CAWS Fall Workshop: Introduction to Inland Wetland Soils

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What is a Wetland?
Wetland Regulatory Definitions

- **U.S. Army Corps of Engineers Definition**
- "Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted to life in saturated soil conditions."

What is a Wetland?
Wetland Regulatory Definitions

- **Connecticut Inland Wetland Definition**
- Watercourses and Waterbodies –

"…rivers, streams, brooks, waterways, lakes, ponds, marshes, swamps, bogs, and all other bodies of water, natural or artificial, vernal or intermittent, public or private…"

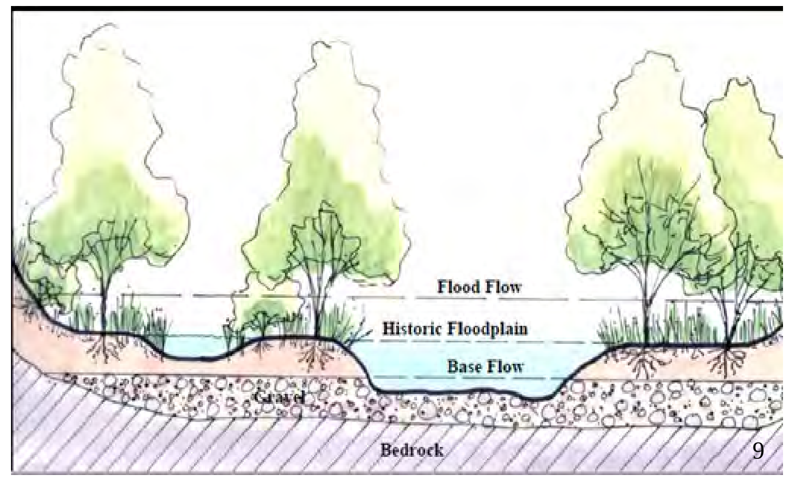
- Watercourses can be perennial or intermittent
- Inland Wetlands
- Poorly Drained Soils
- Very Poorly Drained Soils
- Alluvial and Floodplain Soils

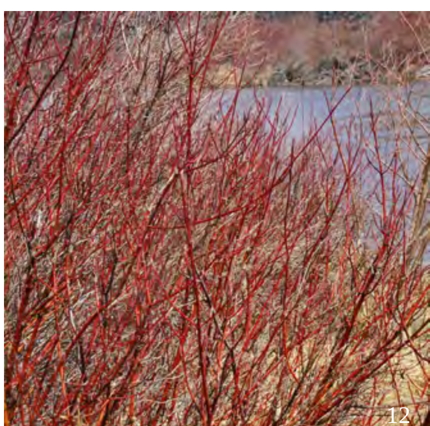
(Alluvial and floodplain soils are outside the scope of today's lessons)

Tidal Wetlands are defined entirely differently from inland wetlands in CT and are based on the presence of certain species of vegetation and certain elevations (CGS §22a-30-1 through 22a-30-17)

Connecticut Definitions - Intermittent Watercourses

- Defined permanent channel and bank and occurrence of <u>two</u> or more of the following:
  - Scour or deposits of recent alluvium
  - Standing or flowing water for duration longer than a storm incident
  - Presence of hydrophytic vegetation



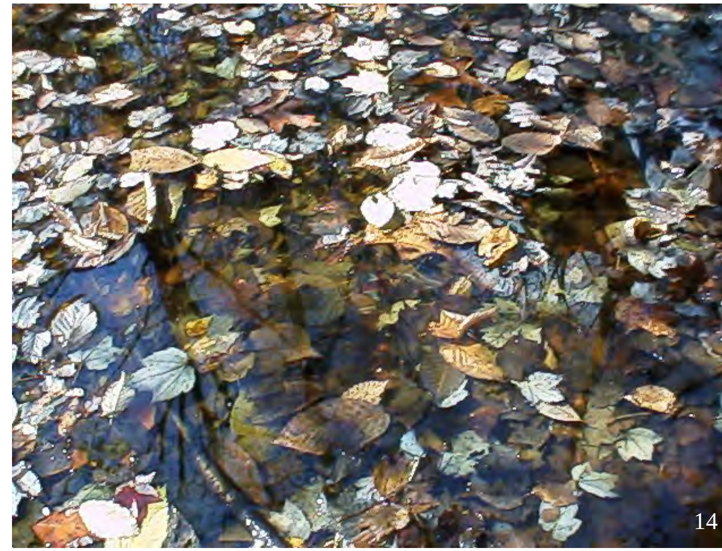


U.S. Army Corps of Engineers
Inland Wetland Delineation Methodology

- 3 - Parameter Method
  - Wetland Hydrology
  - Hydrophytic Vegetation
  - Hydric Soils

Wetland Hydrology

- Inundation or soil saturation >2 weeks continuous within upper 12” of the soil during the growing season



- **Indicators (the BIG 3)**
  - Inundation (e.g. surface water)
  - High Water Table (w/in 12” of soil surface)
  - Saturation (free water draining from the soil
  - – needs to have High Water Table below)
- **Other indicators (primary and secondary)**
  - Water marks on trees
  - Drift lines
  - Sediment deposits
  - Drainage patterns (secondary)
  - Algal mat or crust
  - Iron bacteria deposits
  - Water-stained leaves
  - Aquatic fauna

Etc. etc…

(Secondary indicators are the ones you would be looking for if you were in drought or abnormally dry year)

Hydrophytic Vegetation

- "Hydrophytic species, due to morphological, physiological, and/or reproductive adaptations, have the ability to grow, effectively compete, reproduce, and/or persist in **anaerobic** soil conditions."

(Absence of free **oxygen**)

- Indicator Status
  - OBL = obligate wetland, >99%
  - FACW = facultative wetland, 67 - 99%
  - FAC = facultative, 34 - 66%
  - FACU = facultative upland, 1 - 33%
  - UPL = obligate upland, <1%

  - **Dominant plant species are <u>FAC</u> or wetter (<u>FACW</u> or <u>OBL</u>)**

Hydric Soils

- hydric soil is a soil that formed under conditions of saturation, flooding or ponding ***long enough*** during the ***growing season*** to develop **anaerobic** (No O_2) conditions in the upper part. (NRCS Definition)

(soil has to be warm enough for the microbes to work)

- "…soils classified as hydric or have characteristics associated with **reducing soil conditions.**"
- How do you get reducing soil conditions?
- What even are they?
  - Soil pores fill with H_2O
  - Prolonged saturation leads to depletion of O_2
  - Anaerobic conditions emerge
  - Turnover of microbial population!
    Aerobic microbes → **Anaerobic** microbes

Redoximorphic Features (iron)

Why the heavy emphasis on **anaerobic** conditions and **microbes**?

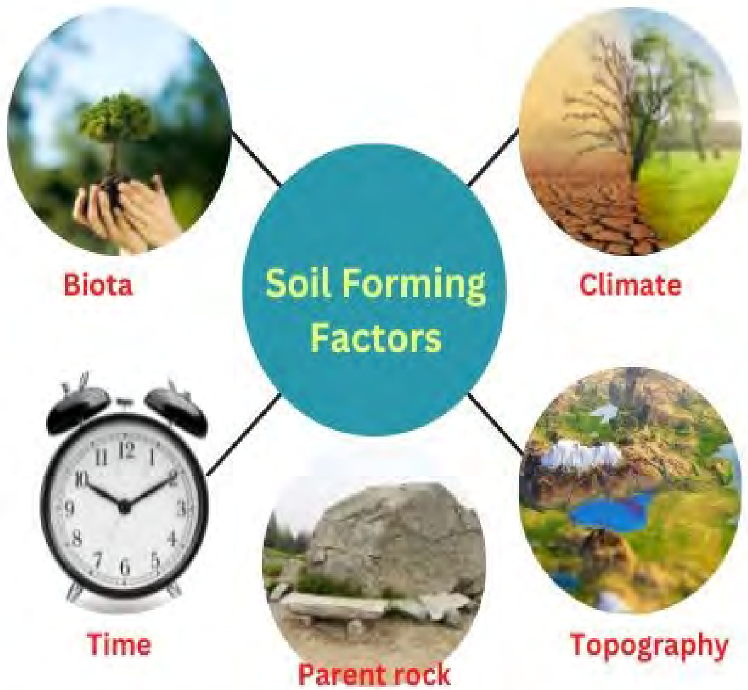
What IS Soil?

"Upper layer of the earth made of mineral and organic parts in which plants can grow."

What Makes Soil?

5 Factors of Soil Formation

1. Time
2. Vegetation
3. Climate/Weather
4. Parent Material
5. Topography



Five Factors of Soil Formation – 1. Time

- Geologic Scale (influence from glaciation, weathering)
- Human Scale (prolonged saturation, wind and rain erosion, compaction, etc.)

