# MASTER GARDENER WATER QUALITY TRAINING MODULE #3

# URBAN LANDSCAPE IRRIGATION

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Portions of Presentation Provided by Loren Oki, Ph.D.
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# Questions

1. How much water do my plants need during various times of the year?

   **It depends.**

# Questions

1. How much water do my plants need during various times of the year?
2. How often and how much water should be applied?

   **It depends.**

# Topics

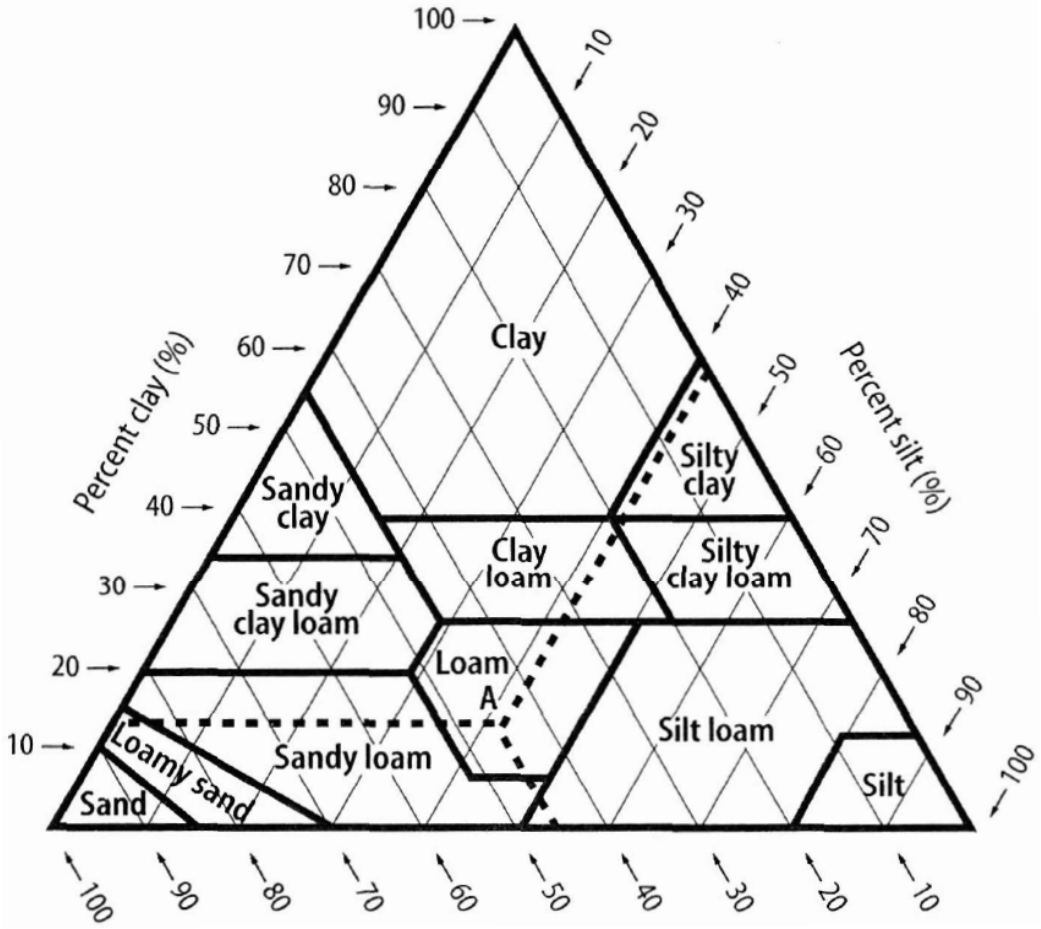
- Soil water effects on plant growth
- Irrigation systems
- Managing irrigation to optimize water use

# Soil Water Effects on Plant Growth

- Soil Moisture
  - Soil textural classes
  - Types of soil moisture
  - Soil moisture constants
- Plant Water Movement
  - Soil-Plant Water Potential

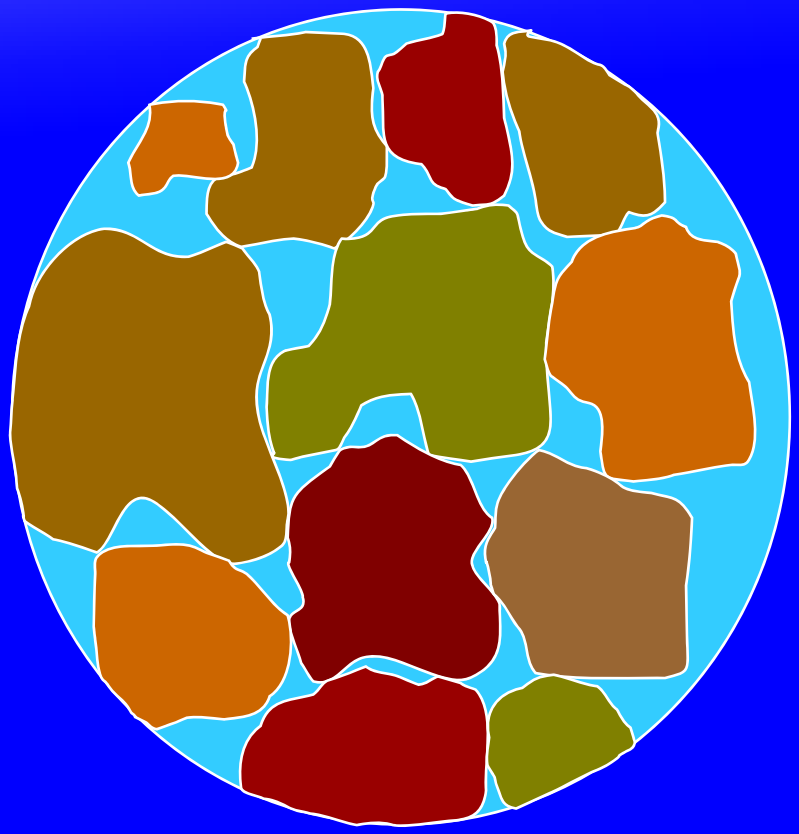
## Figure 3.3

*Soil textural classes.* The chart shows the percentages of sand, silt, and clay in the 12 basic soil textural classes, according to the USDA. Although organic matter may have a significant effect on a soil's physical properties, it is not considered in defining the soil's textural class. Each class is represented by an area in the textural triangle diagram. Thus, two soils may have the same texture but different particle size distributions. *Source:* After Wildman and Gowans 1978, p. 3.



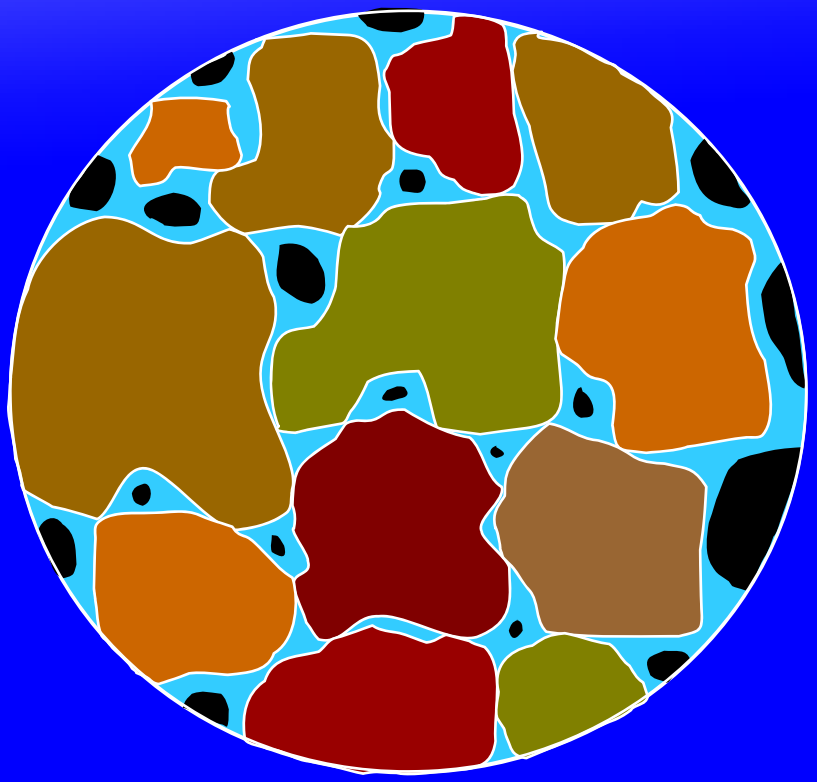
# Types of Soil Moisture

# Gravitational Water



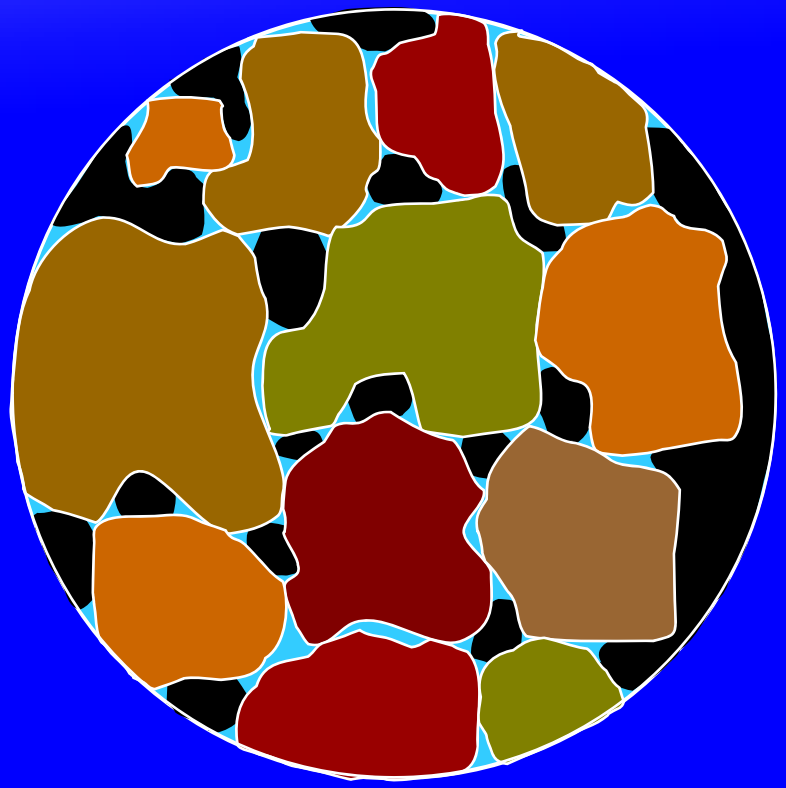
- Free water around soil particles and in soil pores
- Not normally utilized by plants
- Fills all available air space
  - Overwatering

# Capillary Water



- Water in soil pores or around particles in thick film
- Available to plants for growth and transpiration

