# PROJECT 1
# What's the Big Deal about Dirt?

## Areas of Focus

- Biology: General ecology, microorganisms, environmental science
- Science (general): Experimental design, data gathering, calculating averages, preparing graphs
- Language arts: Preparing a journal and report of findings

Target Grade Level: 6 - 8

## The Science Behind the Project

When we think of the natural world, we most often think about plants and animals, topography (mountains, valleys), oceans, and the events that occur every day in the atmosphere (the weather). And when harm is inflicted on the natural world, we focus on things such as extinction of species, air and water pollution, loss of habitat and fire. But rarely do we think about that all too important element of our natural world that lies literally right below our feet - the soil. That stuff that covers almost all of the Earth's surface, from a few centimeters (cm) in some places, to many hundreds of meters thick in others, is usually taken for granted.

So what is so important about soil? Well, first, it forms the connection between the physical world of rock and the world of living things. Life is made of molecules, many of which are extracted from the physical rocks of the Earth. Those rocks need to be broken down to molecule size before living things can absorb it and make it into the molecules necessary for life. There is a lot of chemistry going on in soil to make that happen.

Second, soil provides the critical habitat needed by thousands of species of organisms, such as beneficial bacteria, fungi, and insects. These important organisms convert organic wastes into what in essence is natural fertilizer that can be taken up by plants and eventually animals. Without these minute recyclers in soil we would all be neck deep in leaves, food waste, dead bugs and other animals, animal feces, hair…. well, you get the idea!

Soil is both living and physical. The living part of soil, called the *biotic* component, we have already mentioned. The non-living, physical part of soil (the *abiotic* component) is comprised of the particles of sands, clays, and gravel. For healthy, functional soil, you cannot have one without the other. To learn about the specific soils of the Baldwin Hills Scenic Overlook, take the Overlook Tour. In the next set of activities, you will be taking a closer look at both the biotic and the abiotic aspects of soil. In doing so you will see that good healthy soil is a lot more than just 'dirt'.

## Activity 1: An Easy Way to Sort Soil

Soil scientists typically use a set of soil sifters to sort out soils in terms of the physical particles that make them up. Most schools lack access to such equipment, so in this exercise, a simple jar with a lid will suffice.

Materials – What You Need

- Soil samples
- Empty jars (1 quart size would work best)
- Dish soap
- Magnifying glass
- Water
- Marker pen
- Small ruler

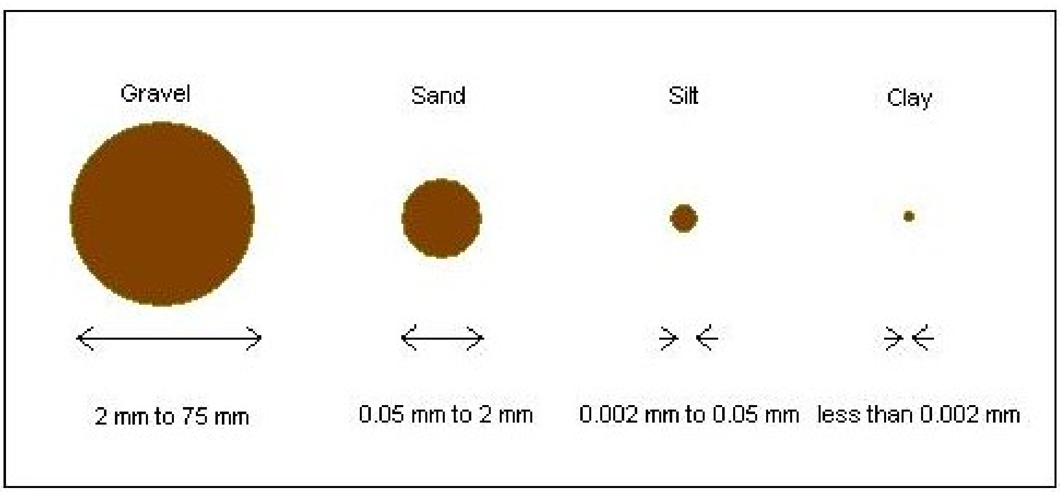
## Procedures – What You Do

1. Begin by filling a jar about ½ full of a natural soil sample. Avoid leaving any larger stones in the sample as these may break the jar.
2. Add water to saturate the soil with enough water to fill the jar within 2 cm or so from the top.
3. Add a couple of drops of dish soap into the jar.
4. Seal the jar. Shake the jar vigorously to break up all the clumps of material in the soil. This may take a couple of minutes depending on the soil type.
5. Let the jar sit undisturbed for about 5 – 10 minutes (or longer).
6. Carefully examine the jar and look for materials of different particle sizes that have formed layers in the bottom of the jar. Gravity has sorted the particles that make up soil, in terms of their size. Which size particles should be at the bottom?
7. Describe each of the layers in terms of particle size. Are there layers made of particles that you cannot see with your naked eye? Can you see the particles with the magnifying lens?
8. Use a marker pen to indicate the location of each layer. You may want to number each layer so you can keep track of them.
9. Measure the thickness of each layer using the ruler. Record your observations in the table like the one below:

| | Thickness (in cm) | | | |
|---|---|---|---|---|
| Soil Sample | Layer 1 | Layer 2 | Layer 3 | Layer 4 |
| | | | | |

10. Repeat steps 1 – 9 with another soil sample taken from a different location. How well do these samples compare in terms of the particles that comprise them?

