THE GLOBE PROGRAM
A worldwide science and education program

Hydrosphere • Water Transparency
Using a Secchi Disk

Overview

This module:

- **Reviews the selection of a GLOBE hydrology site**
- **Reviews the water sampling technique used in GLOBE hydrology protocols**
- **Guides the construction of the necessary instrument for this protocol**
- **Provides a step by step introduction of the protocol method**

Learning Objectives

After completing this module, you will be able to:

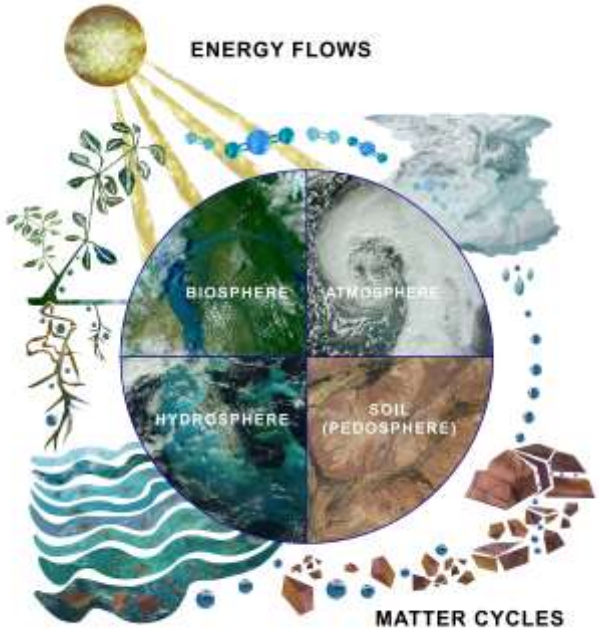
- **Define water transparency and explain how environmental variables result in different transparency measurements**
- **Understand how the protocol procedures ensure the collection of accurate data**
- **Conduct transparency measurements in the field**
- **Upload data to the GLOBE portal**
- **Visualize data using GLOBE's Visualization Site**

Estimated time to complete module: 1.5 hours

The Hydrosphere as part of the Earth System

The hydrosphere is the part of the Earth system that includes water, ice and water vapor. Water participates in many important natural chemical reactions and is a good solvent. Changing any part of the Earth system, such as the amount or type of vegetation in a region or from natural land cover to an impervious one, can affect the rest of the system. Rain and snow capture aerosols from the air. Acidic water slowly dissolves rocks, placing dissolved solids in water. Dissolved or suspended impurities determine water's chemical composition.

Current measurement programs in many areas of the world cover only a few water bodies a few times during the year. GLOBE Hydrosphere protocols will allow you to collect valuable data to help fill these gaps and improve our understanding of Earth's natural waters.



The Earth System:
Energy flows and matter cycles.

Hydrosphere Protocols

What is the condition of Earth's many surface waters – the streams, rivers, lakes, and coastal waters? How do these conditions vary over the year? Are these conditions changing

from year to year? These are questions that are answered by the hydrosphere investigations in the GLOBE program.

Water Transparency is one the measurements used by GLOBE to describe the status of a water body. **Water Transparency** measures depth of light penetration into the water.

Water transparency depends on the amount of suspended particles. These can be organic, such as phytoplankton and algae, or inorganic, such as sediments, as well as other dissolved impurities such as organic or inorganic carbonates. These particles contribute to both the color and the transparency of the water.

GLOBE Hydrosphere Measurements

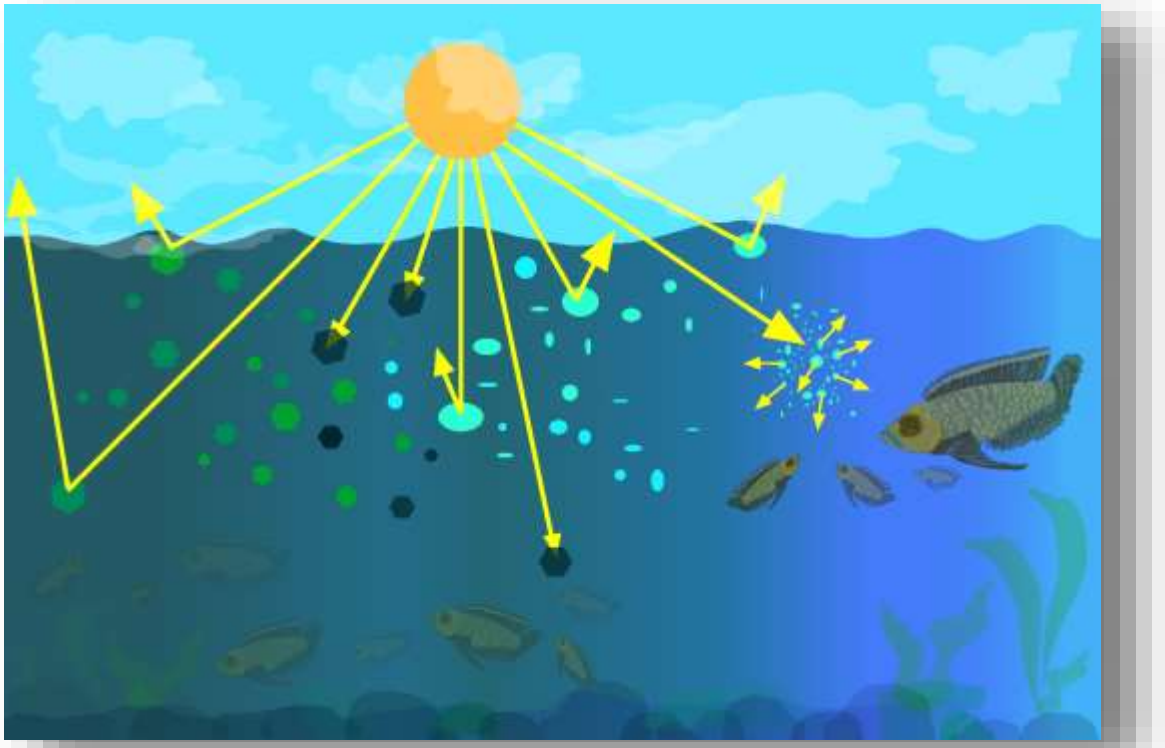
- Hydrosphere Study Site
- Water Temperature
- Water Transparency
- Conductivity
- pH
- Mosquito Larvae
- Alkalinity
- Dissolved Oxygen
- Salinity
- Nitrates
- Freshwater Macroinvertebrates

Water Transparency Describes Water Clarity

Water transparency is measured by determining the the depth of light penetration into the water column from the surface. **Algal blooms** such as this significantly reduce water transparency and contaminate onshore drinking water. The Operational Land Imager (OLI) on the Landsat 8 satellite captured this view of an algae bloom, Lake Erie, August 2014. More

Image: NASA Earth Observatory

What is Water Transparency?