Eubrontes giganteus

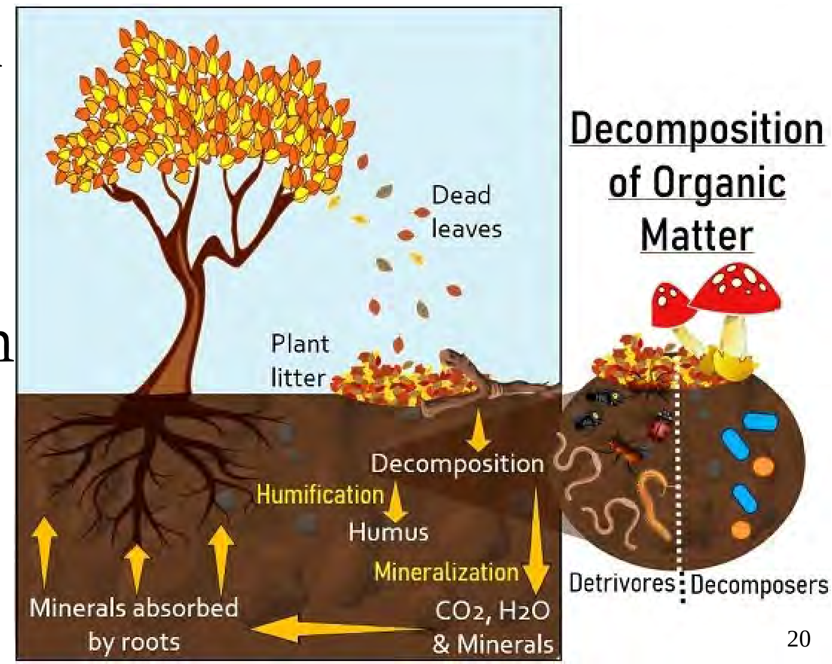
How long does it take for 1” of soil to form?

Five factors of soil formation – 2. Vegetation

- Carbon – the **anaerobic microbes** food

Under **anaerobic conditions**, dead plant and animal material (detritus) breaks down *s l o w l y . . .*

- When amount of detritus accumulation > decomposition You get ORGANIC SOILS!



Five factors of soil formation – 2. Vegetation

Organic matter decomposing slower than it accumulates – A Horizon (topsoil)

Mineral soil material – B Horizon (subsoil)

Five factors of soil formation – 3. Climate

- Meteorological
  - Precipitation events/patterns (Snow, Ice, Rain)
  - Destructive wind events (e.g. hurricane, typhoon)
  - Drought
  - Temperature extremes

- Water is the main way rock erodes into soil.
  - More wet a climate = more water = more erosion = finer and finer textured soil
  - More rain also leads to more leaching of materials out of soil into groundwater
- Heat and cold also help erode rock into soil.
  - Freeze-thaw of water in rocks cracks them. Do this again and again and again and eventually you don't have rocks you have soil!
  - High temps speed up chemical reactions; faster organic matter decomposition
- These factors influence our growing season
- And they influence the soil microbiome
  - Microbes: bacterial, fungi, etc. / Macrobes: worms, insects, etc.

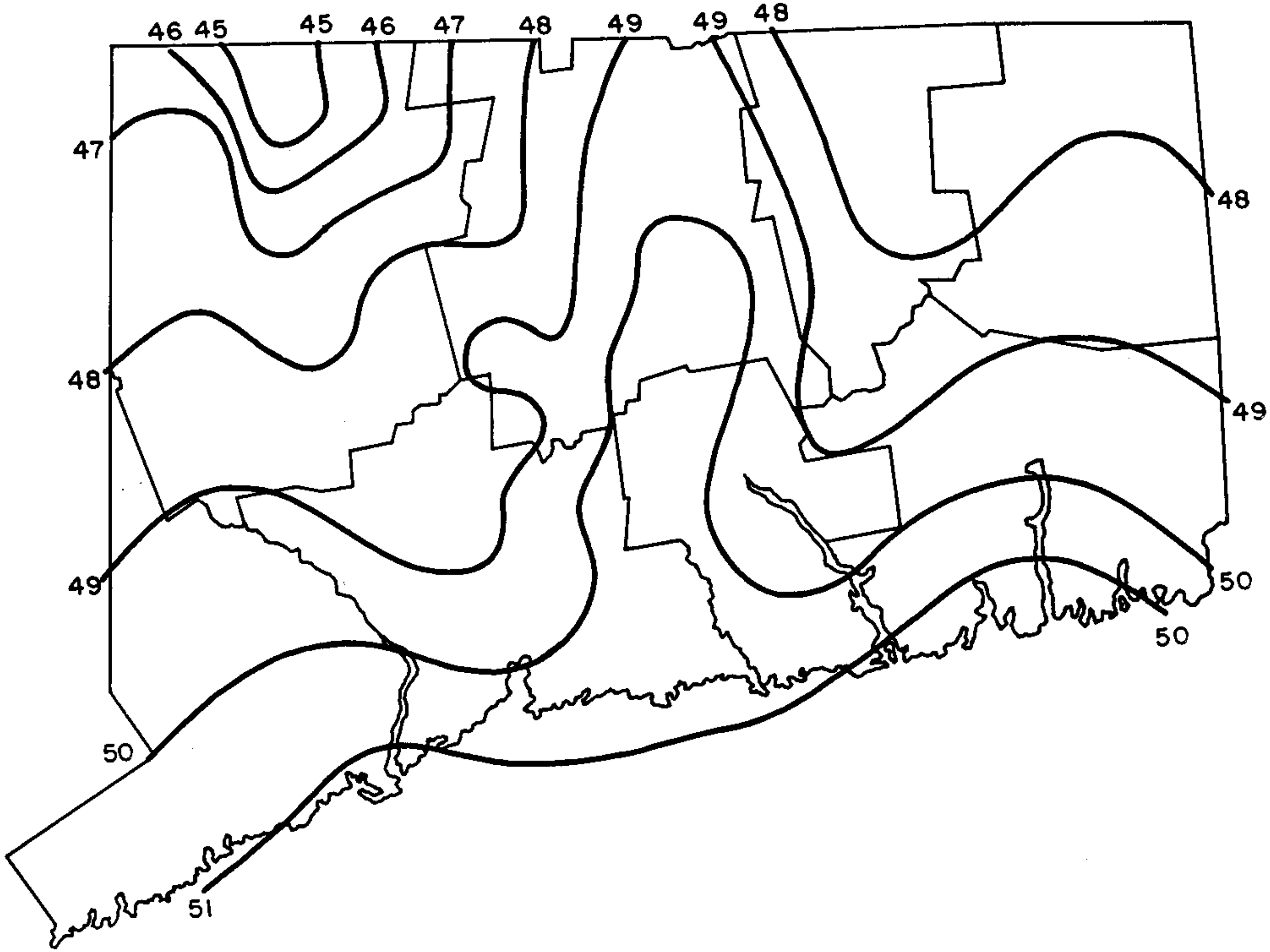
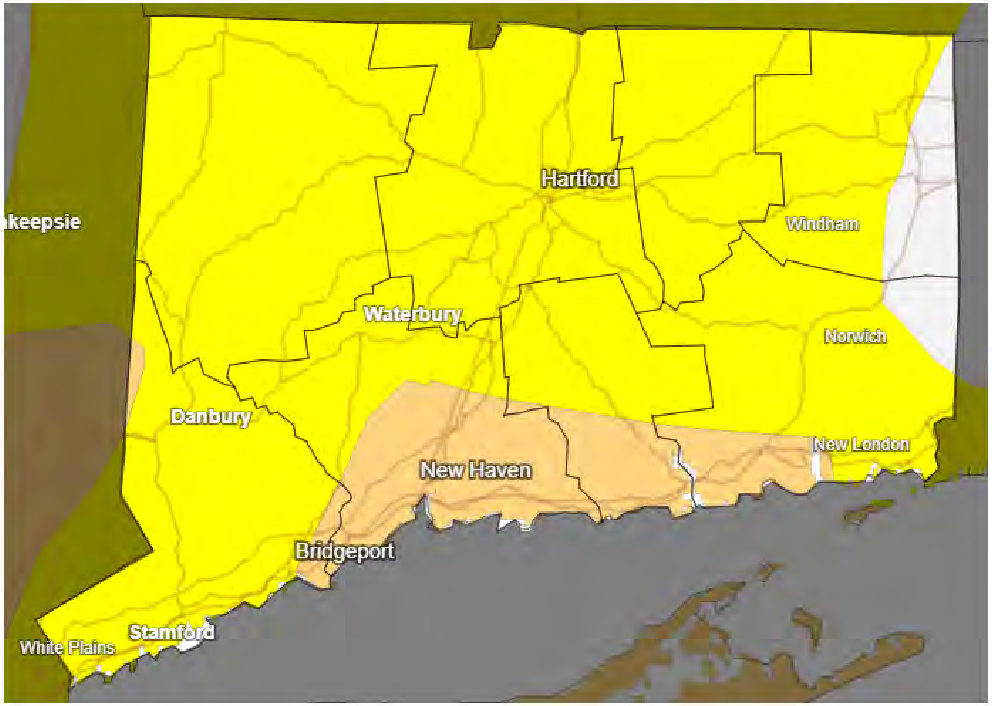