# Hygroscopic Water

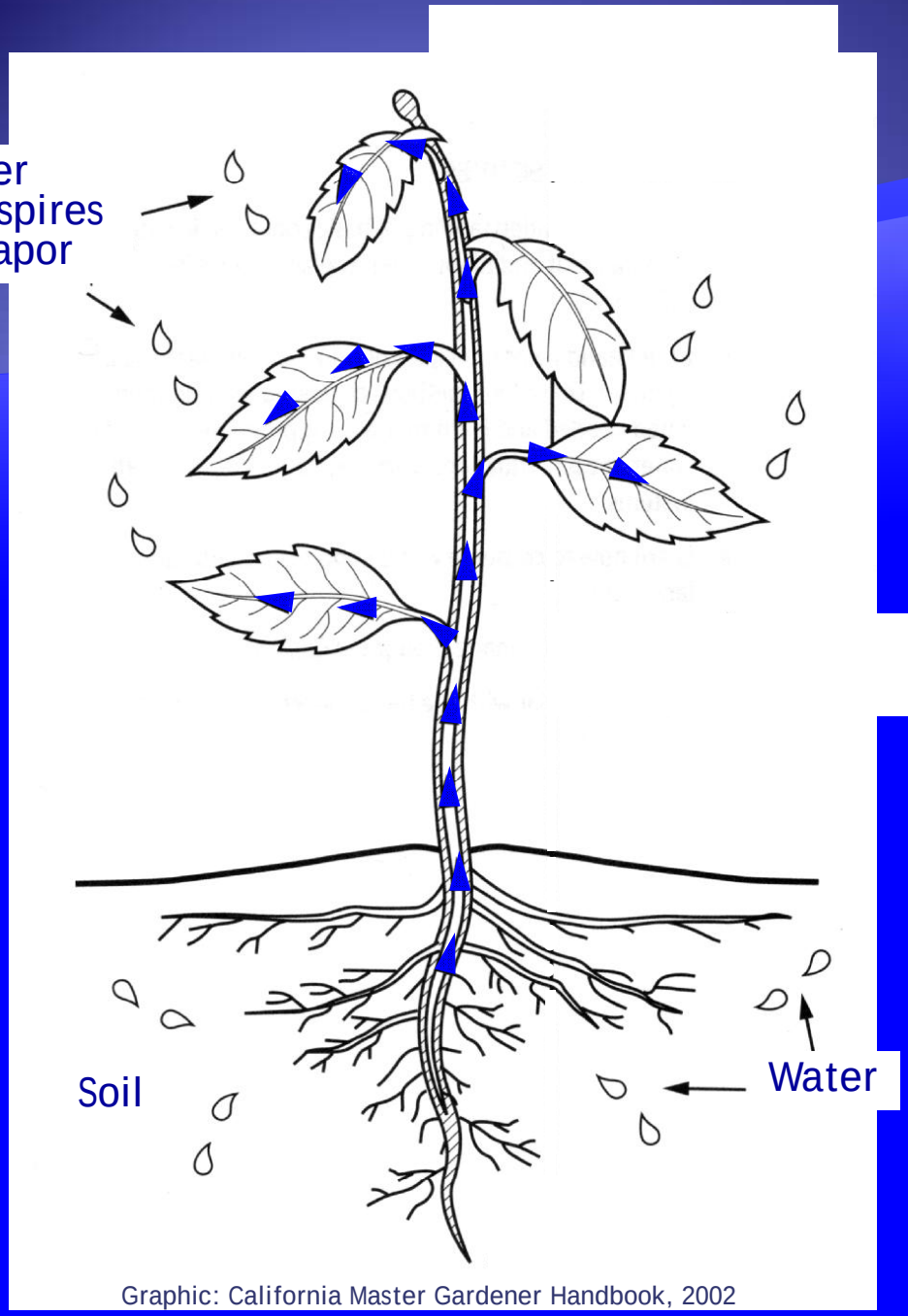


- Very thin film of water around soil particles
- Not usually available to plants
- Water is held very tightly to the soil

# Soil Moisture Constants

- Soil saturation
  - Soil can not hold any more water
- Field Capacity
  - Moisture content after gravity removes water
- Wilting Point
  - Plants can not remove enough water to keep from wilting
- Hygroscopic %
  - Moisture content of soil when air dry
- Oven Dryness

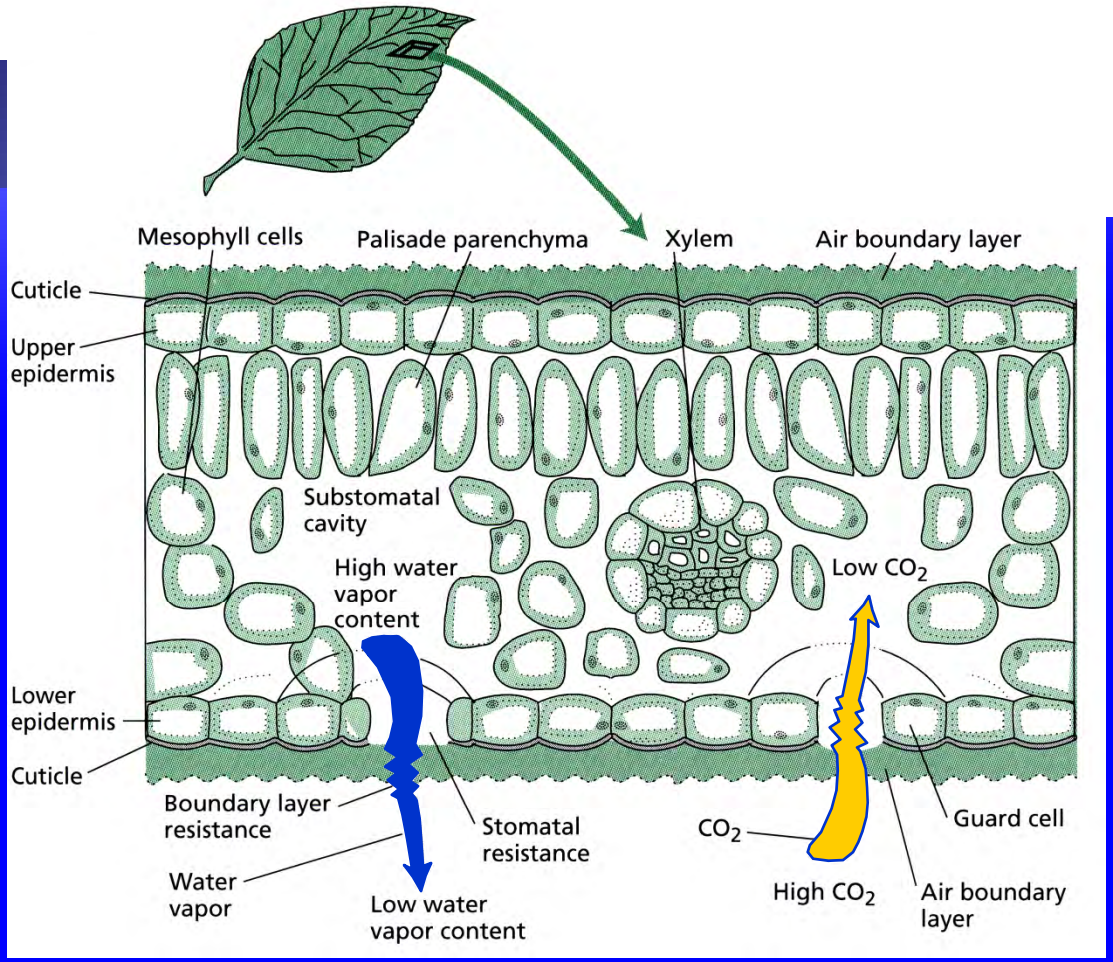
# Soil-Plant-Atmosphere continuum




Graphic: California Master Gardener Handbook, 2002

- Why do plants need water?
- How does water move up a plant?

# Plant Water Relations




- $CO_2$ is necessary for photosynthesis
- Water is lost as $CO_2$ is taken into the leaves

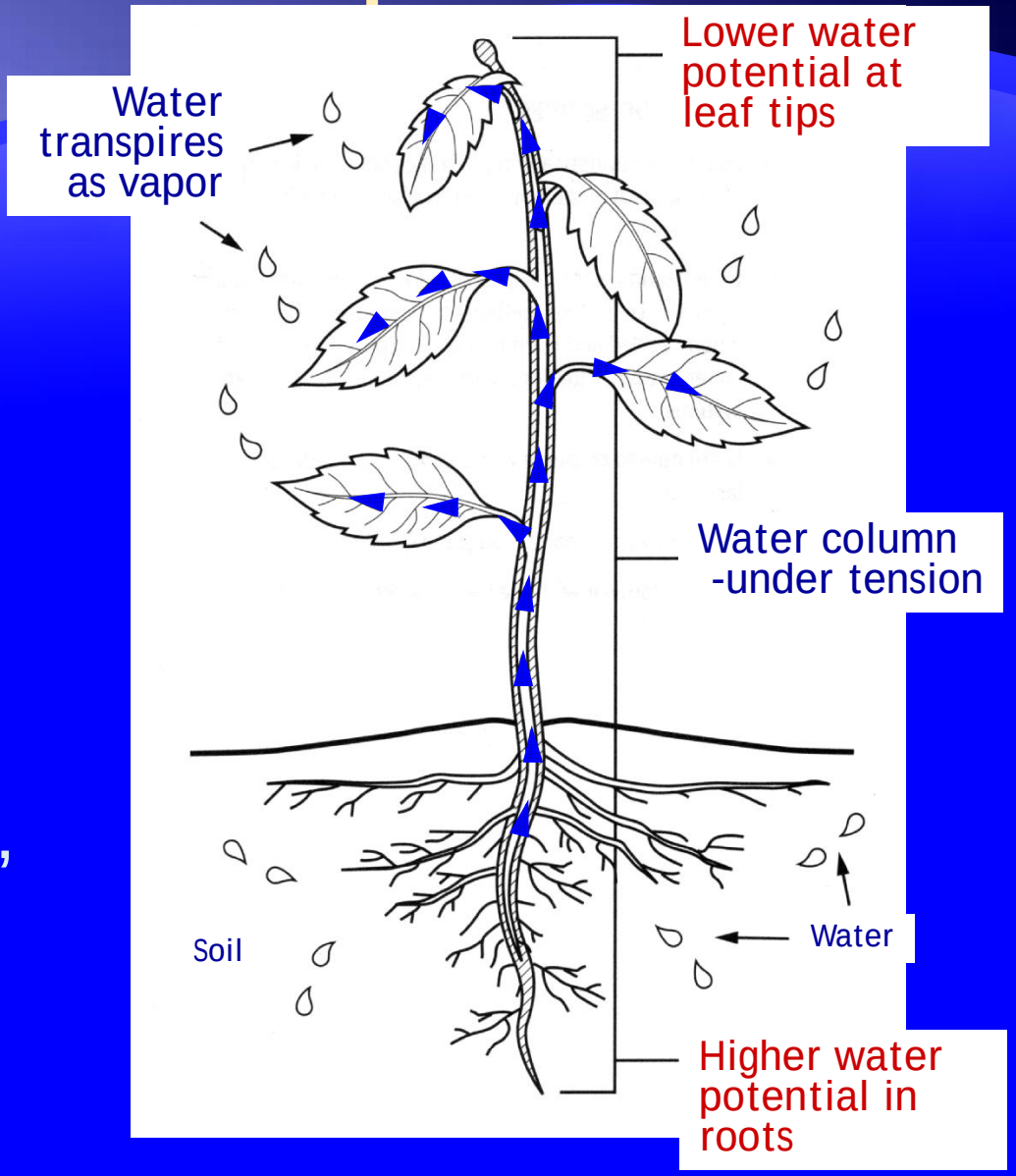
Graphic adapted from: Taiz & Zeiger, Plant Physiology, 2nd ed, 1998

# The concept of water potential

Potential energy components of water in substrates

- Matric potential
- Gravimetric potential
- Solute potential

Water will "flow" down an energy gradient

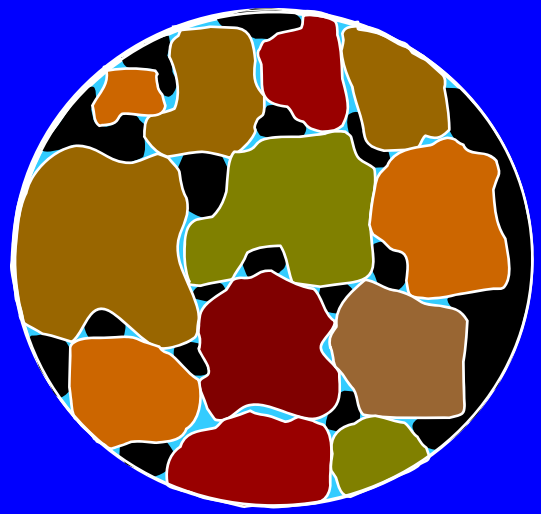



Graphic: California Master Gardener Handbook, 2002

# The concept of water potential

Potential energy components of water in substrates

- Matric potential - the energy required to remove water from the substrate



Units of measure:

Kilopascals (kPa)

