

# IMPORTANT SOIL PROPERTIES



# Important Properties

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- ❖ Color
- ❖ Texture
- ❖ Structure
- ❖ Consistence
- ❖ Shrink-swell Potential
- ❖ Bulk Density
- ❖ Porosity
- ❖ Permeability
- ❖ Infiltration
- ❖ Drainage
- ❖ Depth
- ❖ Available Water Holding Capacity
- ❖ Reaction
- ❖ Cation Exchange Capacity
- ❖ Landscape Position

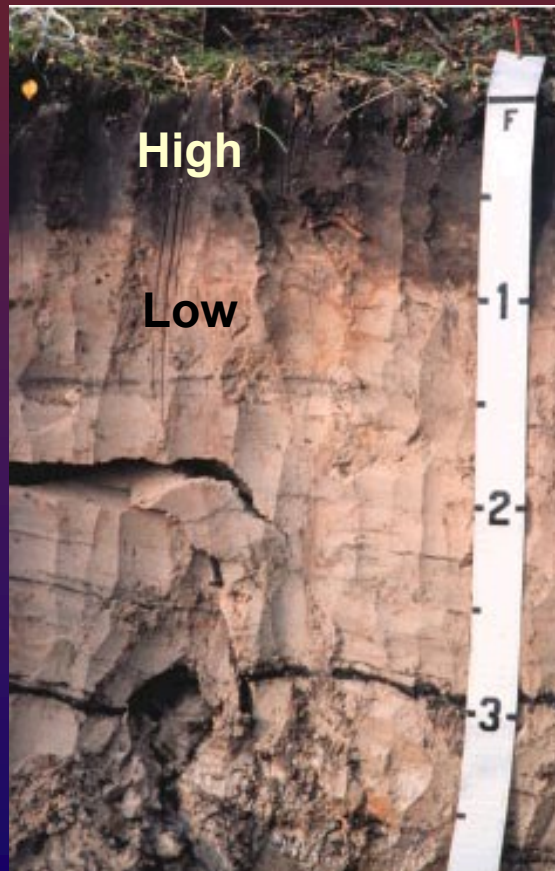
# SOIL COLOR



Appling Series, Granville Co, NC

- ❖ Useful tool for providing information about other soil properties
  - ❖ Organic matter content
  - ❖ Soil minerals
  - ❖ Seasonal high water tables

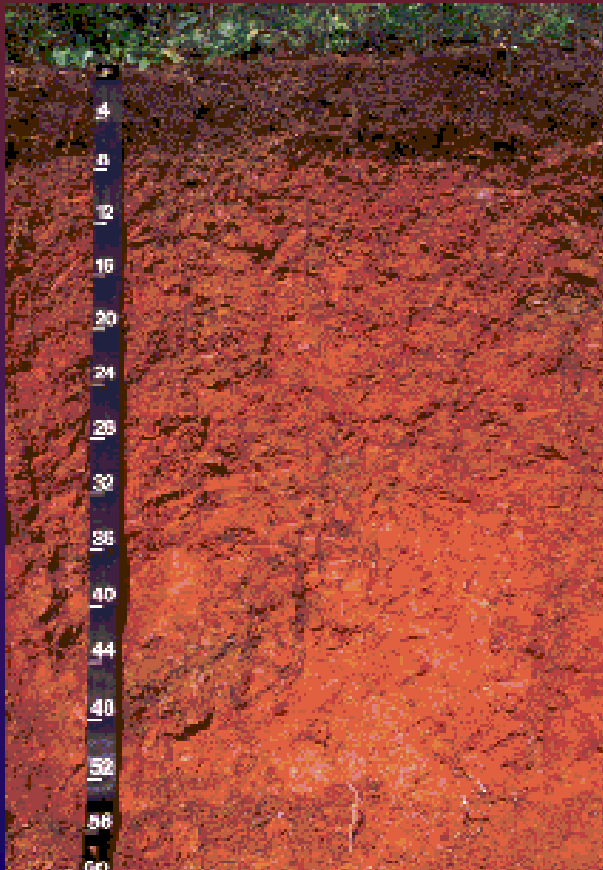
# SOIL COLOR



Englehard Series, Hyde Co, NC

- ❖ Useful tool for providing information about other soil properties
  - ❖ **Organic matter content**
  - ❖ Soil minerals
  - ❖ Seasonal high water tables

# SOIL COLOR

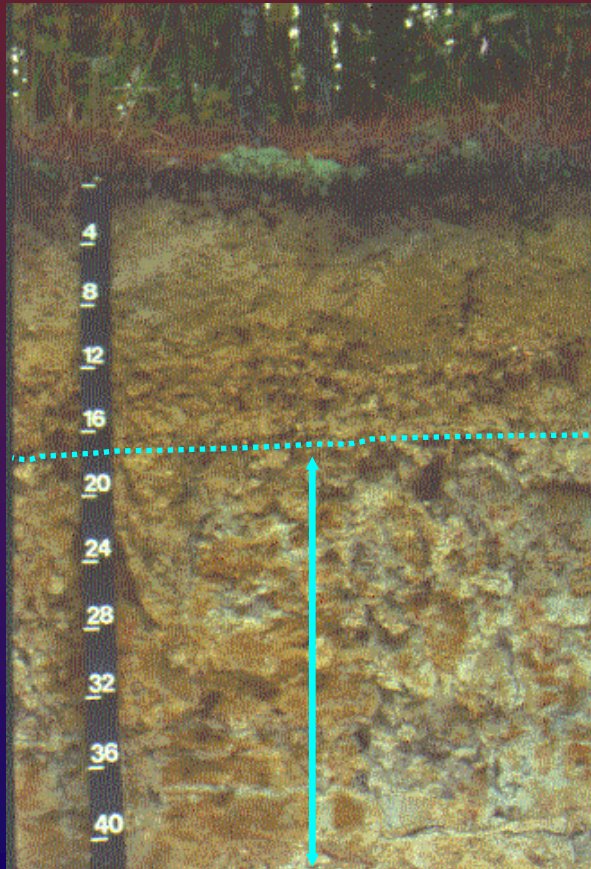


Georgeville Series, Randolph Co, NC

- ❖ Useful tool for providing information about other soil properties
  - ❖ Organic matter content
  - ❖ **Soil minerals**
  - ❖ Seasonal high water tables

Red color - hematite (iron)

# SOIL COLOR



Creedmoor Series, Chatham Co, NC

- ❖ Useful tool for providing information about other soil properties
  - ❖ Organic matter content
  - ❖ Soil minerals
  - ❖ **Seasonal high water tables**

# SOIL COLOR



- ❖ Munsell Color Chart
  - ❖ Used to identify the soil color. This chart allows soil scientists to uniformly describe soil color. In the field, soil scientists compare the colors found in the soil with the color chips found on the chart.



# SOIL COLOR

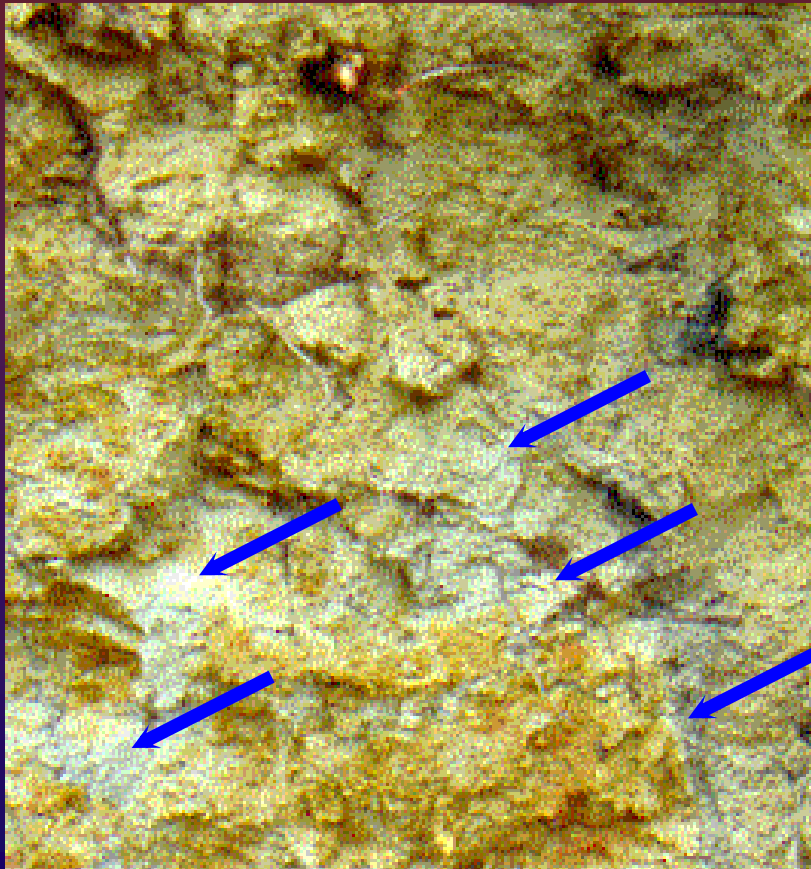


Mattaponi Series, Chatham Co, NC

- ❖ Redoximorphic Features
  - ❖ Soil colors formed by the repeated chemical oxidation and reduction of iron and manganese compounds resulting from saturation.
  - ❖ Useful for predicting the presence and depth of seasonal high water tables in the soil.



