

What's In Our Water?!

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Strawberry Mansion High School

Unit Content

This unit was developed for 9th grade Environmental Science students at Strawberry Mansion High School in Philadelphia, PA. There are 56 students in total across 4 different class blocks. 88% of students identify as Black or African American, 7% as Hispanic or Latino, 2% as Multi-Racial, and 1% White. The class is composed of 50% male and 50% female students. 37% of students are identified as Special Education and 2% are English Language Learners (ELLs).

The unit compliments the School District of Philadelphia's [2022 - 2023 Curriculum for Environmental Science](#). Students are expected to have developed prior knowledge of the following topics before beginning this unit: interdependence in ecosystems and matter cycling. Students will scaffold their knowledge of matter cycling and the water cycle.

The unit will begin with a review of the water cycle and analyze how water is crucial for organisms to survive. Students will be able to show that water is a critical natural resource. They will examine the water molecule through a chemistry oriented lens and use the periodic table to understand common water contaminants and dissolved substances. Students will deepen their knowledge of the water cycle by analyzing the wastewater treatment process that removes harmful contaminants from our drinking water supplies. Students will then plan an investigation to examine the water quality in their school, their homes, and their community. They will be encouraged to share and publish their results with the local community such as - The School District of Philadelphia, The Philadelphia Water Department, Fairmount Water Works, and local news organizations.

Some questions that students have raised in class, which have guided the unit are:

- Why do we have signs that say "Hand Washing Only" on all of our school sinks?
- Why can we only drink water from the designated "Hydration Station"?
- What happens if we drink water from the "Hand Washing Only" sink?
- What makes water "safe" or "unsafe" to drink?

Students will learn about water quality with a primary focus on lead contamination due to the historic use of lead pipes in the US. They will learn about the potential health effects

of consuming water that is contaminated with lead. They will examine case studies of cities in the US that have dealt with water quality crises.

Students will examine resources from experts in their community to learn about water quality testing such as: the PA Department of Environmental Protection, the Philadelphia Water Department, The City of Philadelphia, and the office of Sustainability at The School District of Philadelphia. They will examine public water quality data from their school and from the City of Philadelphia. Students will then plan, design, and carry out a scientific investigation in order to measure water quality within their school. They should be able to collect data in their investigation and compare their results with historic data from their school and the City of Philadelphia. Students should be able to conclude whether the drinking water in Strawberry Mansion High School is safe enough for human consumption.

This investigative unit of water quality will allow students to make real world connections, provide active learning experiences, and develop deep content understanding¹. The unit is built upon an inquiry based investigation and a project based theme. My hope is that students feel more motivated and invested in their personal learning experience within the Environmental Science class. I believe this approach will lead to higher outcomes of learning for students and will allow for my personal growth to develop as a science teacher.

This unit aligns with following NGSS standards:

- **HS-ESS3-1:** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- **HS-ETS1-1:** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- **HS-ESS2-5:** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Teaching Strategies

- Warm Up Questions & Debrief
- Student Investigation
- Turn and Talk
- Compare and Contrast
- Game Play
- Simplified Directions
- Exit Tickets
- Modeling (with Manipulatives)

- Webquest
- Building Challenge
- Data Collection and Comparison
- Newsletter or Community Bulletin

Classroom Activities

Lesson 1: Engage - Water Sommelier Activity (80 minutes, +extension)

Objective: SWBAT examine, smell, taste, and observe under a microscope five different samples of drinking water IOT look for subtle differences in water quality.

Standard: NGSS HS-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

Materials: 2 oz plastic or paper cups (enough for 5 cups per student), tap water, filtered water, 3 different brands of bottled water, marker for labeling cups, microscopes, microscope slides, and pipettes.

Student Worksheet: [Water Sommelier Activity](#)

Teacher Notes: This activity requires five different samples of water. The number of water samples could be increased if desired. The tap water sample should come from the school tap, but you could also have students bring samples of tap water from their homes. The filtered water should be from the “hydration stations” in your school. The three different brands of bottled water are up to the teacher’s discretion. This number could be increased. The teacher could ask the students for their opinions on which brands of bottled water they would like to test before beginning this activity.

Setup: The teacher should set up 5 stations around the classroom (or more if using more water samples). Each station should be for one of the five water samples and should be clearly labeled. For example, “Water Sample A.” It is important that students do NOT know which water source each sample is from before beginning. At each station you will need enough 2 oz cups for the number of students in your class, a microscope, microscope slides, and pipettes.

