Water Quality
with Vernier

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Equipment Used in Tests

Test		Sensors	
1	Temperature	**Choose 1**: Extra-Long **or** Stainless Steel Temperature Probe	
2	pH	**Required**: pH Sensor	
3	Turbidity	**Required**: Turbidity Sensor	
4	Total Solids	No sensor required	
5	Dissolved Oxygen	**Choose 1**: Optical OD Probe **or** Dissolved Oxygen Probe	
6	Biochemical Oxygen Demand	**Choose 1**: Optical OD Probe **or** Dissolved Oxygen Probe	
7	Phosphates	**Choose 1**: Colorimeter **or** SpectroVis Plus	
8	Nitrate	**Choose 1**: Nitrate ISE **or** Colorimeter **or** SpectroVis Plus	
9	Bacterial Concentration	No sensor required	
10	Ammonium Nitrogen	**Required**: Ammonium ISE	
11	Alkalinity	**Required**: pH Sensor	**Optional**: Drop Counter
12	Total Dissolved Solids	**Required**: Conductivity Probe	
13	Calcium and Water Hardness	**Required**: Calcium ISE	
14	Total Water Hardness	No sensor required	**Optional**: Drop Counter
15	Chloride and Salinity	**Choose 1**: Chloride ISE **or** Conductivity Probe **or** Salinity Sensor	
16	Stream Flow	**Required**: Flow Rate Sensor	
17	Physical Profile of a Lake	**Choose 1**: Extra-Long **or** Stainless Steel Temperature Probe **Choose 1**: Optical OD Probe **or** Dissolved Oxygen Probe **Required**: Conductivity Probe **Required**: pH Sensor	
18	PAR Attenuation in Water	**Required**: PAR Sensor	

Turbidity

INTRODUCTION

Turbidity is a measure of water's lack of clarity. Water with high turbidity is cloudy, while water with low turbidity is clear. The cloudiness is produced by light reflecting off of particles in the water; therefore, the more particles in the water, the higher the turbidity.

Many factors can contribute to the turbidity of water. An increase in stream flow due to heavy rains or a decrease in stream-bank vegetation can speed up the process of soil erosion. This will add suspended particles, such as clay and silt, to the water.

Runoff of various types contains suspended solids that may add to the turbidity of a stream. Agricultural runoff often contains suspended soil particles. Other types of runoff include industrial waste, water treatment plant effluent, and urban runoff from parking lots, roads, and rooftops.

Bottom-dwelling aquatic organisms, such as catfish, can contribute to the turbidity of 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 is suspended in the water can also increase the turbidity in a stream.

High turbidity will decrease 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, warming the surrounding water. This can lead to other problems associated with increased temperature levels.

While highly turbid water can be detrimental to an aquatic ecosystem, it is not correct to assume that clear water is always healthy. Slightly turbid water can be perfectly healthy, while clear water could contain unseen toxins or unhealthy levels of nutrients.

MATERIALS

LabQuest
Vernier Turbidity Sensor
soft, lint-free cloth or tissue
distilled water
turbidity cuvette
turbidity standard (StableCal® Formazin Standard 100 NTU)
sampling container with lid (optional)

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COLLECTION AND STORAGE OF SAMPLES

- This test can be conducted on site or in the lab.
- Stand upstream from any activity that could stir up sediment and affect your readings. Hold the sample bottle upstream from your body.
- 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 body of water appear to be unreachable, samplers consisting of a rod and container can be constructed for collection.
- Obtain the sample either directly in the turbidity cuvette, or in a container that has a lid to allow for gentle mixing just prior to testing. Approximately 35 mL of water is required.
- If the testing cannot be conducted within a few hours, place the sample in an ice chest or a refrigerator.

CALIBRATION

1. Calibrate the Turbidity Sensor.
   - If your instructor directs you to use the stored calibration, proceed directly to Step 3.
   - If your instructor directs you to perform a new calibration for the Turbidity Sensor, proceed to Step 1a. **Note:** It is recommended that the calibration be performed prior to going into the field.