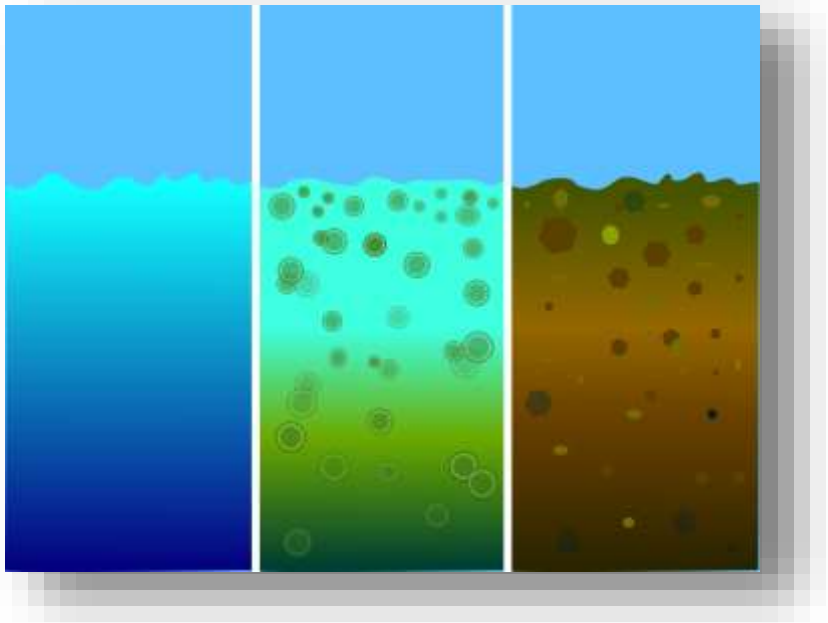


Particles in the water will reflect, absorb or scatter light, thus determining the depth at which light can no longer penetrate. This is called the **extinction depth**. The Water Transparency Protocol measures the light extinction depth of the water in your selected Hydrosphere Study Site.

Particles in water absorb and scatter light

Suspended particles in our water behave similarly to dust in the atmosphere. They reduce the depth to which light can penetrate. Sunlight provides the energy for photosynthesis (the process by which plants grow by taking up carbon, nitrogen, phosphorus and other nutrients, and releasing oxygen). How deeply light penetrates into a water body determines the depth to which aquatic plants can grow.

Transparency decreases with the presence of molecules and particles that can absorb or scatter light. Dark or black material absorb most wavelengths of light, whereas white or light materials reflect most wavelengths of light. The size of a particle is important as well. Small particles (diameters less than 1 µm) can scatter light.



Why Collect Water Transparency Data?

In most countries current measurement programs cover only a few water bodies a few times during the year. As a consequence, the archives of GLOBE hydrosphere data provides important information about water chemistry and water quality not found elsewhere.

By taking measurements over time in multiple locations, it is often possible to determine the times of year and the source of pollution, for instance, and if necessary, remediate the situation to improve water quality.

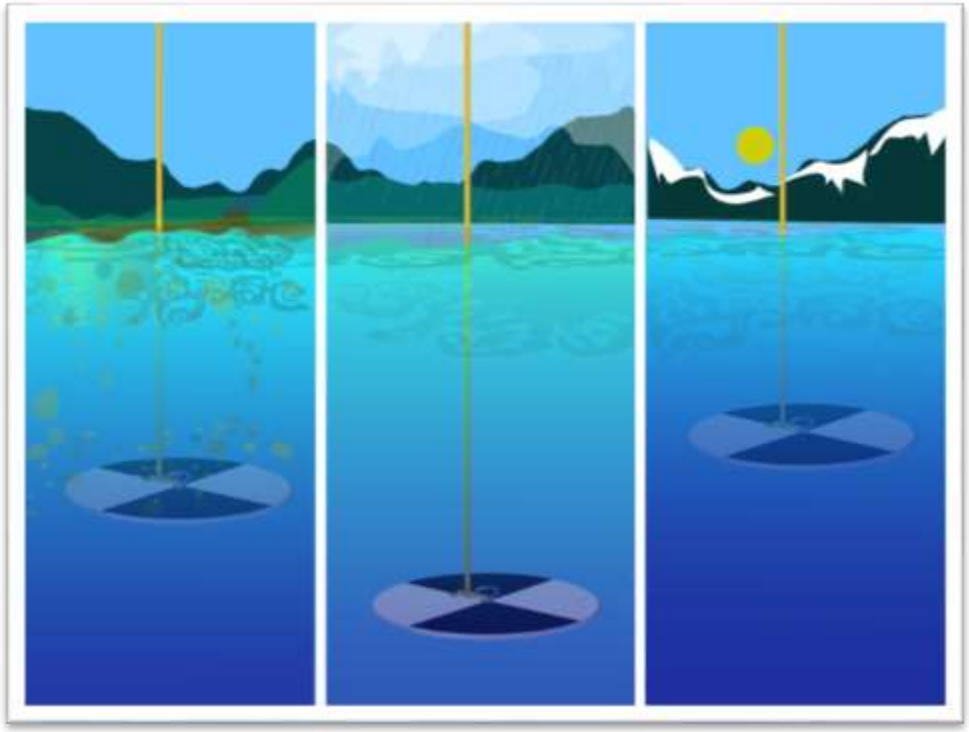
Summary: Water transparency changes in response to environmental factors

Water transparency changes over time in response to environmental factors.

Suspended particles such as phytoplankton, zooplankton, sediment, organic matter...are ***optically active components*** and their density and distribution varies over time. Erosion and run off during a storm is one source of sediment particles. The influx of nutrients such as phosphorus into a water body can cause an algal bloom, greatly increasing the density of these organisms.

- **The more suspended particles, the less transparency**
- An increase in suspended particles in a water body will decrease transparency, and light will be unable to penetrate into deeper water.
- **Light energy is needed by plants to conduct photosynthesis**
- Less light penetration into the water will affect the health of organisms living in the water body.
- **Water transparency affects water quality**
- Suspended particulates impact water quality, both for human consumption and for use by aquatic organisms

Scientists measure water transparency to determine water body health.



Measurement of water transparency allows scientists to calculate inputs from erosion and nutrients. By taking measurements over time in multiple locations, it is often possible to determine the source of the inputs, and if necessary, remediate the situation to improve water quality.

How Your Measurements Can Help-1

Credit: NASA Earth Observatory

Water transparency and color can be observed in satellite imagery. In May 2015, the east coast of Australia was hit by a severe storm and deadly flooding, dropping more than 360 millimeters (14 inches) of rain within about three hours in southeast Queensland, Australia. This image of the Brisbane River entering Moreton Bay was acquired on May 3, 2015 by the Operational Land Imager on Landsat 8.

How Your Measurements Can Help-2

Credit:
NASA Earth Observatory

As a result of the rainfall, flash flooding caused distinct river plumes to form along the coastline. Flood waters usually contain elevated levels of sediment and colored dissolved organic matter (CDOM). Sediment tends to scatter red light, and CDOM absorbs blue light. As a result, a brown color is visible where the Brisbane River mouth where these two optical phenomena work in concert. Further from the mouth, the coarser sediments tend to settle to the bottom but the CDOM is still observed in the water column absorbing blue light. What is coloring the yellow-green patches in the water? Scientists believe it is CDOM, but **ground verification is needed to be sure.** More

Let's do a quick review before moving onto data collection! Question 1

Which of the following suspended particles can influence the depth of light penetration in the water column?

A. Organic, like algae

B. Inorganic, like clay or silt

C. Dissolved impurities, such as carbonates

D. All of the above

What is the answer?

Let's do a quick review before moving onto data collection! Answer to Question 1

Which of the following suspended particles can influence the depth of light penetration in the water column?

A. Organic, like algae

B. Inorganic, like clay or silt

C. Dissolved impurities, such as carbonates

D. All of the above ☺ Correct!

Were you correct?

Let's do a quick review before moving onto data collection! Question 2

Why are GLOBE water transparency data important?

A. Because most water bodies in the world are not sampled by other scientists, the data provides important information that would not otherwise be collected

B. It provides an opportunity for students to collect data that they can use in their own environmental investigations

C. It allows students to monitor water quality in their community

D. Transparency data can be used as ground validation of data collected by satellites.

E. All of the above

F. A and B only

What is the answer?

