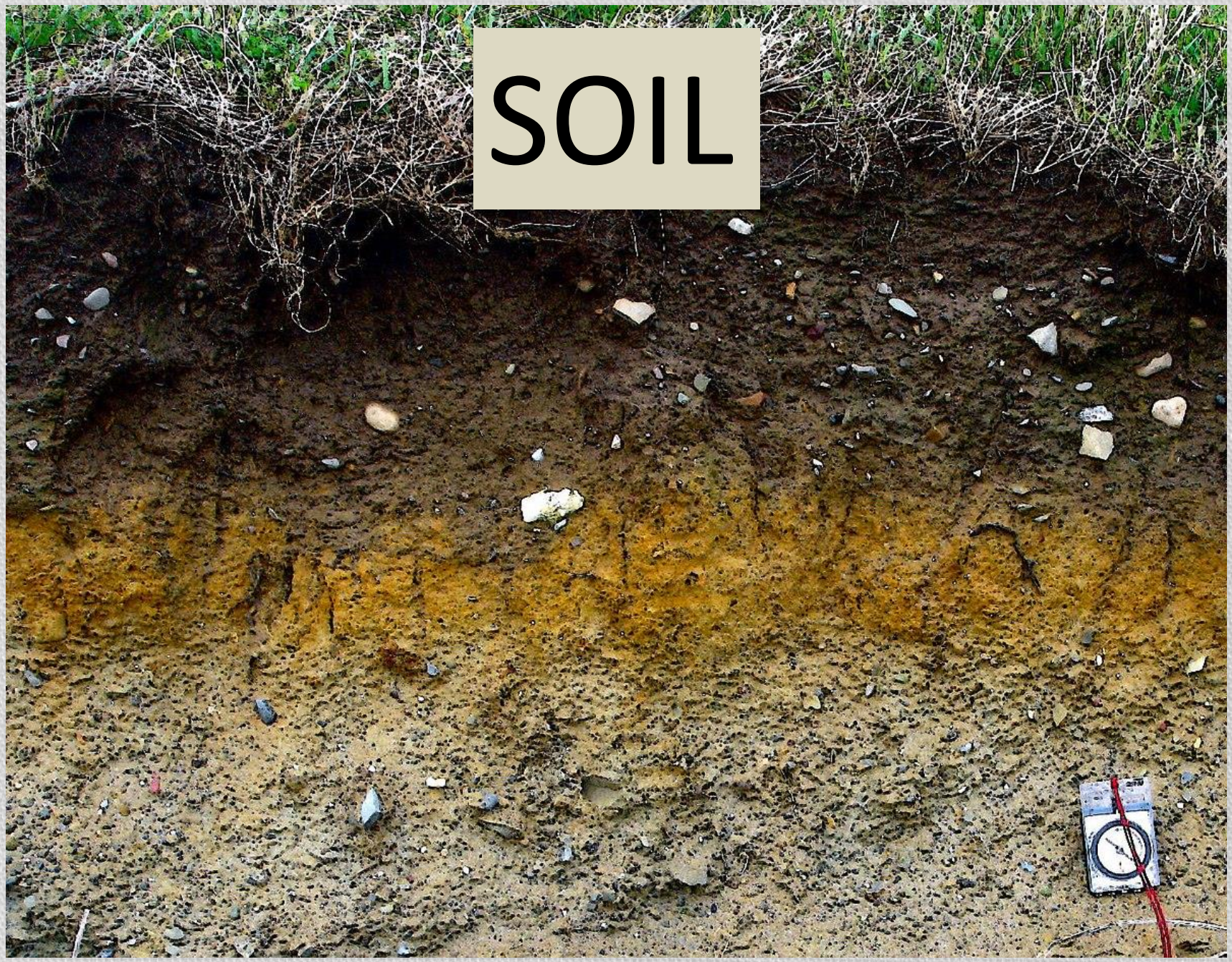
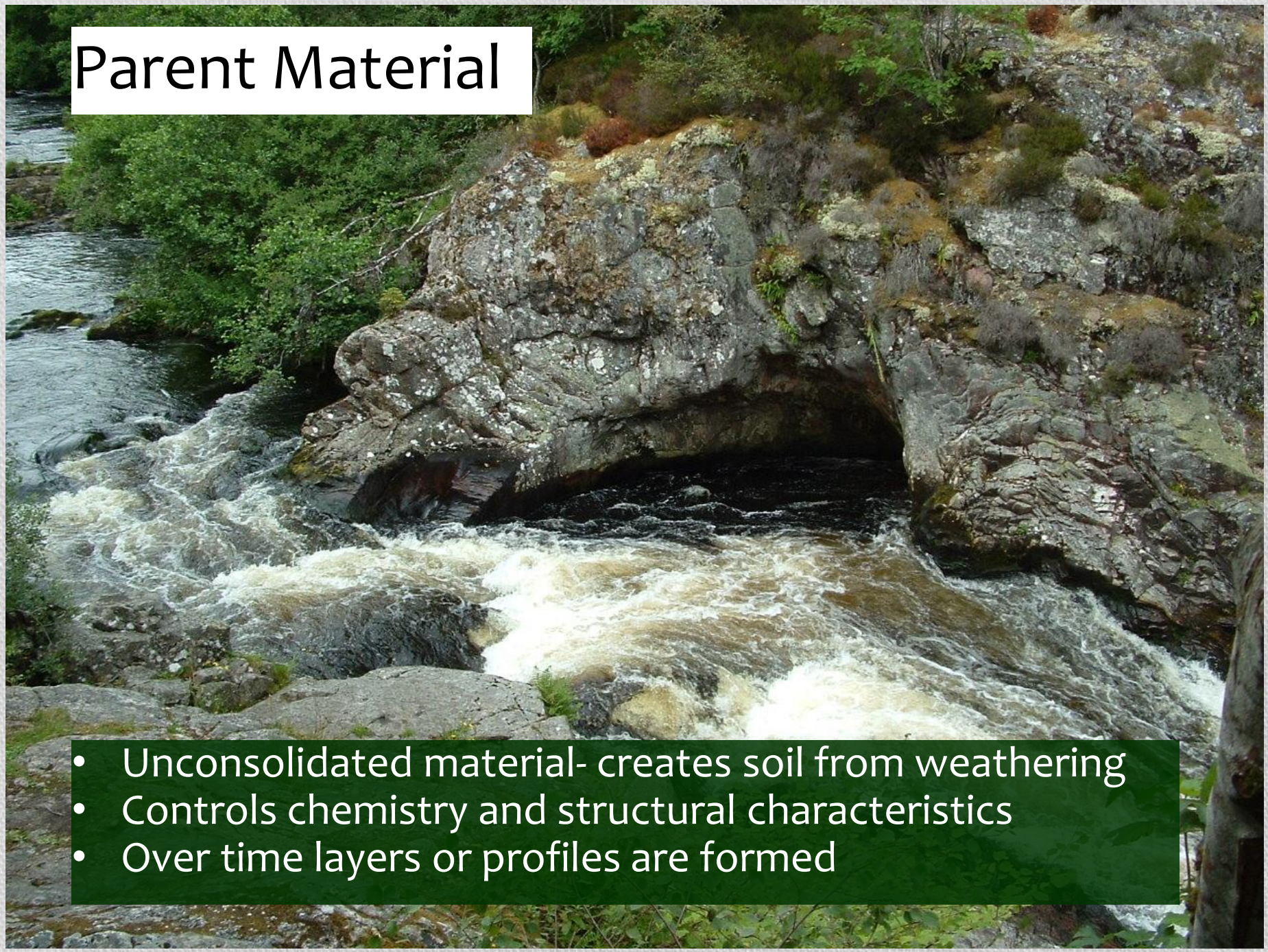
Soil and other Environmental Factors

