Lesson Plan: A Tale of Two Waters

Description

In this lesson, students analyze the water quality at two different locations, compare their measurements, and consider what factors affect the quality of the water. This lesson is designed to take place at Seneca Park with students studying the water in Trout Lake and the Genesee River, but could be done anywhere a pond or lake is within walking distance of the Genesee River.

Essential Question

How does the water quality of two bodies of water compare?
How do scientists study water quality?
What affects the quality of water in rivers and streams?

Learning Targets

1. I can complete and analyze tests for water quality.
2. I can compare water quality at different test sites.
3. I can consider factors that impact water quality.

Class	**Duration**	**Topics**
7th-8th grade science Regents Chemistry Regents Living Environment	2 - 3 hour field study	environmental health water chemistry human impact

Standards: NGSS - HS-ESS2-2 Earth's Systems

Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Analyzing and Interpreting Data	ESS2.A: Earth Materials and Systems - Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.	Stability and Change Feedback (negative or positive) can stabilize or destabilize a system.

NYS Standards:

- 4.7.1e The environment may contain dangerous levels of substances (pollutants) that are harmful to organisms. Therefore, the good health of environments and individuals requires the monitoring of soil, air, and water and taking steps to keep them safe.

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Plan for Lesson

Notes: This lesson is designed to align with the Genesee RiverWatch Water Quality Monitoring Program's protocols. See the attached Genesee RiverWatch Water Quality Testing Kit Instructions for a list of materials and instructions. If you do not have access to the materials necessary for the tests included, other tests can be substituted.

Location Information:

- The Wegmans Lodge and parking lot are a good starting point for this lab.
- A map of Seneca Park can be found on the Monroe County Parks Department website.
- There is access to the pond for water sampling at multiple locations.
- Access to the Genesee River for water testing is along the red trail on this Trail Map of Seneca Park.

Introduction:
(In the classroom or in the field)
Students examine a photo (preferably color) of the study location and are asked to make predictions about sediment and phosphorus levels. They can be directed to the background information about phosphorus and turbidity in this packet.

Data Collection:
Depending on the size of the class and time available students can split up and share data or collect the data individually.
Students measure phosphorus and turbidity levels by following the included instructions. They also sketch the study location and note anything they see that might affect water quality.

Data Analysis:
Students develop a claim about the quality of each water body and provide evidence to support their claim. Using their observations and background information from the attached readings students provide possible reasons one body of water has better quality than the other.

Synthesis:
Students create a Venn Diagram that assesses their understanding of the factors that affect the phosphorus levels and turbidity of each water body. This can be completed through discussion or with additional research in the classroom.

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Name _____ Date _____

Student Worksheet A Tale of Two Waters Lab

A Tale of Two Waters

In this lesson, you will analyze the water quality at two different locations. You will be measuring phosphorus and turbidity because these are two factors that are used to assess the health of the Genesee River. After you compare measurements, you will consider what factors affect the quality of the water.

Essential Question
How does the water quality of two bodies of water compare?
How do scientists study water quality?
What affects the quality of water in rivers and streams?

Learning Targets

1. I can complete and analyze tests for water quality.
2. I can compare water quality at different test sites.
3. I can consider factors that impact water quality.

Genesee RIVERWATCH™ an initiative of CEI

Introduction: Examine the attached picture and use your knowledge of science to make a prediction. Circle each answer and explain why you chose it.

Which water body has a more sediment? Genesee River Trout Lake Same

Why did you make that choice?

Which water body has more phosphorus? Genesee River Trout Lake Same

Why did you make that choice?

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Photo of Seneca Park taken from Google Maps

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Data Collection: Use the water testing equipment and the attached instructions to test the water quality. Record the results in the chart below.