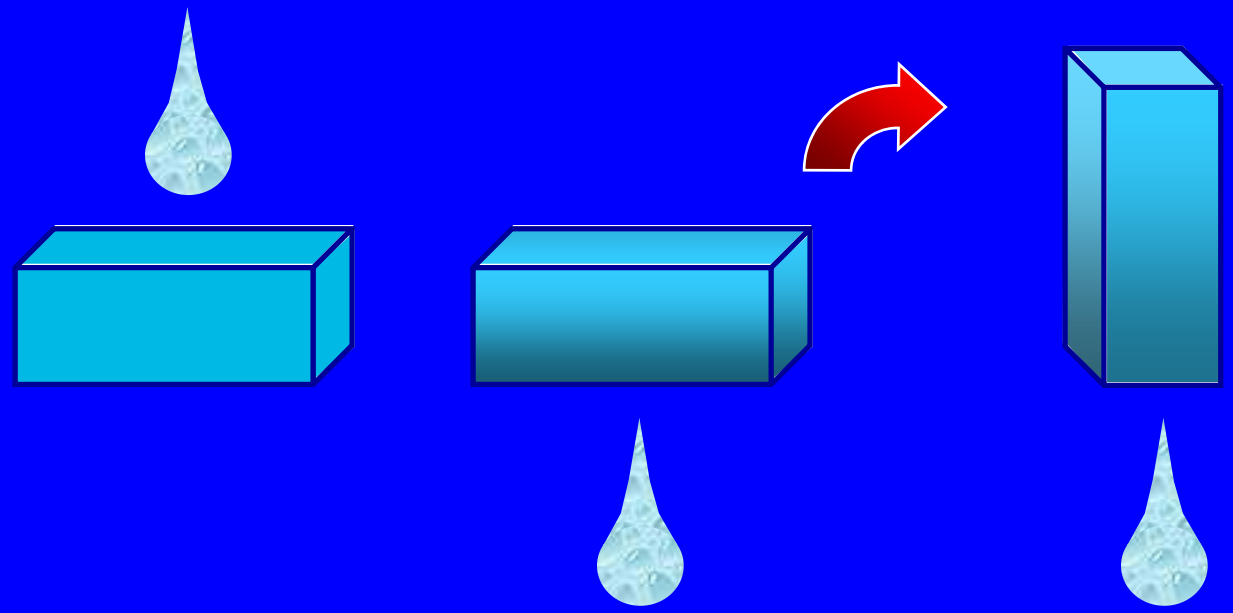
Also:
pounds per square inch (psi), bars or millibars (mbar)

Graphic: L. Oki

# The concept of water potential

Potential energy components of water in substrates

- Gravimetric potential - the energy required to "lift" water

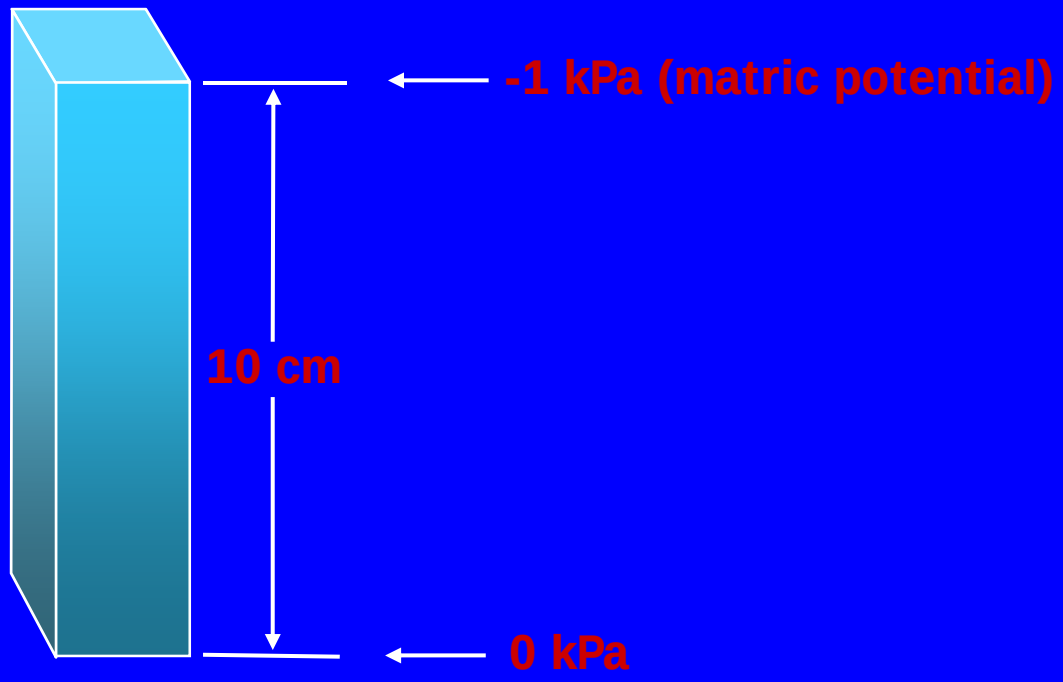


Graphic: L. Oki

# The concept of water potential

Potential energy components of water in substrates

- Gravimetric potential – relationship to height

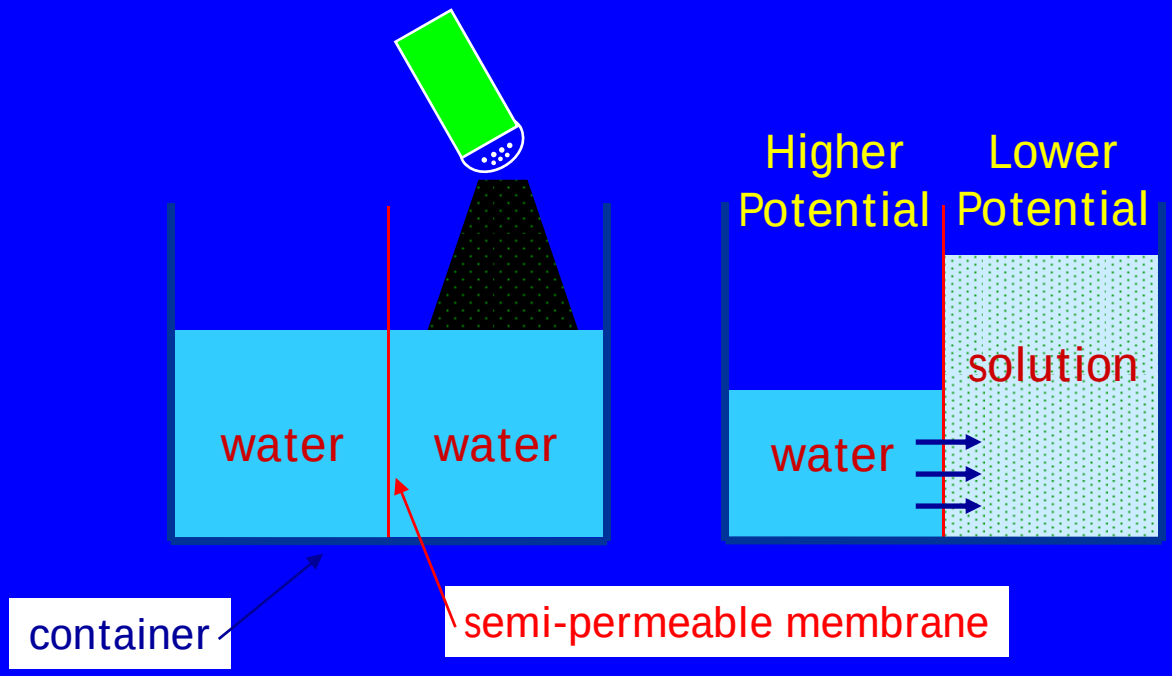



Graphic: L. Oki

# The concept of water potential

Potential energy components of water in substrates

- Solute potential - the energy required to dissolve salts

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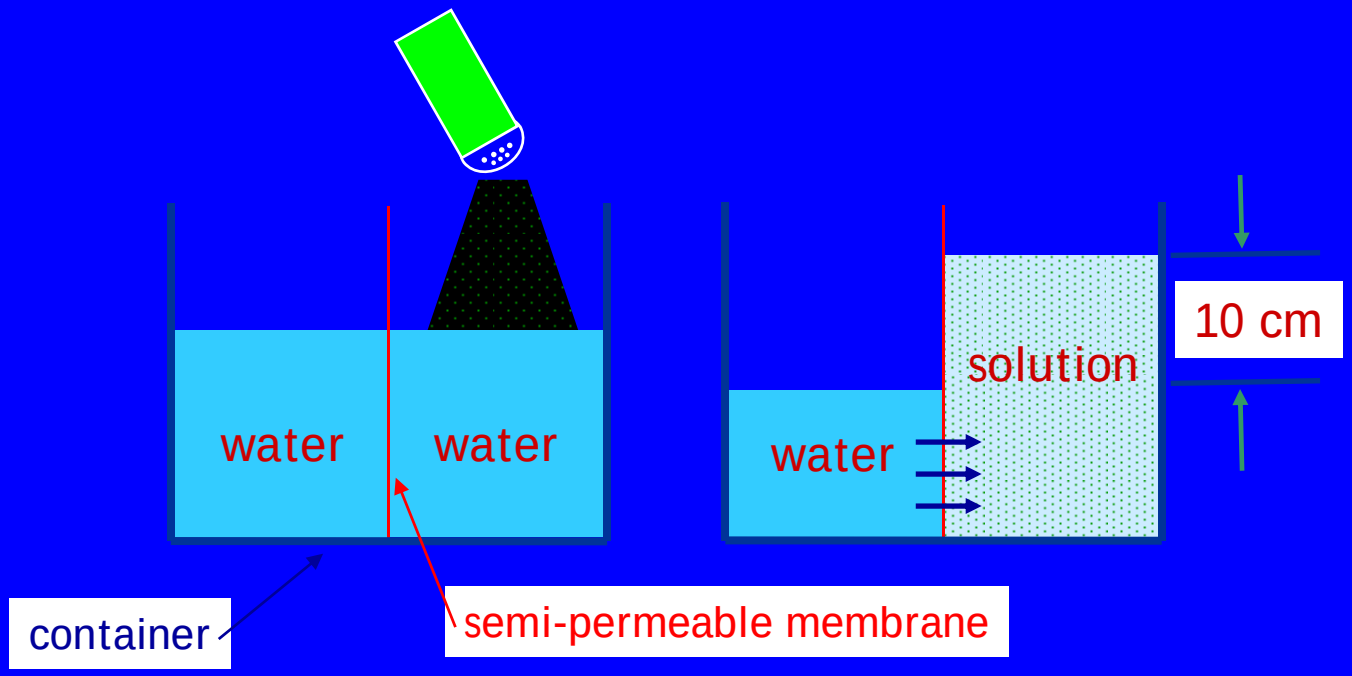


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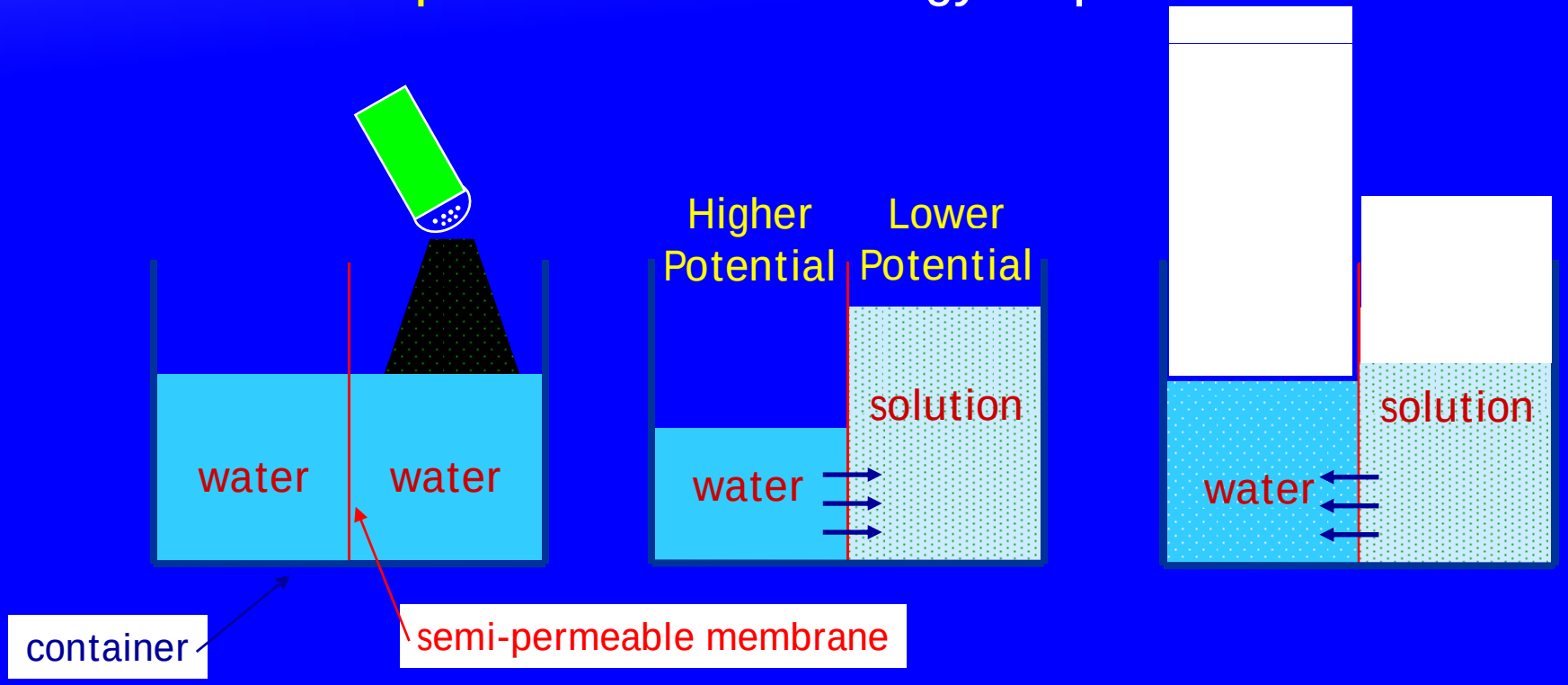