Characteristics, plant responses & management


SOIL

Parent Material

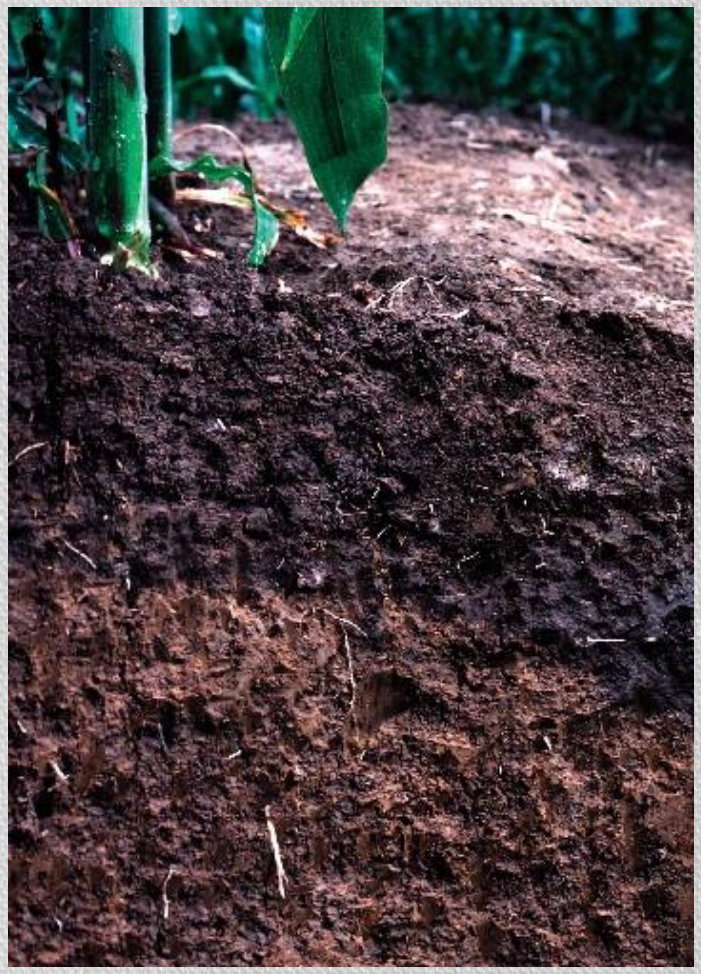


- Unconsolidated material- creates soil from weathering
- Controls chemistry and structural characteristics
- Over time layers or profiles are formed

Soil Profile

- Vertical section through natural soil, extends into un-weathered parent material, exposes all horizons
  - Additions- materials added to soil
  - Losses- materials lost from soil
  - Translocations- materials moved within soil
  - Transformations- materials altered in soil

Soil Horizons



A, B and C = master horizons
O = organic layer
A = “topsoil”- surface layer

B = “subsoil”, illuviation- zone of accumulation of nutrients leached from above layers

C = not really touched by soil-forming processes, typically parent material of soil

- ✓ may include soft, weathered bedrock that roots can penetrate

R = underlying, hard rock bedrock

- ✓ limestone, sandstone, granite, may have root penetration

Why worry about the soil?

- Many plant problems originate in the soil
  - Poor drainage
  - Drought
  - pH (plant selection)
  - Compaction/altered horizons
  - Restricted root space
- Its not just dirt! It's ALIVE !!!

Young Frankenstein

Alive with???

- <u>Microfauna:</u>
- 100 M to 1 B bacteria in a teaspoon of soil
- Lots of fungi- decomposers, mycorrhizae and pathogens
- <u>Macrofauna:</u>
- rabbits and gophers, moles, snails, slugs, earthworms, ants, termites and millipedes

Mother Earth News Almanac

Why think about the soil?

- To understand how it works so you can grow healthy, thriving, long-lived plants
- To protect it
- To manage it

How do you learn about the soil?

- History of the site
  - Construction activity?
  - What management has been done?
  - What has been grown on the site previously?
- Conduct a soil test
- Experience