Fig. 3. Annual mean temperatures in degrees Fahrenheit

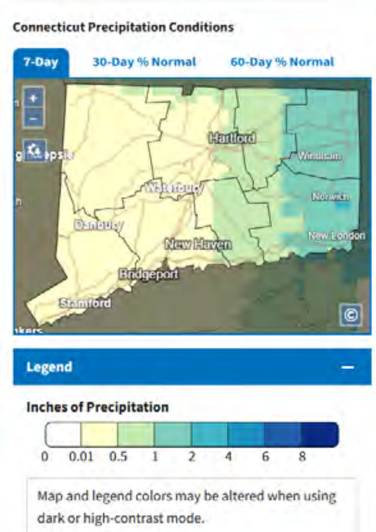
U.S. Drought Monitor

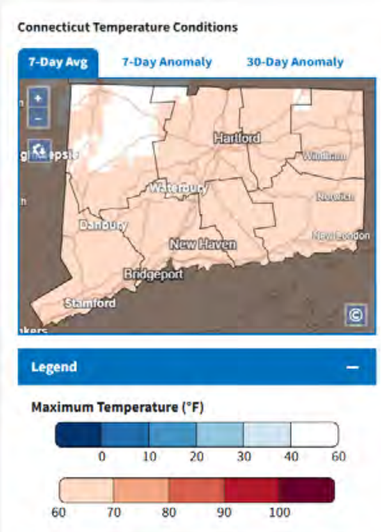


Drought & Dryness Categories	% of CT
D0 – Abnormally Dry	83.6%
D1 – Moderate Drought	12.3%
D2 – Severe Drought	0.0%
D3 – Extreme Drought	0.0%
D4 – Exceptional Drought	0.0%
Total Area in Drought (D1–D4)	12.3%

Source(s): NDMC, NOAA, USDA
Data Valid: 10/21/25

Drought.gov





Data from Week of October 19-25

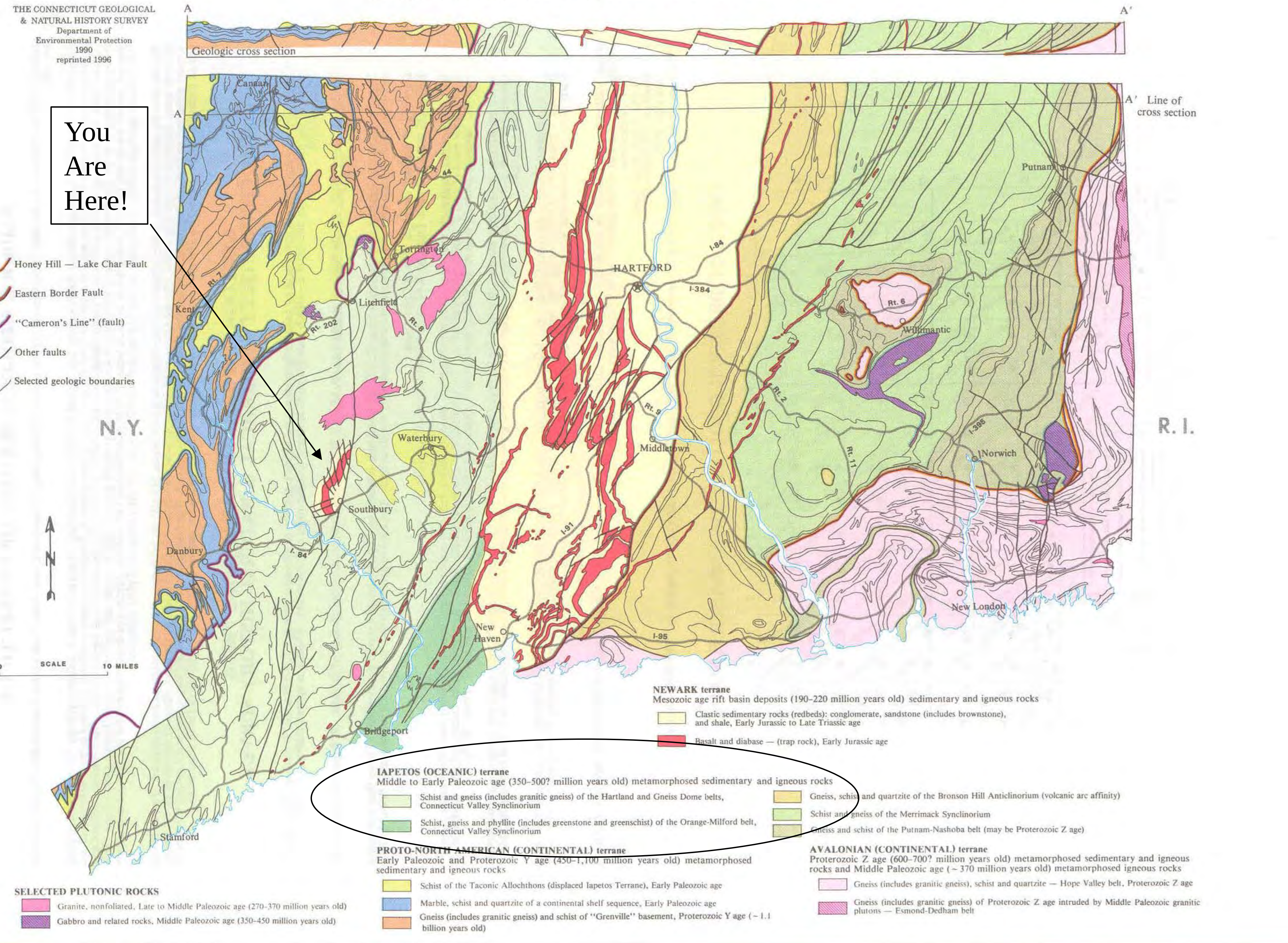
Five factors of soil formation – 4. Parent Material (e.g. Bedrock Geology)

Different rocks = different minerals = different weathering = different soils!

Influences soil texture, permeability, and drainage characteristics

- What rocks do we have in CT?
  - Metamorphosed sedimentary and igneous rocks – **gneiss and schist**
  - Metamorphosed igneous rocks - **granite**
  - Classic sedimentary rocks – **sandstone, limestone**
  - Classic igneous rocks - **basalt**