Let's do a quick review before moving onto data collection! Question 2

Why are GLOBE water transparency data important?

A. Because most water bodies in the world are not sampled by other scientists, the data provides important information that would not otherwise be collected

B. It provides an opportunity for students to collect data that they can use in their own environmental investigations

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D. Transparency data can be used as ground validation of data collected by satellites.

E. All of the above ☺ Correct!

F. A and B only

Were you correct? Now let's look at the GLOBE Protocol for measuring water transparency using a Secchi Disk.

Protocol at a Glance

When	Weekly, if possible
Where	Hydrosphere Study Site
Time Needed	10 minutes
Prerequisites	Described Hydrosphere Study Site
Key Instrument	Secchi Disk
Skill Level	Beginner
References	GLOBE Cloud Chart Water Transparency Using a Secchi Disk Field Guide

How to Collect Your Data

Simultaneous or Prior Investigations Required to do Water Transparency Measurements

You will need to define your **Hydrosphere Study Site. A Hydrosphere Study Site** can be any surface water site that can be safely visited, although natural waters are preferred.

- Sites, in order of preference, may include:
- Streams or rivers
- Lakes, reservoirs, bays or ocean
- Pond
- Irrigation ditch or other water body, if those above are not available

The Hydrosphere Investigation Data Sheet is used to record all the hydrosphere measurements, including Water Transparency. You will also want to map your Hydrosphere Site at some point.

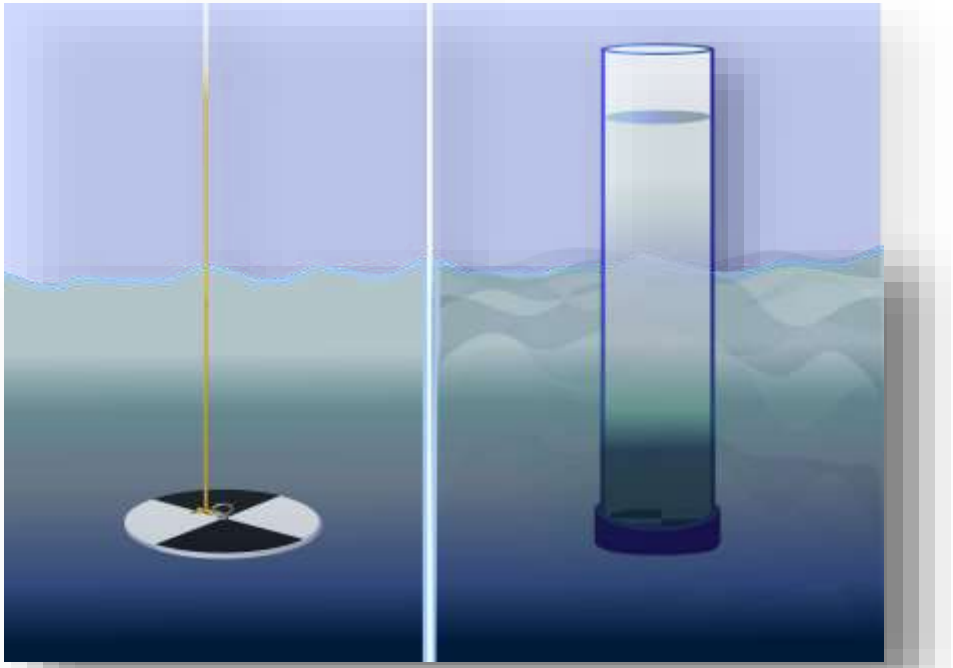
To define you study site you will need these documents:

- Selecting and Documenting your Hydrosphere Study Site
- Hydrosphere Investigation Data Sheet
- Mapping your Hydrosphere Study Site Field Guide

Determine Which is Appropriate for Your Water Body: Secchi Disk or Transparency Tube?

How to Collect Your Data: Select Appropriate Instrument

First, determine if your study site has **deep, still water or shallow and/or flowing water**. If the water is deep and still, you will use a **Secchi Disk** for your water transparency measurements. If the water is shallow or flowing, you will use a **Transparency Tube** (also called a Turbidity Tube). If you will be using the Secchi Disk, use instructions in the the **Water Transparency Secchi Disk Field Guide.**



Secchi Disk used with deep and still water

Transparency Tube used with shallow or Flowing water

Secchi Disk Protocol Overview

- Assemble field equipment
- Collect site data
- Conduct cloud type and cloud cover measurements
- In the Field: Take the measurements using a Secchi disk
- Repeat 3 times to ensure accuracy and precision
- Verify that the data from the three measurements are within **10 cm** of the mean, (but do not average your data for reporting)
- Report your data to the GLOBE website

