Rhode Island Envirothon

Soils

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INTRODUCTION

Rhode Island Envirothon - Soils Section

Team members will be able to:

- Recognize and identify various soil properties
- Understand how soil properties affect soil behavior
- Determine the suitability and limitations of soil for various land uses
- Gain an awareness of soil as an integral part of ecosystems
- Understand the environmental and economical importance of soils and soils information with regard to land use and management

Test Format:

During the day of the Envirothon, the students will be involved in three basic soils activities:

a) Answer multiple choice, fill in the blank, True/False, or short answer questions about important characteristics of soils. These will account for about 70% of the total score.

b) Students will be asked to observe a soil pit, and its associated landscape. (Soil samples from other locations may also be provided for them to evaluate.) Based on their observations, students will answer a series of questions. These questions will account for about 15% of the total score.

c) Use and practical application of soil survey information from printed soil survey and/or the online Web Soil Survey. The students will be asked to use the Soil Survey of Rhode Island, and associated publications, to extract information about a given tract of land and formulate conclusions. These questions will account for about 15% of the total score.

KEY CONCEPTS:

Students should be able to:

- Recognize and understand the features of a soil profile.

- Describe basic soil properties and soil formation factors.
- Understand the origin of soil parent materials.
- Identify soil constituents (e.g., clay, organic matter, sand and silt).
- Identify and list soil characteristics (e.g., texture, structure, etc.) and their relation to soil properties.
- Determine basic soil properties and limitations (e.g., mottling and permeability) by observing a soil pit or a soil profile.
- Understand the nature of plant nutrients and how they are held by soil
- Recognize the characteristics of wetland (hydric) soils.
- Understand soil drainage classes and know how wetlands are defined.
- Understand soil water, its movement, storage, and uptake by plants.
- Understand the effects of land use on soils.
- In land use planning discussions, discuss how soil is a factor in or is impacted by non-point source pollution.
- Identify types of soil erosion and discuss methods for reducing erosion.
- Utilize soil information, including a soil survey.

Key Terms to Know:

Parent material, Soil Horizon: O,E,A,B,C,R

Texture, color, redoximorphic features, density, organic matter content, structure, drainage class, permeability, depth to bedrock or other impermeable layers, surface stoniness, rock fragment content, slope, flooding.

Key Skills to Master

-Be familiar with topographic maps, aerial photographs, and other maps and be able to locate yourself on a map.

-Be familiar with the use of a Munsell or Earth Colors color book and the Hue Value/Chroma naming scheme

-Be familiar with the use of a clinometer to read the slope of a landscape.

INTERPRETATIONS:

Evaluating soil colors to determine the depth to a seasonal high water, determine drainage class.

Available water holding capacity for plant growth.

Identify the limitations of a soil for a dwelling with a basement, septic absorption field, agriculture, etc.

Determine how the soil characteristics would influence on-site and off-site affects of specific land management practices and land uses such as application of pesticides, sub-division development with on-site sewage disposal systems, clear cutting, etc.

SAMPLE QUESTIONS

What is the texture of the A horizon?
What is the parent material of this soil?
What is the major limiting factor of this soil for septic tank absorption fields?
What soil characteristic would lessen the negative impact on aquatic life in the adjacent wetland if fertilizers were to be applied here?

RECOMMENDATIONS FOR PREPARING TEAMS

Concentrate on the sections of the team manual that cover topics listed under Key Concepts.

DIG HOLES!

Obtain soil survey information for your locality. Pick some areas on a soil map that are accessible and undisturbed (athletic fields are often leveled and filled, plowed areas are OK). Read about the soils mapped there, and go out and examine the soils on-site by digging a hole up to three feet in depth (water table permitting). Note the color, thickness and texture of each horizon. Try to identify the individual horizons. The soil survey information will guide you. Try to do this for soils having different drainage classes and parent materials. Complete the soil judging exercise included in the team manuals for each site visited. If a team does this successfully, it will do well on the day of the Envirothon. This can be difficult is from a highly urbanized area. Parks often have areas of undisturbed soils.

To obtain soil maps and descriptive information contact your local USDA, Natural Resources Conservation Service (formerly Soil Conservation Service) office.

Rhode Island State Office, Warwick, RI 401-828-1300

NOTE: When reading the following information you'll see lot's of 'weasel' words such as, usually and typically. Unfortunately, as soils are natural, dynamic bodies on the landscape influenced by an infinite variety of factors, it's impractical to make concrete, black and white statements about it. There are exceptions to every generalization. The information attempts to make fundamental concepts of pedology comprehensible.

SOILS DEFINED

Soils are defined as the unconsolidated organic and mineral material on the surface of the earth that is capable of supporting plants. The upper limit of soil is air, or shallow water, the lower limit is either bedrock or the limit of biological activity. Most of us recognize the importance of soils within the context of food production. However, the use of soils is as varied as the use of land. Webster's Dictionary describes land as, ground or soil of a specific situation, nature, or quality. The soil can be thought of as the land itself and because soils are highly variable, their relative suitability for land use and ability to support plant communities and wildlife can differ greatly.

The objective of the soils section is to provide the students with an understanding of the concepts of soil variability, suitability, limitations, and behavior as an integral part of ecosystems and the ability to apply this knowledge toward environmentally sound land management.

SOIL FORMATION

Soils are formed through the action of climate, plant and animal life, and people on parent material in different topographic locations over time. The relative influence of each of these factors differs in different locations.

Factors of Soil Formation

This section describes the five major factors of soil formation and the effect of each on the soils. There is reference to the main soil particle sizes of sand, silt and clay in this section. For the time being just note that sand is what you probably think it is, silt, is the next size smaller (a silt particle will fit inside your fingerprint) and clay is microscopic. This will be explained thoroughly in a following section.

PARENT MATERIAL

Parent material refers to that great variety of unconsolidated organic and mineral materials in which soils form. Fresh peat and unconsolidated mineral matter are included under this definition, but consolidated bedrock is not.

Much of the mineral matter in which soils form is derived in one way or another from hard rocks, such as granite. Glaciers may grind the granite into rock fragments and earthy material and deposit a mixture of granite particles as glacial till; such parent material is identified as "till derived from granite." In contrast, granite may be weathered with great chemical and physical changes but not move from its place of origin; this altered material is called "residuum from granite."

Material Weathered in Place

Residuum is parent material produced by weathering of rock in place. The kinds of material produced by weathering of rock in place are related to the nature of the original rock.
The parent material of a modern mineral soil is not necessarily residuum from the bedrock that is directly below. The term "residuum" is used when the properties of the soil indicate that it has been derived from rock similar to that which underlies it and when evidence is lacking that movement modified it.

Transported Material

The most extensive group of parent materials in the world is the very broad group of materials moved from the place of their origin and deposited elsewhere. The principal groups of transported materials are usually named according to the main force responsible for their transport and deposition.

Material moved and deposited by water

Alluvium - Alluvium consists of sediment deposited by streams and rivers. It may occur on older terraces well above present streams or in the normally active flooded bottomland of existing streams.

Lacustrine deposits - These deposits consist of material that has settled out of the still water of lakes.

Marine sediments - These sediments settled out of the sea and were reworked by currents and tides

Beach deposits - Beach deposits mark the present or former shorelines of the sea or lakes. These deposits are low ridges of sorted material and are commonly sandy, gravely, cobbly or stony.

Material moved and deposited by wind

Eolian parent material is earthy material deposited through wind action.
Loess deposits are a type of eolian material that is typically very silty but may contain significant amounts of clay and very fine sand.

Materials moved and deposited by glacial processes

Several kinds of material were moved and deposited by glacial processes. Pulverized and other rock material transported by glacial ice and deposited, either directly from the ice or from melt-water is collectively known as glacial drift. Glacial drift is further defined based on the mode of deposition. Till - Till is that part of the glacial deposition that is lain directly by the ice with little or no transportation by water. It is generally an unstratified, mixture of variable amounts of clay, silt, sand, gravel, and often stones and boulders. Some settled out as the ice melted with very little washing by water, and the glacier overrode some. Loose, permeable till deposited during the final downwasting of glacial ice is called ablation till. Basal till is dense, compact, and relatively impermeable till deposited beneath the ice. Till may be found in ground moraines and in drumlins, long, low, cigar-shaped hills of till with a smooth skyline. The long axis of drumlins lies parallel to the direction of the movement of the glacial ice. Till varies widely in texture, chemical composition, and the degree of weathering following its deposition.

Glaciofluvial deposits -These deposits are material produced by glaciers and carried, sorted, and deposited by water that originated mainly from melting glacial ice. Glaciofluvial deposits are also collectively known as glacial outwash. This broad term includes all of the material swept out, sorted, and deposited beyond the glacial ice front by streams of melt water.

Glacial beach deposits - These consist of gravel and sand and mark the beach lines of former glacial lakes. Depending upon the character of the original drift, beach deposits may be sandy, gravelly, cobbly or stony.

Glaciolacustrine deposits - (From laus the Latin word for lake). These deposits range from fine clay to sand. They are derived from glaciers but were reworked and laid down in glacial lakes. Many of them are stratified or laminated. Alternating strata of silt and clay each related to one year's deposition and one season's glacial ice melt, are called varves.

Material moved and deposited by gravity

Colluvium - is a mass of soil material or rock fragments at the base of slopes. It is largely material that has rolled, slid, or fallen down the slope under the influence of gravity. An accumulation of rock fragments is called talus.

Organic material - accumulates in wet places where it is deposited more rapidly than it decomposes. These deposits are called peat and muck, which in turn may become parent material for soils.

A Word about Soil Parent Material in Massachusetts*

Massachusetts*was covered with glacial ice 12 to 14,000 years ago. Consequently, the parent material of the most extensive soils is comprised of various types of glacial deposits. Major kinds of parent material in Massachusetts are till, outwash or glaciofluvial deposits, lacustrine and marine sediments, recent alluvium, and organic deposits.

Till is dominantly unsorted and unstratified sediments deposited from glacial ice. It is a heterogeneous mixture that can include boulders, stones, gravel, sand, and silt and is generally less than 10 percent clay, by volume.

*This document was originally written for Massachusetts Envirothon; Rhode Island has similar soils and parent materials to Massachusetts and was glaciated at a similar time.

Two broad groups of till are in Massachusetts. Basal till, or lodgement till, was deposited beneath advancing or retreating glaciers. It has a dense, firm, substratum that can be sandy or loamy. Ablation till was deposited from melting ice and dropped out on bedrock or other surficial deposits. It is generally coarse-textured, is dominantly sand, gravel, cobbles, and stones, and has a loose, permeable substratum.

Outwash or glacio-fluvial deposits. These deposits generally consist of a substratum of stratified sand and gravel commonly overlain by a more weathered, loamy or sandy surface layer and subsoil. This parent material is generally in major stream valleys. Because of the nature of deposition of this parent material, the soils are in complex patterns on the landscape.

Glaciolacustrine and marine sediments are stratified deposits of very fine sand, silt, and clay that have settled out of water in glacial lakes or in the ocean. Glaciolacustrine sediments settled in freshwater that has since drained, leaving a nearly level plain with depressions and generally poor internal drainage. When ocean levels receded following glaciation, marine sediments were left exposed. These formed low plains along parts of the present coast of Massachusetts. The sediments generally are at elevations as high as 50 feet above sea level and grade gently to sea level.

Recent Alluvium consists of sediments deposited by streams and rivers. It is on terraces above streams, on bottomlands, and in basins that are normally periodically flooded. It consists of strata of gravel, sand, silt, clay, and organic material in all variations and mixtures. This material was deposited during recent history and does not have a developed soil profile. Older Alluvium is on higher stream terraces that are no longer subject to flooding. They may have weakly developed profiles.

Organic deposits are accumulations of plant material in various stages of decomposition. For a soil to be categorized as having organic parent material, the deposits must generally be more than 16 inches thick. This parent material is in inland and coastal wetlands. Thick organic deposits are formed when the rate of accumulation of plant material exceeds the rate of decomposition. Decomposition is slowed by saturated conditions.

Areas of post-glacial Loess deposits are believed to influence texture in the upper part of many Massachusetts soils. 1 to 2.5 feet of silt or very fine sand deposited by post-glacial winds over a substratum of till, glaciofluvial or glaciolacustrine sediment characterize them.

TOPOGRAPHY

The shape of the land surface, slope, and the position of the soil on the landscape are dominant factors in soil formation. Soils that formed in identical parent materials and under the same climatic conditions vary because of position on the landscape. This is largely the result of drainage conditions caused by differences in surface runoff or depth to the seasonal high water table.

Soils formed at higher elevations and in sloping areas generally are excessively drained or well drained. Depth to ground water is typically more than 6 feet, and surface runoff is moderate or rapid. In these areas, soil colors are bright strong brown to yellowish brown in the subsoil grading to a lighter, grayer, unweathered substratum.

On soils at lower elevations, such as those in swales, adjacent to drainageways and water bodies, and in depressions, surface runoff typically flows down from higher elevations. The seasonal high water table is often at a shallow depth. In these areas the soils are moderately well drained and somewhat poorly drained and generally have a yellowish brown color with gray redoximorphic features in the subsoil. In poorly and very poorly drained soils, the seasonal high water table is at or near the surface for prolonged periods. Also, the soil profile typically has a dark colored organic or organic-rich surface layer and a strongly mottled or gray subsoil and substratum. The affect of seasonal high water tables on soil color will be described late on.

CLIMATE

The kind of climate under which a soil forms largely determines the nature and the rate of physical and chemical weathering of parent materials. Climate directly affects the type of vegetation in an area, which in turn affects those soil-forming processes related to plant life. Moderate temperatures in Rhode Island allow the accumulation of organic matter in the surface layer of most soils. Rainfall leaches water-soluble minerals down through the soil, resulting in acid soil throughout most of the state. In winter, cold temperatures and high moisture cause frost action, which is especially active in loamy soils not under forest vegetation. Frost action breaks apart rock fragments, and in some soils influences soil structure.

PLANT AND ANIMAL LIFE AND THE ACTIVITIES OF PEOPLE

Living things influence the soil-forming process. Microorganisms, such as bacteria, fungi, algae, and protozoa, are active in the surface layer of most soils. They are constantly recycling organic materials and minerals, which in turn are used by plants. The dark brown color of the surface layer in most soils is attributable to the activities of these organisms.

Larger animals, such as earthworms, woodchucks, and moles, mix the soil and change its physical characteristics. They help to make the soil more permeable to air and water. Their waste products help to aggregate soil particles, improve soil structure, and conserve nutrients in a less mobile state.