Soil Characteristics

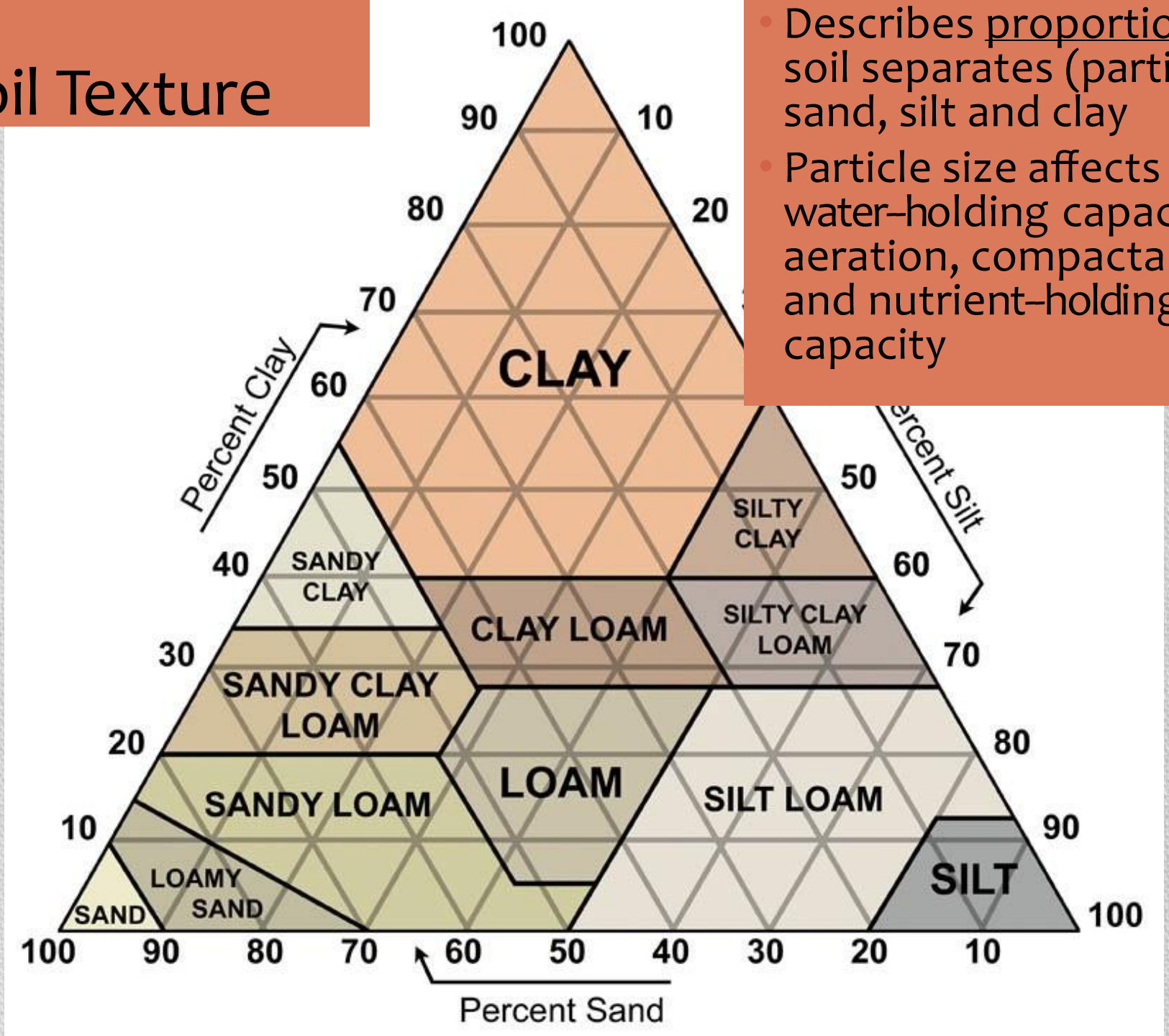
Soil – Particle Size

To describe soils by their particle size, several organizations have developed particle-size classifications.

Particle-Size Classifications				
Name of organization	Grain size (mm)			
	Gravel	Sand	Silt	Clay
MIT	>2	2 to 0.06	0.06 to 0.002	< 0.002
USDA	>2	2 to 0.05	0.05 to 0.002	< 0.002
AASHTO	76.2 to 2	2 to 0.075	0.075 to 0.002	< 0.002
USCS	76.2 to 4.75	4.75 to 0.075	< 0.075	

Soil Texture

- Describes <u>proportion</u> of soil separates (particles): sand, silt and clay
- Particle size affects water–holding capacity, aeration, compactability and nutrient–holding capacity



What Does Texture Influence?

- Behavior of water in soil
  - **Infiltration:** water entering soil
  - **Percolation:** water movement through soil
- Plant nutrient availability
  - Clay type soils retain more plant nutrients
- Ease of cultivation
  - Clay type soils form clods when tilled, soil crusting may occur; readily compacted
  - Takes longer and more horsepower to cultivate finer soils
- Use

SAND

CLAY

Sandy soil

- mostly large pores spaces: air-filled
- Low CEC
- Low nutrient and water holding capacity

Clay soil

- Mostly small pore spaces: filled with water
- High CEC
- High nutrient and water holding capacity

Water Status in Soils

- ✓ Field capacity
- ✓ Permanent wilting point
- ✓ Available water
- ✓ How does water status effect nutrient availability?

Texture-Can you alter it?

- Not practical in large areas
- Can add sand or clay in small areas
  - Need large amounts
  - Still behaves as original soil textural type
- Consider texture
  - Species selection
  - Soil management
  - Amend