Graphic: L. Oki

# Why are water potential concepts important?

- Matric potential indicates how tightly soil holds onto water
- The effect of gravimetric potential is related to height
- Solute potential depends on the salinity of the water and soil

# Why are water potential concepts important?

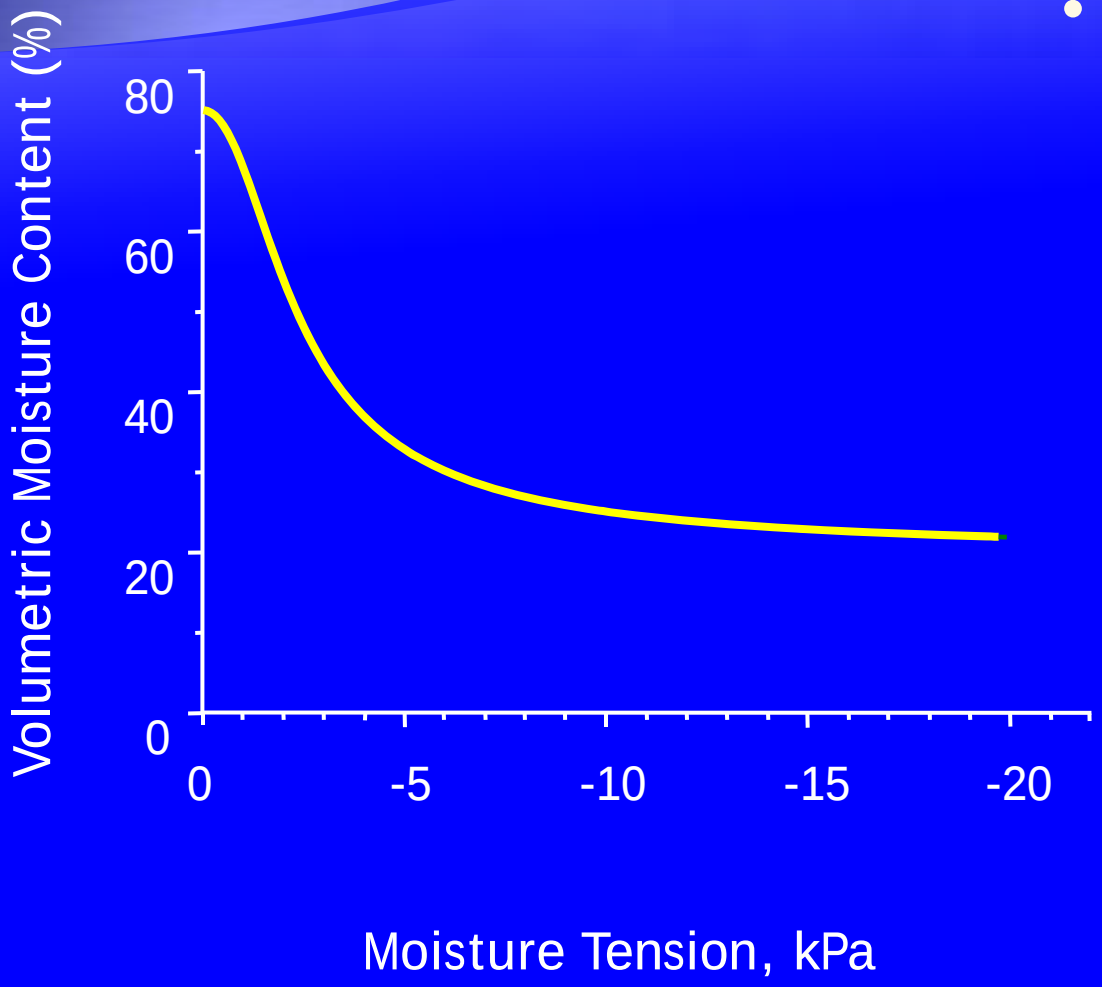
- Matric potential indicates how tightly soil holds onto water