GENERALIZED BEDROCK GEOLOGIC MAP OF CONNECTICUT

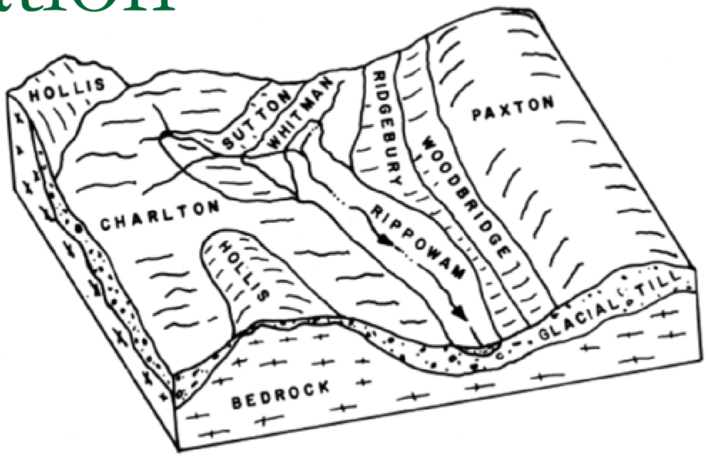


SOIL CATENAS OF CONNECTICUT

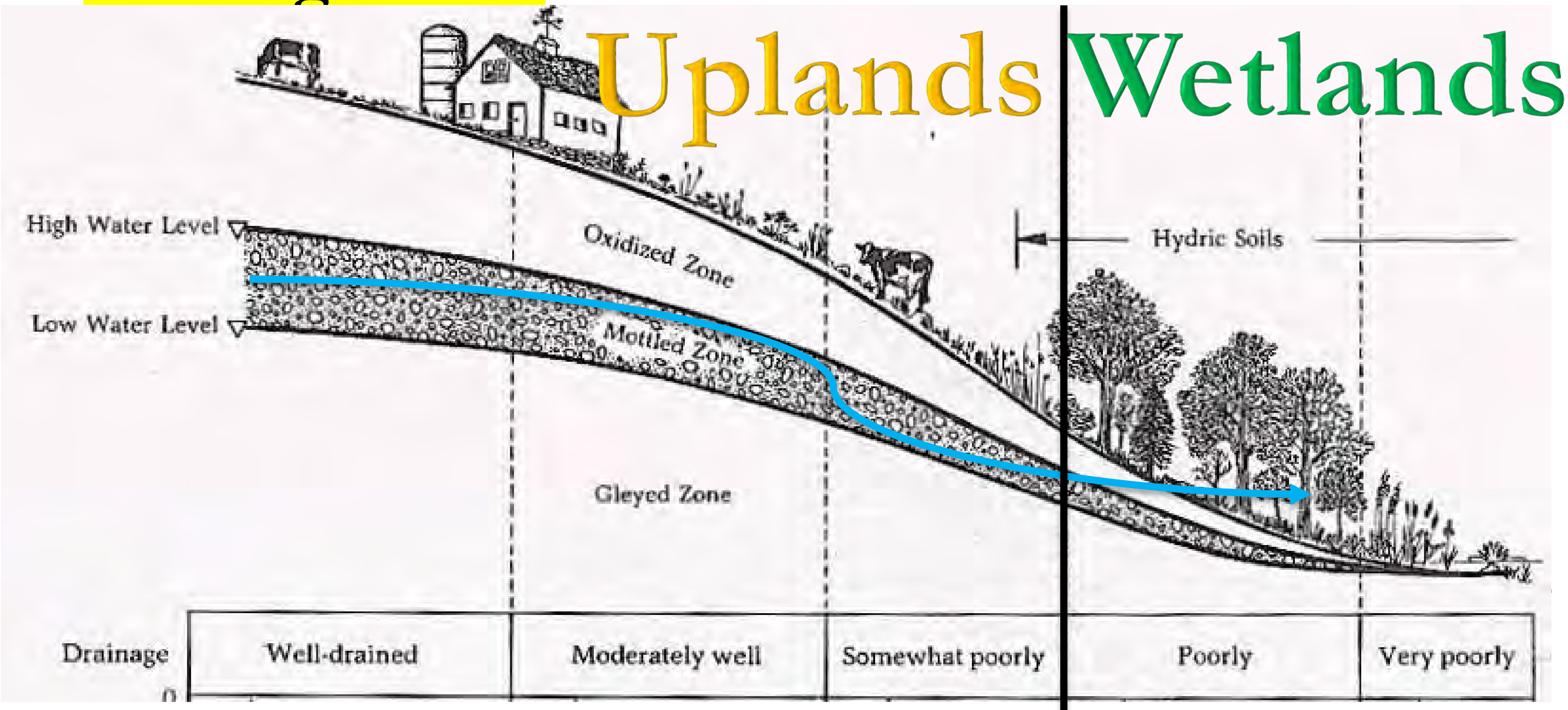
DEPOSIT	LITHOLOGY	TEXTURE GROUP	SOIL DRAINAGE CLASS: Excessively	Somewhat Excessively	Well Drained	Moderately Well	Somewhat Poorly	Poorly	Very Poorly
GLACIAL TILL Unstratified Sand, Silt & Rock	GRANITE & SCHIST	SANDY		GLOUCESTER					
				* WESTMINSTER #					
	SCHIST, GRANITE & GNEISS	LOAMY			** MILLSITE #				
				* HOLLIS [28]					
					** CHATFIELD				
					CHARLTON CANTON	SUTTON [1]		LEICESTER	
					BICE #	SCHROON #			LOONMEADOW #
					* PAXTON * MONTAUK * SHELBURE #	* WOODBRIDGE + ASHFIELD #		* RIDGEBURY	* WHITMAN
	MIXED CARBONATE ROCKS & CRYSTALLINE ROCKS				* FARMINGTON				
					PYRITIES # STOCKBRIDGE NELLIS [11]	* HOGANSBURG # GEORGIA AMENIA		MUDGEPOND [18, 20]	ALDEN [19]
	RED SANDSTONE, SHALE, CONGLOMERATE & BASALT				* HOLYOKE [29]				
					** YALESVILLE				
					CHESHIRE [24, 28]	WATCHAUG [8]			
					* WETHERSFIELD	* LUDLOW		* WILBRAHAM	* MENLO
	BROWN MICACEOUS SCHIST			* BRIMFIELD	BROOKFIELD				
					**NIPMUCK				
	PHYLLITE, SCHIST & SLATE			* TACONIC #	** MACOMBER #				
					* BERNARDSTON				
					* LANESBORO #	* FULLAM #		* BRAYTON #	
					DUMMERSTON #				
	SHALE, SANDSTONE, BASALT & CRYSTALLINE ROCKS				* BROADBROOK	* RAINBOW			
		SILTY / SANDY			NARRAGANSETT	WAPPING			
GLACIOFLUVIAL Stratified Sand & Gravel	ACIDIC CRYSTALLINE ROCKS (granite, gneiss and schist)	SANDY & GRAVELLY	HINCKLEY [11] BOSCAWEN #	MERRIMAC		SUDBURY		WALPOLE MOOSILAUKE #	
		SANDY	WINDSOR			DEERFIELD			SCARBORO [15, 32]
		LOAMY / SAND & GRAVEL			AGAWAM	NINIGRET			
		SILTY / SAND & GRAVEL			ENFIELD [16] HAVEN	TISBURY		RAYPOL	
					BRANFORD	ELLINGTON			
	ACIDIC, RED SANDSTONE, SHALE, CONGLOMERATE	SANDY & GRAVELLY	MANCHESTER	HARTFORD					
		SANDY	PENWOOD						
	MIXED CARBONATE ROCKS & CRYSTALLINE ROCKS	SANDY & GRAVELLY	GROTON						
		LOAMY / SAND & GRAVEL			COPAKE	HERO		FREDON	HALSEY [7]
GLACIOLACUSTRINE Stratified Sand, Silt & Clay	MIXED CRYSTALLINE & SEDIMENTARY ROCKS	LOAMY			POLLUX	AMOSTOWN			
		SILTY				BELGRADE [27]		RAYNHAM [31]	
		LOAMY / CLAYEY				ELMRIDGE [13, 21]		SHAKER [30]	
		SILTY & CLAYEY				BRANCROFT [9] BERLIN		SCITICO [26]	MAYBID [5, 33]
ALLUVIAL Stratified Sand & Silt	GNEISS, SCHIST, GRANITE & QUARTZITE	SANDY	SUNCOOK						
		LOAMY			ONDAWA * OCCUM *	POOTATUCK [23]		RUMNEY # RIPPOWAM	
	MIXED CRYSTALLINE & SEDIMENTARY ROCKS	SILTY			HADLEY [14]	WINOOSKI [12]	BASH [5, 25]	LIMERICK LIM	MEDOMAK # SACO
COASTAL	MARINE DEPOSITS	SANDY	HOOKSAN						SANDYHOOK
HUMAN ALTERED & HUMAN TRANSPORTED	HAHT MATERIALS OVER TERRESTRIAL SOILS	LOAMY/ SANDY			VERRAZANO				

Five factors of soil formation –

5. Topographic Relief



- Water follow the path of **least resistance**
- **Drainage Class**



Earth Tones Native Plant Nursery

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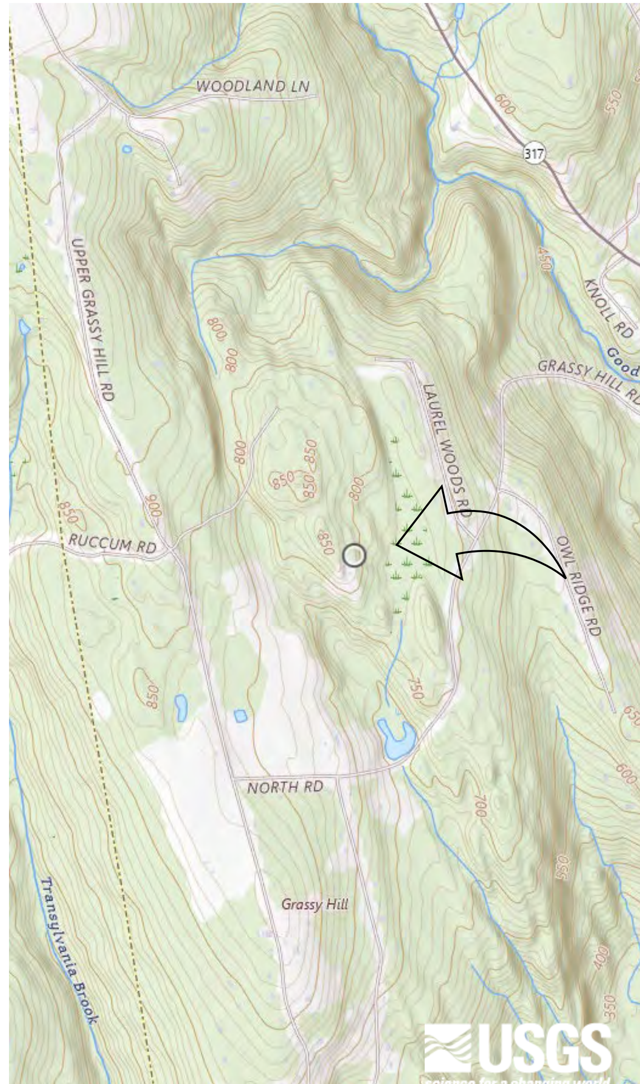

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Symbol	Drainage Class
ED	Excessively Drained
SED	Somewhat Excessively Drained
WD	Well Drained
MWD	Moderately Well Drained
SPD	Somewhat Poorly Drained
PD	Poorly Drained
VPD	Very Poorly Drained