First Calibration Point

a. Place the Turbidity Sensor on a flat surface and connect to LabQuest.

b. Wait approximately five minutes for the sensor to warm up.

c. Choose Calibrate from the Sensors menu and select Calibrate Now.

d. Prepare a *blank* by rinsing the turbidity cuvette with distilled water, then filling it with distilled water so that the bottom of the meniscus is even with the top of the white line. Place the lid on the cuvette. Gently wipe the outside with a soft, lint-free cloth or tissue.

e. Check the cuvette for air bubbles. If air bubbles are present, gently tap the bottom of the cuvette on a hard surface to dislodge them.

f. Holding the cuvette by the lid, place it in the Turbidity Sensor. Make sure that the mark on the cuvette is aligned with the mark on the Turbidity Sensor. Close the lid.

g. Enter **0** as the known turbidity value for Reading 1.

h. When the voltage reading stabilizes, tap Keep.

i. Remove the cuvette, discard the contents, and set aside for use in Step 5.

Second Calibration Point

j. Obtain the cuvette containing the turbidity standard (100 NTU) and gently invert it four times to mix in any particles that may have settled to the bottom. **Important:** Do not shake the standard. Shaking will introduce tiny air bubbles that will affect turbidity.

k. Wipe the outside with a soft, lint-free cloth or tissue.

l. Holding the standard by the lid, place it in the Turbidity Sensor. Make sure that the mark on the cuvette is aligned with the mark on the Turbidity Sensor. Close the lid.

m. Enter **100** as the known turbidity value for Reading 2.

n. When the voltage reading stabilizes, tap Keep.

2. Save the calibration onto the sensor.
   a. Select the Storage tab.
   b. Tap Save Calibration to Sensor and follow the onscreen instructions to save the calibration.
   c. Tap OK.
   d. Remove the turbidity standard from the sensor.

PROCEDURE

3. Place the Turbidity Sensor on a flat surface, connect to LabQuest, and wait approximately 5 minutes for the sensor to warm up (if not already warmed up).

4. Ensure that the correct date and location are displayed, if using Data Matrix mode.

5. Prepare the sample.
   a. Obtain the sample either directly in the turbidity cuvette or from a sampling container. The bottom of the meniscus of the sample water should be even with the top of the white line on the cuvette. **Important:** If the sample has been sitting, gently invert it four times to mix in any particles that may have settled to the bottom. Do not shake the sample. Shaking will introduce tiny air bubbles that will affect the turbidity value.
   b. Place the lid on the cuvette. Gently dry the outside with a soft, lint-free cloth or tissue. Ensure the glass is wiped clean with no fingerprints or residue.
   c. Check the cuvette for air bubbles. If air bubbles are present, gently tap the bottom of the cuvette on a hard surface to dislodge them.
   d. Holding the cuvette by the lid, place it into the Turbidity Sensor. Make sure that the mark on the cuvette is aligned with the mark on the Turbidity Sensor. Close the lid.

