

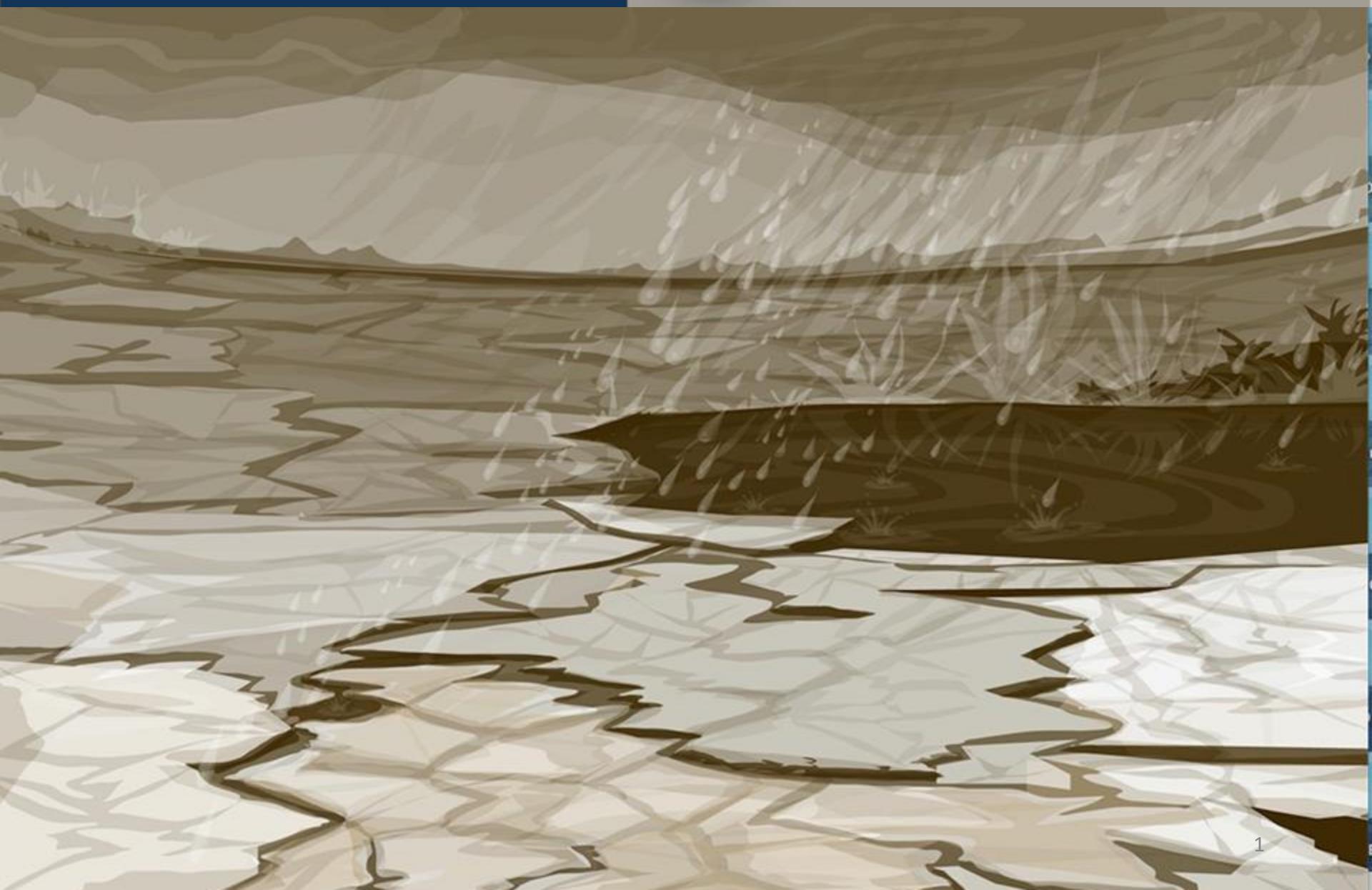


# GLOBE PROGRAM®

A Worldwide Science & Education Program



## Soil (Pedosphere) Infiltration Protocol





A. Why measure infiltration?

B. Soil properties affecting infiltration

C. When and where to measure

D. Required Equipment

E. Preparing a dual-ring infiltrometer

F. Measuring infiltration rates

G. Report data to GLOBE

H. Data Visualization

I. Additional information

## Overview and Learning Objectives

Soil infiltration is a measure of the rate at which soil is able to absorb rainfall or irrigation water. This module provides step-by-step instructions in how to do the Infiltration Protocol.

### Learning Objectives:

After completing this module, you will be able to:

- Explain why soil moisture is worth studying
- Decide where to do an infiltration measurement
- Determine a schedule for taking this measurement
- Measure infiltration using a dual-ring infiltrometer
- Measure gravimetric soil moisture content
- Report these data to GLOBE

To complete the protocol, you will also need to learn either the [Gravimetric Soil Moisture Protocol](#) or [SMAP Soil Moisture Protocol](#).

*Estimated time needed for completion of this module: 1.5 hours*



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## What is a Soil Infiltration Rate?

The infiltration rate is determined by measuring the time it takes for water sitting on a soil to drop a fixed distance. This rate changes with time as the soil pore spaces, filled originally with air, fill with water.

There are three flow rates:

- Unsaturated flow is the initial flow rate and is high as the dry soil pore spaces fill with water.
- Saturated flow is a steady flow rate that occurs as water moves into the soil at a rate determined by soil texture and structure.
- Ponding is the flow rate that occurs when the ground becomes totally saturated and is no longer able to conduct water through its pores.



