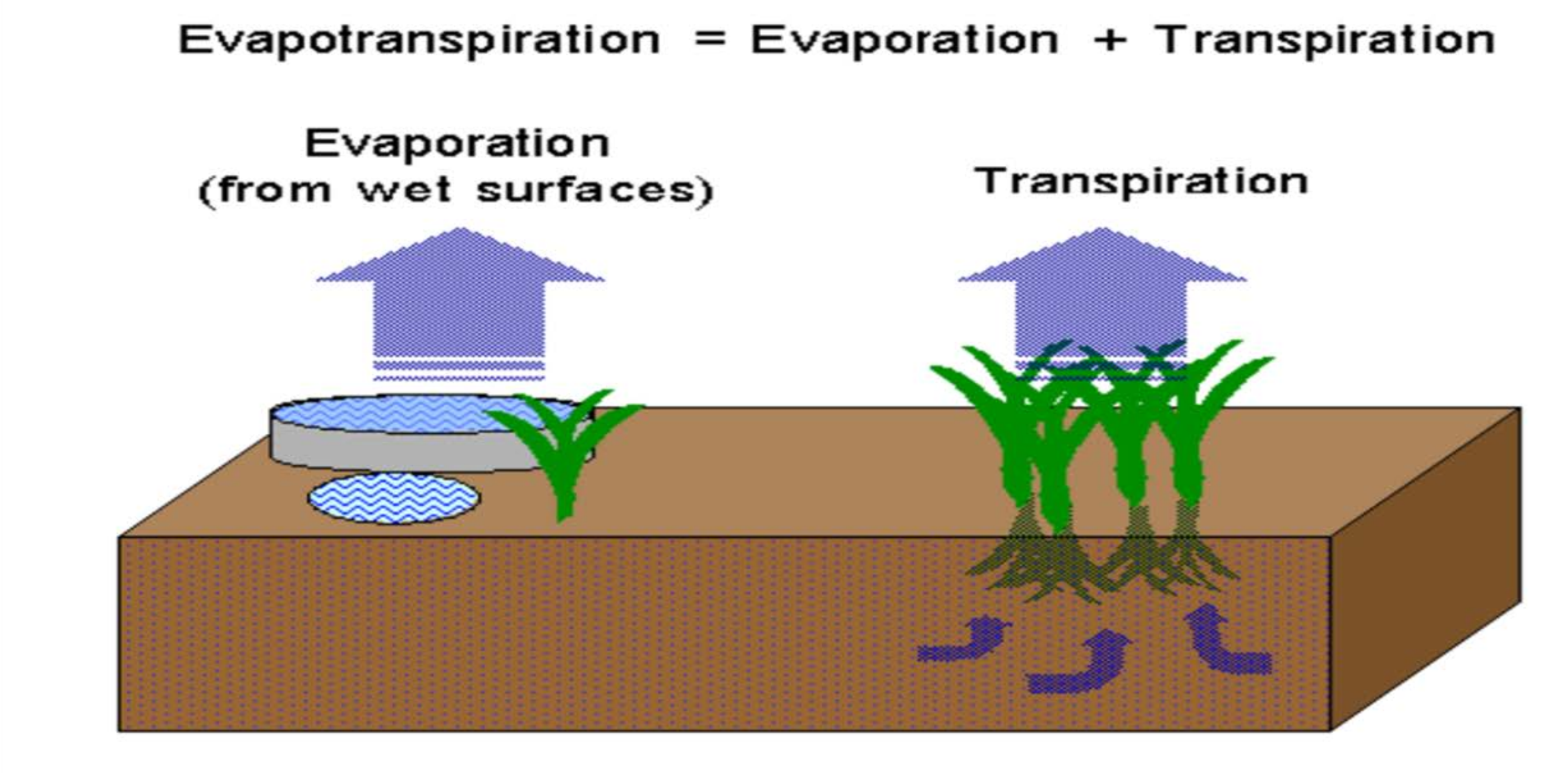
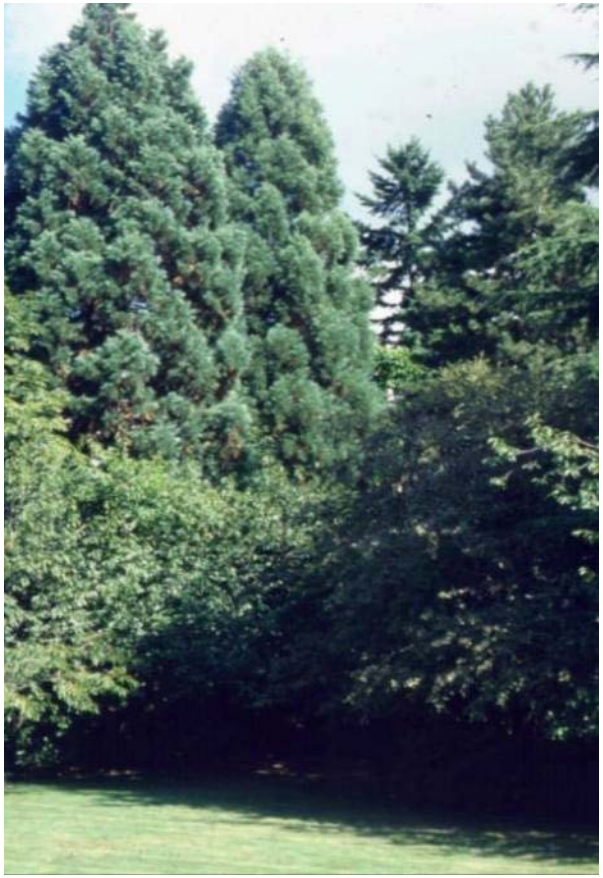