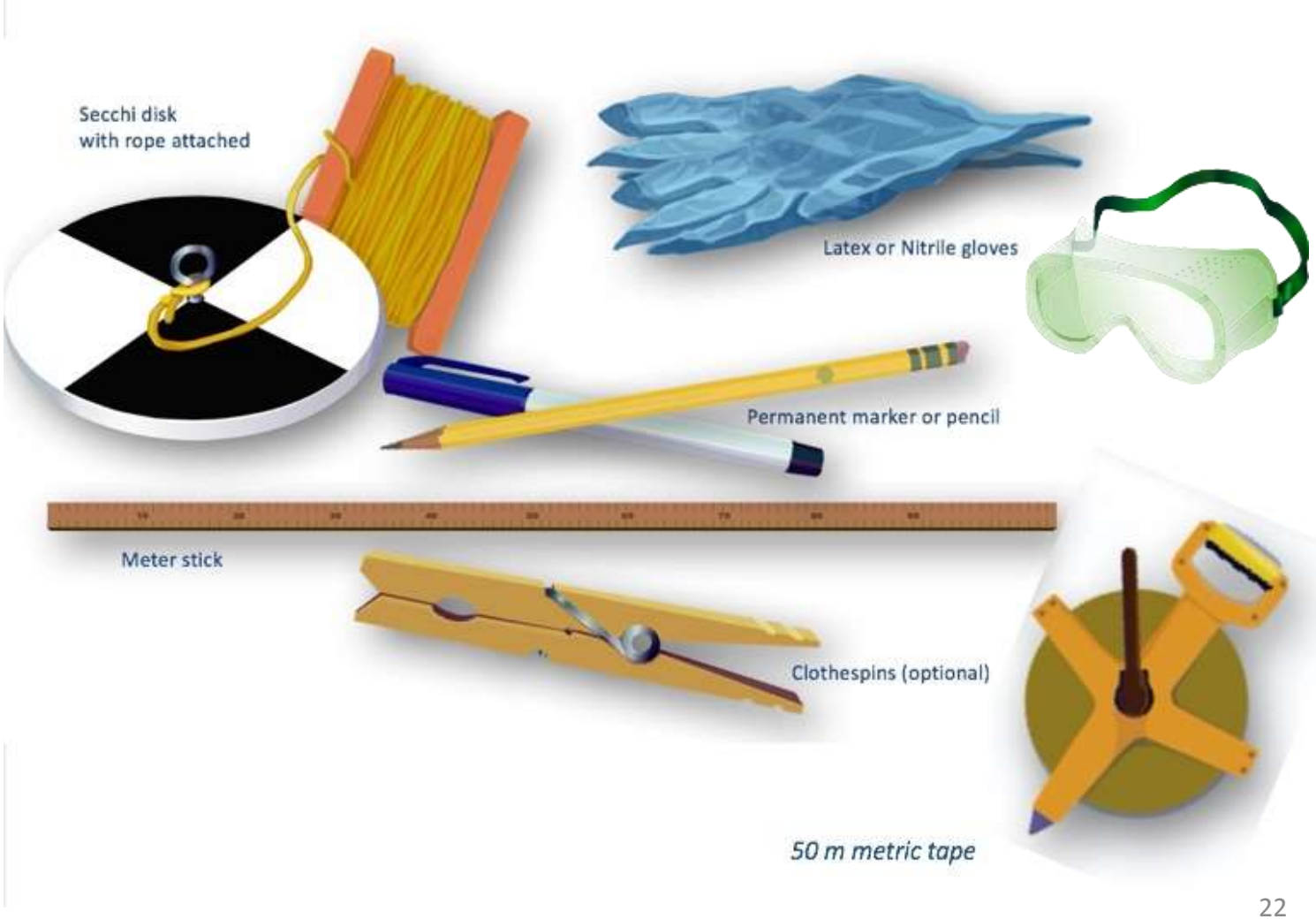
Time Requirements

Time to complete protocol: About 10 minutes

Frequency: Ideally, weekly measurements at the same sampling site

Ease of Protocol: Beginner Level

Assemble Field Equipment



Assemble Field Documents

Before measuring water transparency cloud type and cover must be measured for the site. Measurement of water transparency must be done in the shade to avoid sun glare and differences in visibility.

What You Need:

- Hydrosphere Investigation Data Sheet
- Cloud Type and Cover Protocol Field Guide
- Contrail Type and Cover Protocol Field Guide
- Globe Cloud Chart

Start your Fieldwork with Safety Steps

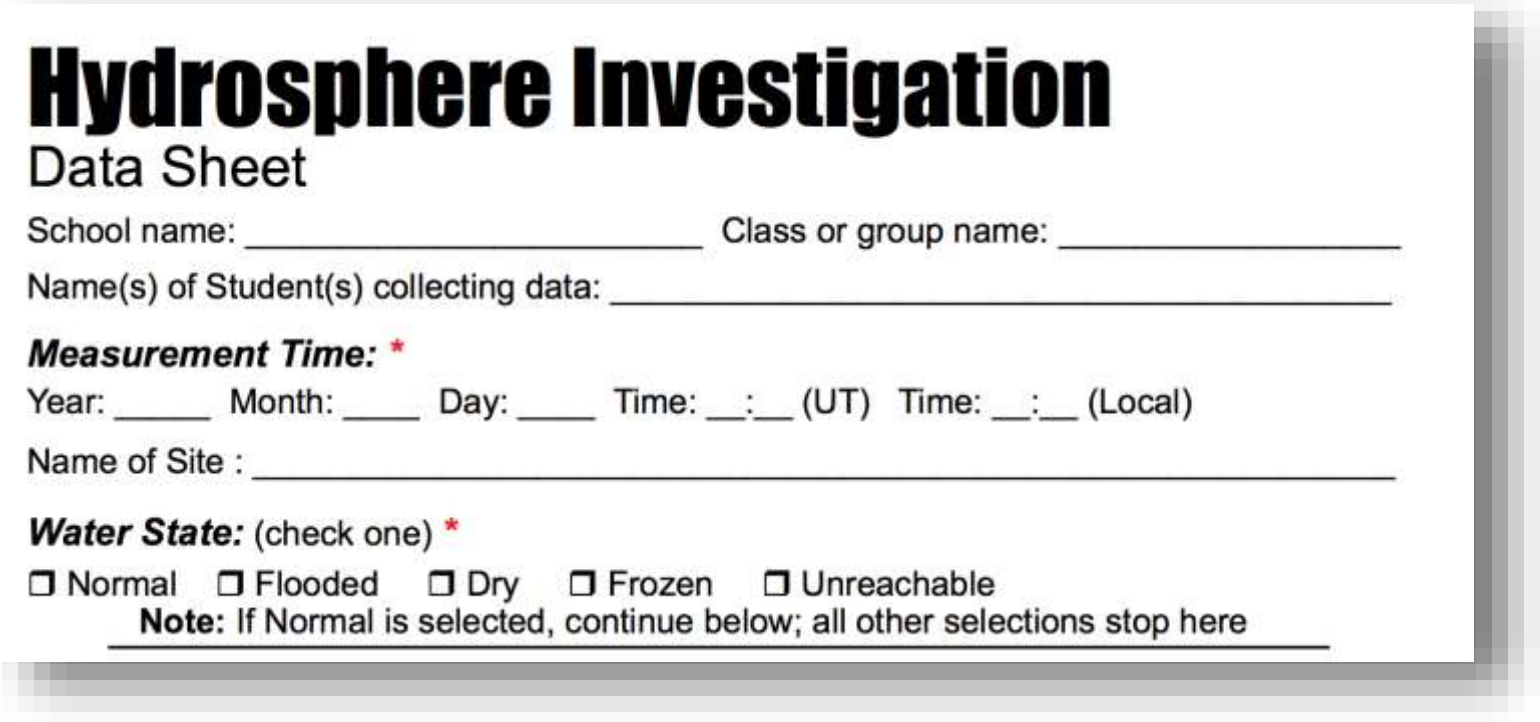
Safety is important when conducting the Hydrosphere protocols. While you will need to use your judgment in selecting only hydrosphere study sites that are safe to access and sample, additional precautions are needed:

- Students should wear protective gloves and goggles when handling water samples and chemicals to avoid danger from splashes.
- When doing GLOBE Hydrosphere Protocols, it is important to protect students from exposure to biting mosquitoes. Ask your students to wear clothes that cover the body so there is little bite area exposed. It is also advisable to apply insect repellent if you are sampling during the mosquito breeding season.

***SAFTEY** be sure students wear gloves and goggles during your investigations*

In The Field

✓ Fill out top portion of **Hydrosphere Investigation Data Sheet**



Hydrosphere Investigation

Data Sheet

School name: _____ Class or group name: _____

Name(s) of Student(s) collecting data: _____

Measurement Time: *

Year: _____ Month: ____ Day: ____ Time: __:__ (UT) Time: __:__ (Local)

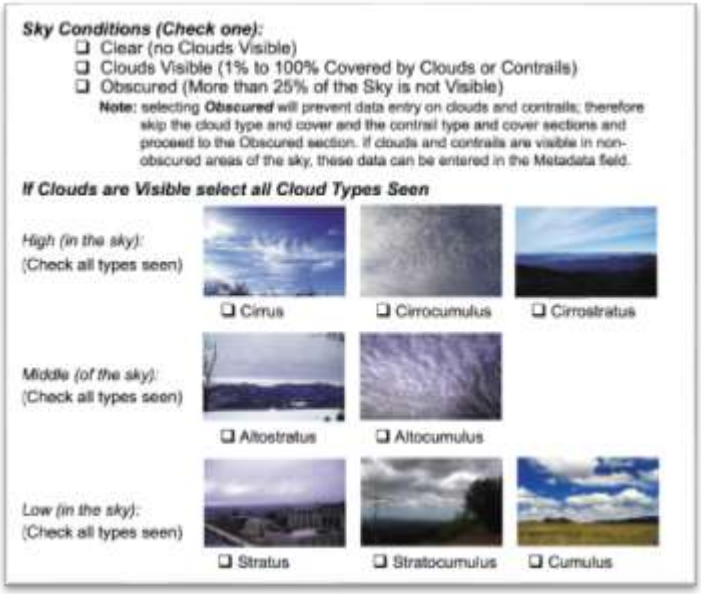
Name of Site : _____

Water State: (check one) *

❒ Normal ❒ Flooded ❒ Dry ❒ Frozen ❒ Unreachable

Note: If Normal is selected, continue below; all other selections stop here

Describe the sky conditions and clouds



Sky Conditions (Check one):

