## *Unit V:*

# *Soil Resources*

# Chapter 5 Soils
## Introduction

***Geology of the Narrow River Watershed***

*The underlying bedrock in the Narrow River Watershed is primarily sedimentary rock, and is part of the same bedrock system as Narragansett Bay. Along the western edge of the watershed the bedrock is made of much older Precambrian granite that underlies most of Rhode Island. The whole Narragansett Bay area is part of an ancient rift left from the breakup of the supercontinent Pangaea starting about 200 million years ago, and was therefore lower in elevation than the surrounding granite. The surficial (overlying) topography was then shaped by a series of glaciers that periodically covered Rhode Island for much of the past two million years. (The supplemental story "Rhode Island's Deep Freeze" contains information about the last glacial period.) As the glaciers moved southward, they carved an even deeper gorge in the soft rock of the Narrow River Watershed, gouging out a steep-sided river valley. Rhode Island's most recent glacial retreat, beginning approximately 13,000 years ago, left behind steep slopes of 15-40% in the western and northwestern reaches of the Watershed.*

*Upper Pond and Lower Pond, the River's two northern basins, were also formed at the end of the latest glacial period. Huge, isolated chunks of ice were left behind by the glacier, buried under tons of earth. Insulated by the overlying debris, these giant chunks of ice melted slowly, and formed rounded depressions known as kettle holes. These kettle holes filled with water and became part of the Narrow River system. Unlike the rest of the River, these basins are very deep, approximately fifteen times deeper than the River's lower reaches and the headwaters region.*

*As the River flows from north to south, the surrounding land becomes level until the elevation reaches sea level near the mouth. The layers of sand and gravel outwash also thin as one proceeds southward, and bedrock outcropping, such as Gooseberry Island in Pettaquamscutt Cove, can be seen in various locations. Throughout much of the Watershed, depth to the water table is usually less than three feet due to the bedrock's close proximity to the surface. The Watershed's extraordinary geologic configuration provides a unique ecosystem and at the same time causes the Narrow River to be extremely susceptible to pollution.*

***Soils***

*Soil formation is an ongoing process that is dependent on the five soil-forming factors: parent material, climate, living organisms, topography, and time. There are approximately 50 different types of soil in Rhode Island, and over 10,000 types around the country. Each soil type has a different capacity for growing plants and sustaining habitats. In addition, some soil characteristics, such as wetness, stoniness, depth to ground water, excessive slope, and erodibility, can pose severe limitations on human development activities. It is important to understand soil limitations to determine if a proposed expansion project is appropriate.*

*Glacial till and outwash are the parent soil materials in the Narrow River Watershed. Till, which covers the upper flanks of the bounding slopes of the River, is consolidated; usually a compact blend of differing sizes of boulders, rocks, pebbles, sand and silt. Outwash, unconsolidated and relatively well-sorted soil particles, is found in the low-lying areas abutting the River. The soil characteristics adjacent to the Narrow River pose severe constraints to development. These constraints are indicated by one or more soil properties or site features that are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. The combination of steep slopes (40%) and soils with a high infiltration rate in the upper Watershed are concerns in relation to ISDS effluent that "would quickly find its way into the poorly flushed, sensitive areas of the estuary." The salt marshes of the southern cove are delimited by soils having a very slow infiltration rate, permanent high water table, and consequently a high surface runoff potential.*

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RHODE ISLAND'S DEEP FREEZE
By Charles Hickox

Imagine standing knee-deep in ice water. The time is mid-summer, 17,000 years ago. The place is your favorite beach along the Rhode Island shore. Look north; immediately before you lies the steep front of an ice sheet that extends northward to Canada and beyond. This ice sheet is almost a mile high. You are soaked to the knees because the ice is melting rapidly in the summer heat. The melt water is pouring down the front of the glacier in a braid of streams. Look south; the sea is nowhere in sight. A soggy, sandy plain slopes gently southward from the foot of the glacier. In the middle distance is a freshwater lake, 8 miles wide and 60 miles long. The lake is between what we know as the southern beaches of Rhode Island and Block Island. Beyond the lake a colossal hill of dirt and rocks towers over the southern horizon. Parts of this hill will become Long Island in New York, Block Island, Martha's Vineyard, and Cape Cod. Out of sight beyond the hill a second sandy plain blankets what is to become the continental shelf. It too slopes gently toward the south, to the sea many miles away. Upon the plains grows tundra-type plants, which feed the musk-ox, wooly mammoth, and great herds of caribou. Waiting to snatch up stray animals are wolves, giant bears, and saber-toothed tigers. All of these animals are soon to be extinct or will be forced to make their homes farther north.