# The concept of water potential

Understanding the **moisture retention curve**

Matric potential increases as
water content decreases

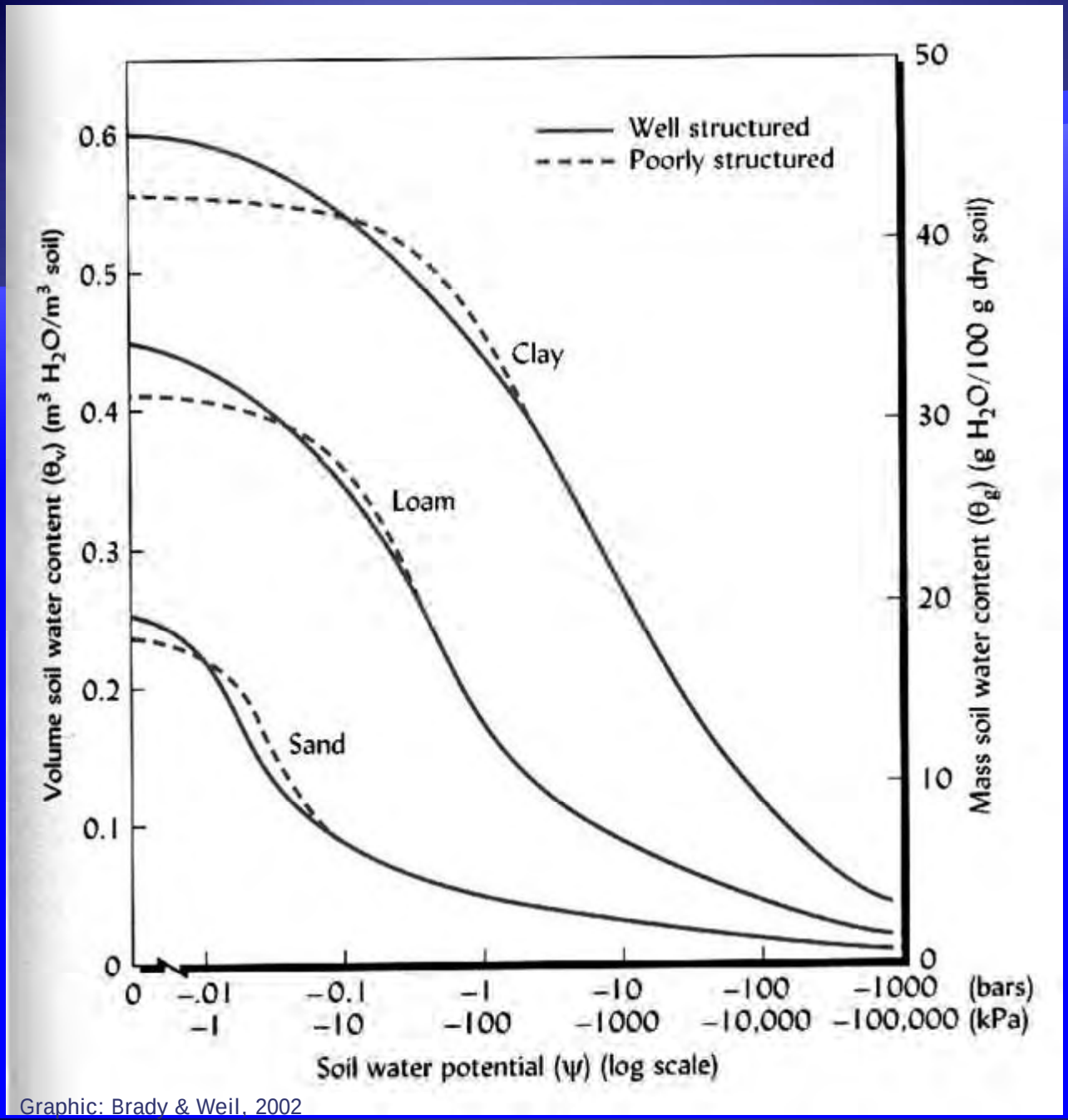
# Moisture Retention Curve




- describes the relationship between moisture content and moisture tension

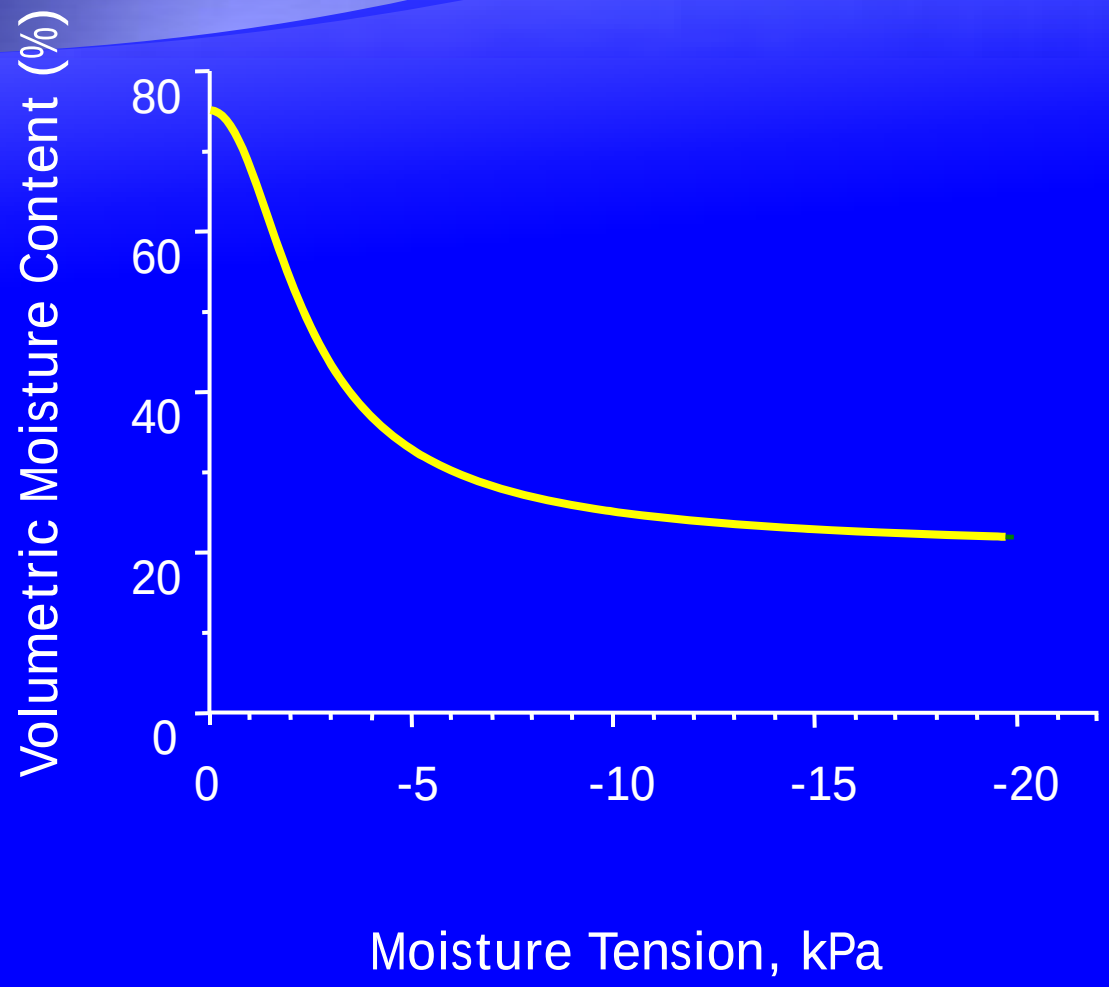
Graphic adapted from J.H. Lieth

# Moisture Retention Curve




Graphic: Brady & Weil, 2002

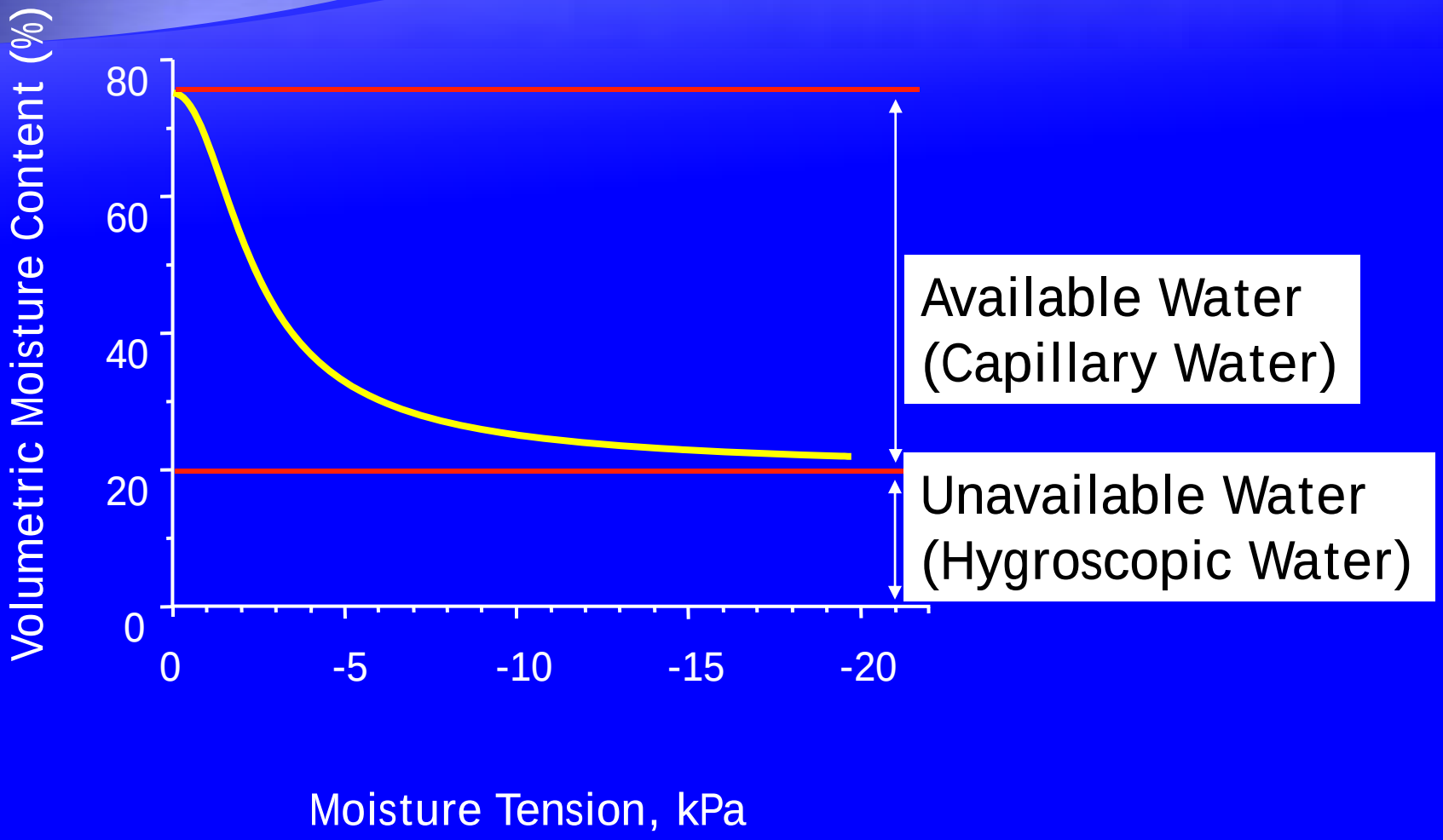
# Moisture Retention Curve




- describes the relationship between moisture content and moisture tension
- is different for every soil, but shape is similar for all potting soils

Graphic adapted from J.H. Lieth

# Moisture Retention Curve

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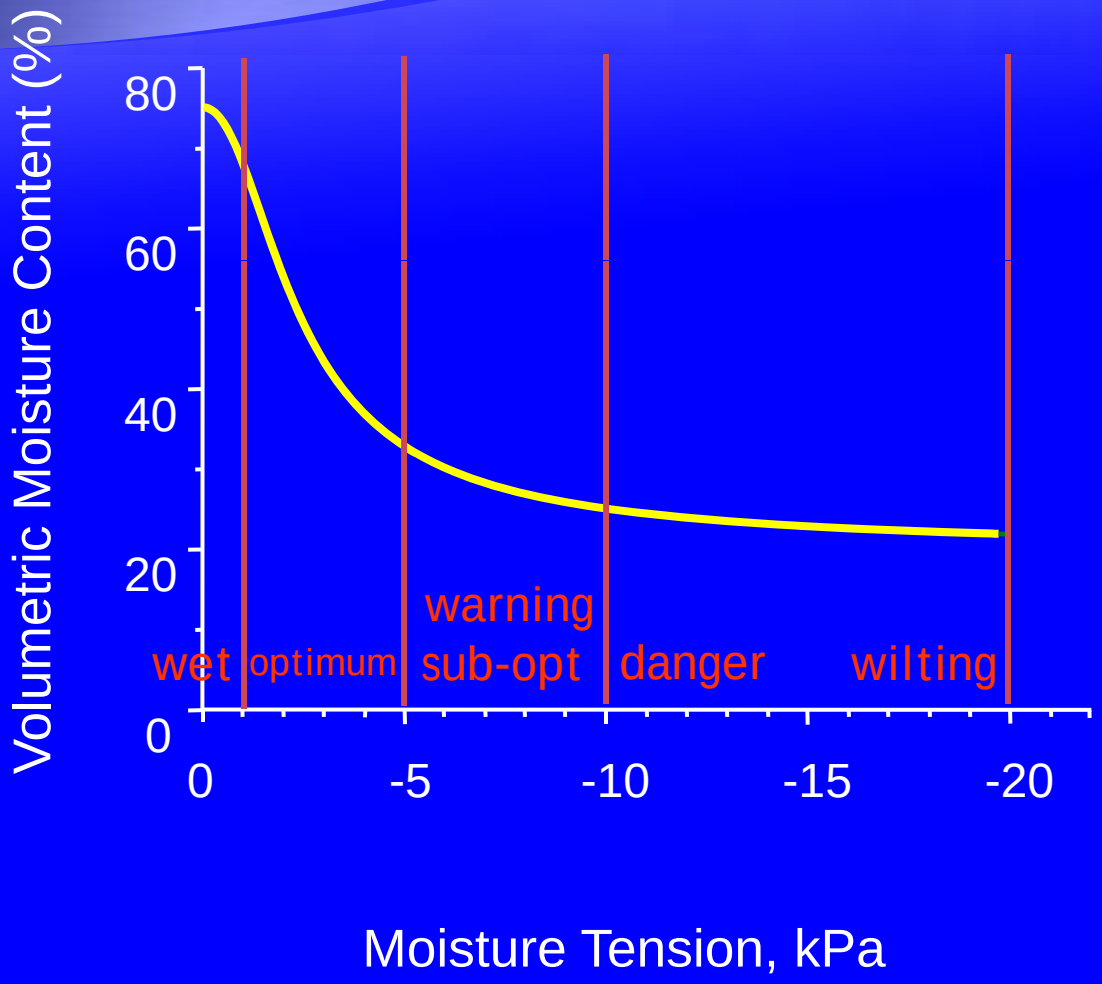
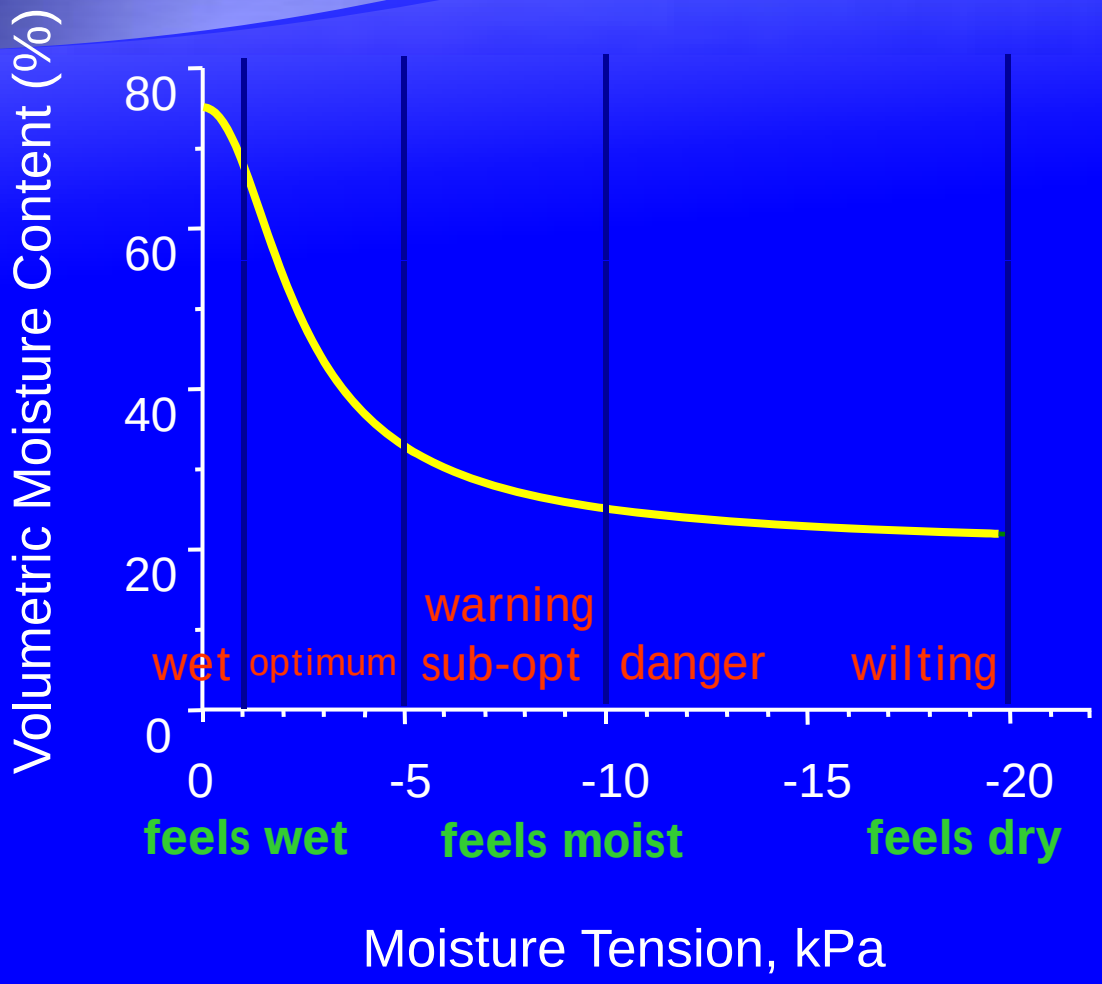



- Note how plants "feel" about different levels of moisture

Graphic adapted from J.H. Lieth

# Moisture Retention Curve




- How people sense moisture levels.

