Assessing and Understanding Soil Characteristics

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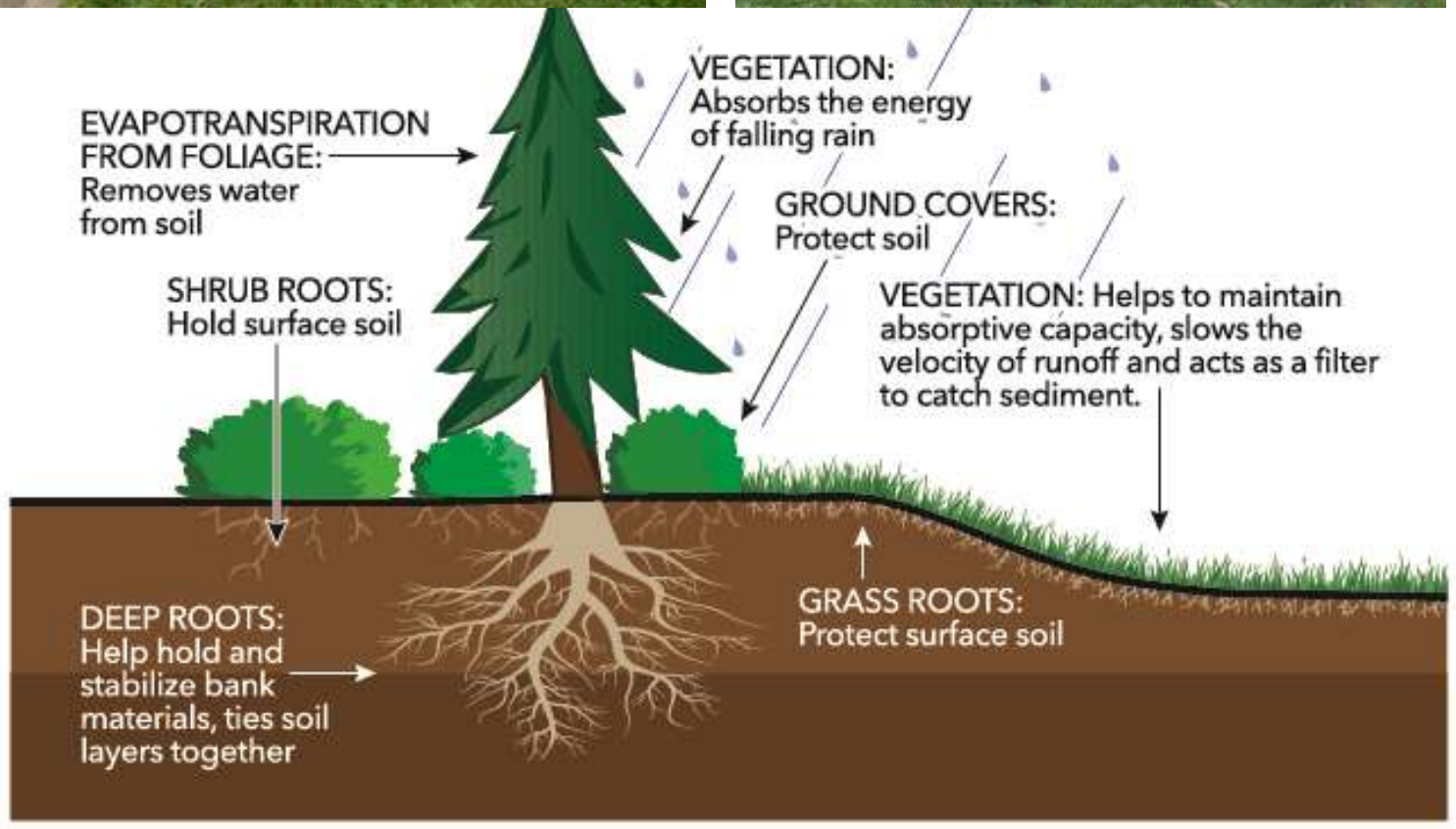
Principles
Behind Landscaping for Water Quality Benefits

1. STOP the sources of water pollutants
2. INFILTRATE runoff into the ground
3. FILTER pollutants from runoff with plants and soil microbes


VEGETATION:
Absorbs the energy
of falling rain
EVAPOTRANSPIRATION
FROM FOLIAGE:
Removes water
from soil
GROUND COVERS:
Protect soil
SHRUB ROOTS:
Hold surface soil
VEGETATION: Helps to maintain
absorptive capacity, slows the
velocity of runoff and acts as a filter
to catch sediment.
GRASS ROOTS:
Protect surface soil
DEEP ROOTS:
Help hold and
stabilize bank
materials, ties soil
layers together

Why use plants as a means to managing stormwater?

The most effective landscape stormwater solutions depend on VEGETATION and INFILTRATION.

Plants slow runoff, allowing particulates to settle out and increasing infiltration.

Roots provide infiltration channels.

Roots help hold soil together, reducing erosion.

Together with soil microbes, plants can remove pollutants, such as heavy metals.

Roots absorb water and nutrients.

Roots exude chemicals that feed the soil microbes.

Leaves intercept rainfall, reducing energy and impaction forces.

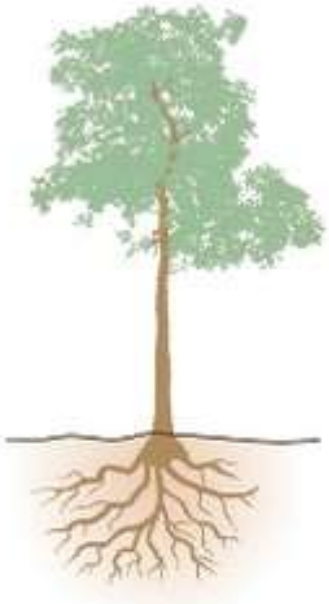
Plants add organic matter to the soil.

Plants add aesthetic value.

Plants increase biodiversity.

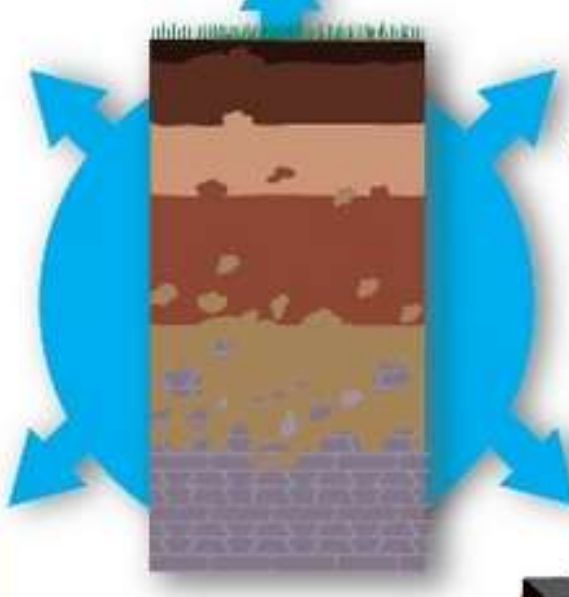
Plants support pollinators and wildlife.

SOIL QUALIITY
and **SOIL HEALTH**
describe the capacity of a soil to perform its **ECOLOGICAL** functions.