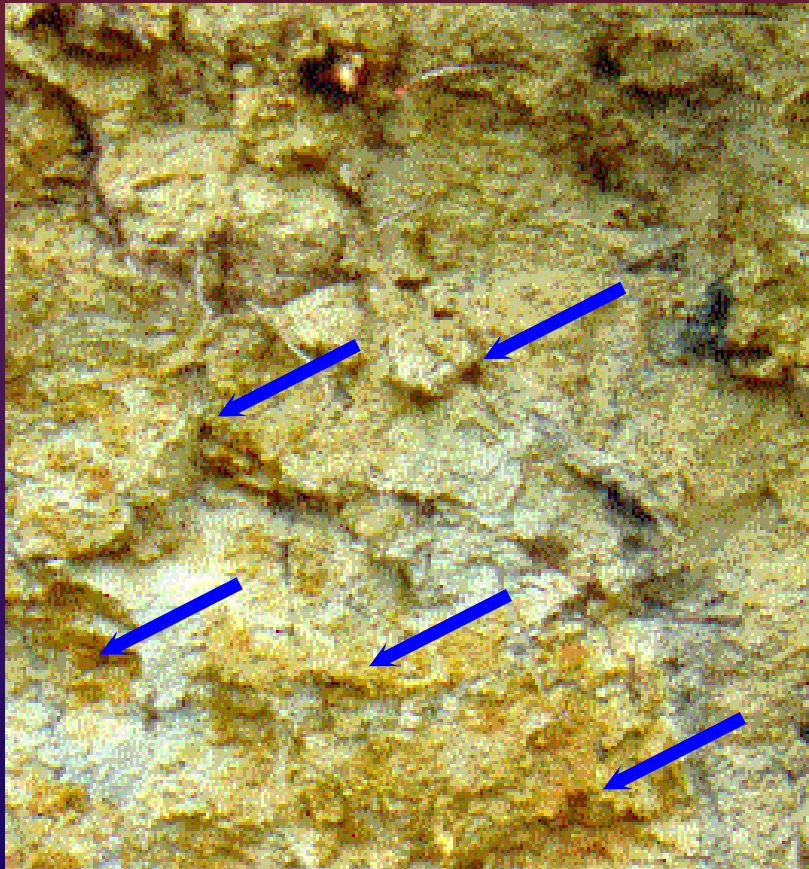
# Redoximorphic Features



Creedmoor Series, Chatham Co, NC

- ❖ Redoximorphic Depletions
  - ❖ Low-chroma (gray) zones from which iron and manganese oxide or a combination of iron and manganese oxide and clay have been removed. These zones are indications of the chemical reduction of iron resulting from saturation.

# Redoximorphic Features

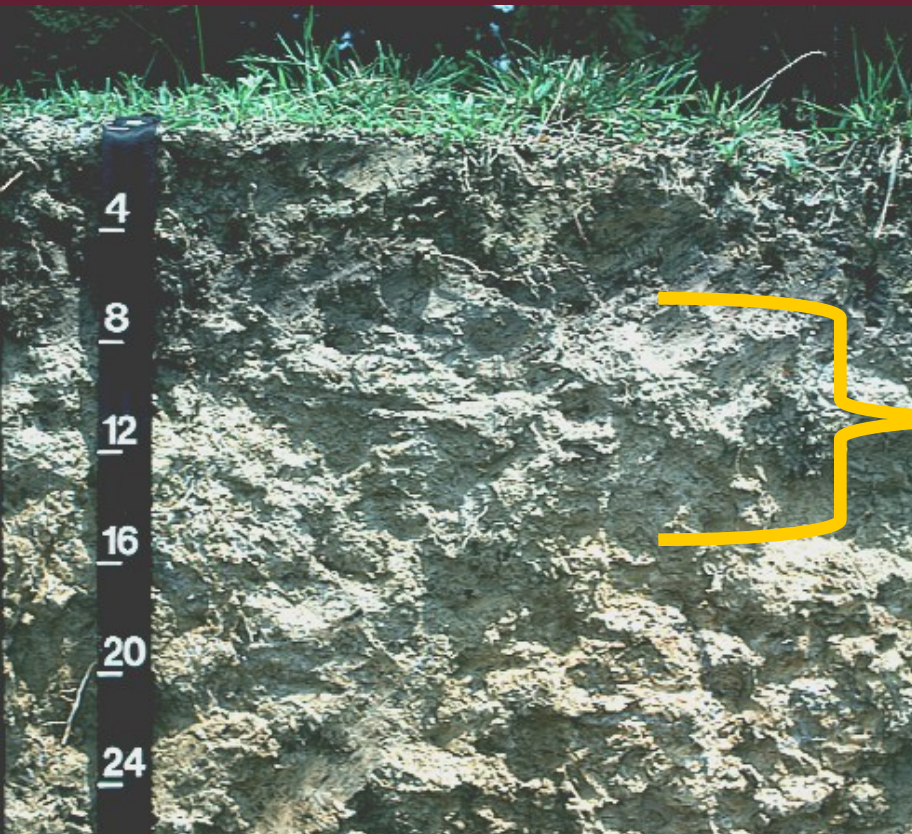


Creedmoor Series, Chatham Co, NC

- ❖ Redoximorphic Concentrations
  - ❖ Nodules, concretions, soft masses, pore linings, and other features resulting from the accumulation of iron or manganese oxide. An indication of chemical reduction and oxidation resulting from saturation.



# Redoximorphic Features

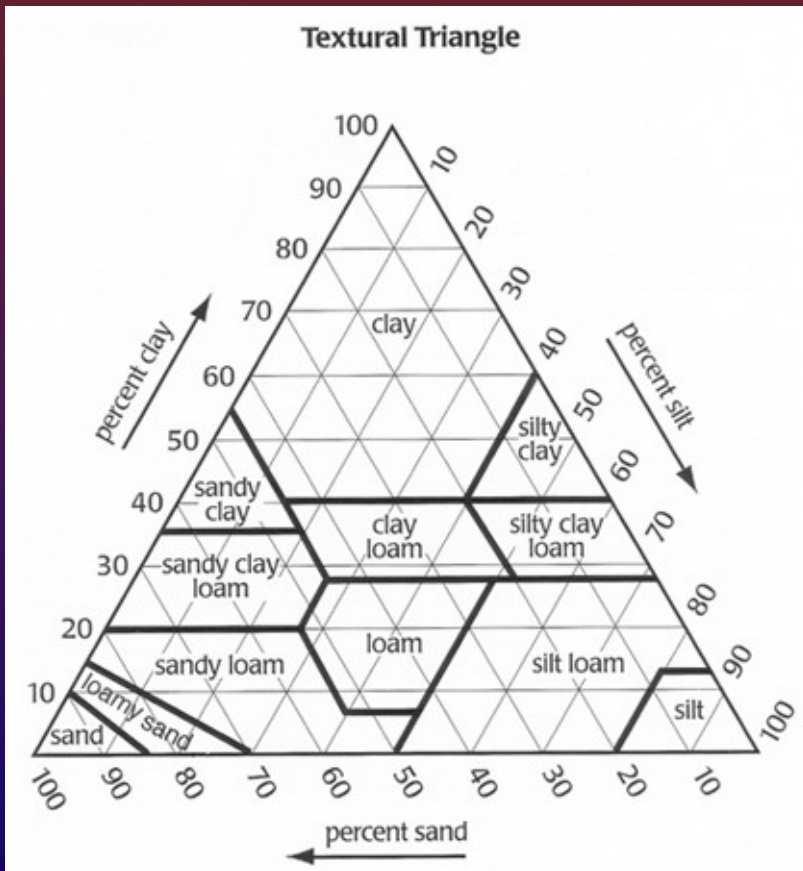


## ❖ Reduced Matrix

- ❖ Low-chroma (gray) horizons from which most iron oxide has been removed by leaching. These horizons are indications of the chemical reduction of iron resulting from long-term saturation.