Most soils are a mixture of particles of different sizes. These particles, by size, are as follows:




Sand and gravel can easily be seen without magnification. To see silt particles, you will need a magnifying lens to see the larger particles. Clay particles are too small to see with a magnifying lens, so you will need to pull out the microscope (assuming you have access to one).

Any experienced farmer or gardener will tell you that the best soils are those that are a mixture of all these particle sizes. Just the right combination of soil particles, mixed with a healthy mix of organic materials is referred to as a *loam*. Loam-type soils provide the best microenvironments for soil organisms. They also possess the right balance of water retention and percolation rates. The two last aspects of soil are the focus of the next activity.

## Activity 2: Just How Leaky is Your Soil?

One of the most important functions of soil is to hold onto water long enough for plant roots and soil microorganisms to use it. In that regard, soil has certain measureable qualities when it comes to water. One is percolation rate, which is the rate by which water passes through a column of soil. The second is water retention, which is the ability of soil to hold onto water. Both these aspects of soil have to do with the size of soil's *interstitial spaces*. These are the tiny spaces that exist between the soil particles. Of course, the size of the particles determines the size of those interstitial spaces. Can you predict how the size of a soil's interstitial spaces will affect its percolation rate and water retention?

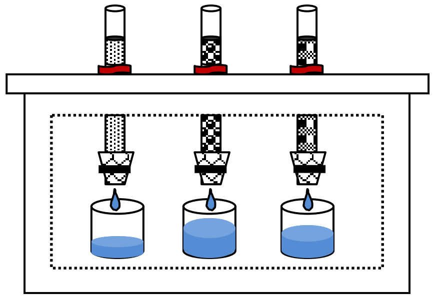
Materials – What You Need

- 3 - 1" diameter PVC pipe cut into 30 centimeter lengths (this material is easy to cut with PVC cutter pliers). Thicker pipe can be used as well.
- Cheesecloth, cut into 2" squares
- Rubber bands
- Sand (play sand is best)
- Pea gravel
- Straws
- Measuring cup or beaker (or similar calibrated glassware)
- Timer or stopwatch
- 3 empty jars
- A cardboard box (a file box will work well)

Procedures – What You Do

1. To begin, cut 3 holes in the lid of the cardboard box (in a row) so that the PVC tubes fit snugly.
2. Cut one side of the cardboard box open so that you can see the inside when the lid is placed on top (see diagram below).
3. Cover one end of each tube with cheesecloth, securing it with rubber bands.
4. Fill one tube ½ full of sand. Since you cannot see through the PVC, use a straw to determine how full your tube is (it should be about 15 cm from the top of the tube).
5. Repeat Step 4 using the pea gravel.
6. In the third tube, repeat Step 4, but use a mixture of both sand and gravel. Mix the material thoroughly before putting it in the tube.
7. Slide each tube through the lid from below so as to avoid the cheesecloth. Use rubber band around the PVC tubes to prevent them from sliding back down the holes. Position the tube in a way that their bottoms are above the jars but not inside of them. These jars are going to be collecting the water than passes through the tubes.
8. Starting with the gravel-filled tube, pour 50 milliliters (ml) of water into the top. Have your stopwatch ready as you are going to measure how fast the water passes though the column of gravel (this can be tricky, but so is the nature of science). As soon as water first appears at the bottom of the column, start the stopwatch. As soon as the flow of water slows to a drip, stop the stopwatch.
9. Measure how much water has collected in the jar. Using that measurement, calculate the percolation rate, which in this case is the volume of water measured in ml passing through the column of material per second.
10. Let the tube remain in place until the dripping stops.
11. Subtract the volume of water collected in the jar from the amount poured into the soil. This number represents the amount of water retained, or still held by the soil. For example, if you collected 35 ml of water, then 50 ml – 35 ml = 15 ml of water retained by the soil.

12. Repeat steps 8 through 11 for the remaining two tubes.
13. These types of data, in which we are comparing what is referred to as *treatments*, are best represented by a bar graph, with soil type along the x-axis and percolation rate and water retention along the y-axis (as two separate graphs).
14. How do the data compare? What problems would plants face if the percolation rate was too high? Or if the water retention was too great?



This experiment really makes clear the importance of loam-type soils in controlling percolation rate and water retention. A simple gardening trick is to pour water on the surface of the ground to get a sense of how fast water percolates below. Water that quickly travels down and disappears and water that pools on the surface for a long time suggests an improper mix of materials, so sands and/or clays may need to be added. In the Baldwin Hills, improper percolation rates can pose a problem. Too slow a rate and water will simply run downhill and away from roots of plants; or plant roots may drown in water-soaked soil due to high levels of water retention (heavy clay soils are notorious when it comes to low percolation rates). Too fast a percolation rate and the plant's roots will not be able to capture the water before it travels too deep into the ground.