Graphic adapted from J.H. Lieth

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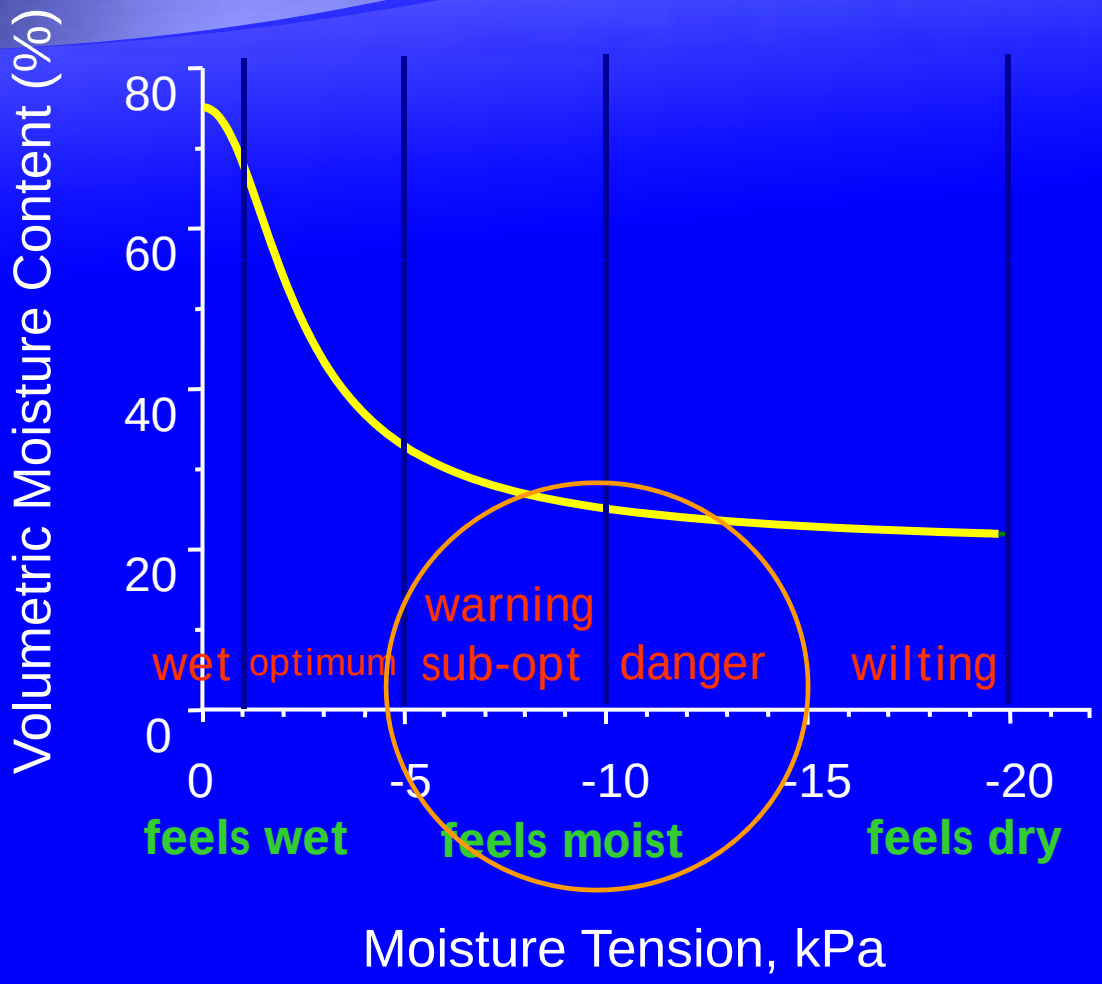


- How people sense moisture levels.

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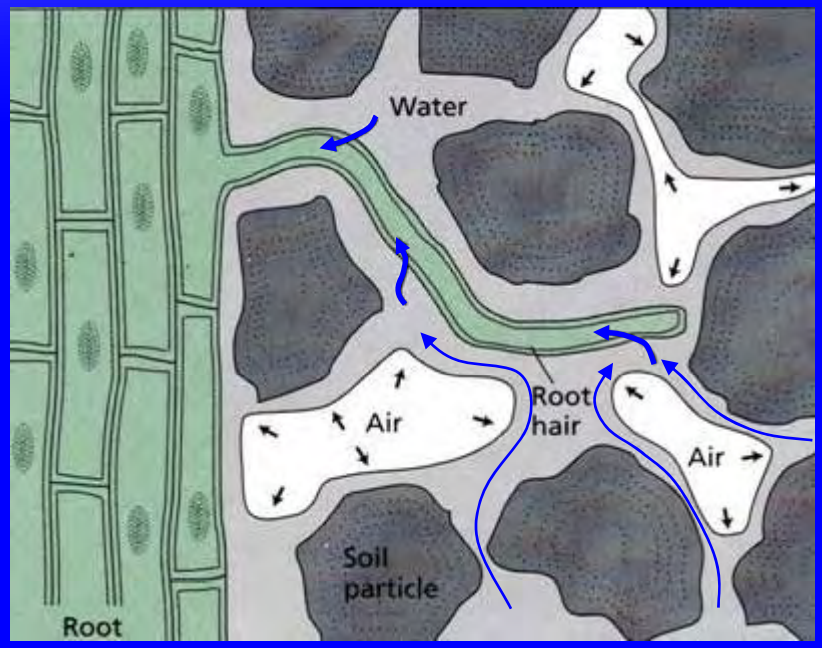
# Soil Water Movement

- As water near the root is removed it is replaced by water that is farther from the root

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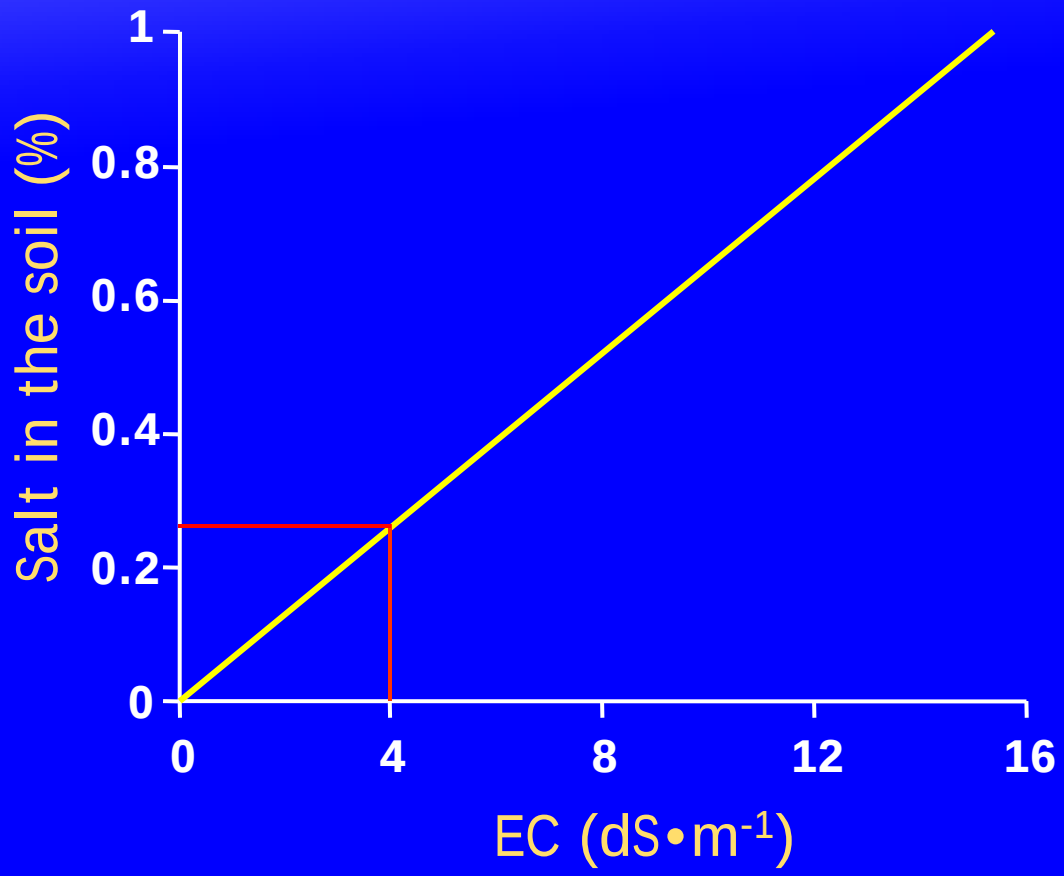
# Salinity and EC




- EC and Salinity are linearly related

Graphic: L. Oki

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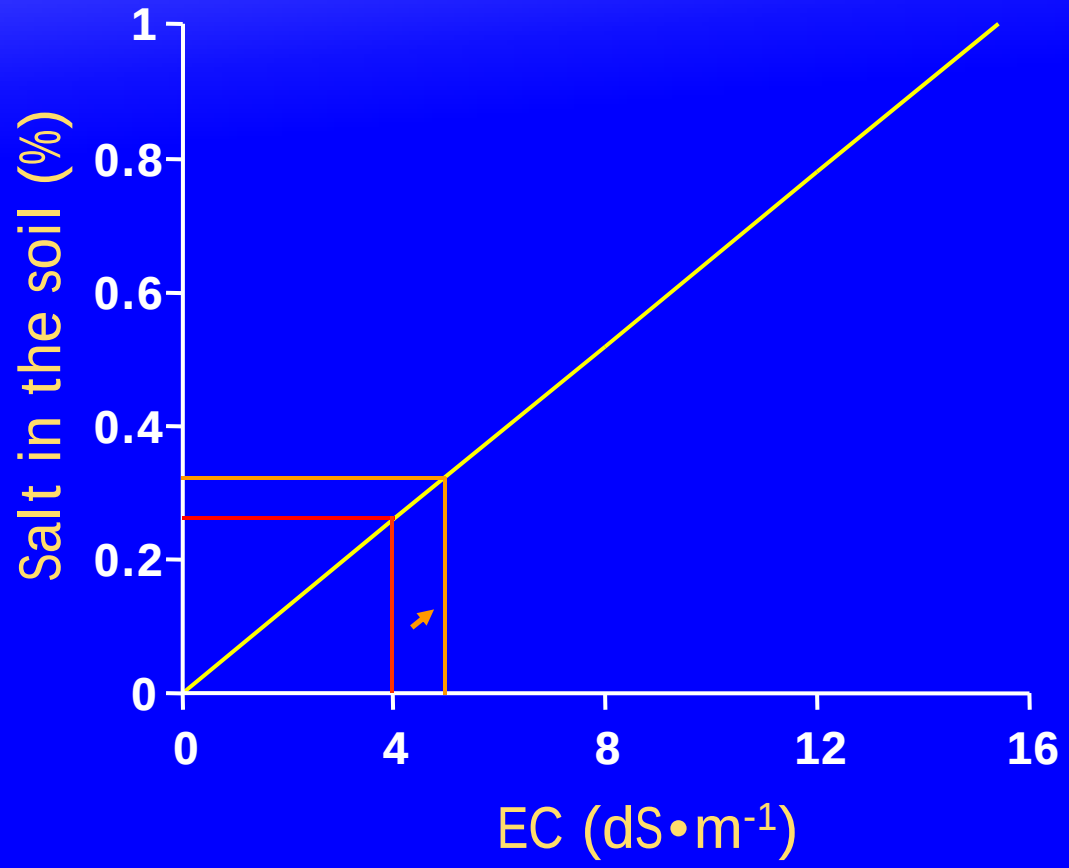