During the past 2.5 million years glaciers have covered most of the northern hemisphere at least four times. Each of these glacial stages lasted about 70,000 years. They were separated from each other by longer periods of time, called interglacial stages, when the earth warmed up. During the interglacial, the ice melted from both Eurasia (Europe and Asia) and North America. Glaciers on the mountains drew back and almost disappeared. No one knows what causes the climate to turn so cold that it would produce glaciers.

The most recent glacial period, called the Wisconsin Stage, began about 75,000 years ago. Huge snow storms covered the area. So much snow fell that it became packed down under its own weight and turned into ice. Like earlier ice sheets, this one developed over the Laurentian mountains east of Hudson Bay, in Canada. It took a long time, but finally it became so thick that it started to flow outward in all directions. The ice covering North America reached its maximum extent about 21,000 years ago. The front edge of the ice reached as far south as northern New Jersey, and ice covered a third of the world's land surface. Ice domes that covered Canada, Scandinavia, and Siberia were as much as 2.5 miles thick. These domes are like the ones that still cover Greenland and the Antarctic today. The tremendous amount of water, locked up in glaciers, came from evaporation of seawater. Because so much water was frozen, sea level worldwide, was lowered 350 feet. The New England shoreline lay along the outer limit of the continental shelf, as much as 150 miles off our present coast.

Glaciers are messy and dirty. That's because as the ice moves forward it picks up soil, sand, gravel, and boulders, which are collectively called sediments. The glacier rolls the sediments up into the ice, just like rolling a snowball over dirt. An advancing glacier is also a bulldozer, pushing ahead of it the loose material that lies in its path. Even when the edge of the glacier begins to melt, the ice is still pushing ahead from its source far to the north, continually bringing more sediment to the edge. When the push finally stops and the ice starts to melt back, a gigantic hill, or ridge, of these sediments is left behind. These ridges are called *terminal* or *end moraines.* Long Island, Rhode Island and southern Massachusetts have some of the finest examples of moraines in the world. The terminal moraine south of New England originally extended unbroken from Brooklyn, New York, eastward along the axis of Long Island, Martha's Vineyard, and Nantucket. When the climate started to warm up again the ice front melted back, but not all at once. About 17,000 years ago the climate cooled again for a short time. It actually became cold enough so that the glaciers started to grow again. This time, the glacier moved forward only about 20 miles. But it did have a chance to bulldoze up another moraine. This *recessional moraine* also begins at Brooklyn, but it stretches eastward along the north shore of Long Island to Orient Point, through Plum and Fisher's Islands, Napatree Point, and Watch Hill, then along the Rhode Island coast near Routes 1 and 1A. At Point Judith it swings seaward to form the Elizabeth Islands and the north shore of Cape Cod. In Rhode Island, this ridge is known as the Charlestown Moraine. If you drive south on Ministerial Road (Rt. 110) to Rt. 1, you will drive up and over the recessional moraine. The Great Swamp and Worden's Pond in South Kingstown and Watchaug Pond in Charlestown were created because the water flowing south could not get through the Charlestown Moraine.

16,000 years ago the climate had warmed once again and the glacial started to move back again. By 12,500 the front had melted back into Canada from whence it came and New England has been ice-free ever since. Each of the above dates has been established by one of several possible radiometric methods.

The glacier left behind special land formations called *kames* and *kettles.* Kames are rounded, twisting ridges that form steep rocky hills. Kames are formed when the huge cracks, or crevasses, in the ice become filled with glacial debris. When the ice melts, these crevasse-fillings are left standing as ridges. Kettles form where great blocks of ice had broken off from the main glacier, but did not melt right away. These great blocks of ice finally melted leaving a depression in the surface of the ground. The depressions were in effect a cast of the ice blocks. The holes filled with ground water to form the kettle ponds commonly seen in New England. They are roughly circular, but the size and depth depend on the size of the melting block. No Bottom Pond and Dr. Lewis Pond are kettles, as are most of those closed depressions and little ponds of Fisher's Island and Watch Hill. Block Island is said to have a pond (kettle) for every day of the year. The water tower off Winnapaug Road sits on a kame; so does the Ocean House. Chin Hill and the Dumplings at the west end of Fisher's Island Sound are kames. Like a great Swiss cheese, the land along Routes 1 and 1A is typically kame-and-kettle topography.

In addition to the moraines, the glacier left behind two main types of glacial deposit from which our modern soils have evolved in Rhode Island. If you live north of the Charlestown moraine, your house probably rests on *till*. Till covers about 80 percent of any area that once had a glacier on it. It is the stuff left behind after the ice has melted, an unsorted hodgepodge of all sizes of rocks, from fine clay to boulders as big as a house. New England till is very coarse and full of boulders because our bedrock is made of very hard granite. Midwestern till, on the other hand, tends to be fine-grained because there the bedrock is made of soft shale and limestone. Anywhere you see a stone fence in the woods around your house, you know that you are on till. All the till in this area made it hard to farm. That is why so many farms in Exeter and West Greenwich were abandoned when the mills started up near the rivers. Mill villages grew up around dams and factories. The farms turned back into woods.