The mineral content of leaves and branches influences the soils that develop beneath the trees. In a very efficient cycle, hardwood trees, such as red oak, take up bases (calcium, magnesium and potassium) from the soil and eventually return them to the soil surface as litter. Coniferous trees, such as white pine, take up smaller amounts of bases than hardwood trees; consequently, the soil beneath them is commonly more acid and bases are leached through the soil. Wind throw is common in places where trees are shallow-rooted because of a seasonal high water table or an impermeable layer. The result is deeper mixing of the soil and irregular boundaries between the surface layer and subsoil. Soils that have been in grass for long periods of time generally develop a thicker, darker surface layer. The surface layer of these soils also has a higher moisture-holding capacity and a higher cation exchange capacity than similar soils developed under forest vegetation.

Human activities have significantly altered soil in some areas. Many soils have a distinct plow layer formed by mechanical cultivation and additions of organic matter, lime, and fertilizer. Some naturally wet soils have been altered by artificial drainage and filling. In urban areas the natural soil has been covered, removed, or replaced.

TIME

The soils of Rhode Island formed in the period since glaciation. They have weathered little compared to soils in non-glaciated areas and have developed relatively weak soil profiles.

The five soil formation factors acting in unison make soils separate, distinctive individuals.
parent material x organisms x topography x climate x time = a specific type of SOIL

SOIL HORIZONS AND PROFILE DEVELOPMENT

A soil profile is a vertical section of the soil extending from the surface through all its horizons, or layers, into the parent material. A soil horizon is a roughly horizontal layer of soil and has distinct characteristics. Some horizons are less than an inch thick; some are over 2 feet thick. The physical and chemical characteristics observed within the soil profile are the basis for differentiating one soil from another.
Most soil profiles have a surface layer of organic material and two or three layers of mineral materials.

HORIZONS

Horizons are the individual layers within the soil and are designated by symbols. Major horizons are symbolized by the capital letters O, A, E, B, C, and R and are identified in the field accordingly. Soils vary widely in the degree to which horizons are expressed. Relatively recent geologic formations such as alluvial terraces, sand dunes, or blankets of volcanic ash, may have no recognizable genetic horizons. As soil formation proceeds, horizons may be detected in their early stages only by very careful examination. As age increases and the soil weathers, horizons are generally more easily identified in the field.

<u>O horizons</u> are layers dominated by organic material (material that was once living tissue). Some O horizons consist of undecomposed or partially decomposed litter such as leaves, conifer needles, twigs and moss, that has been deposited on the surface. Other O layers, called peat, muck, or mucky peat, are organic material that was deposited underwater and has decomposed to various stages. The mineral part of O horizons, if any, is only a small percentage of the volume of the material.

Identifying features:

- at least 20% organic matter (by weight)
- dark color (never used by itself to categorize a horizon as O)
- low strength, light dry weight, may have a high plant fiber content
- usually a surface horizon

A horizons are layers composed mostly of mineral material that formed at the surface or below an O horizon and are characterized by an accumulation of organic matter intimately mixed with the mineral part. The organic accumulation in A horizons give them their characteristic coffee brown or darker brown color.

Topsoil is an analogous term for A horizons.

Identifying features:

- dominantly mineral soil material
- mixed or well decomposed organic material and mineral material
- usually a surface horizon
- typically darker in color than underlying horizons, it takes very little organic matter to darken the predominantly mineral A horizon. Do not confuse the A with an O horizon.

E horizons are mineral layers in which the dominant feature is a loss of clay, iron and aluminum. These are horizons through which clay, iron and aluminum have been leached by the downward movement of weak organic acids through the soil. Iron coatings are stripped from the soil particles and leached down into the underlying subsoil. As iron is the element that gives mineral soil much of its reddish or yellowish brown color, these horizons usually are lighter in color than the overlying A horizon and the underlying B horizon (described below). Also, they are usually coarser in texture because the fine clays have been removed through the leaching process leaving behind the coarser silts and sands.

Field Criteria:

- zone of eluviation - removal of clays, Fe, Al, and humus
- lighter in color (color often interpreted as 'ashy' in appearance) than overlying and underlying layers
- near surface, below O or A horizons and above a B horizon

B horizons are mineral layers that have undergone weathering and soil formation processes. These are dominated by the obliteration of original rock structure, accumulation of clay and, or a concentration of iron or aluminum. There are many types of B horizons, but basically, these layers have characteristics indicative of change. Generally they have formed through the weathering of the underlying parent material and/or the accumulation of iron and aluminum. They usually have finer textures than the underlying material and are usually more brightly colored and often have developed structure. Subsoil is an analogous term to B and E horizons.

Identifying features:

- Subsurface horizon formed below an A, E, or O, and above the C horizons (unless the topsoil is removed by erosion or excavation)
- Developed as a result of soil forming processes
- Color development (in aerated soils yellowish brown to strong brown)
- Illuvial concentration - zone of accumulation

C horizons - are layers excluding hard bedrock that are little affected by soil formation processes and lack properties of O, A, E, or B horizons. Generally the C horizons are comprised of the parent material from which the other horizons developed. Substratum is a term analogous to C horizons.

Identifying features:

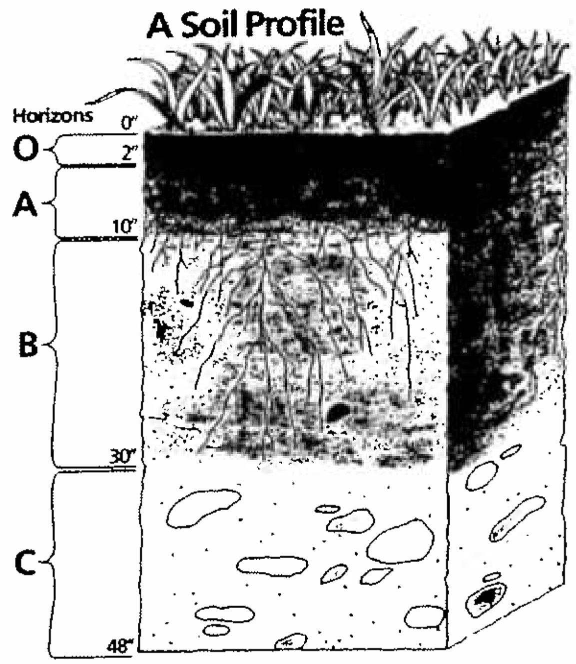
- little affected by soil forming processes
- lack color development, color is that of the unweathered geologic material
- geologic layering or strata is often present
- often, but not always, is the geologic material in which the overlying soil developed.

R layers are the hard bedrock (ledge).

Identifying features:

- typically can not be excavated using a backhoe unless fractured and blasting is often needed to remove this material

- when highly fractured and/or weathered it can be difficult to differentiate from the overlying soil material
- may be difficult to differentiate between large boulders and depth to bedrock



PROFILE DEVELOPMENT

Organic matter accumulates on the surface of soils as an O horizon that has undergone different degrees of decomposition. The dominant source of the organic matter is parts of dead plants such as leaves, branches and bark. In swamps, bogs and marshes, thick, mucky organic deposits resulted from very poor drainage. These soils formed where organic material accumulates with a lack of oxygen and decomposes very slowly. Soils have an A horizon where humified organic material and the underlying mineral matter are naturally mixed.

Soil profile development is similar in many excessively drained, well drained, and moderately well drained soils. It is the result of movement and deposition of aluminum, iron, and humified organic matter within the soil profile. Weak organic acids generated by the decomposition of surface organic litter are percolated by rainwater downward through the soil. Aluminum and iron in the upper part of the soil profile are released into solution and leached downward, along with fine particles of humifid organic matter. A light gray colored E horizon just below the surface horizon can result from this leaching.

The chemical environment within the soil changes with depth, and aluminum, iron, and organic material precipitate out. The greatest concentration of leached material accumulates just below the E horizon and commonly forms a B horizon. The color within the subsoil is caused primarily by iron oxide stains on the surfaces of individual soil particles and generally fades with depth to the relatively unweathered parent material of the C horizon.

The soil has mottled colors where a water table is in the soil or fluctuates within the soil profile. These mottles are called redoximorphic features that are gray, red or orange. These features are produced in the oxidation-reduction process (alternating aerated-saturated conditions) principally when iron within soil aggregates migrate, deplete, or concentrate. Gleying is a condition that develops when the soil is wet for most of the year. In a gleyed soil the matrix color is gray or bluish gray because of prolonged reducing conditions.

Not all soils have all horizons. Most of the soils in Rhode Island have well-defined A, B, and C horizons. Thin O horizons are common in wooded areas. In agricultural land, the O horizons are usually non-existent due to continuous plowing. E horizons can be found sporadically throughout woodlands in the state and are not as common as O, A, B, or C horizons.

SOIL CHARACTERISTICS

TEXTURE

Soil texture refers to the relative proportions of sand, silt and clay in the soil. Sands are the largest, clays the smallest. Sand particles can be seen with the naked eye and feel gritty. They can be easily wiped clean from one's hands leaving no materials in the pores and fingerprints. They can be subdivided into size fractions.

Silt particles can be seen with a hand lens or light microscope. They have a smooth powdery feel when dry, and a slick creamy feel when moist or wet. Some liken the feel to that of talcum powder. Silt is not sticky or plastic. After handling silty soil, a coating will be left on the hand, which for the most part can be brushed off when dry, leaving silt particles in the pores and grooves of your fingerprints.

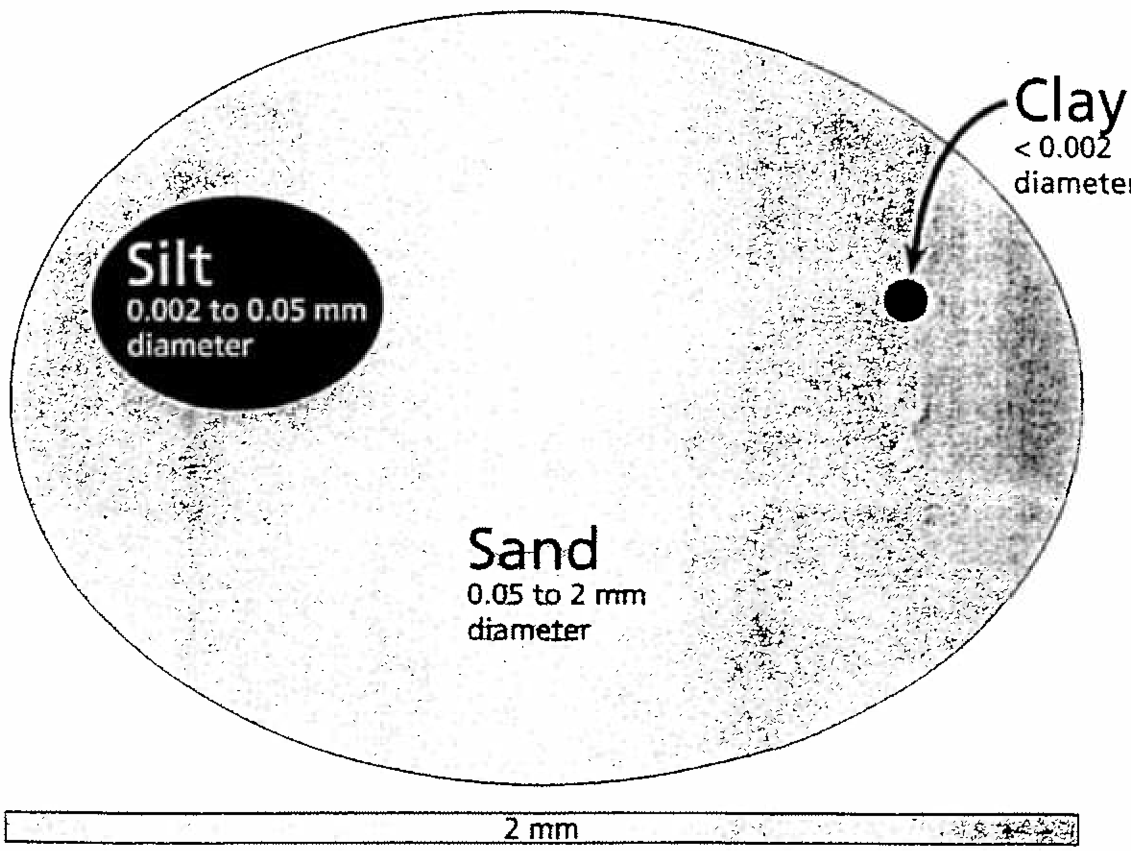
Clay particles can be seen with an electron microscope only. Clay is sticky and plastic when wet. It is hard when dry. After handling clayey soils a film will be left on the hands, the removal of which requires vigorous washing.

SOIL SEPARATES

Soil separates are the individual size groups of mineral particles as designated by the following:

Very coarse sand	2.0 - 1.0 mm
Coarse sand	1.0 - 0.5 mm
Medium sand	0.5 - 0.25 mm
Fine sand	0.25 - 0.10 mm
Very fine sand	0.10 - 0.05 mm
Silt	0.05 - 0.002 mm
Clay	smaller than 0.002 mm

Relative Sizes of Clay, Silt, and Sand



ROCK FRAGMENTS

Rock fragments are larger than sand size. They are classified by size as follows.

gravel	2 mm to 3 inches
cobbles	3 to 10 inches
stones	10 inches to 2.5 feet
boulders	greater than 2.5 feet

SOIL TEXTURAL CLASSES

Few, if any soils consist wholly of particles of one size class. Soils are usually comprised of combinations of different size particles. These different combinations are referred to as textural classes. There are many different textural classes. The basic textures in order of generally increasing proportions of finer particles are sand, loamy sand, sandy loam, loam, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay and clay. The classes of sand are coarse sand, sand, fine sand, and very fine sand. No modifier is used for medium sand.

The basic textural classes typically occurring in Rhode Island in order of increasingly finer texture is sand, loamy sand, sandy loam, loam, silt loam, and silt.

Textures coarser than loam are further subdivided based on the dominant sand size as follows:

- sand; very coarse sand, coarse sand, fine sand, very fine sand (medium sand is referred to as sand),
- loamy sand; loamy very coarse sand, loamy coarse sand, loamy fine sand, loamy very fine sand,
- sandy loam; fine sandy loam, very fine sand loam.

Loam is a term that has different, often conflicting meanings. The local meaning is dark topsoil. In the USDA textural classification loam refers to specific combinations of sand, silt and clay, having significant amounts of each.