Trout Lake Data Collection

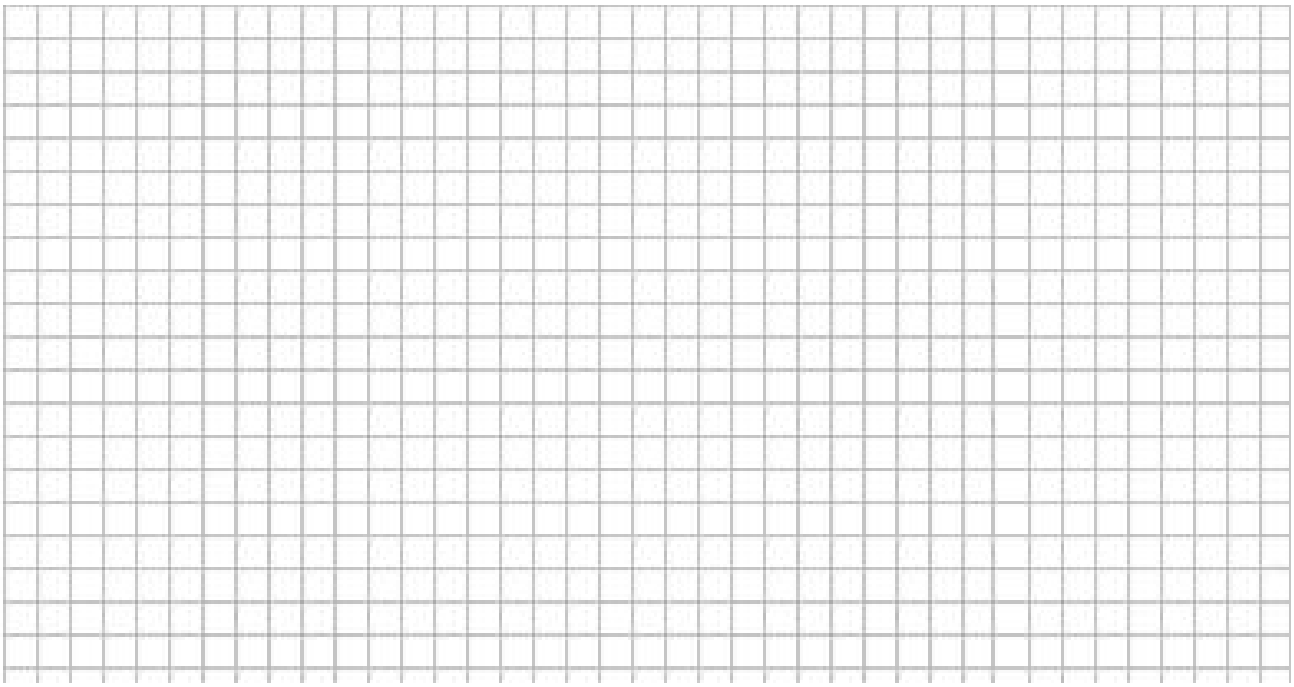
Date _____Time _____ Samplers _____

Water Quality Data Table

Parameter	Measurements	Units
Phosphorus		Milligrams/liter
Turbidity / Transparency		Centimeters

Create a detailed sketch of the site. Pay attention to the landscape and label what features, biotic and abiotic, might affect water quality.