Viewers | Connecticut Environmental Conditions Online

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Drainage Class (determines State wetlands [in part])

Where the wetland scientist sets the line should be the divide between poorly drained and somewhat poorly drained

Symbol	Drainage Class	
ED	Excessively Drained	Free water = very rare; coarse textured
SED	Somewhat Excessively Drained	
WD	Well Drained	Internal free water = common, but water is removed readily, wetness does not inhibit root growth, mostly free of redox features
MWD	Moderately Well Drained	Water removal slow during certain times of the year, internal free water tends to be moderately deep, wet within the rooting depth only for short periods during the growing season, redox features are present
SPD	Somewhat Poorly Drained	Water is removed slowly, soil is wet at a shallow depth for significant periods during the growing season. Wetness restricts crop growth unless drained, redox features common
PD	Poorly Drained	Water drains slowly, free water occurs at shallow depths and is common or persistent; crop growth restricted, high water table, redox features common, depleted matrix
VPD	Very Poorly Drained	Soil is wet at shallow depths or for long periods; free water at or near the surface; redox features common, gleied colors possible to common

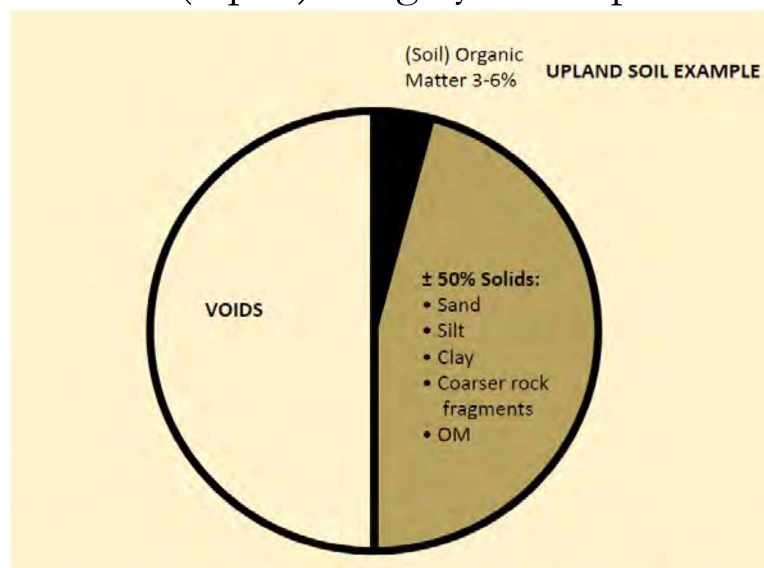
The 5 Soil-forming Factors influence the <u>properties</u> of soils

- pH (Acidic, neutral, basic)
- Chemical content (CEC, pollutants, nutrients, etc.)
- Moisture holding capacity
- <u>Texture</u>
- <u>Color</u>
- <u>Drainage class</u>

Soil Texture - Mineral vs. Organic

- Mineral
  - Sand
    - ≤2 mm to 0.05 mm
    - Visible to barely visible w/ naked eye
    - "gritty" feel
  - Silt
    - 0.05 to 0.002 mm
    - Barely visible to naked eye to microscopic
    - "flour" feel
  - Clay
    - <0.0002 mm
    - Need a microscope to even see individual particles!
    - "sticky" feel

- Organic - when organic matter content is high 5-18%
  - Peat (fibric) – slightly decomposed
  - Mucky Peat (hemic) – moderately decomposed
  - Muck (sapric) – highly decomposed



Pie chart showing components of a Generic Mineral Top Soil

> 2 mm Mineral = Coarse fragment (gravels, cobbles, boulders, etc.)

> 20 mm Organic = Wood fragments

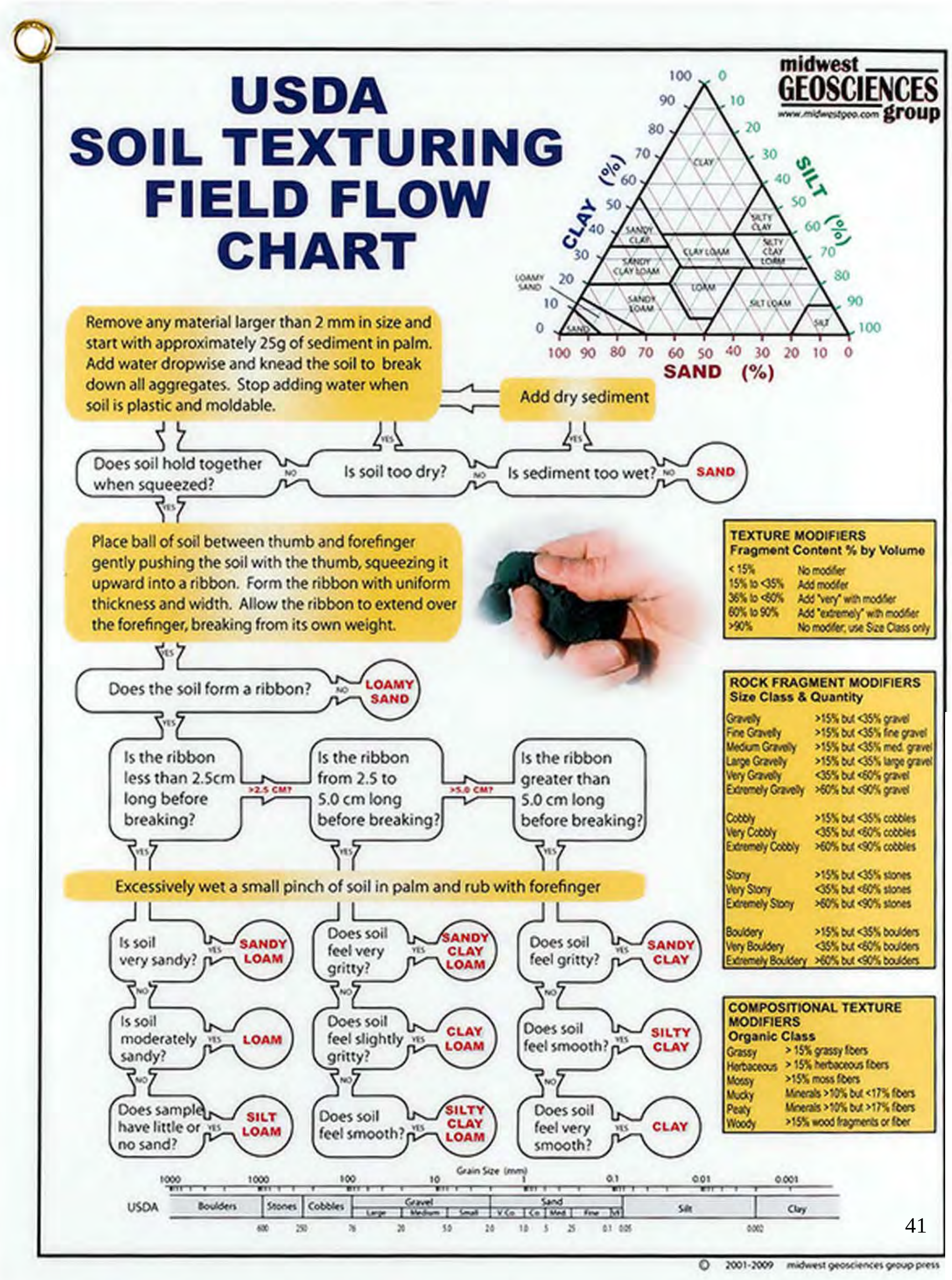
Why Soil Texture Matters?

- Soils that are 20% or more organic matter (dry weight) are *evidence* that slower decomposition rates are present, usually due to *prolonged wetness and anaerobic conditions*
- Once you have 20% OM, you officially have an organic soil!
- If you have less than 20% OM you discount it *entirely*!

- The mineral texture influences the movement of water through the void space
- Sands = lots of big voids
- Silts = less voids
- Clays = the least voids

How do you test OM content in the field?

How do you figure out the texture in the field?