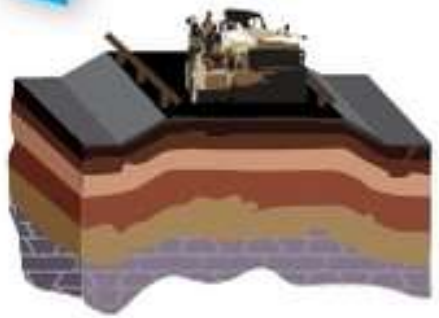
Medium for plant growth

Recycling system for nutrients and organic wastes



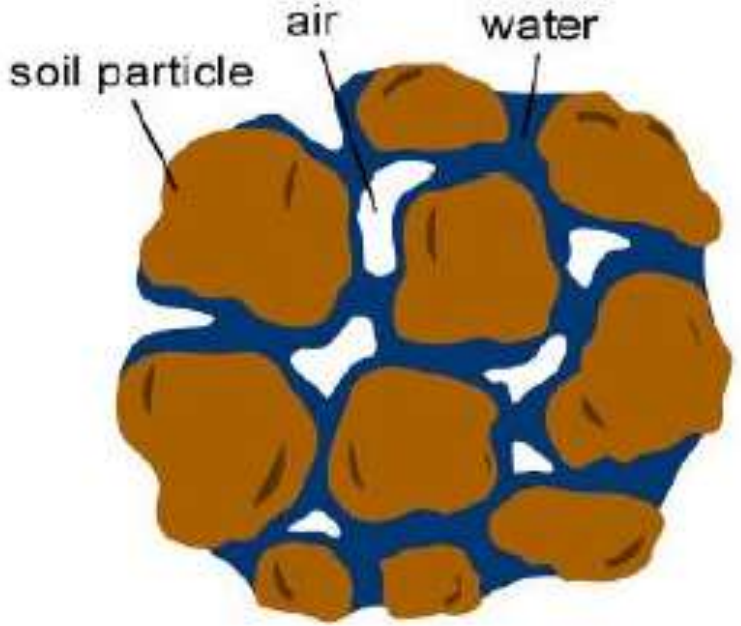
Habitat for soil organisms

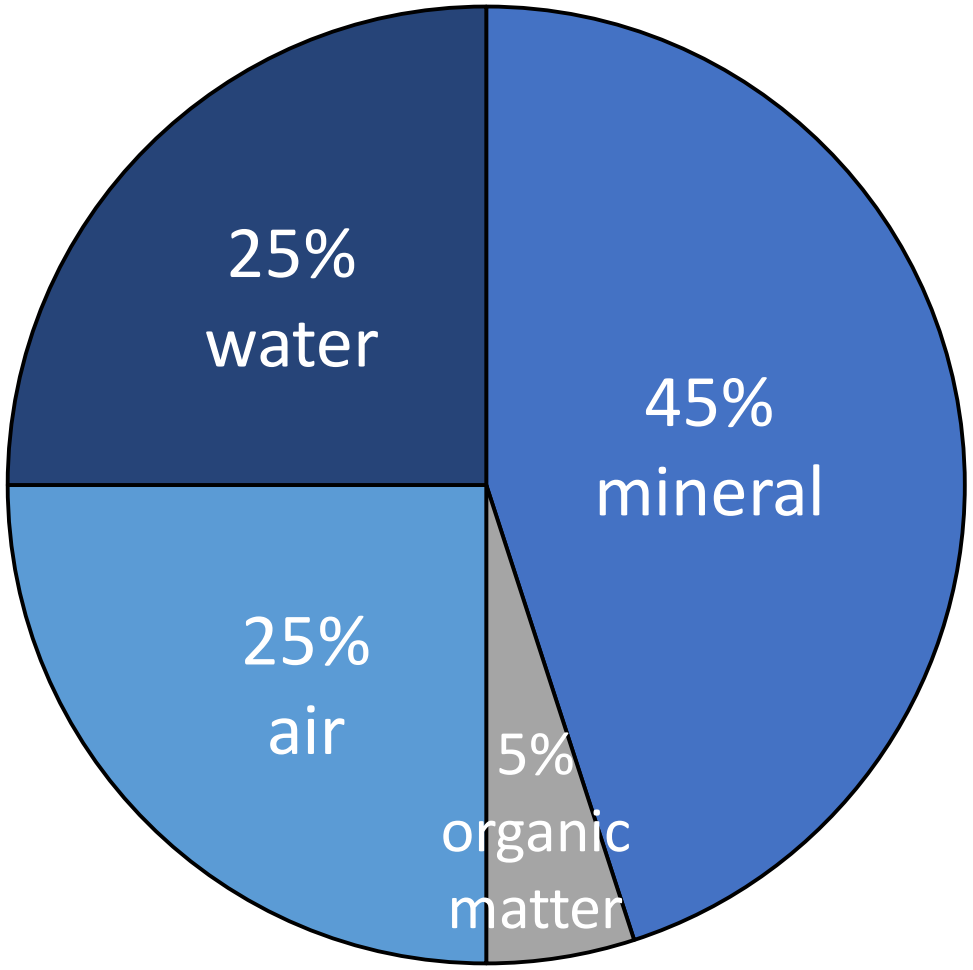
System for water supply and purification