Sketch of Trout Lake



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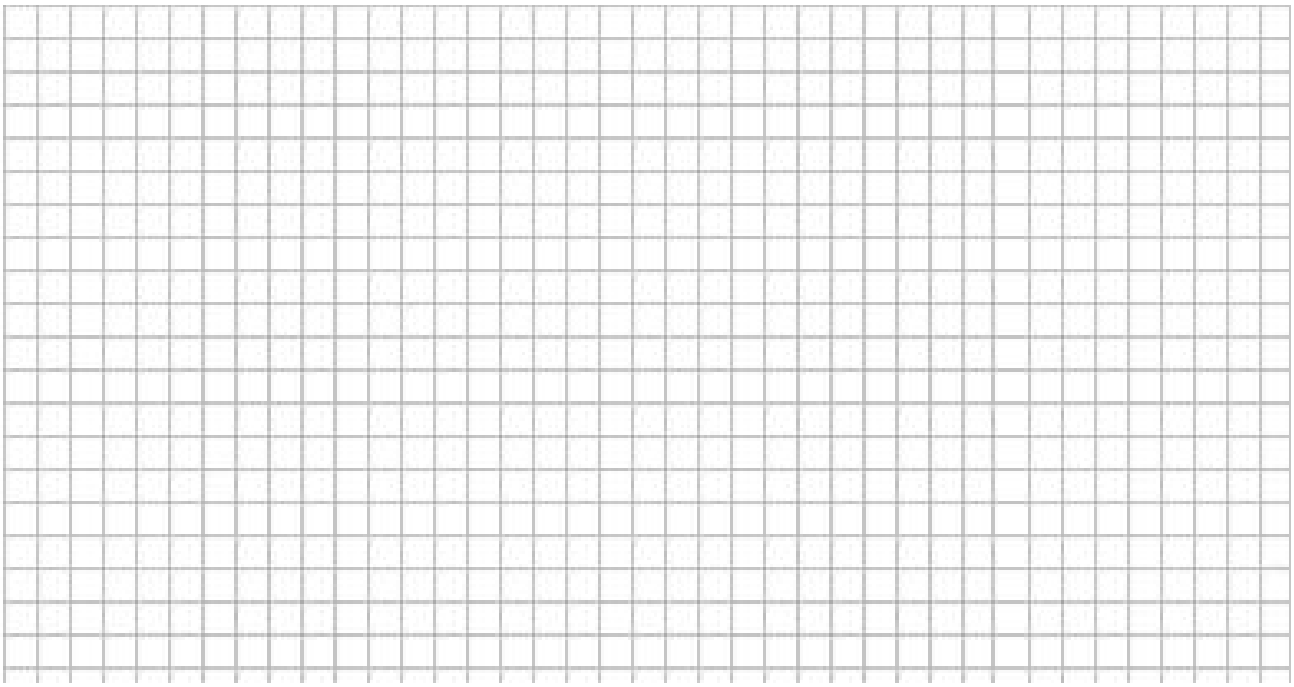
Genesee River Data Collection

Date _____Time _____ Samplers _____

Water Quality Data Table

Parameter	Measurements	Units
Phosphorus		Milligrams/liter
Turbidity / Transparency		Centimeters

Create a detailed sketch **Genesee River** site. Pay attention to the landscape and label what features might affect water quality.



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Data Analysis: Use the data you collected to compare the water quality of the two different sampling sites. Use your knowledge of science and the attached readings about phosphorus and turbidity to provide reasons that explain why the water quality varies (or is the same) for the two bodies of water you have tested.

Claim: Which body of water has a lower **phosphorus level** and is therefore better quality?

_____

_____

Evidence: How does the data you collected support your claim?

Phosphorus Data (mG / L)

Trout Lake	Genesee River

Reasons: What are the reasons this body of water would have a lower **phosphorus** level?

_____

_____

_____

_____

Claim: Which body of water has a lower **turbidity** and is therefore better quality?

_____

_____

Evidence: How does the data you collected support your claim?

Turbidity Data (mG / L)

Trout Lake	Genesee River

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Reasons: What are the reasons this body of water would have a lower phosphorus level?