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## The Role of Soil Moisture in the Environment

- Soil acts like a sponge spread across the land surface. It absorbs rain and snowmelt, slows run-off and helps to control flooding.
- The absorbed water is held on soil particle surfaces and in pore spaces between particles. This water is available for use by plants.
- Some of this water evaporates back into the air; some of this water is transpired by plants; some drains through the soil into groundwater.
- The infiltration rate of water into soil changes depending upon the level of soil saturation. Water that is not stored in the ground evaporates or becomes runoff and may pool on the surface for a time. It is possible to determine how flood-prone an area is, based on the infiltration rate of the soil.



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## The Importance of Infiltration

The rate at which water flows through the soil affects how much water is available for plant use; how nutrients and other particles move through the soil; the amount of water available for use by animals; and the length of time the water will remain in the soil.

### Soil Infiltration Is Important Because It Affects:



Water For Plant Use



Flooding



Evaporation Rates



Water Storage



Weathering and Erosion



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## Soil Properties Affect Infiltration Rates

A soil's structure, texture, density, and relative amount of organic material affect the speed at which water flows through soil.

If the soil is dense and/or compacted, water will likely move through it more slowly.

If the soil has relatively little pore space or is already saturated, flooding or run off will occur.

Organic Soil



High Clay Soil





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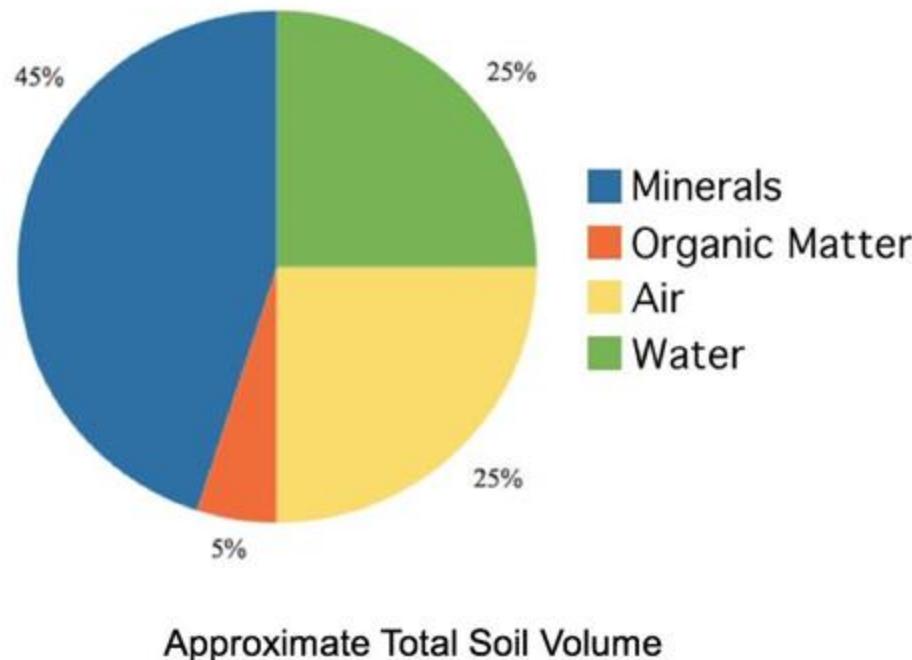
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## Ideal Soil Composition



The air and water in soil represent the soil's pore space. Volumetrically, they should comprise approximately 50% of the soil's volume.

The pore space allows for movement of air, water, and organisms through the soil.



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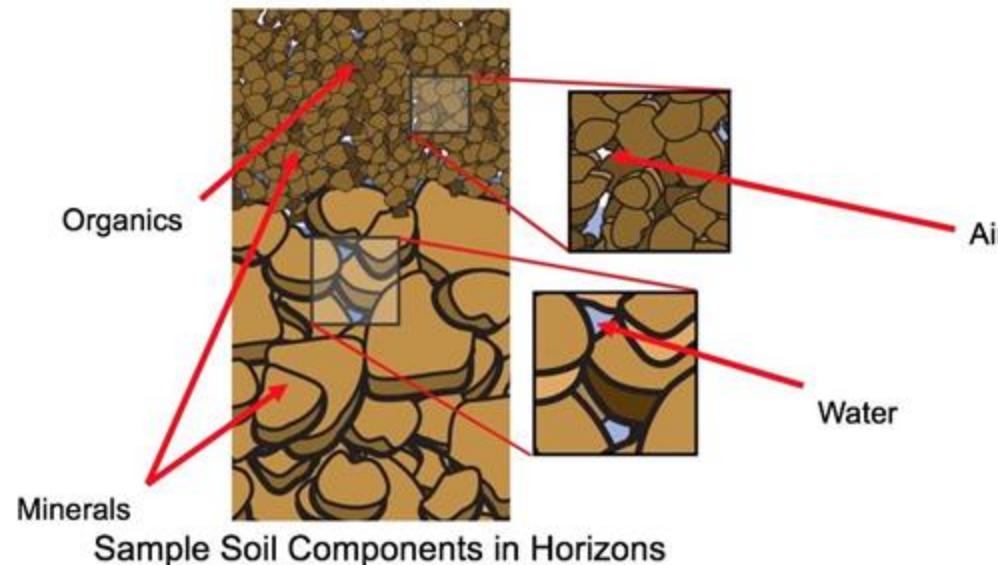
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## Sample Soil Components



If soil pore space increases and density decreases, water moves through soil more quickly. If the pore space decreases and soil's density increases, water moves through the soil more slowly.

A high infiltration rate keeps water and nutrients available to plants for growth. A too-high rate might lead to unwanted chemicals and nutrients in the groundwater or other subsurface water.

A low infiltration rate might lead to increased run-off, which might also lead to flooding and erosion.