Figure 1. Evapotranspiration

Factors Affecting Plant Water Use & ET



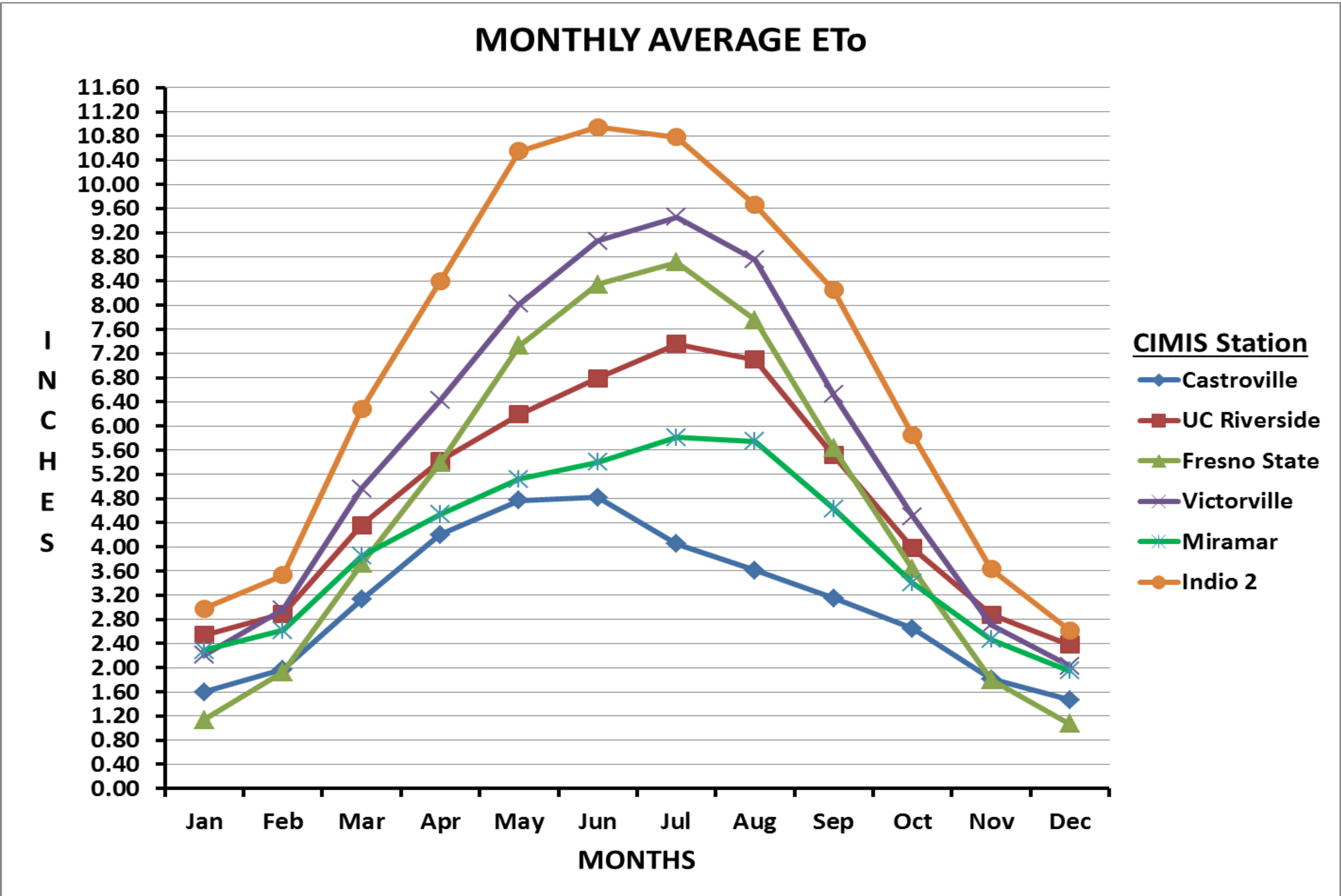
- Sunlight
- Temperature
- Humidity
- Wind
- Plant physiology
- Plant size (leaf area)
- Site characteristics

Reference Evapotranspiration (ETo)

Estimated water demand of a planted area

- Climate-based reference
- Inches per day
- Calculated from weather data
- Sunlight, temperature, wind, humidity
- Hypothetical water use of vigorous tall fescue given unlimited water

Average Reference ET in Selected Locations



Reference Evapotranspiration

Average ETo (in.) – Pomona, CA

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mo.	1.95	2.35	3.67	4.62	5.27	5.93	6.52	6.38	4.87	3.39	2.26	1.64	**48.9**
Wk.	0.4	0.6	0.8	1.1	1.2	1.4	1.5	1.5	1.1	0.8	0.6	0.4	
Day	0.06	0.08	0.12	0.15	0.17	0.20	0.21	0.21	0.16	0.11	0.08	0.05	

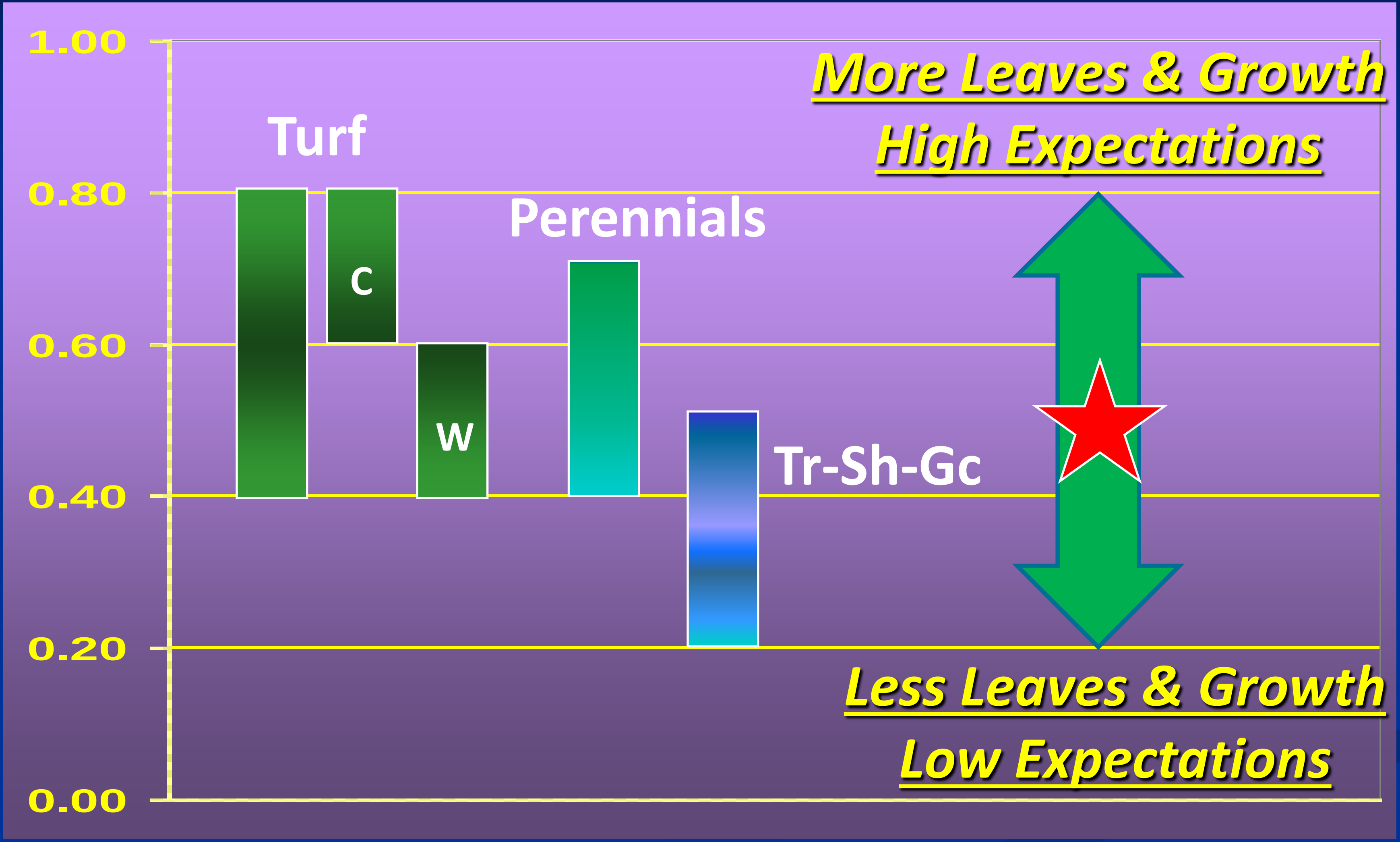
www.cimis.water.ca.gov → Sign-in → *DATA* tab

