

HARDPAN TO SAND: A SOIL QUALITY DISCUSSION

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OUTLINE

- ◉ Soils of the San Joaquin Valley- Origins
- ◉ Soil Survey- Variations on the landscape
- ◉ What makes a good soil good- properties
- ◉ Problem soils- Assessment and evaluation
- ◉ Dealing with problem soils- troubleshooting

SOIL FACTS

- Soils rich enough to produce the worlds food covers only 3 percent of the planet
- One shovel of soil can contain over 4 billion organisms
- There are 12 soil orders or major divisions of soil groups
 - recent to extremely old
 - fertile to nutrient poor
 - challenging to ideal
- Very little research has been done to match soil performance to crop type

VALLEY SOILS

○ Fresno County Soils

- Residual soils formed in place
- Alluvial soils formed from the deposition of minerals following waters action

○ Alluvial soils

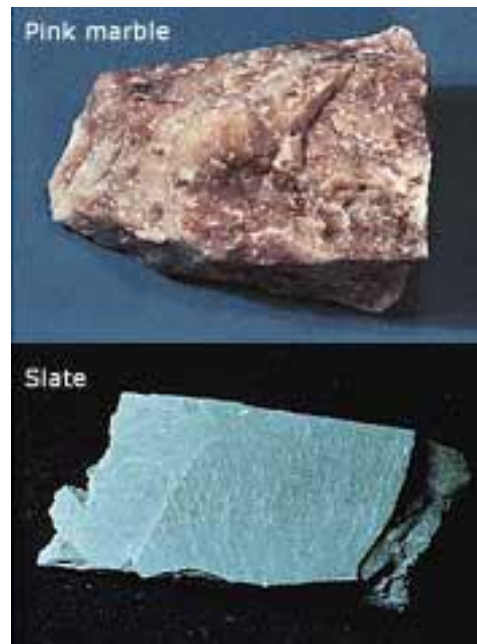
- Young and old
- Variable nutrient holding capacity
- Variable mineralogy
- variable water holding capacity

ORIGIN OF SOIL

- ◉ Most soils are made of decomposed rock
- ◉ Original rock is called the parent material
- ◉ Affects chemical properties and nutrient availability



igneous (granite)



metamorphic



sedimentary

SOIL SURVEY

○ Soil Maps

- soil series
- soil type
- soil mapping unit
- soil associations, consociations and inclusions

○ Examples of Fresno area soils (Age, stratification, chemical and mineral)

- Hanford/Hesperia/Tajunga
- San Joaquin
- Others- Delhi Loamy sand, Merced clay, Oxalis clay
- Wide range of soil characteristics and need for management

SOIL FORMATION FACTORS

- ◉ **Parent material**
- ◉ **Climate**
- ◉ **Living organisms**
- ◉ **Relief (topography)**
- ◉ **Time**

SOIL HORIZONS



- O - partially to completely decomposed organic layer
- A - top soil
- B - zone of deposition
- C - partially broken down parent material
- R - bedrock

Order

Suborder

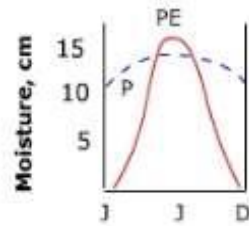
Great group

Subgroup

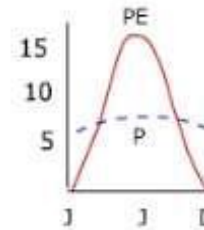
Family

Series

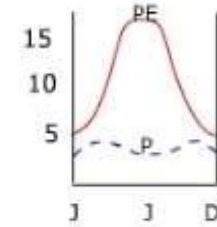
SOIL TAXONOMY



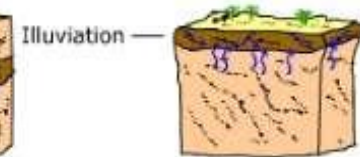
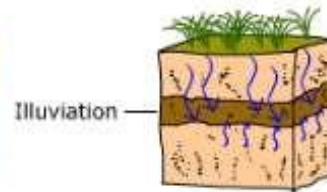
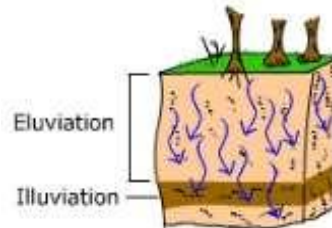
Humid



Semiarid



Arid



You are here: Web Soil Survey Home

Search

Enter Keywords

All NRCS Sites ▾

Browse by Subject

- ▶ Soils Home
- ▶ National Cooperative Soil Survey (NCSS)
- ▶ Archived Soil Surveys
- ▶ Status Maps
- ▶ Official Soil Series Descriptions (OSD)
- ▶ Soil Series Extent Mapping Tool
- ▶ Soil Data Mart
- ▶ Geospatial Data Gateway
- ▶ eFOTG
- ▶ National Soil Characterization Data
- ▶ Soil Geochemistry Spatial Database
- ▶ Soil Quality
- ▶ Soil Geography
- ▶ Geospatial One Stop

The simple yet powerful way to access and use soil data.



I Want To...

- [Start Web Soil Survey \(WSS\)](#)
- [Know the requirements for running Web Soil Survey – will Web Soil Survey work in my web browser?](#)
- [Know the Web Soil Survey hours of operation](#)
- [Find what areas of the U.S. have soil data](#)

Welcome to Web Soil Survey (WSS)



Web Soil Survey (WSS) provides soil data and information produced by the National Cooperative Soil Survey. It is operated by the USDA Natural Resources Conservation Service (NRCS) and provides access to the largest natural resource information system in the world. NRCS has soil maps and data available online for more than 95 percent of the nation's counties and

anticipates having 100 percent in the near future. The site is updated and maintained online as the single authoritative source of soil survey information.

Announcements/Events

- [Web Soil Survey 2.3 has been released! View description of new features.](#)
- [Web Soil Survey Release History](#)

Four Basic Steps

1 Define.



Click to view larger image.

Use the Area of Interest tab to define your area of interest.

2 View.



Click the Soil Map tab to view or print a soil map, and detailed descriptions of the soils in your Area of Interest.

I Want Help With...

- [How to use Web Soil Survey](#)
- [How to use Web Soil Survey Online Help](#)
- [Known Problems and Workarounds](#)
- [Frequently Asked Questions](#)
- [Citing Web Soil Survey as a source of soils data](#)

