The Relationship between the Properties and Features of Wetland Soils and the Adjacent Uplands

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Wetlands and watercourses are features of Connecticut's landscape whose occurrence is dependent upon the local terrain, soil characteristics, and hydrology. Wetlands develop and watercourses exist whenever the presence of water has a dominant or pronounced effect. By occupying low-lying spots and drainages in the watershed, wetlands and watercourses are not only defined by the surrounding uplands but are also interconnected with them. Wetlands can be distinguished from uplands and other ecosystems by examining certain characteristics that relate to features such as water, soils, and biota, and characteristics related to function such as hydrology, biogeochemical cycling, habitat and food webs. As a practical basis, the State of Connecticut defines wetlands using the dominant characteristic of soil type. Wetland soils exhibit specific, well defined physical, chemical, and biological properties and features that are a reflection of the hydrology of the area. These characteristics and features are displayed in the layers (horizons) of the soil profile.

Soils develop as a result of the interaction between the five soil forming factors: the nature of the parent material, climate, organisms, topography, and time. All of these factors are affected by water, and thus the hydrology of an area is important in determining how the soil develops.

The parent material of the soil determines the textures of the soil horizons (layers), and the texture affects how readily water will move into and through the soil. Weathering of the parent material is affected by water, both in liquid and solid ice forms.

Climate determines when the water will be present and whether it will be liquid water or ice.

Decomposing flora and fauna provide organic matter and nutrients to the soil. Earthworms mix the soil, increase the availability of nutrients, and help increase the stability of soil aggregates, which in turn increase the infiltration rate of water into the soil. Soil microorganisms influence chemical weathering and facilitate the development of redoximorphic features.

The soil topography influences where wetlands are on the landscape. Water that cannot infiltrate easily into the soil will flow on the land surface to and from wetlands. The three basic hydrologic positions of wetlands on the landscape are: depressions or low spots, flood plains and alluvial areas, and concave slopes where groundwater seepage surfaces.

There are four basic soil forming processes: additions, deletions, transformations, and translocations. These processes take place in the soil profile, and all are affected by water. Water *adds* materials by deposition of eroded sediment from uplands and by the addition of minerals that precipitate typically as the water evaporates. Water also *removes* minerals and sediment from the soil. Chemical weathering *transforms* the parent material. Soil biota *transforms* biomass into humus and decomposed organic matter. Some of the material is *translocated* in the soil profile, moved from upper soil layers to lower soil layers. For example, clays and iron are often *translocated* and redeposited lower in the soil profile. In fact, the transformations and translocations of iron are dependent on soil microorganisms and result in the formation of redoximorphic features (formerly known as mottles) which are characteristic of wet soils.

The Connecticut Inland Wetlands and Watercourses Act defines wetland soils to include "any of the soil types designated as poorly drained, very poorly drained, alluvial, and flood plain by the National Cooperative Soil Survey". The first two types are defined by the USDA Soil Survey Manual (1), and are the definitions accepted by all of the National Cooperative Soil Survey partners. The second two soil types refer to soils formed in specific types of parent materials. The definitions of these soil types are:

Poorly drained: "Water is removed so slowly that the soil is wet at shallow depths periodically during the growing season or remains wet for long periods…Free water is commonly at or near the surface long enough during the growing season so that most mesophytic crops cannot be grown, unless the soil is artificially drained. The soil, however, is not continuously wet directly below plow-depth." (1)

Very poorly drained: "Water is removed from the soil so slowly that free water remains at or very near the ground surface during much of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown" (1)

It is important to note that specific depths to free water tables are not mentioned in the official definitions of drainage classes, nor are depths and amounts of redoximorphic features. Specific depths to these soil characteristics are determined regionally and statewide by the soil scientists of the National Cooperative Soil Survey.

Alluvial soils form in sediment deposited by streams. Flood plain soils form in the nearly level alluvial plain that borders a stream and are subject to flooding unless protected artificially. These soils are often better drained than the poorly drained soils, but are still considered to be Connecticut state wetlands because they are subject to flooding.

The hydrology of all of these wetland soils encompasses a period of time when water is at or near the surface of the soil. The time period may be longer, as is the case with poorly drained and very poorly drained soils, or shorter with the better drained alluvial and flood plain soils. The water may be present as a result of surface and subsurface flow from uplands to a lower topographic location, ponding of rain water, or from flood waters of a stream or river.

These unique characteristics of wetland soils are linked to the surrounding uplands. Therefore, upland habitats play an important role in protecting the characteristic structure and function of wetland soils. Any alterations in uplands usually affect wetlands.