- EC and Salinity are linearly related
- When salinity doubles, EC also doubles

Graphic: L. Oki

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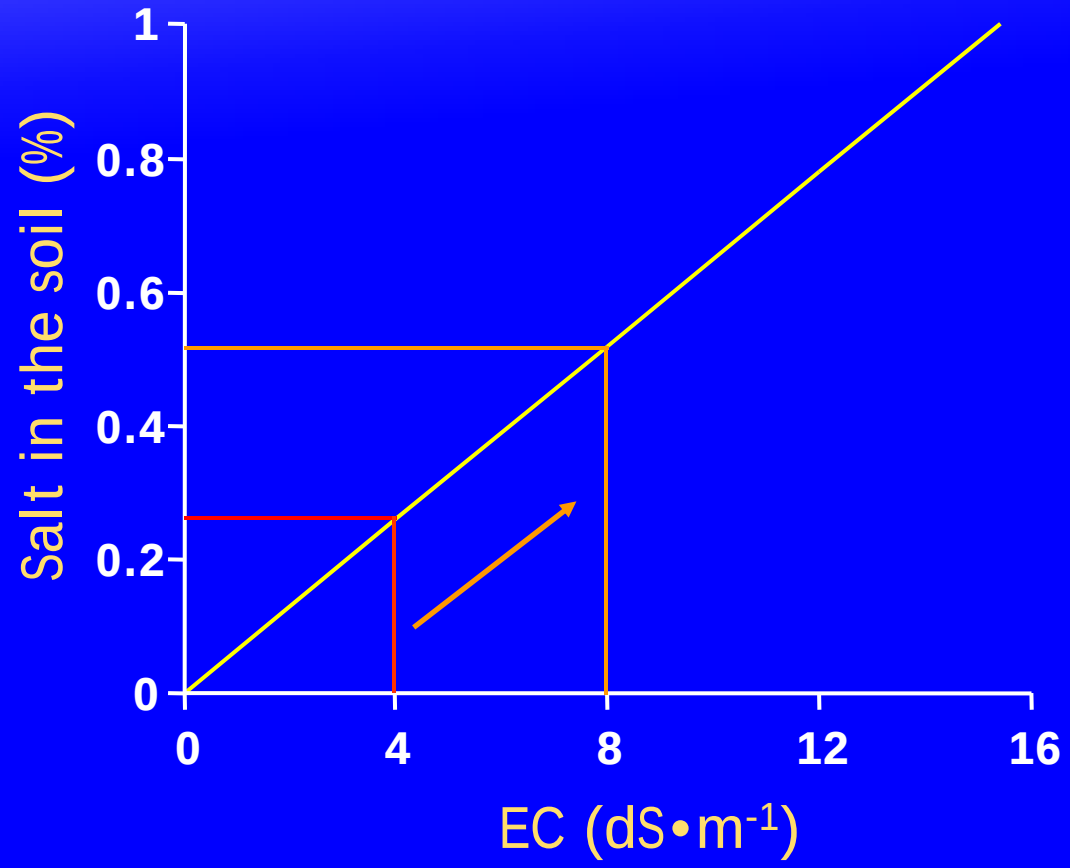


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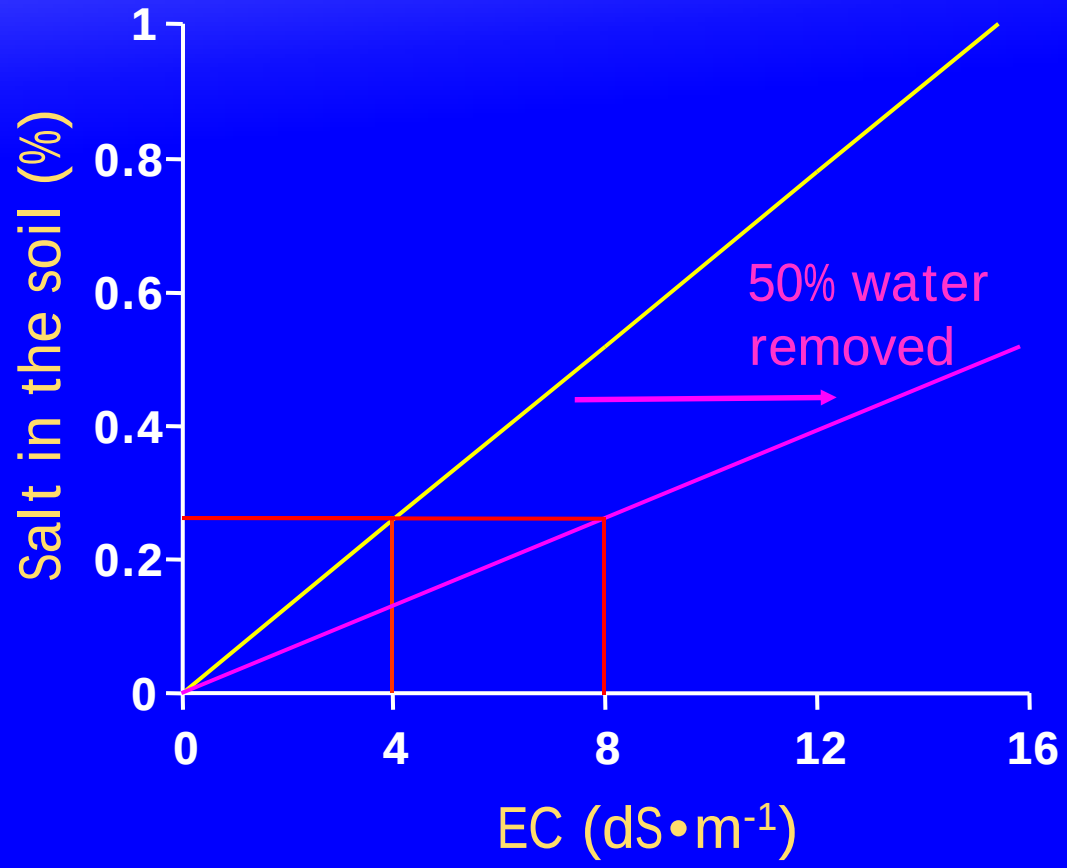
# Salinity and EC




- EC and Salinity are linearly related
- When salinity doubles, EC also doubles
- EC can also double by removing half of the soil water

Graphic: L. Oki

# Irrigation Systems

- Delivery
  - Valves
  - Pipes

# Irrigation Systems

- Delivery
  - Valves
  - Pipes
  - Sprinklers
  - Emitters
- Emitters, sprinklers, and pressure compensation need to be selected to **place** water where it can be used

# Irrigation Systems

- Delivery
  - Valves
  - Pipes
  - Sprinklers
  - Emitters
  - Pressure compensation

- Emitters, sprinklers, and pressure compensation need to be selected to **provide** water at desired rate
- As pipes slope up/down in elevation, pressure decreases/increases
- ~1p.s.i. per 2.3 ft height

# Irrigation Systems

- Delivery
  - Valves
  - Pipes
  - Sprinklers
  - Emitters
  - Pressure compensation

- Emitters, sprinklers, and pressure compensation need to be selected to **provide** water at desired rate
- Should not be applied faster than the soil can absorb it

# Improving Irrigation Efficiency

- Landscape irrigation consumes about 75% of residential water use in arid regions during the summer months.
- Vital components of Irrigation Efficiency
  - Proper design
  - Appropriate hardware
  - Proper scheduling
  - Maintenance

# Calculating Water Use

- Water loss from a landscape occurs from:
  - Soil surface = evaporation.
  - Plants = transpiration.

**Evaporation + transpiration = Evapotranspiration**

# Evapotranspiration (ET)

- ET rates vary among plant species
  - Different transpiration rates due to adaptations such as thick waxy leaves, deeper roots, etc…
- Calculations based on environmental factors.
  - Temperature
  - Relative humidity
  - Solar radiation
  - Wind speed

# Evapotranspiration ($ET_o$)

- Reference rate
- Average daily water use by 4" tall cool season turfgrass with unlimited soil water.
- Rate varies depending on climate where reference turfgrass is grown.
- Allows for comparing water use among plant species.
- Most plants will require less than the reference rate or a percentage of the rate.
  - 80% of reference ET for cool season turfgrass.
  - 60% of reference ET for warm season turfgrass.

# Using Evapotranspiration to Calculate Water Use in the Landscape

- Average Daily ET Rates by Location in California (inches/day)
  - California Master Gardener Handbook (Table 4.2)
  - http://www.ipm.ucdavis.edu/TOOLS/TURF/MAINTAIN/irrsched.html
- Example: Zone 10 (Southern Inland Valleys)
  - July and August = 0.22"/day
  - October = 0.12"/day
  - November = 0.08"/day

# Example: Irrigating Your Lawn

- Determine if you have a cool season or warm season turfgrass.
- Determine the output of your irrigation system.
  - How much water is discharged from my sprinklers in a given time period?
- Determine how long to water the lawn each week.
  - Use lawn watering guide in Master Handbook Gardener (Tables 4.4 and 4.5) or UC Guide for Healthy Lawns

# Example: Irrigating Your Lawn

- Cool season turfgrass (Tall Fescue)
- Sprinkler output (1”/hour)
- Newport Beach (Zone 9)
- November Weekly Runtimes
  - 34 minutes

- Warm season turfgrass (Seashore Paspalum)
- Sprinkler output (1”/hour)
- Newport Beach (Zone 9)
- November Weekly Runtimes
  - 25 minutes

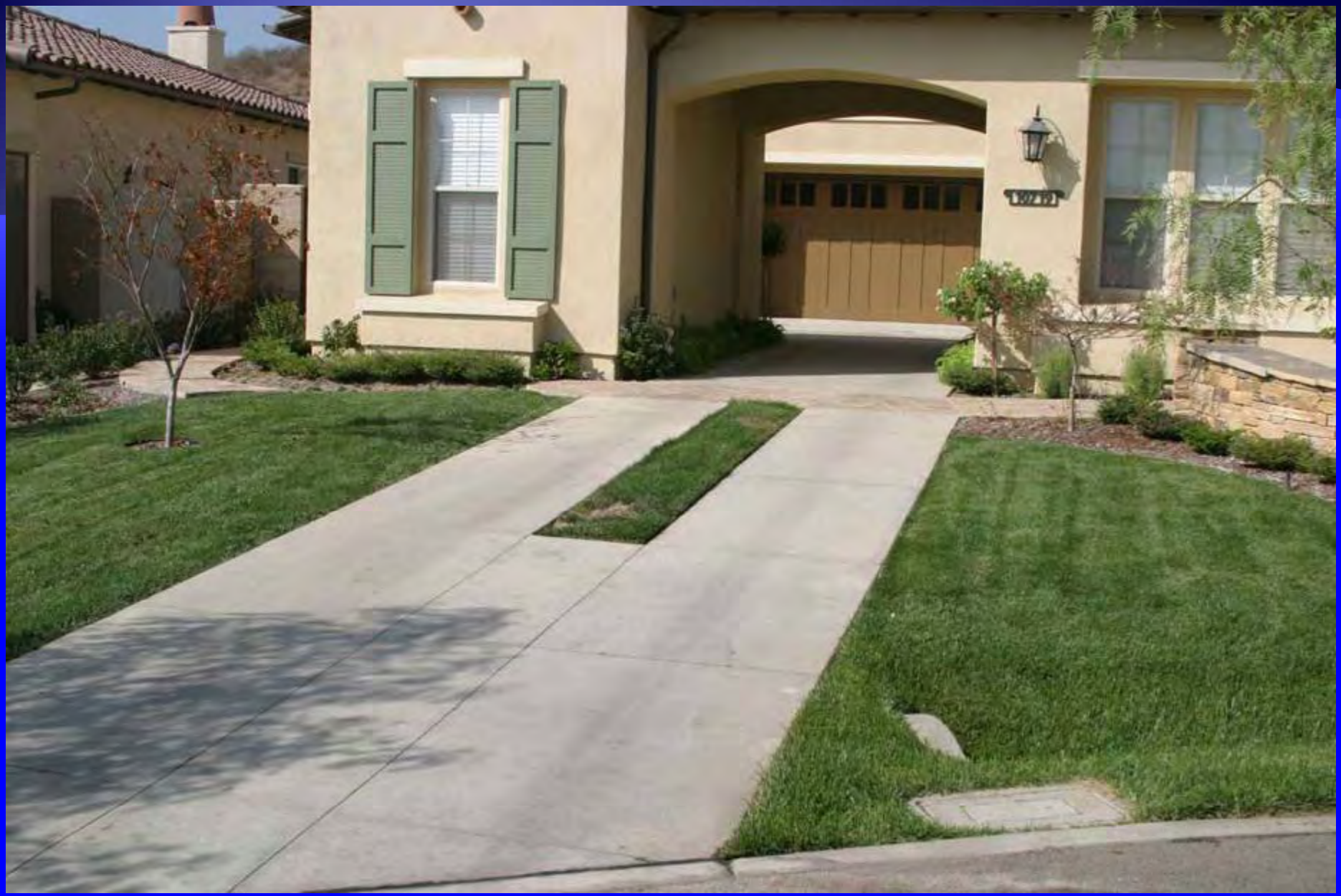
# Calculating Sprinkler Output

- Set out 6 or more catch cans of the same type.
- Run system for 20 min.
- Measure the depth of water in each can and calculate an average.
- Multiply by 3 for inches/hour.
- Large differences in water depth = poor distribution uniformity.