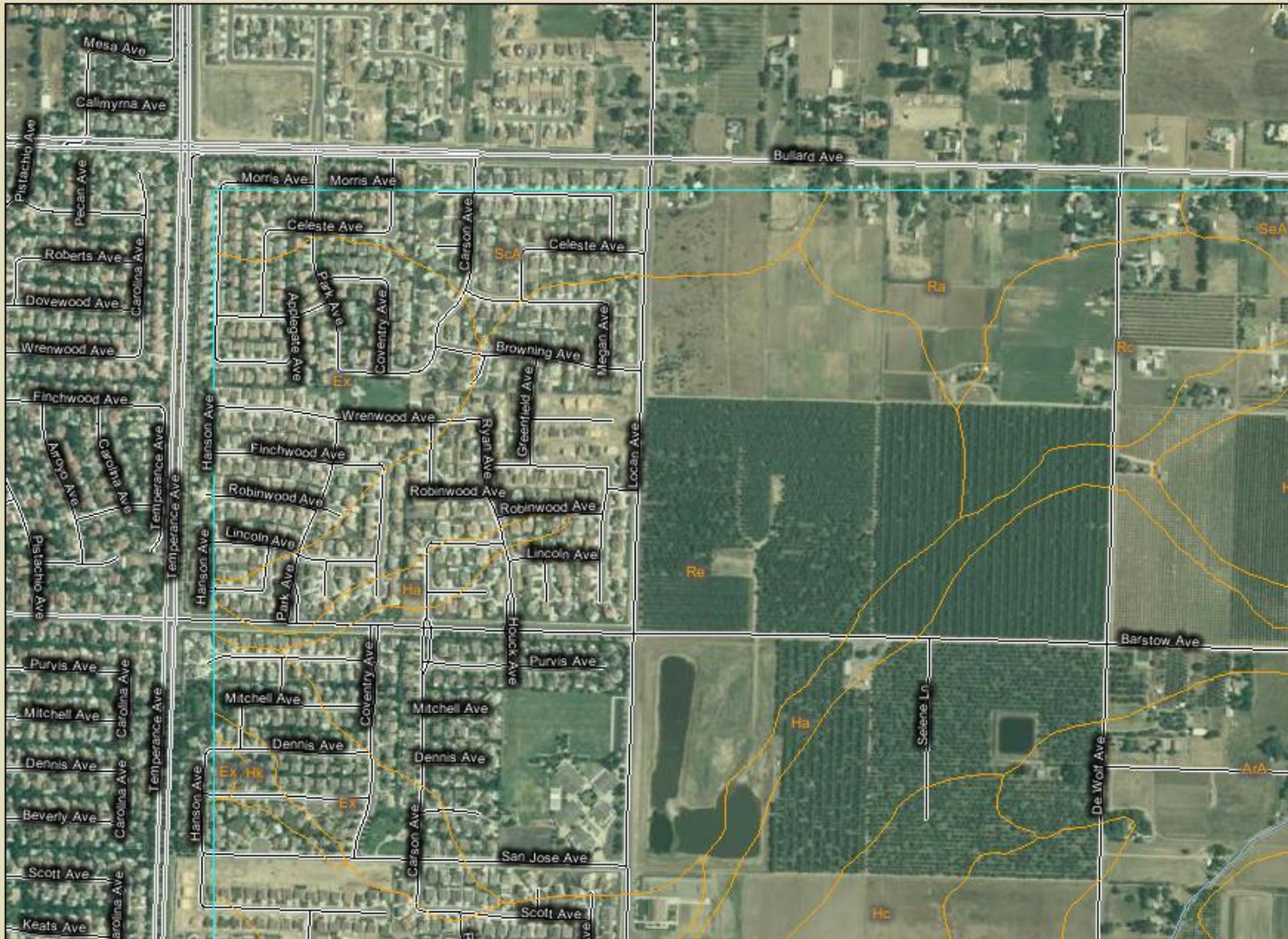


Soil Map

Legend



Scale (not to scale)



Search ⌵

Map Unit Legend ⌵

?

Eastern Fresno Area, California (CA654) ⌵

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
ArA	Atwater sandy loam, 0 to 3 percent slopes	140.7	11.6%
AtA	Atwater sandy loam, moderately deep, 0 to 3 percent slopes	27.1	2.2%
DhA	Delhi loamy sand, 0 to 3 percent slopes	22.3	1.8%
DhB	Delhi loamy sand, 3 to 9 percent slopes	1.4	0.1%
Ex	Exeter loam	68.7	5.6%
GtA	Greenfield sandy loam, 0 to 3 percent slopes	59.8	4.9%
GuA	Greenfield sandy loam, moderately deep, 0 to 3 percent slopes	69.0	5.7%
Ha	Hanford coarse	79.6	6.5%

Legend ⌵



Legend

- Soil Map
- Rivers & Streams
- Soils
- DWR Crops
- Lakes



HANFORD FINE SANDY LOAM

Map Unit Key : 464339
 Map Unit Symbol : Hm
 Total Acres : 29839
 Soil Symbol : Hm
 Farmland Class : Prime farmland if irrigated
 Erodible Land Class : null
 Slope Gradient : 1.20000004
 Depth to Bedrock : null
 Flood Frequency : None
 Slope Gradient : 1.20000004

DELHI

Horizon	Layer	▲ Top Depth (cm)	Bottom Depth (cm)	Sand %	Silt %	Clay %	OM	KSAT	AWC	CaCO3	Gypsum	SAR	EC
A	A	0	18	80	17.5	2.5	0.75	92	0.07999999	0	0	0	0
C1	C	18	64	80	17.5	2.5	0.25	92	0.07999999	0	0	0	0
C2	C	64	152	80	17.5	2.5	0.25	92	0.07999999	0	0	0	0