The second type of soil produced by the glaciers is called *outwash*. It is deposited in front of a melting glacier. When the water flows down the steep front of the glacier and reaches the flat plain at its foot it loses speed. The melt water puts down the sediment, sand and gravel, like a great sandy apron. Outwash is layered and well sorted because it has been moved around by running water. Although most of the outwash along our coast now lies on the continental shelf, remnants extend seaward from the foot of the moraines. The plains along the south shore of Cape Cod, Nantucket, Martha's Vineyard, and Long Island are examples. In Westerly, the gently sloping surface at the foot of the Charlestown Moraine, between Winnapaug and Maschaug Ponds, is outwash. Winnapaug Day Camp lies on outwash, as do most of Pond View Golf Course and holes 10 through 13 of the Winnapaug course. East from Westerly, Quonochontaug Beach, Ninigret Wildlife Preserve, Charlestown Beach, and Matunuck are all located on outwash. Outwash is not only deposited as a broad apron at the foot of an end moraine, but is also deposited in valley bottoms where streams are fed by torrents of glacial meltwater. Advancing ice overrides its own outwash, but a melting glacier will leave behind a valley partly filled with beds of sand and gravel. The outwash plains at White Rock and Shunock Brook are examples. The Little League field at Anquilla Brook, Pawcatuck, is on outwash; so are the turf farms along Rte. 2, Chariho High School, the playing fields at the University of Rhode Island, and Ladd Center in Exeter, as well as the Veterans Cemetery, River Bend, and Elm Grove cemeteries. In fact, most Yankee cemeteries are located on outwash, where digging was easy. Many small and large outwash plains became gravel pits. The Center of Rhode Island, a new mall proposed off Rte. 95 in Coventry, will be built on the site of a gravel pit where most of the sediments from the outwash plain have been removed.

When at last the world's climate began to warm and the great ice sheets melted, the sea came back upon our shore like a great tide flooding a beach. During deglaciation sea level rose so quickly that no lasting shoreline features had time to develop. Today, the Connecticut shore has deep estuaries and snug harbors but few beaches. Long Island and Rhode Island bordered by the Charlestown moraine and gently shelving sandy outwash, are known for their barrier beaches and salt ponds.

Whatever the cause, we are in an interglacial stage today. The cycles of ice ages and interglacial periods of the past were presumably no different from those that will follow in our future.

# ACTIVITY I: DOES IT COME FROM THE SOIL?

**OBJECTIVE**: To demonstrate to students the importance of soil by showing them that many items we use every day, in addition to food, originally came from the soil.

**METHOD**: Students will grab for unknown items through a small hole in a large box. They will then take the item back to their work group and determine if it originated from the soil.

**MATERIALS**: large box; 10-15 items that at least partially came from the soil; activity sheet, pencils

suggested items: socks, leather shoes or belt, pencil, paper, clay pot, aloe or jojoba shampoo or lotion, cork from wine bottle, gelatin (it can be made from horse hooves), aspirin (from salicylic acid, which originally came from willow trees), flea dip containing pyrethrins (which came from Chrysanthemums), any type of food. Also include items that don't come from the soil, such as plastic.

**PROCEDURE:**

1. Split the class into groups of three or four. Have one member from each group come up and grab an item out of the box and identify it.

2. Each group uses the activity sheet to answer the question, "Can the item be traced back to the soil?" The students should describe the path from soil to finished product, either in words or by drawing.

3. Some items may be made of more than one material. Students should describe the paths of all materials that originate from the soil. Some may have interconnecting paths.

4. Have students share the pathways of their items. Discuss places where they had difficulty. Compare the objects that originate from the soil with those that do not. Among those objects that do originate from the soil, compare those that arise more directly from the soil with those that are made more indirectly from the soil.

# ACTIVITY SHEET: **DOES IT COME FROM THE SOIL?**

While blindfolded, pick an item from a box. All of the items in the box are used in everyday life. Try to determine if the item originated from the soil or elsewhere. Remember that plants grow in the soil and animals eat plants. Also, a lot of products are made from plants and animals.

What is your item? _____________________________________________

Can it be traced back to the soil? ______________

<u>If yes, describe how, using words or drawings:</u>

(Example: The item is an apple. It comes from an apple tree that grows in the soil.)