Select closest station

www.cimis.water.ca.gov

Estimating Plant Water Requirements Through Science

Percent of ET Required



Food Gardens & Edible Landscapes

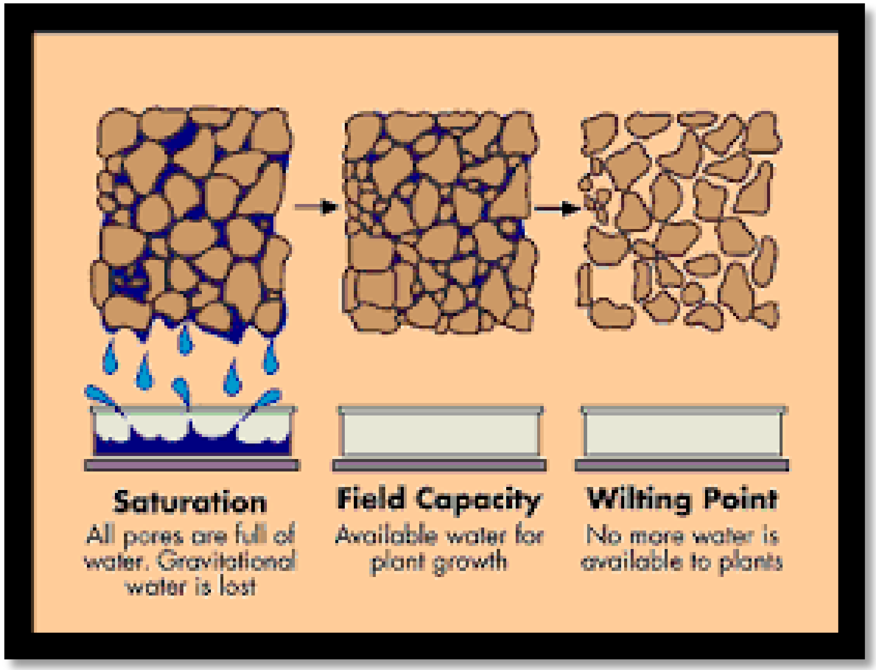
.....Same as cool-season grass

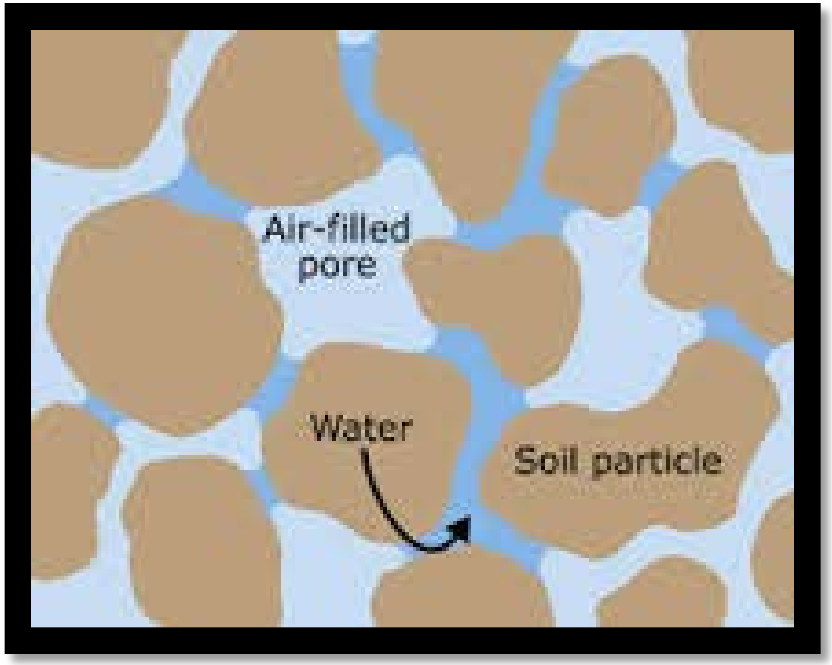
Soil texture (sand vs. silt vs. clay) has little if any influence on plant water use.

TRUE or FALSE?

TRUE

States of Soil Water Content





Plant-Soil-Water Interactions

- Soil texture defines soil water reservoir
- Soil structure & texture affect rooting depth
- Defines soil water reservoir capacity
- Difficult to quantify accurately
- General assumptions
  - Active rooting depth based on plant type
  - 1.5 in. plant-available water per ft. of soil