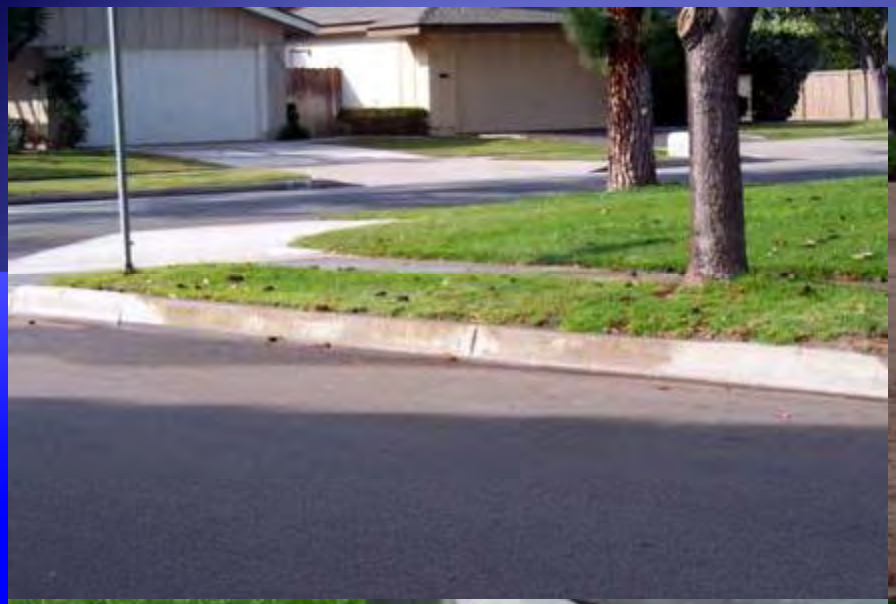
# Improving Distribution Uniformity

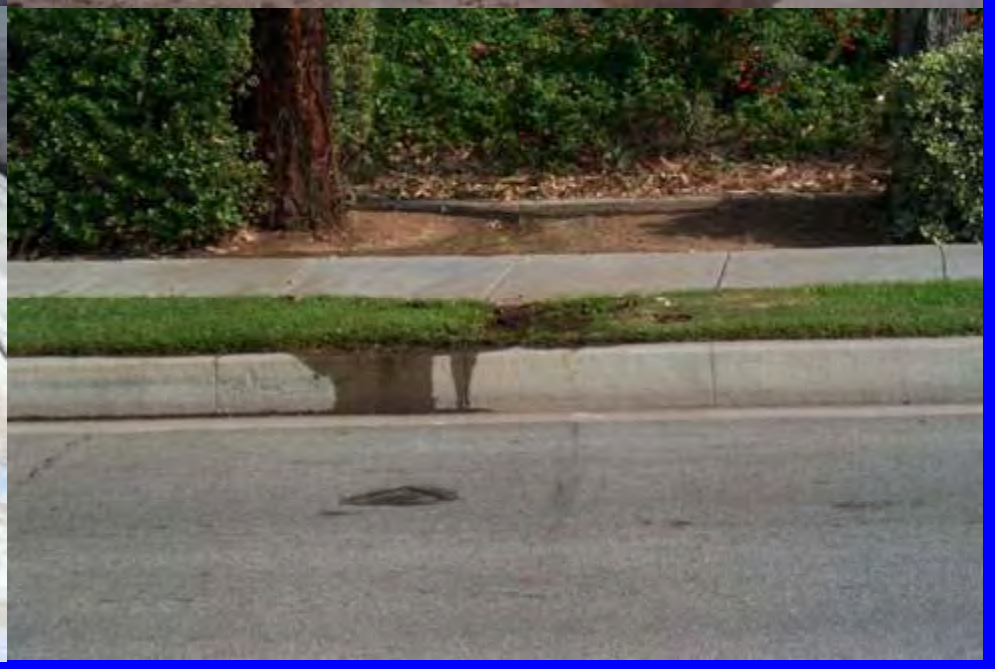
- **ET Lawn Watering Guide assumes distribution uniformity is 80% or greater.**
  - Increased runtimes are required when less than 80%.
  - Runoff and brown spots are the most common symptoms.
- **Possible reasons**
  - Broken or crooked sprinkler.
  - Unmatched sprinkler heads (applying water a different rates).
  - Sunken risers.
  - Water pressure is too high.
  - Turfgrass growing around or over sprinklers.
  - Debris plugging sprinklers.
  - Poor overall design.


50
50

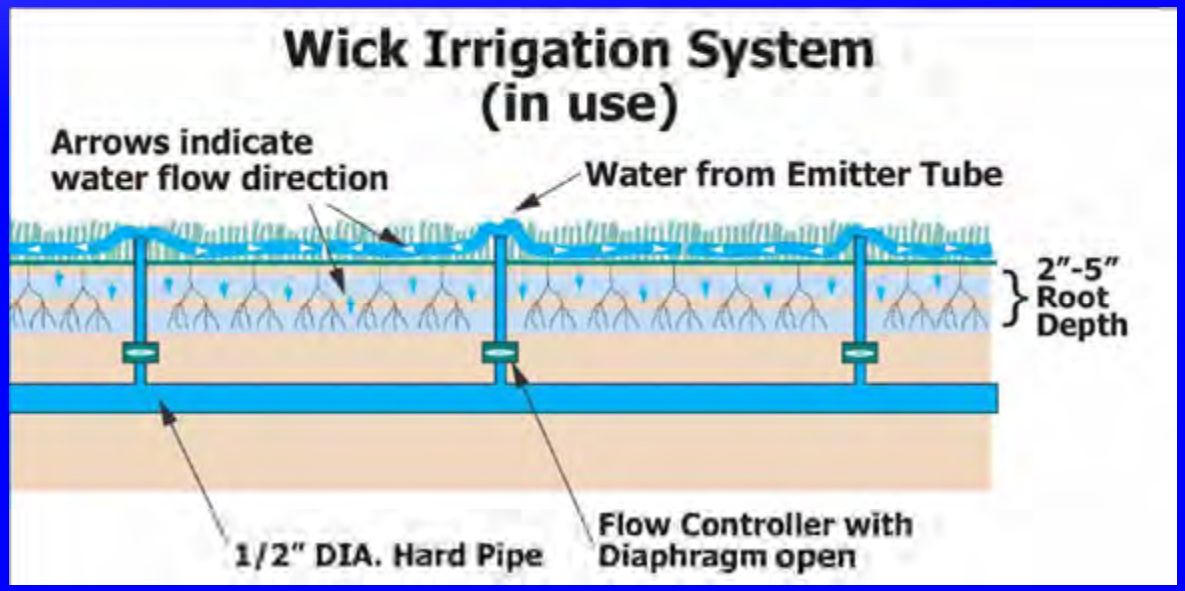


# URBAN DROOL





# SurfaceFlow (www.jardiniercorp.com)




Developed by Dr. Joe Hung at Cal Poly Pomona

# "Smart" Irrigation or Weather-Based Controllers

- Controller adjusts scheduling based on changes in the weather.
- Scheduling is based on weather conditions, plant type, and site conditions.
- Incorporate ET into irrigation scheduling.
- Many types of controllers now available.
- Early studies show a savings of 32-42 gallons/day and a 64-71% reduction in surface runoff.

# Choosing a "Smart" Irrigation or Weather-Based Controller

- **Measurement of weather conditions**
  - Limited on-site measurements with multiple sensors such as temperature and solar radiation to calculate ET.
  - Historic ET as a function of site location.
  - Full set of data from local weather stations or network of sensors transmitted to controller.
- **Professional installation recommended by most manufacturers.**
- **Replacement controller versus receiver add-on.**
- **Automatic run time calculation with adjustment.**
- **Optional rain sensor or other gauges.**

# Aqua Conserve (www.aquaconserve.com)


- Irrigation schedules based on historical ET for specific regions.
- Several models available.
- On-site measurement of temperature used to adjust daily run times.
- Professional installation is available.

# Weathermatic (www.weathermatic.com)

- SmartLine controller and weather station (ET)
- Real time/on-site weather monitoring allows for quick run time changes.
- Settings include sprinkler type, plant type, soil type, fine adjustment.
- Professional installation is recommended

# WeatherTrak (www.hydropoint.com)

- **WeatherTrak *Everywhere* wirelessly delivers local weather-based ET updates to controller.**
  - **Subscription service fee for signal.**
- **Select exposure, plant type, soil, slope, and sprinkler type.**
- **Utilized widely in several research studies.**
- **“Trained” installation recommended.**

# Intellisense (www.toro.com)

- WeatherTrak *Enabled*
- WeatherTrak *Everyone* subscription service fee for signal.
- Select exposure, plant type, soil, slope, and sprinkler type.
- Available for 6, 9 and 12 stations
- Manufactured by Toro under agreement with Hydropoint, Inc.

# Irritrol (www.irritrol.com)


- WeatherTrak *Enabled*
- WeatherTrak *Everyone* subscription service fee for signal. (2 years incl.)
- Select exposure, plant type, soil, slope, and sprinkler type.
- Available for 6, 9 and 12 stations.
- Manufactured by Irritrol under agreement with Hydropoint, Inc.

# Soil Moisture Sensing Devices

- **Watermark Sensors**
  - Gypsum block soil moisture sensor.
  - Buried in root zone to sense available water.
  - Maintenance free.

## Watermark Electronic Module or Multiple Hydrozone System (www.irrometer.com)

- Watermark Electronic Module
  - Wired to controller
  - Set dial to wetter or drier based on observing landscape.
- Watermark Multiple Hydrozone System
  - Allows soil moisture to be monitored in 8 different hydrozones.


# Irrigation Management

## Objectives

### When, Where, How Much

- Apply water to meet and not exceed plant demand
- Apply water where it can be utilized
- Apply water at the intended rate

# Irrigation Systems

## CIMIS

**C** alifornia
**I** rigation
**M** anagement
**I** nformation
**S** ystem

Water use reports are used with a crop or landscape coefficient to estimate site water use

http://www.cimis.water.ca.gov/cimis/

# Irrigation Systems

## CIMIS

- Reference ET ($ET_0$) is reported
- Crop coefficient ($K_c$) is necessary
- Determine ETcrop ($ET_c$) to estimate crop water use

so, $ET_c = ET_0 \times K_c$

Example: warm season lawn

$K_c = 0.60$

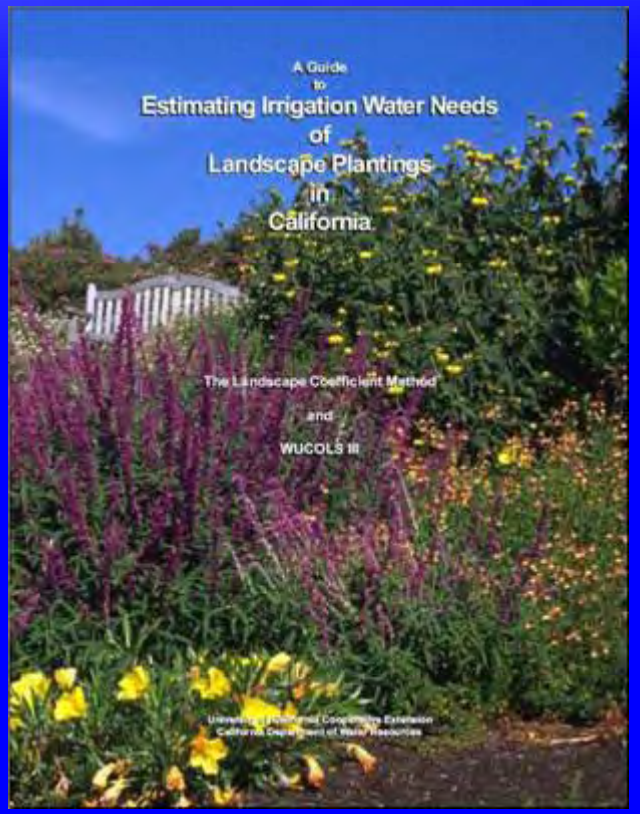
If $ET_0 = 0.5$”, then

crop water use is 0.30”

(0.30=0.5 x 0.60)

# Irrigation Management
## Control

- Group plants of similar water requirements within an irrigation zone (hydrozones)
- Obtain information on plant water use
    - WUCOLS




http://www.owue.water.ca.gov/docs/wucols00.pdf