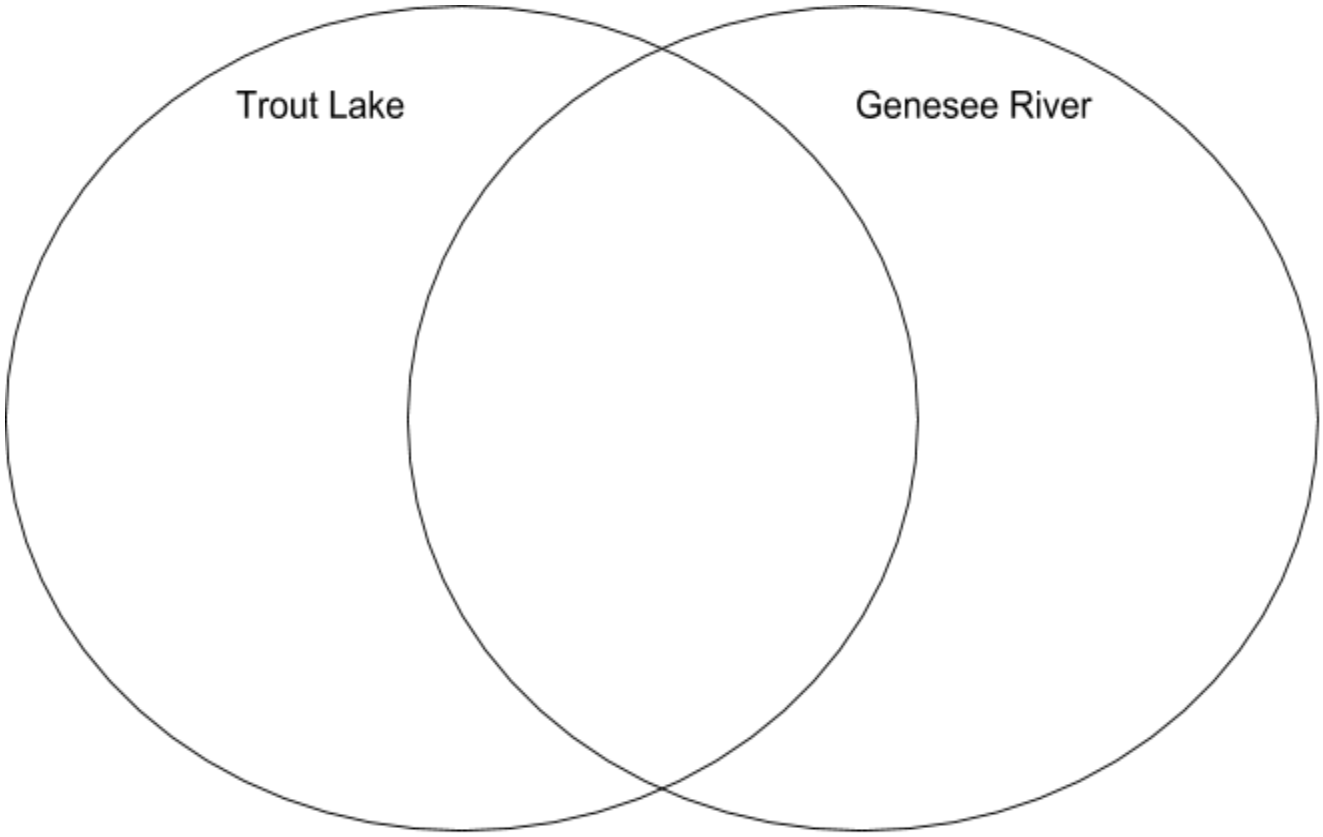
_____

_____

_____

_____

Synthesis: **Create a Venn diagram that shows the different factors that affect water quality in these two bodies of water.**



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Adapted from the USGS Water Science School
https://water.usgs.gov/edu/phosphorus.html

Phosphorus and Water

Phosphorus is a common constituent of agricultural fertilizers, manure, and organic wastes in sewage and industrial effluent. It is an essential element for plant life, but when there is too much of it in water, it can speed up eutrophication (a reduction in dissolved oxygen in water bodies caused by an increase of mineral and organic nutrients) of rivers and lakes. Soil erosion is a major contributor of phosphorus to streams. Bank erosion occurring during floods can transport a lot of phosphorus from the river banks and adjacent land into a stream, as this picture of the Rio Chama near Chamita, New Mexico shows (photograph by Lisa Carter).

Phosphorus in surface and groundwater

Phosphorus gets into water in both urban and agricultural settings. Phosphorus tends to attach to soil particles and, thus, moves into surface-water bodies from runoff. A USGS study on Cape Cod, Massachusetts showed that phosphorus can also migrate with groundwater flows. Since groundwater often discharges into surface water, such as through streambanks into rivers, there is a concern about phosphorus concentrations in groundwater affecting the water quality of surface water.