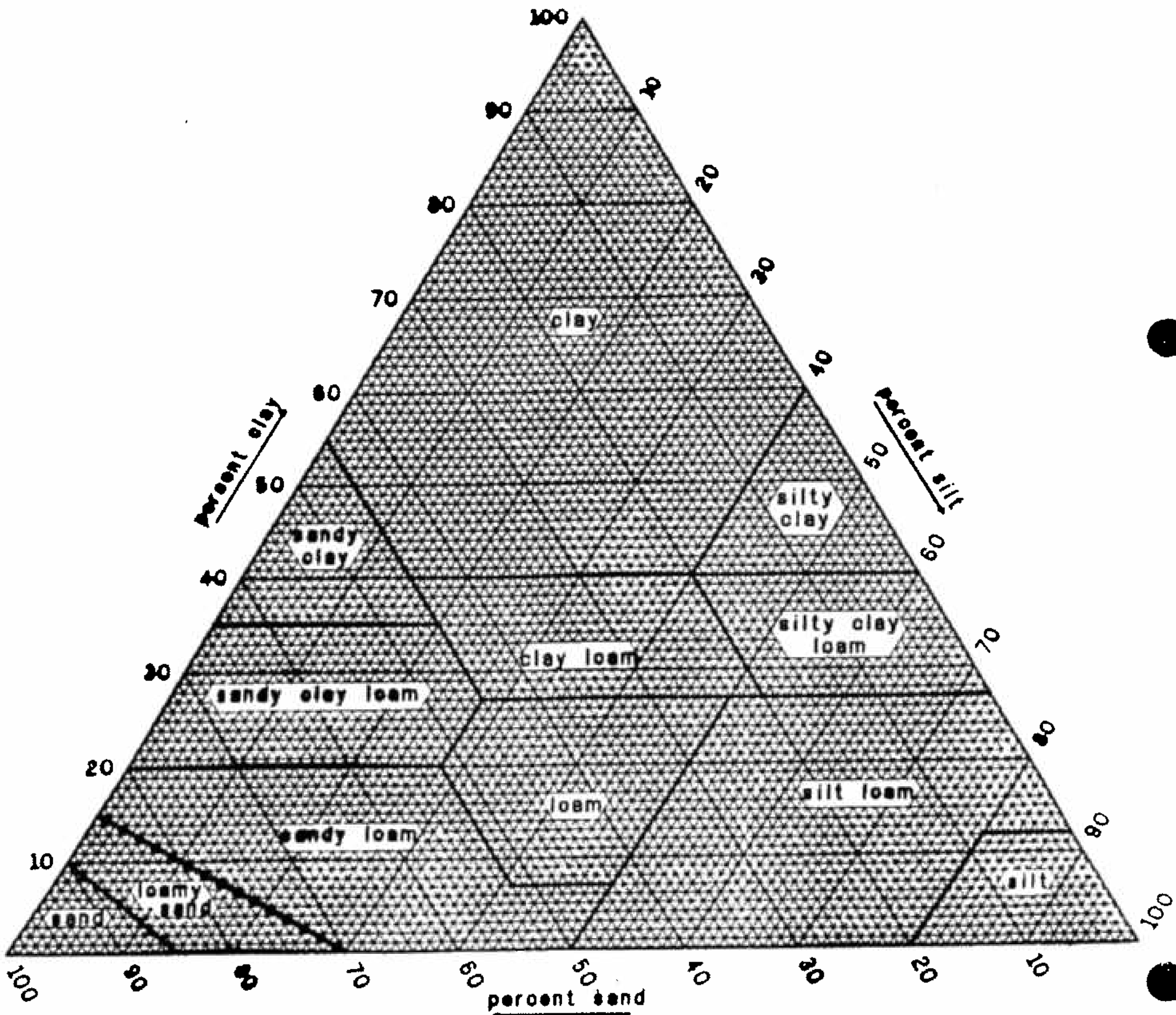
Textural class name provides a basis for making prediction of soil behavior. Soil texture is a primary consideration for predicting hydraulic conductivity, bulk density, water holding capacity, shrink - swell potential, frost infiltration rate, erodibility, and more.

TEXTURAL TRIANGLE

Chart showing the basic soil textural classes and associated percentages of sand, silt and clay. The textural triangle is used primarily when lab data or sieve analysis is available, but it illustrates the ranges of proportions of soil separates within each class.

USDA Textural Classification Chart

In the USDA textural triangle below, the corners represent 100 percent sand, silt, or clay, as indicated. (Gravel and organic soils are not included) The triangle is divided into 10% portions of clay, silt, and sand. Heavy lines show the divisions between 12 basic soil textural classes. If the percentage for any two of the soil separates are known, the correct textural class can be determined. However, the summation of the three percentages must total 100 percent.



FIELD METHODS FOR DETERMINING SOIL TEXTURAL CLASS

The following is a general description of how various textural classes feel and behave when handled

Mineral Soils

Sand is loose and single-grained. The individual grains can readily be seen or felt. Squeezed in the hand when dry, sand will fall apart when the pressure is released. Squeezed when moist, the sand will form a cast, but will crumble when touched.

Sandy loam is a soil containing much sand but which has enough silt and clay to make it somewhat coherent. The individual sand grains can readily be seen and felt. Squeezed when dry, it will fall apart when the pressure is released. Squeezed when moist, sandy loam will form a cast that will bear careful handling without breaking.

Loam is a soil having a relatively even mixture of different grades of sand and of silt and clay. It has a somewhat gritty feel, yet fairly smooth and slightly plastic. Squeezed when dry, loam will form a cast that will bear handling. Squeezed when moist, loam will form a cast that can be handled quite freely without breaking.

Silt loam - is a soil having a moderate amount of the fine grades of sand and only a small amount of clay, over half of the particles being of the size called "silt." When dry, silt loam may appear cloddy, but the lumps can be readily broken, and when pulverized, the silt loam feels soft and floury. When this soil is wet, it readily runs together and puddles. Either dry or moist, it will form casts that can be freely handled without breaking. When moistened and squeezed between the thumb and forefinger, however, silt loam will not "ribbon," but will give a broken appearance.

Clay loam is a fine-textured soil that usually breaks into clods or lumps that are hard when dry. When the moist soil is pinched between the thumb and finger, it will break readily, barely sustaining its own weight. The moist soil is plastic and will form a cast that will bear much handling. When kneaded in the hand, clay loam does not crumble readily, but tends to work into a heavy, compact mass.

Clay is a fine-textured soil that usually forms very hard lumps or clods when dry and is quite plastic and usually sticky when wet. When the moist soil is pinched out between the thumb and fingers, it will form a long, flexible "ribbon."

Organic soils - The terms peat, muck and mucky peat are used for organic materials in a manner similar to the way in which mineral textural terms are used.

Muck is well-decomposed organic soil material. Peat is raw, undecomposed organic material in which the original fibers constitute almost all of the material. Mucky peat is material intermediate between muck and peat.

Following are three field methods for determining texture. Try them all and compare the results. Use that which is most comfortable for you. Determining texture by feel takes practice, the only way to learn it is to do it. HINT; learn to texture the soil by feel with the hand with which you do not write. This is so you can keep your notes clean.

Method 1

Organic Soils vs. Mineral Soils

Soils that have a high amount of organic matter (20 to 30 percent by weight) are classified as organic soils. Depending upon the degree of decomposition, organic soils may have many fibers (peat) or have a very greasy, smooth feel (muck).

Field Test: Place a sample of moist or wet soil material, about the size of a golf ball, in the palm of your hand and squeeze hard. If the sample contains a high percentage of well decomposed organic matter, it will have little strength and ooze through your fingers as if it were mashed potatoes. Mineral soil material will not. Also, when dried, organic material is light in weight whereas mineral material retains most of its weight. A dark soil color indicates the presence of organic matter, but it alone, will not determine if the soil is mineral or organic.

MINERAL SOILS

Sample Preparation:

- Place about a tablespoon of representative soil sample in the palm of your hand.

- Separate out and remove as many particles greater than 2 mm in size (about the diameter of lead in a wood pencil), as practical.

- Moisten the sample and rub vigorously to break up any aggregates or clods of dry soil.

Soil samples that are comprised predominantly of sand size particles vs. soil samples that are predominantly silt and/or clay size particles:

- With the wet soil sample in the palm of your hand, rub and stir with a finger from the opposite hand.

- Soils with greater than 50 percent sand size fraction, have a gritty to very gritty feel.

- Soils that have a smooth creamy feel with little to no grittiness are high in silt and/or clay.

Soils with Greater than 50 percent Sand Size Particles:

Textural classes for soils with greater than 50 percent sand size particles include sands, loamy sand and sandy loam.

- The field test used to differentiate these three textural classes is to make a cast and estimate its durability. The sample should be moist, not wet or dry. The moisture condition of the sample is critical when doing this test. A dry sample will not form a cast and a wet sample will almost always form a cast. Place a tablespoon size sample of moist soil in the palm of your hand and firmly press the sample together with the fingers of the opposite hand, creating a rough ball shaped soil cast.

  SAND TEXTURE (greater than 85% sand) will either not form a cast or will form a cast that crumbles with slight handling.

  LOAMY SAND TEXTURE (70 to 85% sand) will form a cast, which bears only slight to moderate handling before falling apart.

  SANDY LOAM TEXTURE (50 to 70% sand) will withstand moderate handling and retain its shape.

Soils with Greater than 50 percent Silt and/or Clay Size Particles:

The field test used for differentiating soils that are high in silt from those that have a significant clay content (greater than 30 percent) are the tests for stickiness and plasticity.

- Moisture content is critical when doing either test. The moisture content that makes the sample the most sticky or plastic is the one to use. Gradually add moisture to a tablespoon size sample of soil, while mixing in the palm of one's hand is a good procedure.

- Stickiness test: squeeze a very moist soil sample between your thumb and index finger and then pull apart. Soil material that is very high in silt is non-sticky and the sample will adhere to either the thumb or finger and separate cleanly from the other. A soil with a significant amount of clay (greater than 30 percent) will initially stretch between the thumb and finger and then pull apart with some soil adhering to both the thumb and the finger (silty clay).

- Plasticity test: There are two procedures for doing this test, forming a ribbon or making a wire. The ribbon test is done by pinching and pushing a thin ribbon of sample out from beneath the thumb and over the top of the index finger. A soil sample high in silt and low in clay will form a short ribbon; typically less than 1.5 inches long before it breaks and falls off (silt loam). A soil significantly high in clay (greater than 30 percent) will form a ribbon longer than 2 inches (silty clay). Another test for plasticity is to form a wire. A soil sample is rolled out into a wire by placing a very moist sample between one's palms and then moving them back and forth over one another. If a wire cracks or breaks before it reaches 1/8 inch in diameter, this is an indication that the sample is high in silt with a small clay fraction (silt loam texture). If a wire is less than 1/8 inch in diameter is formed, this indicates a relatively high percent of clay (silty clay texture).

NOTE: Very fine sandy loam and loam textural classes typically have the feel of both sandy and silty soils. Loam, when dry, can be crushed under moderate pressure and when pulverized has a velvety feel. Loam when moist may have a very slight tendency to ribbon. Very fine sandy loam textures when thoroughly wetted will have a very slightly gritty sensation when rubbed in one's palm.

Method 2

Use moist samples when trying this method.

The following terms and definitions are used as part of this method.

Molded Ball is the property of a soil that enables it to be molded into a spheroid under pressure and to retain that shape while being deformed. Roll the soil material in the palms to form a ball. Observe the ball's resistance to breakage when a finger applies stress.

Observations should be noted using the following terms:

1. None - a ball cannot be formed
2. Very weak - ball crumbles when touched by a finger
3. Fragile - ball retains its shape when touched gently
4. Strong - ball retains its shape when touched and handled freely
5. Very strong - can be formed into any shape and will retain that shape even under rough handling and high finger pressure.

Ribboning is the property of a soil that allows the development of a flat ribbon under the influence of applied pressure and will retain that shape. Extrude the soil between thumb and forefinger or palm of hand.

Definitions are expressed in the length of ribbons formed.

1. None - No ribbon can be formed.
2. Slight - less than 2.5 cm. (1 inch)
3. Medium - between 2.5 and 5 cm.
4. High - greater than 5 cm.

Grittiness is the abrasive action felt by the thumb and forefinger or palm of the hand when kneading soils containing an appreciable amount of sand. Rub the soil between the soil between thumb and forefinger or palm of hand.

Terms commonly used top describe grittiness are:

1. None - no individual grains are felt
2. Some gritty - some grains can be felt
3. Gritty - abrasive feeling is easily felt
4. Very gritty - most of the soil is individual grains that can easily be seen and felt.

Smoothness is a quality exhibited by some soils when kneading between the thumb and forefinger or palm of the hand. Soils are smoothest when they contain few, if any sand grains. Rub the soil between the thumb and forefinger or palm of the hand. Terms commonly used top describe smoothness are:

1. Somewhat smooth - smooth feeling but some grittiness felt
2. Smooth - very little grittiness
3. Very smooth - no grittiness

GUIDE FOR ESTIMATED USDA TEXTURAL CLASSES

USDA TEXTURE CLASS	CONSISTENCE			OTHER TESTS EVALUATED AT A WET CONSISTENC			
	DRY	WET		MOLDED BALL	RIBBONING[1]	GRITTINESS	SMOOTHNESS[2]
		STICKINESS	PLASTICITY				
SAND	Loose	Nonsticky	Nonplastic	None	None	Very gritty	---
LOAMY SAND	Soft	Nonsticky	Nonplastic	Very weak	None	Very gritty	---
SANDY LOAM	Soft[3] to slightly hard	Nonsticky to slightly sticky	Nonplastic to slightly plastic	Very weak to fragile	Slight	Gritty	---
SANDY CLAY LOAM	Slightly hard to hard	Sticky	Plastic	Strong	Medium	Gritty	---
SANDY CLAY	Hard to very hard	Very sticky	Very plastic	Very strong	High	Gritty	---
LOAM	Slightly hard to soft	Slightly sticky to nonsticky	Slightly plastic to nonplastic	Strong to fragile	Slight to none	Somewhat gritty	Somewhat smooth
CLAY LOAM	Hard	Sticky	Plastic	Strong	Medium	Somewhat gritty	Somewhat smooth t smooth
SILT LOAM	Slightly hard to soft	Slightly sticky to nonsticky	Slightly plastic to nonplastic	Strong	Slight	None	Very smooth to smooth
SILT	Soft to slightly hard	Nonsticky	Nonplastic	Fragile to very weak	Slight	None	Very smooth
SILTY CLAY LOAM	Hard	Sticky	Plastic	Strong	Medium	None	Very smooth
SILTY CLAY	Very hard	Very sticky	Very plastic	Very strong	High	None	Very smooth
CLAY	Very hard to extremely hard	Very sticky	Very plastic	Very strong	High	None	Smooth to very smooth