- ❑ Clear (no Clouds Visible)
- ❑ Clouds Visible (1% to 100% Covered by Clouds or Contrails)
- ❑ Obscured (More than 25% of the Sky is not Visible)

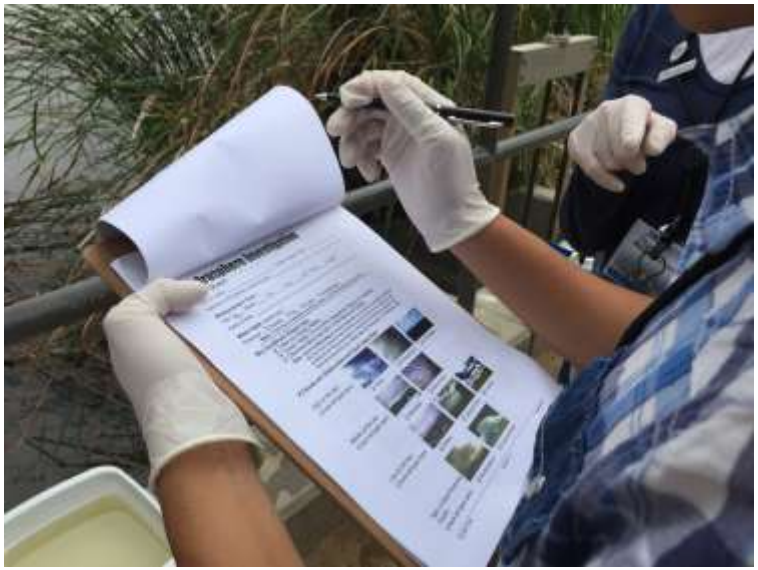
Note: selecting **Obscured** will prevent data entry on clouds and contrails; therefore skip the cloud type and cover and the contrail type and cover sections and proceed to the Obscured section. If clouds and contrails are visible in non-obscured areas of the sky, these data can be entered in the Metadata field.

If Clouds are Visible select all Cloud Types Seen

High (in the sky): (Check all types seen)
❑ Cirrus ❑ Cirrocumulus ❑ Cirrostratus

Middle (of the sky): (Check all types seen)
❑ Altostratus ❑ Altocumulus

Low (in the sky): (Check all types seen)
❑ Stratus ❑ Stratocumulus ❑ Cumulus



Proper Technique Using the Secchi Disk

Stand so that the **Secchi disk** will be shaded or use an **umbrella or cardboard** to shade the measurement area.

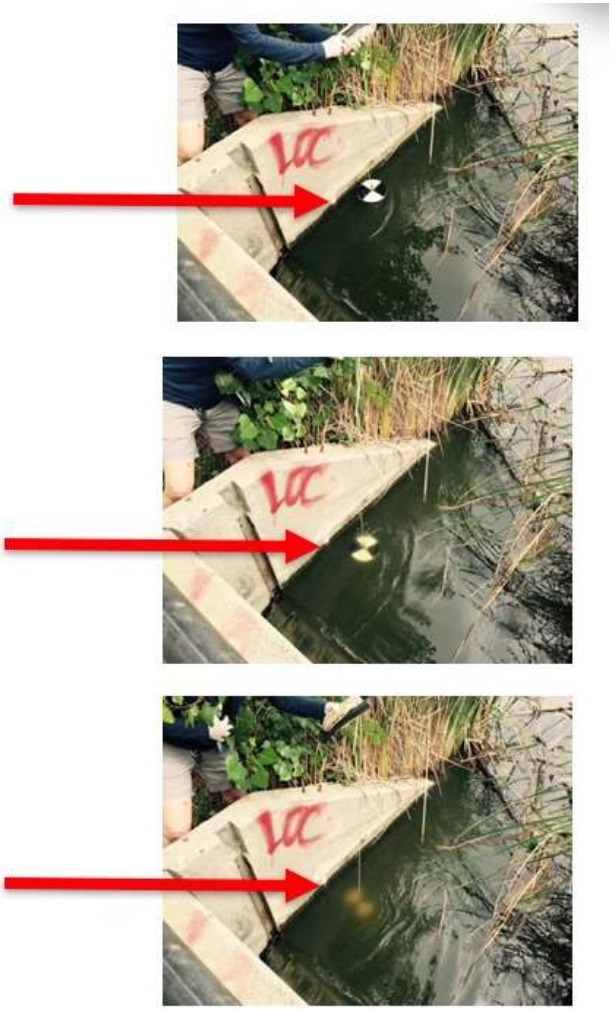
If you cannot reach the water surface, establish a reference height. This can be a railing, a person's hip, or the edge of a dock. All measurements should be taken from this point.

***SAFTEY** be sure to wear gloves and goggles during your investigations*

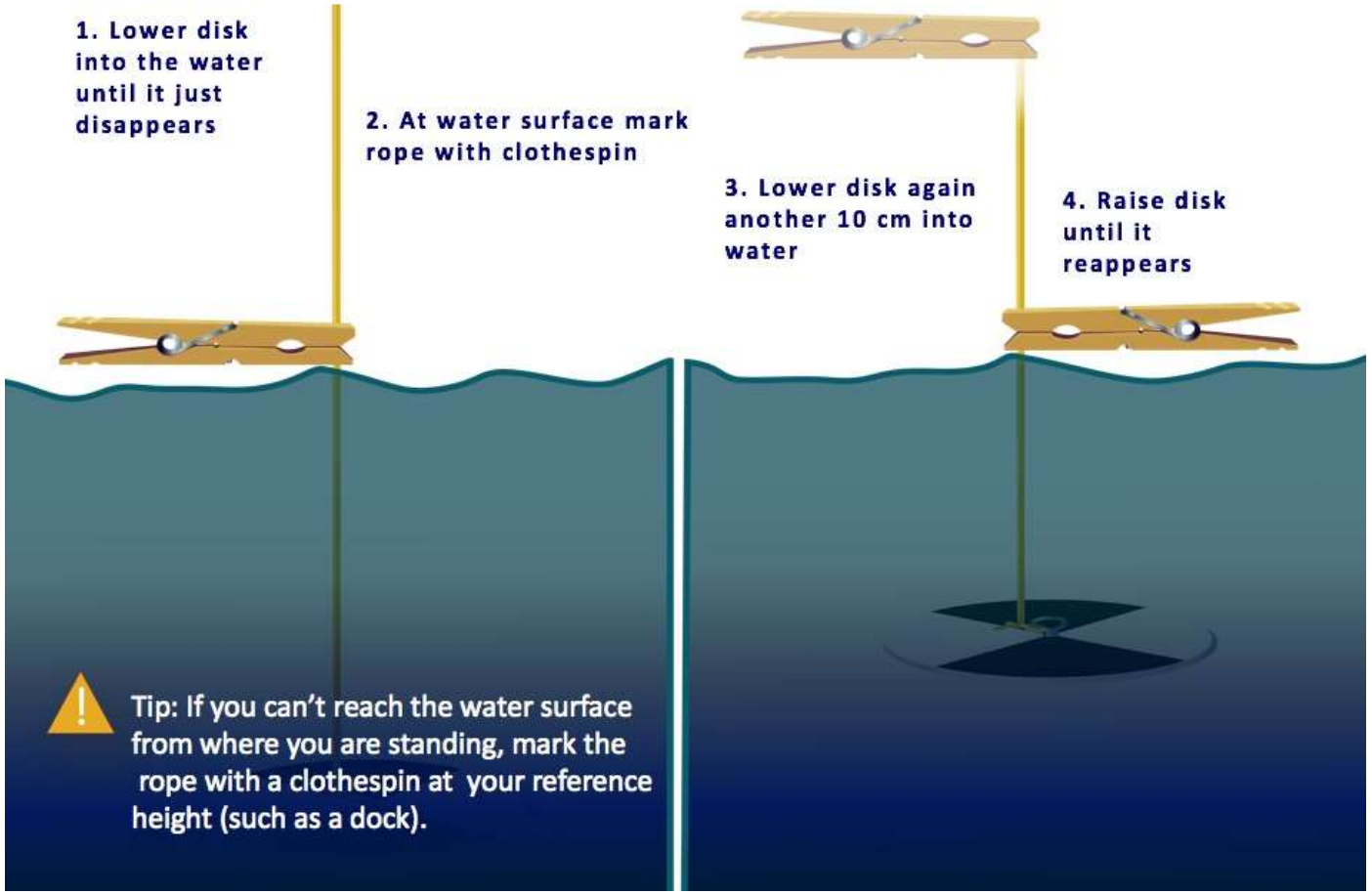
Lower the Secchi Disk until it disappears under the water