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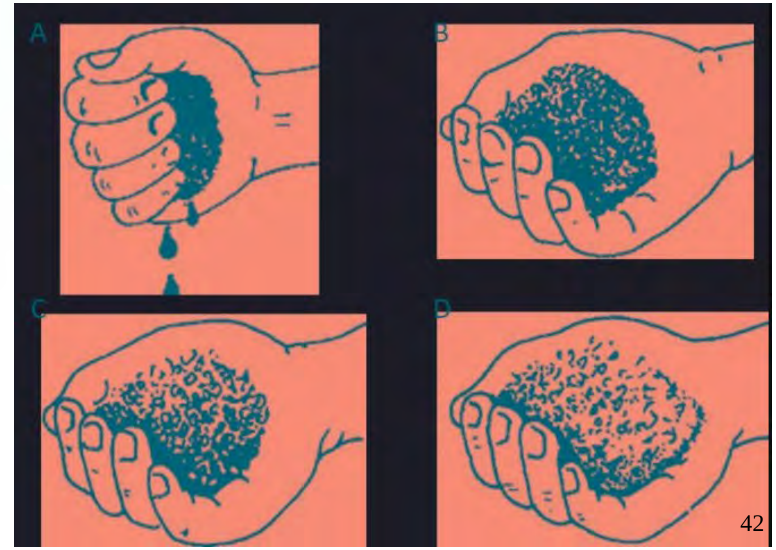

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The *SQEEZE* Test

% Organic Matter (dry weight) via Lab Test

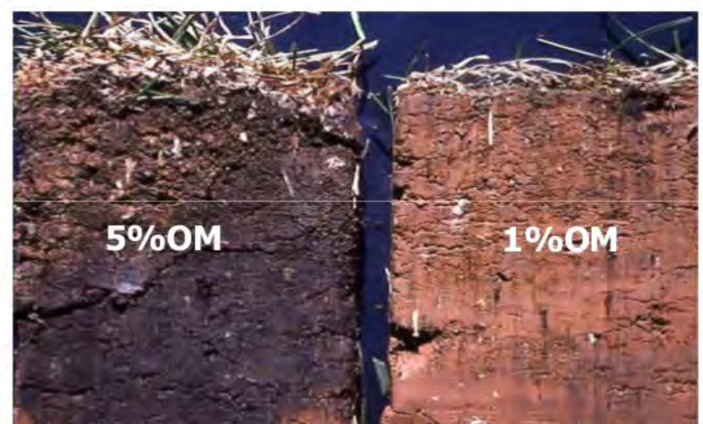

Image: Rodale Institute

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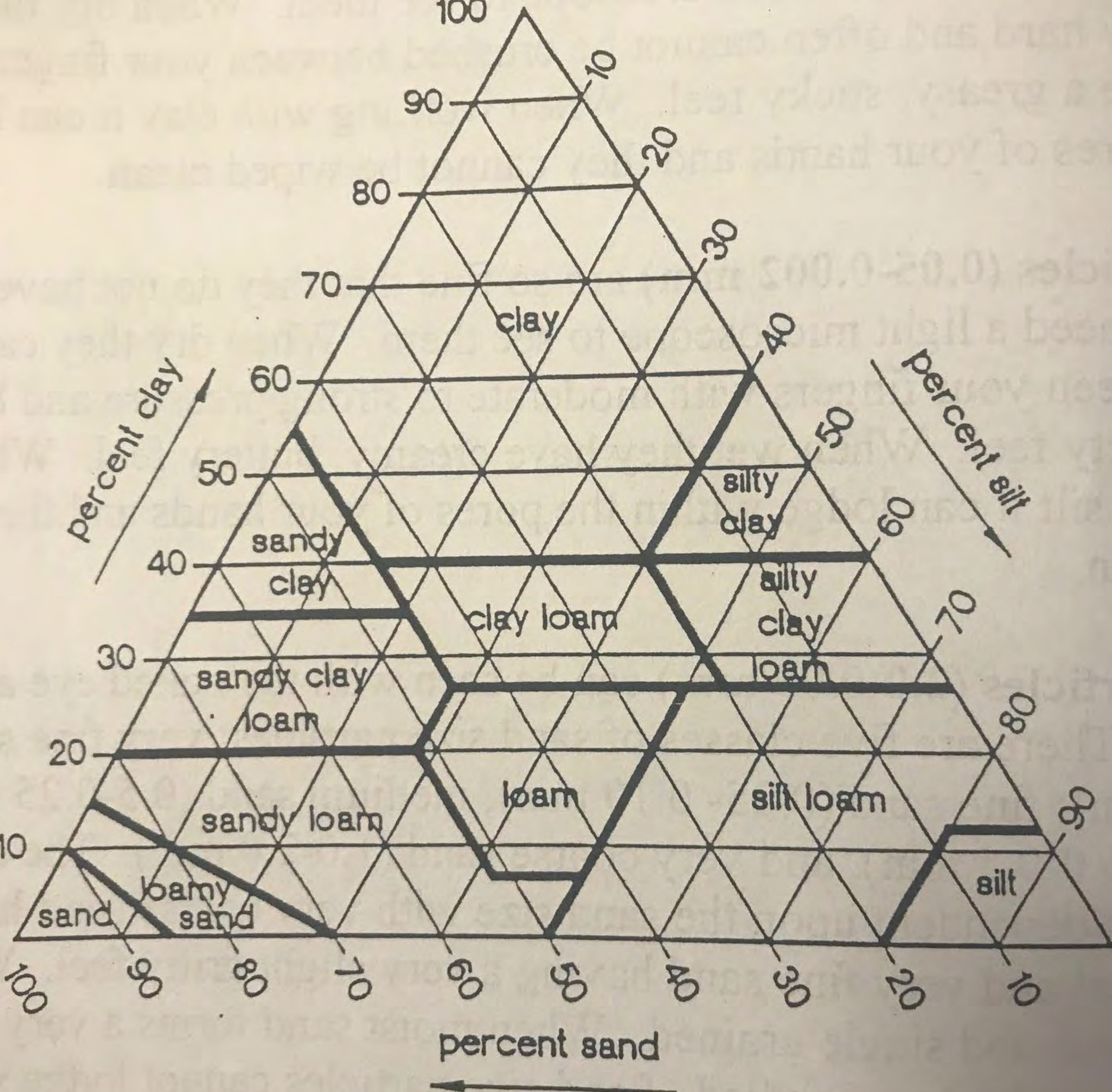
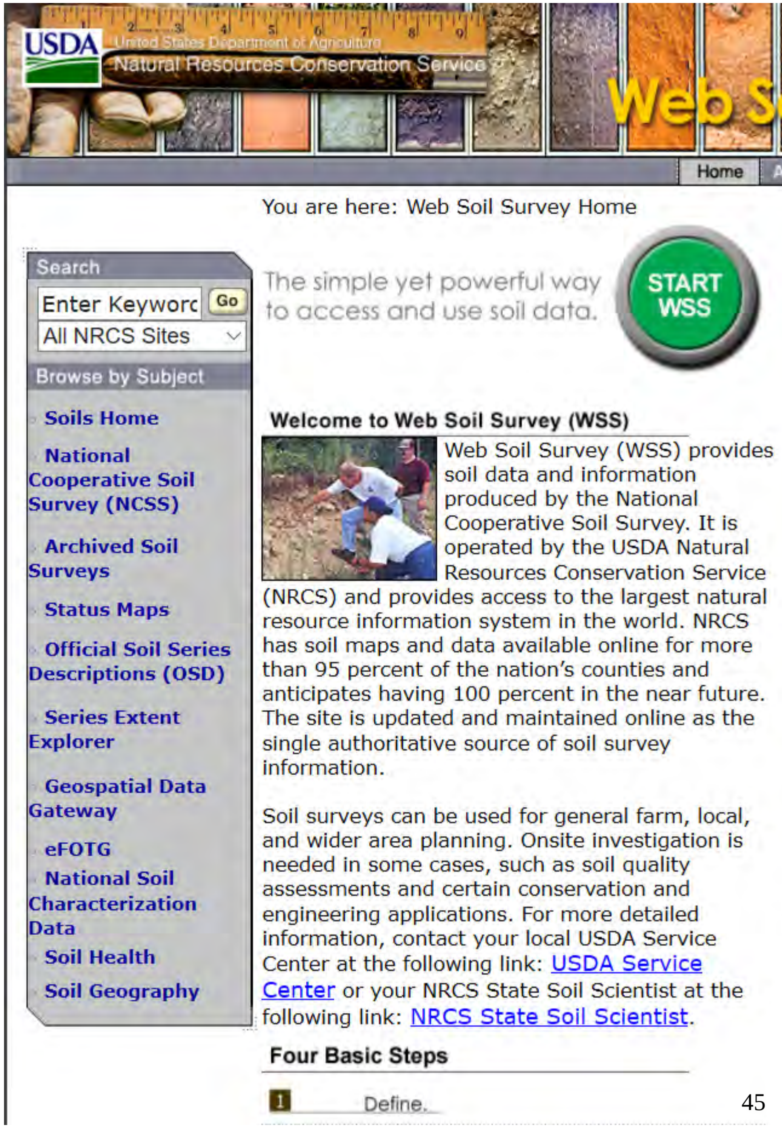
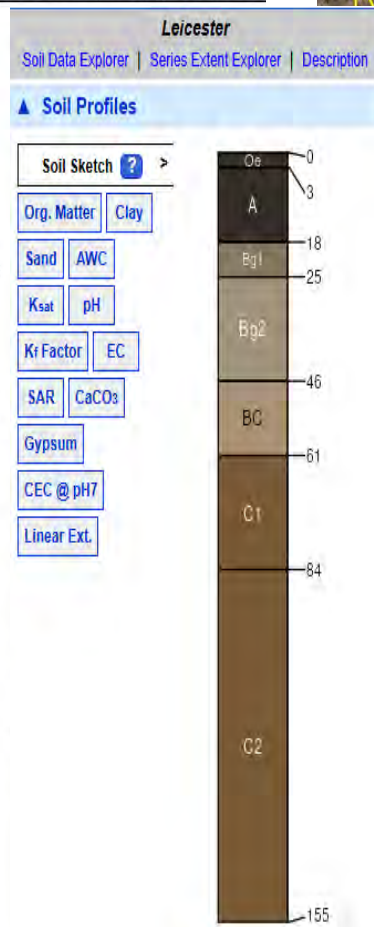