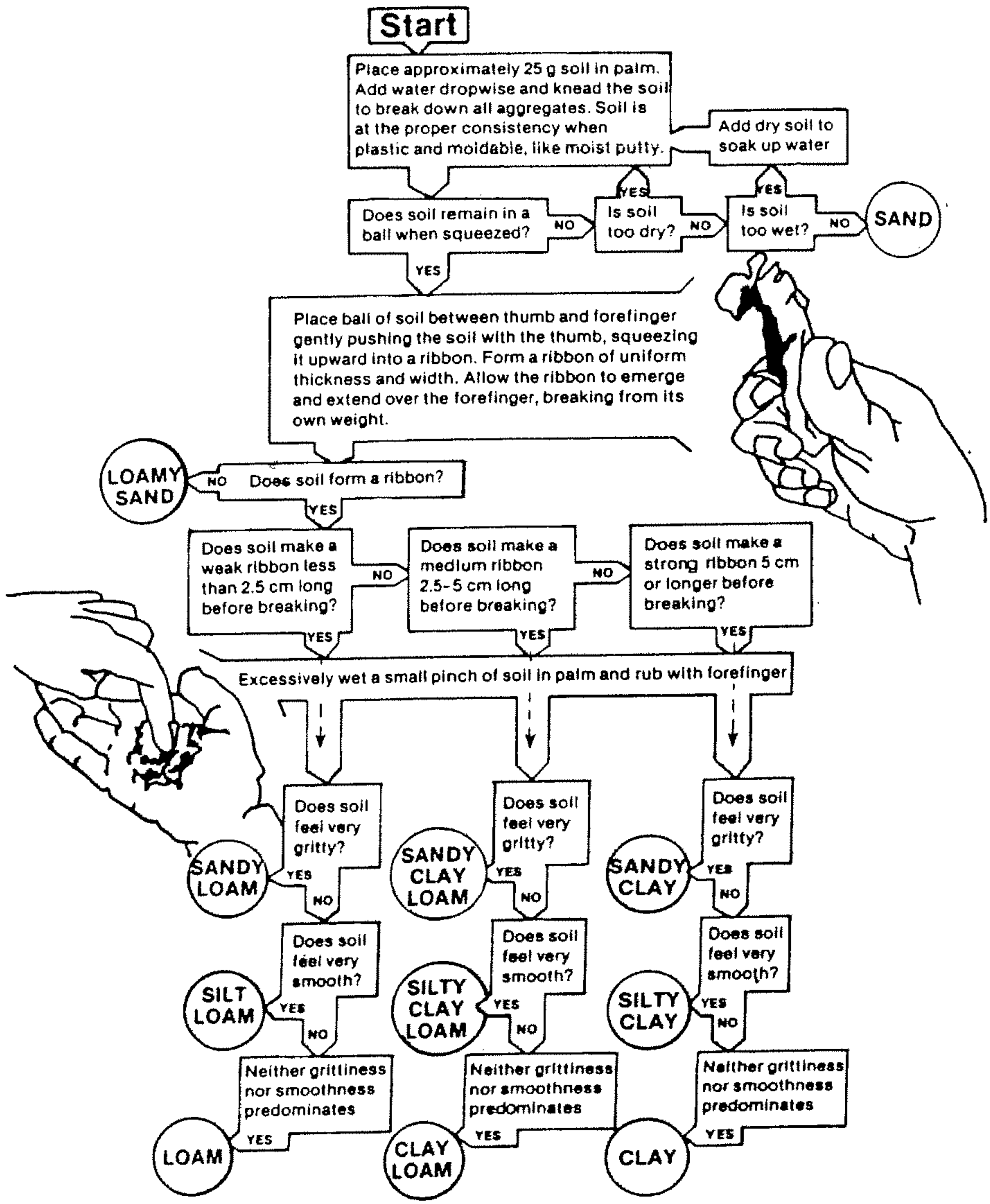
1 Length of ribbon guidelines are based on experience with soils containing significant amounts of montmorillonite clay. These guidelines should be adjusted locally to account for any difference in mineralogy. For instance, ribboning guidelines for soils having clays that are predominantly kaolinitic should be scaled downward.

2 Smoothness is not evaluated for the textural classes of sand, loamy sand, sandy loam, sandy clay loam, and sandy clay because of their sand content.

3 The descriptive term listed first is generally the reaction most often observed

Method 3

Flow diagram for estimating soil texture by feel



Rhode Island Envirothon
Soil Texture Samples

Envirothon teams are provided with small reference samples of typical soil textures. These samples are intended to aid the teams in getting a "feel" for the different textures. See the "Soil Texture by Feel" flow chart for "field identifcation" of soil textures. (Formal identification of texture is done via laboratory analysis.)

Not all soil textures that occur in RI are included in these samples, but they do include the full range of textures in RI. Your kit should include the following soil texture samples:

* silty clay loam
* silt loam
* fine sandy loam
* sandy loam
* loamy sand
* sand & gravel

Pointers for using the soil samples:

* Make sure the sample is not too dry or to wet. It should be <u>moist</u>. Finer textured soils, especially those containing any clay, must have just the right water content in order to determine if the soil will "ribbon" between the fingers. If your sample has become too dry, <u>slowly</u> add water to a <u>portion</u> of the sample. If it becomes too wet, add some of the dryer part of the sample (the part which you had set aside before starting to add water).

* Do not mix, or contaminate the samples. Clean your hands before moving on to handle the next sample. In general, it is best to handle the coarser textured samples first, then move to the finer ones. Clayey soils are particularly likely to stick to your hands. Do not handle other samples without first cleaning your hands.

* Remember: Soil texture is unrelated to soil color. Many of these samples were collected from the subsoil layer, hence they have a yellow-brown color. Sand, silt and clay come in all colors: browns, yellows, reds, grays, black, etc.

Textural Class Modifiers

Rock fragments: If a soil sample has between 15 to 35 percent by volume of rock fragments (>2 mm in diameter), a textural modifier is used, i.e. gravely sandy loam.

If a soil sample has greater than 35 percent by volume of rock fragments, a textural modifier is used, i.e. very gravely sandy loam.

Organic matter: If a soil has a high percentage of sand, silt and/or clay and a significant volume of organic matter (8 to 12 percent by volume), a textural modifier is used as mucky sandy loam.

SOIL STRUCTURE

Soil structure refers to the natural organization of soil particles into units. These units are separated by surfaces of weakness. An individual natural unit is called a ped. Peds are distinguished from:

Clods which are caused by disturbances (for example, plowing which molds the soil into transient bodies).

Soil fragments that form when the soil cracks or is broken and are bounded by ephemeral planes that do not reappear in the same place upon drying.

Concretions or nodules which are local concentrations of substances binding grains of soil together into discrete units within the soil.

Some soils lack structure and are called structureless, while those soils that have structure are described in terms of shape, size, grade distinctness) of the peds.

SOIL COLOR

Soil color is the most obvious and easily determined soil characteristic. Although it has little known direct influence on the functioning of the soil, important soil characteristics can be inferred from color.

Coloring Agents in the Soil

The two major coloring agents are organic matter and iron. Organic matter darkens the soil and as little as 2 to 5 percent can give the soil a dark brown to black color. It is a strong coloring agent and will mask all other s in the soil. Organic matter is typically associated with the surface layers (O and A horizons).

Iron is the primary coloring agent in the subsoil (B horizons). The bright orange to yellowish brown colors associated with well- aerated upland soils is the result of iron oxide stains coating individual soil particles.

Where soils lack color coatings, colors are generally gray due to the preponderance of quartz minerals.

Color Charts

Soil colors are conveniently measured by comparison with a color chart. The soil color charts consist of some 245 different colored chips, systematically arranged according to their Munsell notations according to hue, value and chroma. Hue refers to the wavelength of light (red, yellow, green, blue etc.). Value refers to the degree of lightness and darkness, and chroma is the relative purity of strength of the hue.

Soil Redoximorphic Features

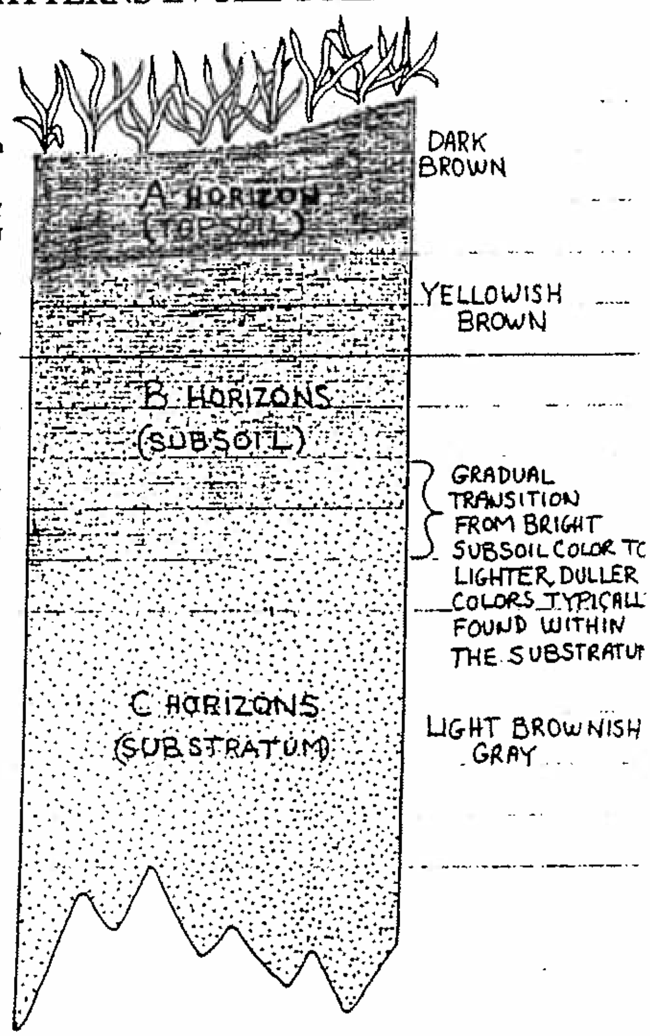
In a soil with a fluctuating water table, there are two contrasting chemical environments. When the water table is high and the soil is saturated such as in wetlands, there is a reducing environment in the soil (lack of free oxygen). When the water table is low, the soil is well aerated and oxygen moves freely through the open pore spaces. Within this zone of a fluctuating water table, iron, the main color agent in the subsoil, takes on two different forms.

When the soil is saturated, iron is reduced (ferrous state), is soluble and mobile, migrating from one place to another, leaving gray areas in the soil where the iron is depleted. When the water table recedes, air is reintroduced into the soil environment and iron is oxidized (ferric state) and becomes less mobile. This results in areas of relatively bright colors of orange, yellow, and or red where the iron had migrated and concentrated. The areas of bright color and the processes that form them are similar to the rust on a nail.

Spots or blotches of color form within this area of fluctuating water: gray where the iron was reduced, and orange, yellow, and or red where the iron accumulated. These blotchy areas of bright and dull colors due to the movement of water are referred to as redoximorphic features. The term is derived from "redox" referring to the oxidation-reduction process and "morphic" meaning form or the way something looks. These features are interpreted in the soil to determine the height of the seasonal water table, soil drainage class, and wetland determinations and delineation.

COLOR PATTERNS IN THE SOIL

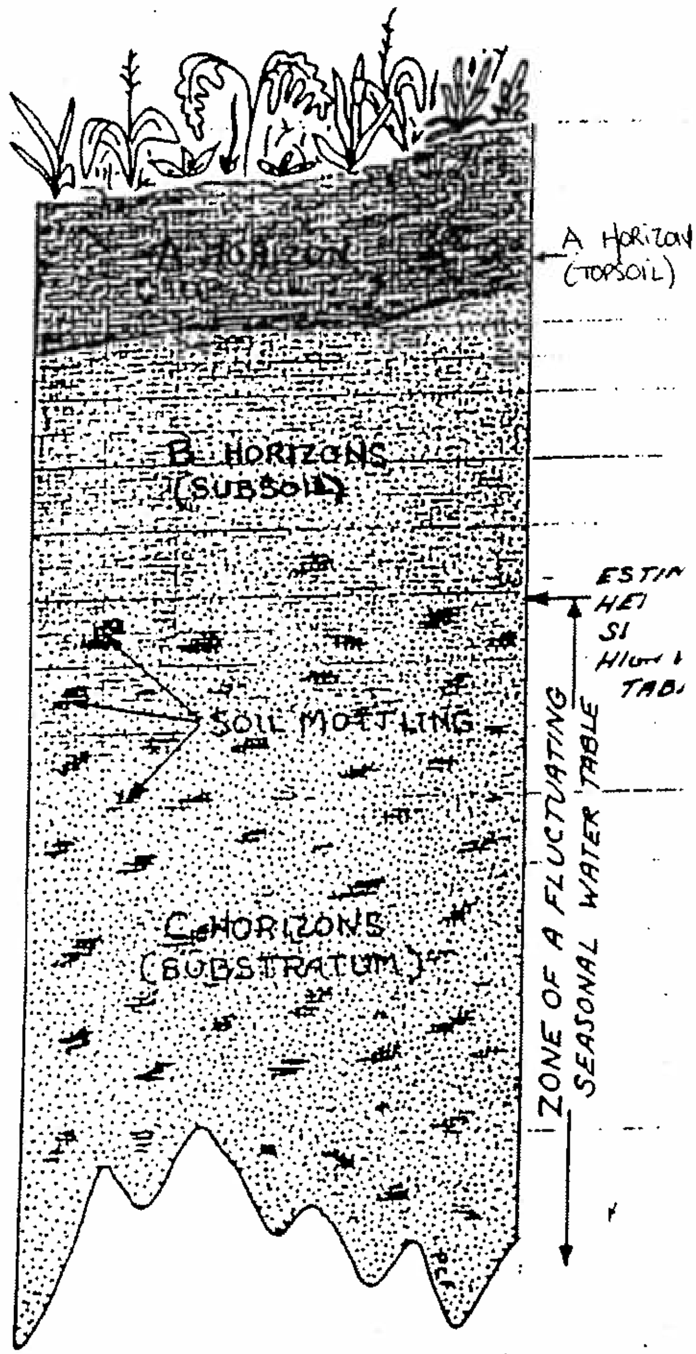
In a well drained soil, the topsoil is typically a dark brown color underlain by a weathered yellowish brown to strong brown subsoil. The bright colors of the subsoil are the result of iron oxide stains coating the individual sand grains. With depth the color of the subsoil gradually fades to the substratum. The color of the substratum is dependent on the mineralogy of the individual soil particles and may range from a light brownish gray (soils high in quartz) to a dark grayish brown color (soils high in dark minerals).