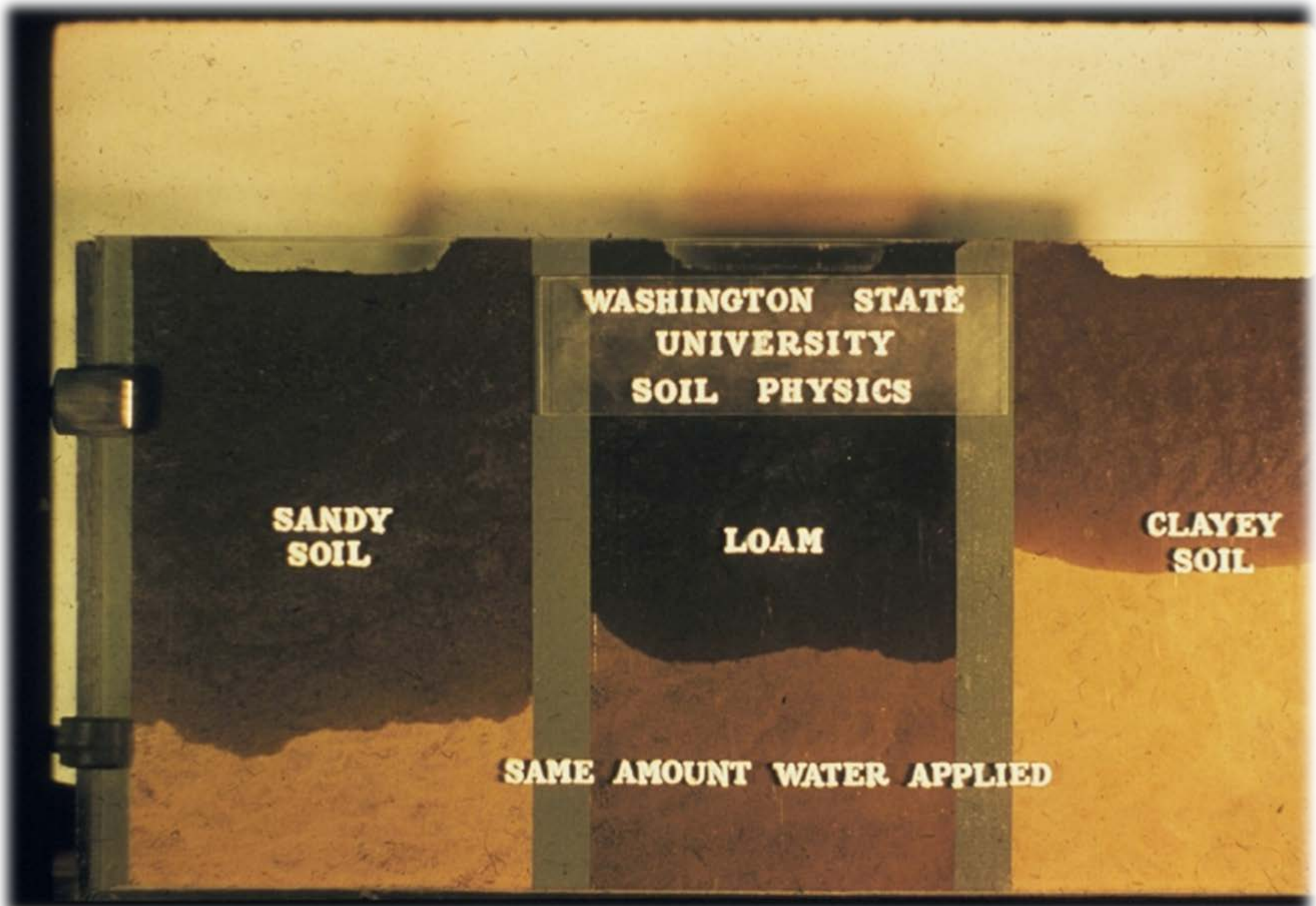
Approximate Effective Root Depths

- *Turfgrass:* 6-24 inches
  - Cool-season: 6-12 inches
  - Warm-season: 12-24 inches
- *Perennials:* 12 inches
- *Groundcover, Shrubs, Vines*: 12-24 inches
- *Trees:* 12-24 inches
- *Bedding Plants*: 6 inches
- *Vegetables, Strawberries & Similar Crops*
  - Leafy & root crops: 6 inches
  - Fruiting veg. & small fruits: 9-12 inches

Soil Water Holding Characteristics

	Inches of water per foot of soil		Gallons of water per cubic foot of soil
Soil Texture	Plant-available	Plant-unavailable	
Sand, Fine Sand	0.4-1.0	0.2-0.8	0.33-0.66
Sandy Loam	0.9-1.5	0.9-1.5	0.66-1.00
Loam	1.3-2.0	1.4-2.0	1.00-1.25
Silt Loam	2.0-2.1	2.0-2.4	1.25-1.33
Clay Loam	1.8-2.1	2.4-2.7	1.25-1.50
Clay	1.8-1.9	2.7-3.0	1.33-1.66

Source: Table 3.5, U.C. Calif. Master Gardener Handbook 2nd ed.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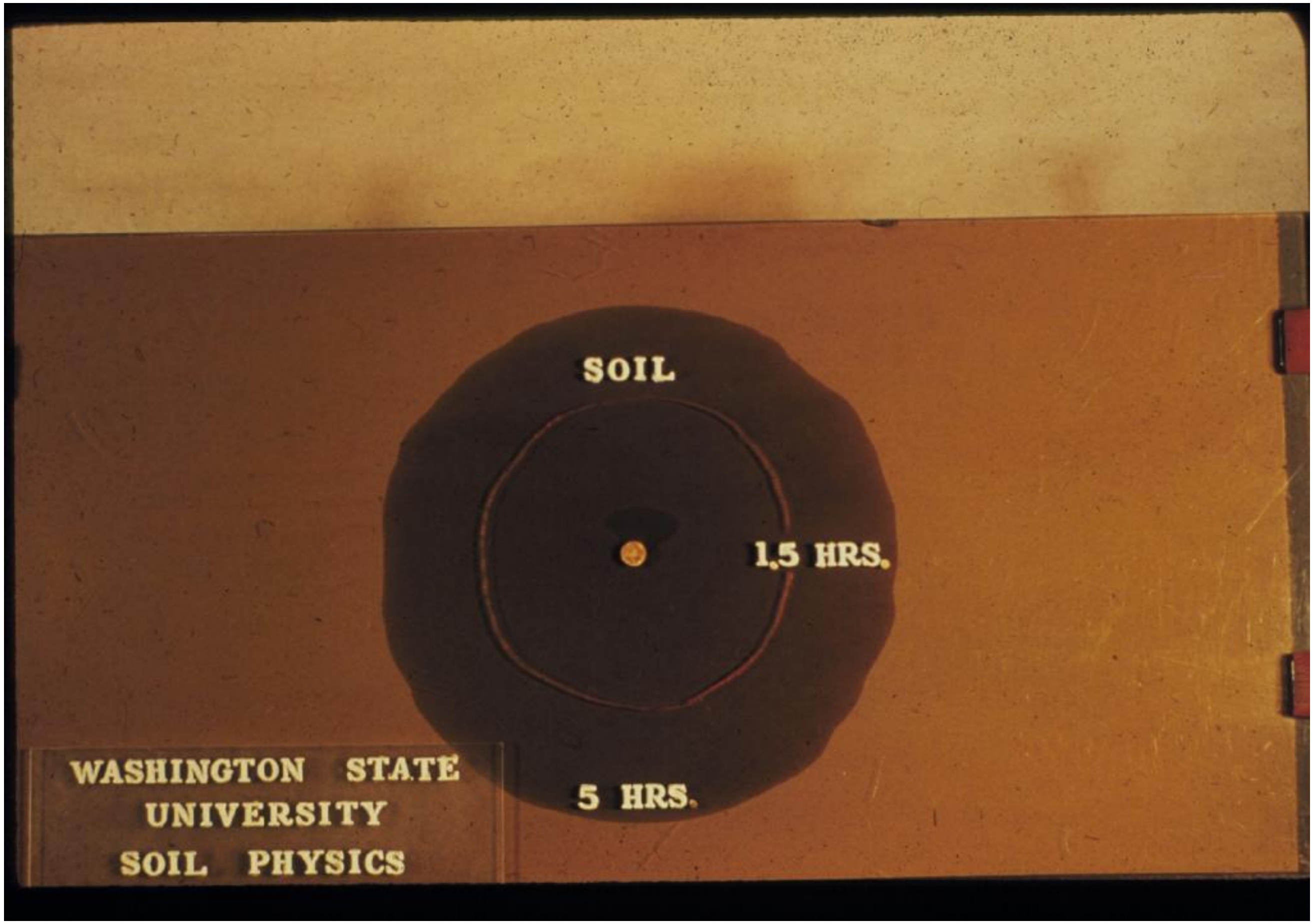
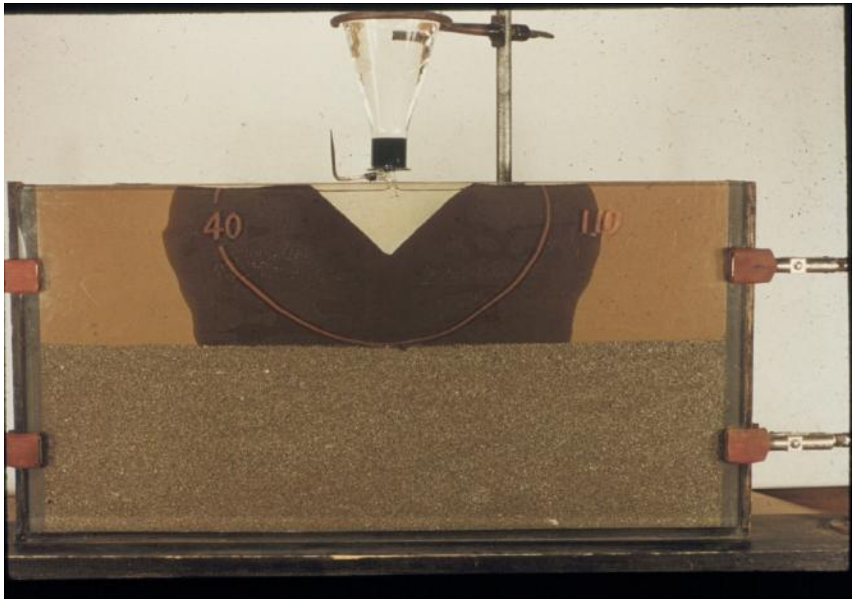
SANDY
SOIL
LOAM
CLAYEY
SOIL
SAME AMOUNT WATER APPLIED