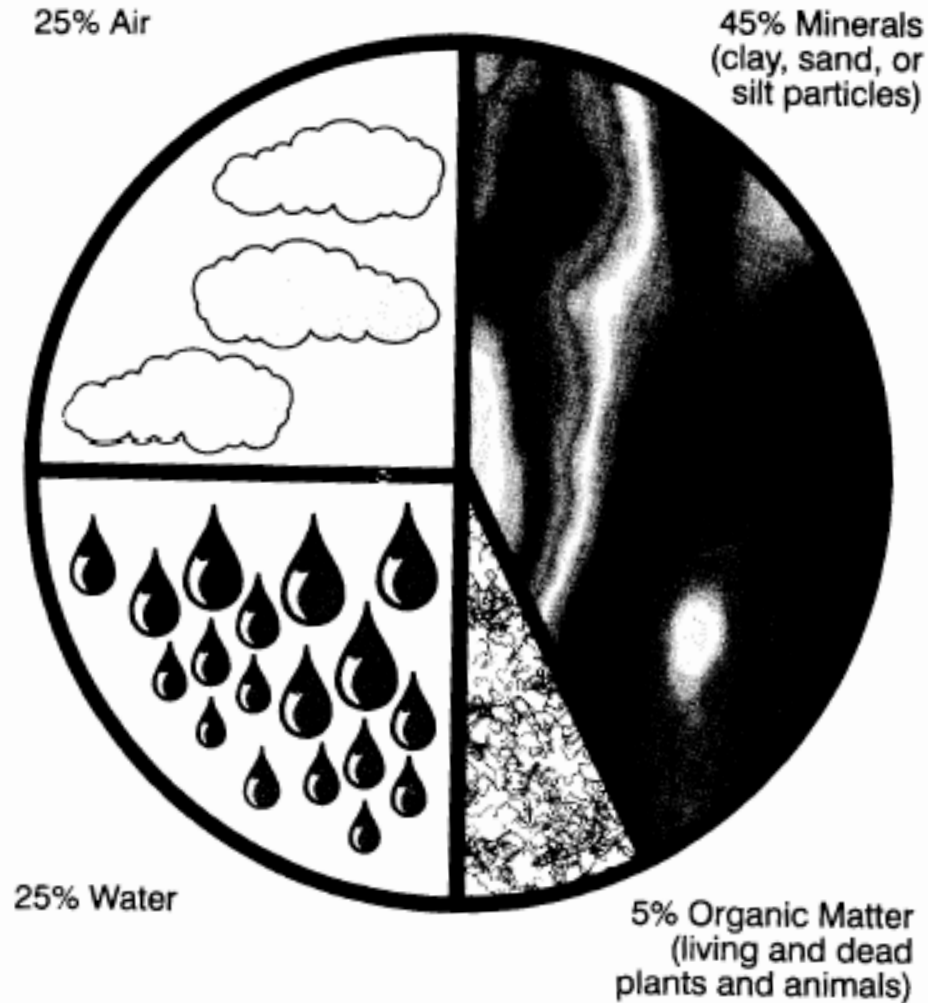


VARIATION IN THE LANDSCAPE

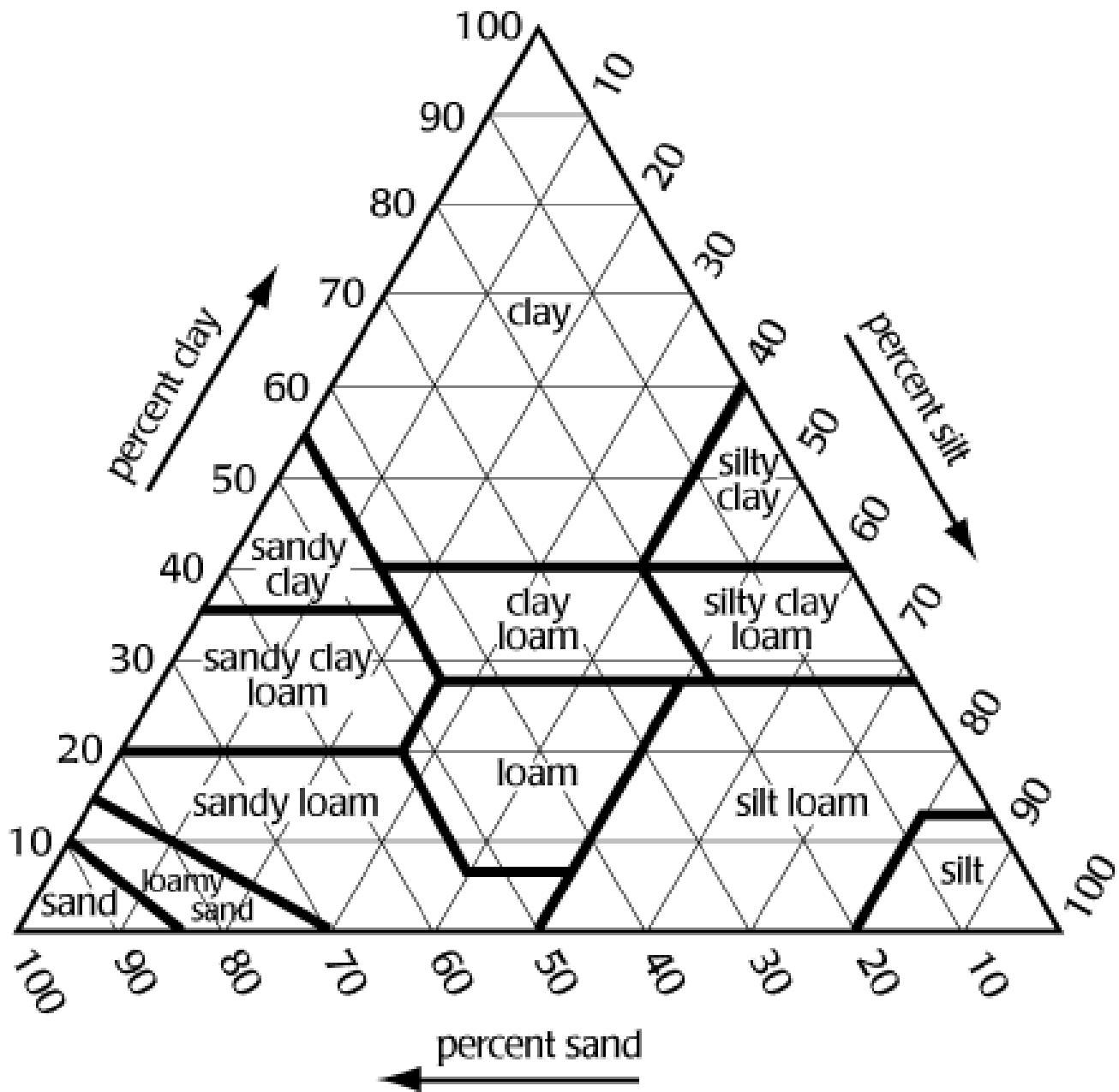


VARIATION IN THE LANDSCAPE

SOIL COMPOSITION



Minerals (Solid)
Water (Liquid)
Air (Gas)
Organic Matter
(solid)



Soil Texture Triangle

SPACES IN SOIL

- Soil not a solid medium unless compacted to make a road bed
- Optimum soil has 50% pore space
- 50% of the pore space is air and 50% is water

SOIL STRUCTURE

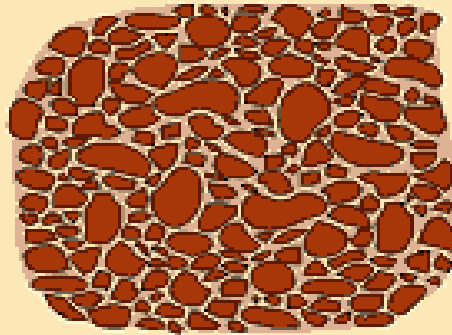
- Spatial Arrangement and Orientation of Soil Particles
- Related to mineralogy, climate, soil age
- Types of Structure
 1. Single grain
 2. Massive
 3. Granular
 4. Columnar
 5. Prismatic
 6. blocky
 7. Platy (compacted)



Soil Pores

Large pores
conduct
water and air

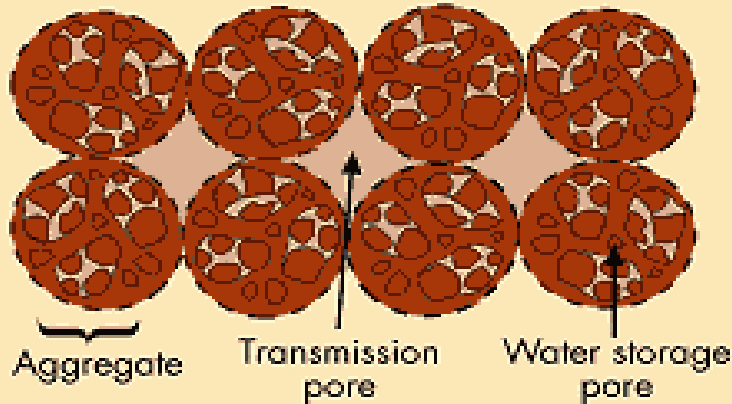
Structureless condition



Particles are packed as close together as possible. High density, low porosity.

Sandy soils more
large pores

Structured or aggregated condition



Particles are formed into aggregates and are loosely packed. Low density, high porosity.

Small pores
hold water

Clayey soils more
small pores

PROBLEM SOILS- ISSUES

- Drainage
 - Infiltration
 - Retention of Nutrients and Water
-

- Quality soils are therefore soils with good drainage, few barriers to infiltration and have optimal levels of water and nutrient storage.

PROBLEM SOILS

- Definition may depend on application
 - Lawn
 - Vegetables
 - Orchards
 - Roses
- Drainage area

SOIL ASSESSMENT

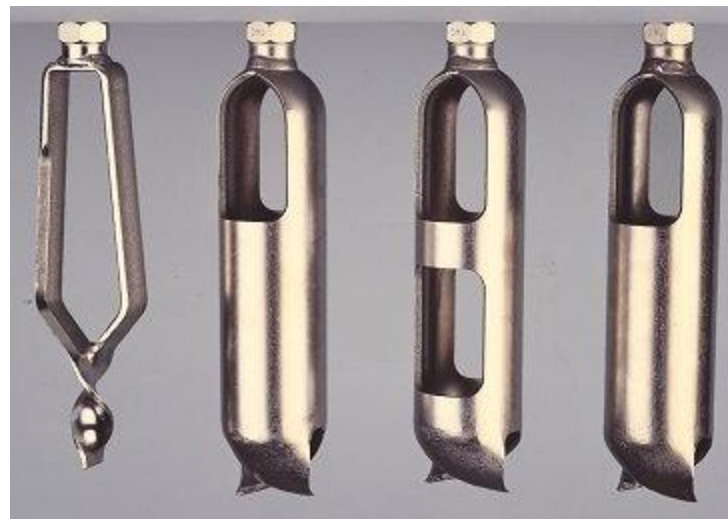
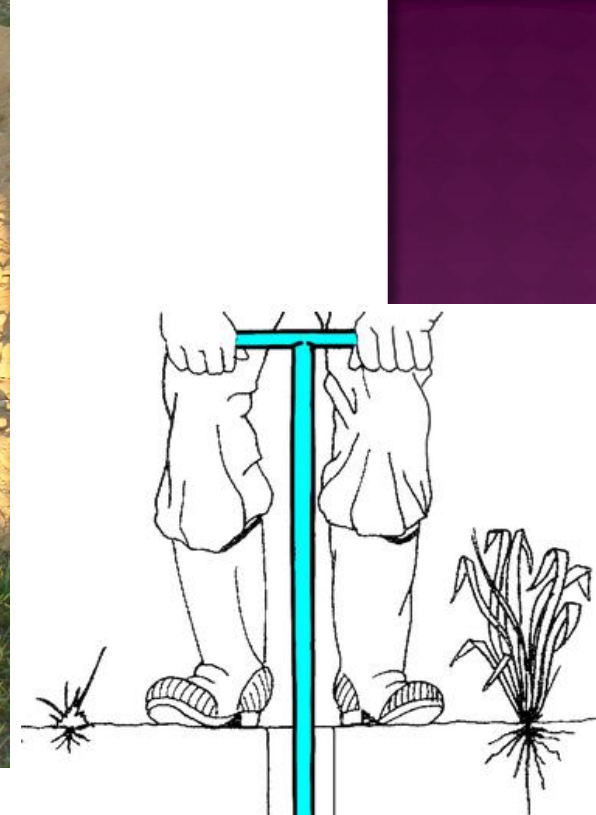


- Responses to rainfall-
 - Runoff
 - Ponding
 - Rapid intake
- Responses to drought- plant
- Response over time- early vs. late season

SOIL ASSESSMENT

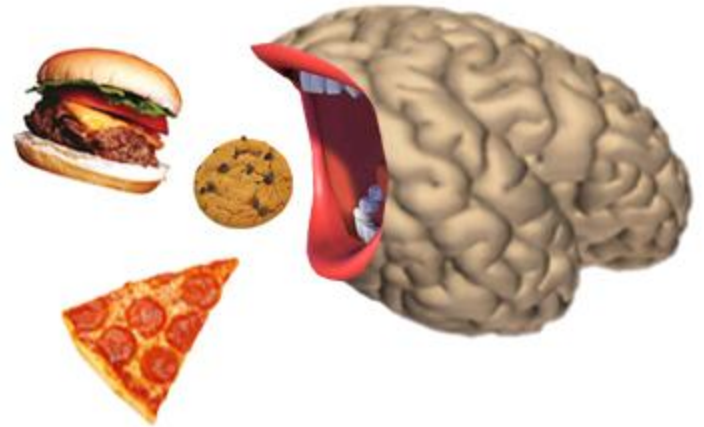


- Use your tools
 - View the soil- what problem are you seeing?
 - Probe the soil- Loose or compact? Rooting depth?
 - Feel the soil- wet and dry, Structure? OM?