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## Overview of Protocol

<b>Where</b>	Conduct this protocol at your soil moisture study site and your soil characterization sample site, within 5 m of your sample site
<b>Key Equipment</b>	Infiltrometer, can be built using 2 different sized coffee cans
<b>Time</b>	One class period to build and test the double-rig infiltrometer; 45 minutes to make the measurement
<b>Frequency</b>	3-4 times a year at Soil Moisture Study Site 1 time at Soil Characterization Sample Site
<b>Documents needed</b>	<a href="#">Soil Infiltration Protocol and Field Guide</a> <a href="#">Soil Infiltration Data Sheet</a>



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## Required Materials

- Metal ring with a diameter of 10 - 20 cm (Coffee cans work!)
- Metal ring with a diameter of 15 - 25 cm (Coffee cans work!)
- Buckets or other containers to transport at least 8 L of water to the site
- Ruler
- Waterproof marker
- Stop watch or watch with a second hand
- Block of wood
- Hammer
- Three soil sample containers suitable for soil moisture measurement
- Grass clippers
- Funnel



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## Constructing a Dual-Ring Infiltrometer

- Cut out the bottom of your cans



- Place one inside the other and be sure that the distance between the walls of the cans is between 2-5 cm.

2-5 cm



*Caution students when cutting the bottom of the cans, and when handling the cans when doing the infiltration protocol- the raw edges are sharp.*



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## Measuring your Dual-Ring Infiltrometer

- Measure and record the width of your reference band (in mm).
- Measure and record the widths of your inner and outer rings (in cm- see below).





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## Marking the Outside of the Dual-Ring Infiltrometer

Mark 2 cm and 5 cm from the bottom of each can as a reference for when you will push the can into the soil at least 2 cm but not deeper than 5 cm.





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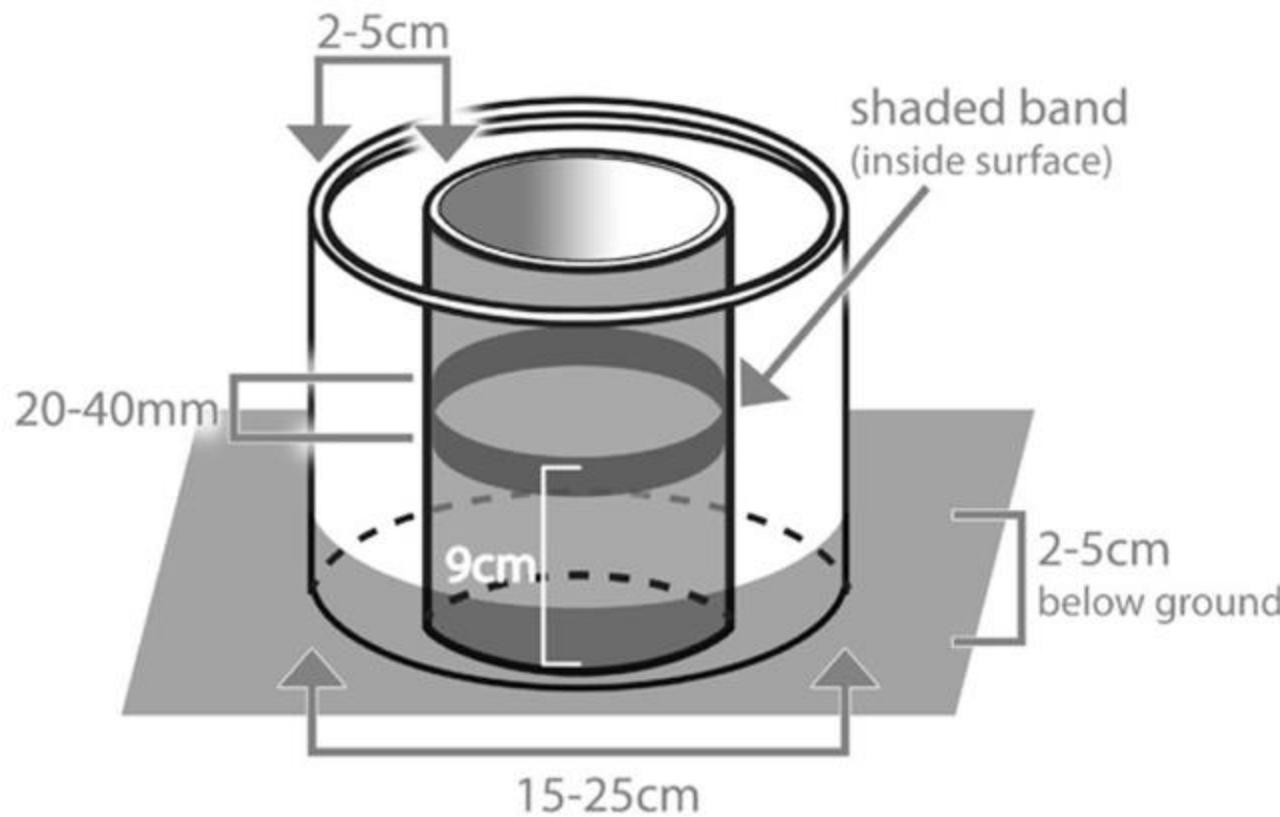
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## Diagram of the Finished Dual-Ring Infiltrometer

This illustration shows a fully constructed Dual Ring Infiltrometer in the soil.





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## Measuring Infiltration Rates: Clear Vegetation

Clip any vegetation (grass) to the ground surface and remove all loose organic cover over an area just larger than your largest can. Try not to disturb the soil.





# Soil (Pedosphere)



# Soil Infiltration Protocol

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## Push Cans into the Soil

- Starting with the smaller can, twist the cans 2 - 5 cm into the soil.





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## Instilling Cans in Hard Soil

You may use a hammer to pound the can into the surface. If you do, place a block of wood between the hammer and the top of the can to distribute the force of the hammering.

Do not hammer so hard that the can crumples, but a little bending at the top is okay.