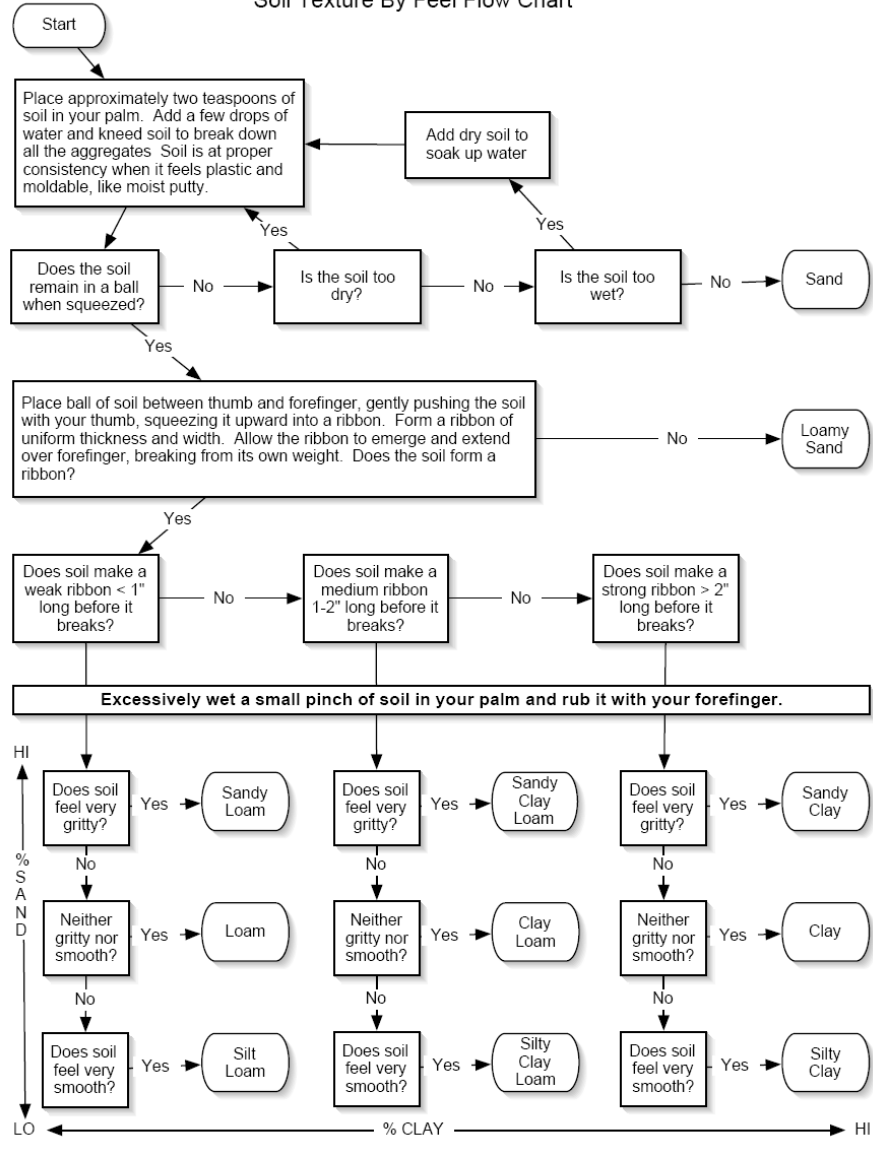


# Texture Triangle

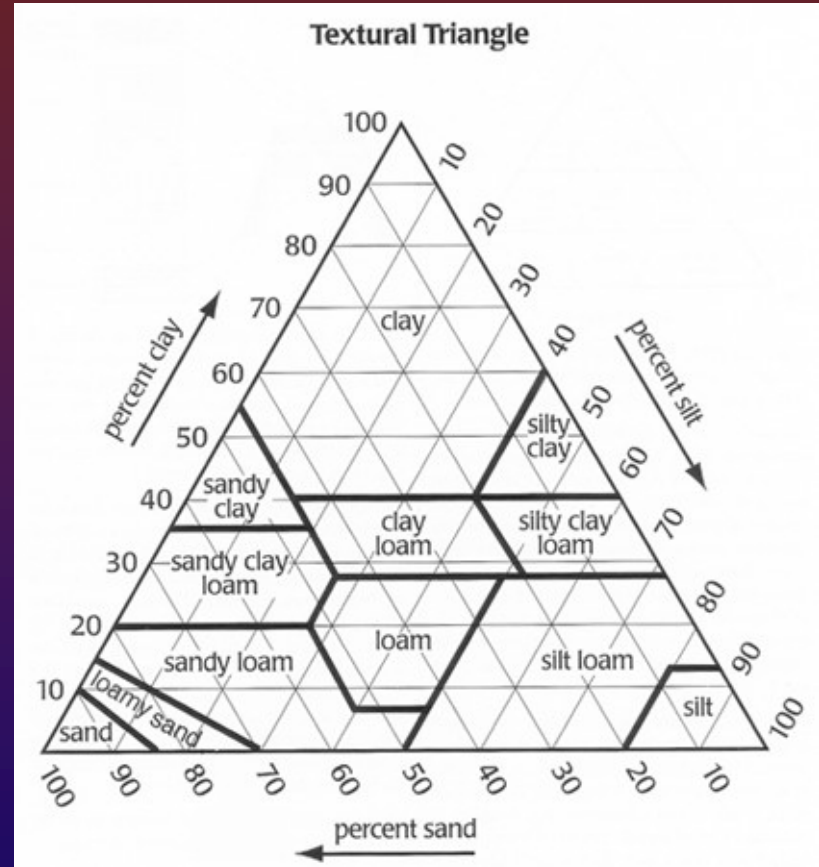


- ❖ Used by soil scientists to define the basic textural classes
- ❖ Field soil scientists frequently estimate the texture by feel using their hands.
- ❖ For more exact measurements there are laboratory techniques that can determine the exact amount of sand, silt, and clay.

## Soil Texture By Feel Flow Chart



## Textural Triangle





# Texture



Seabrook Series, Hyde Co, NC

- ❖ Soils containing large amounts of **sand** exhibit little plasticity and cannot retain large amounts of water or nutrients. They have large voids between the particles and can readily transport water and air.

# Texture



Callison Series, Anson Co, NC

- ❖ The properties of **silt** are intermediate between sand and clay. Silty soils can retain large amounts of water but tend to have moderately slow to slow permeabilities. Soils high in silt can present problems for engineers since they will shift under stress and slide and flow when wet.



# Texture



Vance Series, Granville Co, NC

- ❖ **Clays** exert a great influence on soil chemical and physical properties. Clay particles are chemically active and the proportion of clay-sized particles greatly influences soil physical properties, including aggregation, porosity, water movement and storage, aeration and workability of the soil.

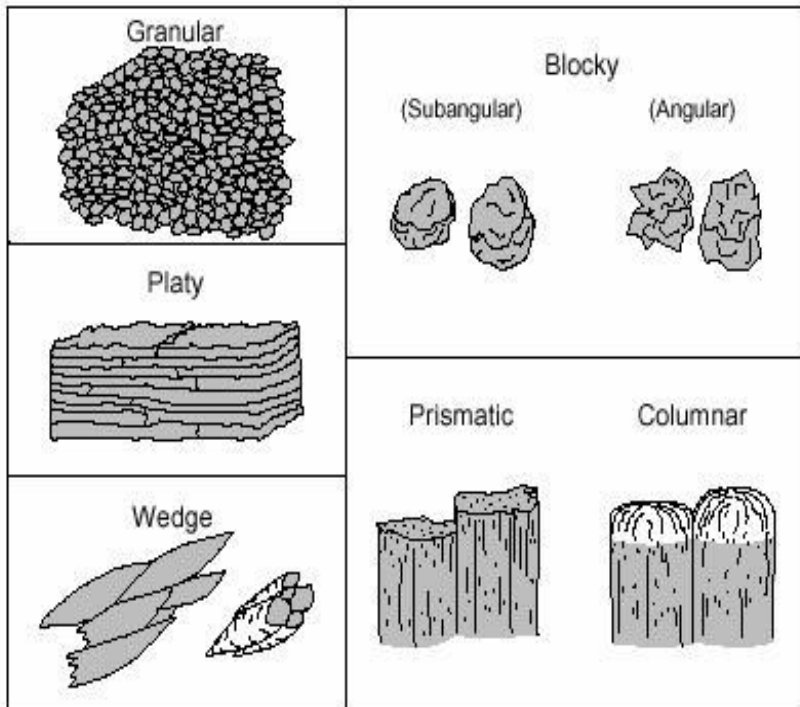


# Structure



- ❖ The arrangement of primary soil particles into compound particles or aggregates.
- ❖ The type and grade of structure plays an important role in the movement of water within soils.