https://extension.umn.edu

Physical Soil Properties

Arcticatlas.org

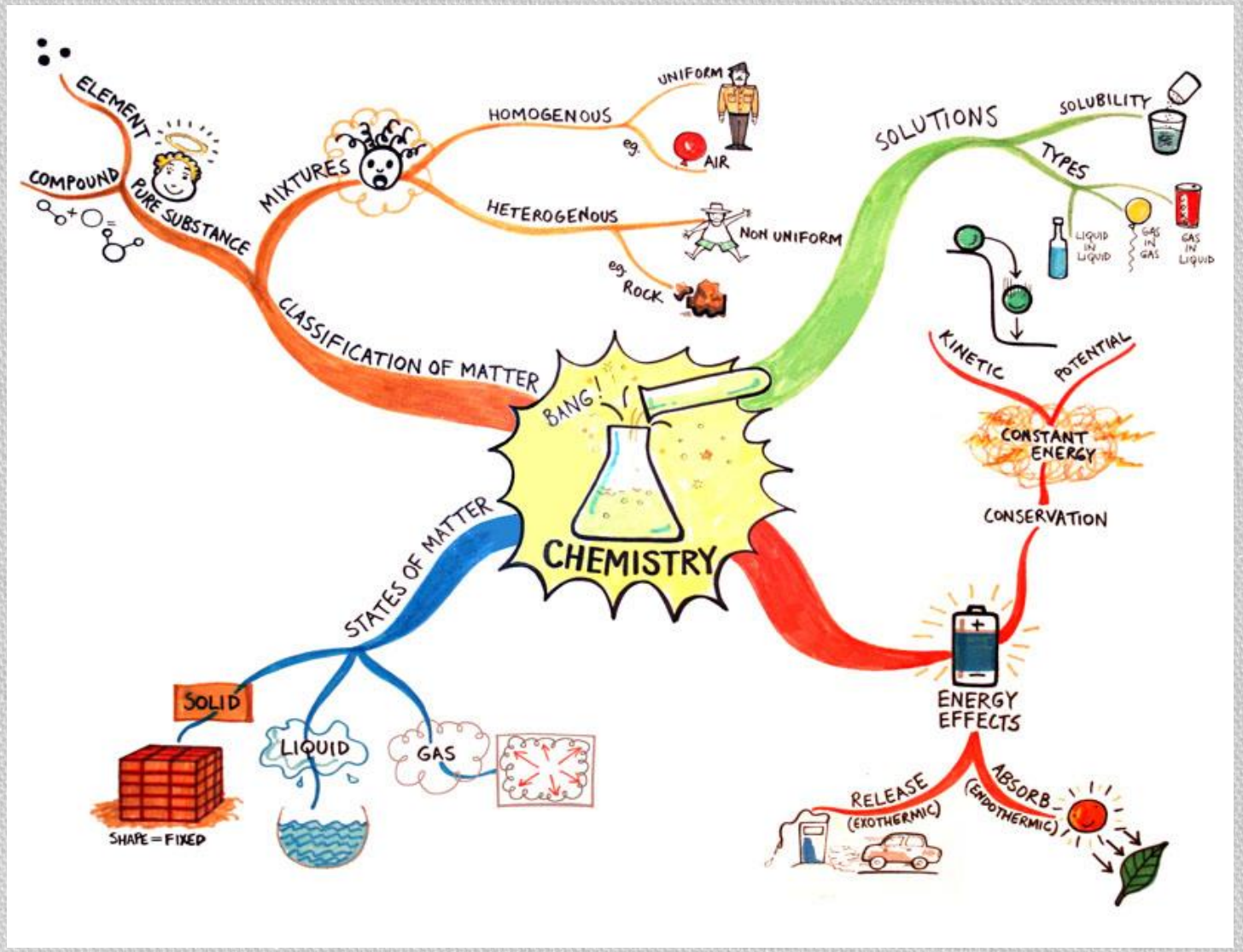
Soil Structure

- ✓ Describes aggregation
- ✓ Good structure:
  - ✓ Large continuous pores
  - ✓ Highly permeable
- ✓ Poor structure
- ✓ What affects structure?

Soil aggregation

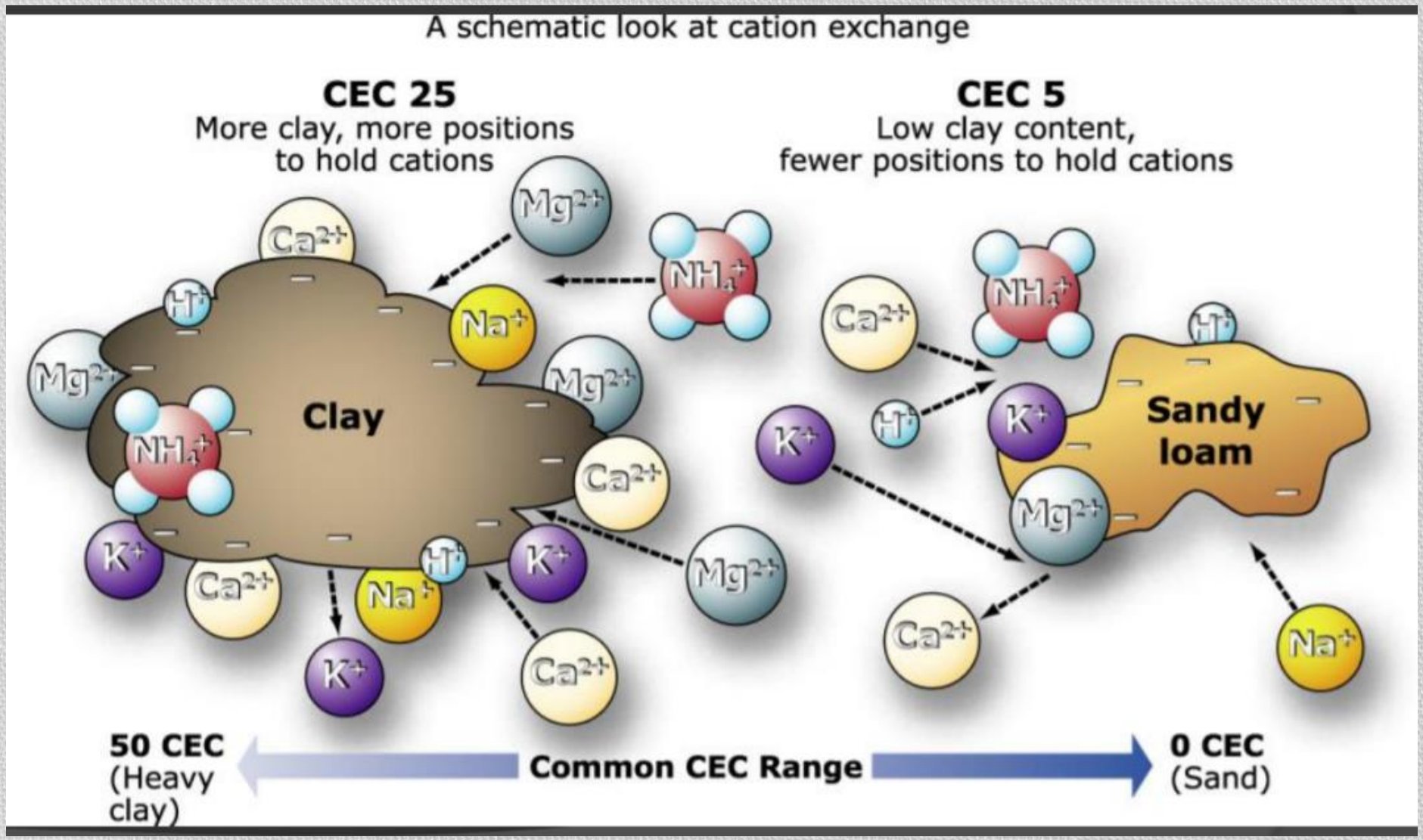
How do you think aggregates are formed?
Is aggregation good?

Soil Chemistry



Ion Exchange

- ✓ CEC- Cation Exchange Capacity, What is it?
  - ✓ Represents total negative surface charge on soil minerals and organic matter
    - ✓ Expressed as milliequivalents of negative charge per 100 g oven-dried soil; meq/100 g
  - ✓ Affected by nature and quantity of clay and organic matter
  - ✓ Texture a factor


A schematic look at cation exchange
CEC 25
More clay, more positions to hold cations
CEC 5
Low clay content, fewer positions to hold cations
Clay
Sandy loam
50 CEC (Heavy clay)
Common CEC Range
0 CEC (Sand)

- ✓ CEC
  - ✓ pH a factor
    - ✓ Acidic soils: Al^{+3}, H^{+}, Ca^{+2}, Mg^{+2}, and K^{+}
    - ✓ Neutral or basic soils: Ca^{+2}, Mg^{+2}, K^{+}, Na^{+}
- ✓ Most exchangeable ions are plant nutrients
- ✓ Roots exhibit CEC
  - ✓ Legumes tend to absorb divalent cations (Ca^{+2}), grasses absorb monovalent cations; e.g. K^{+} absorption
- ✓ Varying adsorption strengths: lyotropic series
  - ✓ $Al^{+3} > H^{+} > Ca^{+2} > Mg^{+2} > K^{+} = NH^{+}_{4} > Na^{+}$