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## Overview of Measuring Soil Infiltration

- Once the rings are in the soil, if you are using a stop watch, start it.
- Pour water into both rings
- When you pour water into the rings, the outer ring should not be leaking water to the surface around its rim. If it is, start over in another location, push the outer ring deeper into the soil, or pack mud around its base.
- Prepare to record your data with the Data Entry app or on the Data Entry Sheet





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## Pouring Water into the Rings

In the inner ring, pour water to just above the upper reference band and maintain the same water level of the outer ring.





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## Topping up the Outer Ring

The level of the water in the outer ring tends to drop faster than the inner ring as water spreads outward and not just downward.

To keep the water in the inner ring flowing only downward it is important to keep the water level in the outer ring at the same level as the inner ring by adding water to the gap between the rings.





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## Begin Timing Infiltration Rate

- As the water level in the inner ring reaches the upper reference mark of the band, read the stop watch or note the time to the second.
- This is your start time.
- Record this time in the Data Entry App, or on the Data Entry Sheet.





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## Maintain the Water Level in the Outer Ring Equal to the Water Level in the Inner Ring

During the timing interval, keep the water level in the outer ring approximately equal to the level in the inner ring.





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## Record the End Time

As the water level in the inner can reaches the lower reference mark, note the time on the stop watch. This is your end time.

Be careful not to pour water into the inner ring (using a funnel can help).





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## Troubleshooting: Soils Impervious to Water Infiltration

At times, some clays and compacted soils will be impervious to water infiltration and your water level will not drop to the bottom of the marked band in a 45-minute time period.

In this case:

- Record the time at which you stopped your observations as the end time.
- Record the level to which the water fell and report it as the:
  - “Height Above Ground (Lower Mark)”.
- Your infiltration measurement will consist of a single interval.



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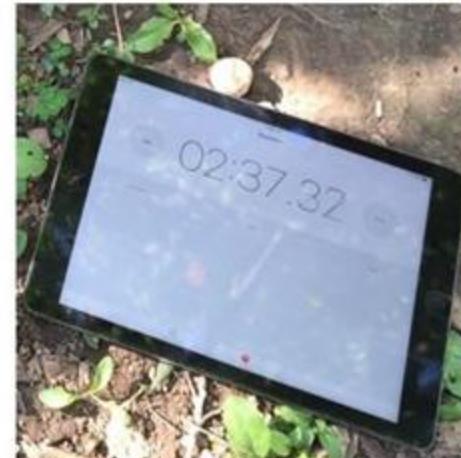
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## Recording and Calculating the Time Interval

- Record your end time in the Data Entry App, or on the Data Entry Sheet.
- Calculate the time interval by taking the difference between the start and end times.
- Record this interval on the Data Entry App, or on the Data Entry Sheet.



$$3:39 - 2:37 = 1:02$$



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## Repeat Measurement

Refill the two cans to the level of the top of the band.

Repeat timing the fall of the water level in the inner ring for 45 minutes or until two consecutive interval times are within 10 seconds of one another.

After you have finished the previous steps, **wait five minutes**. If the water has not soaked into the soil, remove the cans.



3:39-2:37=1:02



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## Infiltration Measurement of a Top 5 cm Soil Moisture Sample- 1

Take a single 0-5 cm soil moisture sample from where the inner ring sat.

Proceed to measure the gravimetric soil moisture of this sample following the Gravimetric Soil Moisture Protocol.





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## Infiltration Measurement of a Top 5 cm Soil Moisture Sample- 2

Make two other infiltration measurements within a 5 m diameter area of your first sample site. These measurements can be done at the same time using other groups or over several days (if the near-surface soil water content is not changed by rain).

It is not critical that multiple runs have the same number of reading sets, but do not submit runs that are incomplete (e.g. a run that was cut short due to lack of time).

Report your data to GLOBE even if you conduct one or two series of infiltration measurements. If you take more than three sets of measurements, enter your three best sets on the Data Entry App.



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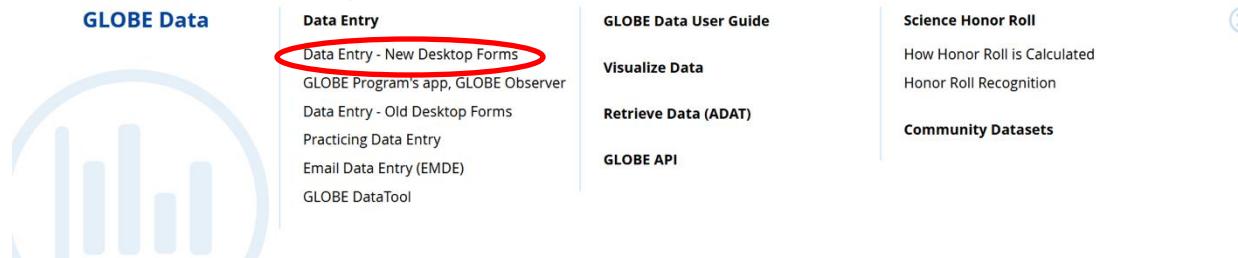
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## Reporting Data to GLOBE

### Two Options for Uploading Data:

These methods all allow users to submit environmental data – collected at defined sites, according to protocol, and using approved instrumentation – for entry into the official GLOBE science database.

1. Download the GLOBE Observer mobile app from the [App Store](#).
2. [Data Entry](#): Visit [globe.gov](http://globe.gov), click on the “GLOBE Data” tab, then underneath “Data Entry” click on “Data Entry – New Desktop Forms”.





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## Soil Infiltration Site Creation

If this is your first time making Soil Characterization observations at this location, you will need to create a new Soil Characterization site before entering data.

To do this, please review the Soil Characterization training.



# Soil (Pedosphere)



# Soil Infiltration Protocol

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## Soil Infiltration Protocol Data Entry

The GLOBE PROGRAM

THE GLOBE PROGRAM

GLOBE Observer

Choose your protocol:

Data Entry (Now including Pedosphere!)

