Chapter 5

SOILS

Formation of the Soils

Soil is a natural body on the earth's surface in which plants grow. It is a mixture of varying proportions of rock, minerals, organic matter, water and air. The main constituents are rock and mineral particles produced by the weathering process from the parent material of the soil. The parent material of soil is either local bedrock or material brought to its location by glacial ice, water, wind or environmental forces. These particles become mixed with decaying vegetables and animals that have fallen to the ground. The spaces between the combination of organic and inorganic particles fill with air and water and the end result is soil.

Soil Characteristics

Soils differ from one to the other in different localities and within short distances. The chemical composition and physical structure of the soil at any given location is determined by the kind of geological material from which it originates, by the vegetation cover, length of time that soil has been weathered, by the topography and by artificial changes caused by human activities.

The general texture of a soil depends on the proportions of particles of various sizes of which it is constituted. Soil particles are arbitrarily divided into sand, silt and clay. Particles of sand range in size from 2 to 0.05 mm. in diameter those of silt from 0.05 to 0.002 mm.; and those of clay smaller than 0.002 mm. In general, sand particles can easily be seen by the naked eye and feel pronouncedly rough or gritty to the touch. Silt particles can scarcely be seen without the aid of a microscope and feel like flour when rubbed through the fingers. Clay particles are invisible to the naked eye and form a gummy mass when wet.

Soils are classified according to the proportions of sand, silt and clay. Single soil classes seldom exist alone. Soil scientists use terms like sandy clay, silty clay, clay loam, sandy clay loam, silty clay loam, sandy loam, silt loam and loamy sand. Loam soils, for example, contain 7 to 27 percent clay, 28 to 50 percent silt and less than 52 percent sand.

The texture triangle shown in Figure 12 gives the names of the soil classes and the percentage of different particle sizes in each class.

The texture of a soil greatly affects its productivity. Soils with a high percentage of sand are usually incapable of storing water to provide the best plant growth and lose large amounts of plant-nutrient minerals by leaching to the subsoil. Soils containing a larger percentage of finer particles, for example, the clays and loams, are excellent reservoirs for water and contain readily available mineral materials. Heavy clay soils composed largely of clay particles, however, tend to contain a water excess; these soils have a gummy texture rendering them resistant to cultivation and are frequently inadequately aerated for normal plant growth. The chemical composition of clay also allows the water to bond to the individual particles. The effectiveness of the bonding is increased by the unusually high surface-to-volume ratio of the clay particles. As a result, clay expands when wet. As it dries, it shrinks and cracks.