Our current development patterns (2), construction techniques, planning and zoning regulations, health code, and a lack of natural resource based planning has created significant impacts on the ecosystem goods and services (3) that wetlands provide. Because of the integral relationship between upland areas as the *contributing watersheds* of wetland soils, a review of the relationship of "physical characteristics" of wetland soils to adjacent uplands is helpful (Table 1). It is important to understand that some of the potential impacts of development can be mitigated or lessened by the use of BMP's (Best Management Practices), updated regulations, standards and codes, and smart growth concepts that incorporate natural resource information (4).

In addition, although the focus is on “physical characteristics” of wetland soils, it is well understood by soil scientists that the physical, chemical, and biological characteristics of wetland soils and their relationship to upland areas are inextricably linked.

For additional information please consult the listed references.

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Table 1: Relationships between Physical Characteristics, Uplands and Potential Development Impacts

Connecticut wetland soil "Physical Characteristics"	**Relationship to adjacent "non-wetland" uplands**	**Some potential impacts to wetland soil "physical characteristics" from traditional development on uplands (2)**
Higher accumulations of **organic matter** in the surface layer (poorly drained soils, very poorly drained soils)	Plant materials (roots, leaves, twigs) wash or drop into wetlands; wetter conditions from seasonal saturation from water supplied by uplands slows decomposition of organic materials	• Increased runoff adds additional sediments and organic matter • Decreases/changes in seasonal groundwater levels creates drier conditions; organic matter decomposes faster, with less accumulation • Changes to vegetation community changes rate of organic mater accumulation
Saturated conditions near soil surface during the growing season (soil pore spaces filled with water) (poorly drained soils, very poorly drained soils)	Seasonal ground water level and fluctuation defined by surface runoff, infiltration, and percolation over and through upland soils to downslope and depressional areas	• Drainage systems associated with development reduce/change depth of water table and length of saturation by reducing base flows to wetlands soils • Areas with municipal water/no sewer, sewer, and individual wells can change baseflow and saturation of wetland soils • Increased runoff changes time of year and the part of soil profile that is saturated
Anaerobic conditions (oxygen not available to soil organisms or plant roots at or near the growing surface during the growing season) (poorly drained soils, very poorly drained)	Depends upon fluctuations of seasonal groundwater during the growing season supplied by surface and groundwater from upland watershed	• Same as saturated conditions • Changes in saturation and time of year of saturation may increase or decrease anaerobic conditions • Sedimentation from uplands may increase the depth to saturation, causing drier aerobic conditions

Presence of **redoximorphic features** (mottles) at or near the surface of the soil (poorly drained soils, very poorly drained soils)	Depends upon fluctuations of seasonal groundwater during the growing season supplied by surface and groundwater from upland watershed	• Same as saturated conditions • Changes in seasonal saturation may lead to decreased or increased redoximorphic features
Accumulation of **sediments and organic matter** from flooding events (flood plain soils & alluvial soils)	Saturation of upland soils leads to surface runoff in the watershed; amount and timing of runoff, stream dynamics and stream bank erosion determine amounts.	• Increased runoff, decreased baseflow changes frequency, depth, and duration of flooding events • Changes to streamside vegetation, runoff and baseflow and increases in road sand may cause downcutting and /or bank erosion with corresponding increases or decreases in sedimentation
Seasonal flooding over channel banks causing saturation, recharge, scour and deposition (flood plain soils & alluvial soils)	Saturation of upland soils leads to surface runoff in the watershed; amount and timing of runoff, stream dynamics and stream bank erosion determine flooding duration and extent	• Same as accumulation of sediments • Changes in the watershed from culverts, bridges, streamside vegetation and wetlands saturation can change duration, location, and storage and release of floodwaters
Landscape position: Depression or low spot Concave slopes Adjacent to watercourse	Concave slopes, depressions, and areas along watercourses capture surface runoff and groundwater flow	• Changes to direction and concentration of surface flow and baseflow through and over the soil landscape by grading and altered or human designed drainage systems changes amount of water accumulating in wetland soil landscape positions

(1) USDA NRCS, Soil Survey Manual, USDA Handbook #18, page 73 (1993)

(2) Examples of traditional development include non-cluster housing, curbed roads, catch basins to storm sewer system, large areas of paved surfaces
(3) Identifying "ecosystem goods" is a way to give recognition to the role ecosytems play in the production of natural resources products. Examples might include birds, timber, and food crops. "Ecosystem services" are the outcome of processes occurring within ecosytems valued by people – examples might include storage of flood waters, nutrient cycling and habitat for plants and animals.
(4) Technical assistance is available from Connecticut's five Conservation Districts - for a list go to www.conservect.org

REFERENCES

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