Engineering medium

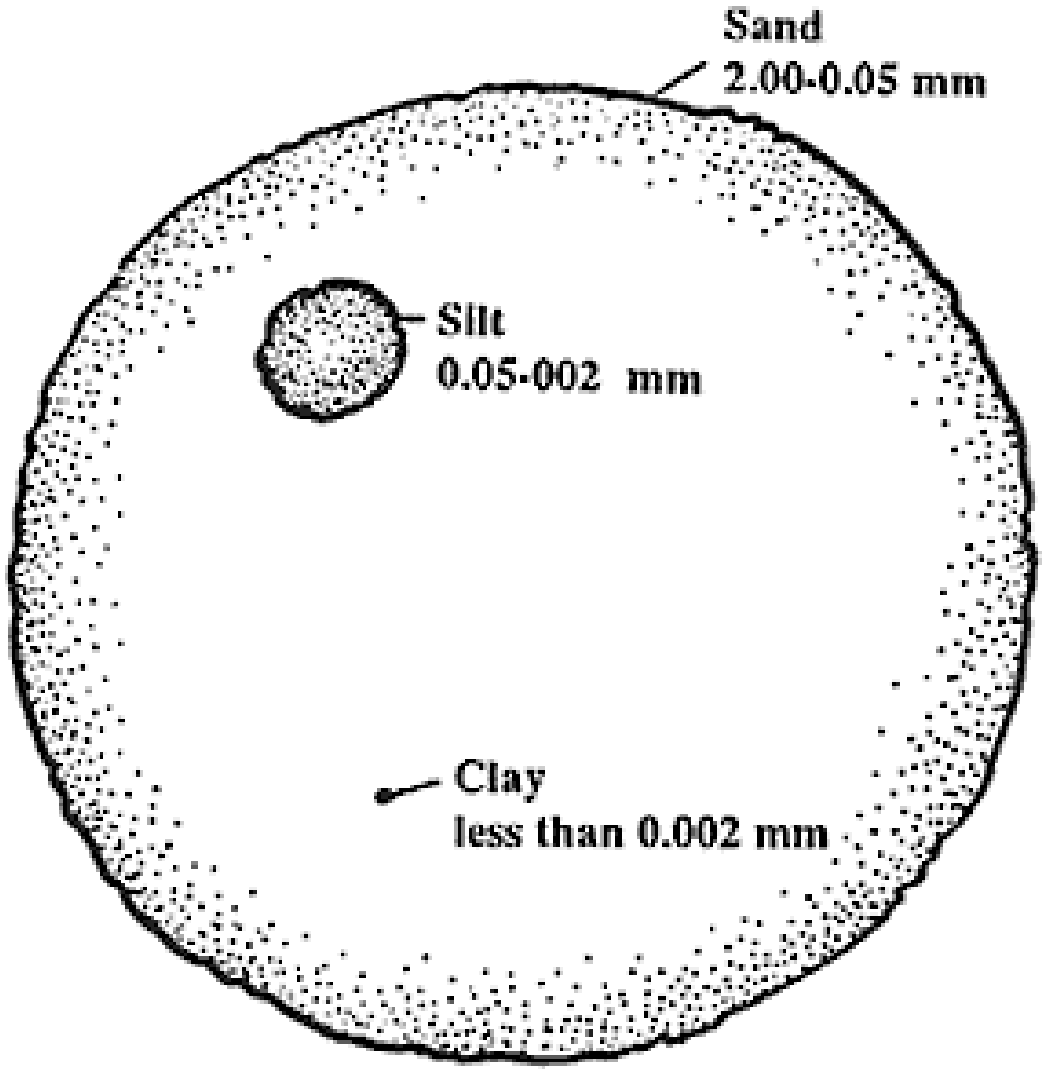
PHYSICAL PROPERTIES

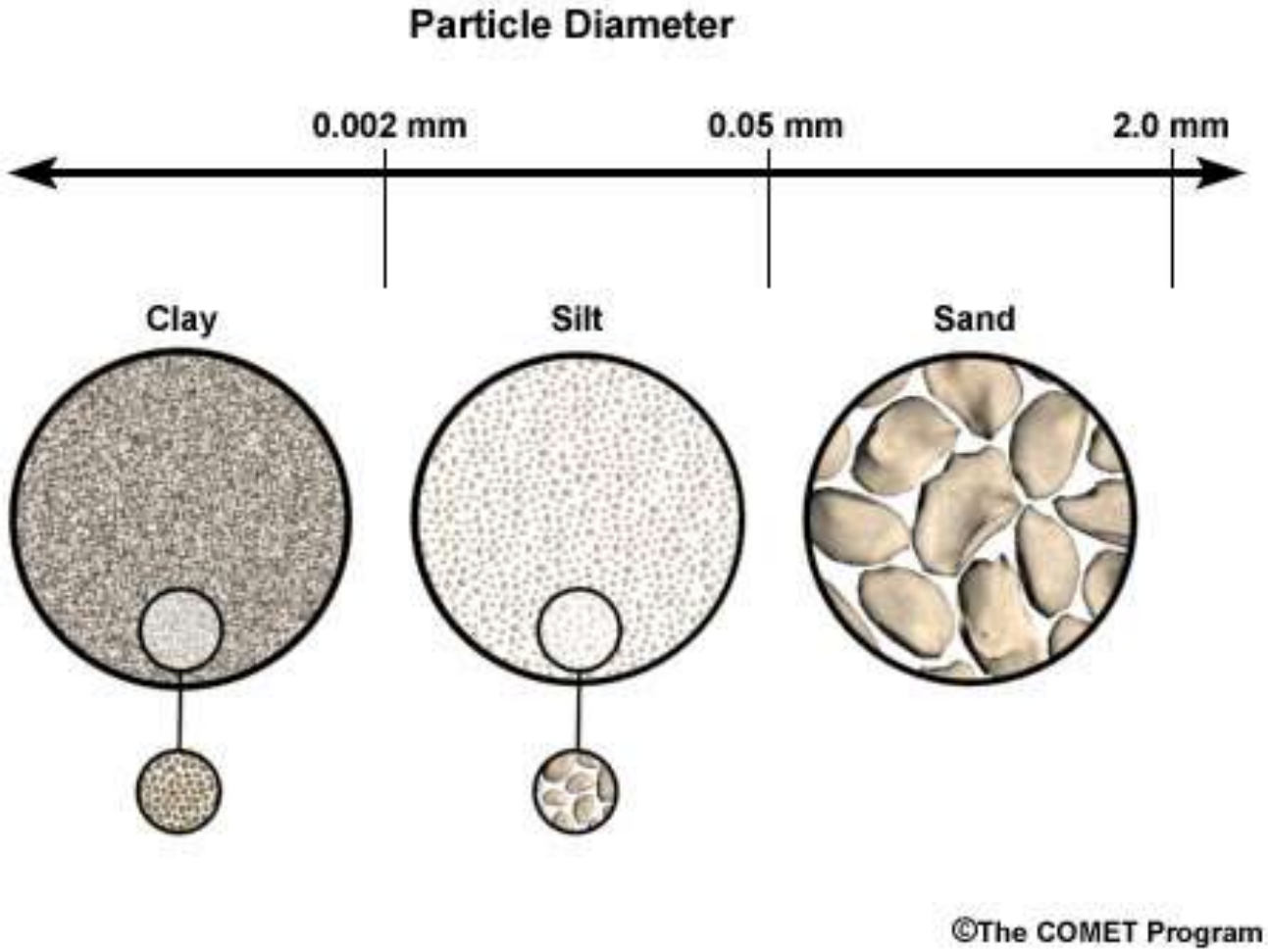




Mineral matter Organic matter Air Water

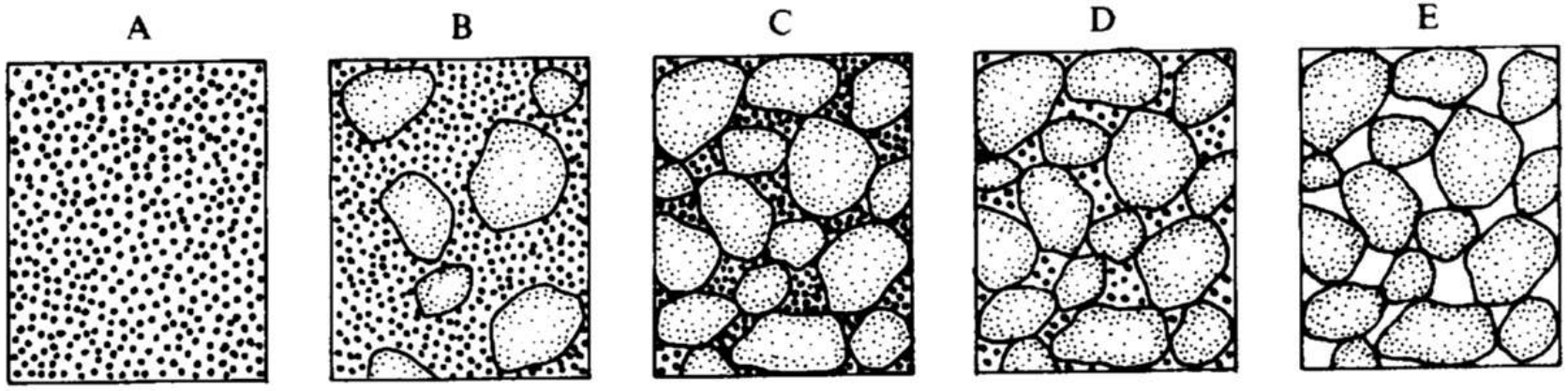
PHYSICAL PROPERTIES – MINERAL PARTICLES





PHYSICAL PROPERTIES – SOIL TEXTURE

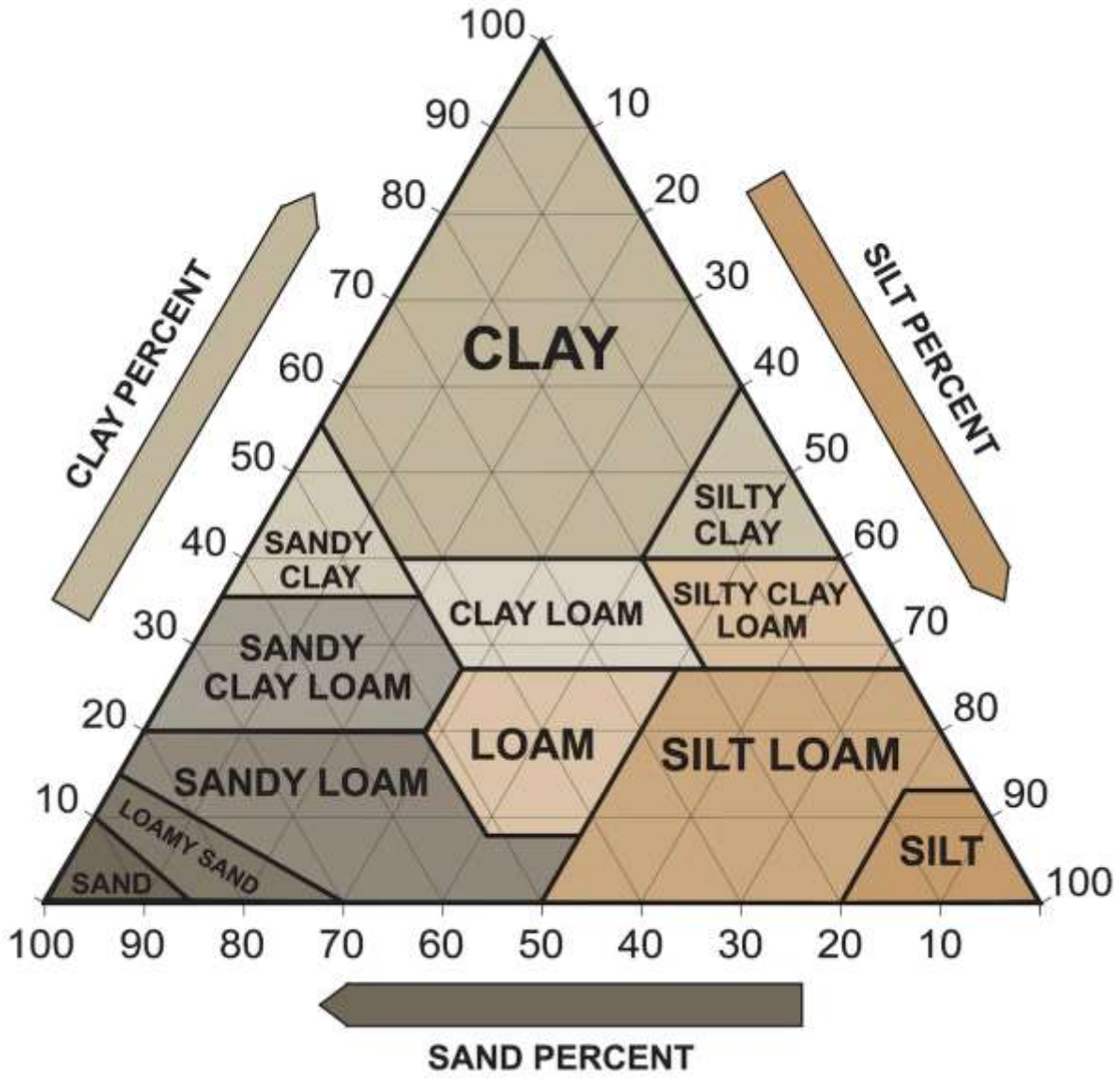
What happens to the air and water holding capacity of a soil when you add sand to clay?



Percent Volume	A	B	C	D	E
Clay	100	75	50	25	0
Sand	0	25	50	75	100
Small Pores	50	37.5	25	12.5	0
Large Pores	0	0	0	25	50

FIGURE 7-1 The effect of mixing increasing proportions of a coarse sand to a fine clay, each having 50% pore space (A and E). In this example, even when equal volumes of sand and clay are mixed (C), large pore space is 0 and small pore space has been reduced to 25%. Soil mix C has the poorest aeration; aeration improves as a higher proportion of sand is present. Soil mixes A and B can be easily compacted, whereas C, D, and E have better compaction resistance. *(Adapted from Spomer, 1983.)*

PHYSICAL PROPERTIES – SOIL TEXTURE



Clay soils:

- Heavy soils
- High water retention
- Low air space
- Drain slowly
- Easily compacted
- Bake & crack

Loams:

- Intermediate
- Fertile
- Well drained
- Easily worked

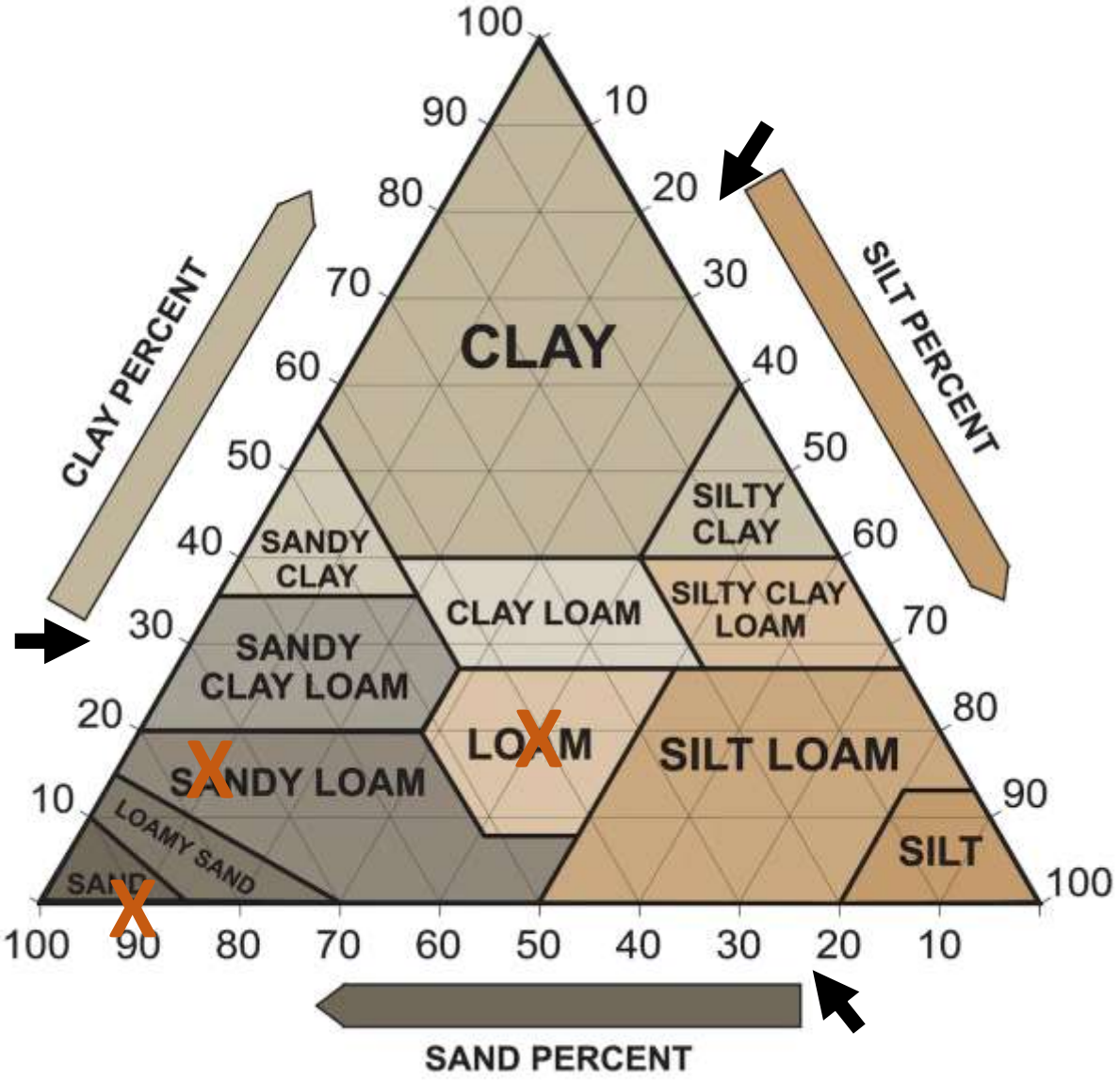
Sandy soils:

- Light soils
- Low water retention
- High air space
- Drain quickly
- Low in nutrients

Silt soils:

- Fertile
- Fairly well drained
- Easily compacted

PHYSICAL PROPERTIES – SOIL TEXTURE

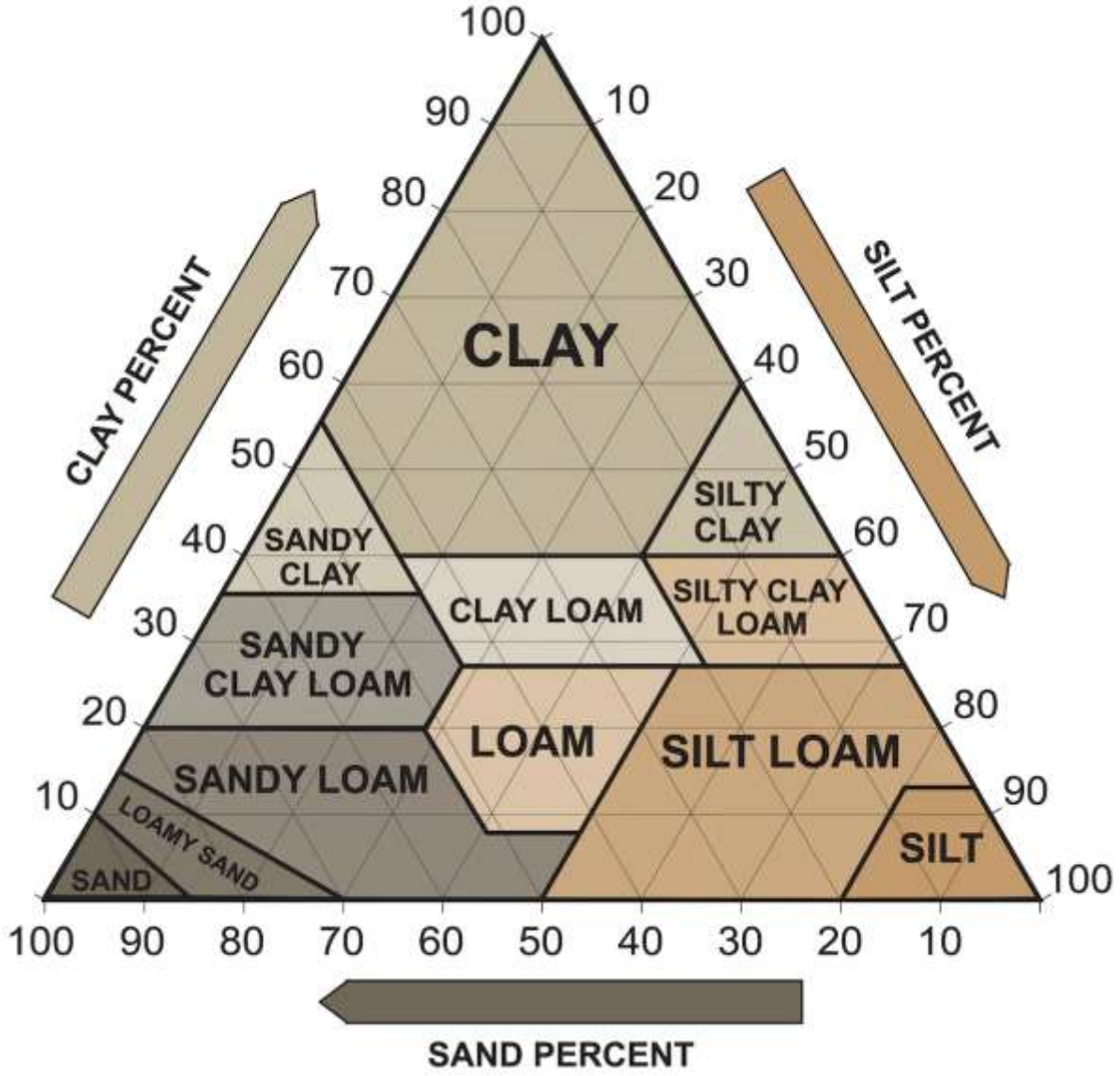


What are the texture classes of the following soils?

- 0% clay 10% silt 90% sand **SAND**
- 15% clay 10% silt 75% sand **SANDY LOAM**
- 20% clay 40% silt 40% sand **LOAM**

Which is most suitable for a stormwater installation such as a rain garden or vegetative swale? Why?

PHYSICAL PROPERTIES – SOIL TEXTURE



Clay soils:

- Heavy soils
- High water retention
- Low air space
- Drain slowly **(0.04 – 0.2 in/hr)**
- Easily compacted
- Bake & crack

Loams:

- Intermediate
- Fertile
- Well drained **(0.2 – 0.4 in/hr)**
- Easily worked

Silt soils:

- Fertile
- Fairly well drained **(0.2 – 0.4 in/hr)**
- Easily compacted

Sandy soils:

- Light soils
- Low water retention
- High air space
- Drain quickly **(>0.8 in/hr)**
- Low in nutrients

PHYSICAL PROPERTIES – DETERMINING SOIL TEXTURE CLASS

Soil test report

Extension

Commercial Landscape
Soil Report
River Pit Stockpile

Lab ID: 52834 **Lab Run Date:** 02/24/24

Test Data

				Optimum Range
pH - Soil (pH)	5.8			
Mehlich - Lime Test (Buffer pH)	6.20			
Calcium, Mehlich 3	894.9	(ppm)	O	800 - 1200
Magnesium, Mehlich 3 (Mg)	81.0	(ppm)	O	60 - 120
Potassium, Mehlich 3 (K)	52.0	(ppm)	VL	170 - 280
Phosphorus, Mehlich 3 (P)	225.0	(ppm)	VH	30 - 50
Est. CEC	5.3			
Est. Base Sat.	100.0	%		
Est. Ca Sat.	84.7	%		
Est. Mg Sat.	12.8	%		
Est. K Sat.	2.5	%		
Org. Matter, LOI-360 (OM)	3.2	(%)		
Copper, Mehlich 3 (Cu)	1.1	(ppm)		
Zinc, Mehlich 3 (Zn)	1.9	(ppm)		
Manganese, Mehlich 3 (Mn)	5.9	(ppm)		
Iron, Mehlich 3 (Fe)	124.3	(ppm)		
Clay	4.1	(%)		
Sand	63.2	(%)		
Silt	32.7	(%)		
Texture Class:	Sandy Loam			