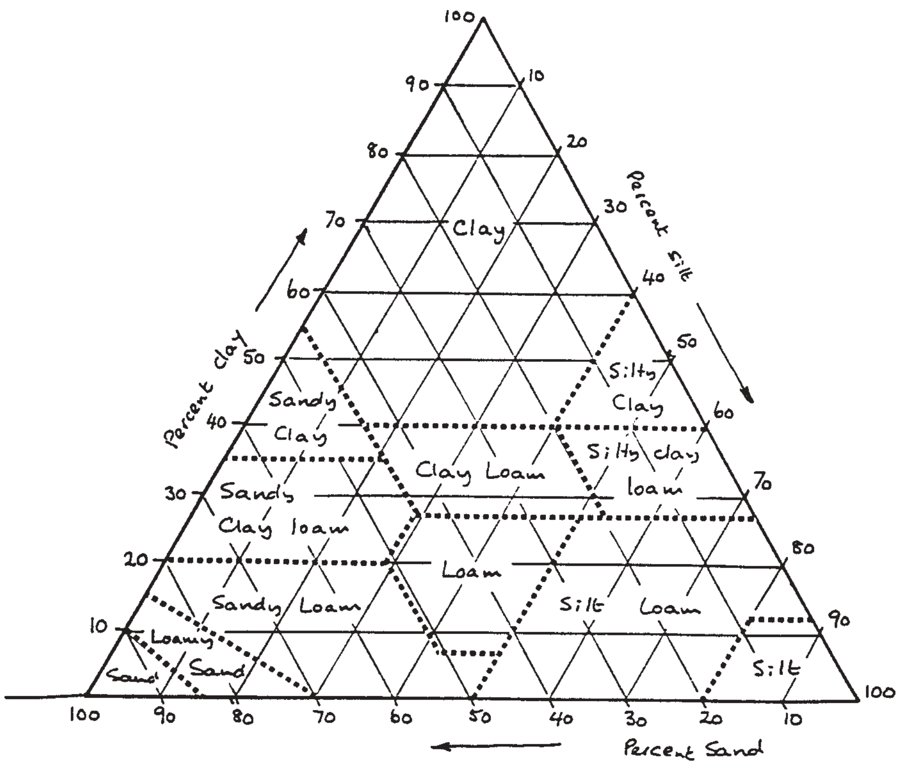

Figure 12—Soil Texture Triangle

Source: Getting It All Together, 1980.

The organic fraction of soils is composed of undecayed plant and animal debris, together with variable amounts of an amorphous organic material called “humus”. The organic fraction makes up 2 to 5 percent of the surface soils in humid regions, but may be less than 0.5 percent in and soils or more than 95 percent in peat soils. Peat soils or muck are located particularly in swamp and marsh areas. An unusual characteristic of muck soil is its ability to burn when dried and ignited because of its high carbon content. A rough estimate can be made by observing the color of the soil; usually the darker the soil, the higher the percentage of organics.

The spaces between the minerals and organic materials are occupied by water or air. The relative amount of water and air in soil depends on local precipitation and on the properties of the soil itself. Water flows through the soil under the force of gravity until it reaches a depth at which all of the interparticle space is filled with water. This level is called the “water table”. The depth of the water table below the surface of the ground varies with time, depending on precipitation level. In general, the water table reaches a high point in the late spring. The long-term average level of this high point is called the “seasonal high water table”. It can be determined at any specific location by color changes in the soil. Long-term presence of water gives the soil a grayish color, whereas soil that has fairly steady exposure to air is a brownish or reddish color due to oxidation of iron in the soil particles. Red color in a soil, therefore, is generally an indication that the soil is well-drained, not excessively humid and fertile. This generalization is particularly true in the southeastern United States but is not always true in other parts of the world, where reddish color in the soil may be the result of freshly formed mineral materials not chemically available for plant use. Almost all yellow or yellowish soils are low in fertility. They owe their color to iron oxides that have reacted chemically, thus a sign of poorly drained land. Grayish soils may be deficient in iron or oxygen, or these soils may have an excess of alkaline salts such as calcium carbonate. The gray discoloration is also present in soils which are flooded regularly.

Soil Profiles

Water, which infiltrates into soil, sorts the soil materials by carrying the finer particles into deeper pore spaces and leaving the coarser particles in place. The simultaneous process of accumulation of material and differentiation of that material into layers is called "soil horizons" which takes place over a long period of time. The soil horizon structure shown in Figure 13 can often be seen in road cuts and other sites where excavation has exposed the soil. The surface layer, or "A" horizon, is referred to the topsoil or zone of leaching. The farmer is primarily interested in the properties of the "N' horizon, while the engineer is concerned with deeper layers that remain after the "A" horizon has been removed from a construction site. The "B" horizon is called the sub-soil or zone of accumulation of material leached from the "A" horizon or formed in places as a result of weathering. Most soils in Morris County have a "B" horizon in which clays and associated oxides of iron and aluminum leached from "A" horizon have accumulated. The "B" horizon is generally firmer and lighter colored than the "A" horizon but darker colored that the "C" horizon. Most younger soils have a weakly developed "B" horizon. The "C" horizon is below the "A" and "B" horizons. It consists of material that is little altered by the soil forming process but may be modified by weathering. The "C" horizon is commonly called "parent material". This layer varies in depth from just a few feet to tens of feet