# ACTIVITY II: WHAT IS SOIL MADE OF?

**OBJECTIVE**: Students will be able to identify and understand the importance of each component in the soil.

**METHOD**: A pie chart is used to show the four components of soil.

**MATERIALS**: none

**BACKGROUND INFORMATION:**

1. There are four components of soil:

   a. Mineral (45%): many of the nutrients get into the soil from the weathering of the minerals in the soil. Minerals come from rocks. Many of the minerals in soil are necessary for plant growth.

   b. Air (25%): the source of oxygen for plant roots and for the organisms that break down organic matter (soil microbes).

   c. Water (25%): helps in the chemical breakdown of minerals; it is essential for plant growth and for soil microbes.

   d. Organic Matter (5%): supplies nutrient to the soil.

**PROCEDURE:**

1. Draw a circle on the board and ask students to help fill in the pieces of the pie. Divide the circle up into four "pieces" sized according to the percentage of each component in the soil.

2. As you help the students identify each component and its percentage share, write it down in the appropriate place on the pie chart.

3. As you reach the final piece, have students mathematically calculate the remaining percentage in the pie chart. Explain the importance of each component as it is identified.

# ACTIVITY III: **THE FIVE SOIL FORMING FACTORS**

**OBJECTIVE**: Students will be able to list and describe the five factors that affect soil formation. Learning about these factors will increase their awareness of the importance of respecting and conserving soil. In addition, students will understand how each factor affects the type of soil found in Rhode Island.

**METHOD**: Discussion and simple demonstrations.

**MATERIALS**: Rocks such as granite and quartzite; limestone or chalk and a strong acid, such as vinegar.

**BACKGROUND INFORMATION:**

Soil is very different around the country and even in as small an area as Rhode Island. There are approximately 50 different types of soil just in Rhode Island, and over 10,000 types around the country. Each soil has a different capacity for growing plants and sustaining life. The five factors that affect soil formation influence the type of soil that is present. Soil formation is an ongoing process that is dependent on all five soil forming factors.

The **five soil forming factors** are:

1. <u>Parent material:</u> the unconsolidated residue resulting from the physical and chemical weathering of various types of bedrock, transported material and organic deposits. Chemical and physical weathering are the two ways that rocks are broken down over time to help form soil. Therefore, the type of rock present affects the type of soil formed; in Rhode Island, most bedrock material is granite or shale. The parent material also largely dictates what texture the soil has, whether it is sand, silt, or clay (or in most cases, a combination of all three). Texture largely affects the soil's ability to store water and nutrients, and therefore greatly affects plant growth.

2. <u>Climate:</u> consists of precipitation, temperature, humidity, and seasonal variation. Precipitation and temperature have a direct effect on the weathering of rocks. The higher the precipitation and temperature, the greater the weathering. Climate indirectly affects soil formation by dictating what plants are able to grow. The plants add organic matter to the soil in the form of humus. In areas of low rainfall or extremely low temperatures, soil formation is minimal.

3. <u>Living organisms:</u> the amount of organisms in soil depends upon the climate. Soils in warmer, moister climates have more microbes. The organisms break down the humus in the soil and turn it into usable nutrients for more plant production. More plant production adds more humus. This increases the aggregation, nutrient content, and water holding capacity of the soil.

4. Topography: primarily affects the formation of soil by altering the distribution and movement of water. A level area will have a deeper soil because more water will percolate through the soil, thus speeding the process of weathering. Soil formation on steep slopes will not be as great because the water will run off and not percolate through the soils. Also, a greater slope will cause erosion of soils.

5. Time: the more time that passes, the more intense the soil forming processes are, which usually means the soil is deeper. Compare your state's soil development to another state's, based on time since glaciers covered the state. Hence, since Rhode Island was "recently" covered by glaciers, our soils are less developed than areas such as Georgia. It takes about 30-50 years to form one inch of soil.

**PROCEDURE:**

1. Ask students to list as many things as they can that are part of the soil forming process. Make sure all five soil forming factors are discussed.

2. What determines the texture of the soil that is formed?

3. Why does soil texture greatly affect plant growth?

4. To demonstrate physical weathering, rub two rocks together to show how particles are rubbed off the rocks by the physical action.

5. To demonstrate chemical weathering, place vinegar on a piece of limestone or chalk to show how it bubbles and partially dissolves.

6. Why are all factors necessary for the formation of soil? What would happen if there was no weathering? If the climate was too cold or dry? If there were no soil organisms? How would each of these scenarios affect plant growth?

7. How do plants in an area affect soil formation?

8. How does the slope of the land affect soil formation? Where would you be more likely to find deeper soil, on a slope or on level ground?

9. (**Ask why your state's soil is more or less developed than another's** [*Why are Rhode Island soils less developed than Georgia's?*]) How long does it take for one inch of soil to form?