## Activity 3: Is Anyone Alive in There?

Living organisms represent that other side of the soil equation. Most of them, such as bacterial, single-celled protists, and fungal spores are too tiny to see without a good microscope. But the more macroscopic soil creatures are familiar to most anyone who has taken the time to dig around in the dirt – like insects, earthworms, and fungi. In this next activity, you will focus on the macroscopic members of the soil. Here you will be constructing a Berlese (pronounced ber-lace-ee) funnel - standard equipment of the soil ecologist.

Materials – What You Need

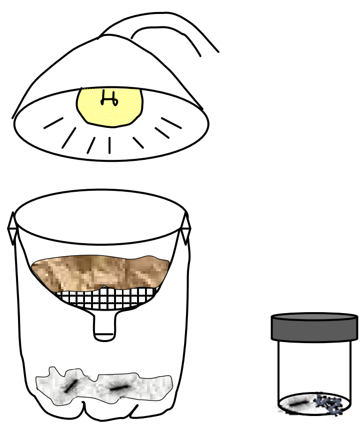
- (1) 2-liter plastic bottle, cut in half
- A reading lamp tall enough to position above the container
- A soil sample from the yard. The soil should be from a more moist area and include lots of leaf litter
- A piece of screen, the diameter of the 2-liter bottle
- Several sheets of paper towel
- A holding jar (with lid)

Procedures – What You Do

1. Begin by placing damp a paper towel in the bottom of the 2-liter bottle
2. Place the neck end of the bottle down into the lower half, using paper clips along the edge to keep the neck half from sliding down too deep (see diagram below).
3. Place the piece of screen/hardware cloth in the bottom of the neck half of the bottle.
4. Carefully place your soil sample onto the screen.

5. Position the reading lamp over the apparatus, but not too close as to cause the 2-liter bottle to melt. The heat from the lamp will drive the larger soil organisms down through the neck to toward the moisture of the paper towel.
6. Let the apparatus sit for one day. Watch closely for the appearance of insects and other organisms as they make their way to the damp paper towel.
7. Now collect your specimens into a holding jar and examine them. How many different kinds of organisms can you see? Try to draw or photograph some of them and include them in your journal.

The Berlese funnel is a fast and easy way soil ecologists can tease the larger soil organisms out of the soil. These organisms help to breakdown the organic material of the soil, such as the leaf litter, to a condition in which plant root systems can use the material as a natural fertilizer. What the Berlese funnel does not reveal is the presence of the many species of microscopic organisms that are critical for living soil to function as a nutrient recycling center, many of which of include beneficial bacteria.



## Going Further

- If you have access to a microscope and microscope slides, you can make a slide of living soil microorganisms. To do this, simply take a small sample of good healthy soil into a small jar and add enough spring or distilled water to liquefy the soil (tap water may harm the microorganisms). Using a dropper, make a slide of this liquid and examine it under the microscope. You will be astonished how many living organisms you see. Don't worry about drowning them, as microorganisms living in soil are actually aquatic in nature. They live their entire lives in the thin coating of water that collects on the surface of soil particles.

- Farmers can tell good healthy soil from unhealthy soil simply by smelling it. Try this yourself by placing soil in bags and jars and taking a long hard sniff. Does all soil smell the same? What does healthy soil smell like? To what degree is the smell of soil due to the microorganisms that live inside? To answer this question, take a sample of what you believe is healthy, living soil, and divide it into two halves. Place one half in a zip-lock bag or clean jar that has been sealed. Place the other half in a pie pan or cookie sheet and keep it in a 350° oven for 30 minutes. Let the soil cool, and add water until it is about the same moisture as the other half. Now place this sterilized sample in a second jar and perform your sniff test. Can your nose tell the difference between the two samples?

## Wrap It Up

Today, much of Earth's living soils are under siege as a result of various human activities. These include the poisoning effects of artificial fertilizers, pesticides, and herbicides. Overharvesting of forests and intense unsustainable farming practices result in soil becoming so destabilized that it either washes away in heavy rains or blows away in strong winds. The laying of concrete and asphalt quickly kills underlying soil. Healthy living soil is central to a functioning ecosystem. How can you maintain healthy soil in your garden? Simple practices include leaving some leaf litter on the ground at all times. This material, also known as *detritus*, provides homes and food for soil organisms. As it breaks down, it forms the organic surface of soil called *humus*. It is this dark humus layer that gives good soil its unique odor. This detritus also helps to keep water in the soil. This is particularly important in the drier climate of Southern California. Another way of maintaining healthy soils is to limit the use of artificial fertilizers and pesticides that can kill soil organisms. Never underestimate the ecological power of good, healthy soil. So go out there and thank some dirt!