

Accompanying Worksheet: Soil Bulk Density (W-S-07)

Objective: Students will take samples in the field of each horizon at the sample site. They will use a scale, a sieve, and a graduated cylinder to determine how much of the soil density is attributed to rocks. They will also use graphing skills to visually represent their data and test hypotheses.

Considerations:

1. It is advised that you complete the Soil Characterization protocol before embarking on this activity, for the purpose of introducing your class to the concept of soil horizons and properly identifying them at your sample site. This is not necessary, however, as long as your class is sufficiently knowledgeable.
2. The samples taken in this activity can also be used in the Soil Moisture protocol, provided you take a wet mass of your sample as soon as you return to the classroom, and we recommend that they be performed concurrently. Refer to the Soil Moisture protocol for further instructions.
3. This activity may require using tools to take samples if the soil is dry or hard. Be sure that your students can handle them responsibly.
4. Choose your study site carefully. Contact local power companies to verify that your site is not located near any cables.
5. After being dried and sieved, the samples can be stored and used for the Soil pH protocol.
6. If you are sampling in an area where the soil is hard, rocky, or dry enough to make digging difficult and cannot find a natural or artificial cutaway, you may wish to forgo the depth sampling in favor of site sampling. That is, you may wish to take samples from different areas (perhaps from around a tree, in a stream bed, near a roadway, etc) at a uniform depth of 5 or 10 cm, to avoid the frustration of digging a deep hole in hard soil.

Materials: In the field

- ___ Worksheet W-S-07
- ___ Sample containers (metal is better. We suggest soup cans or cat food cans. Failing all else, plastic drinking cups that are cut to leave about 2 inches above the base, can be used). You will need 3 for each horizon.
- ___ Hammer and nail
- ___ Trowels
- ___ Meter stick
- ___ Plastic wrap (optional)

Materials: In the classroom

- ___ Worksheet W-S-07
- ___ Scale (with at least 0.1 g sensitivity)
- ___ Graduated Cylinder
- ___ Water
- ___ #10 2mm sieve (alternative: Window screen. Not as scientific, but will work in a pinch)
- ___ Small bowl or paper plate

Instructions

Before Leaving the Classroom:

1. Mark each container with a unique ID. Take the volume of your container by filling it with water and pouring it into the graduated cylinder. Remember to measure at the meniscus! Record the volume of each container on the table provided on the worksheet.
2. Use the hammer and nail to poke a small hole in the center of the bottom of each sample container.
3. Weigh each container on your scale, and record the mass on the table provided with the worksheet.

In the Field:

1. If the soil site has already been characterized per the Soil Characterization protocol, simply refer to the instructions pertaining to taking samples (Steps 5-7, 11).
2. Expose your study site by removing all vegetation and scraping off the top layer of soil to uncover a fresh layer.
3. Using the trowel, begin digging downward into the soil. Attempt to keep the sides of the hole as vertical as possible. This will reduce incidents of collapse. The hole should be wide enough to reach your arm down with the container. We suggest starting with a diameter of 1 foot as the hole will inevitably narrow as it gets deeper.
4. Continue digging until you see a marked change in soil texture, color, moisture, or composition. This means you have reached the second soil horizon and have thus completely exposed the first.
5. Place the container against the side of the hole and press it into the soil. The puncture you placed in the bottom of the container will allow air to escape. You will know the container is full when soil starts coming out of the puncture hole.
 - a. If the soil is too hard and you are unable to press the container into the soil, lightly tap the hammer against the edges.
6. Smooth off any irregular clumps from the top of the sample to create a flat face.
7. Record on the table the depth and horizon number of the sample.
8. Take 2 additional samples at this horizon.
9. Continue digging until the second horizon is fully exposed. Repeat the sampling procedure (Steps 5-7).
10. Repeat for as many horizons as feasible.
11. You may wish to cover the sample containers in plastic wrap to avoid accidental spilling.

In the Classroom:

1. Wait until your samples have dried. The simplest way to achieve this is to set the samples on a windowsill in your classroom. Check daily if the samples are dry. Unless your samples were quite moist, 48 hours should be plenty.
 - a. If you used metal containers, you also have the option of drying the samples in an oven: bake them at 100 degrees and check every 10 minutes.
2. Weigh the samples on the scale, and record the mass on the table provided.
3. Pour the sample through the sieve, collecting the throughput soil on the paper plate. Use your hand to lightly brush back and forth on the top of the sieve to break apart clumps push soil through. DO NOT FORCE IT! Rocks larger than 2mm will remain on top of the sieve.

4. Weigh the rocks on the scale and record the mass.
5. Take the volume of the rocks: fill the graduated cylinder to a predetermined amount (say 20 ml), and gently drop the rocks into the cylinder. The difference between this final reading and the initial reading is the volume of the rocks. Record rock volume on the table.
6. Calculate **Bulk Density = (Sample Mass-Rock Mass)/(Sample Volume-Rock Volume)**. Since the object of this activity is to determine how tightly packed the soil is, this calculation alters the typical density equation ($D = M/V$) to account for the contributions made by the rocks.
7. Use the worksheet to answer further questions.
8. If you intend to use the samples for the soil pH protocol, store the dried, sieved soil in sealed, properly-labeled bags or containers.

Adapted from GLOBE Soil Bulk Density Protocol:
<http://www.globe.gov/documents/352961/353769/bulkden.pdf>

Visit www.flagstaffscies.org for more information and field worksheets!