# ACTIVITY IV: **SOIL HORIZINATION**

**OBJECTIVE**: Students will be able to visualize the different layers in the soil. This will further their understanding of how soil is formed.

**METHOD**: Students will be shown an overhead transparency and then actually help dig and explore soil horizons outside on the school grounds.

**MATERIALS**: overhead transparency showing soil horizons*, overhead projector, digging spade or shovel

**BACKGROUND INFORMATION:**

1. See Soil Conservation Service publication entitled "Conserving Soil", which is enclosed with this curriculum. Overhead transparencies used in this activity are contained in this publication.

2. The horizons are coded with letters, as follows:

| | |
|---|---|
| O – <u>organic layer</u> | usually the darkest horizon, formed from organic litter |
| A – <u>topsoil</u> | minerals and organic materials, dark colored |
| B – <u>subsoil</u> | mostly minerals from bedrock and C horizon with few organics, reddish brown to yellowish in color |
| C – <u>parent material</u> | unconsolidated rock, transported material or organic material |
| R – <u>bedrock</u> | consolidated rock |

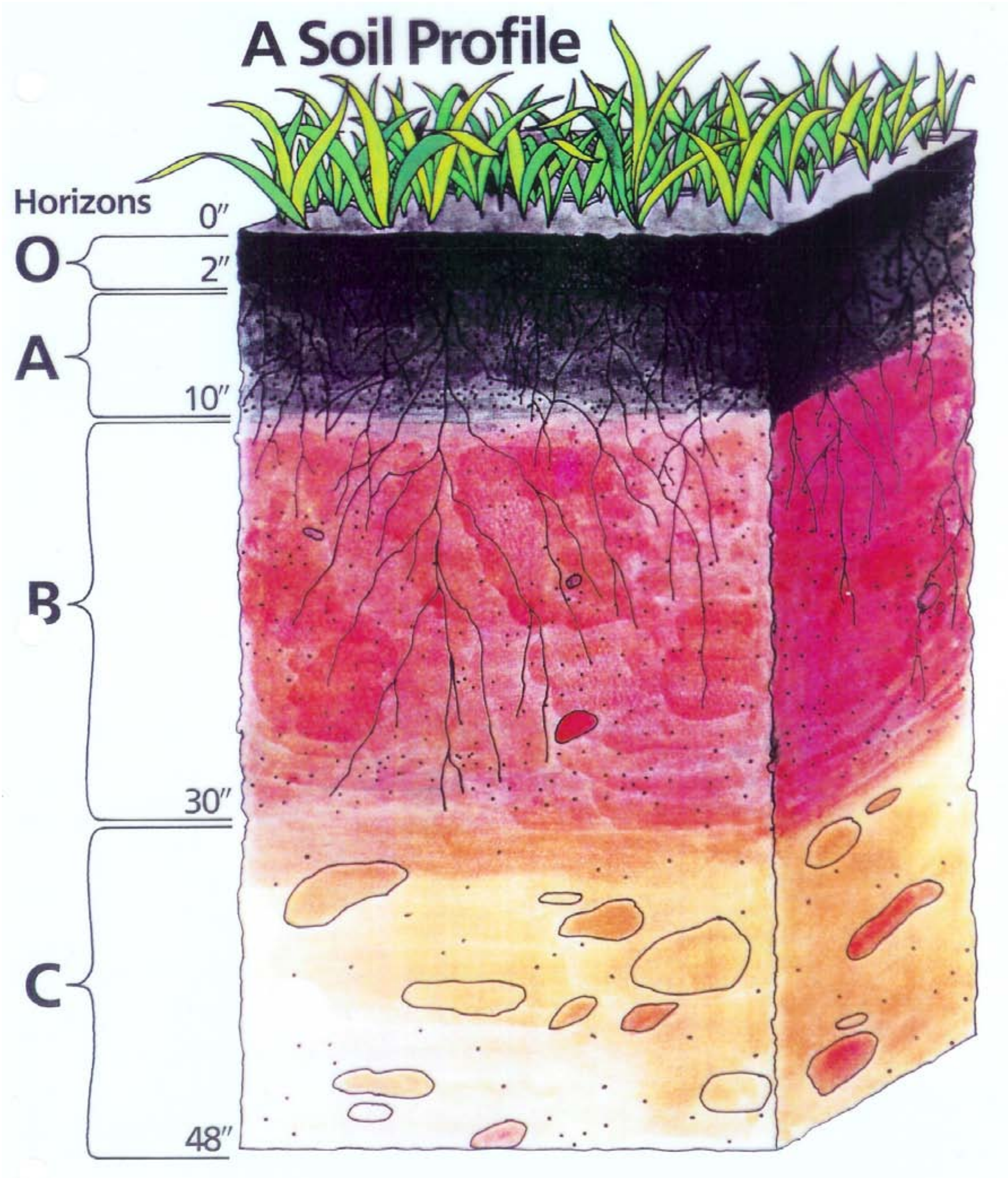
**PROCEDURE:**

1. Show students the overhead transparency and discuss each layer, referring back to the five soil forming factors and how they might affect the layer formation.