Soil pH

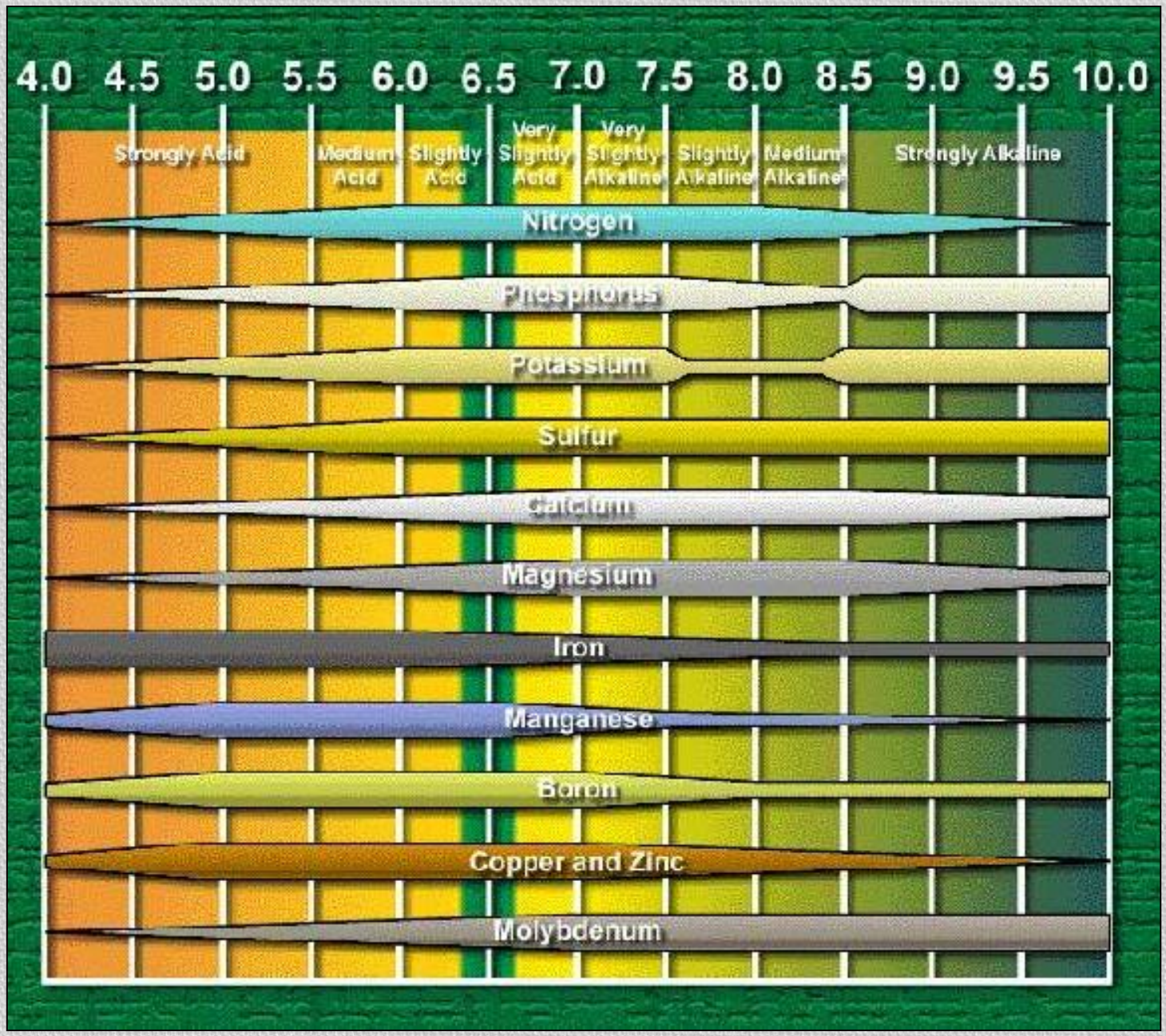
- ✓ Describes acidity or alkalinity of soil
- ✓ Calculated from the base 10 logarithm of the H^+ ion concentration
- ✓ Balance between H^+ and OH^- ions determines pH
- ✓ 0-14, 7 being neutral → equal concentrations of H^+ and OH^- ions
- ✓ For soil: pH typically between 3.5 - 10.5