Clouds

Mosquito Habitat-Mapper

Land-Cover

Trees

Atmosphere • Hydrosphere • Biosphere • Pedosphere

Data Entry

Welcome,

New Observation(s)

Review/Send Observations

Edit/Delete Measurements

Create/Edit My Sites

My Observations

To enter data, first return to GLOBE Observer main page by clicking the home button in the bottom left.

Select “Data Entry”.

Next, click “New Observation(s)”



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## Entering Measurement Data

The screenshot shows the GLOBE Pedosphere measurement data entry interface. On the left, a sidebar titled "Select Protocols" lists categories: Atmosphere (0), Biosphere (0), Hydrosphere (0), and Pedosphere (1). Under Pedosphere, there are two sections: "Soil Characterization" and "Soil Moisture and Temperature". Under "Soil Characterization", "Soil Infiltration" is checked. Other options include: Soil Bulk Density, Soil Particle Size Distribution, Soil Fertility, Soil Particle Density, and Soil pH. Under "Soil Moisture and Temperature", options include: Soil Moisture - Gravimetric, Soil Moisture - SMAP, and Soil Temperature. At the bottom of the sidebar are navigation icons for back, forward, search, and help. The main area is titled "Site Location" and contains a sub-instruction: "Select your site from this list of sites shown on the map:". Below this is a search field labeled "Search Site Names" with a magnifying glass icon. A list of sites is shown: "Test entry site", "Yankovich unburned area frost tube", "Yankovich burned area frost tube", and "Museum Birch". A "Show ten more" button is at the bottom of this list. At the very bottom is a large "New Site Location" button with a plus sign and a gear icon for settings.

Under the Pedosphere tab, select “Soil Infiltration” then click Continue at the bottom of the page.

Next, select your Soil Characterization Site. Existing sites near you will show up below “Search Site Names”



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## Entering Measurement Data

< Date and Time

Enter the local date and time of the observation:

Local Date: 2025-11-07 

Local Time (24hr): 10:56:00 

[Get Current Time](#)

Observation Date: 2025-11-07 UTC  
Observation Time: 19:56 UTC  
Solar Noon: 21:35 UTC

[Soil Infiltration](#)

- Enter the date and time you took the measurements.
- Once you enter the date, select Soil Infiltration to enter your data.



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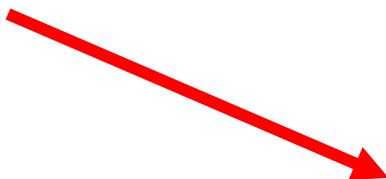
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## Enter Specifications of your Dual Ring Infiltrometer



Soil Infiltration

Set 1

Water Level Change (Interval Depth)

Height Above Ground Level (Upper Mark) \*

Height Above Ground Level (Lower Mark) \*

Diameter of the Inner Ring \*

Diameter of the Outer Ring \*

Saturated Soil Water Content (Below rings, 0-5 cm, at end of experiment)

Wet Weight (g) \*

Dry Weight (g) \*

Weight of Can (g) \*

Home

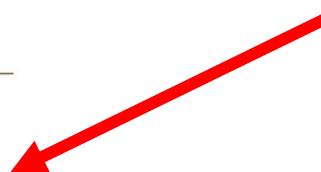
Back

Forward

Help

?

Enter the soil moisture data you collect for the saturated soil from the center of the infiltrometer at the end of the protocol.





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## Adding Sequence Times

Add sequence start and end times.

Click “Add Sequence” to add another set of sequence times.

Soil Infiltration

Saturated Soil Water Content (Below rings, 0-5 cm, at end of experiment)

Wet Weight (g) \*

Dry Weight (g) \*

Weight of Can (g) \*

Enter the sequence of times below related to a single continuous infiltration experiment

Sequence #1

Start Time (24hr): 00:00:00

End Time (24hr): 00:00:00

Sequence #2

Add Sequence



# Soil (Pedosphere)



# Soil Infiltration Protocol

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## Review data entry and send data

Review

► Date/Time 2025-11-07 / 10:56:00

► Atmosphere	0
► Biosphere	0
► Hydrosphere	0
▼ Pedosphere	1

Soil Infiltration

Set 1

Height above Ground Level (upper mark):  
25mm

Height above Ground Level (lower mark):  
21mm

Diameter of the inner ring:  
14cm

Diameter of the outer ring:  
18cm

Review

Diameter of the outer ring:  
18cm

Wet weight g:  
45g

Dry weight g:  
31g

Weight of can g:  
5g

Sequence #1

Start Time (24hr):  
11:15:00

End Time (24hr):  
11:30:00

Review the data you entered and check for errors.

When complete, select Finish to complete the send the observation to GLOBE.



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## Data System Responses

If your observations are within the appropriate ranges, you will see a green smiley face.

You can review or edit your observation if needed.

When ready, select “Send these measurements now” to send your data to GLOBE. When it has been sent, you will see a “Success” message.

### Concluding Options



Your Data has been saved on this device

Send These Measurements Now

Review/Edit Observations

Return Home

### No observations collected

Select All

No Observations Recorded

Success

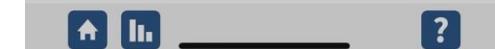
Your observation has been successfully sent to GLOBE.