# Structure



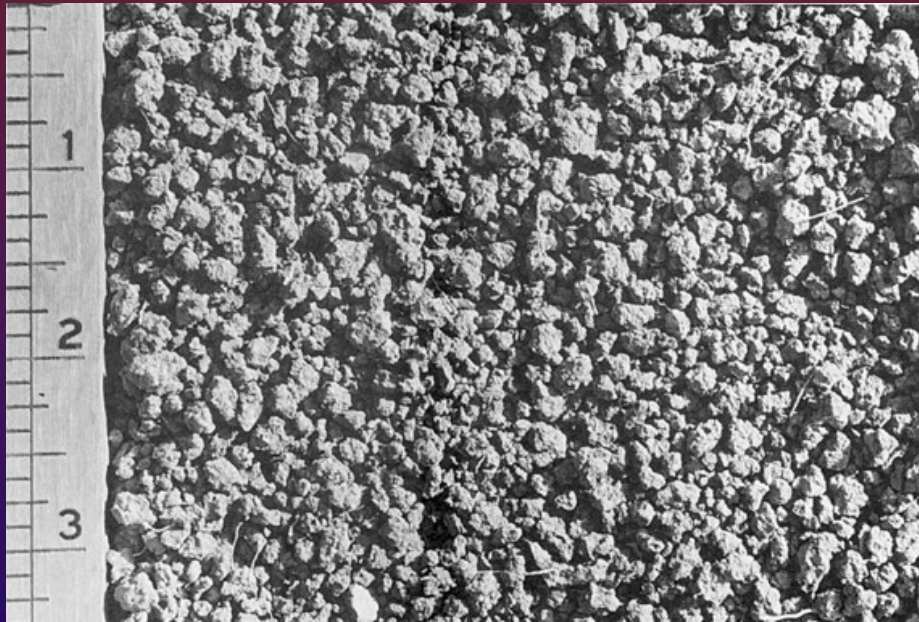
**Examples of Soil Structure**

- ❖ There are eight structural types commonly recognized in soil profiles: Granular, single grain, blocky, prismatic, columnar, platy, wedge, and massive.



# Structure

- ❖ **Granular - Rounded** aggregates usually less than 1/4 inch in diameter. These rounded complexes lie loosely on the surface and are readily shaken apart. The aggregates are called *granules* and the pattern is called *granular*. This is the most common type of structure found in topsoil.





# Structure



- ❖ **Single grain** – Each individual soil particle is separate and there is essentially no structure. This is only found in very sandy soils and is the type of structure commonly seen in sand dunes at the beach.



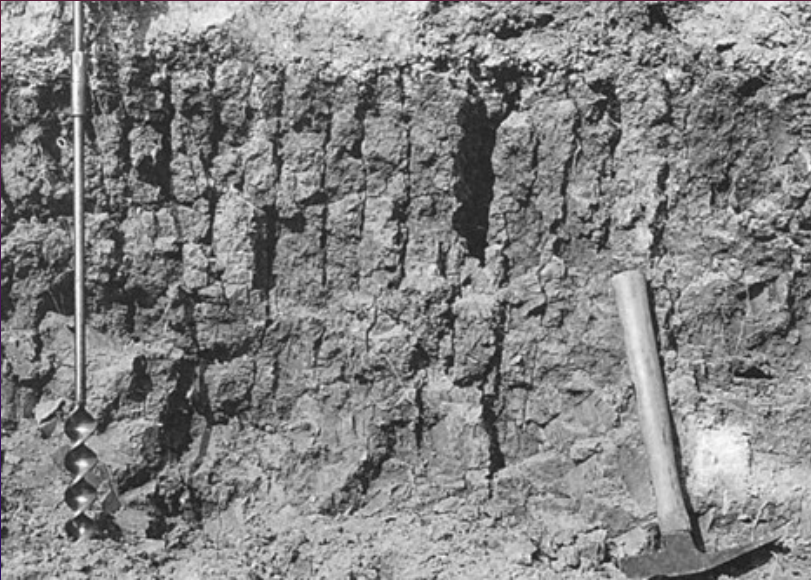
# Structure



- ❖ **Blocky** - The original aggregates have been reduced to blocks, irregularly faced, and basically equal in height, width, and depth. Blocky structure is the most common type of structure seen in the subsoil (B horizon) in North Carolina.

# Structure

- ❖ **Prismatic** – Characterized by vertical oriented aggregates or pillars with flat tops. These elongated columns vary in length with different soils. Prismatic structure is commonly seen in soils with high clay content and in horizons dominated by high shrink-swell clays.





# Structure

- ❖ **Columnar**—Characterized by vertical oriented aggregates or pillars with rounded tops. These elongated columns with flat tops vary in length with different soils. Most commonly seen in soils that have a high sodium content in a dry climate.







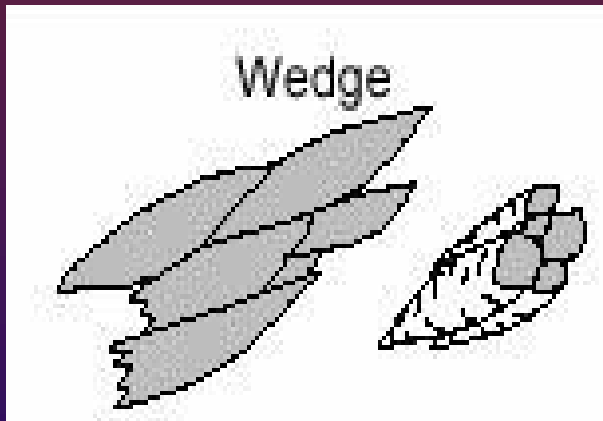
# Structure



- ❖ **Platy** – The aggregates are arranged in thin horizontal plates or sheets. This structure is commonly found in soil layers that have been compacted. Platy structure inhibits the downward movement of water.

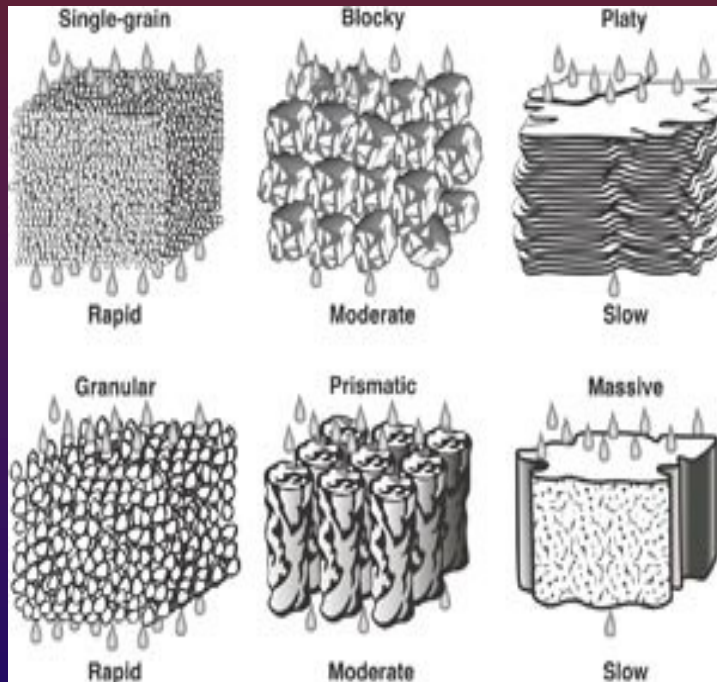


# Structure



- ❖ **Wedge** – The aggregates resemble wedges, thinner at one end and thicker on the other. This structure is seen in soils with a high clay content that is dominated by expansive clays such as montmorillonite. (2:1 clays)

# Structure



- ❖ Affects permeability by influencing the path by which water can flow through the soil. The type of structure determines the number of interconnected macropores, which readily permit downward movement of water.



# Consistence



- ❖ The degree and kind of cohesion and adhesion that soil exhibits, and/or the resistance of soil to deformation or rupture under applied stress. Field evaluations of consistence usually include rupture resistance, stickiness, and plasticity.