Lower the Secchi disk gradually. As it is lowered, the black cross will become less visible. Eventually it will disappear completely.

Note: You will need to remove sunglasses/goggles when lowering the Secchi Disk, so you can identify the extinction depth correctly. Replace your goggles before you pull up the Secchi disk.

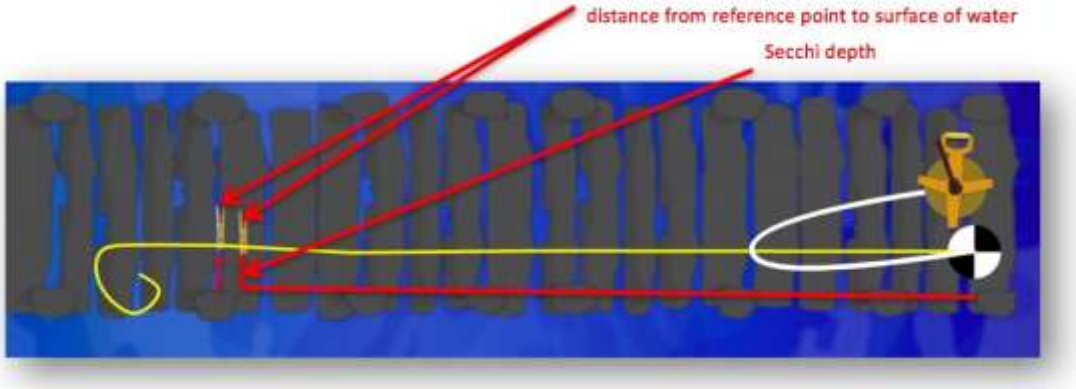


Marking the Secchi Depth



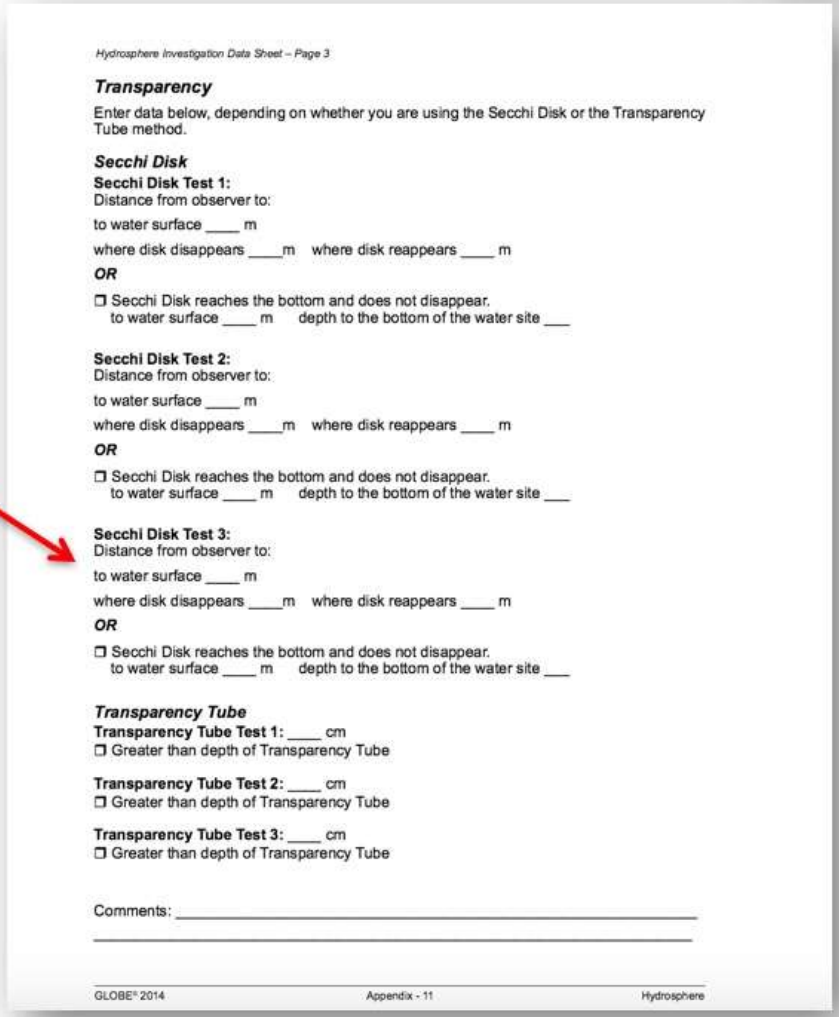
Measure the length of rope

- There should now be **two points marked on the rope**. Record the length of the rope between each mark and the **Secchi disk** on your **Hydrosphere Investigation Data Sheet** to the nearest cm.
- If you marked the rope at the water surface, record "0" as the distance between the observer and the water surface.
- If you marked the rope at a reference point, lower the disk until it reaches the surface of the water and mark the rope at the reference point. Record the length of the rope between the mark and the Secchi disk as the distance between the observer and the water surface.



Repeat measurement 3 X and you are done!

Repeat the Secchi disk measurement for a total of 3x and record your data



Hydrosphere Investigation Data Sheet – Page 3

Transparency

Enter data below, depending on whether you are using the Secchi Disk or the Transparency Tube method.

Secchi Disk

Secchi Disk Test 1:
Distance from observer to:
to water surface ____ m
where disk disappears ____m where disk reappears ____ m
OR
❒ Secchi Disk reaches the bottom and does not disappear.
to water surface ____ m depth to the bottom of the water site ___

Secchi Disk Test 2:
Distance from observer to:
to water surface ____ m
where disk disappears ____m where disk reappears ____ m
OR
❒ Secchi Disk reaches the bottom and does not disappear.
to water surface ____ m depth to the bottom of the water site ___

Secchi Disk Test 3:
Distance from observer to:
to water surface ____ m
where disk disappears ____m where disk reappears ____ m
OR
❒ Secchi Disk reaches the bottom and does not disappear.
to water surface ____ m depth to the bottom of the water site ___

Transparency Tube

Transparency Tube Test 1: ____ cm
❒ Greater than depth of Transparency Tube

Transparency Tube Test 2: ____ cm
❒ Greater than depth of Transparency Tube

Transparency Tube Test 3: ____ cm
❒ Greater than depth of Transparency Tube

Comments: _____

GLOBE® 2014 Appendix - 11 Hydrosphere

Let's do a quick review before moving to GLOBE data reporting and visualization! Question 3

If you have deep, still water, what is the water transparency method of preference in GLOBE Hydrosphere investigations?