TYPICAL COLOR CHANGES
IN A WELL DRAINED UPLAND SOIL

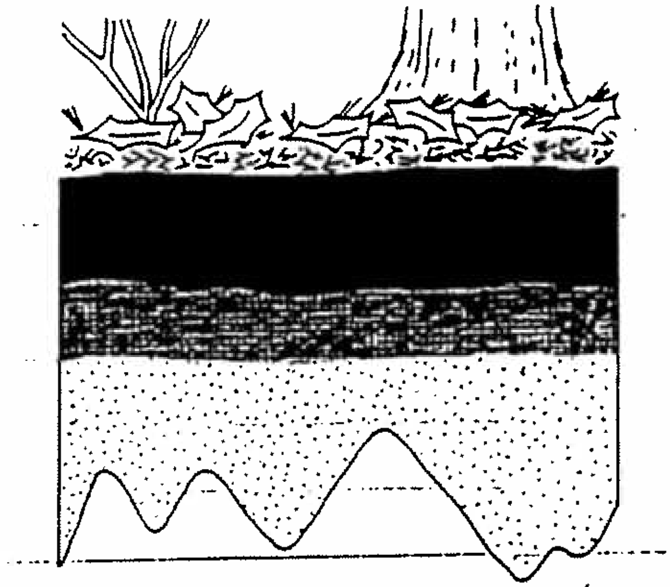
SOIL MOTTLING

In a soil with a fluctuating water table, there are two contrasting chemical environments. When the water table is high and the soil is saturated, there is a reducing environment within the soil (lack of free oxygen). When the water table is low the soil is well aerated and oxygen moves freely through the open pore spaces in the soil. Within this zone of a fluctuating water table, iron the main color agent in the subsoil, takes on two different forms. When the soil is saturated, iron is reduced (ferrous state) and is mobile in the soil migrating from one area to another developing gray areas in the soil where the iron has been depleted. When the water table recedes, in areas where the iron has migrated and concentrated, the iron is oxidized (ferric state) and is less mobile in the soil developing bright colors of yellow, orange and or red. Within this zone of a fluctuating water table spots or blotches of color are formed, grey areas where the iron has been reduced and flushed from the soil; and yellow, orange and or red areas where iron has accumulated. This blotchy pattern of both bright and dull colors is referred to as soil mottling and is interpreted by soil scientists as zone in the soil with a fluctuating seasonal high water table.

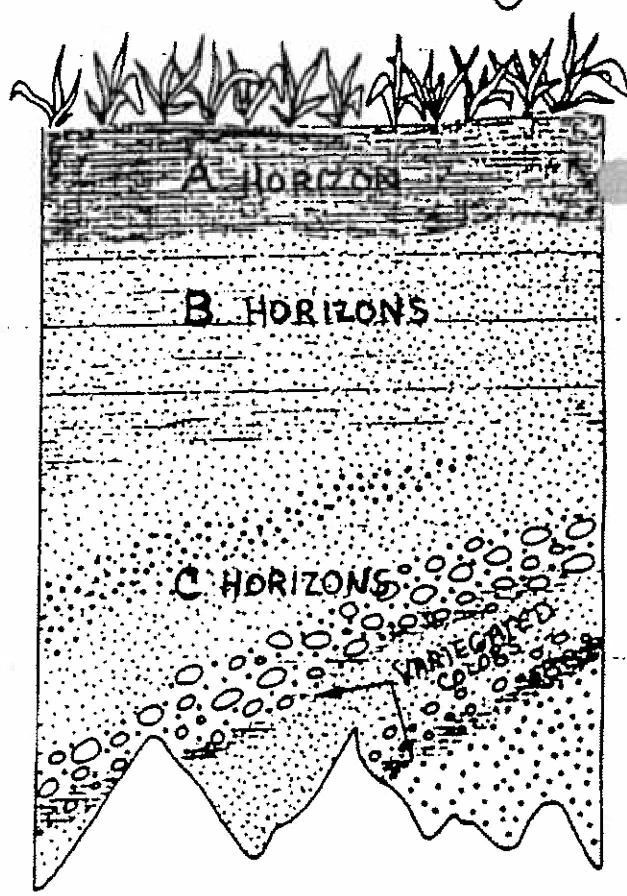


For purposes of this illustration soil mottling has the same meaning as redoximorphic features

Soil developed within wetland areas where the soil is saturated to the surface for prolonged periods of time, there is typically a black organic rich topsoil (O, A or Ap horizon) underlain by a light grey subsoil (gleyed) that may or may not have mottles. In these soils the iron has been reduced and flushed out of the soil and the color is the result of the stripped quartz sand grains.



A soil color pattern common to some stratified sands and gravels is variegated colors. These are typically bright streaks of color associated with the different textural breaks in the soil. They are often mistaken for soil mottles but are not the result of a fluctuating water table. Variegated colors are caused by momentary pauses in the downward movement of a wetting front at the different textural breaks in the soil. Over time iron (ferric) precipitates in the soil causing bright streaks. Iron is not reduced under these conditions and grey colors are absent.



Soil Drainage Classes

Soil drainage class, in general, refers to the relative depth of a seasonal high water table from the soil surface and the duration of saturation. Whether a soil is subject to saturation by seasonally fluctuating water is dependent on landscape position more than any other factor. Soils in low lying positions such as depressions and swales that receive a great deal of surface runoff from the surrounding areas will tend to be saturated with water for relatively long periods. Soils in landscape positions close to the higher levels of ground water aquifers will naturally tend to be wetter.

Following landscape position, the second most important factor determining drainage is permeability or the ease at which water moves through the pores in the soil. Dense, impermeable layers such as basal till can impede the downward movement of water resulting in a temporarily perched water table or zone of saturation above the dense layer.

It's important to understand that the presence of a dense layer does not automatically mean the soil will be poorly drained or wetter. For example, if the soil is on steep, convex slopes, free water will tend to drain out of the soil fairly rapidly. Also significant amounts of surface water will not move into theses soils due to the shape of the slope. In contrast, a sandy, highly permeable soil can have poor drainage if it is in a landscape position that is close to the seasonal high water table.

Drainage class is determined in the field by observing landscape position and interpreting redoximorphic features. These blotchy colors resulting from the reduction and oxidation of iron tell the story of fluctuating water within the soil. You can think of them as sort of a bathtub ring in the soil profile. The higher and more pronounced the redoximorphic features in the soil profile, the more poorly drained is the soil. Also, thick deposits of organic matter are usually indicative of a high water table and poor drainage. The decomposition of organic matter is slowed under saturated conditions due to lack of activity by microorganisms. Vegetation is also a good clue, particularly on poorly and very poorly drained soils.

Seven drainage classes are recognized. The seven classes refer to the frequency and duration of periods of saturation or partial saturation. The first two; excessively drained and somewhat excessively drained, describe soils that are dry longer than is typical for the dominant soils of an area. Well-drained soils are neither unusually dry nor unusually wet. Increasing degrees of wetness limit agricultural and other uses of moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained soils.

Excessively drained - Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky or shallow. Some are steep. Most are in higher landscape positions relative to their immediate surroundings. All lack redoximorphic features.

Somewhat excessively drained - Water is removed from the soil rapidly. Many are shallow to bedrock. Some are so steep that much of the water they receive is lost as runoff. All lack redoximorphic features.

Well drained - Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well-drained soils are commonly medium textured. Redoximorphic features, if any, are deep (typically deeper than 30 inches) in the soil profile.

Moderately well drained - Water is removed from the soil somewhat slowly during the growing season, but periodically they are wet long enough that most mesophytic* crops are affected. They may have a slowly permeable layer within or directly below the B horizon. Landscape positions include broad nearly level areas, benches in slopes, and low areas relative to the immediate surroundings. Redoximorphic features can be common within 18 to 30 inches from the soil surface.

Somewhat poorly drained - Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils may have a slowly permeable layer, usually within a depth of 25 inches. They are usually in low landscape positions such as depressions and swales. Redoximorphic features can be abundant within 18 inches of the soil surface.

Poorly drained - Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. Poor drainage results from a high water table, a slowly permeable layer within the profile, seepage, low landscape position or a combination of these. Redoximorphic features are common within one foot of the soil surface. Often the dominant color within the upper B horizon is gray due to the depletion of iron.

Very poorly drained - Water is removed from the soil so slowly that free water remains at or near the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic plants cannot grow. Very poorly drained soils are on level or depressed parts of the landscape and some are commonly ponded. The high water table impedes the decomposition of organic matter so that often these soils have thick accumulations of muck or peat.

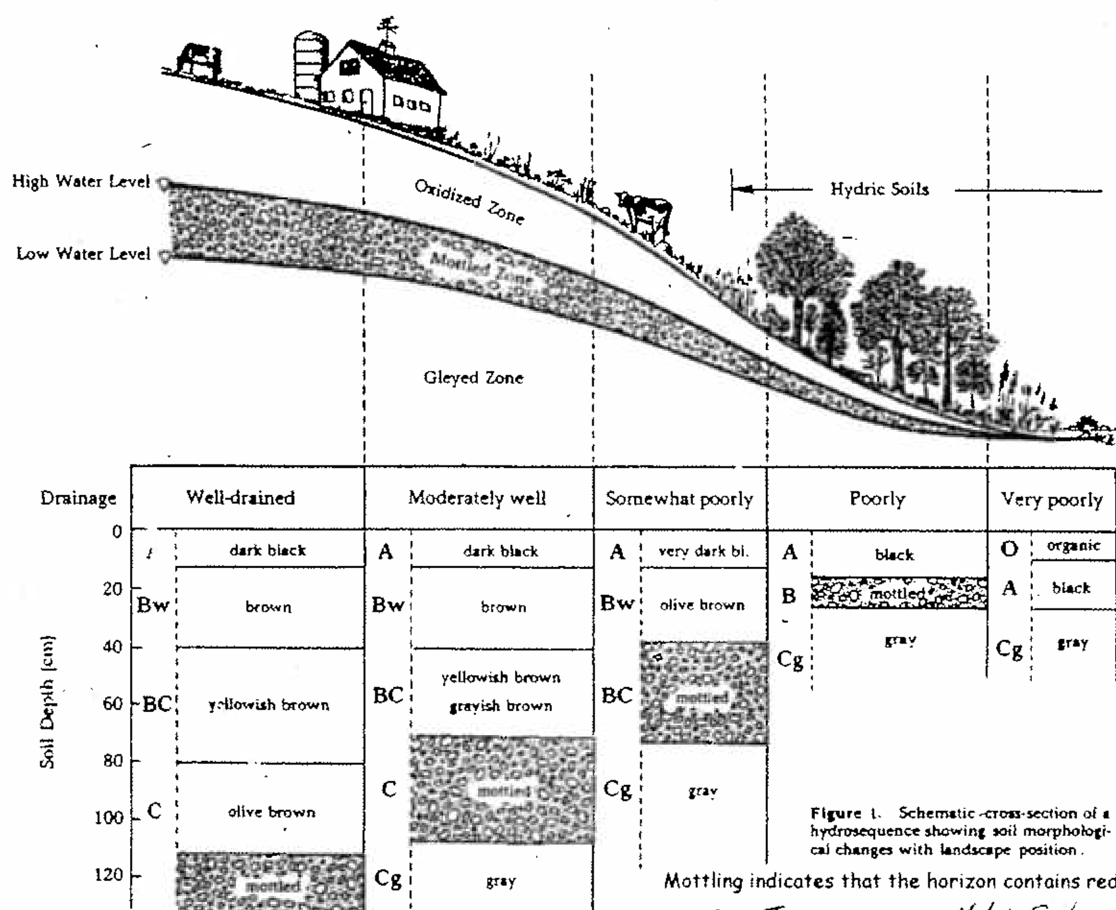


Figure 1. Schematic cross-section of a hydrosequence showing soil morphological changes with landscape position.

Mottling indicates that the horizon contains redoximorphic features

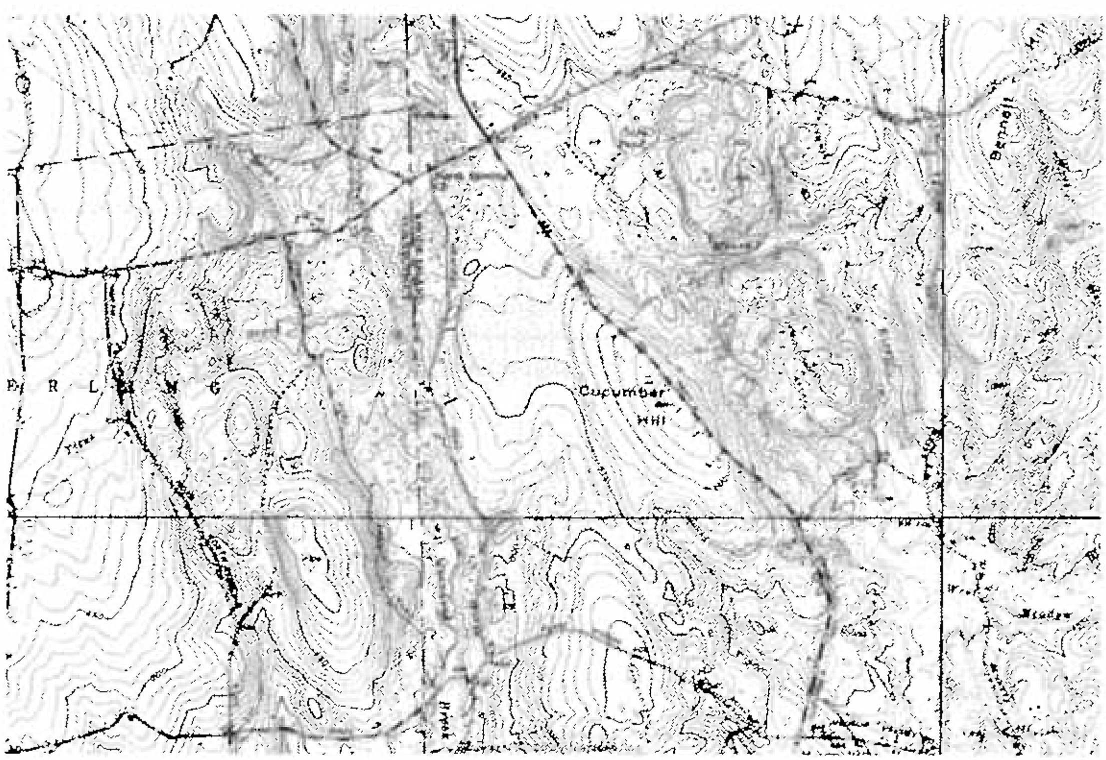
From Tiner [illegible], Hydric Soils of New England

YOU ARE HERE: Using Maps

In order to use a soil survey or any other map, you must be proficient in locating yourself or other landmarks on a map using aerial photographs and/or topographic maps. A GPS or a compass can help, but it is possible to pinpoint your location without these technologies. Practice.