SOIL PROBLEMS-

- Even “perfect” soils can have problems
 - Ideal texture and water holding capacity does not always translate to peak quality
 - How does that soil function in the environment and under the requirements of its use?



SOIL QUALITY- DRAINAGE

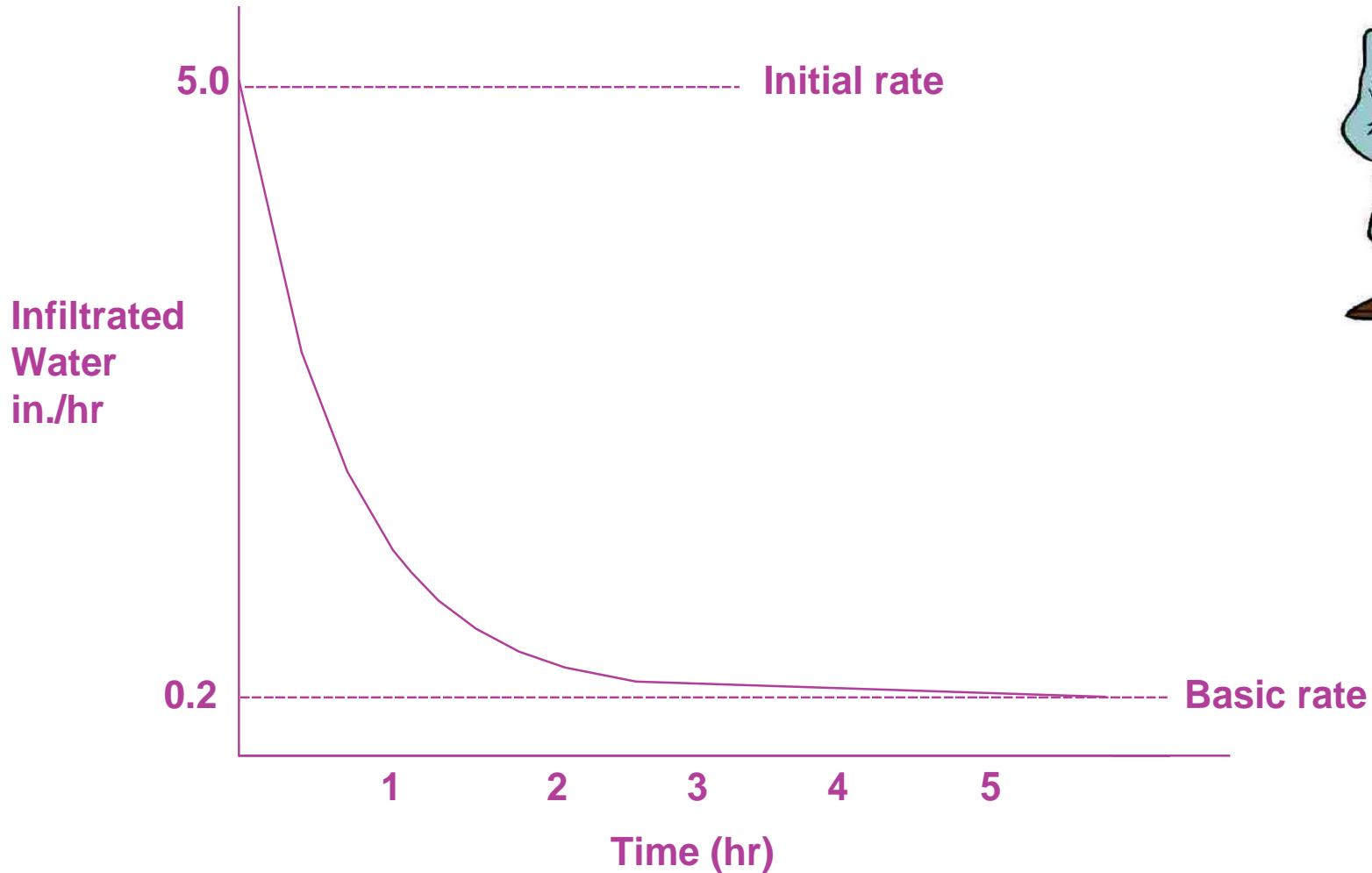
- Wet roots, Nutrient availability (denitrification), Salinity
- Where?
 - Heavy soils
 - Dead Level
 - Basins
 - Underlying strata

SOIL QUALITY- INFILTRATION

- Standing water
- Runoff
- Increasing problem during season
- Late season water stress

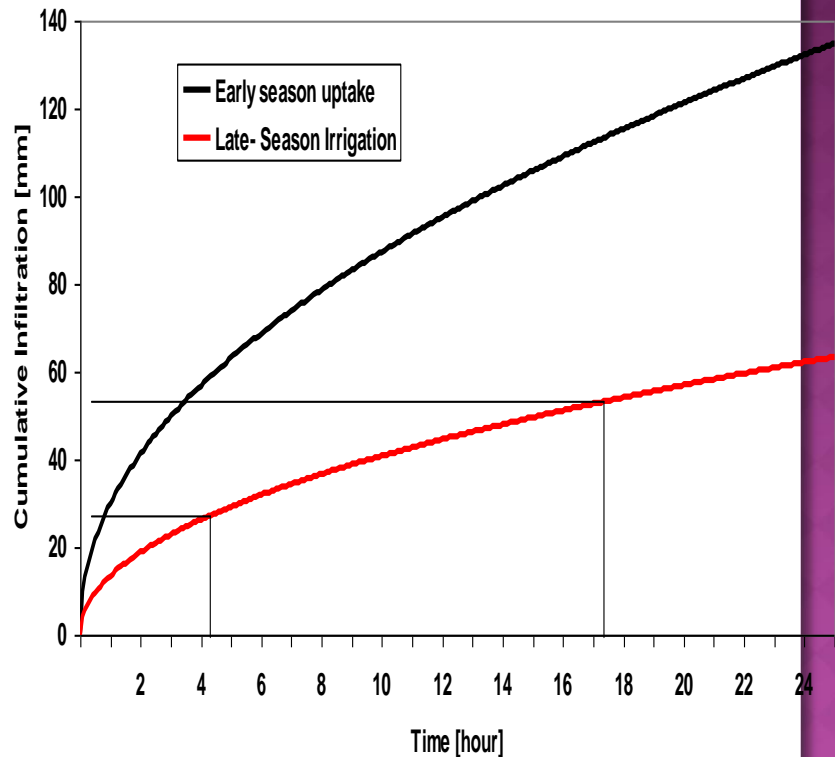


SOIL CONTROLLED WATER INFILTRATION



PROBLEMS WITH SURFACE IRRIGATION METHODS

- Standing water occurs when water is applied above the soils infiltration capacity
- Runoff can take with it essential nutrients and can result in environmental degradation
- Salt balance can be a concern