$$H_2O \leftrightarrow H^+ + OH^-$$

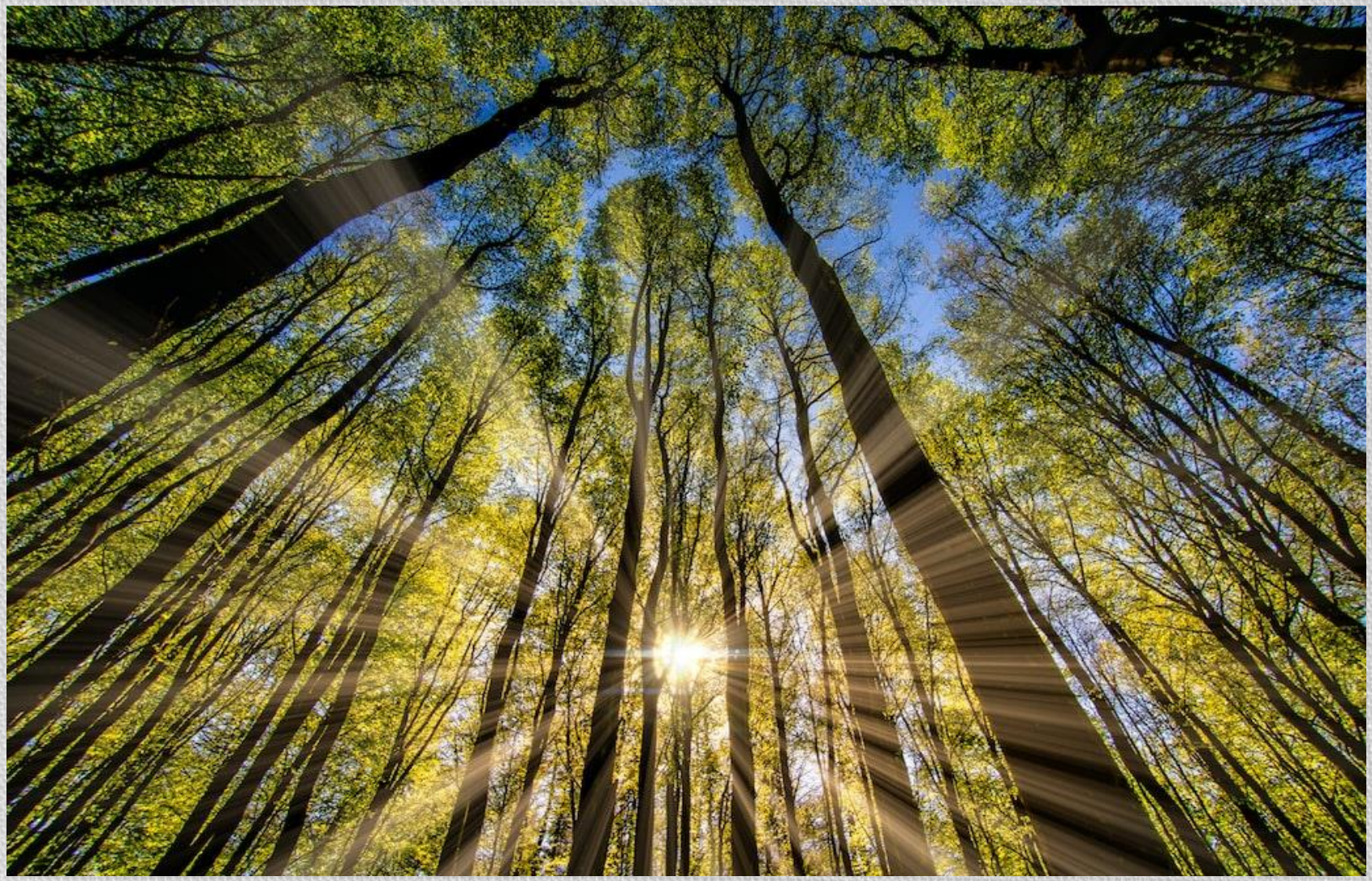
pH Effects on Plants

- ✓ Most do well at 6.0 – 7.0 pH
- ✓ Species specific
- ✓ Effects nutrient availability
- ✓ Effects microbial activity
  - ✓ Microbes work best at near-neutral pH
  - ✓ Acidic soils slow activity
- ✓ Effects concentrations of Al and other metals
  - ✓ Al and Mn reach toxic levels at pH below 5.5
  - ✓ Restricts root growth and movement of other nutrients

Nutrient Availability based on Soil pH



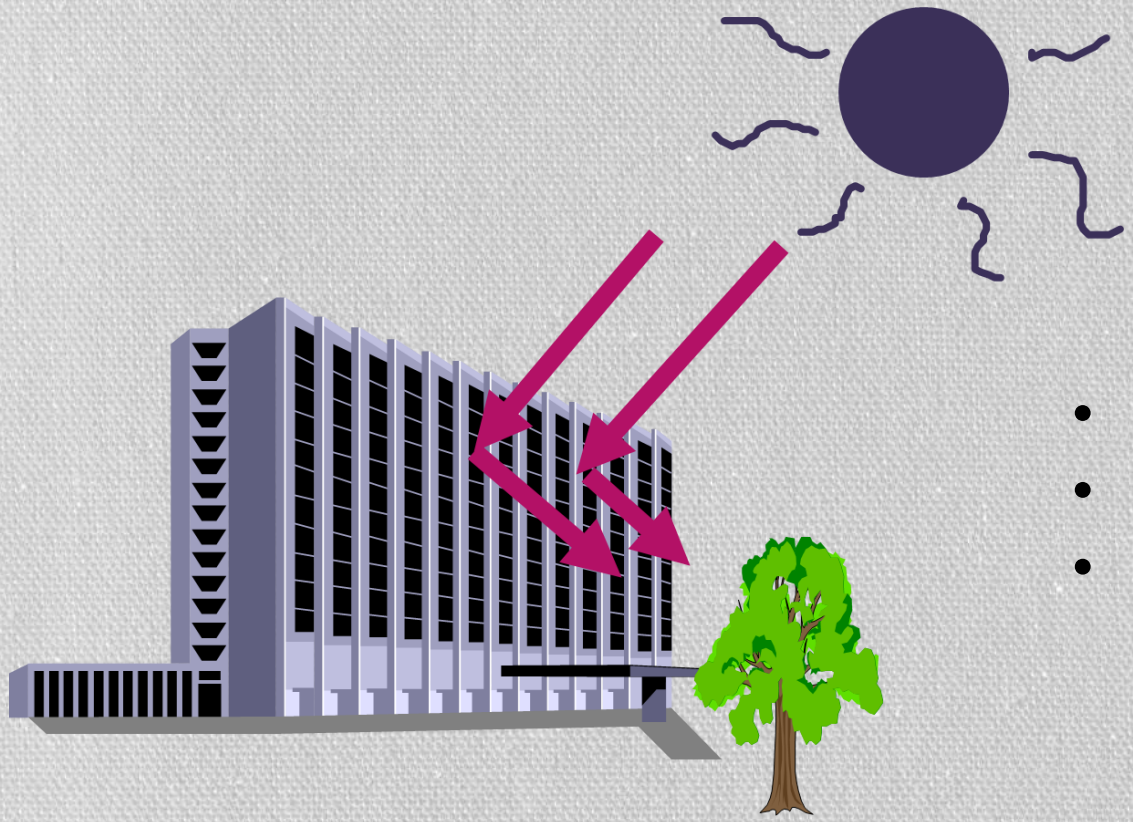
LIGHT



Light Levels

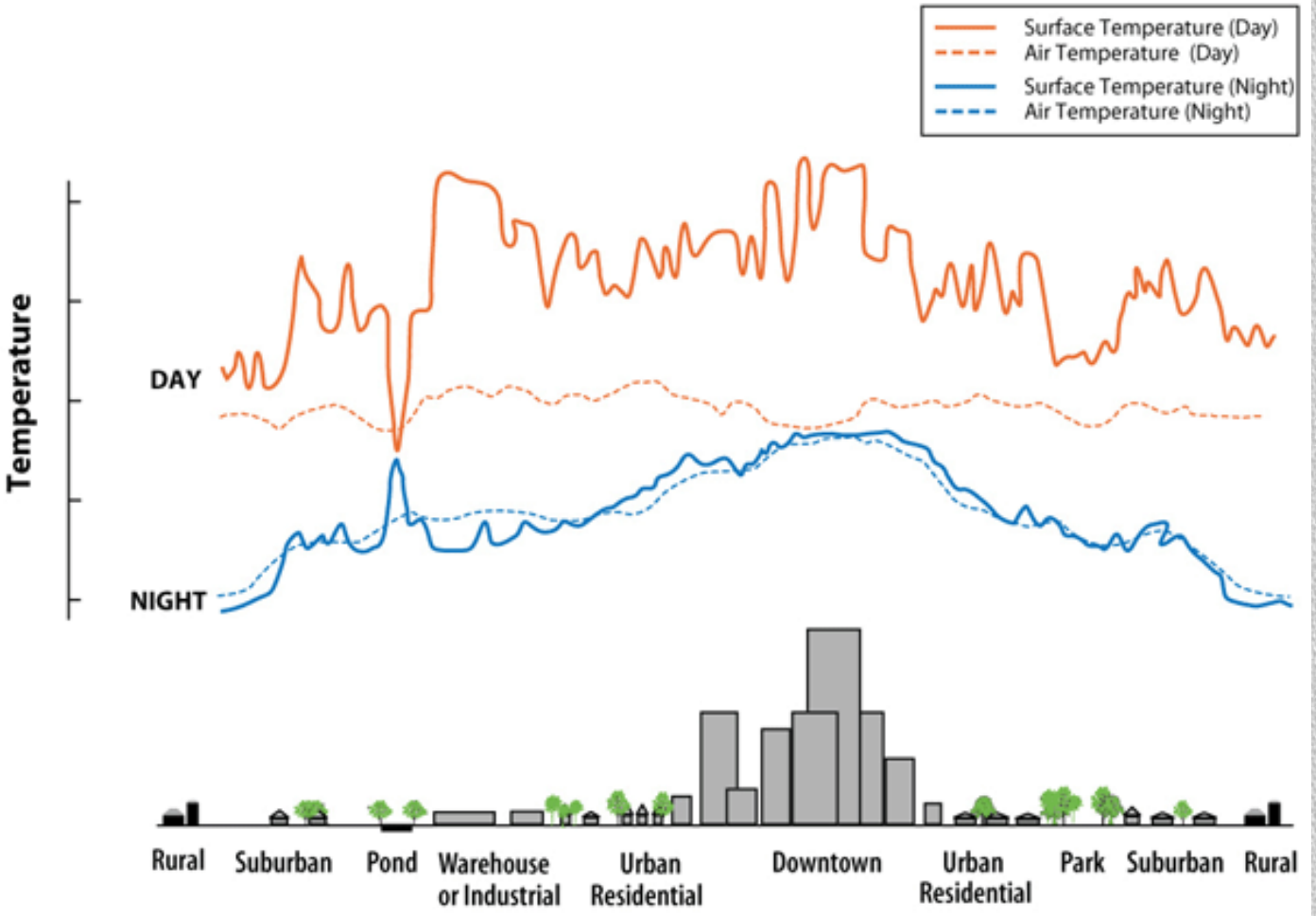
Full sun: ≥ 6 hrs
Partial sun: 4-6 hrs
Partial shade: 2-4 hrs
Shade: < 2 hrs