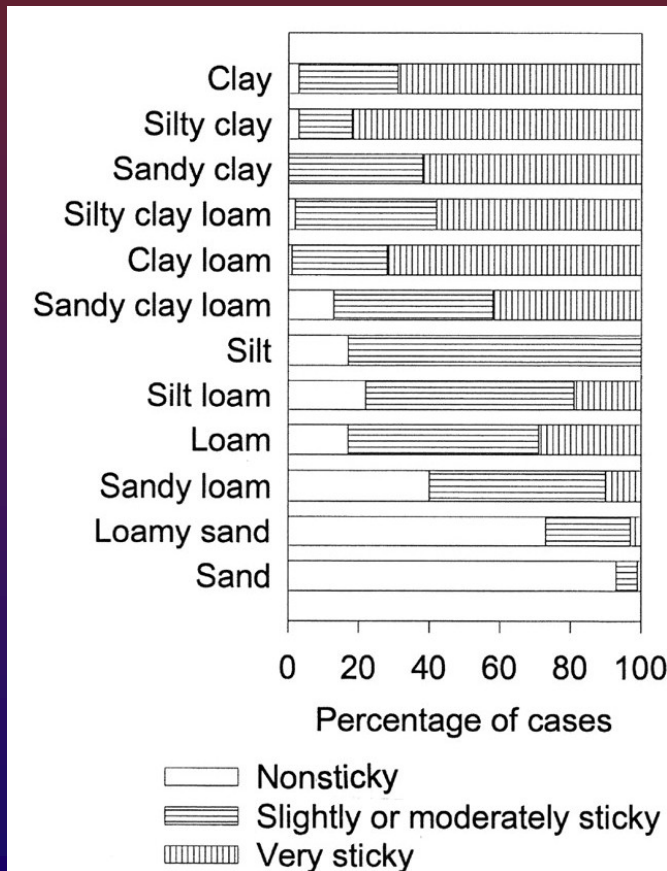


# Consistence



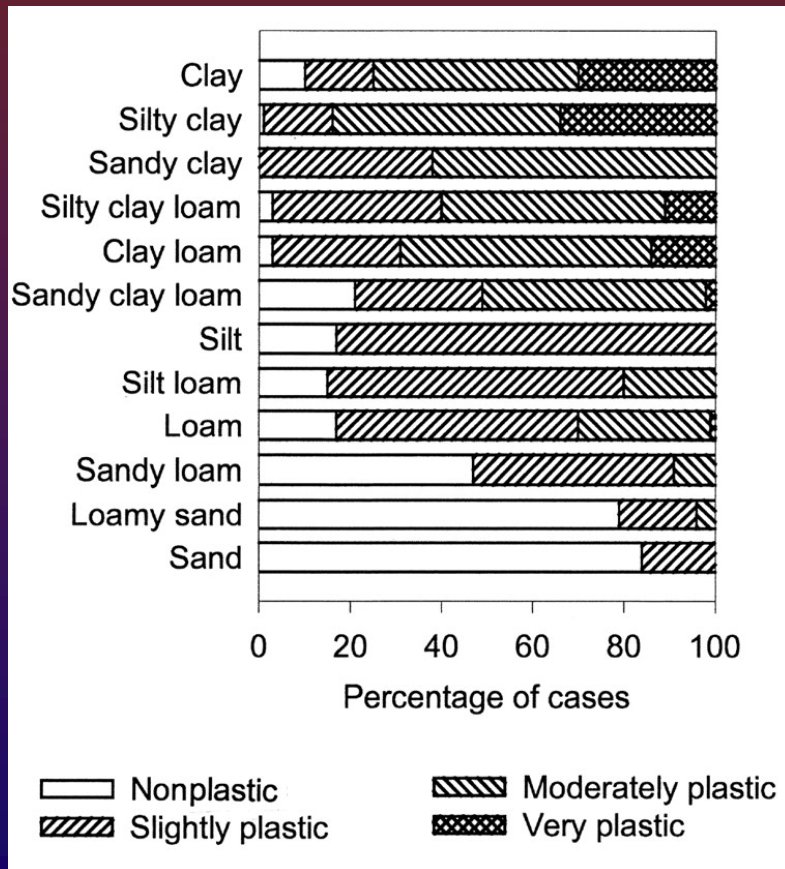
- ❖ **Rupture resistance** is a measure of the soil's ability to withstand applied stress. For this test, moist soil is normally used. A naturally occurring soil aggregate is placed between the thumb and index finger. Pressure is slowly applied to estimate the amount of force that is required to rupture a soil aggregate.

# Consistence



- ❖ **Stickiness** is the capacity of a soil to adhere to other objects. Stickiness is estimated at the moisture content that displays the greatest adherence when pressed between the thumb and forefinger. This normally occurs when the soil is quite wet.

# Consistence



❖ **Plasticity** is the degree to which a reworked soil can be permanently deformed without rupturing. Plasticity is evaluated by forming a roll (wire) of soil that is 4 cm long.

# Shrink-swell Potential



- ❖ **Shrink-swell potential** is a measurement of the amount of volume change that can occur when a soil wets and dries. Most of this volume change is due to the clay fraction of the soil. Clays swell when wet and shrink when dry. Soils high in 2:1 clays such as montmorillonite tend to have high shrink-swell potentials. Soils high in 1:1 clays such as kaolinite tend to have low shrink-swell potentials.

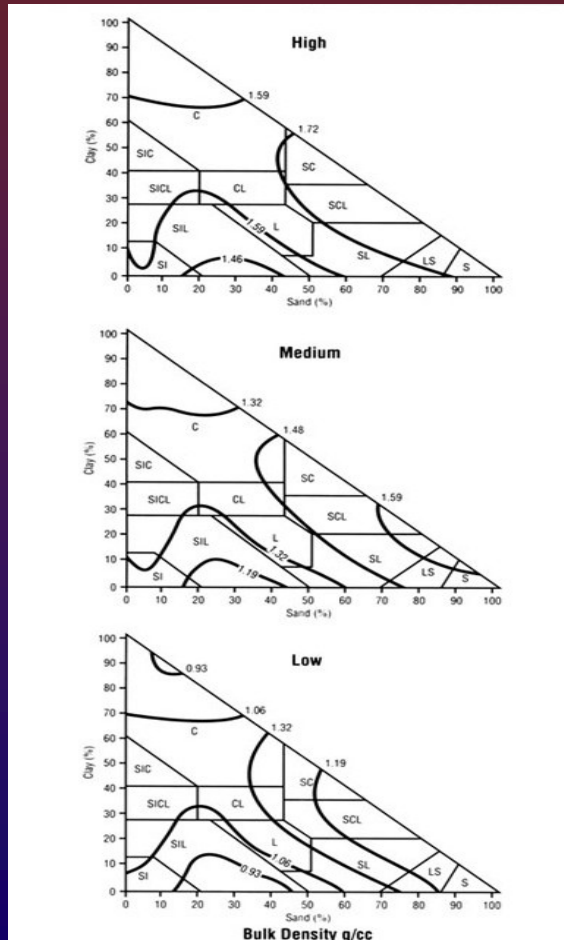


# Shrink-swell Potential



- ❖ A soil with a high shrink-swell potential can cause severe problems when used for urban development unless the problem is recognized and proper engineering precautions taken. Shrinking and swelling can buckle roads, crack building foundations and walls, and even damage plant roots.

# Bulk Density

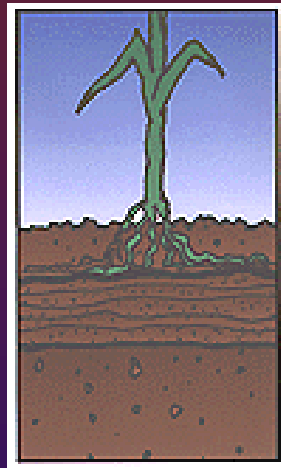


- ❖ Bulk density is the mass of dry soil per unit volume, including the air space.
- ❖ Bulk density has a major effect on the movement of air and water in soils.
- ❖ Soils with high bulk densities are often compacted.

# Bulk Density



No  
Compaction



Compaction  
(plow pan)

- ❖ **Soil compaction** restricts rooting depth, which reduces the uptake of water and nutrients by plants.



# Bulk Density



- ❖ **Compaction** also decreases infiltration, thereby increasing runoff and the hazard of water erosion.



# Permeability

- ❖ *Permeability* refers to the movement of air and water within the soil.
- ❖ *Permeability rate* is the rate at which a saturated soil transmits water, usually expressed in inches per hour. Texture, structure, bulk density, and the type and connectivity of macropores influence permeability.
- ❖ *Hydraulic conductivity* is a measurement of the amount of water that can move downward through a unit area of unsaturated soil in a unit of time.
- ❖ *Saturated hydraulic conductivity* ( $k_{\text{sat}}$ ) is a measurement of the amount of water that can move downward through a unit area of saturated soil in a unit of time.