Phosphorus is an essential element for plant life, but when there is too much of it in water, it can speed up eutrophication (a reduction in dissolved oxygen in water bodies caused by an increase of mineral and organic nutrients) of rivers and lakes. This has been a very serious problem in the Atlanta, Ga. area, as a major lake that receives Atlanta's waste water, West Point Lake, is south of the city. In metropolitan Atlanta, phosphorus coming into streams from point sources, primarily wastewater-treatment facilities, have caused West Point Lake to become highly eutrophic ("enriched"). A sign of this is excess algae in the lake. State laws to reduce phosphorus coming from wastewater-treatment facilities and to restrict the use of phosphorus detergents has caused large reductions in the amounts of phosphorus in the Chattahoochee River south of Atlanta, Georgia and in West Point Lake.

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Adapted from the USGS Water Science School https://water.usgs.gov/edu/turbidity.html

Turbidity

Turbidity is the measure of relative clarity of a liquid. It is an optical characteristic of water and is an expression of the amount of light that is scattered by material in the water when a light is shone through the water sample. The more the scattered light is diffused, the higher the turbidity. Material that causes water to be turbid include clay, silt, finely divided inorganic and organic matter, algae, soluble colored organic compounds, plankton and other microscopic organisms.

During a rainstorm, particles from the surrounding land are washed into the river making the water a muddy brown color, indicating water that has higher turbidity values. Also, during high flows, water velocities are faster and water volumes are higher, which can more easily stir up and suspend material from the stream bed, causing higher turbidites.

Turbidity and water quality

High concentrations of particulate matter affect light penetration and productivity, recreational values, and habitat quality, and cause lakes to fill in faster. In streams, increased sedimentation and siltation can occur, which can result in harm to habitat areas for fish and other aquatic life. Particles also provide attachment places for other pollutants, notably metals and bacteria. For this reason, turbidity readings can be used as an indicator of potential pollution in a water body.

Turbidity and human health

Excessive turbidity, or cloudiness, in drinking water is aesthetically unappealing, and may also represent a health concern. Turbidity can provide food and shelter for pathogens. If not removed, turbidity can promote regrowth of pathogens in the distribution system, leading to waterborne disease outbreaks, which have caused significant cases of gastroenteritis throughout the United States and the world. Although turbidity is not a direct indicator of health risk, numerous studies show a strong relationship between removal of turbidity and removal of protozoa. The particles of turbidity provide "shelter" for microbes by reducing their exposure to attack by disinfectants. Microbial attachment to particulate material has been considered to aid in microbe survival. Fortunately, traditional water treatment processes have the ability to effectively remove turbidity when operated properly. (Source: EPA)

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Genesee RiverWatch
Water Quality Testing Kit Instructions

Before beginning your water sampling, examine the contents of the Stream Monitoring Kit in the plastic container provided by Genesee RiverWatch.

Sampling Equipment Checklist

- ☐ Rope
- ☐ Sample bucket
- ☐ Extension rod
- ☐ One-gallon sample container
- ☐ Water bottles for samples
- ☐ High visibility vest/jacket
- ☐ Gloves
- ☐ Clipboard with data sheets
- ☐ Marker
- ☐ Pen
- ☐ Distilled water in squirt bottle
- ☐ Towel
- ☐ Colorimeter
- ☐ Transparency tube
- ☐ Instrument instruction manual packet

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Instructions for water sampling, measuring, recording and reporting of data.

Obtaining a water sample

There are two options for getting an adequate water sample needed for both the phosphate measurement as well as the transparency tube test.

Option A Bridge/Overpass: Use this method whenever possible, as long as the bridge/overpass can be accessed safely.

1. Do not park on the bridge.
2. Put on the hi-visibility vest and the rubber-palm gloves.
3. Remove the rope from the box. There are two 50-foot sections.
4. Use the section with the clip (Figure 1) to attach the rope to the plastic bucket. You may use the other section of rope to extend the line so that the bucket can be lowered into the water from the bridge.
5. Secure the other end of the rope with the carabiner clip to the bridge.
6. Go to the center of the flow, lower the bucket into the water, retrieve the water sample.
7. Take the water sample back to your car or field work station.

