Glossary of Relevant Terms:

- **Adsorption:** Binding of molecules to the surface of another substance. Different from absorption, where molecules will enter into the pores of another substance.
- **Heterogeneous:** A mixture of different substances.
- **Humus:** The topmost layer of soil, derived from organic matter.
- **Inorganic Matter:** Matter that does not originate from a living entity.
- **Invertebrate:** Animal that does not have a spine.
- **Kerogen:** Insoluble organic compound created by the compression of organic materials during the formation of sedimentary rock. Through heat and pressure, kerogen can become oil or natural gas.
- **Organic Matter:** Matter that is or was once living.
- **Weathering:** The breakdown of bedrock into smaller pieces. Weathering can take place through physical processes (freeze/thaw, wind, abrasion from other rocks), biological (organic acids), or chemical (oxidation) weathering.

Development of this guide was the result of a partnership between the East Stroudsburg Area School District, the Pike County Conservation District and the Pike County Office of Community Planning. Support from the Pike County Board of Commissioners and grant funding from the Pennsylvania Department of Environmental Protection's Environmental Education Grants Program contributed to the production of these materials.

Soils and Geology

At East Stroudsburg Area School District's North Campus

Outdoor Learning Guide

How to use the Outdoor Education Guide

This Outdoor Education Guide is intended to provide faculty and staff with a background knowledge of what can be found on the North Campus Trail. While the Interpretive Trail Guide provides a brief overview of the natural features found along the North Campus Trail, the Outdoor Education Guides go into greater detail on five of the Trail's most salient features. The five Outdoor Education Guides augment the topics presented in the Interpretive Trail Guide with case studies, discussion questions, and examples found along the North Campus Trail. These guides are not meant to take the place of existing lessons and instruction; instead, this guide should be used to help draw connections between the North Campus Trail and existing classroom instruction.

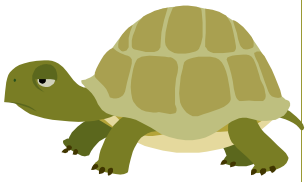
Access Road to North Campus Trail (PCCP Photo)

Outdoor Education Guide Series:

- **Green: Interpretive Trail Guide**
- **Red: Invasive Species**
- **Blue: Water and Watersheds**
- **Grey: Local Geology and Soils**
- **Brown: Trees**
- **Orange: Ecology and Species Habitat**

What can you see?

Watch for these things while on your adventure! Please don't pick up or disturb any items on your hunt. Want another challenge? Take a picture of all the items you find so you can look for them at home too!

Soil  What color is it?	**A smooth rock** What made it smooth? 	**A pointy rock**  Why isn't it smooth?
Mushroom/ Fungi  MUSHROOMS CAN BE POISONOUS, DO NOT TOUCH!!!	**Snail** 	**Turtle** TURTLES CAN BITE, DO NOT TOUCH!!! 

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Soils 101

What is soil?

Soil is a **heterogeneous** mixture of sand, silt, clay, organic matter, liquids and gas. Soil contains both organic and inorganic matter, meaning that it came from living and nonliving sources. The ratio of each of these materials to the mixture plays a large role in the composition of the greater ecosystem. Pedology refers to the study of soils, while geology refers to the study of rocks.

Where do our soils come from?