OK

See Today's Land Cover Measurements

See Today's Tree Height Measurements

See Current NASA Data





# Soil (Pedosphere)



# Soil Infiltration Protocol

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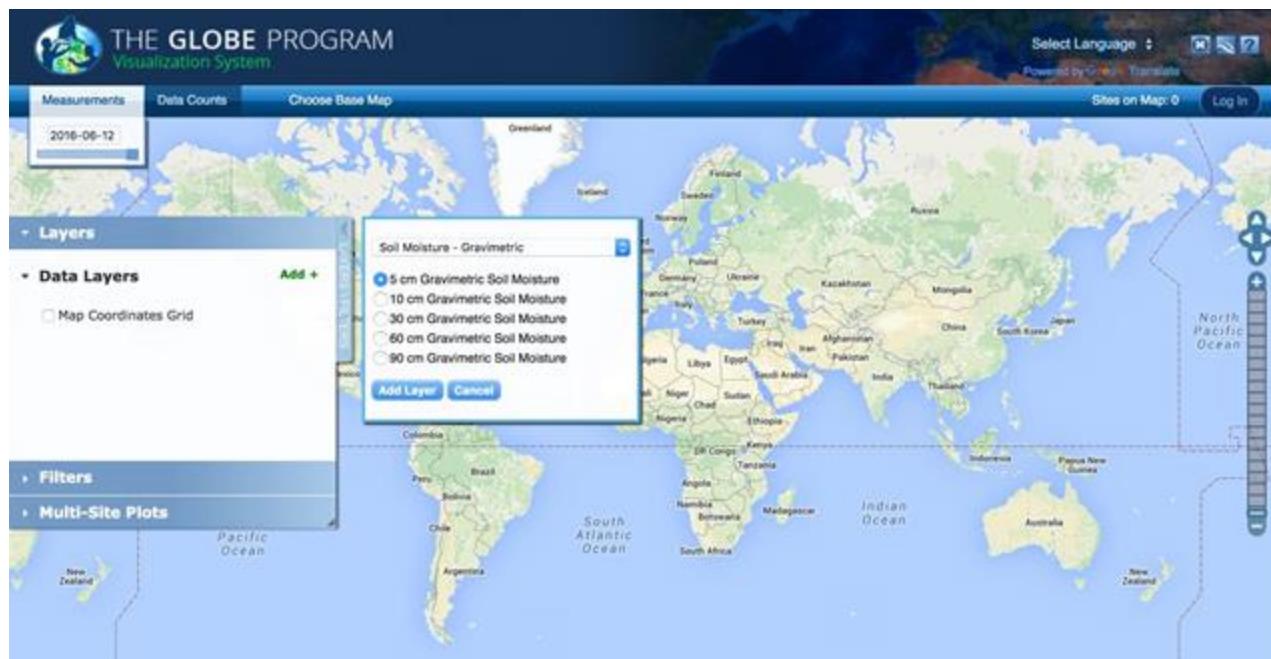
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## Visualizing Data-1

Currently soil infiltration data are not available in the GLOBE Visualization System. However, soil moisture data are available and are shown below.





# Soil (Pedosphere)



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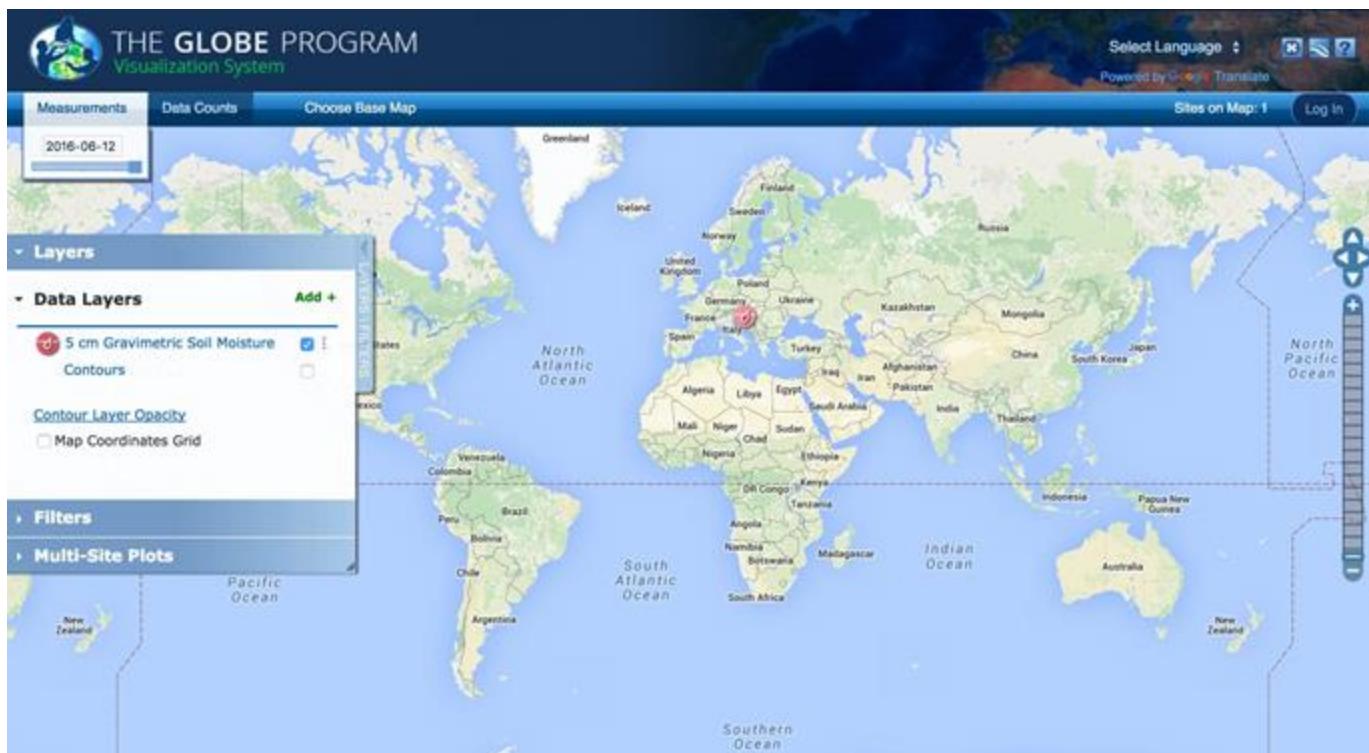
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## Visualizing Data-2

Currently soil infiltration data are not available in the GLOBE Visualization System. However, soil moisture data are available and are shown below.





