Soil is the basis of life on land. It includes mineral matter, organic material, water, and air. This laboratory will introduce you to the basic descriptive aspects of soil. Texture refers to the size range of the mineral fraction of the soil and is typically measured in terms of the percentages of sand, silt, and clay. Structure refers to the arrangements of particles within the soil. The soil profile is the overall arrangement of layers in the soil. The color of the soil is a precise description of the soil color. Finally, permeability refers to the rate at which water can percolate through the soil.

Three soil samples are presented in the laboratory. Be careful not to destroy them, as you will need them for Laboratory 3 as well as this laboratory. They are as follows:
- Chili Loam – Deep, well drained, moderately rapidly permeable soil formed on kame
- Condit Silt Loam – Deep, poorly drained, slowly permeable soil formed on glacial till
- Holly Silt Loam – Deep, poorly drained soils formed on flood plains.

Designation of the soil series is from the Trumbull County Soil Survey.

These four soils are quite different from each other, although they occur fairly closely together. They provide a good opportunity to examine some of the basic factors used to describe and classify soils.

### Texture

Texture refers to the mineral size composition of the soil, with the proportion of sand, silt, and clay placed on a ternary graph. Soils that are most beneficial to most plants consist of a mixture of all three size fractions. In general, the best soil for most agricultural crops is loam, with about 40% each of sand and silt and 20% clay. Probably the best way to measure the size distribution of the soil is by mechanical separation of the fractions. This process is highly accurate, and it enables the analyst to distinguish a range of size fractions such as those shown in the table below:

<table>
<thead>
<tr>
<th>Particle Size Designation</th>
<th>Diameter in millimeters</th>
<th>Diameter in Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravel</td>
<td>&gt; 2.0</td>
<td>&gt; 0.08</td>
</tr>
<tr>
<td>Very coarse sand</td>
<td>1.0 - 2.0</td>
<td>0.04 - 0.08</td>
</tr>
<tr>
<td>Coarse sand</td>
<td>0.5 - 1.0</td>
<td>0.02 - 0.04</td>
</tr>
<tr>
<td>Medium sand</td>
<td>0.25 - 0.5</td>
<td>0.01 - 0.02</td>
</tr>
<tr>
<td>Fine sand</td>
<td>0.1 - 0.25</td>
<td>0.004 - 0.01</td>
</tr>
<tr>
<td>Very fine sand</td>
<td>0.05 - 0.1</td>
<td>0.002 - 0.004</td>
</tr>
<tr>
<td>Silt</td>
<td>0.002 - 0.05 (2 - 50 μ)</td>
<td>0.00008 - 0.004</td>
</tr>
<tr>
<td>Clay</td>
<td>&lt; 0.002 (&lt; 2μ)</td>
<td>&lt; 0.00008</td>
</tr>
</tbody>
</table>

We will demonstrate the equipment used to make a physical separation, but the time available to us does not enable you to do a physical separation for all 4 soils. We will, therefore, use an different (and less accurate) method for estimating the texture of the soil. This method does, however, enable us to make determinations of soil texture in the field.

### Structure

Soil structure refers to the arrangement of natural soil particles. The smallest natural lump in a soil, or
cluster of particles, is termed a ped. Structure refers to the arrangement of natural soil particles – that is the arrangement of these peds. In general, soil structure can be described as crumb, granular, platy, blocky, prismatic, or columnar.

**Profile**

The profile refers to the layering of soils from top to bottom. Technically, a soil profile can be studied from the surface to the deepest extent of plant roots or to the level of bedrock (regolith). A detailed study of a soil profile would involve a pedon, which is a hexagonal column of 1-10 m² in surface area. Obviously, we do not have pedons available for the four soils in this exercise, but the National Resources Conservation Service did have these pedons available to them when they named the soils preparatory to the Soil Survey of Trumbull County.

The profile includes a series of horizons, which have visible boundaries from adjacent horizons. The boundaries can be discriminated through changes in color, texture, porosity, moisture, mineral content, etc. These are not always immediately obvious, but they can be extremely significant.

There are several characterizations of soil horizons in a profile. The basic horizons are as follows:

- **O**: Organic materials from plant and animal litter
- **A**: Uppermost mineral horizon; Dark colored layer rich in humus and fine clays
- **E**: Zone of eluviation (leaching); Lighter in color and richer in sand and coarse silt
- **B**: Zone of illuviation (deposition); May be colored, typically rich in clay
- **C**: Weathered parent material
- **R**: Parent material or regolith

**Color**

Color is one of the most obvious aspects of a soil. Different soils have different colors, and the color of a single soil may vary significantly from horizon to horizon. In general, oxidized iron minerals can confer a reddish or yellowish color, organic matter and some clays can confer a black color, reduced iron confers a gray or greenish color, and soils rich in silicates and aluminum oxides are often white to pale gray. To measure color in a standardized way, one uses the Munsell Color Chart, which characterizes color in terms of Hue, or the dominant spectral color, Value, or the degree of darkness or lightness, and Chroma, or the purity and saturation of the color (as opposed to gray).

In measuring color, it is best to use light which is as close as possible to white light. Low values and low chromas are more difficult to characterize than high values and high chromas. Color is indicated in the Munsell system with a rather cryptic notation – Hue Value/Chroma. Each of the three parameters is indicated by letters or numbers. For example, a pale brown might be 10YR 6/3, where 10YR is the Hue, 6 is the value, and 3 is the chroma. A strong red might be 5R 6/14, and a dark brown might by 10YR 2/2. This nomenclature will be much clearer when you actually use the color chart.

**Permeability**

The availability of water and air are very important factors determining the ability of a particular soil to support crops or other plants. This is a function of texture and structure, and of the way these two factors change from top to bottom of the soil profile. Some soils, especially sandy soils, are extremely permeable. They are able to absorb great quantities of water, but the water passes quickly through. Clayey soils may be close to impermeable. They absorb water very slowly, and they can retain it for a long time. Even then, a clay soil can be so tightly packed that very little water is available to plants. The overall ability of soil to hold water is a function of its porosity; the rate at which soil can recharge its moisture is a function of its permeability. Overall, the best balance between water retention and water recharge is in the loams, whose permeability is sufficiently high that water recharge is moderately high, but whose water retention is such that soil water does not drain quickly.
Exercise

Texture
Use the USDA Texturing Field Flow Chart to estimate the proportions of the three mineral components for several levels of each of the four soils. Are your estimates consistent with the

Structure
Examine the four soils carefully. Compare them with illustrations of the clods making up each of the soil structure types. Describe the soils with regard to their structures. If structure changes from one level to another, indicate the changes.

Profile
Observe the four soils from top to bottom. Do you see any differences in the makeup of different layers? That is, does the color change from the top to lower levels? Does the structure change? As you examined the texture, was it uniform at all levels? Do you see any other changes? Describe any layering you may see in each of the soils. Can you identify the soil horizons?

Color
Using the Munsell Color Chart, characterize the color of each horizon in each of the four soils. Do you have any difficulties in using the chart?

Permeability
Take samples of the four soils and place them in flower pots. Be sure that the soil in the flower pots is neither more compacted nor looser than it was when the sample was obtained. Take 250 ml water and pour the water over the soil in each flower pot. Place a beaker beneath the hole in each flower pot and measure [1] the time it takes for water to begin to flow out the hole in each pot, [2] the time it takes for water to stop flowing out the hole in each pot, and [3] the amount of water that drains from each pot. Do you see any relationship between the flow of water through the soil and the characteristics of the soil?