A. Secchi Disk Method

B. Transparency Tube (also called turbidity tube) method

What is the answer?

Let's do a quick review before moving to GLOBE data reporting and visualization! Answer to Question 3

If you have deep, still water, what is the water transparency method of preference in GLOBE Hydrosphere investigations?

A. **Secchi Disk Method** ☺ **Correct!**

B. Transparency Tube (also called turbidity tube) method

Were you correct?

Let's do a quick review before moving to GLOBE data reporting and visualization! Question 4

How many replicate measurements should you make, in order that ensure your data are reliable?

A. Only once- since it is a very straightforward protocol and since there is no chemical measurements, there is less chance of human error.

B. Three times, report the average of the three measurements

C. Three times, report all three measurements

What is the answer?

Let's do a quick review before moving to GLOBE data reporting and visualization! Answer to Question 4

How many replicate measurements should you make, in order that ensure your data are reliable?

A. Only once- since it is a very straightforward protocol and since there is no chemical measurements, there is less chance of human error.

B. Three times, report the average of the three measurements

C. Three times, report all three measurements ☺ Correct!

Were you correct?

Let's do a quick review before moving to GLOBE data reporting and visualization! Question 5

When scientists take water transparency measurements, they also describe other conditions that may affect their measurements. What are they?

A. Lithosphere-the local rock types

B. Atmosphere-the cloud conditions

C. Biosphere-the plants found by the side of the water

What is the answer?

Let's do a quick review before moving to GLOBE data reporting and visualization! Answer to Question 5

When scientists take water transparency measurements, they also describe other conditions that may affect their measurements. What are they?

A. Lithosphere-the local rock types

B. Atmosphere-the cloud conditions ☺ Correct!

C. Biosphere-the plants found by the side of the water

Were you correct?

Let's do a quick review before moving to GLOBE data reporting and visualization! Question 6

What safety precautions should you take in the field with your students?

A. Students should wear protective gloves and eyewear

B. Protection from biting insects, such as wearing clothes that limit skin exposure and using insect repellent

C. For this protocol, it is not necessary, because the Water Transparency methods do not use dangerous chemicals

D. A and B

What is the answer?

Let's do a quick review before moving to GLOBE data reporting and visualization! Answer to Question 6

What safety precautions should you take in the field with your students?

A. Students should wear protective gloves and eyewear

B. Protection from biting insects, such as wearing clothes that limit skin exposure and using insect repellent

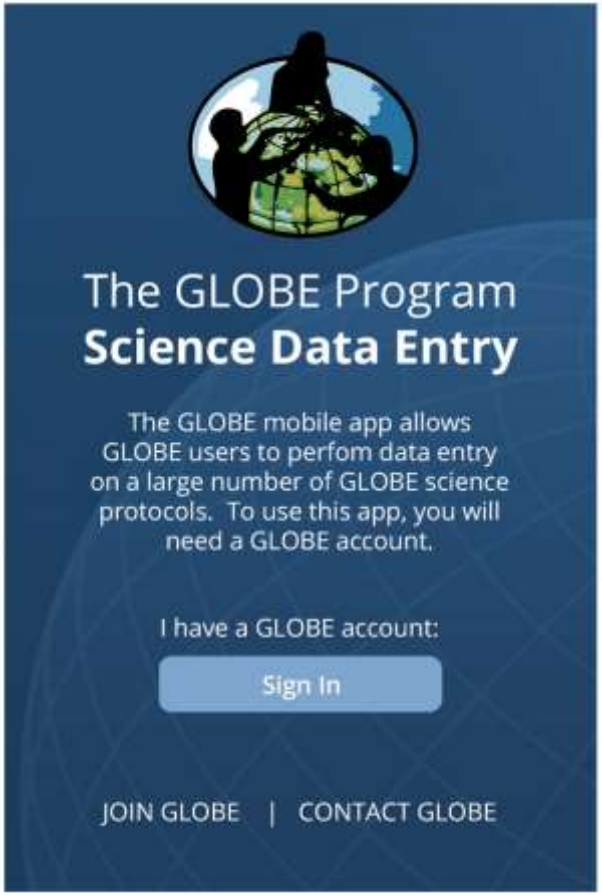
C. For this protocol, it is not necessary, because the Water Transparency methods do not use dangerous chemicals

D. A and B ☺ Correct!

Were you correct? Now let's review the procedure for reporting and visualizing GLOBE data.

Submitting your data to GLOBE

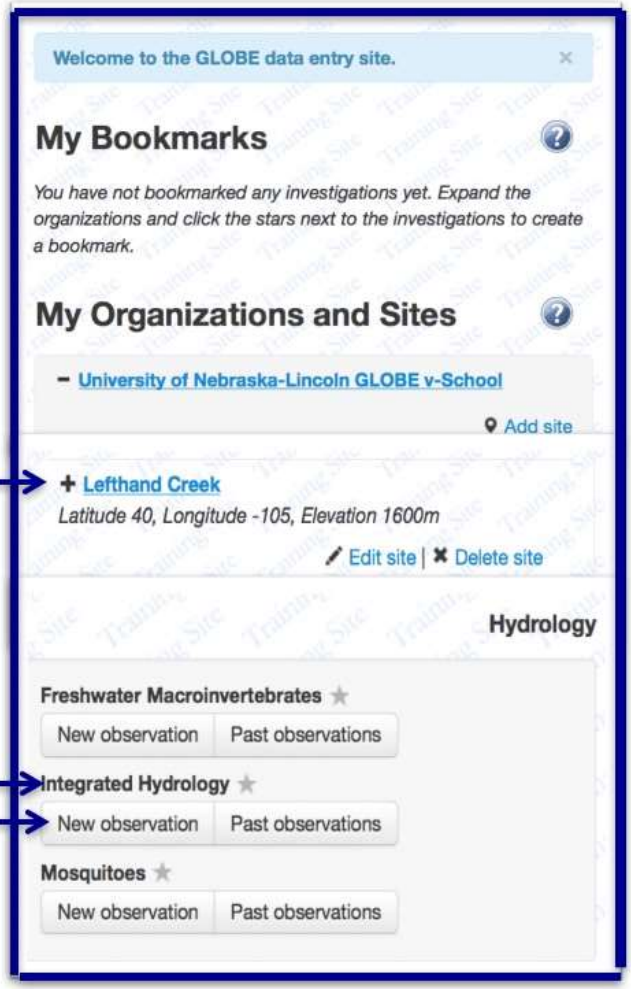
- Live Data Entry: Upload your data to the official
- **Email Data Entry**: Send data in the body of your email (not as an attachment) to DATA@GLOBE.GOV
- **Mobile Data App:** Download the GLOBE Science Data Entry app to your mobile device and select the right option.
- **For Android** via Google Play
- **For IOS** via the App Store
-



Entering your data via Live Data Entry or Data Entry Mobile App- Step 1

Identify your Sampling site

Select *"Integrated Hydrology"* and *"New observation"*

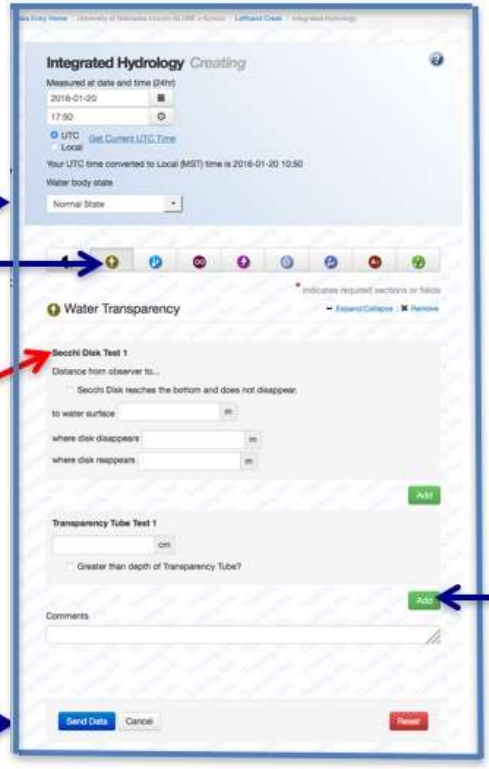


Entering your data via Live Data Entry or Data Entry Mobile App- Step 2

1. Select water body state

2. Select protocol

*Be sure to enter data as **Secchi Disk***



3. Enter each measurement and click "add"

4. Click to send data

You are done! Want to check who else has submitted transparency data using the GLOBE Visualization System?