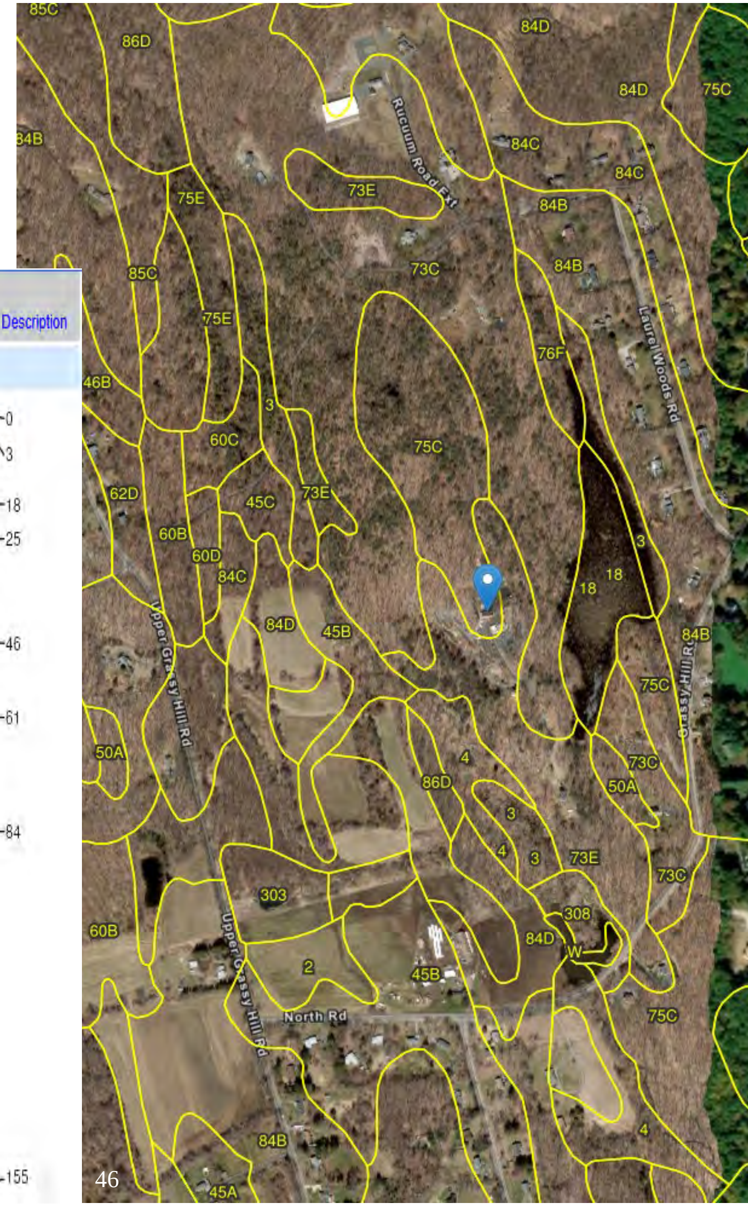
Soil Textural Triangle

Web-based Soil Survey

- https://websoilsurvey.nrcs.usda.gov/app/HomePage.htm
- https://casoilresource.lawr.ucdavis.edu/gmap/







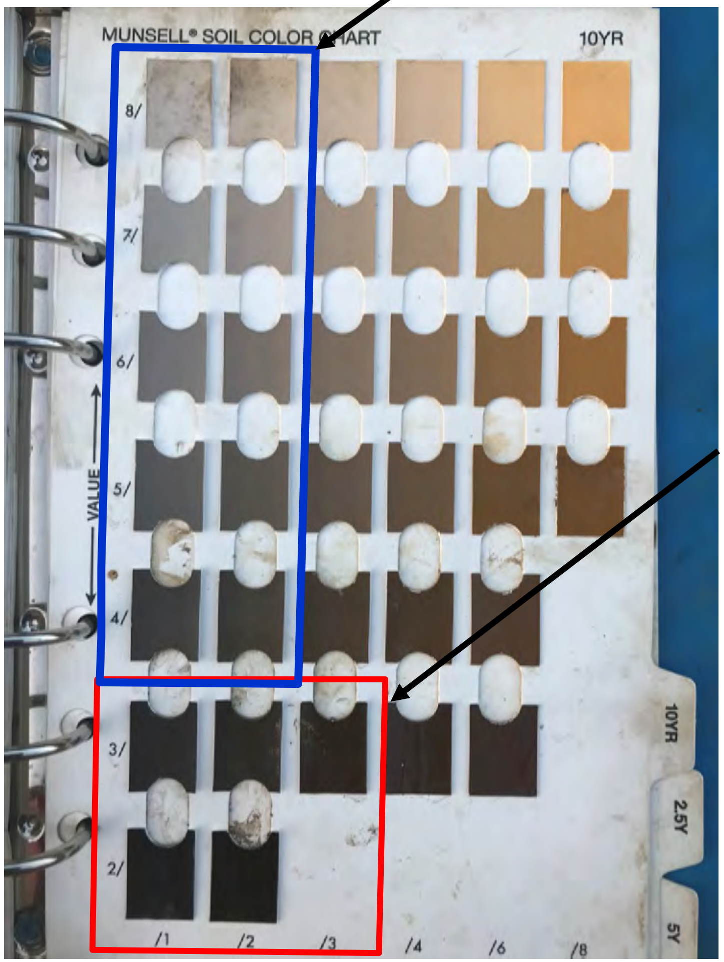
Soil Color –
Composed of 3 measurable variables

- Hue – The dominant spectral color (related to the wavelength of light)
  - *(The page tab)*
- Value – Measure of the degree of darkness or lightness of the color (related to the total amount of light reflected)
  - *(The left side of the page)*
- Chroma – A Measure of the purity or strength of spectral color
  - *(The bottom of the page)*

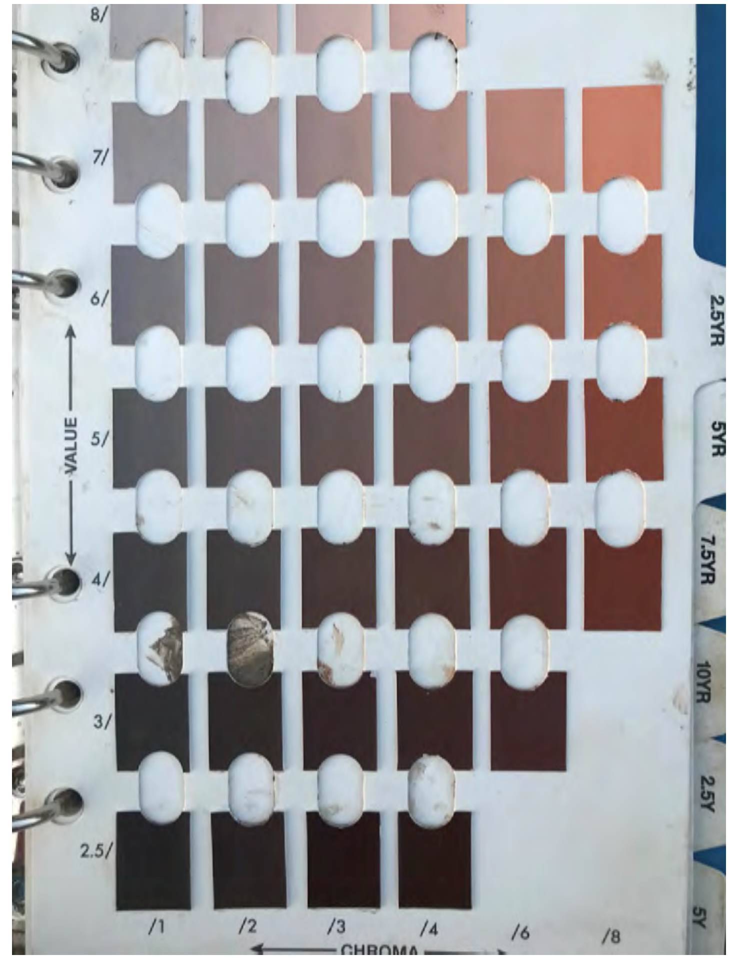
These three variables have been combined into reference charts that cover the range of colors found in soils = Munsell ® Soil Color Charts

Soil Color – Munsell® Color Chart

The Wetland Colors



Topsoil / OM colors



Gleyed Page

Not Gley Colors

Why Soil Color Matters?