Steps:

1. Have the water sample stations set up prior to students entering the classroom.

2. When students enter the classroom, ask them to answer the Warm Up Questions on slide 3 of the [Lesson Slides](#). You can have students answer the questions on a sheet of paper. Give students at least 5 minutes to write their answers. Next, you can ask a few volunteers to share their answers. (~10 minutes)
3. Next, have students participate in a Turn & Talk discussion with a partner or a small group. Students should discuss the questions on slide 4. (~5 minutes)
4. Pass out the Student Worksheet and read through the directions as a class. Have students examine the chart and ask any clarifying questions.
5. Model a demonstration of what students should do when they arrive at their station: Pick up one of the 2 oz cups and note the appearance of the water. Smell the water and note the smell. Taste the water and note the taste. Use a pipette to place a drop of the water sample on a microscope slide and observe the sample through a microscope. Draw a sketch of what you saw. Record any other notes in the note column.
6. Divide the class between the different stations. Allow students enough time to fill out the chart as they rotate through the different water sample stations. Students could move through the stations in teams or individually. (5 minutes per station)
7. After students have moved through each station, they should complete the chart to guess which water source matched with each water sample. Make sure students provide a justification for their guess.
8. After all the students have cleaned up and filled out both charts, reveal the actual sources of water to the class. Students should respond by filling out the results section of the activity and respond to the questions on slide 9.
9. Optional: Students who have finished early or who need an extension could use a computer or laptop to research either Extend #1 or Extend #2 on slide 10.

Lesson 2: Explain - Review of the Water Cycle (80 minutes, +extension)

Objective: SWBAT analyze the updated water cycle IOT recognize that humans caused changes in Earth's climate which have impacted the water cycle.

Standard:

- NGSS HS-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

Materials: (1 of each per student group of 3 - 4)

- Color Printout of [USGS: The Water Cycle Poster \(2022\)](#)
- Color Printout of [USGS: The Natural Water Cycle \(2019\)](#)
- Color Printout of [Water Cycle Game](#)
- Printout of [Score Sheet](#)
- 6-Sided Die
- Game Piece for each student (from another game or a small item like a coin or bottle cap)
- Pencils / Pens

Teacher Notes: Spanish versions of USGS Printouts and digital versions of the Water Cycle Game & Score Sheet are available (see Resources below).

Setup: Students will work together in small groups throughout this lesson. Students may choose their own partners or the teacher can prepare a list of student groups ahead of time. Make sure each student group has 1 copy of each printout and other materials.

Steps:

1. Ask students to answer at least one of the warm up questions independently on slide 13 of the [Lesson Slides](#). Give students at least 5 minutes to write their answers. Next, you can ask a few volunteers to share their answers. (~10 minutes)
2. Next, have students participate in the Turn & Talk on slide 14. Students will compare and contrast the updated USGS water cycle diagram for 2022 with the 2019 version. (15 minutes)
3. Next, students will play the Water Cycle Game in their small groups. Read through the directions as a class and have students brainstorm any clarifying questions. Model an example of how to start the game by rolling the die from a starting position. (15 minutes)
4. Allow students time to play through the Water Cycle Game. Students should be able to make it through at least 10 rounds in order to come up with a winner. (30 - 45 minutes)
5. Ask students to respond to the Exit Ticket Question on a sheet of paper after completing the game, slide 20. (10 minutes)
6. Optional: Students can complete the extended activity on slide 21.

Lesson 3: Explore & Explain - Examine a Water Molecule (80 minutes)

Objective: SWBAT use manipulatives to model a water molecule IOT develop an explanation of what chemicals and elements can affect water quality.

Standard:

- NGSS HS-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

Materials:

- Printouts of [The Periodic Table](#)
- [3D Molecular Design Water Kit](#) (Set of 10)
- [3D Molecular Design: Basic Lesson Plan](#)
- Printout of Pg 2, 3 & 5 of the [3D Molecular Design: Water Runoff and the Environment Lesson](#)
- 2” 3 ring binder
- Tape
- Green construction paper
- 40 colored paper clips (20 each of two different colors)
- Tissue box, dry erase board eraser or block
- Article: [The Water Crisis in Flint Michigan](#)

Teacher Notes: The School District of Philadelphia’s [Science Lending Library](#) allows public school teachers in Philadelphia to borrow the 3D Molecular Design Water Kit. Teachers will be able to borrow a set of 10 kits for a lending period of three weeks. The Lending Library recommends teachers request the kit at least 2 weeks in advance before planning prior to usage.

Any of the activities or lessons from the 3D Molecular Design: Basic Lesson Plan could be added to this Unit Plan to extend learning experiences for students.

Setup: Students can complete this lesson within their small groups from the previous lesson. The teacher should set up materials for each small group ahead of time.