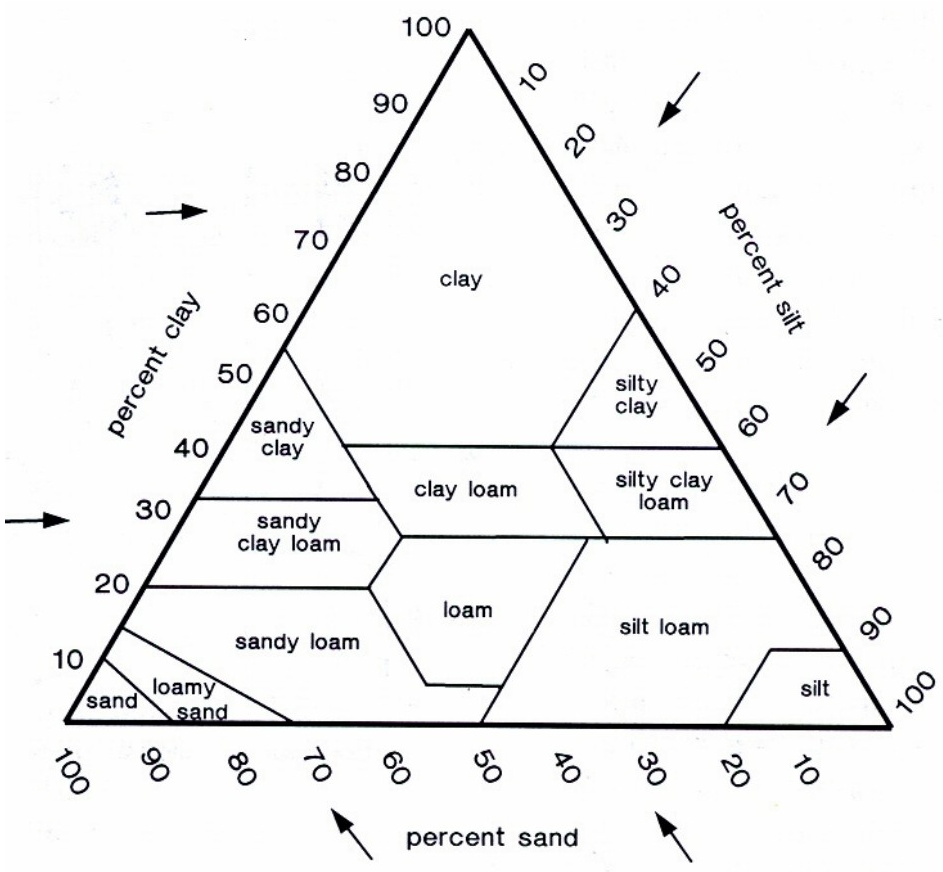
The soils in Pike County are from a variety of origins. Due to the fact that the Pocono Area of Pennsylvania was covered by a glacier during the last ice age, the movement of these glaciers carved many of the lakes, mountains, and valleys you see today. Glacial movement also cleared away many of the soils from this area, but left soils and rocks from other areas. The soils here today are a mix from our existing bedrock, and those soils deposited by the glaciers thousands of years ago. Bedrock in Pike County is composed of sandstone, siltstone, mudstone, shale, and conglomerate, and comes from the Devonian geologic period over 300 million years ago.

Why are soils important?

Based upon factors such as soil depth, moisture, proximity to water, acidity, alkalinity, and permeability, soil plays an important role in the development of the natural and built environments.

The available nutrients in the soil, the soil's ability to retain nutrients, and the soil chemistry play a role in the development of the natural environment. Different plants prefer different mixtures of soil. Some plants desire nutrient-rich soils, and others will work better in nutrient-deficient soils. Other plants require a constant intake of water, while others thrive in desert-like environments. As a result, the animals, fungi, and other organisms that depend upon plants are also impacted by soil chemistry. For example, oak trees prefer acidic soils. Since deer, squirrels, and other organisms depend upon oak trees for their acorns and other products, soil composition will help to determine what creatures will live in a certain location. If you look at the map on pages 8-9, you will see that the trail covers at least four different types of soils.

Soil composition also influences building construction and location. Early human settlements clustered around river valleys where seasonal flooding would keep the soils full of nutrients for farming. Today, soils play a role in where one can build a house (or any other building), drill a water well, and place a septic system. Soil permeability, depth to bedrock, slopes, and water table will influence the development of a site for construction. Simply put, people will want to build buildings, roads, and other infrastructure where it is easiest, and most practical to do so. People will want to build where the soil is strong enough to support construction. Italy's Leaning Tower of Pisa is an example of what can go wrong when a building is constructed on weak soil. Conversely, the more rocky and steep the soil and the terrain, the less desirable the land is for development.