Optimum Range Key

VL - Very Low L - Low O - Optimal H - High VH - Very High

Clay	4.1	(%)
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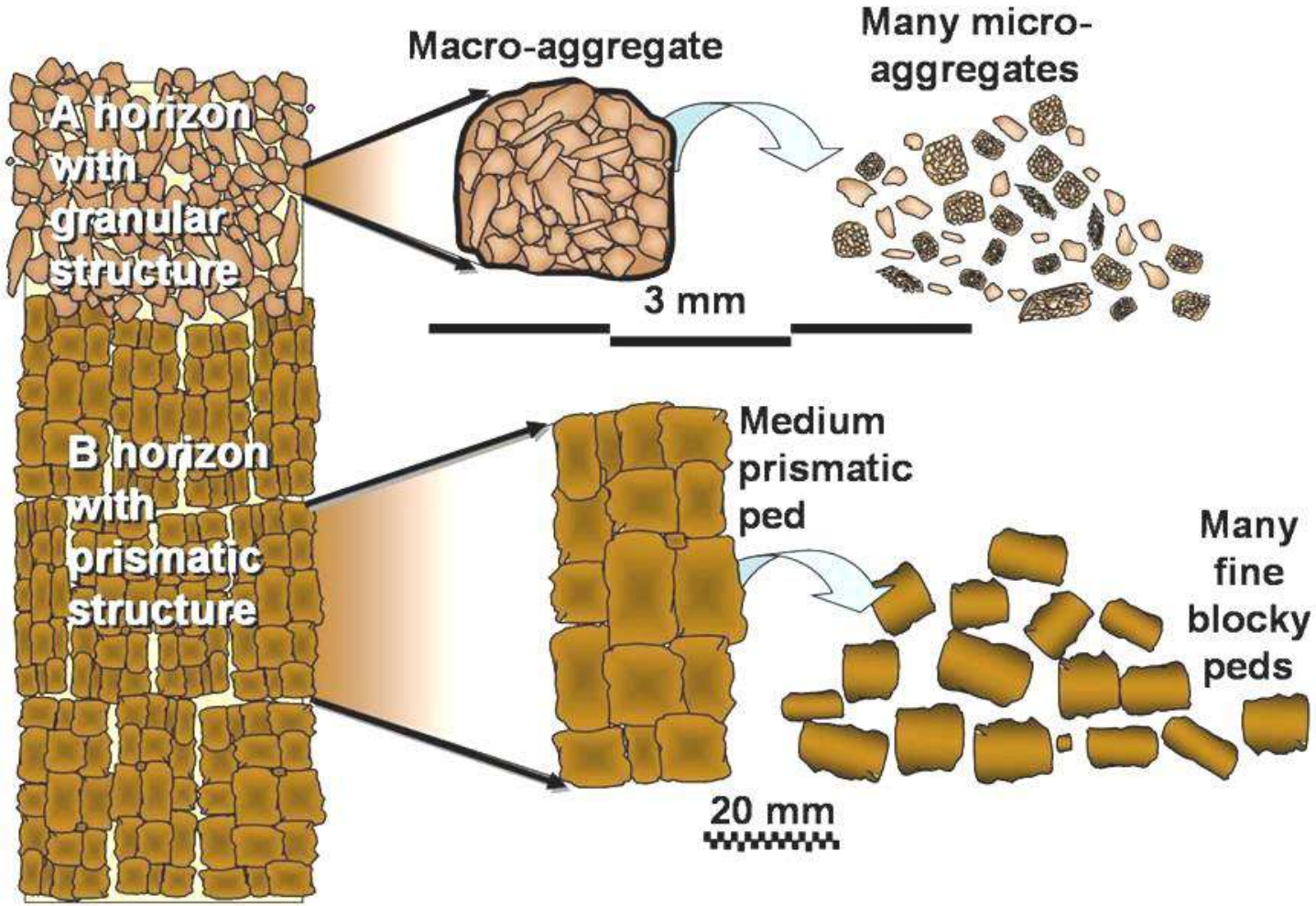
Ribbon test

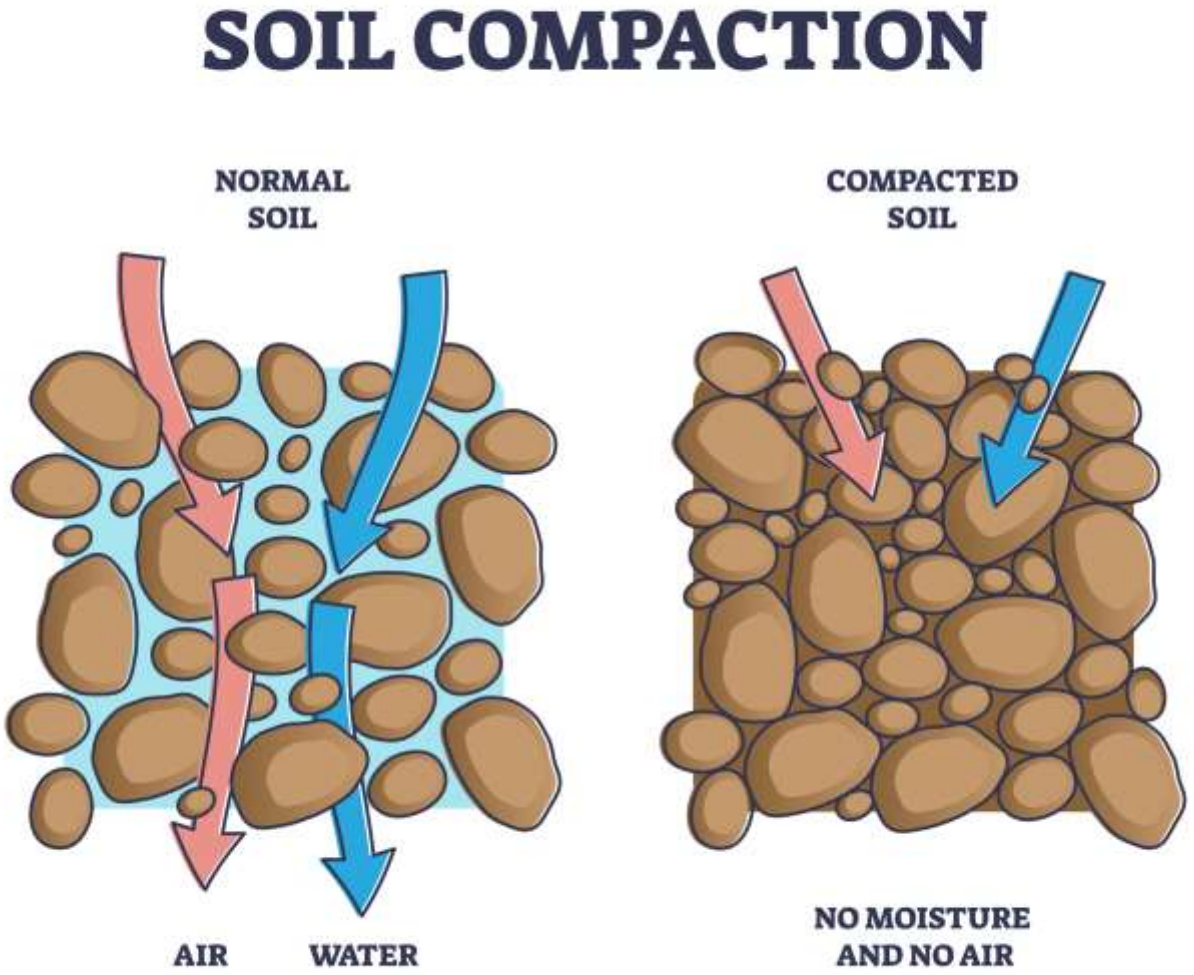
Jar test

PHYSICAL PROPERTIES – SOIL STRUCTURE



Aggregates are glued together by **glomalin**, a product of living organic matter

PHYSICAL PROPERTIES – SOIL STRUCTURE



Improve soil structure by

- Growing plants with robust root systems
- Minimizing rainfall on bare soil
- Minimizing foot traffic and vehicles

Avoid working wet soil or driving on wet soil.