Steps:

1. Ask students to answer at least one of the warm up questions independently on slide 24 of the [Lesson Slides](#). Give students at least 5 minutes to write their answers. Next, you can ask a few volunteers to share their answers. (~10 minutes)
2. Next, have students participate in the Small Group activity on slide 25. Allow students time to experiment and play with the models. Ask them to put together two molecules of water and then more. Have students compare their model to other groups in the classroom. (15 minutes)

3. Have students complete the lesson from Page 2, 3 & 5 of the 3D Molecular Design: Water Runoff and the Environment Lesson (45 minutes).
4. Ask students to respond to the Exit Ticket Question on a sheet of paper after completing the game, slide 30. (10 minutes)
5. Optional: Students can read the article: The Water Crisis in Flint Michigan. Ask students to annotate the article directly and write a 1 paragraph summary of what they read.

Lesson 4: Explain - Water Webquest

Objective: SWBAT research what factors influence water quality IOT analyze the water treatment process which provides safe drinking water for large communities.

Standards:

- NGSS HS-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- NGSS HS-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

Materials:

- Student Computers or Laptops
- [Water Webquest](#)

Teacher Notes: This activity could be done independently or chunked into smaller assignments. Students with IEPs relating to reading and writing may have difficulty with reading comprehension. To modify the assignment for these students, the teacher could reduce the amount of questions each student is responsible for and/or have students read through each website with a small group.

Another way this assignment could be modified would be to have the class use a jigsaw style technique. The teacher could separate students into small groups and have each group read the information on one of the websites. Students could share with the class what they learned and exchange information gathered from this activity. Please note that the reading level increases with difficulty throughout the assignment. Students with higher reading levels should be asked to complete one of the websites towards the end of the assignment. Students with lower reading levels should be asked to complete one of the first few websites in the assignment.

Setup: Decide whether to have students complete the activity independently or in small groups. Make sure there are enough computers or laptops for each student or small student group.

Steps:

1. Prepare the materials for individual students or for small student groups. The teacher should decide which would be more appropriate for the class and their reading levels. Accommodations and modifications should be made ahead of time to help students navigate the lesson successfully.
2. Ask students to answer the warm up questions independently on slide 34 of the [Lesson Slides](#). Give students at least 5 minutes to write their answers. Next, you can ask a few volunteers to share their answers. (~10 minutes)
3. Next, explain the directions of the Water Webquest activity to students. The teacher should model an example of what to do once they open the activity on their computers.
4. Allow students time to complete the Webquest activity. The length of time on the webquest is dependent on how the teacher organizes the activity - independent vs small grouping. Students may need two or more class periods to complete the activity which may be chunked appropriately. Students will be practicing important research and reading comprehension skills. (at least 60 minutes, multiple class periods may be necessary)

Lesson 5: Explore - Build a Water Filter

Objective: SWBAT build their own water filter based on the general procedures that municipal water plants may use to purify water for drinking IOT analyze the water treatment process.

Standards:

- NGSS HS-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- NGSS HS-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

Materials: (for each student group)

- Copies of the [Water Filtration Activity](#)
- 5 Liters of “swamp water” (or add 2 1/2 cups of dirt or mud to 5 liters of water)

- 1 Two liter plastic soft drink bottle with its cap (or cork that fits tightly into the neck)
- 2 Two liter plastic soft drink bottles, one with its bottom cut off and one with the top cut off
- 1 large beaker (2 cups) or measuring bowl that will hold the inverted two liter bottle or you can use
- Another two liter plastic soft drink bottle with its top cut off so the other bottle will fit inside of it.
- 2 tablespoons of alum (potassium aluminum sulfate available in the spice aisle at grocery stores)
- 1 1/2 cups fine sand (white play sand or beach sand)
- 1 1/2 cups coarse sand (multi-purpose sand)
- 1 cup small pebbles (washed, natural color aquarium rocks work best)
- 1 coffee filter
- 1 rubber band
- 1 tablespoon (for the alum)
- 1 large spoon (for stirring)
- A clock with a second hand or a stopwatch

Teacher Notes: Students should work together in small groups to build their own water filter using the provided materials. They will most likely need more than one class period to achieve this objective. Ask students to bring in clean 2 Liter Bottles a few weeks prior to beginning this activity. The rest of the materials could be purchased from a dollar store or a hardware store.

One suggestion for this activity is to use water from a local stream or river to increase connections to the local community.

Safety Note: Advise students that the final step at the treatment plant is to add disinfectants to the water to purify it and kill any organisms that may be harmful. Because the disinfectants are caustic and must be handled carefully, it is not presented in this experiment. The water that was just filtered is therefore unfit to drink and can cause adverse effects. It is not safe to drink!