Soil Textural Class Chart: Courtesy of Cornell University Cooperative Extension.

maps, images, GIS Data, coloring pages, identification guides. Accessed January 2013: **http://education.usgs.gov/**

- The United States Department of Agriculture's Natural Resource Conservation Service (NRCS) has a K-12 education page with tools for educators, activities, lesson plans, photos, and links to outside resources. Accessed January 2013: **http://soils.usda.gov/education/**

- *Sustaining Penn's Woods:* Produced in 2000 specifically for Pennsylvania educators, *Sustaining Penn's Woods* is a curriculum guide for forest education, grades 5-10. Every school in Pennsylvania received a copy of this program. Activity of interest for grades 5-10 "Soil Sleuths." This activity will allow students to review the different types of soils, and how different soils support a variety of can be found as a pdf (as of January 2013) at:(**http://www.hlma.org/pennswoods/online/activities/Sec2-3.pdf**). The investigation and reference tables may be found at (**http://www.hlma.org/pennswoods/online/studentpages/Sec2-3sp.pdf**)

- National Geographic's education program has a page dedicated to soil for students and teachers. Resources here include photographs, encyclopedic entries and articles. Last accessed in January 2013: **http://education.nationalgeographic.com/education/topics/soil/?ar_a=1**

- The PBS Television Program, Nova, has an education page that includes videos, photos, maps, and other interactive resources geared towards earth science. Accessed January 2013: **http://www.pbs.org/wgbh/nova/education/**

- The Soil Science Society of America has an "Educational Resources" page that includes links to other websites on soil, and is divided by grade level groups K-4, 5-8, 9-12. Accessed January 2013: **https://www.soils.org/about-soils/lessons/resources**

- The Geological Society of America has lesson plans for K-12 Earth Science Educators on a variety of geology topics. Accessed January 2013: **http://www.geosociety.org/educate/resources.htm**

- The Pike County Conservation District has an Educators' Resources page on Soil, that provides information and graphics on the basics behind soil and watersheds. Accessed April 2013: **http://www.pikeconservation.org/nat_res_lrn_site.htm**

Activities and Resources:

- The United States Department of the Interior's Bureau of Land Management has a page on soil resources, which includes a page on soil ecology for elementary school students, as well as reference materials on soils and soil biological communities. Accessed January 2013: **http://www.blm.gov/wo/st/en/prog/more/soil2/soil2.html**

- The National Association of Conservation Districts has a page on the importance of soil called "Soil to Spoon," for grades K-12. Some of the materials are available on the website to sample, but there is a fee for the purchase of the materials and resources. Accessed January 2013: **http://www.nacdnet.org/education/resources/soil-to-spoon**

- The National Aeronautics and Space Administration (NASA) has a website on soil science education that includes learning activities, helpful links to outside sites, and informational resources. Accessed January 2013: **http://soil.gsfc.nasa.gov/**

- Discovery Education has an educational page on soils, "The Dirt on Soil." The site provides an overview on soil strata, composition, and resident species. Accessed January 2013: **http://school.discoveryeducation.com/schooladventures/soil/**

- *Project Wild:* Project WILD is an interdisciplinary conservation and environmental education program emphasizing wildlife. This program periodically publishes a Curriculum and Activity guide for Grades K-12. As of January 2013, the website is: **http://www.projectwild.org/**. To receive further information and materials from this program, the contact for Pennsylvania is Theresa Alberici with the Pennsylvania Game Commission. She can be reached at: (717) 787-1434 (talberici@pa.gov). While activity and curriculum information can be accessed through this contact, the Pike County Conservation District has a copy of the guide that may be accessed for reference. Relevant activities in the 2000 Edition of Project WILD include "Eco Enrichers" (Page 102-104), exploring how plants and animals contribute to soil creation (recommended for grades 5-8).

- The United States Geologic Survey (USGS) has an education page with resources, information and activities for grades K-12. Site includes videos, lectures,

How is soil made?

The different materials that make up soil are created from decaying plant matter and the weathering of rocks and minerals. Decomposers, such as bacteria and fungi, will digest plant and animal matter into nutrients for living plants and animals. These nutrients also help to add an organic element to soil, known as **humus**. For the purposes of this discussion, **organic matter** refers to something that came from a plant, animal or other organism. In contrast, **inorganic matter** is a product that came from something that was never considered living, such as a rock or a metal. As inorganic matter weathers, through physical (freeze/thaw, wind, abrasion from other rocks), biological (organic acids), or chemical (oxidation) weathering, smaller pieces, based on their size, first become sand (largest in particle size), then silt, and finally clay (smallest in size). The Soil Textural Class Chart on the previous page shows how these different size substances create soils with different characteristics. The table below describes the composition of the five different soils identified near the North Campus Trail.