Depositional Crust

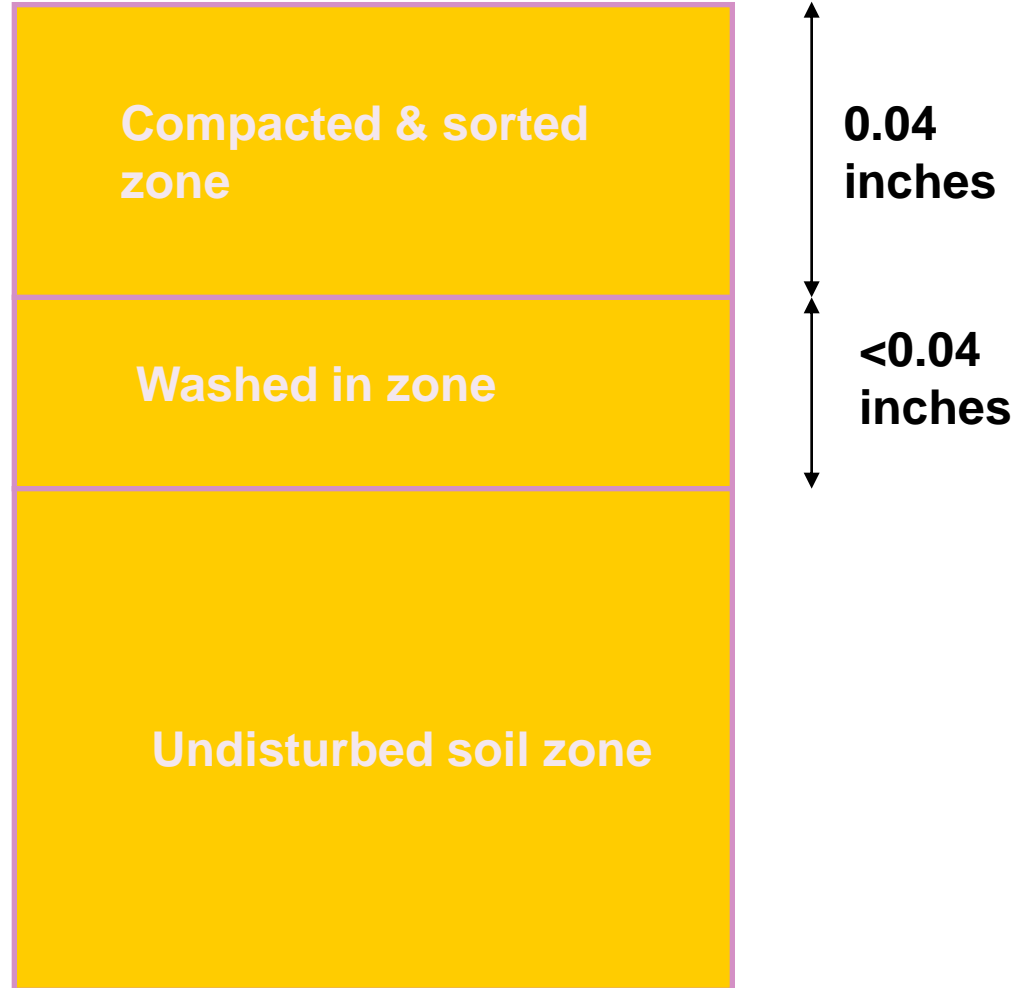


↕
0.1 - 0.5
inches

Depositional crusts



Structural Crust





Raindrops falling on exposed soil can break off soil particles to be lost in run-off water.

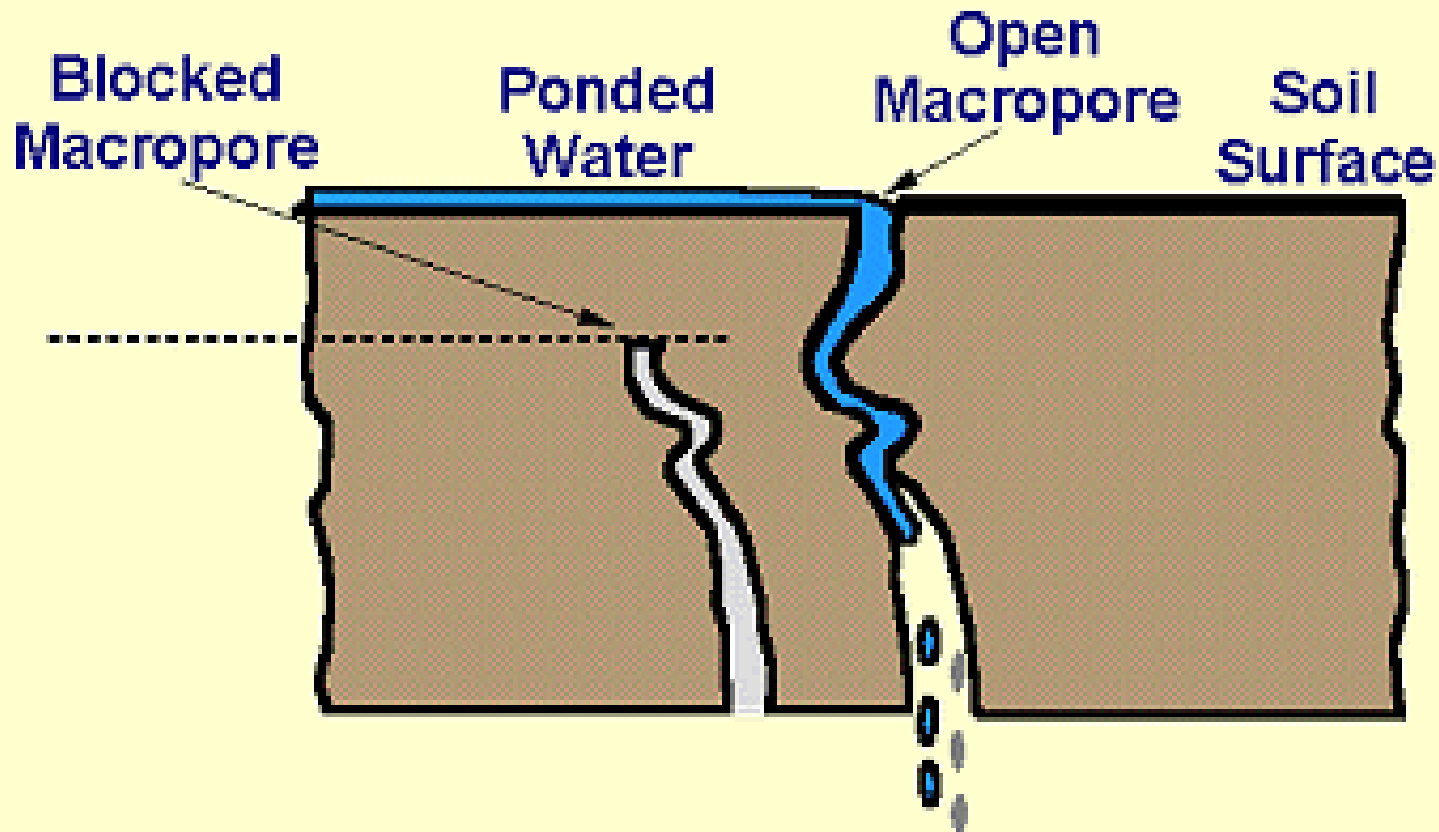
<http://www.netc.net.au/enviro/fguide/soiloverview.html>

SALINITY & SODICITY EFFECTS ON INFILTRATION



SOIL CRUSTS & ACCESS TO SOIL PORES

WATER FLOW THROUGH MACROPORES



SOIL QUALITY - WATER AND NUTRIENT RETENTION

- ◉ Water stress- frequent irrigation, not just late season
- ◉ Frequent fertilizer applications
- ◉ Can be excessively drained
- ◉ Lower productivity

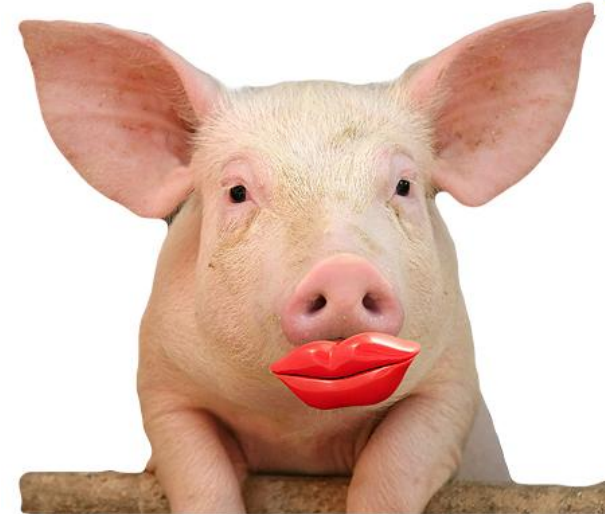
SOIL QUALITY - PROBLEMS WITH WATER AND NUTRIENT RETENTION?