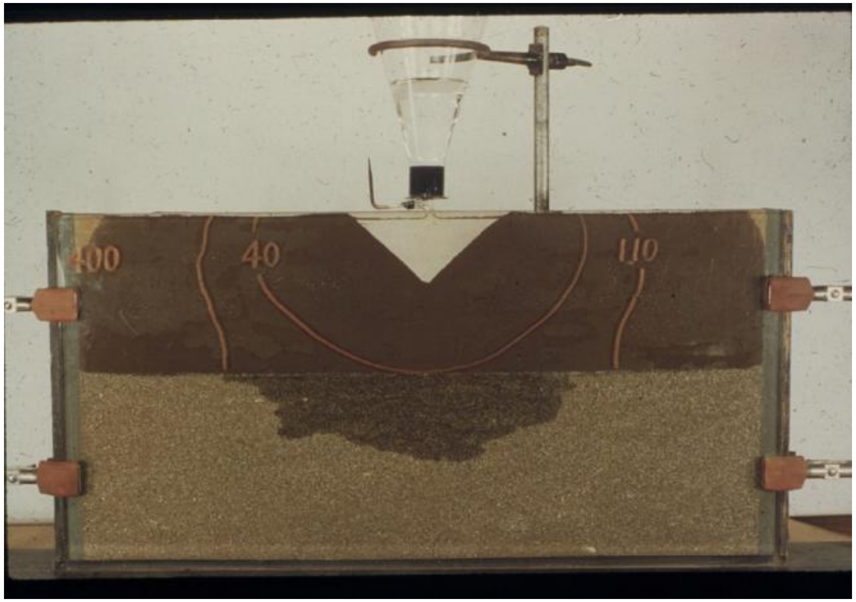
Water Movement in Uniform Soil



Water Movement in Layered Soil

Fine over coarse soil





Plants require irrigation when.....

.....performance expectations exceed plant adaptation to precipitation

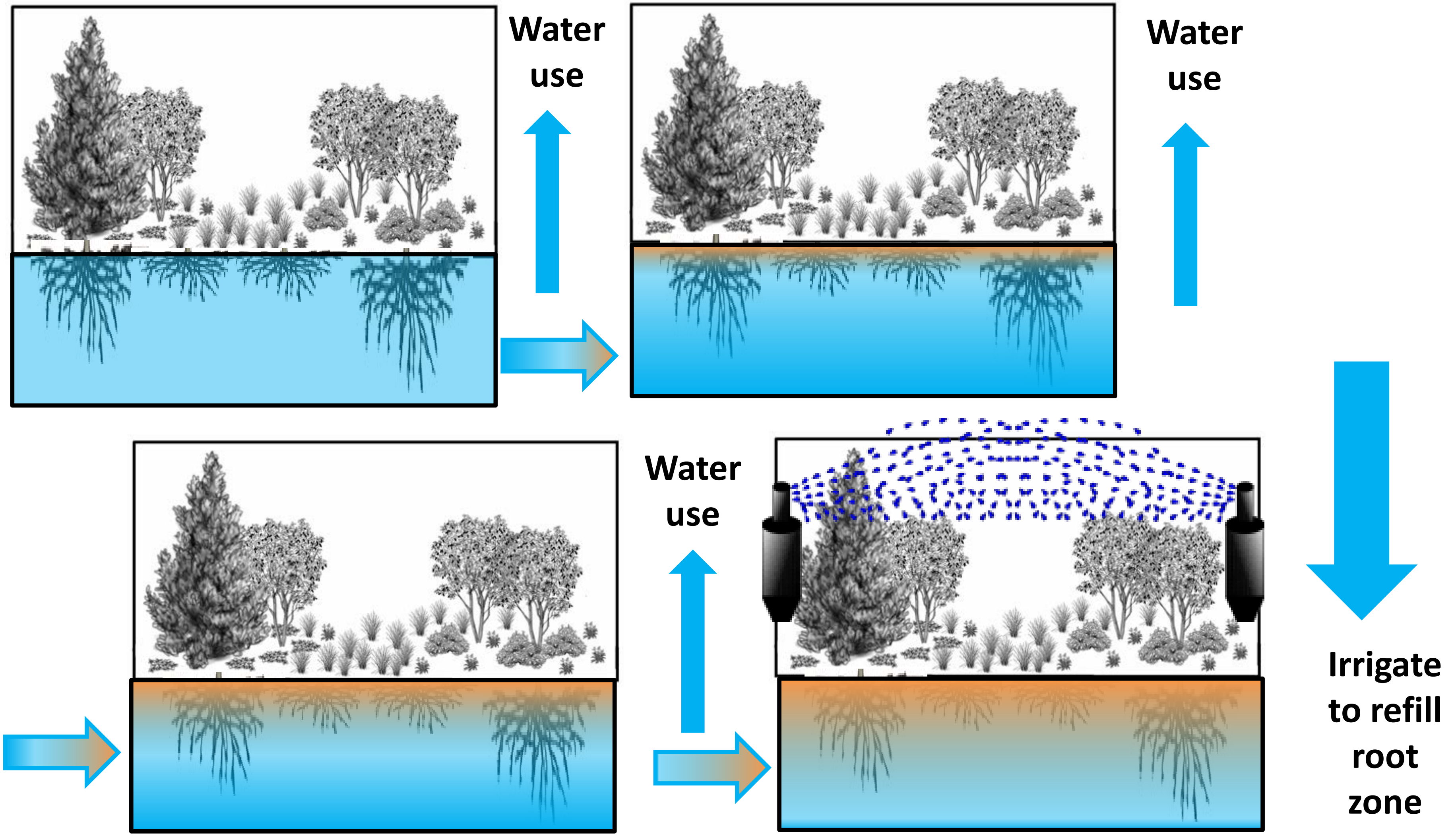
Expectations and Design Intent determine landscape water need

Irrigation Scheduling & Management

Apply water in the <u>amount</u>…

and

…at the <u>interval</u> needed



Irrigate before plant performance affected – *deplete 30-70% avail. water*

Irrigation Scheduling & Management

- How much? How often?
- Irrigate 11 PM – 6 AM
- Set July runtime & cycles
- Global % adjust monthly
- Adjust interval every 2-3 mos.