Code	Soil Name	Percent Sand	Percent Silt	Percent Clay
7B	Shohola-Edgemere Complex, 0-8% slopes, very rubbly	45.3%	43.2%	11.5%
30B	Wurtsboro stony fine sandy loam, 0-8% slopes, extremely stony	69.6%	16.4%	14.0%
30C	Wurtsboro stony fine sandy loam, 8-15% slopes, extremely stony	67.5%	21.0%	11.5%
38B	Swartswood stony fine sandy loam 0-8% slopes, extremely stony	68.5%	16.1%	15.3%
240F	Oquaga-Arnot Rock outcrop complex, 20-60% slopes, very rubbly	43.3%	39.7%	17.0%

Composition of soils found along the North Campus Trail, for the first twelve inches of soil. Percentage data courtesy of The Pennystone Project.

Local Topic on Soil and Geology:

Natural Gas Exploration

Gas drilling rig in Bradford County, Pennsylvania. Inset: Shale rock cuttings from the drilling process. Their dark color indicates a higher percentage of organic compounds contained in the shale. Shale rock with less organic content is lighter in color.

Pennsylvania news is filled with headlines about natural gas: "fracing" or "fracking" in the Marcellus and Utica Shale. Oil and natural gas exist below the surface in the bedrock of Pennsylvania due to geologic factors that took place nearly three hundred million years ago. During that time, Pennsylvania was located under a shallow sea. Most of the time, when plants and algae die, they decompose and are broken down into organic compounds that return to the carbon cycle. Oxygen is needed for this process to take place. When there is not enough oxygen to aid in decomposition, these plants and algae will settle to the bottom of the sea. As time progresses, inorganic soils and mud begin to cover up the plants and algae. After enough pressure from the soils, the water is pushed out, and the plant and algae matter is broken down into organic compounds known as **kerogens**. After more continued heat and pressure, kerogens can become oil and gas. These molecules wrap themselves

Discussion Questions

These questions are suggested starting points to help spur discussion and critical thinking about soils and geology and their impact on a local ecosystem.

- How do soils impact our everyday life? In what way does bedrock impact our daily life?
- What impact does soil composition have on a surrounding ecosystem?
- As you walk along the trail, take a look at the soil map. What differences in plant life do you notice that appear to correspond with the change in soil type? Do you notice any differences? What characteristics of a given soil type would influence these changes?
- Speculate as to some of the impacts to the forest community if a pollution event caused a disruption to the population of soil bacteria. What would happen if decomposers were absent from an ecosystem?
- Think about the geologic processes it takes to turn plant matter into oil and gas products. What characteristics of a living organism's chemical makeup could help to eventually create a high-energy product?
- Consider the needs of plants, animals, and humans when it comes to soil. Speculate as to why different soil types would be desired by each group.
- Why could Marcellus shale rock be considered organic matter? Is it organic or inorganic? Argue your case.

Life Underneath the Soil

Besides supporting plant life, soil provides habitat to a variety of animal, fungi, and other organisms. Besides a handful of insects, spiders and snails, Pennsylvania does not have a comprehensive distribution atlas of **invertebrates,** mushrooms, mosses or lichens (Rawlins and Bier, Pennsylvania Natural Heritage Program 2011). That said, here are a few species that may inhabit the soil along the North Campus Trail.