2. Take students outside to an area of natural ground that probably wasn't disturbed during the construction of the school. Have students help dig a hole about 15-18 inches deep. Depending on the soil, you should be able to see at least three layers – the O, A, and B layers where B horizon generally begins in your state. In Rhode Island, you usually encounter the B horizon at around 6 to 12 inches down.

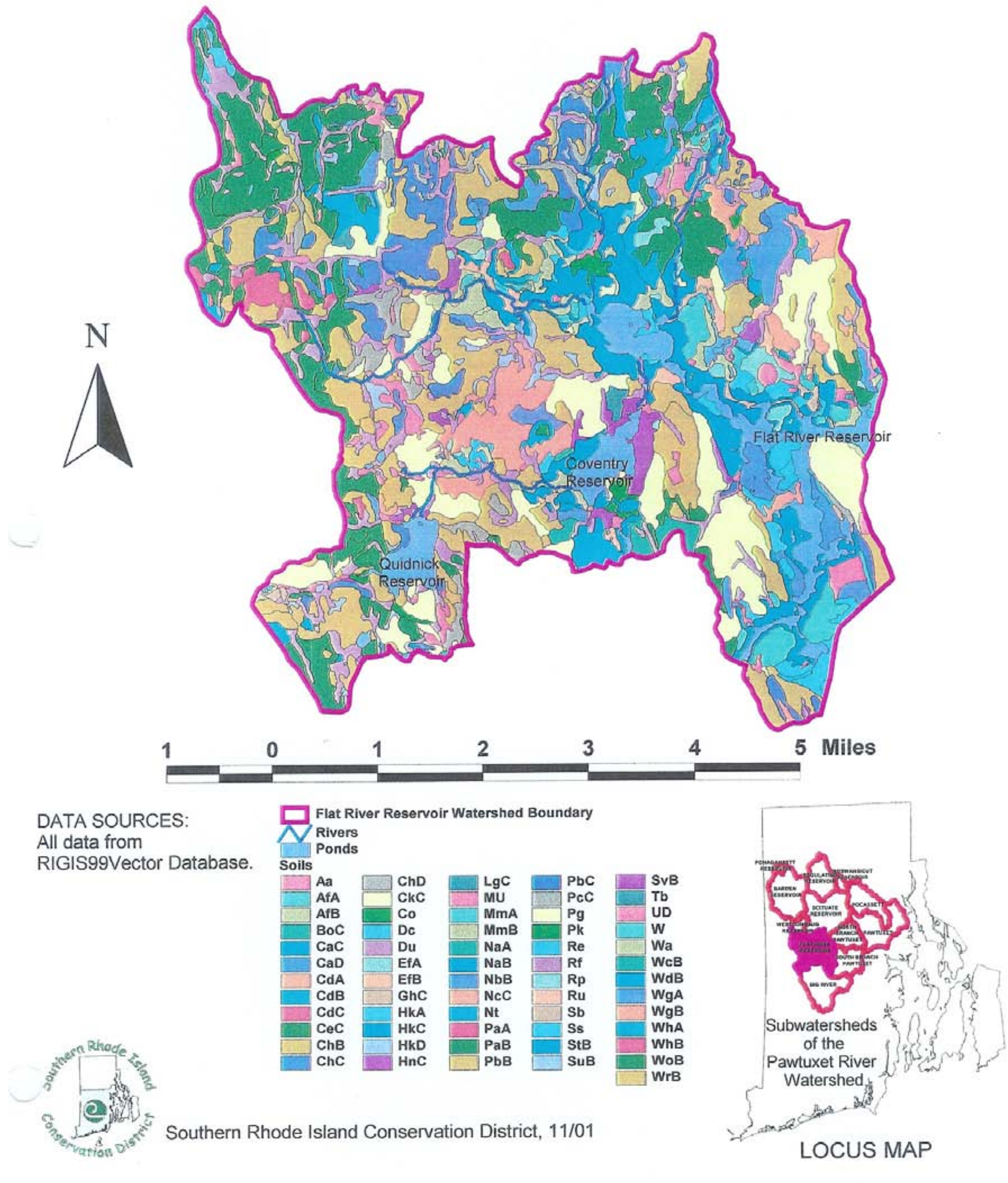
3. How do the layers differ, in texture, color, and moisture?