Topographic Maps

Also known as 'topo' maps, US Geologic Survey (USGS) topographic maps show elevations of the land using contour lines. Contour lines are lines on a map connecting points of equal elevation. Topo maps are very useful in predicting landscapes and parent materials of certain areas. Where contour lines are very close together, this indicates a steep slope. Where contour lines are very far apart, this represents a flat area. Topo maps also show wetland areas, water bodies, roads, houses, urban areas, location names, and latitude, longitude markings. Topo maps can be purchased as outdoor recreation stores or directly from USGS. Digital copies are also available to be viewed on line or with computer mapping software.



Aerial Photos:

Most people are now very familiar with aerial photography due to Google Earth and online mapping services that provide an aerial view. Soil scientists have used aerial imagery for decades in mapping because it is possible to identify vegetation type, wetland areas, and slope as well as locate roads and buildings. Practice with online images such as those in Google Earth to try to locate your school, your house, wetland areas in the middle of the woods, or any other interesting feature that can be seen using aerial imagery. Also try taking an image with when you are outside and try to pinpoint where on the image you are at any given time.

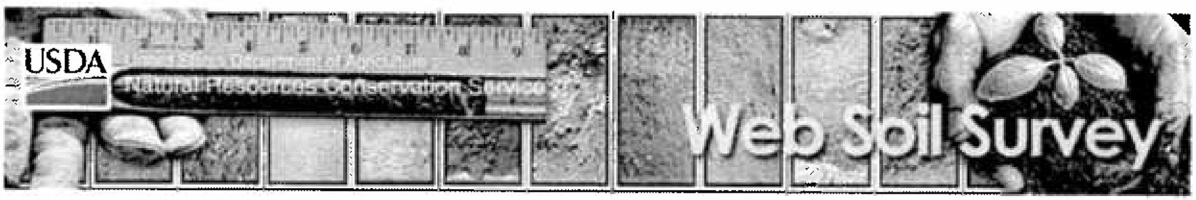
SOIL SURVEYS

A great way to learn about the soils of an area is to consult a soil survey report. Soil Surveys are made and published by the Natural Resources Conservation Service (formerly Soil Conservation Service) of the United Stated Department of Agriculture. They are usually completed on a county basis, but for Rhode Island, the whole state was completed as one document. Soil Surveys show soil types delineated on an aerial photo base and have accompanying information about the soils. The soil survey is the most intensive resource inventory of land ever made in the United States. It is an extremely useful tool for people to examine the intricate relationships between ecosystems, humans and the world around them. **Envirothon teams are expected to be familiar with the use of soil survey reports**. A good way to start is to obtain the soil maps of an area, your school for example, and determine what the soil types are. Read about the soil and check out the interpretive tables that tell you what the limitation of the soil is for various land uses. You may begin to have an understanding of how soil conditions effect our environment.

The usefulness of soil survey maps becomes evident as you explore different land uses and their effects on the quality of life and the environment. A soil map displays the types of soils found in any locations of interest. You can use these maps and text to determine which land uses are best suited to each soil landscape. The information in a soil survey report identifies the limitations and potential of the land for various uses. It provides ad database that can help people make economical and environmentally sound land management decisions.

Soil surveys help in planning the layout and maintenance of open space, parks, campsites, ski areas, and golf courses. They can be used to identify prime and important farmland and to locate environmentally sensitive places such as ground water recharge areas and wetland soils. Your soil survey can help you decide where to buy property or where to build you house.

THE WEB SOIL SURVEY:



Soil survey data is now available online at a site known as the Web Soil Survey (http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm). This website enables you to access soil maps and data from any part of the country. Any updates that are made to soil survey data is now published online instead of reprinting paper copies of the surveys.

In order to access data from the Web Soil Survey, all you need is a computer with an internet connection. You can navigate to any location within the United States and select an area of interest to get soil survey data. Tabs allow you to view soils by limitation or classification and soil maps can be printed out along with a multitude of data about the soils. Envirothon teams should be able to navigate the Web Soil Survey and be familiar with using maps created from Web Soil Survey.

A Note on Maps and Scale:

All maps are produced at a certain scale. Scale means the ratio of distance on the land to distance on the map and is represented as a ratio of distance on the map: distance on the ground. Topo maps, for example are usually produced at a scale of 1:24,000, which means that 1 inch on the map represents 24,000 inches or 2,000 feet on the ground. Another common scale is 1:12,000, which means that 1 inch on the map equals 12,000 inches or 1,000 feet on the ground.

Soil maps for Rhode Island were produced at a scale of 1:15,840 (1 inch equals ¼ miles). The scale of the map limits the amount of detail that can be shown in a map. In soil maps, for example, the smallest area of soil that can be shown at the scale of 1:15,840 is about 3 acres. On a landscape, however, there can often be a patch of a different soil that is 1 acre in size or less that would not be mapped at the scale of mapping done for the entire state. With digital mapping and products like Web Soil Survey where we can view soil maps online, it is possible to zoom into an image so that your map scale changes. It is important to remember that zooming in to a small area shows no more detail on a soil map than if you are viewing the map at the scale at which it was produced.

Study Questions:

Soil surveys are a valuable tool for exploring our environment. The following questions and issues can be addressed using soil survey information:

- How is soil formed? What is the geologic connection to soil type and properties?

- Did the glaciers affect the soils in your area? How?

- Study the relationships between soil, climate and native plants.
- What role does wetland soil play in the ecosystem?
- Discuss which is the best use of a level, well-drained soil - homes or farms? What is the best use of hilly land?
- If you could rebuild your town, how would you change it based on the information in the soil survey?
- Which soils are subject to erosion? What types of soils carry pollutants quicker more readily than other types?
- Which soils can support endangered species? Why?
- What landscapes do the soil maps represent? How do soils relate to the ecosystems on each type of and landscape
- How have land use patterns developed historically in relation to soil types? Where is future development likely to occur?

SOIL INTERPRETATIONS

There are many environmental concerns associated with various land uses. These include surface and groundwater quality, erosion and sediment control, non-point source pollution, stormwater management, forestland management, farmland conservation, and wetland conservation. Additionally, environmentally sound land management and land use planning requires knowledge of soils and their behavior and capability. The following information describes important soil characteristics as they relate to some environmental issues, and their intricate role in ecosystems.

SOILS AND PLANTS

The amount of open space between soil particles has a lot to do with how easily water moves through a soil and how much water it will hold. Too much clay, in proportion to silt and sand causes a soil to take in water very slowly. Such a soil also gives up its water to plants slowly.

Individual pore spaces are relatively large in coarse textured soils. Sandy soils do not hold much moisture since there is less surface area for the water to cling to and the pores are so large that the weight of the water causes much of it to run down and out of the soil. For this reason, medium and coarse sandy soils low in clay are known as droughty soils. Crops cannot live long in them without very frequent rains or irrigation. In areas of sandy, well drained soils in woodland, the tree species are dominated by drought tolerant species.

Finer textured soil can hold more water for plants because there is more surface area on which water adheres. Since the size of the pores is reduced, the weight of the water is less and it doesn't run out of the soil so readily. There is however, a fine line. Some soils high in clay hold a great deal of water but so tightly that many plants can not extract the moisture. In general, silt loam textures have the greatest available moisture holding capacity for plant growth.

Rate of water intake determines the amount of water that runs off. The more water that enters the soil the less there is to run off. But there are other advantages to soils that take in water readily. Much of the rain that falls during heavy rainstorms soaks into the soil and is available for plants later on.

Plants need air in the soil for best root development and growth, as do many kinds of bacteria. Water movement in the soil brings better air circulation. When water enters the soil, air moves out and is replaced by fresher air as soon as the soil pores are again free of water.

To a great degree, soils determine the type of natural vegetation within a given area. The soil is therefore an environmental parameter for many wildlife species dependent on specific vegetation for food and shelter.

EROSION

In its broad sense, erosion means the wearing away of the earth's surface by the forces of ice, water, and wind. The inevitable wearing down of high places and filling of low places of the earth's surface continues with or without assistance from people.

Natural erosion

Natural erosion is the detachment and movement of material under conditions unaffected by the activities of people. Natural erosion may be very slow or very rapid, and it may fluctuate considerably depending on local conditions.

Accelerated erosion - The process of erosion influenced by people can be divided into two classes, water erosion and wind erosion, depending upon the moving agent.

Sheet erosion is the more or less uniform removal of soil from an area without the development of conspicuous water channels.

Rill erosion is the removal of soil through the cutting of many small but conspicuous channels where runoff concentrates. Rill erosion is intermediate between sheet and gully erosion. The channels are shallow enough that they are easily obliterated by tillage.

Gully erosion is conspicuous. Gullies form where water concentrates and flows as a stream, cutting down into the soil along the line of flow. Gullies form in exposed natural drainage ways, in plow furrows in animal trails in vehicle ruts, between rows of crop plants, and below broken people-made terraces. In contrast to rills, gullies cannot be obliterated by ordinary tillage. Deep gullies cannot be crossed with common types of farm equipment.

Erosion detaches individual soil grains from the soil mass and carries them away in raindrop splash or running water. Soil erodibility therefore is a combination of its detachability and transportability.

Soil texture has an effect on the rate of erosion. Sand particles are difficult to transport because of their relatively large size, even though they are easily detached from the soil mass. Clay particles tend to stick together and are difficult to detach. Silty soils are often well aggregated but the aggregates break down readily when wetted and the particles are easily detached and transported. Soils with high silt contents are therefor the most highly erodible, all other factors being equal.

Whenever vegetation is removed and the soil is bare or disturbed, such as on building site development, logging operations and farmland, there is potential for accelerated erosion. After the sediment leaves the farm or building site some of it gets into streams and begins to affect everyone.

Sediment from soil erosion is a national problem. The national sediment damage amounts to millions of dollars annually. Much of the sediment is topsoil, the most agriculturally productive.

Pesticides can travel with soil particles through the process of soil erosion. More than 3,200 water-supply reservoirs are losing water-storage capacity each year to sediment. Water bills are higher because the water must be further treated. Many harbors must be dredged annually to allow ships to enter.

Erosion that causes sediment deposition can be reduced up to 90 percent with soil and water conservation measures. The first step is to understand the nature of the soil.

WATER QUALITY

Water entering the soil moves downward to become groundwater unless taken up by plants, evaporated into the atmosphere, held within soil pores, or diverted by an impermeable layer. The downward movement of water through the soil is called percolation. If percolating water reaches the ground water, it is referred to as recharge. The quality and amounts of recharge are influenced by the characteristics of the soils through which the water travels.

There are many sources of potential pollutants to groundwater including pesticides from farms, lawns and gardens, runoff from roads, and septic system effluent. The soil can act to reduce the pollutant levels in groundwater recharge. The extent of treatment the water receives is influenced by a variety of soil characteristics.

Soil texture affects the surface area available for the adsorption of pollutants (adsorption is the attraction between a chemical compound and a soil particle). Pollutants strongly adsorbed to soil particles are less likely to move through the soil with percolating water. As the amount of small particles in the soil increases, the total surface area in the soil increases. Therefore, soils having clayey textures remove pollutants from recharge more effectively than those having sandy textures would.

Soil texture influences pore space and therefore water holding capacity. There is more pore space in soils that have high contents of silt and clay than in sandy soils. In fine textured soils the individual pore spaces are small but there are a lot of them, particularly in clay soils. Water is held tightly in these soils. Sandy soils have less pore space, and the size of individual pores is large. Water readily percolates through sandy soils therefore if polluted there is a greater risk of groundwater contamination from recharge water through coarse textured, sandy soils.

Texture also influences infiltration rate. The greater the rate at which water enters the soil, the less amount of water available for surface runoff. The large pores between sand particles permit rapid infiltration. The tiny pores in fine-textured soils such as clay and clay loam resist water movement. A moderate storm often produces more runoff and erosion from the finer textured soils than from the sandy ones.

Organic matter increases the ability of the soil to adsorb chemicals by providing more surface area for adsorption. It also increases water-holding capacity. Organic matter is beneficial to microorganisms in the soil. Reactions involving soil microorganisms can help degrade many pollutants before they reach groundwater. Soil structure improves and the individual aggregates become more stable as organic matter content increases.

Soil structure, the way the soil particles are held together, will affect water movement. Well aggregated, non-compacted soils allow for more rapid movement of water than massive, compacted soils. Improved structure is accompanied by increased infiltration and by decreased runoff and erosion. Sometimes large openings (macropores) occur as a result of animal bores, freeze/thaw action, root penetration, or drying. Under certain conditions, macropores can cause rapid pesticide movement.

Soil drainage in general refers to the relative distance from the soil surface to groundwater. The depth to groundwater represents the distance water must percolate and therefore the time it will take pollutants to reach groundwater. When the water table is close to the surface, groundwater can be more easily contaminated.

Additionally, areas of poorly drained and very poorly drained soils are usually wetlands and therefore important resources.

The type of parent material in which the soils formed influences the movement of water. Large deposits of sandy, gravelly outwash are good areas for groundwater recharge because water moves through them readily. In New England, these soils are usually found at the lower elevations of the watersheds and often receive water from the surrounding uplands. They are often good places for public well water supplies. Quite often, these are also areas where there is a demand for building sites for homes, commerce and industry. These soils can be identified as high priority resource areas and protected accordingly.

SOIL COLOR
The EarthColors Soil Color Book

Color is often an indicator of chemical, biological, or physical processes taking place in the soil environment. In fact, the USDA (United States Department of Agriculture) Soil Survey Staff has stated that color is one of the most useful properties for soil identification and appraisal.

The EarthColors Soil Color Book has been designed to facilitate color identification of soil samples under a wide range of environmental conditions. So that soil colors can be easily and reliably identified, colors are arranged by their Hue, Value, and Chroma, the three dimensions of color upon which the Munsell system of color notation is based.

Each color chip on EarthColors' pages is identified below it with it's Munsell notation. Each color has its own unique notation. When evaluating colors of soil samples, their hue, value, and chroma should be recorded.

EarthColor's colors were especially formulated using earth-based pigments. This ensures that colors not only match under perfect lighting conditions, but will also match better under less than ideal conditions. Each page represents a specific hue and chroma with a range in color values. Each color chip is mounted on the edge of the page allowing for direct contact between the page and the soil sample. This is especially helpful when determining the color notation of mottles, including redoximorphic features. The ability to turn each of the pages within or between hues allows for quick selection of the closest color match. All pages are printed on specially coated, waterproof stock. This feature permits cleaning of smudged pages, prolonging the effective life of EarthColors. This feature is also helpful in the delineation of hydric soils where wet conditions often prevail.