# Infiltration



- ❖ *Infiltration* is the downward entry of water into the immediate surface of the soil and is influenced by texture, structure, bulk density, and the type and connectivity of macropores.
- ❖ Soils with a high infiltration rate are resistant to erosion because there is little runoff.



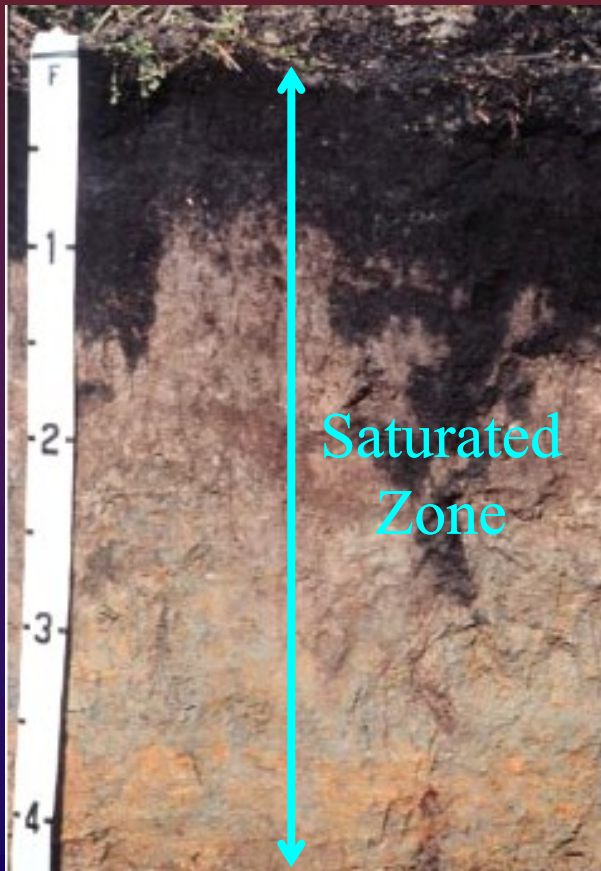
# Drainage



- ❖ *Drainage* refers to the frequency and duration of periods of saturation or partial saturation. Internal soil drainage is important because of its effect on land use and management decisions.



# Drainage



Hydeland Series, Hyde Co, NC

- ❖ An *apparent water table* is a type of saturation in which all horizons between the upper boundary of saturation and a depth of 6 feet are saturated.
- ❖ Apparent water tables are frequently encountered in low-lying areas where the slope of the land is insufficient to provide good drainage such as flood plains, depressions, and nearly level areas.



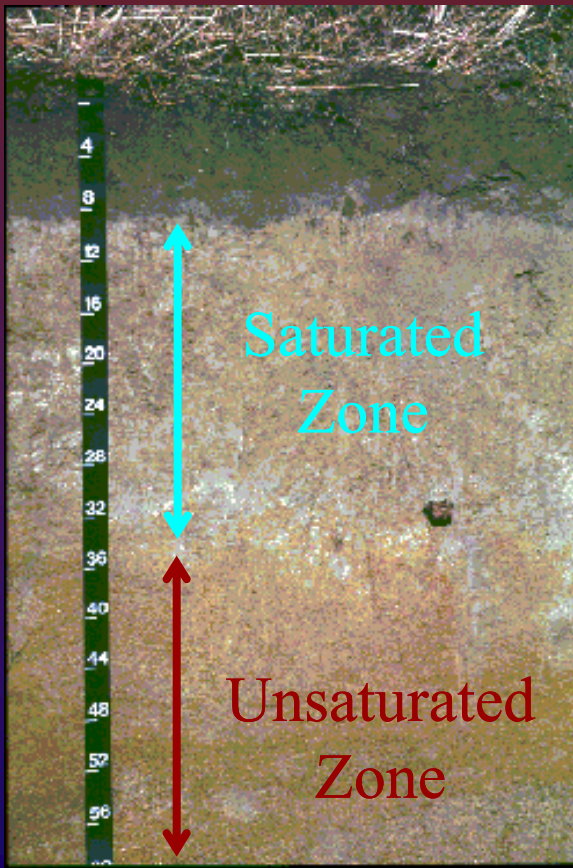
# Apparent Water Table

Unsaturated

Seasonal High Water Table

Saturated

# Drainage



Helena Series, Wake Co, NC

- ❖ A *perched water table* is a water table in a soil in which saturated layers are underlain by one or more unsaturated layers within 6 feet of the surface.
- ❖ Often caused by a restrictive layer that has slow or very slow permeability.
- ❖ Common in soils that have clayey subsoils and poor structure.