- Soil and textural deficiencies

- Single grain/structureless
- gravelly

- Root limitations

- Compaction
- Compression
- True hardpan
- Poorly drained



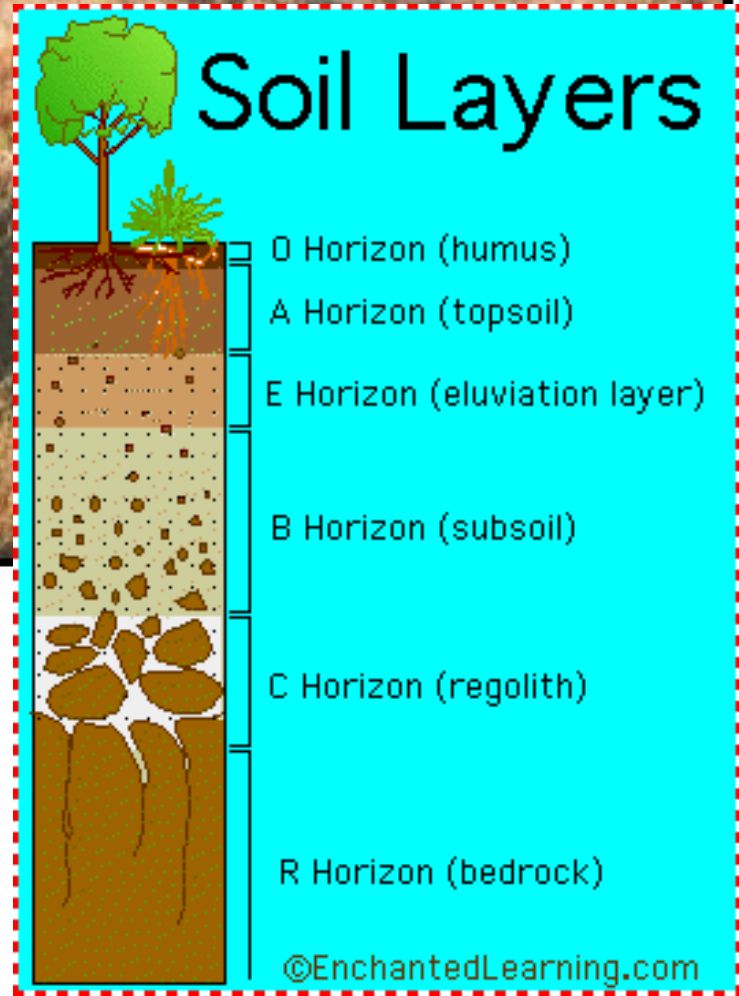
SOIL QUALITY AND SOIL TEXTURE

Texture	Drainage	Retention	Infiltration
Sands	-	**	-
Clays	**	-	*
Loams	-	-	**





SAN JOAQUIN -- CALIFORNIA STATE SOIL



TROUBLESHOOTING PROBLEM SOILS

-INFILTRATION



ORGANIC MATTER

- Dead organisms decompose to form a fine, dark-colored humus
- Food for soil organisms - earthworms, fungi, bacteria

Chemical Properties

- High water holding capacity, slowly releases plant nutrients, and buffers pH

AMENDING SOIL WITH COMPOST

HOW DOES IT HELP?

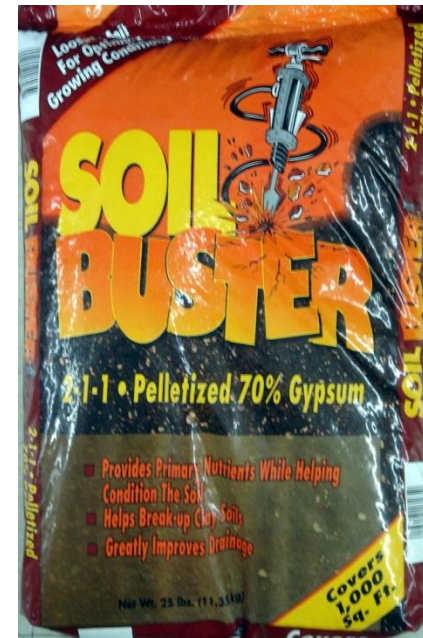
◎ Form soil aggregates

- Improved air and water movement
- Improved soil structure and soil tilth
- Reduced surface crusting and soil erosion
- Turns soil into a “sponge” - helps absorb and infiltrate onsite water

◎ Clay soils - increases aeration, water infiltration

◎ Sandy soils - increases water holding capacity, helps hold nutrients

MODIFY SOIL -WATER PROPERTIES



IMPROVING INFILTRATION

- 1. Improve total pore volume*
- 2. Improve individual pore size*
- 3. Improve access to surface pores*

Increase salinity of irrigation water

Use soluble calcium to reduce sodium effects

Organic matter additions / management

Physical crust disruption

TROUBLESHOOTING PROBLEM SOILS -RETENTION

- Break up compacted layers
- Blend layered/stratified soils



Medium Scale



Small Scale



ORGANIC MATTER

- Dead organisms decompose to form a fine, dark-colored humus
- Food for soil organisms - earthworms, fungi, bacteria

Chemical Properties

- High water holding capacity, slowly releases plant nutrients, and buffers pH

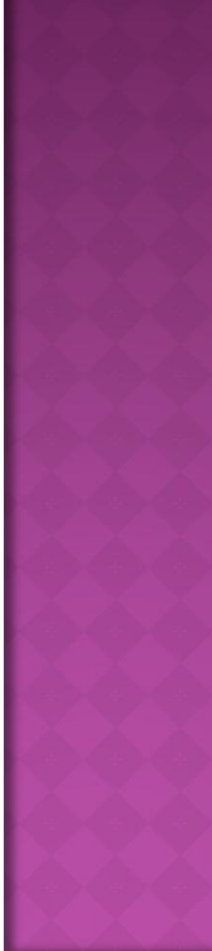
POLYMERS

Polyacrylamide (PAM)

- Long chain polymer
- Binds soil particles together for a short period of time



Making the best of a bad situation



STEPS TO IMPROVING SOIL QUALITY



- ◉ Identification- first observations, problem?
- ◉ Evaluation- investigation phase
- ◉ Amelioration- Action phase
- ◉ And finally...

...ACCEPTANCE

It's not you...
it's me!

- *Plant selection* plays a key role in compatibility, especially in the most challenging soils
- Local examples



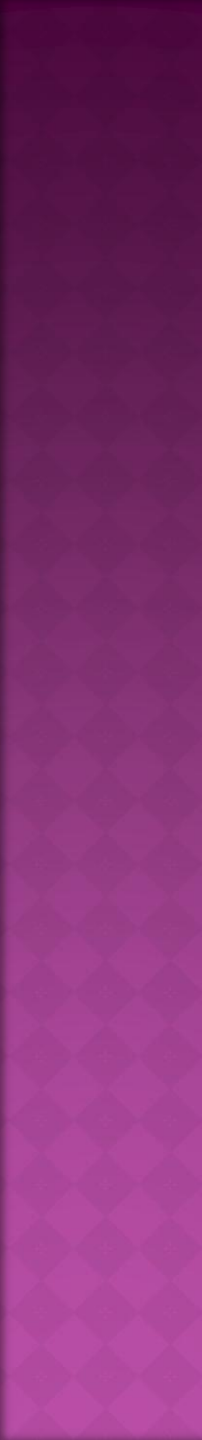
Pressurized water deliver systems

- Infiltration
- Drainage
- Soil water storage

(Properly Managed)







SOIL WATER STORAGE

Primarily effected by texture

- Particle size distribution
 - Soil OM
 - Soil structure
 - Pore size distribution
-
- ◉ Sandy- 1.0 inches/foot
 - ◉ Sandy loams- 1.25 to 1.5 inches/foot
 - ◉ Clay loams- 1.5 to 2.0 inches/foot
 - ◉ Clays- 1.5 to 2.0 inches/foot

PARTICLE SIZE OF MINERAL FRACTION

- Sand (0.06 - 2 mm)
 - low surface area, so low chemical exchange and water holding capacity
- Silt (0.002 - 0.06 mm)
 - intermediate in chemical exchange and water holding capacity
- Clay (<0.002 mm)
 - high surface area, chemical exchange, and water holding capacity
- The combination of particle size classes gives a soil its texture