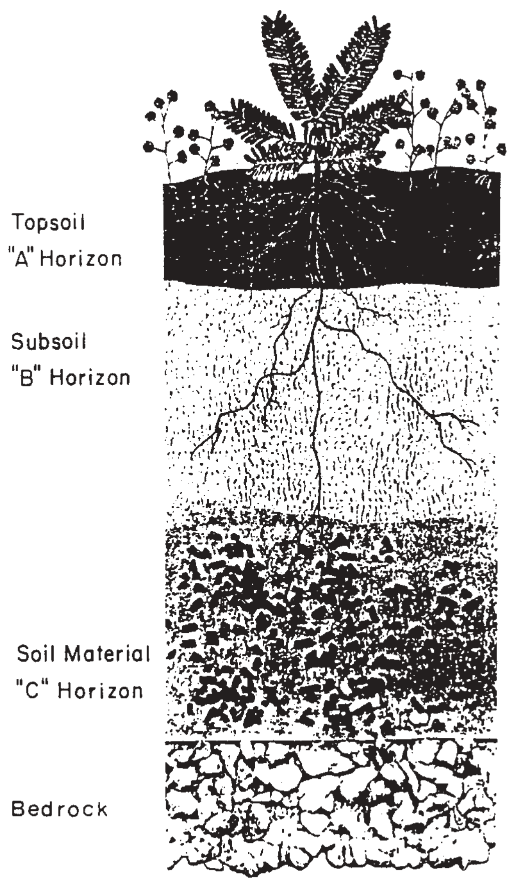

Figure 13—Soil Horizon Structure

Source: Getting It All Together:, 1980.

Most of the soils in Morris County have a distinct subsoil. It is believed that some of the lime and other soluble salts were leached before the translocation of iron and clay took place. Well drained and moderately well drained soils in Morris Country have a yellowish-brown or reddish-brown subsoil. These colors are mainly caused by thin coatings of iron oxides or sand and silt grams.

The infiltration rate is the rate at which water enters the soil at the soil surface. It is controlled by surface conditions. Hydrologic soil groups (HSG) are used to estimate runoff from precipitation. HSG also indicates the transmission rate—the rate at which the water moves within the soil. This rate is controlled by the soil profile. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long duration storms. The four hydrologic soil groups are:

Group A — Soils having a higher filtration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sand or gravely sand. These soils have a high rate of water transmission (greater than 0.30 in/hr).

Group B — Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission (.15—.30 in/hr).

Group C — Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission (0.05-0.15 in/hr).

Group D — Soils have a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay that has high shrink-swell potential, soils that have a permanent high water table, soils that have a clay pan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission (0-0.05 in/hr).

As a result of urbanization, the soil profile may be considerably altered and the listed group classification may no longer apply, In these circumstances, use the following to determine HSG according to the texture of the new surface soil, provided that significant compaction has not occurred:

HSG	Soil Textures
A	Sand, Loamy Sand or Sandy Loam
B	Silt Loam or Loam
C	Sandy Clay Loam
D	Clay Loam, Silty Clay Loam, Sandy Clay, Silty Clay or Clay

Some soils in the list are in Group D because of a high water table that creates a drainage problem. Once these soils are effectively drained, they are placed in different groups. Well drained, coarse texture soils with high infiltration capacity minimizes surface runoff. Extensive root development in the surface layer also increases infiltration; bare, compacted soil increases runoff.

The physical characteristics of soils vary greatly. Analysis of Morris County soils is found in a soil survey completed by the US Department of Agriculture's Soil Conservation Service (S.C.S) and published in 1976. This study was done by soil scientists using geological and topographical maps and aerial photographs. On-site investigations were also made by the soil scientists going through the different areas observing the length and shape of slope of the terrain, the texture, color, mineralogy, permeability, water level and depth of soils. In order to analyze the soil characteristics, samples were taken using auger borings; to a depth of 5 feet, or observations were made in pits by a backhoe to a depth of 8 to 10 feet. In developed areas, road cuts and foundation holes were observed.

Detailed descriptions of each soil series found in the area are given as well as interpretations about the potential use of each soil for farming, roads, dwellings, recreation, septic systems, engineering and other uses. Engineering properties such as depth of bedrock, seasonal high water table percolation rate, drainage potential, shrink-well potential etc. are also included. Limitations for soil uses are expressed as slight, moderate and severe. These terms are defined as follows:

Slight	Soils are relatively free of limitations affecting the intended use, or with limitations that are easy to overcome by use of normal equipment and/or methods.
Moderate	Soil properties are unfavorable but can be overcome by careful planning, design and management at somewhat greater costs
Severe	Soil properties are so unfavorable resulting from the effects of steep slopes, high water table, stream flooding, unfavorable soil texture, acidity, large numbers of stones, rock, etc. The limitations are such that they can be overcome only by exceptional, costly or complex measures.