Visualize and Retrieve Data- Step 1

GLOBE provides the ability to view and interact with data measured across the world. Select GLOBE's Visualization System to map, graph, filter and export Secchi Disk transparency data that have been measured across GLOBE protocols since 1995.

Link to step-by-step tutorial on using the GLOBE Data Visualization System

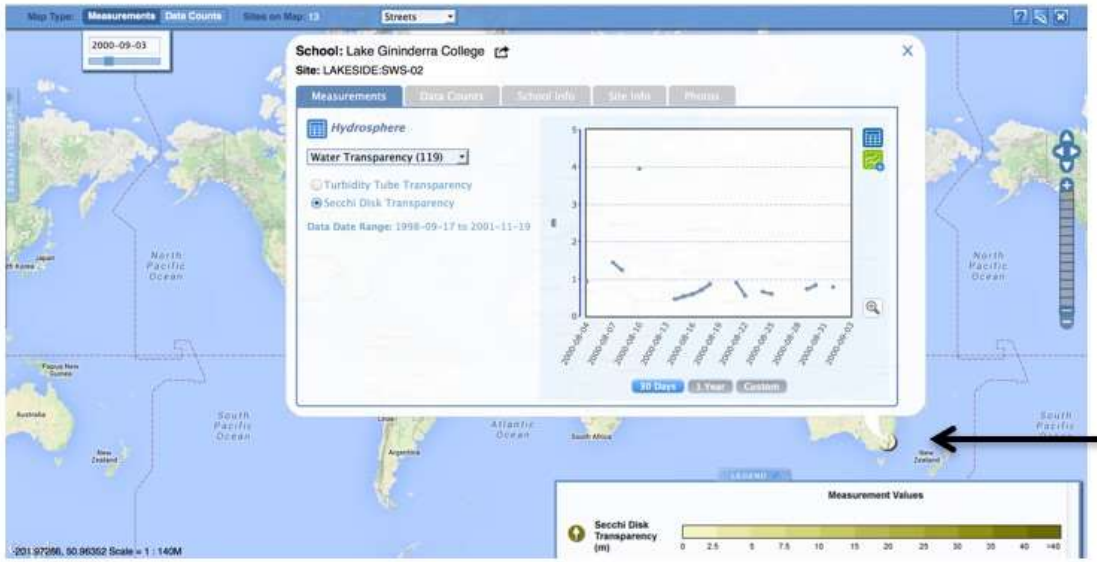
Visualize and Retrieve Data- Step 2

Select the date for which you need Secchi Disk Transparency data, add layer and you can see where data is available

Locations where Secchi Disk Transparency data is available for the week you selected

Visualize and Retrieve Data- Step 3

Select the sampling site for which you need Secchi Disk Transparency data, and a box will open with a data summary for that site.



Clicking on a location will open to a map note providing Secchi Disk Transparency data for that location and time. Follow instructions in the tutorial to download data as a .csv file for analysis using a spreadsheet program.

Review questions to help you prepare to measure Water Transparency at your Hydrosphere Study Site

1. What does water transparency measure?
2. What kind of suspended particles are found in water bodies?
3. The absolute depth at which light can penetrate through a water column is called _____?
4. The more suspended particles, the (more/less) transparency.
5. When water is still and deep, the appropriate transparency instrument is (Secchi disk/Transparency Tube).
6. Your three replicate measurements should be within _____cm of the mean.
7. Why do you need to take your transparency measurement in the shade?
8. Why is it necessary to describe cloud cover when taking transparency measurements?
9. What are some reasons water transparency measurements may change over the course of a year?
10. What safety precautions should you take prior to conducting any of GLOBE's hydrosphere protocols?

Are you ready to take your quiz?

- You have now completed the slide stack. If you are ready to take the quiz, sign on and take the quiz corresponding to **Water Transparency Secchi Disk Protocol.**

- When you pass the quiz, you are ready to take **Water Transparency Secchi Disk Protocol** measurements!

Frequently Asked Questions- FAQs

When comparing data between sites, do you need to make an adjustment for data taken at the water surface compared to data taken from a bridge or dock?

This distance is not used to adjust the Secchi disk data. However, reporting the distance between the observer and the water helps in data interpretation.

My students are using a pond for our hydrosphere measurements. They go out in a boat and use a Secchi disk for the transparency. We are not sure of the two measurements we are asked to give. They measure the line at the surface of the water to the top of the disk when it disappears and reappears. What is the other measurement?

For the other measurement, distance from where you read the line to the water surface, you should enter zero. Some schools will make Secchi disk readings from a bridge or pier, and report the depth measured using a reference level that is not the water surface, but some distance above the water surface. So they need to also enter the distance from the pier to the water. That way we have all of the raw data in the database.

Frequently Asked Questions- 2

Question: When are the measurements taken?

Collect all water measurements at roughly the same time each day, on a weekly basis. If your sampling site freezes over in winter or runs dry, be **sure** to enter this information each week until you again have free-flowing surface water to measure.

Note: Certain times of the year provide more exciting measurements. When runoff from a spring snowmelt is occurring on a river, the increased flow and sediment will dramatically change water measurements. One or more times a year, lakes can 'turnover' and the waters in the lake totally mix. This can occur in spring after the ice melts. Turnover can cause surprising changes to your measurement results. Be observant of seasonal and monthly changes. Use the Comments section of the GLOBE data entry pages to record observations that may help others interpret your water data.

Connections to the Classroom: Suggested Sequence of Learning Activities from the GLOBE Teacher's Guide

• The Water Walk Learning Activity sets the stage for developing a baseline knowledge and interest in your Hydrosphere Study Site.

• The Model a Catchment Basin Learning Activity provides the big picture view of the students' watershed and the water and study site in relation to this watershed.

• Map Your Hydrosphere Study Site. At the beginning of your study as part of defining your site, and once each year thereafter, create a map of the Hydrosphere Site and take photographs.

• The Practicing Your Protocols Learning Activity guides students through learning how to use the instruments and following the protocols so they collect reliable data.

• Begin Field Sampling. Go to the site and begin the weekly measurements for water.

• Use the Looking at Data section at the end of each protocol as a guide to examine your data, ask questions and interpret what you find. Start linking water data to other GLOBE measurements.

• Focus on Key Science Ideas by performing the following Learning Activities:

- Water Detectives and The pH Game introduce students to key water chemistry variables and to the need using instruments to take certain measurements.

- Modeling Your Water Balance lets students explore how to use their data for modeling.

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