# Perched Water Table

Unsaturated

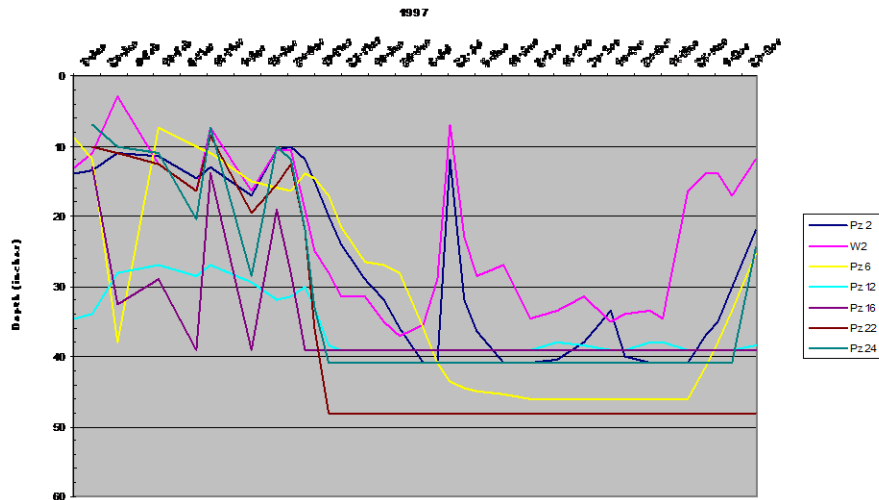
Seasonal High Water Table

Saturated

Aquard

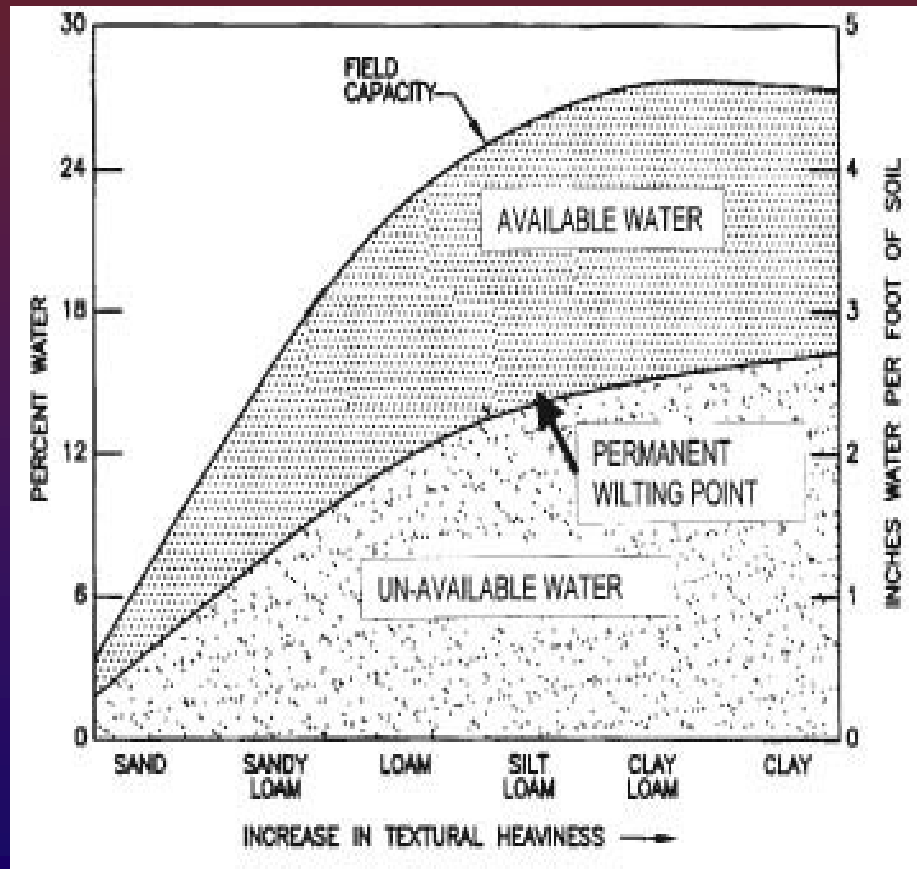
Unsaturated

# Drainage



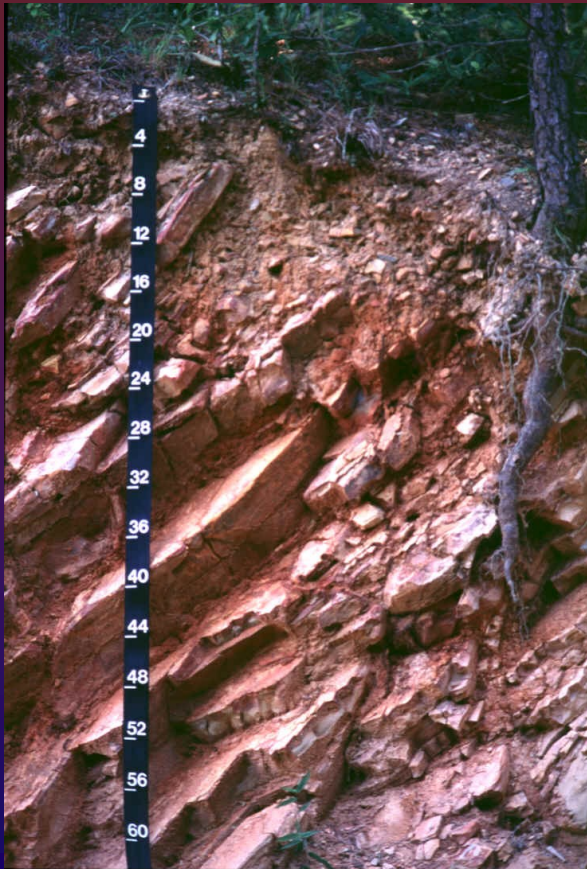
- ❖ The depth to soil water tables fluctuates throughout the year. Most of this is due to rainfall variability and seasonal changes in the rate of evapotranspiration.
- ❖ In North Carolina, the highest water tables are normally encountered in the winter and early spring months.

# Available Water Holding Capacity



- ❖ The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point.

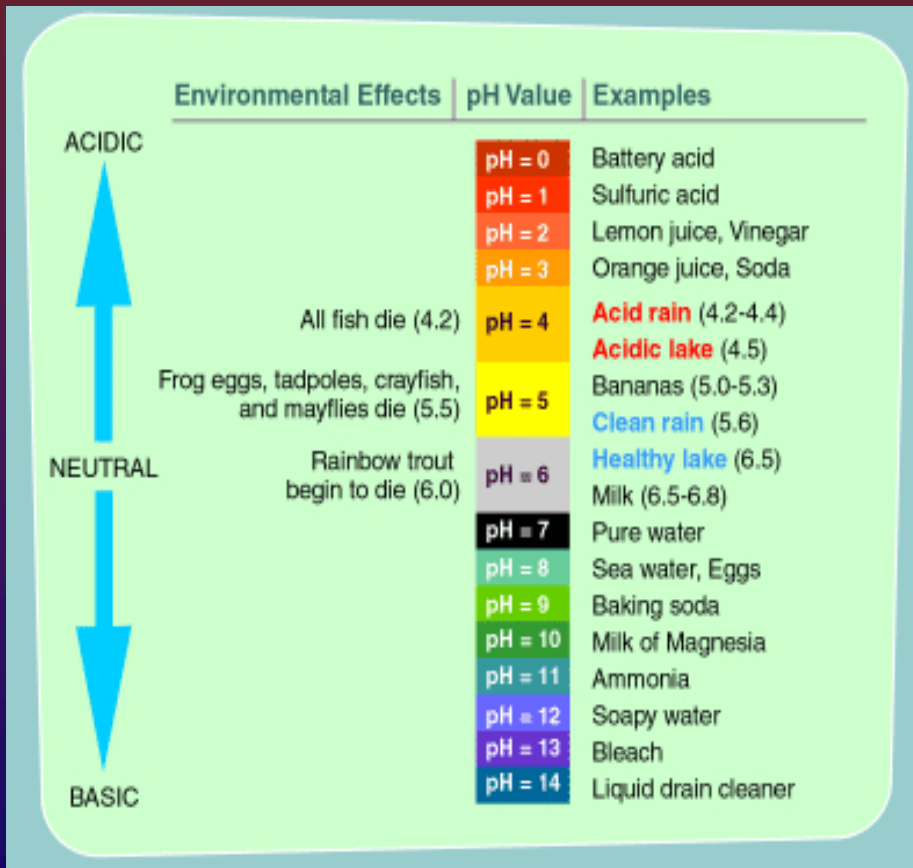
# Depth



Goldston Series, Randolph Co, NC

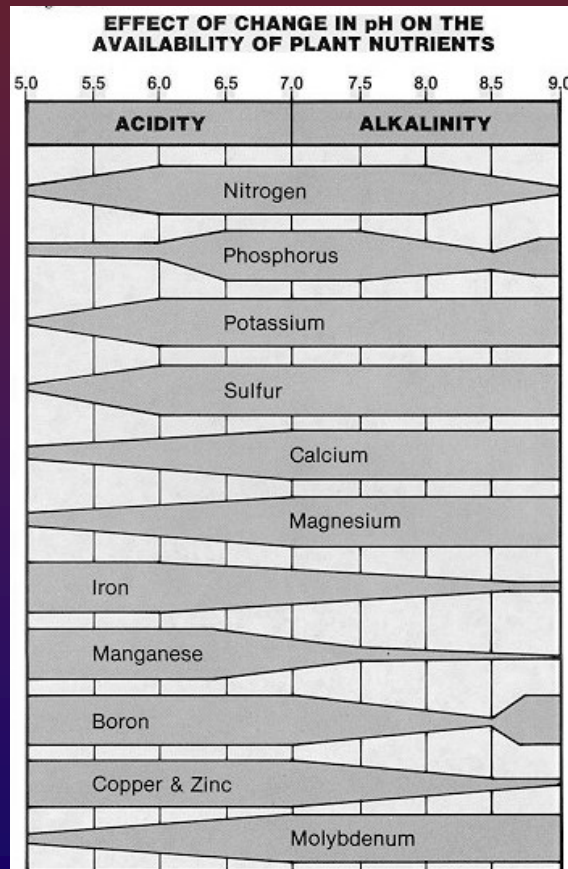
- ❖ The useable depth of the soil is an important consideration when evaluating a soil for a particular land use.
- ❖ Groundwater can be easily impacted in soils with a shallow depth to rock.
- ❖ **Root restrictive layers** are any permanent zones in the soil that restrict the growth of plant roots. Bedrock is the most common root restrictive layer.

# Reaction



- ❖ *Reaction* is a measure of acidity or alkalinity of a soil. Acidity or alkalinity is determined by the amount of hydrogen and hydroxyl ions in the soil. When hydrogen ions outnumber hydroxyl ions the soil is acidic. In the reverse condition the soil is basic. A pH scale is used to measure the level of acidity or alkalinity.

# Reaction

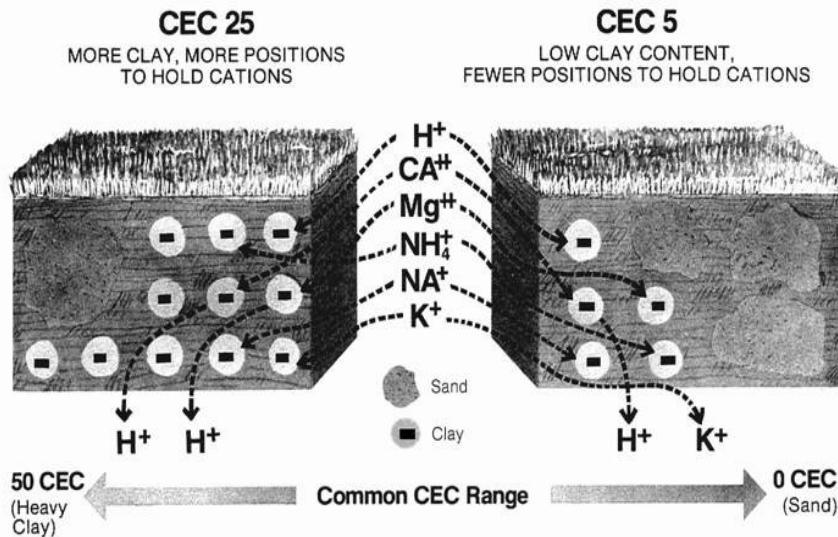


- ❖ In NC, the natural soil pH will range from 4.0 to 8.0 with most soils tending to be acidic with pH values of 4.5 to 6.0.
- ❖ In order to optimize plant growth, farmers and homeowners commonly adjust the pH of a soil by adding soil amendments such as lime. The amount of lime that needs to be added should be determined by a soil test.