# Soil (Pedosphere)



# Soil Infiltration Protocol

A. Why measure infiltration?

B. Soil properties affecting infiltration

C. When and where to measure

D. Required Equipment

E. Preparing a dual-ring infiltrometer

F. Measuring infiltration rates

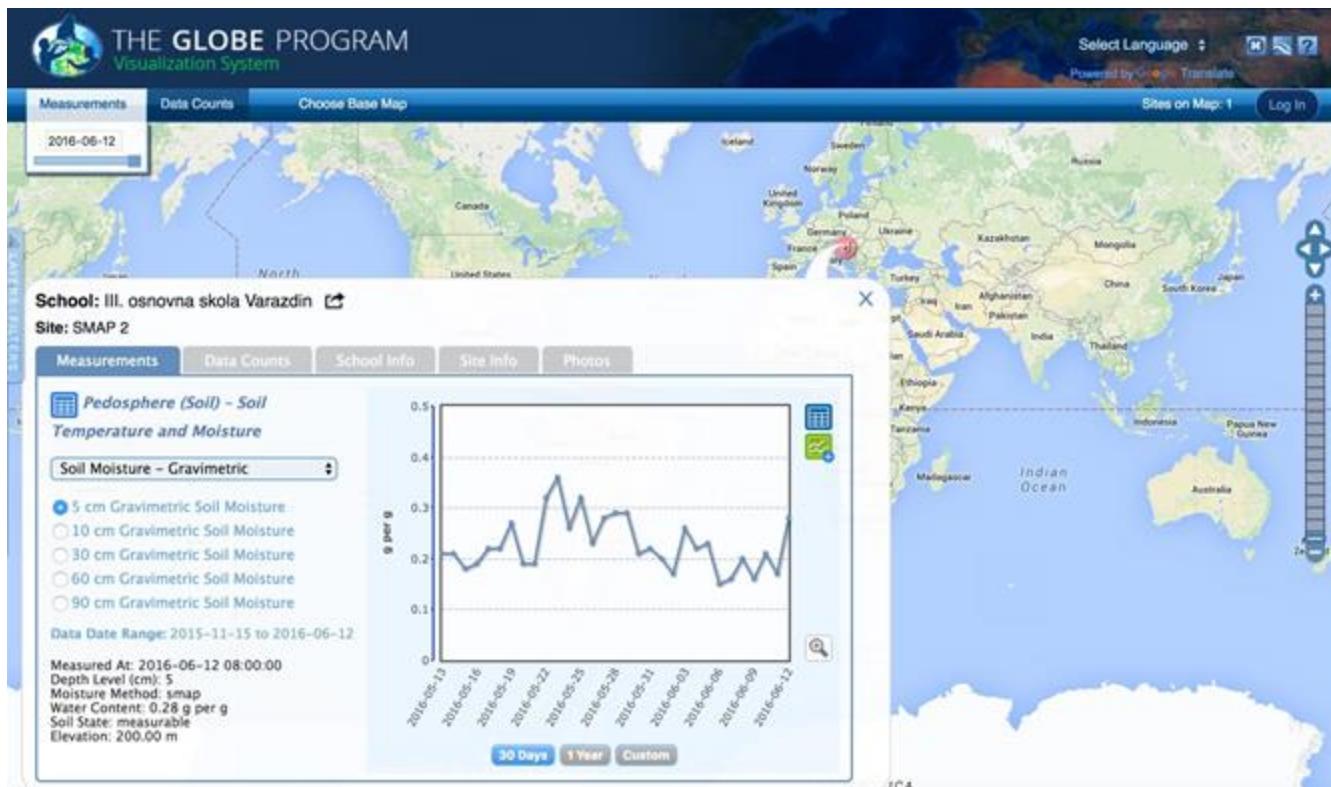
G. Report data to GLOBE

H. Data Visualization

I. Additional information

## Visualizing Data- 3

Currently soil infiltration data are not available in the GLOBE Visualization System. However, soil moisture data are available and are shown as an example below.





# Soil (Pedosphere)



# Soil Infiltration Protocol

A. Why measure infiltration?

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C. When and where to measure

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E. Preparing a dual-ring infiltrometer

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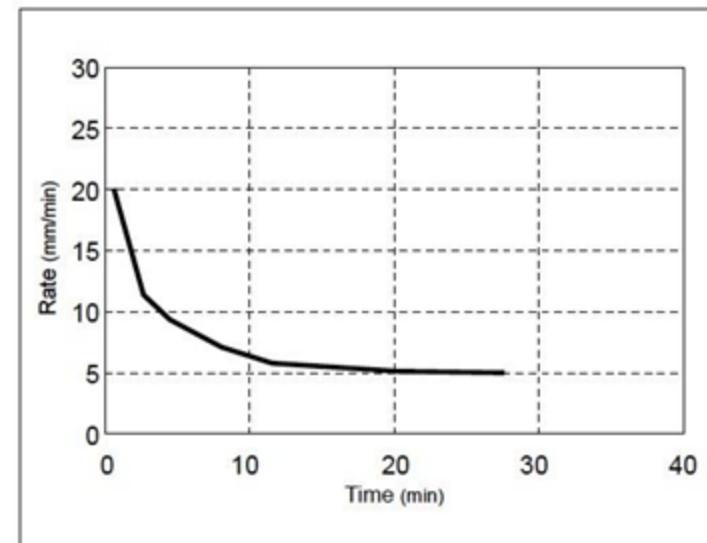
## Looking at the Data

Infiltration rate is determined by dividing the distance that the water level decreases by the time required for this decrease. For GLOBE measurements this is equal to the width of the reference band on the infiltrometer divided by the difference between the start and end times for an interval.

The Infiltration Data Sheet can be used to record and help calculate the values needed to plot measurement results. The flow rate for each timing interval is the average value during an interval. The flow rate should be plotted at the midpoint of the interval times.