6. Once the turbidity reading has stabilized, tap it to keep the value.

7. When finished with the Turbidity Sensor, empty the cuvette and rinse thoroughly with distilled water.

8. If testing is complete at this time, stop data collection. If not, proceed to your next test.

DATA

Site Information

Name of site	
Date of collection	
Time of collection	
Group members	

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

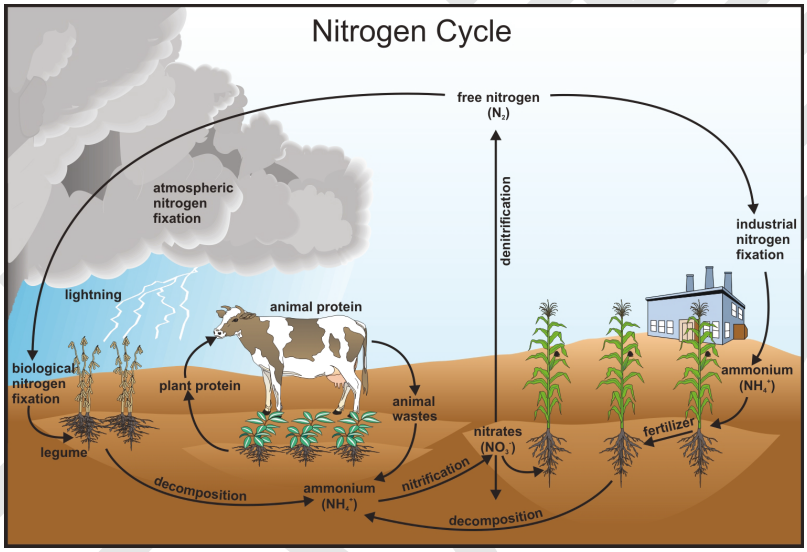
Test Results

Turbidity (NTU)	
Date test completed	
Time test completed	
Test completed by	

Ammonium Nitrogen

INTRODUCTION

The ammonium ion, NH_4^+, is an important member of the group of nitrogen-containing compounds that act as nutrients for aquatic plants and algae. In surface water, most of the ammonia, NH_3, is found in the form of the ammonium ion, NH_4^+. This fact allows us to approximate the concentration of all of the nitrogen in the form of ammonia and ammonium combined, commonly called ammonia nitrogen, by measuring only the concentration of the ammonium ions.



All plants and animals require nitrogen as a nutrient to synthesize amino acids and proteins. Most nitrogen on earth is found in the atmosphere in the form of N_2, but plants and animals cannot utilize it in this form. The nitrogen must first be converted into a useable form, such as nitrate, NO_3^-. These conversions among the various forms of nitrogen form a complex cycle called the *nitrogen cycle*, illustrated above.

In the nitrogen cycle, bacteria convert atmospheric nitrogen into ammonium in a process called *nitrogen fixation*. This process often occurs in the roots of leguminous plants such as alfalfa, beans, and peas.

Bacteria can also convert the nitrogen in decaying plant and animal matter and waste products in soil or water to ammonium in a process called *ammonification*. Other sources of organic matter for ammonification include industrial waste, agricultural runoff, and sewage treatment effluent.

Some trees and grasses are able to absorb ammonium ions directly, but most require their conversion to nitrate. This process, called *nitrification*, is usually accomplished by bacteria in the

soil or water. In the first step of nitrification, ammonium ions are oxidized into nitrite. The nitrite is then converted into nitrate, which can subsequently be utilized by plants and algae.

Animals require nitrogen as well. They obtain the nitrogen they need by eating plants or by eating other animals, which in turn have eaten plants.

If ammonium nitrogen levels in surface waters are too high, they can be toxic to some aquatic organisms. If the levels are only moderately high, plant and algal growth will usually increase due to the abundance of nitrogen available as a nutrient. This will have a ripple effect on other attributes of water quality, such as increasing biochemical oxygen demand and lowering dissolved oxygen levels. Dissolved oxygen levels can also be lowered when ammonium nitrogen is high due to the increased amount of nitrification occurring.

If enough nutrients are present, *eutrophication* may occur. Eutrophication occurs when there is such an abundance of nutrients available that there is a significant increase in plant and algal growth. As these organisms die, they will accumulate on the bottom and decompose, releasing more nutrients and compounding the problem. In some cases, this process of eutrophication can become so advanced that the body of water may become a marsh, and eventually fill in completely.

If too little ammonium nitrogen is present, it may be the limiting factor in the amount of plant and algal growth. Ammonium nitrogen can quickly be converted into nitrites or nitrates; therefore, a low level of ammonium-nitrogen does not necessarily indicate a low level of nitrogen in general.

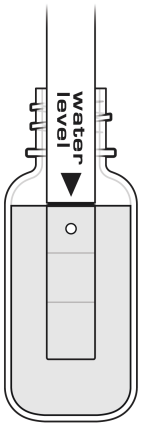
MATERIALS

LabQuest
Vernier Ammonium Ion-Selective Electrode
Low Standard (1 mg/L NH_4^+-N)
High Standard (100 mg/L NH_4^+-N)
distilled water
waste container
sampling container (optional)

COLLECTION AND STORAGE OF SAMPLES

- This test can be conducted on site or in the lab. A 100 mL water sample is required.
- It is important to obtain the sample water from below the surface of the water and as far away from shore as is safe. If suitable areas of the body of water appear to be unreachable, samplers consisting of a rod and container can be constructed for collection
- If the testing cannot be conducted within a few hours, place the samples in an ice chest or a refrigerator.