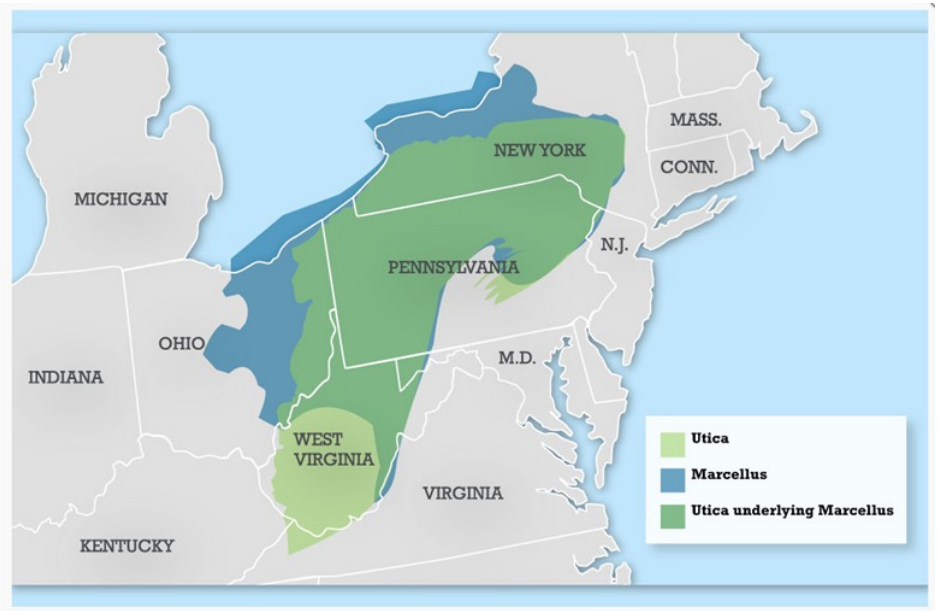
- **Bacteria:** Billions of bacteria cells inhabit the soil. A teaspoon of healthy soil will contain anywhere from 100 million to 1 billion bacteria cells. These microorganisms perform a variety of tasks, including decomposing of plant matter, fixing (acquiring) nitrogen for plants, serving as pathogens to plants, as well as obtaining their energy from compounds other than carbon (USDA Soil Biology Primer).

- **Mushrooms and Fungi:** While these have not been inventoried in Pike County in an official capacity, mushrooms, shelf fungi and other fungi have been spotted along the trail. These organisms also help to act as decomposers, breaking down plant and animal matter into usable nutrients. The mushrooms you see on the ground are generally considered to be the tip of the iceberg, with regard to the entire organism. Mushrooms can contain a large network of root-like structures, called hyphae that will extract nutrients from dead plants, animals and other organic matter.

- **Snails:** Snails are known to exist throughout Pennsylvania, in most terrestrial habitats, but their small sizes (1-25mm in shell diameter) prohibit an accurate inventory (Pearce). Snails will feed upon vegetation (consumers), but will also act as decomposers. Like mushrooms and fungi, snails also help in the decomposition process and will feed upon decomposing organic matter, converting it to usable nutrients by other organisms. Look for them following a rain event.

