Computer
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Total Solids

INTRODUCTION

Total solids, TS, is a measure of all the suspended, colloidal, and dissolved solids in a sample of water. This includes dissolved salts such as sodium chloride, NaCl, and solid particles such as silt and plankton. An excess of total solids in rivers and streams is a very common problem. The Environmental Protection Agency's National Water Quality Inventory[1] has concluded that siltation, one of the primary contributors to total solids, is the most common pollutant of streams and rivers they sampled.

Sources of Total Solids
• Soil erosion - silt - clay - dissolved minerals
• Agricultural runoff - fertilizers - pesticides - soil erosion
• Urban runoff - road grime - rooftops - parking lots
• Industrial waste - dissolved salts - sewage treatment effluent - particulates
• Organics - microorganisms - decaying plants and animals - gasoline or oil from roads
• Abundant bottom-dwellers

Many factors can contribute to the total solids in water. Soil erosion is a large contributor. An increase in water flow or a decrease in stream-bank vegetation can speed up the process of soil erosion and contribute to the levels of suspended particles such as clay and silt. Naturally occurring rocks or minerals in the soil such as halite, NaCl, or limestone, $CaCO_3$, may also dissolve into the water, adding to the total solids.

Total solids can also come from various types of runoff. Agricultural runoff often contains fertilizers and suspended soil particles. Other sources include industrial wastes, effluent from water treatment plants, and urban runoff from parking lots, roads, and rooftops.

Bottom-dwelling aquatic organisms, such as catfish, can contribute to the total solids in the water by stirring up the sediment that has built up on the bottom of the stream. Organic matter such as plankton or decaying plant and animal matter that are suspended in the water will also add to the total solids in a stream.

Dissolved solids often make a significant contribution to the amount of total solids in water. In fact, the mass of the dissolved solids is sometimes higher than the mass of the suspended particles. Dissolved solids in freshwater samples include soluble salts that yield ions such as calcium, chloride, bicarbonate, nitrates, phosphates, and iron.

If the levels of total solids are too high or too low, it can impact the health of the stream and the organisms that live there. High levels of total solids will reduce the clarity of the water. This decreases the amount of sunlight able to penetrate the water, thereby decreasing the photosynthetic rate. Reduced clarity also makes the water less aesthetically pleasing. While this may not be harmful directly, it is certainly undesirable for many water uses. When the water is cloudy, sunlight will warm it more efficiently. This occurs because the suspended particles in the water absorb the sunlight which, in turn, warm the surrounding water. This leads to other problems associated with increased temperature levels.

[1] From the EPA's Office of Water web site at www.epa.gov/OW/resources.

As previously mentioned, dissolved solids often make a large contribution to total solids. The correct balance of dissolved solids in the water is essential to the health of aquatic organisms for several reasons. One reason is that many of these dissolved materials are essential nutrients for the general health of aquatic organisms. Another reason is that the transport of ions through cellular membranes is dependent on the total ionic strength of the water. Too many dissolved salts in the water can dehydrate aquatic organisms. Too few dissolved salts, however, can limit the growth of aquatic organisms that depend on them as nutrients.

Effects of High Total Solids
• Can be harmful to aquatic organisms
• Reduce water clarity
• Aesthetically unpleasing
• Decrease photosynthetic rate
• Increase water temperature

Expected Levels

Total solids in surface water usually fall within the range of 20 mg/L to 500 mg/L. Values can go much higher especially after heavy rain when the water levels are high. Some sample data from selected rivers are listed in Table 1.

Table 1: Total Solids in Selected Rivers

Site	Season	Total Solids (mg/L)	Season	Total Solids (mg/L)
Hudson River, Poughkeepsie, NY	Spring	134	Fall	259
Colorado River, CO-UT state line	Spring	1226	Fall	873
Sacramento River, Keswick, CA	Spring	112	Fall	68
Mississippi River, Memphis, TN	Spring	222	Fall	371
Columbia River, Northport, WA	Spring	81	Fall	88

Summary of Method

You will determine the total solids in a sample of water by adding a precise amount of water to a carefully cleaned, dried, and weighed beaker. The water is then evaporated away using a drying oven and the beaker is reweighed. The difference in mass before and after is the mass of the total solids. Calculations are made to convert the change in mass to mg/L total solids.

TOTAL SOLIDS

Materials Checklist

___ sampling bottles
___ 100-mL graduated cylinder
___ two 250 mL beakers
___ drying oven
___ analytical balance (0.001 g)
___ tongs or gloves to hold beaker

Collection and Storage of Samples

1. This test must be conducted in the lab. Collect 500 mL of sample water so that you can run two 200 mL trials. **Note:** If your stream or lake could have low levels of total solids, then collect a larger sample volume (see Step 5 of the Testing Procedure).

2. It is important to obtain the water sample from below the surface of the water and as far away from the shore as is safe. If suitable areas of the stream appear to be unreachable, samplers consisting of a rod and container can be constructed for collection. Refer to page Intro-4 of the Introduction for more details.