Chatham Township Soils

The Soils Map of Chatham Township is taken from the Morris Country Soil Survey. It shows the location of the different soil series and their relation to other landscape features. A soils series consists of all of those soils which are essentially alike in all major profile characteristics except the texture of the surface layer. Each area on a soil layer is identified by a series of letters and numbers. The first capitalized letter and any lower case letters that may follow are abbreviations for the name of the soil series (Pt for Pompton). The second capital letter signifies the average percent of slope of the area-nearly flat land is classified as A, and as the slope increases the lettering progresses from A to E or F. If the digit 2 is appended of the slope category, it denotes eroded soil. “No A” is Norton soil nearly flat. “No C2” is Norton Soil with a slope from 6% to 12% which has undergone prior erosion. The soils series plus its slope designation is called a “soils type”. Soil series names like “Norton” usually derive from the place where a soil with a particular set of characteristics was first analyzed. These names have been systematized on a national basis by the SCS.

The General Soil Map of Morris County shows that Chatham Township soils fall into several soil associations. A soil association is a landscape with a distinctive pattern of soils, consisting of one or more major soils and several minor soils. Almost 14% of the Great Swamp is located in Chatham Township and categorized as Carlisle Muck (Cm) on the SCS map. This soil is in low swampy areas. The Carlisle series consists of deep, nearly level, very poor organic soils. Over a period of thousands of years, this swamp has gradually been filled by the accumulation of organic material or a mixture of a mineral sediment and organic material.. In a representative profile, the surface layer is black, highly decomposed muck about 18 inches thick. Below this and extending to a depth of 60 inches, is a very dark, grayish-brown, decomposed mulch that contains many fibers and pieces of wood. Permeability and available water capacity is high. The water table is at or above the surface most of the time, These soils are compressible and unstable under load. Carlisle Muck is poorly suited to the community development.

As of a 1988 survey, 40% of Chatham Township is mapped as Riverhead, Neshaminy or Penn Complex. Riverhead complex (Up) consists of well drained, nearly level to strongly sloping sandy and gravelly soils. Slopes range from 0 - 20 percent but are typically 5 to 12 percent. The underlying material is loose, unweathered, sorted sand and gravel out wash, most of which is granite material. Permeability and runoff is moderate (Group B). Neshaminy complex (Uk) consists of well-drained, gently sloping stony soils. Slopes commonly range from 3 to 8 percent. Depth of bedrock is variable, ranges from 1 foot to more than 10 feet This complex is deep over a water table and has moderate permeability (Group B), rapid runoff, moderate to severe hazard of erosion. Perm complex (Um) consists of well-drained soils that are underlain by red shale bedrock. Slopes commonly range from 0 to 10 percent. The soil material is residuum weathered from the underlying shale bedrock. On the sloping soils rapid runoff (Group C) causes a moderate hazard of erosion.

Surrounding areas of the Great Swamp and also certain areas spread inside the Great Swamp consists of Pompton sandy loam, 3 to 8 percent slopes (PtB). This soil is in swales and waterways in relatively low positions and receives runoff from the surrounding uplands.

The section of Chatham Township that drains directly into the Passaic River dominantly consist of Ellington fine sandy loam, loamy subsoil variant 3 to 8 percent slope (EIB), 8 to 11 percent slopes (EIC) and 15 to 25 percent slopes (EID). The Ellington variant consists of gently sloping to steep, moderately well drained and somewhat poorly drained soils. This series formed gravelly material derived from shale, siltstone and sandstone and contains a small amount of other materials including granite gneiss. They are underlain at a depth of 36 to 72 inches by finer textured residual material weathered from trap or shale bedrock. Permeability is moderately slow and available water capacity is moderate. The high content of fine sand limits the capability and workability of the soils.

One of the significant soils in Chatham Township is Riverhead gravelly sandy loam with 3 to 8 percent slopes (RmB) and 8 to 15 percent slopes (RmC). This type of soil covers Hickory Tree and certain sections of Green Village. The Riverhead series consists of well drained, nearly level to strongly sloping gravelly soils. This series of soils, formed in sandy and gravelly outwash, is derived mainly from granite material containing a small amount of shale, sandstone, quartzite and conglomerate. In a representative profile the surface layer is very dark, grayish-brown, gravelly sandy loam and about 2 inches thick. Permeability is moderately rapid (Group C), and available water capacity is moderate. It exhibits excellent recharge capability.

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