TROUBLESHOOTING PROBLEM SOILS -DRAINAGE



SOIL STRUCTURE

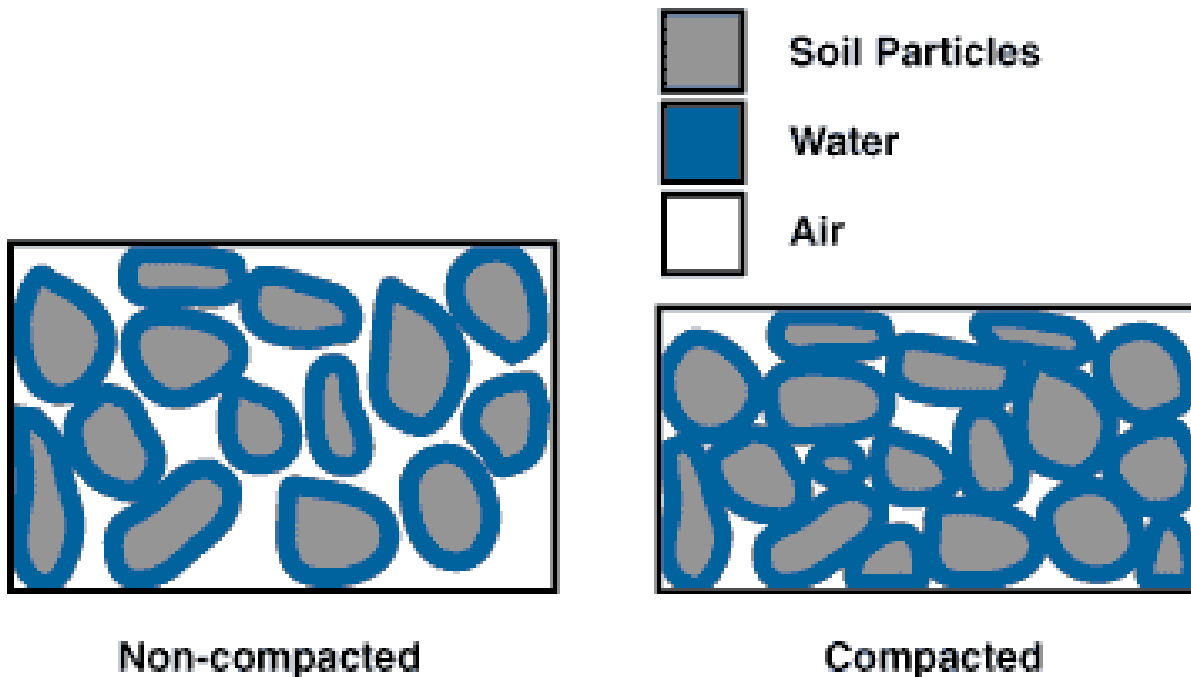
- Determines the size and distribution of soil pores!
- Govern access for roots and movement of water
- Ratio of Large, medium and small pores

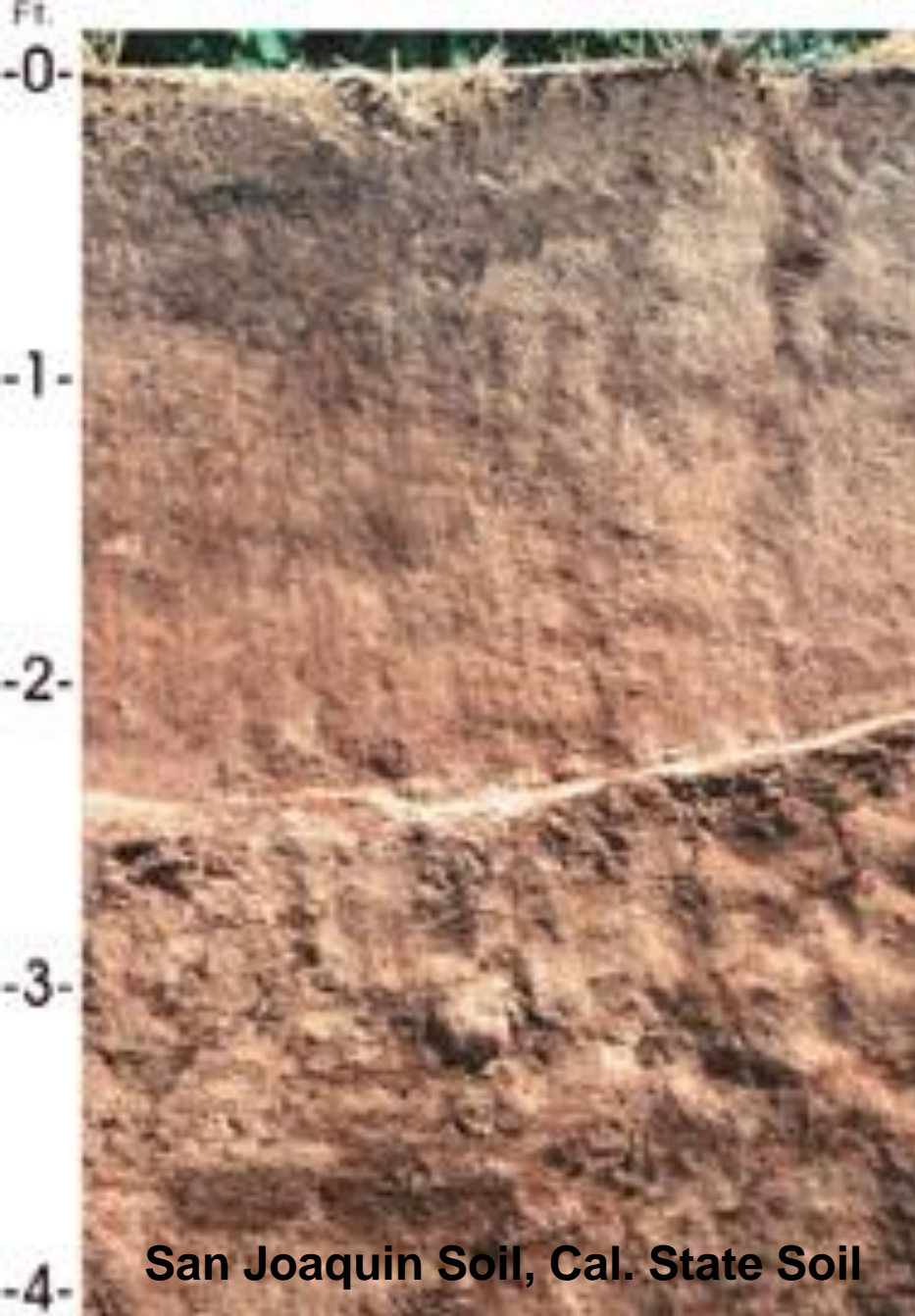
IMPROVING WATER PENETRATION

- ◉ *Water Management*
- ◉ *Organic Matter Management*
- ◉ *Tillage*
- ◉ *Chemical Treatment of Soil and Water*