4. If possible, dig holes in different areas to compare. Compare an area on a slope versus on level ground. Discuss differences and similarities.

5. 


A Soil Ecosystem

# SOILS
# Flat River Reservoir Watershed



# ACTIVITY V: **PLANT AND SOIL RELATIONS**

**OBJECTIVE**: Students will understand the interdependence of soil and plants – how soil type affects plant growth, and how plant decomposition releases nutrients back to the soil.

**METHOD**: Students will carry out their own experiments, spending several weeks growing plants in a variety of different soils, and compare their results.

**MATERIALS**: six different soils of varied textures, from clay to sand*; six 4 inch pots and drainage plates; packet of seeds; watering can; data sheet for recording plant growth

**PROCEDURE:**

1. Fill pots to within one inch of the rim with the moistened soil samples, one soil to each pot. All pots should be the same size.

2. Plant seeds in pots, following directions on seed package.

3. Water all pots with the same measured amount of water per week. ½ to 1 cup should be sufficient, depending on how much sun and how hot and dry your classroom is. Some soil media will be waterlogged, others will seem too dry; try to give an intermediate amount of water. It is most important that all the pots are given the same amount on any given week, but that amount can vary week to week, depending on how sunny the weather has been.

4. Students should keep a weekly log on the growth of the plants, recording on the data sheets: when seeds germinate, the inches of growth, when buds are set, when blooms are set, when plants die, etc.

5. Discuss the results and reasons for the differences observed in plant growth in each of the soil mediums.

* Consult your local Conservation District Office or the USDA Natural Resources Conservation Service for assistance with verifying soil textures.

# Plant Growth Data Sheet

SOIL TYPE ____________________        TYPE OF SEEDS ______________________

| week # | amount watered | growth (inches) | comments |
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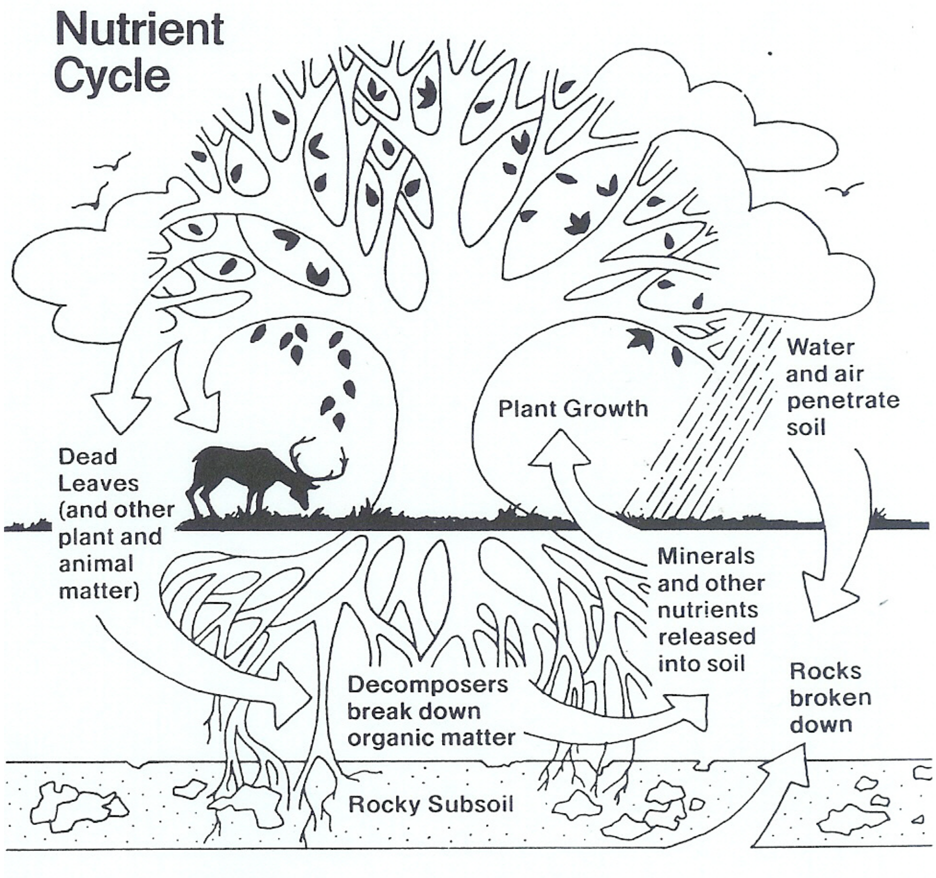
Nutrient Cycle
Dead Leaves (and other plant and animal matter)
Plant Growth
Water and air penetrate soil
Minerals and other nutrients released into soil
Decomposers break down organic matter
Rocks broken down
Rocky Subsoil

# ACTIVITY VI: SOIL TEXTURE ANALYSIS

**OBJECTIVE**: Students will be able to determine textures of different soils.

**METHOD**: Students will be able to feel different soils of known texture, and then try to determine the textures of “mystery” soils.

