NSTA 2025
Philadelphia, PA

What's in Your Water? Introduction to Water Quality Testing

Experiment

Watershed Testing

- Go Direct® Optical Dissolved Oxygen Probe
- Go Direct Conductivity Probe
- Go Direct pH Sensor

Workshop Presenter

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Watershed Testing

(Optical Dissolved Oxygen Probe)

There are many reasons for determining water quality. You may want to compare the water quality upstream and downstream to locate a possible source of pollutants along a river or stream. Another reason may be to track the water quality of a watershed over time by making measurements periodically. When comparing the quality of a watershed at different times, it is important that measurements be taken from the same location and at the same time of day.

In 1970, the National Sanitation Foundation, in cooperation with 142 state and local environmental specialists and educators, devised a standard index for measuring water quality. This index, known as the Water Quality Index, or WQI, consists of nine tests to determine water quality. These nine tests are; temperature, pH, turbidity, total solids, dissolved oxygen, biochemical oxygen demand, phosphates, nitrate, and fecal coliform. A graph for each of the nine tests indicates the water quality value (or Q-value) corresponding to the data obtained. Once the Q-value for a test has been determined, it is multiplied by a weighting factor. Each of the tests is weighted based on its relative importance to a stream's overall quality. The resulting values for all nine tests are totaled and used to gauge the stream's health (excellent, good, medium, poor, or very poor).

While the WQI can be a useful tool, it is best used in light of historical data. Not all streams are the same, and without historical data it is difficult to determine if a stream is truly at risk. For example, a stream may earn a very low WQI value and appear to be in poor health. By looking at historical data, however, you may find that samples were collected just after a heavy rain with an overflow from the local city sewer system and do not accurately reflect the stream's health.

For the purpose of this exercise, you will perform only four of the WQI tests: water temperature, dissolved oxygen, pH, and total dissolved solids. A modified version of the WQI for these four tests will allow you to determine the general quality of the stream or lake you are sampling.

OBJECTIVES

- Use an Optical Dissolved Oxygen Probe, Conductivity Probe, and a pH Sensor to make on-site measurements.
- Calculate the water quality based on your findings.

MATERIALS

Chromebook, computer, **or** mobile device
Graphical Analysis app
Go Direct Optical Dissolved Oxygen
Go Direct Conductivity Probe
Go Direct pH Sensor
four water sampling bottles, stoppered
plastic cup or beaker

PROCEDURE

You will measure dissolved oxygen concentration, pH, water temperature, and total dissolved solid (TDS) concentration at four different sites.

1. Set up the sensors and Graphical Analysis.
   a. Launch Graphical Analysis.
   b. Connect the Optical Dissolved Oxygen Probe, pH Sensor, and Conductivity Probe to your Chromebook, computer, or mobile device.
   c. You will use the temperature sensor that is built into the Optical Dissolved Oxygen Probe to measure temperature. Click or tap Sensor Channels for the Optical DO Probe. Enable the Temperature channel.
   d. Click or tap Done.
2. Click or tap on View Options, , and select Meter.
3. Choose a desirable location to perform your measurements. It is best to take your samples as far from the shore edge as is safe. Your site should be representative of the whole watershed.
4. Rinse the sampling bottle a few times with stream water. Place the sample bottle below the surface, allowing water to flow into the opening for 2 to 3 minutes.
5. Fill the sampling bottle so it is completely full and then stopper the bottle under water. This should minimize the amount of atmospheric oxygen that gets dissolved in the water prior to making measurements.
6. Measure the temperature and dissolved oxygen of your sample.
   a. Remove the Optical Dissolved Oxygen Probe from its storage bottle.
   b. Place the tip of the probe into the water sampling bottle.
   c. Monitor the temperature and dissolved oxygen values displayed on the screen. When the values are stable, record the temperature and the dissolved oxygen concentration in Table 1 for Site 1a.
   d. Remove the probe from the water and place it back into the storage bottle.
7. Measure the pH of your water sample.
   a. Remove the pH Sensor from its storage bottle.
   b. Rinse the pH electrode thoroughly with the stream water.
   c. Place the sensor into the sample.
   d. Monitor the pH value. Record the pH in Table 1 for Site 1a when the value has stabilized.
   e. Remove the sensor from the water and place it back into the storage bottle.
8. Measure the TDS of your sample.
   a. If the Conductivity Probe is value in a unit other than mg/L, click or tap the Conductivity meter and select mg/L from the units menu. Dismiss the conductivity box.

b. Place the tip of the Conductivity Probe into the water sample. The hole near the tip of the probe should be submerged completely.

c. Monitor the TDS value. Record the TDS value in Table 1 for Site 1a when the value has stabilized.

d. Remove the probe from the water.