Factors Affecting Scheduling

- Root system depth – how much
- Soil type (texture) – how much
- ETo (weather) – how often
- Plant type/PF – how much & how often
- Planted area or canopy area – how much
- Plant drought resistance, desiccation tolerance & expected performance
- Irrigation system – drip vs. spray & unformity

Irrigation Scheduling Approach

- Set controller for July schedule
- Adjust 10-20% May-Jun & Aug-mid Sep
- Extend interval mid Mar-Apr & mid Sep-Oct
- Further extend interval & turn off controller Nov-mid Mar with rain

Irrigating Turfgrass

- *No* lawn requires daily irrigation (except desert)
- 3 days/wk. in summer
- Warm-season grasses less often

Approximate Irrigation Intervals

June-July-August

- Overhead Irrigation
  - Turfgrass:
    - Cool-season 2-3/wk.
    - Warm-season: 5-10 days
  - Perennials: 4-6 days
  - Tree/Shr/Grcvr: 10-21 days
- Drip Irrigation
  - *Non-grid:* 2-5 days
  - *Grid:* see Overhead

Rewet soil to root system at depth each irrigation!!

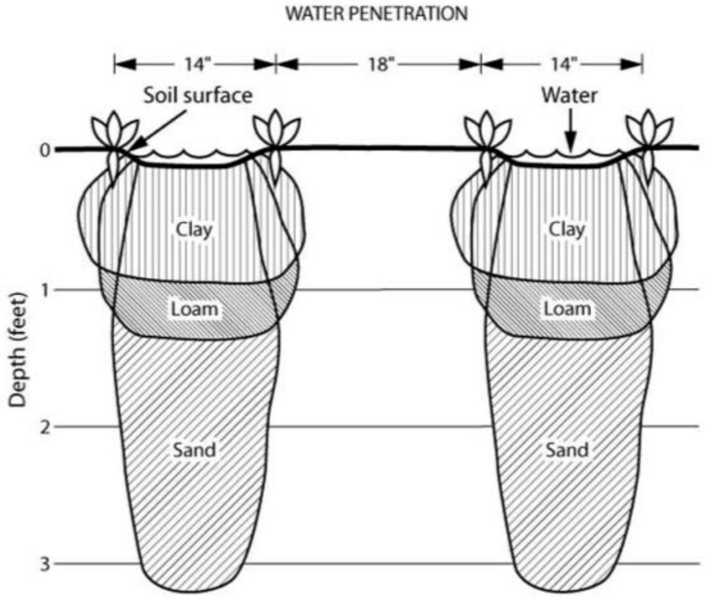
Drip Irrigation Management

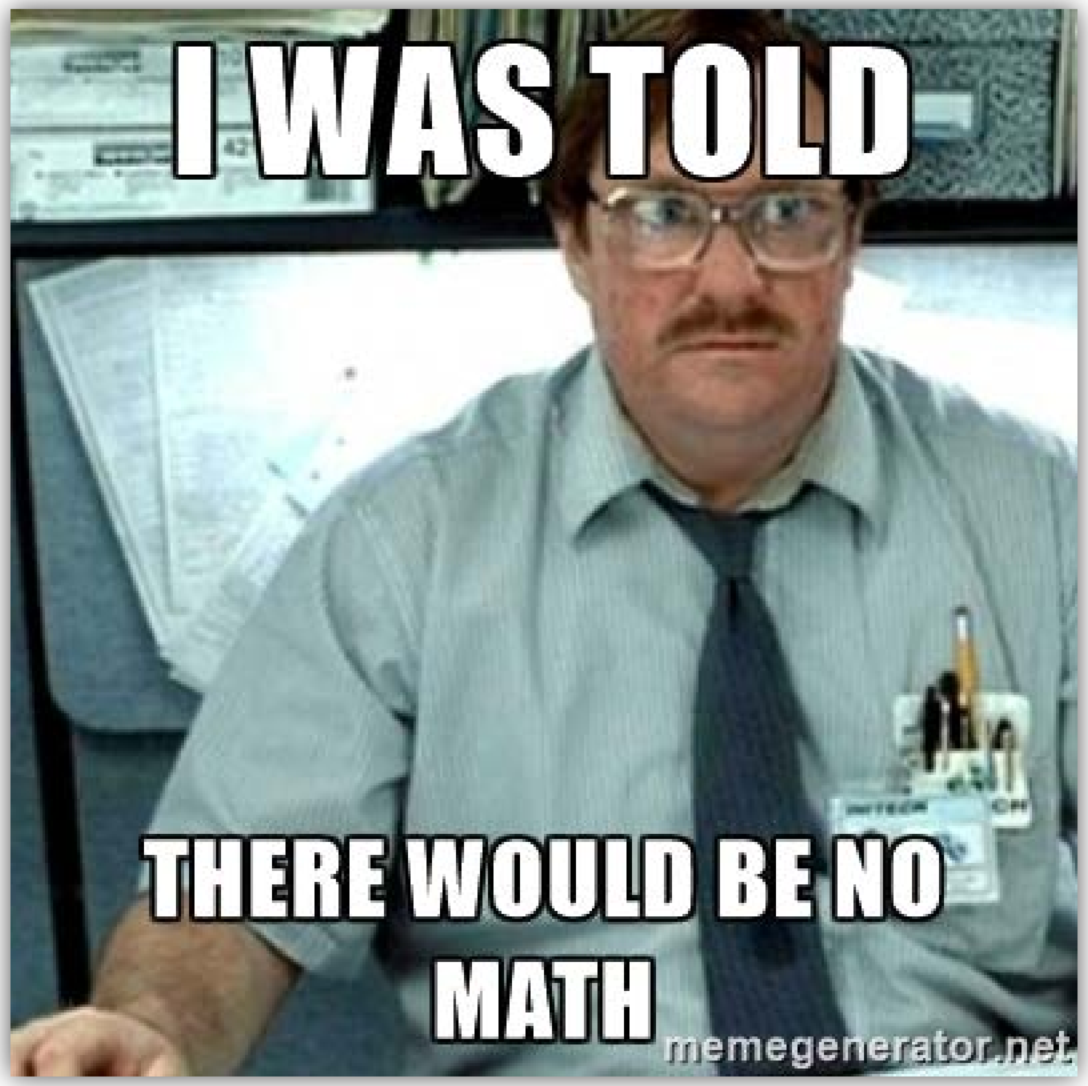
- Wet at least 50% of root area but full depth
- Keep soil moist (not saturated) in wetted zones
- More frequent with less wetted area
  - *Summer*: every 2-5 days
  - *Winter*: once per 2 wks. or less frequent
  - Grid design irrigates less frequently