Not all possible combinations of hue, value, and chroma are represented in EarthColors. Colors were chosen to provide a large selection, while minimizing the possibility of confusion in locating a unique match to a soil sample. Colors should be rounded to the nearest color chip.

Soil Color Determination

The quality of the light reflected by a soil sample is dependent on many factors, including the roughness of the sample, its moisture condition, size and shape. Early morning and late afternoon light, particularly during the winter when the sun is low on the horizon; smoky atmospheric conditions; and very cloudy weather conditions all affect determination of the soil color. This is especially true when trying to match low chroma colors as is done in hydric soil delineations. With practice, the user will be able to ascertain which light conditions still allow a proper color determination.

Color elements include the color name, the Munsell notation, the moisture state, and the physical state. Colors for both the moist and dry moisture states are commonly recorded. In humid regions, moist colors are usually used as the standard (described first). In arid and semi-arid regions dry colors are usually used as the standard. Moist colors are determined on samples (usually freshly broken) that are moistened until the color does not change with additional moistening.

The sample should not be moistened to the extent that glistening occurs since light may be reflected by the water, affecting the color determination. Dry soil colors are recorded for samples that are dry enough that they do not change color upon additional drying. When colors are determined on soil samples other than freshly broken, the physical state should be indicated as rubbed, crushed, and crushed and smoothed. The term "crushed" usually refers to the dry state; and "rubbed" to the moist state.

The soil color is determined by holding the appropriate EarthColors color page against the sample. Make sure that the light falls at about a right angle to the sample and the color book, and view the reflected light at about a 45 angle to the perpendicular. The reverse of this viewing geometry is also satisfactory. This will ensure the best repeatability between color evaluations.

Three Dimensions of Color and the Munsell System of Color Notation

Every color sensation unites three distinct qualities, defined in the Munsell System as Hue, Value, and Chroma. One quality may be varied without disturbing another.

Hue is the quality by which we distinguish one color family from another, as red from yellow, or green from blue. There are five principal hues: red (R), yellow (Y), green (G), blue (B), and purple (P). There are also five intermediate hues, which retain a suggestion of both of their neighboring hues: yellow-red (YR), green-yellow (GY), blue-green (BG), purple-blue (PB), and red-purple (RP). In the EarthColors book, these ten major hues are subdivided into four segments of equal visual steps representing the 25th, 50th, 75th, and 100th percentile. They are written in an abbreviated format as 2.5, 5, 7.5, and 10 respectively. For example, for the yellow-red hue these would be 2.5YR, 5YR, 7.5YR, and 10YR. Not all possible hues are used in the EarthColors soil color book. Only those colors that can be expected to occur in soils are included.

Value is that quality by which we distinguish a light color from a dark one. A pure black has a value of 0/; a pure white a value of 10/. A medium gray, halfway in between black and white, has a value of 5/. Chromatic colors, as well as grays, are described using the Value scale. Each page in EarthColors has a series of color stripes arranged vertically to show equal steps from the highest to the lowest values of that hue/chroma combination.

Chroma is that quality of color by which we distinguish a strong color from a weak one; the intensity, purity, or saturation of a color; or, the difference between a particular color and a neutral gray of the same value. The scale of chroma extends from /0 for neutral colors to /14 and above for very strong colors. Soil colors are typically somewhat muted and a chroma of /8 is the maximum represented in EarthColors. Colors with a chroma of /0 are achromatic and are called neutral. Neutral colors have no hue or chroma, and are indicated by "N" notation followed by the value; for example, N6/. These colors tend to indicate wet soil conditions and are depicted on the gley pages.

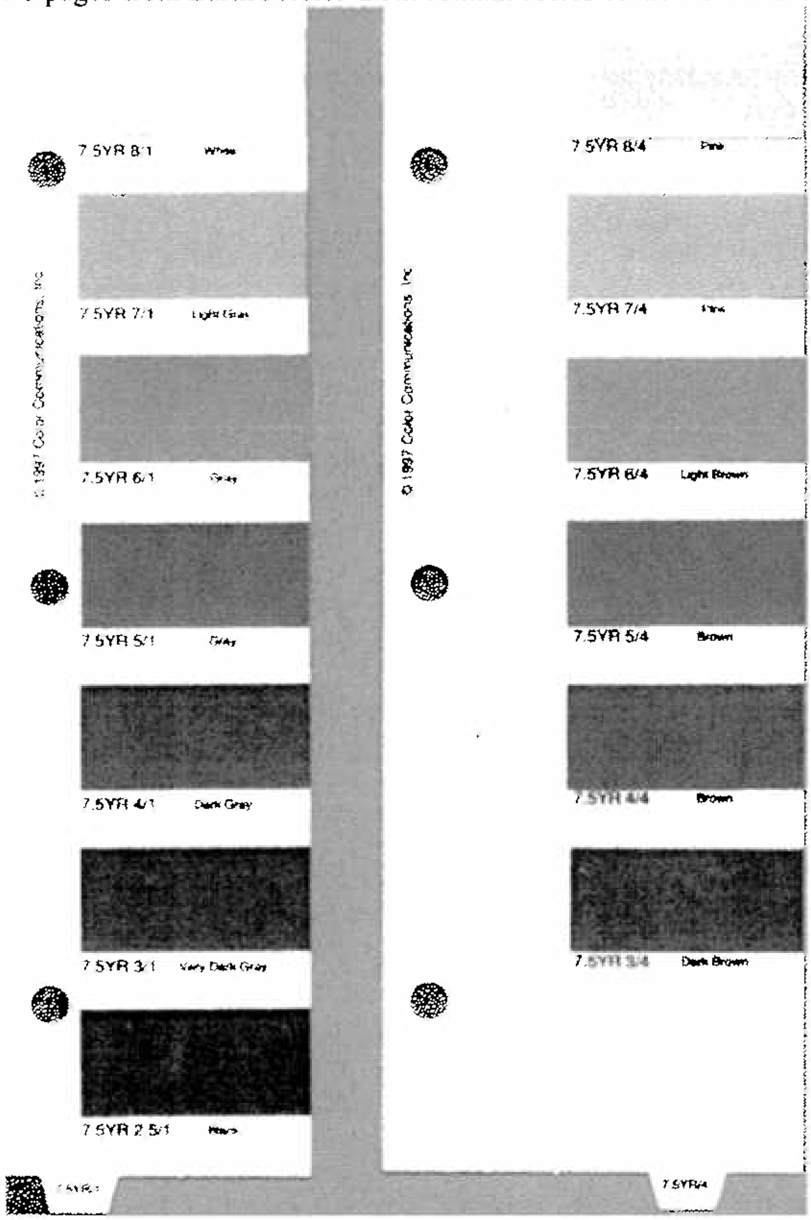
A sample Munsell notation is 7.5YR 4/3

The hue is 7.5YR

The value is 4

The chroma is 3

Below are two pages from EarthColors. Both contain colors of the 7.5YR hue.



All are 1 chroma colors — All are 4 chroma colors

The Munsell Color book is also used and has the same naming convention, but a different organizational structure.

SOIL DEPTH

The depth from the surface, to layers that are impermeable to water such as bedrock and hardpan, varies. Compared to deeper soils, shallow soils are a smaller filter through which water percolates. Contaminated water percolating through shallow soil will have less contact with soil material resulting in less effective treatment.

In areas where land is developed for building sites, the management of storm water is a concern. Water contained within a watershed must be managed to minimize erosion and pollution. Soils act like a sponge in containing precipitation. Shallow soils retain relatively small amounts of water. In general, a watershed that comprised mostly of shallow soils will have greater stormwater runoff than one consisting of very deep soils. The soil depth therefore is an important planning consideration when managing runoff in developed areas within a watershed.

Degree of slope is considered to be a soil characteristic. Precipitation on steep slopes results in faster surface runoff and less contact time in the soil.

PRIME AND IMPORTANT FARMLAND

The conservation and preservation of open space is a function of wise land use planning and management. Soils information, particularly that which is provided in soil survey reports is an invaluable tool in assessing potential land use and identifying those areas most suitable for preservation.

One important consideration in targeting land for open space is its' suitability for agricultural use. Farmland, in addition to its basic value for the production of crops and forage, is highly valued for aesthetic qualities.

Soil surveys provide information to identify areas that are prime, or important farmland. Prime farmland soils are those that have the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and are also available for these uses (the soil's use could be cropland, pasture, forestland, or other land, but not urban built up land or water). In general, prime farmland soils have the following traits: adequate and dependable precipitation; a favorable temperature and growing season; acceptable acidity or alkalinity; level or nearly level slopes; permeability that allows the uninhibited movement of air and water in the root zone; adequate drainage; infrequent flooding events; acceptable rates of erosion; acceptable moisture holding capacity (not droughty); acceptable depth to impermeable layers; and few or no surface stones. Prime farmland soils are not excessively erodible or saturated with water for a long period of time, and they either do not flood frequently or are protected from flooding.

HYDRIC SOIL AND WETLANDS

Wetlands provide important benefits that are well documented. Proper identification and delineation of wetlands are essential to preserve the important values and functions they provide. Soil morphology and soil survey information are tools used extensively for this purpose.

This may seem simplistic but the thing that causes a landform to be a wetland is water. Places in the landscape that are subject t a high water table at or near the surface of the soil for significant periods of time is land that is wet. Wetlands are therefore driven by hydrology. How does one determine whether the ground meets this definition? There are several methods, one of which is to examine and interpret the soils. As discussed earlier, the seasonal high water table influences the soil morphologies of color and organic matter accumulations.

Soils in a suspected wetland area can be described and interpreted to see if they meet the classification criteria of a hydric soil. Hydric soils are define as soils that formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register, July 13, 1994). Hydric soils are those that have thick accumulations of organic matter due to long periods of saturation, or have dominantly gray colors in the upper B horizons due to the loss of iron from individual soil particles. These morphologies are indicative of an environment without oxygen (anaerobic conditions). For further information, see the section on soil drainage class.

The soil survey maps identify those areas mapped poorly and very poorly drained as predominantly hydric soils. To get and idea of where wetlands are, simply consult soil maps,

SOIL JUDGING

The soil judging exercise is designed to encourage "Hands-on" learning. Teams can perform this exercise by visiting a site, digging a hole with an ordinary shovel or post hole digger to a depth of about 30 to 40 inches, and recording their observations on the enclosed form.

It is strongly recommended that the Natural Resources Conservation Service (formerly Soil Conservation Service) soil maps and accompanying information be used in conjunction with this process. The team members can locate the site on the soil map, read about the soils, and use the information to help them complete the soil judging form.

The Envirothon team members will be expected to be familiar with the soil survey maps and information as well as the soil characteristics and land use interpretations referred to in this exercise.

Name: ________________________________

School/Group Name: ____________________________

Location: ____________________________

A. Landscape Features:

1. Landform

_____ Glaciated Upland

_____ Glaciofluvial

_____ Floodplain

_____ Depressional

2. Parent Material:

_____ Till

_____ Glaciofluvial

_____ Eolian

_____ Alluvium

_____ Glaciolacustrine

_____ Organic

3. Slope:

_____ Nearly level 0-3%

_____ Gently sloping 3-8%

_____ Moderately sloping 8-15%

_____ Strongly sloping 8-25%

_____ Steep >25%

4. Stoniness:

_____ Non-stony

_____ Very stony

_____ Extremely stony

B. SOIL FEATURES

1. Color of Topsoil: Hue:_______ Value:________ Chroma:______

Color of Subsoil: Hue:_______ Value:________ Chroma:______

2. Texture

Determine the texture of these horizons given the following choices: sand, loamy sand, sandy loam, loam, silt loam, silt, clay

<u>**Topsoil, A horizon(s)**</u>	<u>**Subsoil, B horizon(s)**</u>	<u>**Substratum, C horizon(s)**</u>
__________________	__________________	________________________

3. Drainage

_____ Excessively drained

_____ Well drained

_____ Moderately well drained

_____ Somewhat poorly drained

_____ Poorly drained

4. Root Restricting Depth

_____ Very Deep >150 cm

_____ Deep 100-150 cm

_____ Moderately Deep 50-100 cm

_____ Shallow 25-50 cm

_____ Very Shallow <25 cm

5. Permeability

______ Rapid

______ Moderate

______Slow

C. Land Assessment

1. Prime Farmland ______Yes ______No

2. Major Limitations for Agriculture:

______ Depth

______ Drainage

______ Slope

______ Moisture holding capacity

______ Stoniness

3. Limitation for residential homes with basements

Limitation	**Major Limiting Factor**
______ None to slight	______ Drainage Class
______ Moderate	______ Slope
______ Severe	______ Flooding
	______ Stoniness
	______ None

4. Limitations for septic tank absorption fields

Limitation	**Major Limiting Factor**
______ None to slight	______ Drainage Class
______ Moderate	______ Slope
______ Severe	______ Flooding
	______ Stoniness
	______ None

INTERPRETATION OF SOIL JUDGING EXERCISE

Soil or land judging involves learning how to evaluate a soil for its best use through an examination of its properties. With only a brief introduction to soil science, you can make several basic evaluations of a soil and make at least limited predictions about its behavior under various types of management and use. The Soil Judging Score Card which follows outlines the types of information requiring evaluation. Brief descriptions of these characteristics follow:

A. LANDSCAPE FEATURES

1. Landform

can be evaluated by observing the soil and the surrounding area. Topographic maps can be helpful.

Glaciated Upland - Areas unaffected by stream activity in recent geological time and ordinarily lying at higher elevations of the landscape.

Glaciofluvial - Relatively flat to hummocky areas formed by the deposition of material carried in water from melting glacial ice. These landforms occur as upper stream terraces, kames, eskers, deltas, and outwash plains. They are usually situated between flood plains and uplands.

Flood plain - Low-lying areas bordering streams that are subject to periodic flooding.

Depressional - Areas that are in low lying, closed depressions such as kettle holes, swamps, bogs marshes and swales. These areas may or may not be wetlands.

2. Slope

The slope or gradient is generally expressed as a percentage that is calculated by dividing the difference in elevation between two points by the horizontal distance and multiplying by 100. For example, a 10% slope would have a 10 foot drop per every 100 feet.

Slope class	%
Nearly level	0 - 3%

Gently sloping	3 - 8%
Moderately sloping	8 - 15%
Strongly sloping	15 - 25%
Steep	>25%

3. Parent Material

There is an extensive section describing soil parent material in the manual.

4. Stoniness

Non-stony - 1% of the surface is covered with stones.

Very stony - 1% to 15% of the surface is covered with stones.

Extremely stony - 15% of the surface is covered with stones.

B. SOIL FEATURES

1. Color

Topsoil - The A horizon(s)Black or very dark colors in the A horizon (surface soil) are indicative of relatively high organic matter contents. Generally, the darker the A horizon, the higher its organic matter content. Pale colors indicate that the horizon has relatively low organic matter content.