CHEMICAL PROPERTIES

- Nutrients
- pH
- Cation exchange capacity (CEC)

CHEMICAL PROPERTIES – NUTRIENTS

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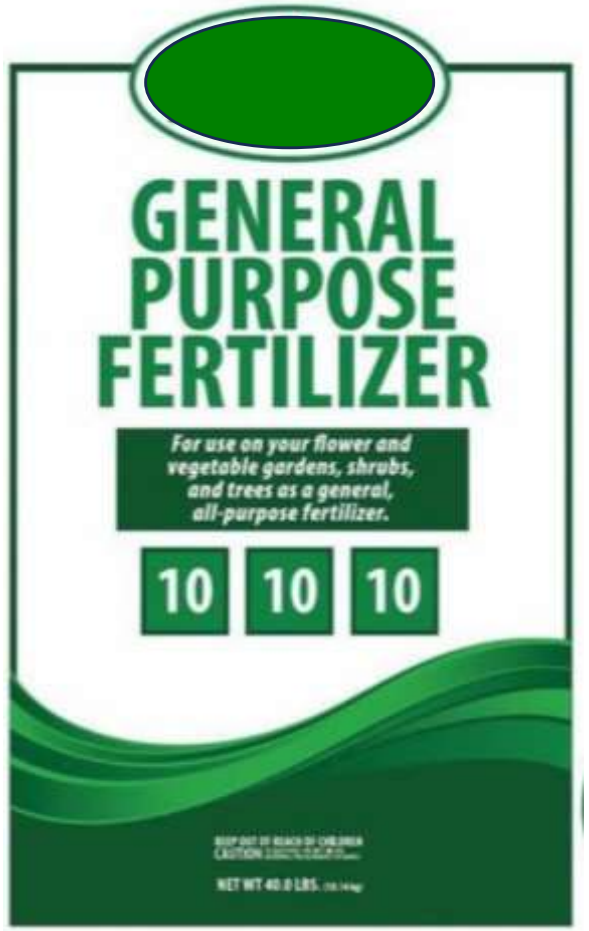
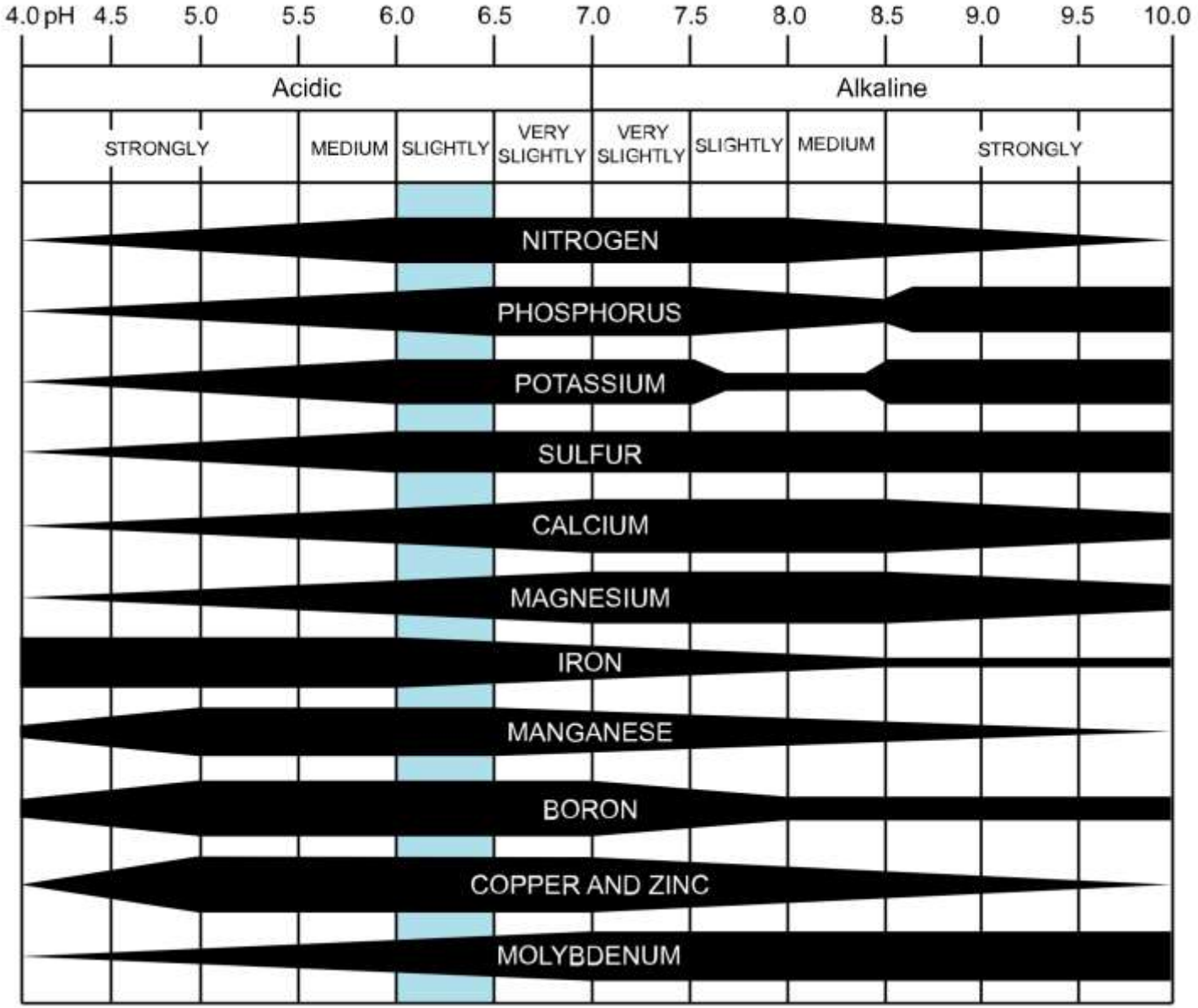
Optimum Range Key

VL - Very Low L - Low O - Optimal H - High VH - Very High



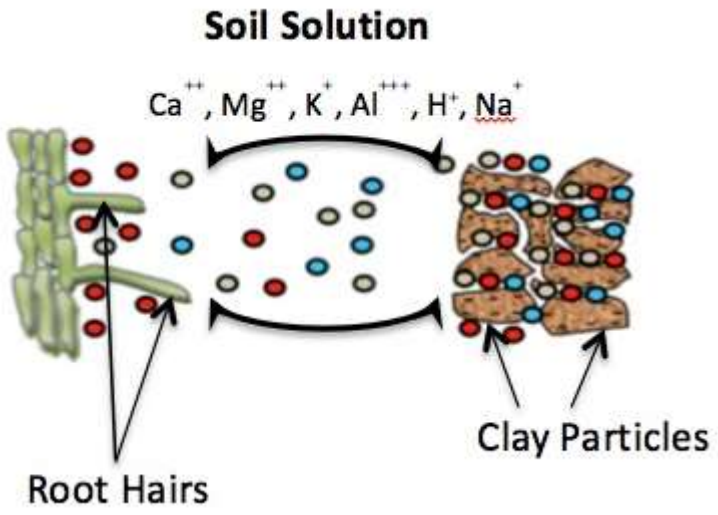
Avoid adding nutrients that are not needed.

CHEMICAL PROPERTIES - pH



pH measures acidity or alkalinity by measuring the concentration of hydrogen ions in the solution.