# Cation-Exchange Capacity

A SCHEMATIC LOOK AT CATION EXCHANGE



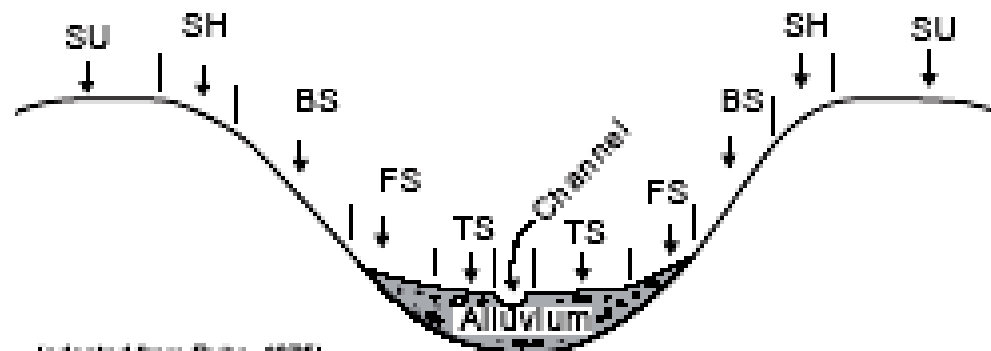
SOME PRACTICAL APPLICATIONS	
Soils with CEC 11-50 Range	Soils with CEC 1-10 Range
<ul style="list-style-type: none"> <li>• High clay content</li> <li>• More lime required to correct a given pH</li> <li>• Greater capacity to hold nutrients in a given soil depth</li> <li>• Physical ramifications of a soil with a high clay content</li> <li>• High water-holding capacity</li> </ul>	<ul style="list-style-type: none"> <li>• High sand content</li> <li>• Nitrogen and potassium leaching more likely</li> <li>• Less lime required to correct a given pH</li> <li>• Physical ramifications of a soil with a high sand content</li> <li>• Low water-holding capacity</li> </ul>

- ❖ *Cation-exchange capacity (CEC)* is a measure of the ability of a soil to hold and exchange cations. It is one of the most important chemical properties in soil and is usually closely related to soil fertility. A few of the plant nutrient cations that are part of CEC include calcium, magnesium, potassium, and ammonium.

# Landscape Position

**Hillslope - Profile Position (Hillslope Position in PDP)** - Two-dimensional descriptors of parts of line segments (i.e., slope position) along a transect that runs up and down the slope; e.g., *backslope* or *BS*. This is best applied to transects or points, not areas.

Position	Code
summit	SU
shoulder	SH
backslope	BS
footslope	FS
toeslope	TS

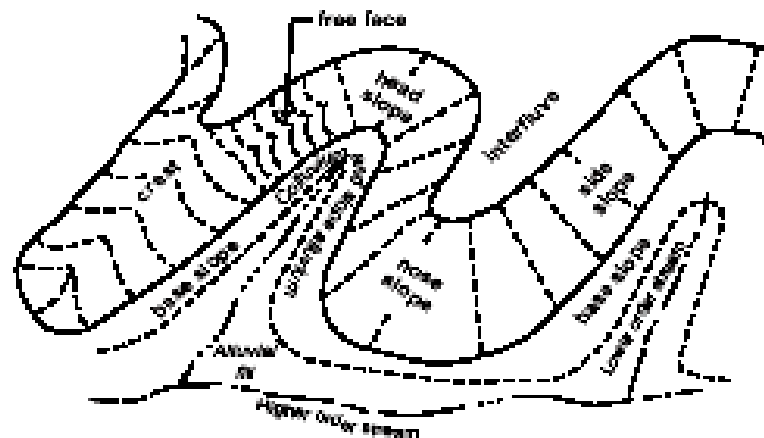


(adapted from Rumba, 1975)

# Landscape Position

Geomorphic Component - Three-dimensional descriptors of parts of landforms or microfeatures that are best applied to areas. Unique descriptors are available for Hills, Terraces, Mountains, and Flat Plains; e.g., (for Hills) nose slope or NS.

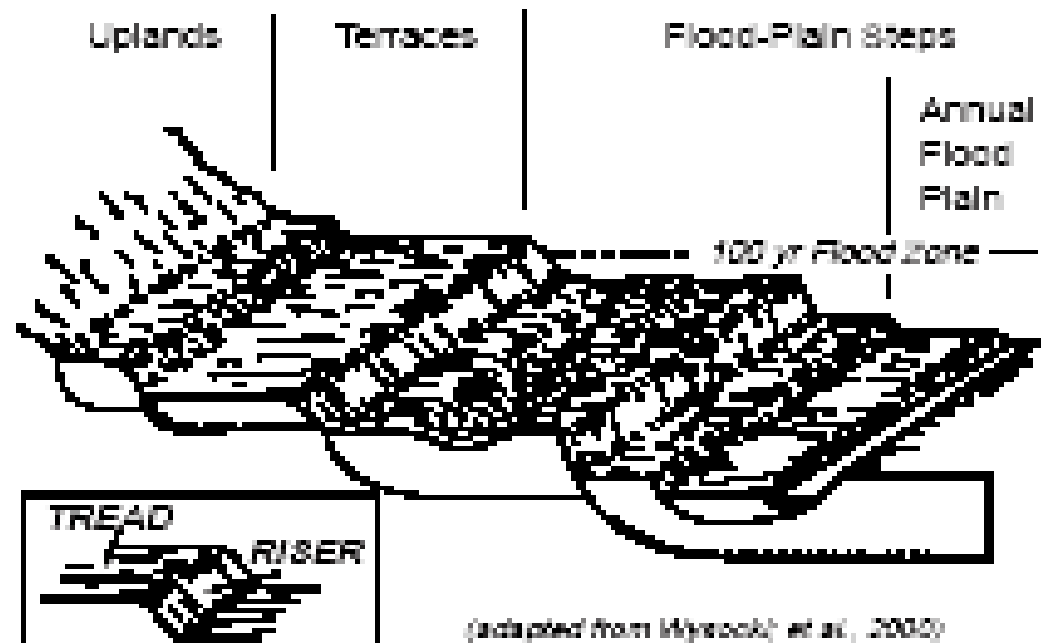
Hills	Code	
	PDP	NASIS
interfluve	IF	IF
crest	—	CT
head slope	HS	HS
nose slope	NS	NS
side slope	SS	SS
free face	—	FF
base slope	—	BS



(adapted from Myerick, et al., 2000)

# Landscape Position

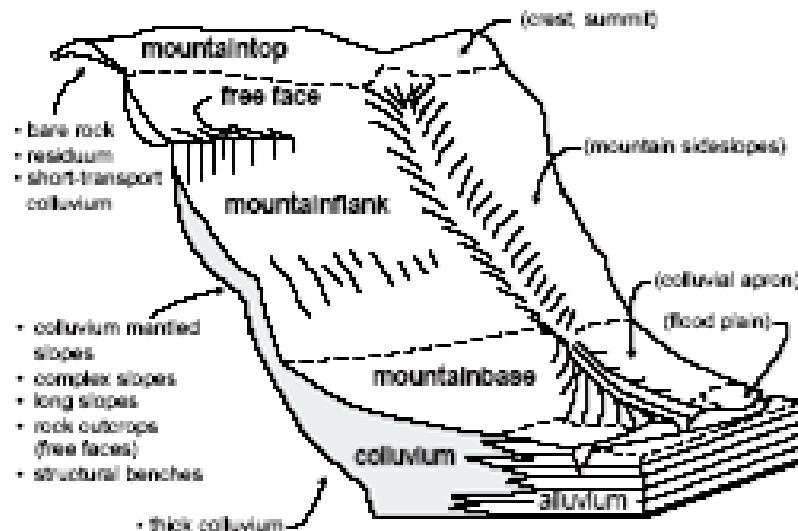
Terraces, Stepped Landforms	Code
riser	RI
tread	TR



(adapted from Myrback et al., 2000)

# Landscape Position

Mountains	Code
mountaintop	MT
mountainflank	MF
upper third - mountainflank	UT
center third - mountainflank	CT
lower third - mountainflank	LT
free face	FF
mountainbase	MB



(adapted from Wysocki, et al., 2000)