Drip Irrigation Management

- Check wetting pattern & add/move emitters as plants grow
- Check for watering below roots

Same Amount of Water




I WAS TOLD
THERE WOULD BE NO MATH
memegenerator.net

Estimating Landscape Water Requirement

Accurate and Simple Equations

$$\textbf{Gallons} = \textbf{ETo} \times \textbf{PF} \times \textbf{LA} \times 0.623$$

$$\textbf{Inches} = \textbf{ETo} \times \textbf{PF}$$

- ETo = reference evapotranspiration; climate impact
- PF = plant material adjustment factor from ANSI/ASABE S623
- LA = sq. ft. landscape area
- 0.623 = converts depth to volume [gal. ÷ (in. x sq. ft.)]

Landscape Plant Factors (PF)

Plant Factors (Fraction of ET_o) for estimating water required to maintain acceptable appearance of established landscape plants	
Plant Type	**Plant Factor**
Turf-Cool Season	0.8
Turf-Warm Season	0.6
Woody/Herb. Peren'ls.- Humid	0.7
Woody /Herb. Peren'ls.- Arid	0.5
Desert plants	0.3

ANSI/ASABE Standard S623 & SLIDE Rule #2

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water amount = ETo ✕ Plant Factor ✕ Area

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Questions & Answers About Drought & Water Conservation

Q. How much water do landscapes use in California?

A. Landscape irrigation accounts for only about 9% of total statewide developed water use, but the percentage varies widely among communities. Water applied to landscapes is estimated to account for about 50% of residential water consumption statewide, but the amount varies from about 30% in some coastal communities to 60% or more in many inland suburban communities.

Q. What are some easy things I can do to save water in a landscape?

A. Check the irrigation system regularly for leaks as well as physical and operational problems that reduce the efficiency and function of sprinklers, drip emitters, and other water delivery devices. Correcting these problems can reduce water use by 10% or more, improve the uniformity of water application, and likely improve the health of plantings. Check that automatic valves are functioning and repair any

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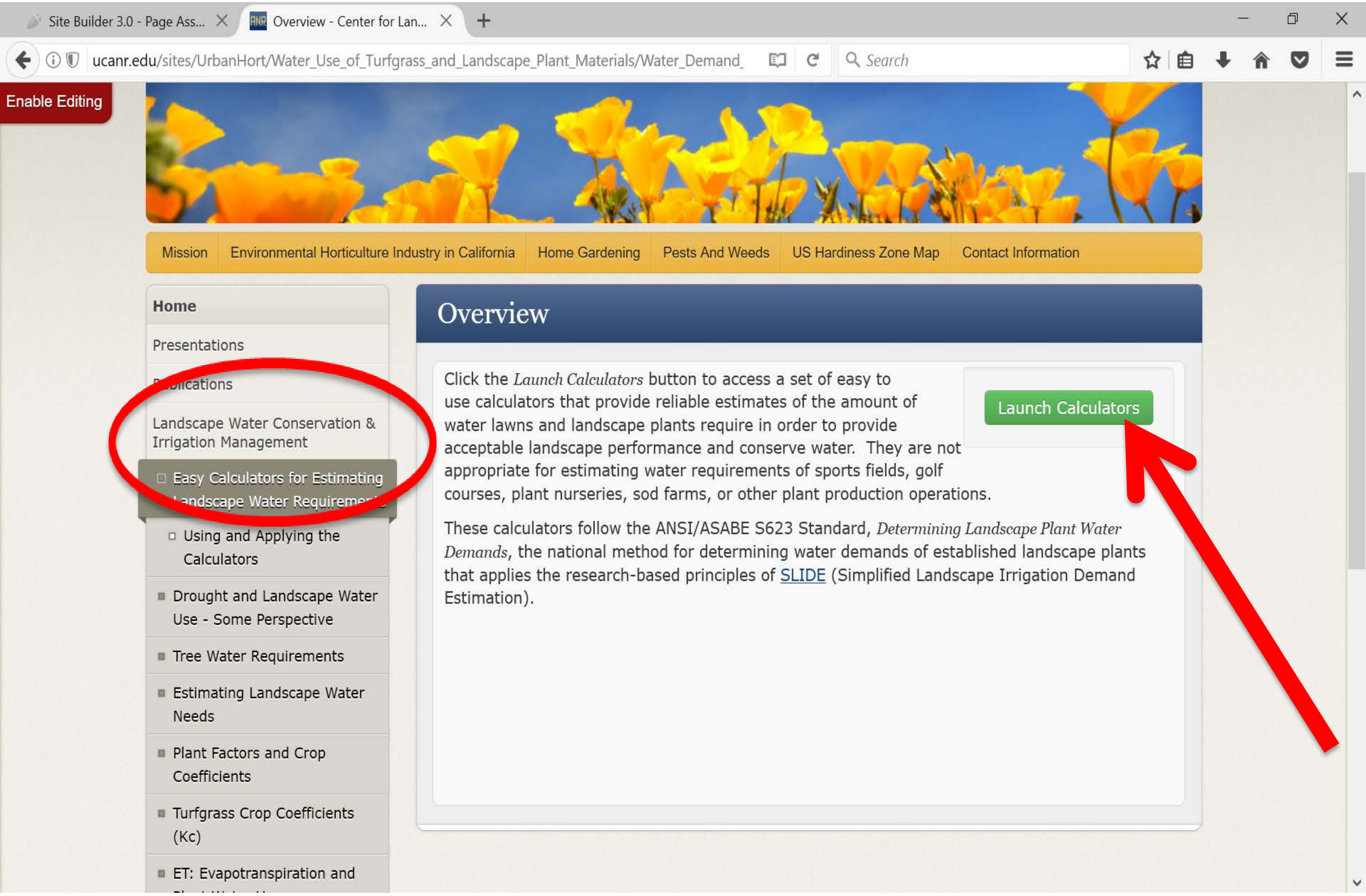