Infiltration should decrease with time and it is important to keep track of the cumulative time from when water was first poured into the inner ring. The table and graph below demonstrate how to calculate infiltration rates and plot them on a graph.

Figure SOIL-IN-3: Infiltration





# Soil (Pedosphere)



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## The Soils on Planet Earth

By studying the soil in your area and reporting these data to GLOBE, you will make an invaluable contribution to our knowledge of planet Earth.

As you take your soil measurements, remember that you are likely the only ones who will study your specific soil. For much of this critical information, there exists no other way to study the soil in your community. Your contribution to science will be important and unique.



Courtesy of the Natural Resources Conservation Service



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## Frequently Asked Questions

### How often should I conduct the soil protocols?

It depends on which soil property you are examining. Soil properties change over time on different timescales. Properties such as temperature, moisture content, and local composition of air change over a period of minutes or hours. Other properties change over months or years, including soil pH, soil color, soil structure, bulk density, soil organic matter, soil fertility, and the microorganisms, animals and plants in the soil. Over much longer timescales, that is, tens to hundreds and thousands of years, changes in mineral content, particle size distribution, horizons and particle density take place. These last measurements you need to do only once.



## Frequently Asked Questions (Cont'd)

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E. Preparing a dual-ring infiltrometer

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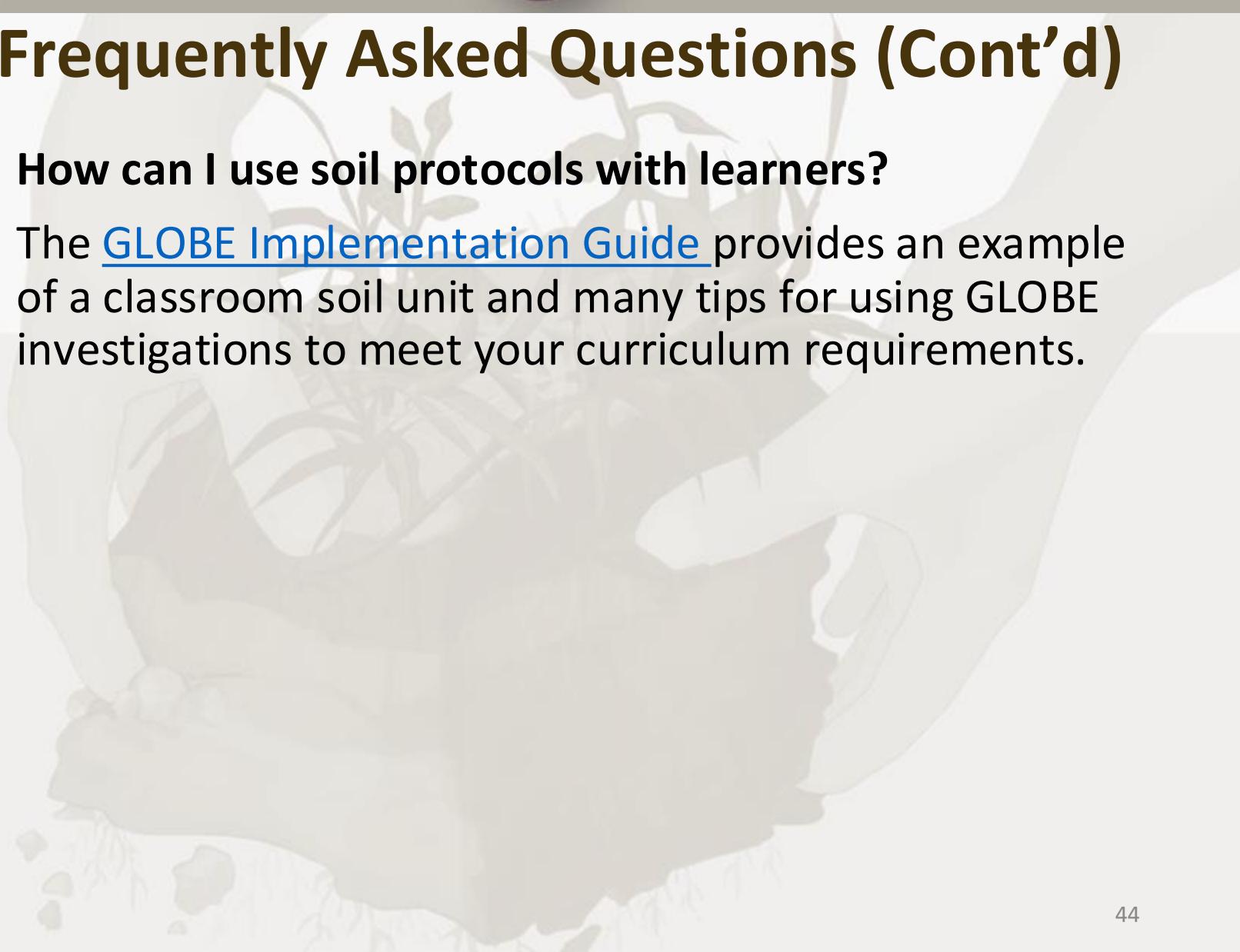
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### How can I use soil protocols with learners?

The [GLOBE Implementation Guide](#) provides an example of a classroom soil unit and many tips for using GLOBE investigations to meet your curriculum requirements.





# Soil (Pedosphere)



# Soil Infiltration Protocol

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**Request for your feedback on this module! Please provide us with feedback about this module. This is a community project and we need your comments, suggestions and edits!**

**Questions after reviewing this module? Contact GLOBE: [help@nasaglobe.org](mailto:help@nasaglobe.org)**

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## More Information:

[GLOBE Program](#)

[NASA Earth Science](#)

[NASA Global Climate Change: Vital Signs of the Planet](#)

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