Re-reflected Heat

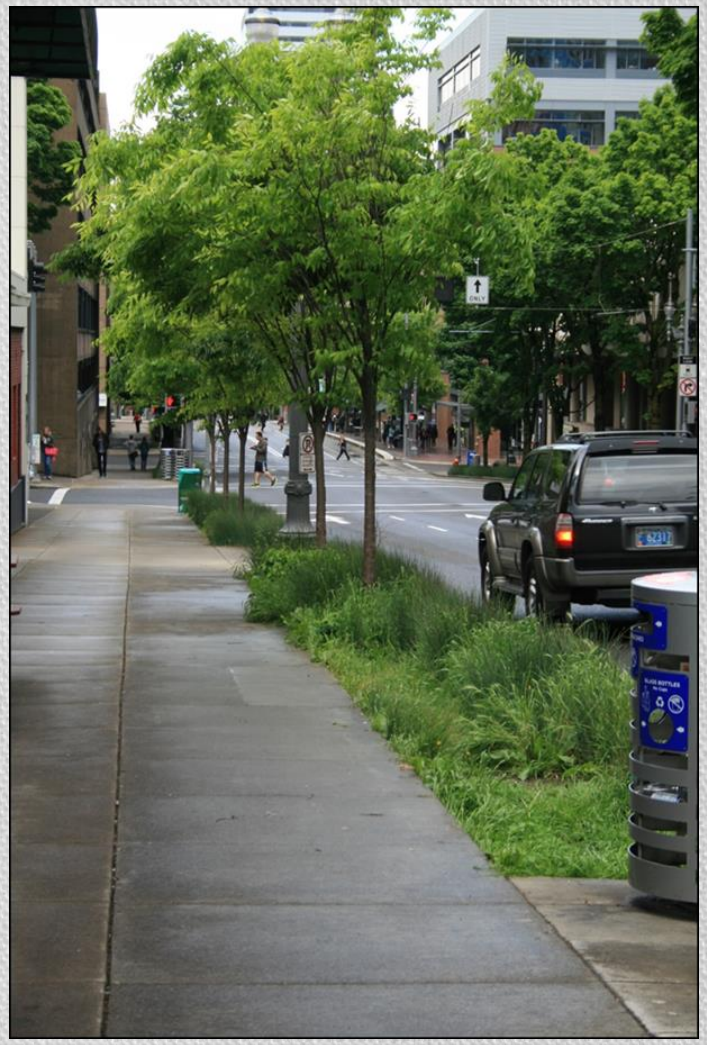


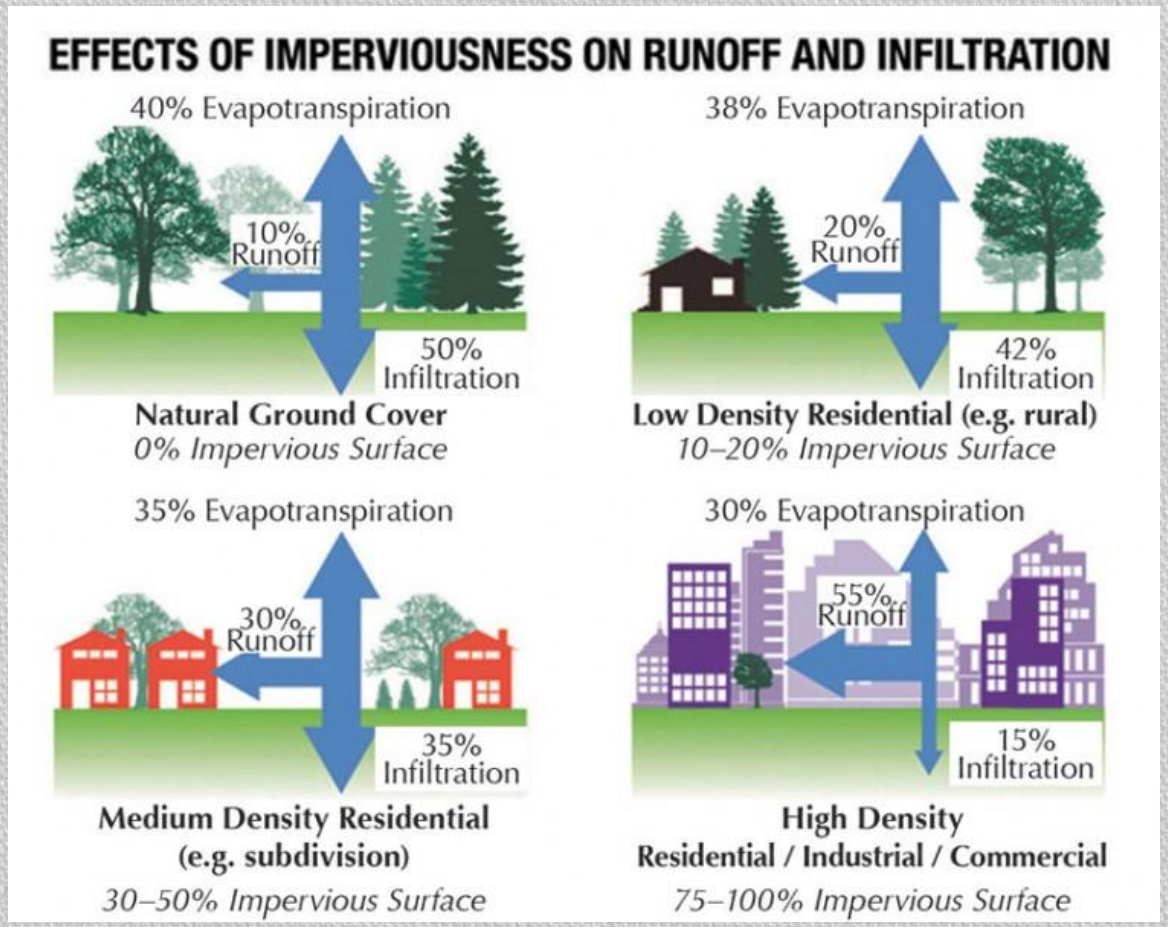
- Increases temperature
- Decreases humidity
- Increases water stress