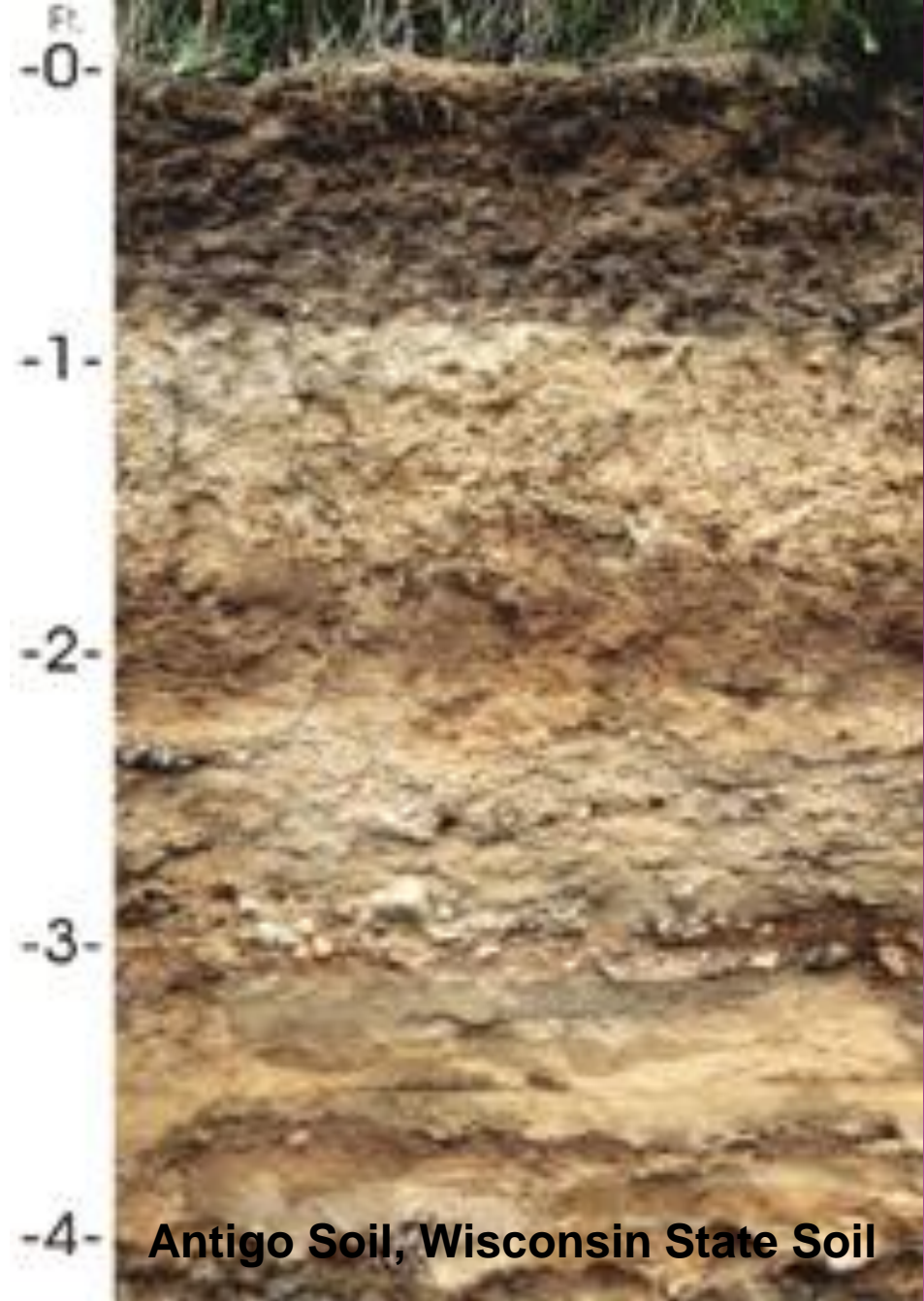
SOIL COMPACTION

- occurs when soil particles are pressed together, reducing pore space between them





San Joaquin Soil, Cal. State Soil



Antigo Soil, Wisconsin State Soil

KEY SOIL PROPERTIES

- Texture and Structure - Together they play a primary role in the way soils take up (infiltrate) and retain water
- Texture and Structure - Together determine how water moves from one zone to another (transport of water and salts)

SOIL PROPERTIES

- Texture - % of sand, silt, and clay
- Structure - arrangement of sand, silt, and clay into larger aggregates (units)

AMENDING SOIL WITH COMPOST

HOW DOES IT HELP?

- **Helps form soil aggregates**
 - Improved air and water movement
 - Improved soil structure and soil tilth
 - Reduced surface crusting and soil erosion
 - Turns soil into a “sponge” - helps absorb and infiltrate onsite water
- **Clay soils - increases aeration, water infiltration**
- **Sandy soils - increases water holding capacity, helps hold nutrients**

SURFACE SEALING CHEMICAL VARIABLES

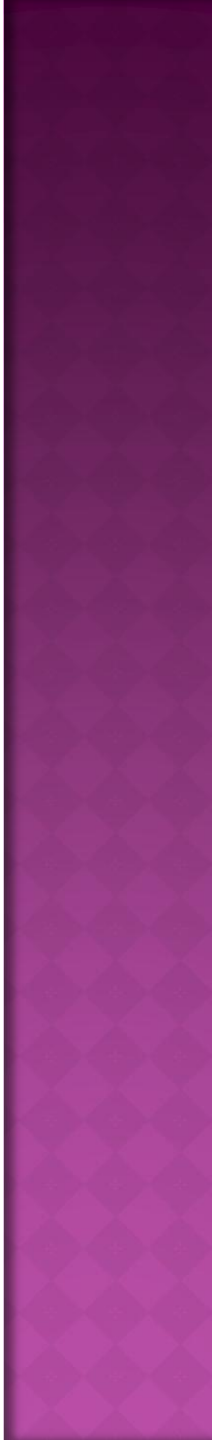
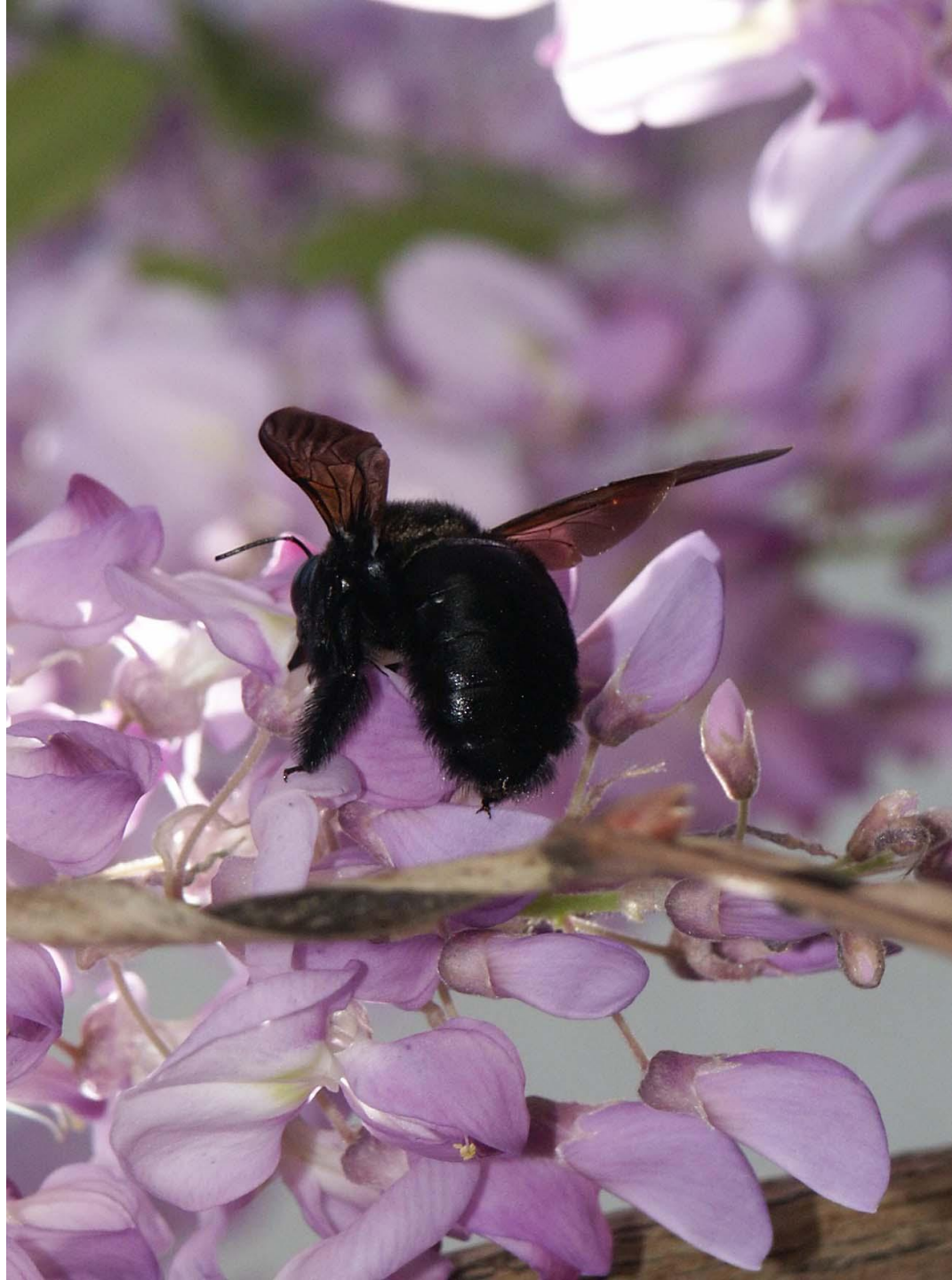
- Clay Content
- Mineralogy
- Cationic composition of exchange phase
- Sesquioxide and organic matter content
- Electrolyte concentration
 - In rain/irrigation and soil water
- Presence of dissolvable amendments

CALCIUM CONTAINING MATERIALS

Soil pH
Solubility
Cost

- ⊙ gypsum (CaSO_4)
- ⊙ lime (CaCO_3)
- ⊙ dolomite ($\text{CaCO}_3 + \text{MgCO}_3$)
- ⊙ calcium chloride (CaCl_2)





CONTRASTING SOIL CONDITIONS

1. Uniform unstratified loam- uniform water and nutrient uptake, even better if organic matter and optimal water quality
2. Stratified soil hardpan
3. Clay soil



SOIL

- ⦿ Plant requirements- drainage, water storage, nutrient holding capacity, water intake, root inhibition i.e.. aeration, compaction
- ⦿ sands
- ⦿ clay
- ⦿ loam

TROUBLESHOOTING PROBLEM SOILS