CALIBRATION



1. Place the Ammonium Ion-Selective Electrode (ISE) in the Ammonium High Standard solution (included with the ISE) for at least 30 minutes. **Important:** Make sure the ISE is not resting on the bottom of the container, and that the small white reference contacts are immersed. Make sure no air bubbles are trapped below the ISE.

2. Calibrate the Ammonium ISE.
   - If your instructor directs you to use the stored calibration, proceed directly to Step 4. **Note:** It is only recommended to use the stored calibration if the ISE was calibrated on that day.
   - If your instructor directs you to perform a new calibration, follow this procedure. **Note:** It is recommended that the calibration be performed prior to going into the field.

First Calibration Point

a. Ensure the Ammonium ISE is still in the Ammonium High Standard solution and connect the ISE to LabQuest.

b. Choose Calibrate from the Sensors menu and select Calibrate Now.

c. Enter **100** as the concentration of the standard in mg/L NH_4^+-N for Reading 1.

d. When the voltage reading stabilizes, tap Keep.

Second Calibration Point

e. Rinse the ISE thoroughly with distilled water and gently blot it dry with a tissue or paper towel. **Important:** Failure to carefully rinse and dry the ISE will contaminate the standard.

f. Place the tip of the ISE into the Low Standard (1 mg/L NH_4^+-N). Note: Be sure that the ISE is not resting on the bottom of the bottle and that the small white reference contacts are immersed. Make sure no air bubbles are trapped below the ISE.

g. Enter **1** as the concentration of the standard in mg/L NH_4^+-N for Reading 2.

h. After briefly swirling the solution, hold the ISE still and wait approximately 60 seconds for the voltage reading to stabilize.

i. When the voltage reading stabilizes, tap Keep.

3. Save the calibration onto the sensor.
   a. Select the Storage tab.
   b. Tap Save Calibration to Sensor and follow the onscreen instructions to save the calibration. **Note:** ISEs should be calibrated frequently. Only use a stored calibration on the day the calibration was done.
   c. Tap OK.
   d. Rinse the Ammonium ISE with distilled water into a waste container and gently dry off the probe.
   e. If the ISE is to be transported to the field, remove the cap from the Short-Term ISE Soaking Bottle and fill it 3/4 full with High Standard. Slide the bottle's cap onto the ISE, insert it into the bottle, and tighten. **Important:** Do not leave the ISE soaking for more than 24 hours. Long-term storage should be in the Long-Term ISE Storage Bottle.

PROCEDURE

4. With the ISE still soaking in the High Standard solution, ensure it is connected to LabQuest and if using Data Matrix mode, that the correct date and location are displayed.
5. Rinse the ISE thoroughly with distilled water into a waste container and gently blot it dry.
6. Place the tip of the ISE into the sample water. **Note:** Make sure the small white reference contacts are immersed, and that the ISE is not resting on the bottom. Be sure no air bubbles are trapped below the ISE.
7. After briefly swirling the solution, hold the ISE still and wait approximately 60 seconds for it to stabilize. **Note:** If the reading is stable at 1 mg/L and has not changed, the calibration was not saved and will need to be redone.
8. Once the Ammonium ISE reading has stabilized, tap it to keep the value. **Note:** The sensor does not read values accurately below 0.1 mg/L. If the reading is less than 0.1, write < 0.1 on the Data sheet.
9. When finished with the Ammonium ISE, rinse the tip thoroughly with distilled water, gently dry off the probe and store properly.
10. If testing is complete at this time, stop data collection. If not, proceed to the next test.

DATA

Site Information

Name of site	
Date of collection	
Time of collection	
Group members	

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

Test Results

NH_4^+-N (mg/L)	
Date test completed	
Time test completed	
Test completed by	