Urban Heat Island Effect



It’s getting quite hot out here




EFFECTS OF IMPERVIOUSNESS ON RUNOFF AND INFILTRATION
40% Evapotranspiration
10% Runoff
50% Infiltration
Natural Ground Cover
0% Impervious Surface
38% Evapotranspiration
20% Runoff
42% Infiltration
Low Density Residential (e.g. rural)
10–20% Impervious Surface
35% Evapotranspiration
30% Runoff
35% Infiltration
Medium Density Residential
(e.g. subdivision)
30–50% Impervious Surface
30% Evapotranspiration
55% Runoff
15% Infiltration
High Density
Residential / Industrial / Commercial
75–100% Impervious Surface

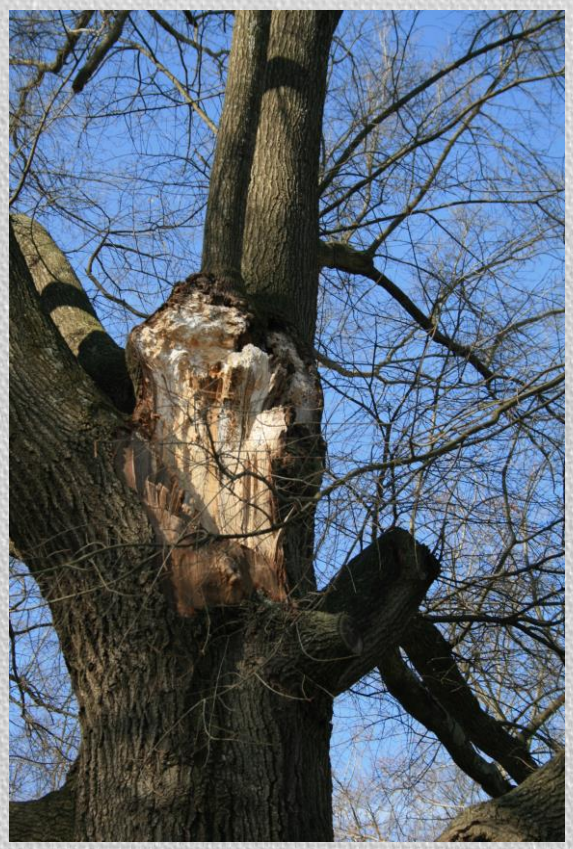
Is it getting chilly out here?

- Cold temperatures slow activities in tree
- Extreme cold- frost cracks or sunscald
  - Rapid fluctuations in wood temps
  - Can kill vascular cambium

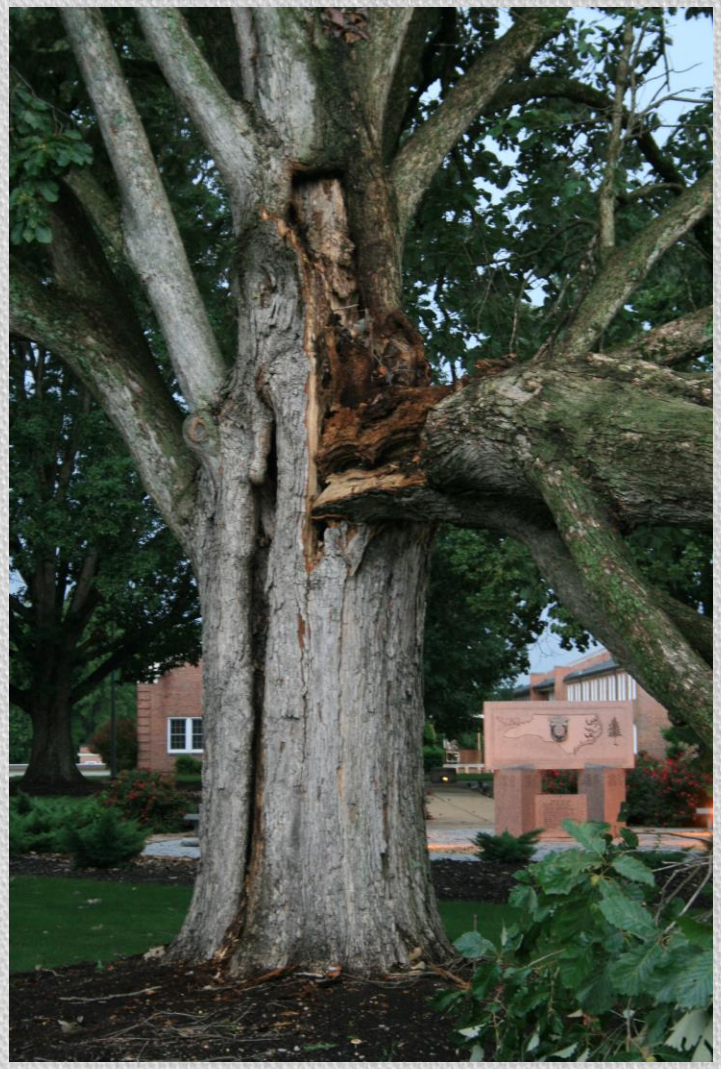
- ✓ Wind a greater issue when trees have poor structure
  - ✓ Prune trees when young!
- ✓ Wind issue when trees grow alone
  - ✓ Plant trees in groups
  - ✓ Plant right tree for site
  - ✓ Right place!

Branch issues

- Poor attachments
- Bark growing in between branch unions
- Large pruning wounds
- Cavities



Bark growing between branch unions can lead to branches breaking



Don’t plant large maturing trees to close to utility lines and stay as far from structures as possible

Allow some air circulation and sufficient light

Wrap Up

- ✓ Learn a bit about soil- it is key to life on this little planet!
- ✓ Explore environmental factors that affect trees and avoid or prepare!