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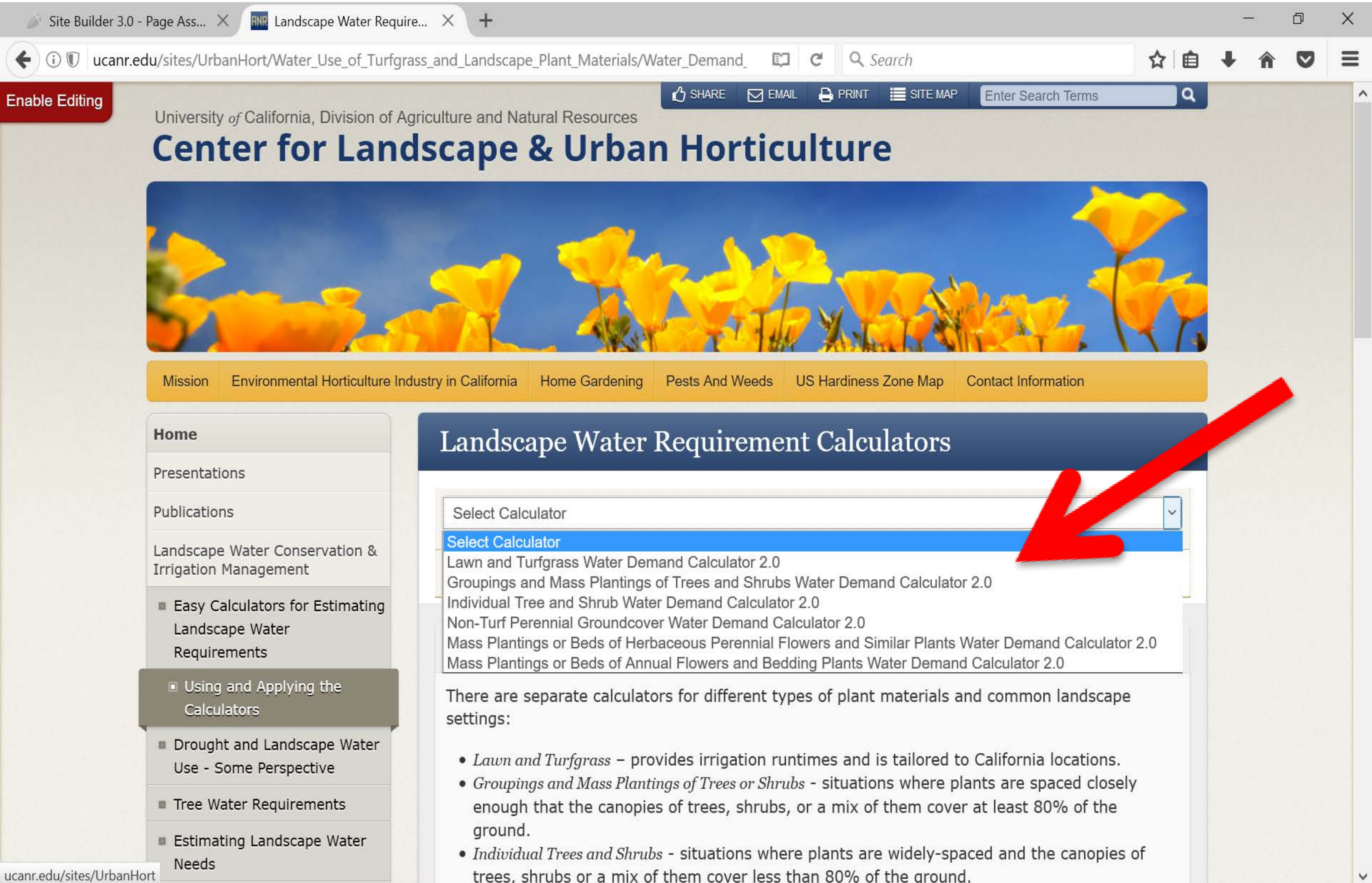

Basic Irrigation Scheduling Equations

$$\text{Amount to Apply (in.)} = \frac{\text{in. water held}}{\text{foot of soil}} \times \text{root depth (ft.)} \times 0.5$$

$$\text{Interval (days)} = \frac{\text{amount to apply (in.)}}{\text{ETo} \times \text{PF}}$$

$$\text{Runtime Minutes} = \frac{\text{amt. to apply} \times 60}{\text{in. applied per hr.} \times \text{efficiency \%}}$$

Irrigation Scheduling Equation

$$\textbf{Runtime Minutes} = \frac{\textbf{in. or gal. to apply} \times 60}{\textbf{in. or gal. applied per hr.} \times \textbf{efficiency \%}}$$

- Calculate Runtime Minutes per week or other period
- *Inches* for spray and overhead systems
- *Gallons* for drip systems
- Spay & overhead Efficiency %: start with 60% (0.6)
  - *Adjust Efficiency % after observation or system upgrade*
- Drip Efficiency ≈ 90% (0.9)

Spray Irrigation Scheduling Example

$$\textbf{Runtime Minutes} = \frac{\textbf{in. or gal. to apply} \times \textbf{60}}{\textbf{in. or gal. applied per hr.} \times \textbf{efficiency \%}}$$

- 2,500 sq. ft. of tall fescue turfgrass
- ETo avg. 0.2 in./day
- System applies about 2.0 in./hr.
- Allow 50% of soil water to deplete
- ***How long and how often do I irrigate?***

Spray Irrigation Scheduling Example

- Assume 9 in. root depth
- Assume 1.5 in./ft. soil water holding capacity
- Amount = 1.5 in. per ft. × 0.75 ft. × 0.5 = ***0.6 in.***
- $\text{Interval (days)} = \frac{\text{inches to apply}}{\text{Daily ETo} \times \text{Plant Factor}} = \frac{0.6 \text{ inches}}{0.2 \times 0.8}$ = ***3.8 days***
- $\text{Runtime (min.)} = \frac{0.6 \text{ in.} \times 60}{2.0 \text{ in. applied per hr.} \times 0.8 \text{ efficiency}}$ = ***22.5 min.***
- ***Irrigate 23 minutes every 4 days***

(3 cycles @ 8 min. OR 4 cycles @ of 6 min. to avoid runoff)

Drip Irrigation Scheduling Example

$$\textbf{Runtime Minutes} = \frac{\textbf{in. or gal. to apply} \times \textbf{60}}{\textbf{in. or gal. applied per hr.} \times \textbf{efficiency \%}}$$

- 1,500 sq. ft. of trees and shrubs (150 ft. x 10 ft.)
- ETo avg. 0.2 in./day
- *System:* applies 750 gal./hr. = 0.8 in./hr.
  - 5 drip lines, 2 ft. apart 150 ft. long, emitters 1 ft. in-line
  - 750 emitters; 1 gal./hr. emitters
- Allow 25% of soil water to deplete
- ***How many long and how often do I irrigate?***

Drip Irrigation Scheduling Example

- Assume 1 ft. (12 in.) root depth
- Assume 1.5 in./ft. soil water holding capacity
- Amount = 1.5 in. per ft. × 1.0 ft. × 0.25 = ***<u>0.4 in.</u>***
- $\text{Interval (days)} = \dfrac{\text{inches to apply}}{\text{Daily ETo} \times \text{Plant Factor}} = \dfrac{0.4\ \text{inches}}{0.2 \times 0.5}$ = ***<u>4 days</u>***
- $\text{Runtime (min.)} = \dfrac{0.4\ \text{in.} \times 60}{0.8\ \text{in. applied per hr.} \times 0.9\ \text{efficiency}}$ = ***<u>33 min.</u>***
- ***Irrigate 33 minutes every 4 days***

  (1 cycle of 33 minutes)

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