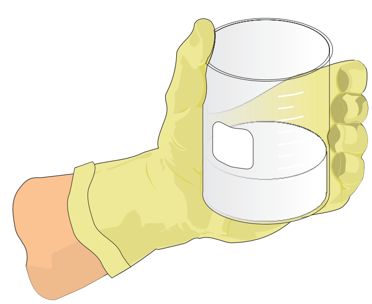
3. Stand upstream from any activity that could stir up sediment and affect your readings. Hold the sample bottle upstream from your body.

4. If the testing cannot be conducted within a few hours, place the samples in an ice chest or a refrigerator.

Testing Procedure

Day 1

1. Prepare two 250 mL beakers for drying and sample evaporation.
   a. Carefully clean two 250 mL beakers and place them in a drying oven at 100–105°C for at least one hour to dry.
   b. Using tongs or gloves, remove the beakers from the oven and allow them to cool. **Note:** From this point on, always handle the beakers with tongs or gloves to prevent the oils on your hands from affecting the masses of the beakers.
   c. Using a pencil, number your beakers “1” and “2”. Do not use labeling tape.
   d. Use an analytical balance to measure the mass of each beaker. Record the values on the Data & Calculations sheet (round to the nearest 0.001 g).
   e. If you complete Step 1 before collecting your samples, store the beakers in a clean, dry, dust-free space until you return to the lab.



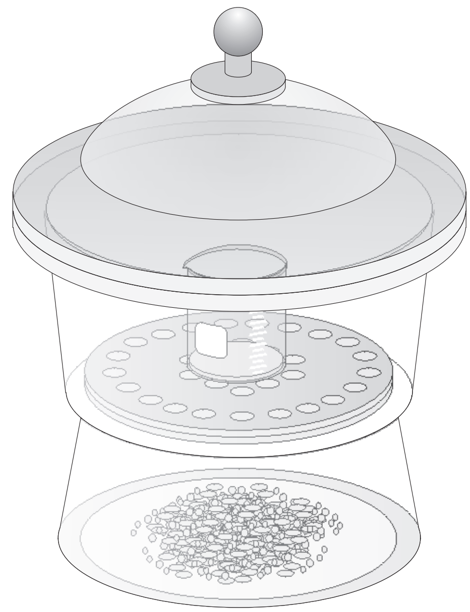
Use gloves or tongs when handling the beaker.

2. Transfer the samples to the beakers.
   a. Remove any large particles, such as twigs or insects, from the sample water.
   b. Swirl the samples to attain uniformity of suspended particles.
   c. Using a 100 mL graduated cylinder, carefully measure 200 mL of sample water into each beaker.

3. Using tongs or gloves, place the beakers into the oven and allow the water to evaporate overnight at a temperature of around 100105°C.

Day 2

4. Measure the mass of the beakers and solids.
   a. Using tongs or gloves, remove the beakers from the oven and place them in a *dessicator*, if available, to cool. A dessicator will keep the samples from absorbing any water from the air that would increase their mass. If no dessicator is available, the beakers can be cooled on a table top. Proceed to the next step as soon as possible to minimize any absorption of water.
   b. Use an analytical balance to measure the mass of each beaker with the solids now left behind. Record the values on the Data & Calculations sheet (round to the nearest 0.001 g).
   c. Obtain the mass of the solids by subtracting the mass of the empty beaker from the mass of the beaker with the solids. If the mass of the solids is at least 0.025 g, proceed to Step 6. If the mass of the solids is less than 0.025 g, proceed to Step 5.



Cool sample in a dessicator, if available.

5. If the mass of the solids is less than 0.025 g, add another 200 mL of sample to each beaker and repeat Steps 3 and 4. Make a note on the Data & Calculations sheet that your total volume is now 400 mL instead of 200 mL.

6. Record the mass of the solids on the Data & Calculations sheet (round to the nearest 0.001 g).

DATA & CALCULATIONS

Total Solids

Stream or lake: ______________________________ Time of day: ______________________________

Site name: ______________________________ Student name: ______________________________

Site number: ______________________________ Student name: ______________________________

Date: ______________________________ Student name: ______________________________

Column	A	B	C	D	E	F
Beaker number	Mass of empty beaker (g)	Mass of beaker plus solids (g)	Mass of solids (g)	Mass of solids (mg)	Total volume (L)	Total solids (mg/L)
Example	95.255 g	95.297 g	0.042 g	42 mg	0.200 L	210 mg/L
1						
2						

Average TS (mg/L)	

Column Procedure:

A. Mass of empty beaker
B. Mass of beaker with dried solids
C. Mass of solids (g) = B – A
D. Mass of solids (mg) = C × 1000
E. Total volume (L) = mL water / 1000
F. Total solids = D / E

Field Observations (e.g., weather, geography, vegetation along stream) ______________________________

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Test Completed: ________________ Date: ______

Vernier Lab Safety Instructions Disclaimer

THIS IS AN EVALUATION COPY OF THE VERNIER STUDENT LAB.

This copy does not include:

- **Safety information**
- **Essential instructor background information**
- **Directions for preparing solutions**
- **Important tips for successfully doing these labs**

The complete *Water Quality with Vernier* lab manual includes 16 water quality tests and essential teacher information. The full lab book is available for purchase at: http://www.vernier.com/cmat/wqv.html

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