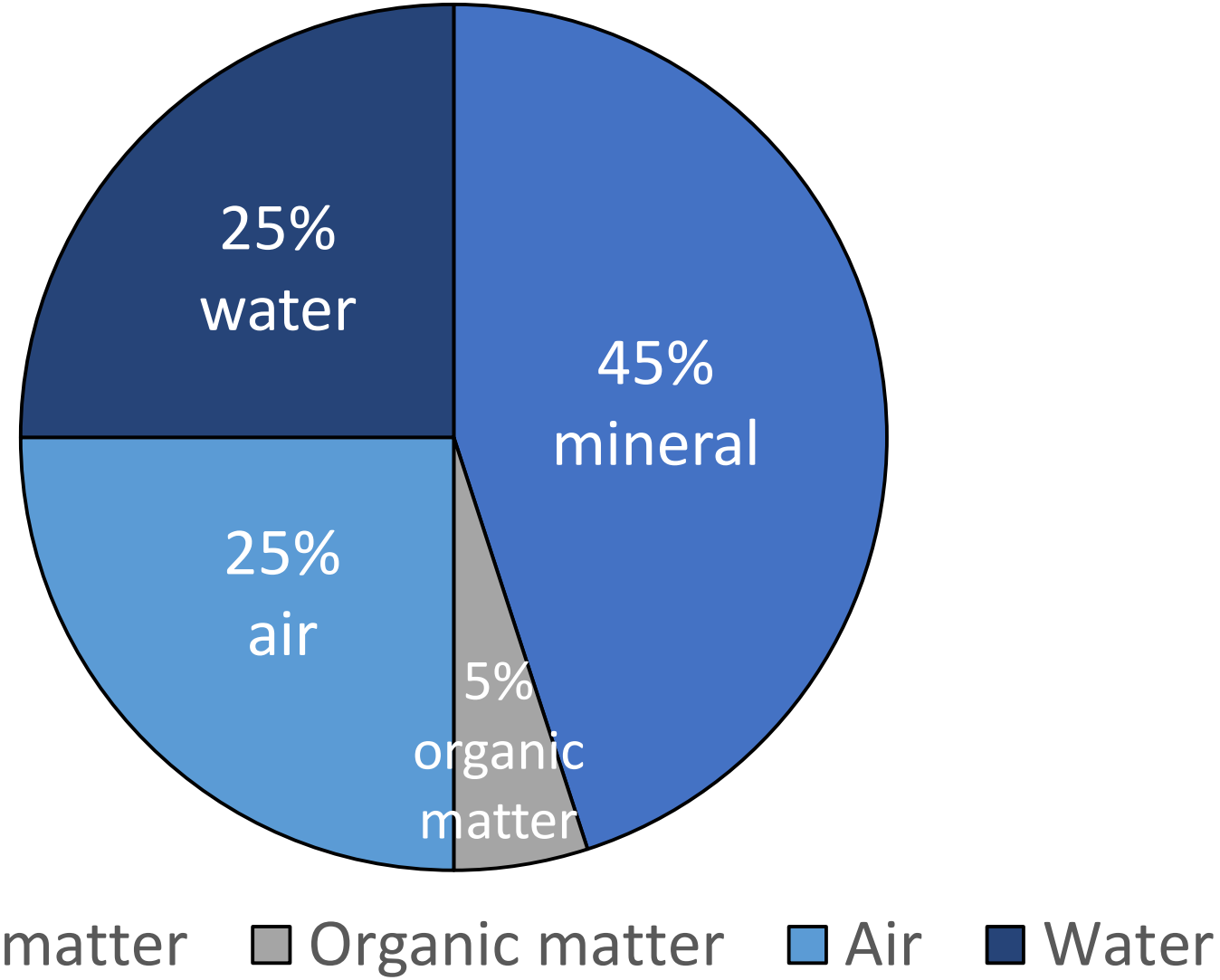
CHEMICAL PROPERTIES – CATION EXCHANGE CAPACITY (CEC)



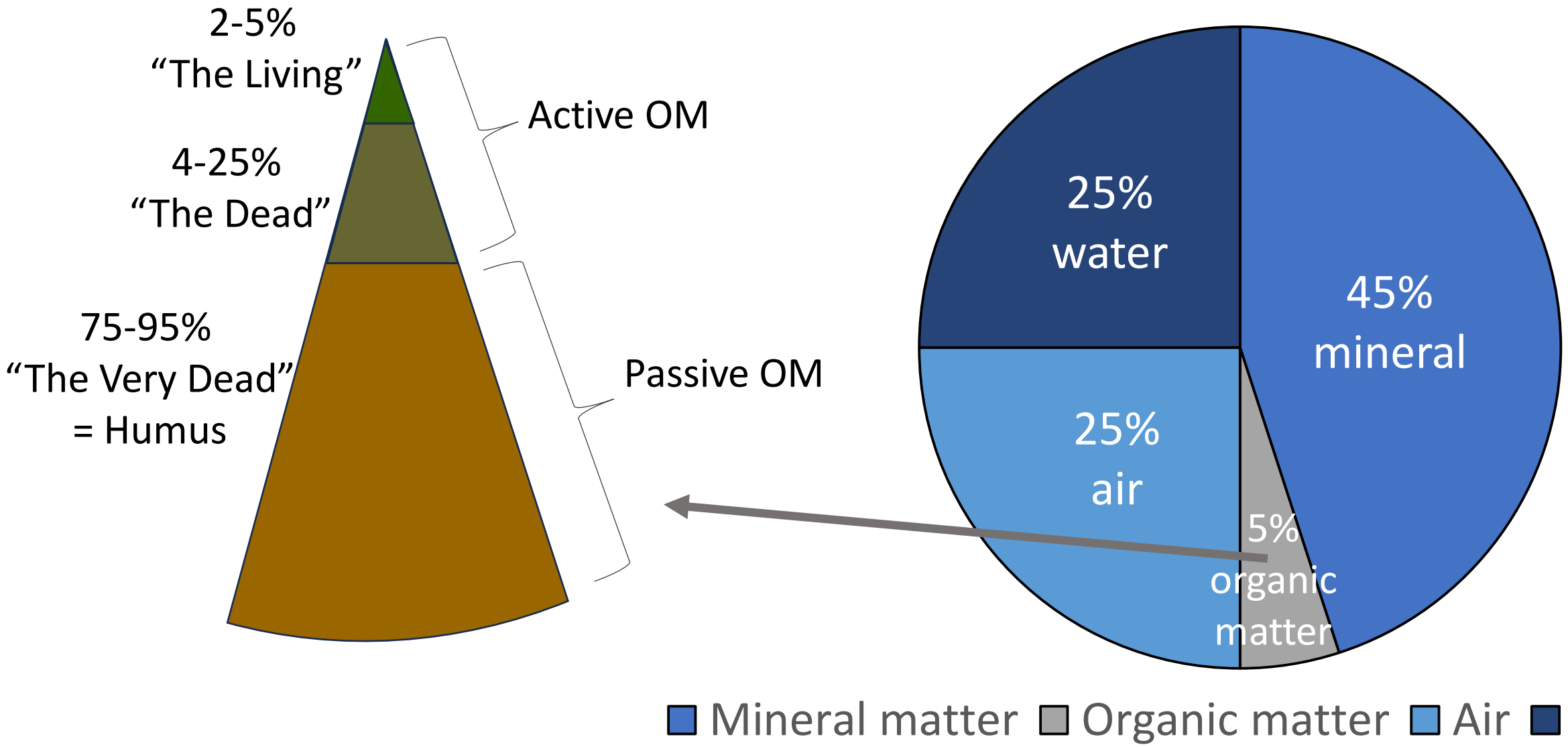
Soil Texture	CEC (meq/100 g)
Sand	1–5
Fine Sandy Loam	5–10
Loam	5–15
Clay Loam	15–30
Clay	>30
Organic Matter	200–400

Cation exchange capacity is a measure of a soil's ability to hold on to positively charged nutrients and to supply those nutrients to the soil solution.

BIOLOGICAL PROPERTIES



BIOLOGICAL PROPERTIES – ORGANIC MATTER



BIOLOGICAL PROPERTIES – ORGANIC MATTER

Functions of **Active Organic Matter**

- Feeds the biomass (carbon source)
- Releases nitrogen and other plant nutrients
- Promotes and stabilizes soil aggregation
- Creates pores and channels
- Sustains diversity and suppresses pathogens/pests

BIOLOGICAL PROPERTIES – ORGANIC MATTER

Functions of **Passive Organic Matter**

- Water holding capacity
- Cation exchange capacity
- Long term nutrient storage
- Contributes to soil structure

SOIL QUALITY ASSESSMENT

Make observations: See, Smell, Feel

- Water movement
- Crusting, erosion
- Plant appearance
- Root growth
- Soil organisms
- Organic material
- Color, moisture, smell

Soil core:

- Soil texture
- Structure
- Compaction
- Rocks and debris

Simple tests:

- pH and nutrient levels
- Aggregate stability
- Percolation

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