Subsoil - The B horizon(s) - Subsoil colors are not greatly influenced by organic matter. Usually the iron compounds coating the mineral particles are largely responsible for the color of this horizon.

Soils formed under well-drained conditions have subsoil with relatively bright colors, usually yellowish brown or reddish brown. These colors can be interpreted as indicating good natural drainage. Septic systems should work well in these soils, and they should provide good, dry locations for houses with basements.

When these colors are mixed with spots of gray, the soil has developed under conditions of imperfect drainage. The mixed color pattern is termed redoximorphic features (*RMF's is* *the abbreviation for redoximorphic features*) and indicates that the soil is saturated with water for long periods during the year. Basements may be wet and septic systems are subject to periodic failure when installed in these soils.

When gray colors predominate, the soil has usually formed under poorly drained conditions. This situation indicates that the water table is at or near the surface for long periods during the year. Artificial drainage is necessary for crop production, and the soil is not suited for building sites, especially where septic systems are needed.

Substratum - The C horizon(s) - Reflects the original condition of parent material. Colors are dull and relatively unaffected by organic matter or chemical weathering. It may have RMF's under conditions of imperfect drainage.

2. Texture

The mineral grains in soils can vary in size from coarse gravel and sands to fine silts and clays. The size of the individual mineral grains and their relative proportion in the soil mass is referred to as soil texture. Check out the manual for methods of determining texture.

TIP: When texturing soils use the hand opposite your writing hand. This will help keep your papers clean!

3. Drainage class

Drainage class reflects the depth to a seasonally high water table that is indicated by the presence of redoximorphic features or gray colors in the subsoil (B horizons).

Soil redoximorphic features are irregular spots of different colors that vary in number and size. Redoximorphic features generally indicate poor aeration and impeded drainage.

Excessively drained - Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky or shallow. Some are steep. Most are in higher landscape positions relative to their immediate surroundings. All are free of redoximorphic features.

Well-drained - Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well-drained soils are commonly medium textured. Redoximorphic features, if any, are deep in the soil profile.

Moderately well drained - Redoximorphic features at 18+ inches. These soils may retard crop growth in wet years. Septic systems may experience periodic failure.

Somewhat poorly drained - Redoximorphic features at 8 to 18 inches. unless artificial drainage is provided, crop production is restricted and septic systems commonly fail.

Poorly drained - Redoximorphic features at 0 to 8 inches or gray. These soils are productive only if they are artificially drained. Development of these soils for home sites should be avoided.

4. Permeability

This soil property is defined as the rate at which air and water move in the soil. Permeability is dependent upon soil structure, texture, porosity, cracking, and the presence or absence of dense, compact subsoil layers. For each soil, permeability is determined for the least permeable horizon.

Rapid - Water moves through the soil at a rate of at least 6 inches per hour. Coarse-textured soils such as sands, loamy sands, and gravel are included in this category. These soils tend to be droughty.

Moderate - Water moves through the soil at rates ranging between 0.6 inches to 6 inches per hour. Most of the medium-textured soils fall into this class if no impervious layers are present.

Slow - Water moves through the soil at a rate of less than 0.6 inches per hour. Fine-textured soils or those with impervious layers are included in this category.

5. Root Restricting Depth

The depth to a physically restricting layer such as bedrock, fractured bedrock or dense till.

C. LAND ASSESSMENT

1. Prime farmland - Soils that have few limitations that restrict their use of crop production in Massachusetts and that are:

a. deep or moderately deep

b. well drained or moderately well drained

c. slopes are less than 8%

d. medium to high available moisture holding capacity. Soils having textures of loamy sand or sand have low moisture holding capacities. Consider the upper two feet of the soil when making this evaluation.

e. non-stony

2. Limitations for residential homes with basements

None to slight - Deep, well drained, non-stony soils with slopes less than 8% are considered suitable for home sites.

Moderate - Deep or moderately deep, moderately well drained soils, stony soils, or slopes of 8-15% would have moderate limitations.

Severe - Where soils possess serious hazards or have excessive construction costs, the site is rated as severe. These limitations include poorly and very poorly drained soils, extremely stony soils, areas subject to flooding, slopes greater than 15% and shallow depth to bedrock

3. Limitations for septic tank absorption fields

None to slight - Very deep (greater than 60 inches to bedrock), well-drained soils with moderate to rapid permeability and slopes of less than 8% are preferred for septic systems.

Moderate - Deep (40 to 60 inches to bedrock), well-drained soils with slopes of 8 to 15%, which may be stony will have moderate limitations.

Severe - Where soils possess serious hazards or where excessive construction costs would result, the site is rated severe. These hazards include imperfectly drained soils, extremely stony soils, areas subject to flooding, slow permeability, slopes greater than 15%, and moderately deep or shallow to bedrock.

This document was originally developed for Massachusetts Envirothon by Al Averill, USDA NRCS in 2000

Narragansett Silt loam -- Rhode Island's State Soil

Typical Landscape Setting of Narragansett Soils

Narragansett Soil Profile
Surface layer: dark brown silt loam
Subsoil - upper: yellowish brown silt loam
Subsoil - lower: olive brown silt loam
(the top and subsoil layers consist of a silty eolian (loess) post-glacial deposit)
Substratum: light olive brown loamy fine sand to gravelly coarse sand (loose, sandy, ablation till deposit)

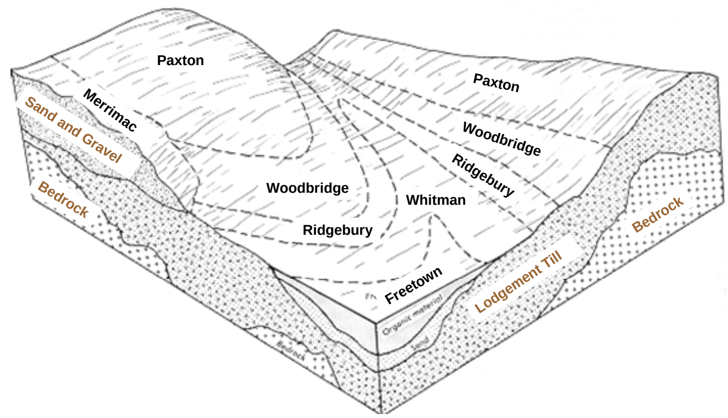
Narragansett soils occur on approximately 12,000 acres in Rhode Island and also occur in the adjacent states of Connecticut and Massachusetts. They are productive agricultural soils. Silage corn, hay, and vegetables are the principal crops. Oaks, white pine, and beech are the most common forest species. Many areas are used for residential development. The name "Narragansett" is the name of the town where the soil was first classified. The town was named for the indigenous Narragansett Tribe. Narragansett is an English corruption of Nanhigganeuck, their actual name meaning "people of the small point."

The Narragansett soil series consist of well drained, loamy soils that formed in friable (ablation) glacial till mantled with a silty eolian (loess) cap. These soils are on uplands. The average annual precipitation ranges from 40 to 50 inches. The average annual temperature is 45 to 52 degrees F.

Distribution of Narragansett Soils

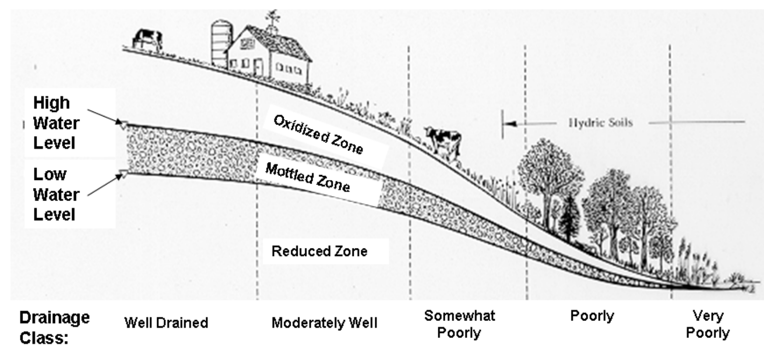
SOIL DRAINAGE CATENAS OF RHODE ISLAND

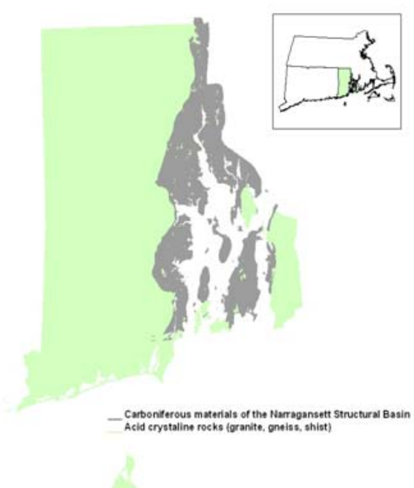
The soil catena concept is a useful guide to understand the complex nature of soils that cover the landscape. A soil catena is a sequence of soil types, or series, that are developed from similar parent material and extend across landscape positions. Related soils of about the same age, derived from similar parent material, and occurring under similar climatic conditions, can be arranged into a sequence of increasing wetness. The diagram to the right shows a block diagram of a drainage catena on lodgement till parent materials on drumlins. The diagram below shows such a sequence in which wetness increases at lower elevations.



GEOLOGY

Drainage catenas in Rhode Island are formed in soils with similar geology and similar parent materials. Two major geologic formations dominate the bedrock geology of Rhode Island; the Narragansett Structural Basin, and the granitic upland of the north and western part of the state. The Narragansett Basin consists mainly of carboniferous materials such as dark colored metasandstone, phyllite, and shale. The granitic upland of Rhode Island consists of acidic crystalline rocks including granite, gneiss, granodiorite, and shist. The map below show the general area covered by these two formations.





PARENT MATERIALS

Glacial tills and glaciofluvial deposits are the two most common parent material types in Rhode Island. Till can be either subglacial lodgement till or supraglacial melt-out till. Lodgement till is very dense and often impedes water movement through the soil. Melt-out, flow, or ablation till is generally more friable and allows water to move through the soil. Glaciofluvial deposits consist of stratified sands and gravels and allow for rapid water movement though the soil. Many soils in Rhode Island have a loess or eolian mantle that consists of 6 inches to over 4 feet of silty material that overlies both glacial till and glaciofluvial deposits. This loess mantle was formed shortly after the glaciers retreated as wind picked up and redeposited the fine sands and silts over the landscape. Other soil parent materials in RI consist of alluvium, organic material, overwash and beach deposits, and human transported material.

The key that follows uses the catena concept by matching geology, parent material, and drainage for each series mapped in Rhode Island. This is helpful in identifying the relationship of one series to others. It is intended to be used only as a guide; the Official Series Description should be used to identify a soil being evaluated.

Visit: http://www.ri.nrcs.usda.gov/technical/soils.html for more information.
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PARENT MATERIAL	LITHOLOGY	TEXTURE GROUP	SOIL DRAINAGE CLASS				
			Somewhat Excessively Drained	Well Drained	Moderately Well Drained	Poorly Drained	Very Poorly Drained
LODGEMENT TILL**	carboniferous materials*	coarse-loamy		Newport	Pittstown	Stissing	Mansfield
		sandy mantled (eolian) over loamy till		Poquonock	Birchwood		
	acidic crystalline rocks (granite, gneiss and shist)	coarse-loamy		Paxton	Woodbridge	Ridgebury	Whitman
		coarse-loamy with < 40" of loess overlying till		Broadbrook	Rainbow		
		coarse-silty with > 40" of loess overlying till			Scio		
MELT-OUT/FLOW TILL++	acidic crystalline rocks (granite, gneiss and shist)	coarse-loamy		Charlton	Sutton	Leicester	
		sandy and gravelly to bouldery	Gloucester				
		sandy and gravelly, moderately deep to bedrock	Lippett				
		coarse-loamy over sandy to sandy skeletal		Canton			
		coarse-loamy over sandy and gravelly with loess mantle		Narragansett	Wapping		
GLACIOFLUVIAL DEPOSITS‡	carboniferous materials*	sandy and gravelly with high percentage of dark channers	Quonsett				
	acidic crystalline rocks (granite, gneiss and shist)	sandy and gravelly	Hinckley	Merrimac	Sudbury	Walpole	
		sandy	Windsor		Deerfield		Scarboro
		loamy over sandy and gravelly		Agawam	Ninigret		
		coarse silty over sandy and gravelly with <40" loess mantle		Enfield	Tisbury	Raypol	
		coarse silty with > 40" loess mantle		Bridgehampton			
ALLUVIAL+	acidic crystalline rocks	coarse-loamy			Podunk	Rumney	
HUMAN ALTERED	dredged sand	sandy	←	Bigapple	Fortress		
COASTAL DEPOSITS	Sand	sandy formed in eolian and/or overwash deposits on dunes and back barriers	←	Hooksan	Succotash		Sandyhook
			←	←	Udipsamments (UAB Map Unit)		
	Clay	mixed clay and till on coastal escarpments along Block Island	←	←	Udorthents, very steep (UBE Unit)		

	WETLAND TYPE	ORGANIC THICKNESS	SUBSTRATE	SOIL SERIES
ORGANIC	FRESHWATER (INLAND)	16-50"	Variable	Adrian
		>50"	Variable	Carlisle
	SALT AND BRACKISH (TIDAL)	16-50"	Loamy	Westbrook
			Sandy	Pawcatuck
		>50"	Variable	Ipswich
		8-16"	Sandy	Matunuck
		0-8"	Sandy	Sandyhook

	PARENT MATERIAL	HIGHLY FLUID SURFACE	NOT SULFIDIC	SULFIDIC
SUBAQUEOUS (SALT AND BRACKISH WATERS)#	MARINE/ESTUARINE SANDS	0-10 cm	Massapog	Nagunt
			Rhodesfolly	
		10-50 cm		Marshneck
	MARINE/ESTUARINE SILTS			Fort Neck
		>100 cm		Pishagqua
	SUBMERGED TERRESTRIAL	0-10 cm	Napatree	Anguilla
		>10 cm		Billington

DEFINITIONS

* Derived from carboniferous materials of the Narragansett Structural Basin (dark colored metasandstone, phyllite, and shale)

\# Coastal subaqueous soils are covered with saline water for more than 21 hours per day

** Lodgement till: (firm, compact, basal, dense) Unsorted/unstratified heterogeneous mixture of sand, silt, clay, and clasts deposited directly by a glacier

++ Melt-out till: (ablation, friable, loose) Dominantly unstratified heterogeneous mixture of clasts, sand, and minor percentages of silt and clay

‡ Glaciofluvial deposits: material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice

\+ Alluvial deposits: Material deposited in modern-day flood plains; mixture of stratified sand and fines

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