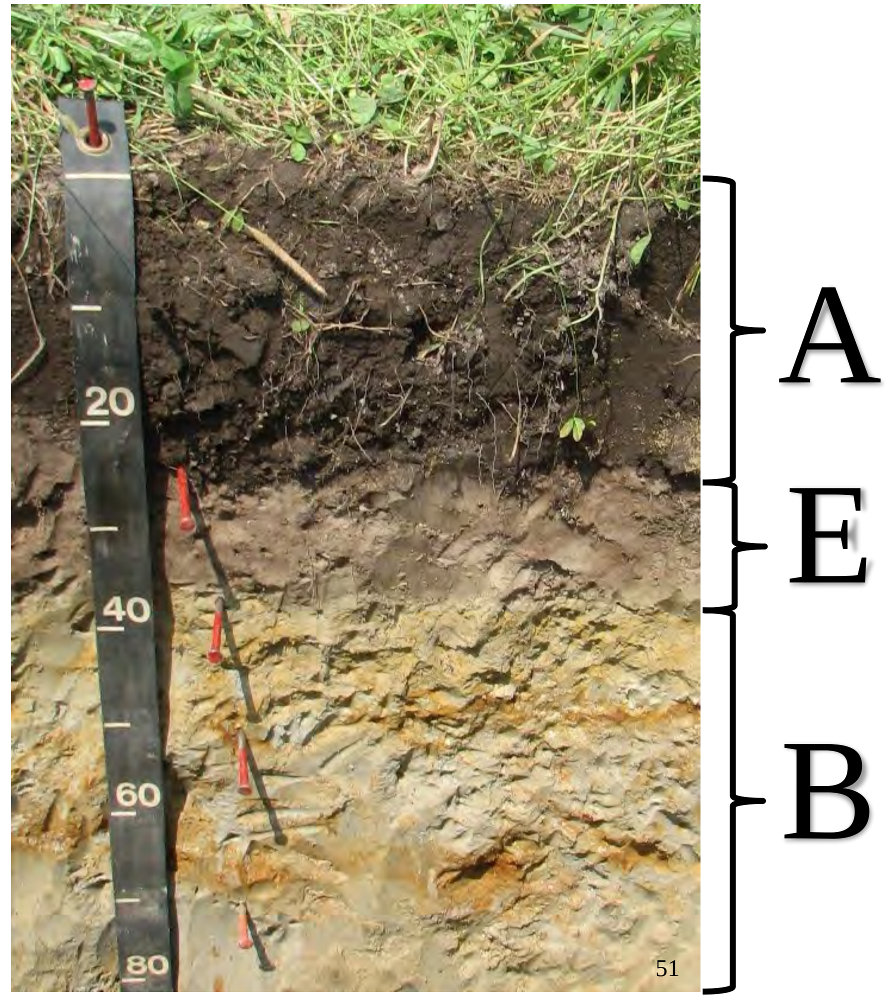
- Color is the **MAIN** indicator to long term conditions
- Grey soils mean that water has sat in those soils long enough to leach out all the iron that makes soil rusty
  - The more gray color there is the more wet!
- Mottled reddish/orange or grey patches indicate a fluctuating water table – when water table is present, leaches away the color, when it recedes, iron re-precipitates
- Organic matter is dark brown to black and can mask other colors – lots of OM also indication very wet

Redoximorphic Features

- Matrix depletion (grey spots – iron leached away)
- Concentrations (red spots – iron concentrating)
- Concretions (Iron [Fe] – red spots, Manganese [Mn] – black/purple spots)
- Oxidized rhizospheres
  - Plants pump oxygen into really wet soil to keep their roots alive
  - The presence of oxygen allows iron to re-precipitate around the roots (red lines in soil)

Soil Horizons

- O – layers dominated by organic material
- A – "Top Soil" Mineral horizons that form at the surface or below an O horizon
- E – Zone of **e**luviation (not always present) – loss of color containing clays, Fe, Al leaving behind colorless quartz and sand particles
  – DOESN'T NECESSARILY MEAN A WETLAND DUE TO GREY COLOR
- B – "Subsoil" Zone of color formation due to **i**lluvial accumulation
- C – Layers (excluding bedrock) that are little affected by soil forming processes



Soil Profiles

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Example Soil Profiles - Uplands

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Example Soil Profiles - Wetlands

Histosol (Hydric)

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Histic Epipedon (Hydric)

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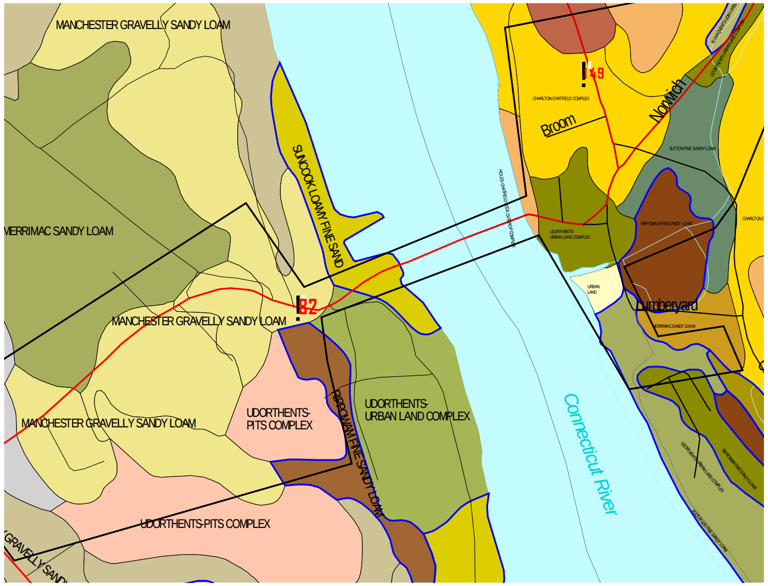
Wetland Delineation Methodology

- Existing mapping
  - USGS, soil survey, NWI, design drawings
- Existing information
  - Soil descriptions, borings
  - Property owners
- Field Delineation
  - overall site recon.
  - pick a logical point to start
  - perpendicular transect sampling
  - consecutively numbered flagging
  - documentation (Corps sheets, F&V assessment, other notes)



Delineation Field Equipment

- Dutch auger, bucket auger
- Munsell Color Charts
- Guidance Documents (local regs.)
- Field Forms
- Field Guides
- Special (PPE, etc.)
- Other (ruler, flagging, markers, etc.)

Tools of the Trade

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Web Links

- www.pwrc.usgs.gov/wli/ (Wetland Science Institute)
- https://nwpl.sec.usace.army.mil/ (National Wetland Plant List)
- www.epa.gov/owow/ (Office of Wetlands, Oceans & Watersheds)
- www.wes.army.mil/el/wetlands/wetlands.html (Waterways Experiment Station)
- www.usfws.gov (U.S. Fish and Wildlife Service)
- www.nrcs.usda.gov/technical/ (Natural Resource Conservation Service)
- https://casoilresource.lawr.ucdavis.edu/ (UC DAVIS California Soil Resource Lab)
- https://apps.nationalmap.gov/ (US Geological Service)
- dep.state.ct.us/ (Connecticut DEP Home Page)
- https://www.drought.gov/states/connecticut (National Oceanic and Atmospheric Association National Integrated Drought Information System)
- https://maps.cteco.uconn.edu/ (Connecticut Environmental Conditions Online)
- https://www.cga.ct.gov/current/pub/Chap_440.htm#sec_22a-29
- **Special Thanks to Dr. Deborah Henson – University of Massachusetts and Anthony Zemba – Secretary for CAWS for several of the photos used in this presentation (cited below)!**

- **And a big thank you to Kyle Turoczi of Earth Tones Native Plant Nursery and Landscapes for hosting us all!**

Photo Credits

- 1: Connecticut Association of Wetland Scientists - Home
- 2: Alexander Wojtkowiak – Society of Soil Scientists of Southern New England (SSSSNE) 2025 Alluvial Soils Workshop – Walpole Soil Taxadjunxt
- 3: Earth Tones Native Plants
- 4: Wetland hydrological monitoring explained - Thomson Environmental Consultants
- 5: Earth Tones Native Plants
- 6: Army Corps of Engineers :: U.S. Army Fort Hunter Liggett
- 7: University of Minnesota Soil Judging Team: September 2015
- 8: Photo Gallery
- 9: RiverRoots: Stories of the Conestoga River: Presettlement Conditions
- 10: Trail Creek Watershed, Colorado, 2010 – 2013
- 11: Anthony Zemba - Municipal Wetlands & Wetland Soil Workshop – Slide 12
- 12: Swida sericea red (red-twig dogwood, red-osier dogwood) – Butterfly Effect Farm
- 13: Alexander Wojtkowiak – Pennsylvania USA
- 14: Anthony Zemba - Municipal Wetlands & Wetland Soil Workshop – Slide 6
- 15: Anthony Zemba - Municipal Wetlands & Wetland Soil Workshop – Slide 7
- 16: Anthony Zemba - Municipal Wetlands & Wetland Soil Workshop – Slide 11
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- 49: Anthony Zemba - Municipal Wetlands & Wetland Soil Workshop – Slide 50
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- 51: Dr. Deborah Henson (UMass Amherst) – NRC 568: Wetland Soils
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