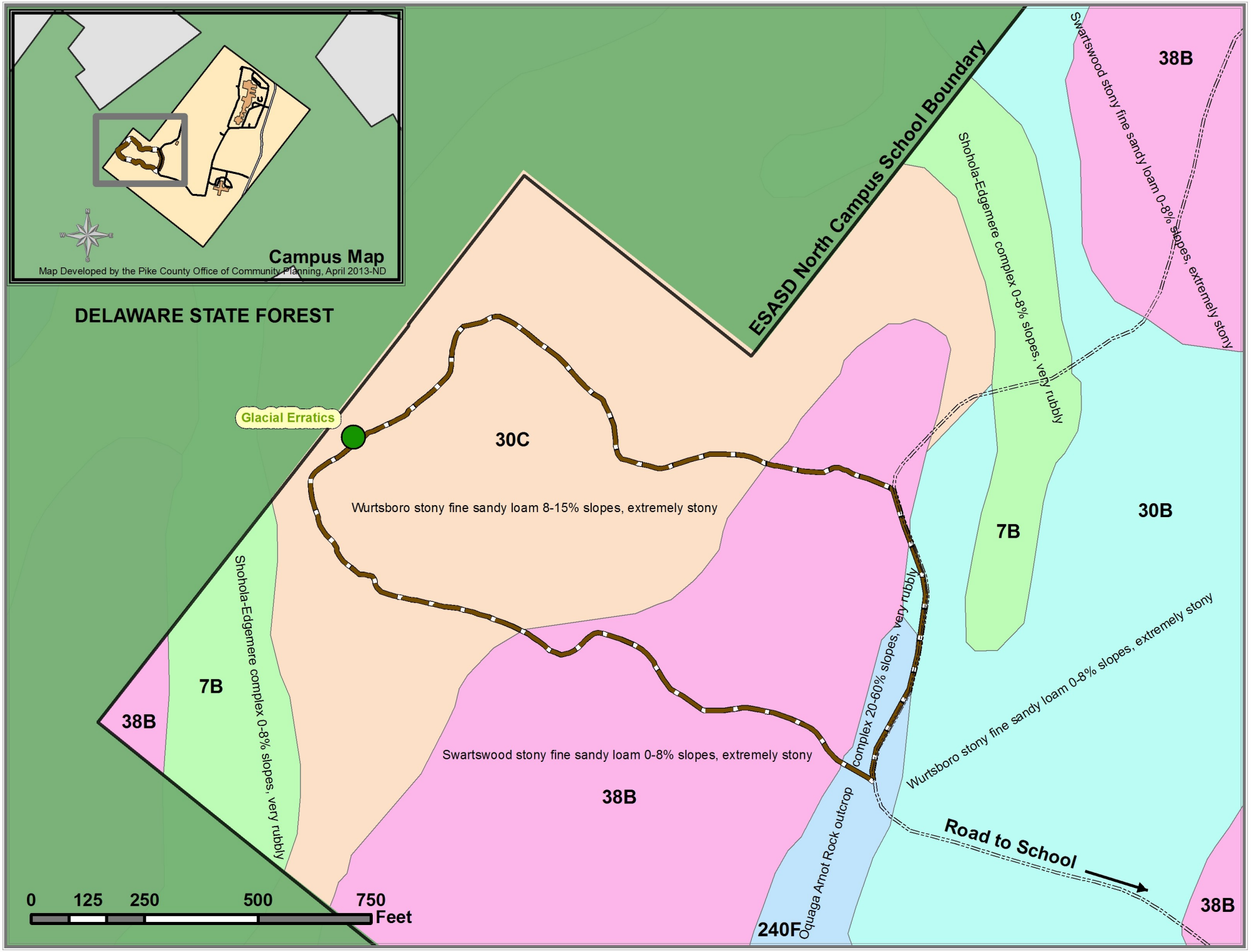
- **Earthworms:** Earthworms play a large role in the development of the soil creation matrix. People who compost their organic waste will add earthworms to the mix in order to quickly break down the matter into nutrient-rich soil.

around the microscopic surfaces of bedrock, in a process called **adsorption**. As time passes, these compounds will make their way to the earth's surface. Oil and gas trapped underground form reservoirs. These reservoirs are accessed in a number of different ways, depending on their specific geologic characteristics, and their location. While oil and gas extraction has taken place across Pennsylvania since the mid-



Marcellus and Utica Shale Formations. Image Source: Marcellus Shale Coalition.

nineteenth century, the most recent exploration into the Marcellus and Utica shales has garnered considerable attention. This is likely due to several factors, such as the increased depth below the earth's surface, the fact that these shales are relatively narrow bands of rock, and that extraction of oil and gas from these layers is different due to its unique geologic characteristics. As a result, extraction of oil and gas from these formations have taken place through horizontal drilling and hydraulic fracturing of the formation. To reach the oil or gas formation, drillers will first drill vertically down until they reach the desired formation. They will then drill horizontally through the formation to increase the amount of surface area of rock. The hydraulic fracturing process takes place when water, sand and chemicals are pumped into the well to push open cracks in the formation and further increase surface area where oil and gas can escape and then be collected at the surface.


Campus Map
Map Developed by the Pike County Office of Community Planning, April 2013-ND
DELAWARE STATE FOREST
ESASD North Campus School Boundary
Glacial Erratics
30C
Wurtsboro stony fine sandy loam 8-15% slopes, extremely stony
Swartswood stony fine sandy loam 0-8% slopes, extremely stony
38B
Shohola-Edgemere complex 0-8% slopes, very rubbly
7B
Wurtsboro stony fine sandy loam 0-8% slopes, extremely stony
30B
Oquaga Arnot Rock outcrop complex 20-60% slopes, very rubbly
240F
Road to School
0 125 250 500 750
Feet