**MATERIALS**: water; containers for holding soil; six different soil textures: sand, loamy sand, sandy loam, silt loam, silt, clay*

**BACKGROUND INFORMATION:**

1. Soil textures can affect plant growth by limiting water and nutrient availability. Sandy soils do not hold water very well and thus they dry out more quickly than soils with silt and clay in them. In addition, they do not “trap” (through chemical bonding) nutrients and other charged particles, such as pesticides, that might be present in the soil.

2. Silt and clay soils tend to hold onto the water and the nutrients, as well as many pesticides that might be present. However, because of the increased moisture holding capacity, plants in these soils are more susceptible to fungus problems.

3. Loam is the ideal soil. It is a combination of sand, silt, and clay. Soils with textures containing a combination of these three types are more difficult to determine, but in general will feel similar to which ever particle size is most prevalent. Sandy loam has more sand content while silt loam has more silt content. Loamy sand is sand with a small silt content, and thus is more sandy than sandy loam.

4. Textures can be analyzed simply by rubbing the soil between your fingers:

   Sand: gritty, like fine sand at the beach
   largest particles, .05 to 2.0 mm in diameter

   Silt: smooth, like powder
   medium sized particles, .002 to .05 mm in diameter

   Clay: sticky, holds together when pushed out between the fingers
   smallest particles, less than .002 mm in diameter

**PROCEDURE:** Moisten one soil sample with a small amount of water (do not saturate). Have students rub the soil between their fingers to determine its texture. Repeat for all samples and compare.

* Consult your local Conservation District Office or USDA Natural Resources Conservation Service for advice on verifying soil textures.

# ACTIVITY VI: SCIENCE LABORATORY ACTIVITIES

(By Walter A. Cole)

These sessions can be used as supplemental activities if the classroom is set up for science experiments.

**OBJECTIVES:**

1. Students will discover what organisms live in at least two soil sample sites. Students will learn about the basic ways these organisms are adapted to life in their soil environment and learn about the life cycles of these organisms.
2. Students will discover the causes and effects of acid rain and thermal pollution upon the microscopic organisms that inhabit the soil.

**METHODS:**

1. Under parent/guardian supervision, students will gather at least two different types of soil from around their home. Stay away from water areas as much as possible.
2. Place soil samples in a plastic bag or a jar and label with its location.

**SUPPLIES NEEDED**

-Same as Unit III laboratory sessions.

**PROCEDURES**: (sessions may last one or more class sessions)

***STUDENTS MUST WEAR SAFETY GEAR!***

**First Session**

1. Students bring in various soil samples from around their home.
2. Visually examine the soil with hand lenses for organic and inorganic material.
3. Record pH.
4. Record temperature.
5. Record organic and inorganic things that were found. Discuss findings.

**Second Session**

1. Place very small sample of soil onto a microscope slide without a cover. (A few grains will do.)
2. Examine samples under the microscope.
3. Record observations as in the first session. Discuss findings.

**Third Session**

1. Place 2 grams of soil into a test tube with 10mL of tap water. Shake the contents thoroughly.
2. Place one drop or 20 microliters of the solution onto a microscope slide. Do not cover the slide.
3. Examine under the microscope.
4. Record observations. Discuss findings.

**Fourth Session**

1. Measure 2 grams of soil and mix with 10mL of tap water in a test tube. Shake thoroughly.
2. Add one drop or 20 microliters of ammonia ($NH_3$) to increase the pH to at least 9 but no higher than 10. Add more as needed.
3. Make microscope slides as previously directed in Unit III.
4. Examine under the microscope.
5. Record observations. Discuss findings.

**Fifth Session**

1. Measure 2 grams of soil into a test tube with 10mL of tap water. Shake the contents thoroughly.
2. Add one drop or 20 microliters of vinegar at a time to decrease the pH to about 4.
3. Make microscope slides as previously directed.
4. Examine under the microscope.
5. Record observations. Discuss findings.

**Sixth Session: DONE BY TEACHER!**

1. Mix 20 grams of soil and 100mL of tap water into a 250mL flask.
2. Place flask onto a hot plate. Make sure contents are thoroughly stirred.
3. Heat contents to at least 55 degrees Celsius but no more than 80 degrees Celsius.
4. Make microscope slides as previously directed.
5. Examine under the microscope.
6. Record observations. Discuss findings.