Setup: Divide the class into small groups prior to beginning this activity. Have the activity materials set up on a table or somewhere easily accessible for students. Alternatively, the teacher could put together materials needed for each group. The teacher should also prepare an example water filter so that students have an idea of what they should be able to create by the end of this lesson.

Steps:

1. Ask students to answer the warm up questions independently on slide 38 of the [Lesson Slides](#). Give students at least 5 minutes to write their answers. Next, you can ask a few volunteers to share their answers. (~10 minutes)
2. Have students read through the procedure for the activity. Give students the opportunity to ask clarifying questions. The teacher should pass around the model water filter and allow students to observe how it works. (~10 minutes)
3. Students will follow the steps on the activity printout to build a water filter with the provided materials. The teacher can display the directions on the smart board or projector for students to follow along with as well. Students may need more than one class period to complete this activity. (60 minutes, multiple class periods may be necessary)
4. When students have completed their water filters, debrief the lesson by asking students to Turn & Talk to answer the discussion questions on slide 46.

Lesson 6: Elaborate - Plan an Investigation

Objective: SWBAT plan and conduct an investigation exploring the properties of water and what factors influence water quality IOT determine whether the water in our school is clean and safe enough for drinking.

Standards:

- NGSS HS-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- NGSS HS-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- NGSS HS-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Materials:

- [LaMotte™ Lead Screening Test Kit](#) (set of 10) or similar Lead Testing Kit
- Small glass containers for water samples
- Water Samples from the school building - from multiple different points
- Computers or Laptops
- Printouts of Latest Water Quality Data in School (if available)

Teacher Notes: This last lesson of the Unit Plan will have multiple class periods to complete depending on the nature of the student investigation. Students should plan their own investigation and have control over what variables they test and where they collect water samples from. Using a Lead Testing Kit could be one option to explore, but students may want to test for other contaminants or chemicals. Allow students to design their own investigation regardless of what materials are available. When it is time to carry out the investigation, use what materials you have or are able to access.

Setup:

Steps:

1. Ask students to answer the warm up questions independently on slide 49 of the [Lesson Slides](#). Give students at least 5 minutes to write their answers. Next, you can ask a few volunteers to share their answers. Ask students which contaminant or chemical they would like to test for. (10 - 15 minutes)
2. Have students get into small groups and discuss what materials they might need to investigate the water quality in our school. Ask them to make a list of any materials they think they might need, slide 50. (15 minutes)
3. Have students plan and design an investigation to explore the water quality within their school, regardless of what materials are available. (60 minutes)
4. Carry out student investigation, collect data, analyze results. (80 minutes, multiple class periods may be necessary)
5. Compare investigation results with public published data, see slide 52. (60 minutes)
6. Share investigation results with the school and local community - students could write a letter, lab report, news report, poster, or create a science fair project. Share with PhilaSD, PWD, Fairmount Water Works, etc. See slide 53. (80 minutes, multiple class periods may be necessary).

Resources

Lesson 1:

- [What's in Our Water?! Lesson Slides](#)
- [Water Sommelier Activity](#)

Lesson 2:

- [USGS: The Water Cycle Poster \(2022\)](#) (Spanish Version Available)
- [USGS: The Natural Water Cycle \(2019\)](#) (Spanish Version Available)
- [NOAA: Water Cycle Board Game](#) (Digital and X-Large Versions are Available)

Lesson 3:

- [NIH: The Periodic Table](#)
- [3D Molecular Design: Water Kit](#)
- [3D Molecular Design: Basic Lesson Plan](#)
- [3D Molecular Design: Water Runoff and the Environment Lesson](#)
- [The Water Crisis in Flint Michigan](#) (Simplified and Spanish Versions Available)

Lesson 4:

- [Water Web Quest](#)
- [EPA: Safe Drinking Water Act Overview](#)
- [EPA: Understanding the Safe Drinking Water Act](#)
- [EPA: National Primary Drinking Water Regulations](#)
- [EPA: Types of Drinking Water Contaminants](#)
- [PA DEP: Lead in Drinking Water](#)
- [PWD: Drinking Water Quality](#)
- [PWD: 2021 Drinking Water Quality Report](#)

Lesson 5:

- [EPA: Water Filtration Activity](#)

Lesson 6:

- [LaMotte™ Lead Screening Test Kit](#) (set of 10) or similar Lead Testing Kit
- [PWD: Lead and Drinking Water](#)
- [City of Phila: Lead Guide](#)
- [PhilaSD: Safe Water Drinking Program](#)
- [PhilaSD: Water Testing Archives](#)
- [PhilaSD: Strawberry Mansion High School 2017 School Water Testing Data](#)

Appendix

¹ [Temple Standards for Skillful Teaching | Temple University College of Education and Human Development](#)