Figure 1

Option B Streambank: Use this method when you cannot safely use Option A

1. Attach the one gallon sample container to the extension rod.
2. Get as close to the water as you can.
3. Scoop up a water sample in the gallon jug.
4. Remove the gallon sampler from the extension rod.

Measuring Phosphate Concentrations

<u>Measuring the phosphate</u> concentration

1. Fill the Hach vial (optical glass AccuVac Ampule).
2. Rinse the vial with sample water and fill to the white line on the vial.
3. Wipe clean with the towel.
4. Make sure the vial is clean and that there are no fingerprints on the outside.
5. Turn on the Hach meter by pressing the power button. (#1 in Figure 3)
6. Insert the sample vial and cover with the plastic shield.
7. Press the blue button (#2 in Figure 3); meter display (#4 in Figure 3) will read zero.
8. Remove the vial from the meter and place in holder slot in the Hach kit.
9. Open the reagent pillow and cut along the blue line with scissors.
10. Pour the reagent into the sample

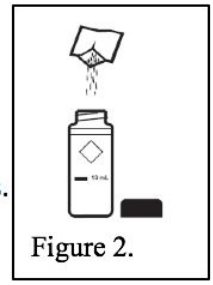

Figure 2.

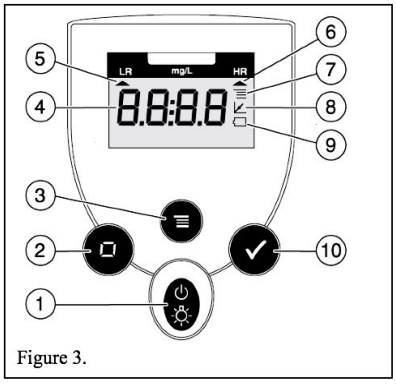

Figure 3.

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11. Put the top on. Shake vigorously for 15 seconds, or, for 60 seconds if water is cold (< 20 deg C) or, until reagents have dissolved.
12. Let the reaction stand for at least 2 minutes but no more than 10 minutes.
13. Insert the vial with the white diamond facing the display (#4 in Figure 3).
14. Put on the light shield. See Figure 4.
15. Press the green button (#10 in Figure 3).
16. Record the value that appears on the display (#4 in Figure 3) on the Data Collection Sheet (mg/L).
17. Empty and clean the vial with distilled water (in the squirt bottle). Wipe the vial clean.
18. Return the vial to box. Turn off the Hach meter.

Testing Turbidity / Transparency

1. Get out the transparency tube.
2. Pour water from the gallon container of stream water into the tube, filling it to the top.
3. Allow the bubbles to leave the solution. Make sure your back is to the sun with your shadow over the tube.
4. Open the hose clamp on the tube at the bottom and drain the water gradually until you can just distinguish the white and black pattern on the Secchi Disk at the bottom by looking down the tube through the water.
5. If working alone, lower that water in 5 cm increments as you get close to visualizing the pattern.
6. Record the transparency (cm) on the data sheet.

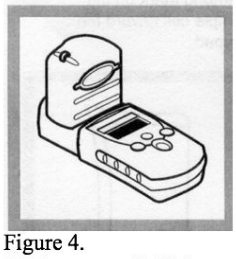

Figure 4.
Hach meter with light shield over vial holder.

Glossary of terms:

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Biotic - relating to or resulting from living things, especially in their ecological relations.

Abiotic - physical rather than biological; not derived from living organisms.

Industrial Effluent - The water or liquid waste carried away from an industrial process.

Eutrophic/Eutrophication - excessive richness of nutrients in a lake or other body of water, frequently due to runoff from the land, which causes a dense growth of plant life and death of animal life from lack of oxygen.

Erosion - the process of eroding or being eroded by wind, water, or other natural agents.

Runoff - the draining away of water (or substances carried in it) from the surface of an area of land, a building or structure, etc.

Point Sources - a localized and stationary pollution source.

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