9. Repeat Steps 2–8 at a second location 6 meters from Site 1a. The second location will be designated Site 1b.

10. Repeat Steps 1–8 at two locations 1.6 km from Site 1a that are approximately 6 m apart. These sites will be designated Site 2a and Site 2b.

DATA

Table 1				
Location	Dissolved oxygen (mg/L)	pH	Total dissolved solids	Temperature (°C)
Site 1a				
Site 1b				
Average				
Site 2a				
Site 2b				
Average				

Temperature difference: ________________

Table 2 DO (% Saturated)			
	Dissolved oxygen (mg/L)	DO in saturated water	Percent saturated
Site 1			
Site 2			

PROCESSING THE DATA

1. Calculate the averages for measurements at each location and record the results in Table 1.

2. Determine the % saturation of dissolved oxygen.

   a. Copy the value of dissolved oxygen measured at each site from Table 1 to Table 2.

   b. Obtain the barometric pressure, in mm Hg, using either a barometer or a table of barometric pressure values according to elevation (your instructor will provide either the barometer reading or the table of values).

   c. Note the water temperature at each site.

   d. Using the pressure and temperature values, look up the level of dissolved oxygen for air-saturated water (in mg/L) from a second table provided by your instructor. Record the results for each site in Table 2.

   e. To determine the % saturation, use this formula:

$$\%\ \text{saturation} = \frac{\text{measured DO level}}{\text{saturated DO level}} \times 100$$

   f. Record the % saturation of dissolved oxygen in Table 2.

3. Using Tables 3–5, determine the water quality value (Q-value) for each of the following measurements: dissolved oxygen, pH, and TDS. You may need to interpolate to obtain the correct Q-values. Record your result in Table 7 for Site 1 and in Table 8 for Site 2.

4. Subtract the two average temperatures from the sites that are about 1.6 km apart. Record the result as the temperature difference in the blank below Table 1.

5. Using Table 6 and the value you calculated above, determine the water quality value (Q-value) for the temperature difference measurement. You may need to interpolate to obtain the correct Q-values. Record your result in Table 7 and Table 8. The temperature Q-value will be the same in both tables.

6. Multiply each Q-value by the weighting factor in Table 7 for Site 1 and in Table 8 for Site 2. Record the total Q-value in Tables 7–8.

7. Determine the overall water quality of your stream by adding the four total Q-values in Table 7 for Site 1 and in Table 8 for Site 2. Record the result as the "Overall Quality." The closer this value is to 100, the better the water quality of the stream at this site. **Note**: This quality index is not a complete one—this value uses only four measurements. For a more complete water quality determination, you should measure fecal coliform counts, biological oxygen demand, phosphate and nitrate levels, and turbidity. It is also very valuable to do a "critter count"—that is, examine the macroinvertebrates in the stream.

Table 3: DO Test Results	
DO (% saturation)	Q-Value
0	0
10	5
20	12
30	20
40	30
50	45
60	57
70	75
80	85
90	95
100	100
110	95
120	90
130	85
140	80

Table 4: pH Test Results	
pH	Q-Value
2.0	0
2.5	1
3.0	3
3.5	5
4.0	8
4.5	15
5.0	25
5.5	40
6.0	54
6.5	75
7.0	88
7.5	95
8.0	85
8.5	65
9.0	48
9.5	30
10.0	20
10.5	12
11.0	8
11.5	4
12.0	2

Table 5: TDS Test Results	
TDS (mg/L)	Q-Value
0	80
50	90
100	85
150	78
200	72
250	65
300	60
350	52
400	46
450	40
500	30

Table 6: Temperature Test Results	
ΔTemp (°C)	Q-Value
0	95
5	75
10	45
15	30
20	20
25	15
30	10

Table 7 Site 1			
Test	Q-Value	Weight	Total Q-Value
DO		0.38	
pH		0.24	
TDS		0.16	
Temperature		0.22	

Overall Quality ________________

Table 8 Site 2			
Test	Q-Value	Weight	Total Q-Value
DO		0.38	
pH		0.24	
TDS		0.16	
Temperature		0.22	

Overall Quality ________________

QUESTIONS

1. Using your measurements, what is the quality of the watershed? Explain.
2. How do you account for each of the measurements? For example, if the pH of the downstream site is very low, and you took measurements above and below an auto repair station, perhaps battery acid leaked into the stream.
3. How did measurements between the two sites compare? How might you account for any differences, if any?
4. Compare the measurements you obtained with those from previous months or years. Has the water quality improved, remained about the same, or declined? Explain.
5. Why would you expect the DO in a pond to be less than in a rapidly moving stream? If applicable, did your measurements confirm this assumption? Explain.
6. What could be done to improve the quality of the watershed?