Freshwater In Our World

Philadelphia's freshwater supply and the role we each play in its future.

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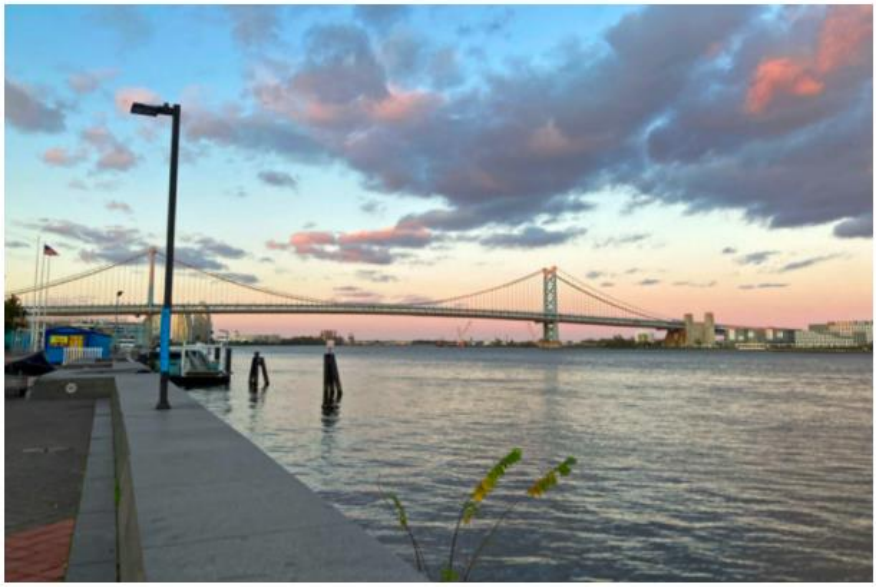


The Delaware River

Abstract

This 3rd to 6th grade Science and English Language Arts curriculum utilizes both print and digital resources such as NewsELA, Vimeo and Google Slides to inform and engage students in the issue of Water Pollution and how our everyday actions affect the larger global issues. Students will investigate the history of water treatment and distribution in their own neighborhoods of Philadelphia and the problems that have developed along the way. They will construct knowledge relating to the water cycle, personal and industrial water usage in Philadelphia, the problems associated with our current system and the implications of climate change on this delicate balance.

This six lesson unit will help middle school students gain a deeper understanding of their connection to the land defined as the urban watershed and the system defined as the urban water use cycle. For Philadelphians, watershed education is about understanding the delicate balance between land and water, how we are supplied with abundant safe drinking water, proper sanitation and the management of stormwater runoff along with how we sustain healthy ecosystems. Ultimately, this unit will encourage young people of all ages to discuss, assess, calculate and evaluate the value of water.

Unit Content

Introduction

Water is essential and invaluable to our world. It keeps our communities healthy, our cities

running and our economies growing. The lifestyle we have become accustomed to would not be possible without water and the infrastructure that fuels it.

There has always been an inseparable connection between people and water. Personally, we need water to keep us healthy, to keep ourselves clean, to cook, and to carry our waste away. Collectively, we use water to keep our streets clean, and to keep our homes and businesses safe. We enjoy the beauty of our waterways for fishing, boating, and spending time with friends and family.

In Philadelphia, our sources of public drinking water supply are the Schuylkill and Delaware Rivers. The Philadelphia Water Department is responsible for cleaning the raw water from these rivers and making it safe enough to drink before they send it to consumers. The more polluted the water is, the greater the job the PWD has to clean it up. In addition, the rivers don't begin and end along city boundaries but extend far beyond Philadelphia into other areas within our collective watershed. Therefore, we also need to work with our upstream and downstream neighbors to ensure safe water for all. Towns and cities upstream from Philadelphia discharge stormwater runoff and wastewater into the same rivers that become our source of drinking water; we do the same for people downstream. Everyone must work together to help ensure the quality of our waterways and play a part to keep others healthy.

In fifth grade, students begin to explore the value of water and its relationship to themselves, the environment, the economy and their communities. This unit, *Water Pollution in Our World*, will focus specifically on water pollution issues in Philadelphia, our history of water management, where we are now and the role we all play in our collective future.

This unit is particularly relevant to the students at my school, Potter Thomas for many reasons. The school is part of the Acceleration Network, which means it is one of the 19 lowest performing schools out of the 339 in the district. Currently, 1.4% of students in grades 3-8 are performing on grade level in math, and 4.2% in ELA. 75% of students are Hispanic, 25% are black, and nearly all live below the poverty line. Unfortunately, the issues of water pollution often hit the marginalized and impoverished the worst. Much of the Fairhill neighborhood surrounding our school is paved with asphalt or concrete, or covered with buildings. These surfaces are usually impervious, meaning that water runs off of them without being absorbed into the soil, making it easier for stormwater to pick up, absorb, and carry pollutants directly into the water supply, leading to contamination, poor sanitation and transmission of often preventable diseases. Those who struggle the most, will continue to do so, unless we learn how to prevent and protect the water we rely upon each day. Using this unit as a guide will allow middle schools students in Philadelphia and beyond to do just that.

Problem Statement:

Philadelphia's water system is one of the oldest in the country. It dates back to 1815, when it was originally serving about 63 homes. Today, Philadelphia uses more than 200 million gallons of water every single day.

The need for water is something that unites all living things. Abundant fresh water may cause a region to flourish whereas the lack of access to clean water can destroy a community. Most of us turn on the tap or flush the toilet without much thought about how the water got there or where it goes, about its drinkability, supply or cost. Many of us do not know anything about the people and the processes that make a citywide water system operate on a daily basis in order to ensure public health or the balanced ecology of our streams.

Learning about our local water story contributes to our sense of place, which sparks our interest in taking care of it so that it can take care of us. Watershed education helps us feel more connected to the life and health of our waterways, helping us learn where drinking water comes from, how it gets to the consumer, where it goes next, how it can be threatened, and how to take better care of it. Simply put, effective watershed education is essential to transforming the way people think and live by making them more aware of how individual actions impact the collective quality of water for all living things.

Philadelphia began using the river for drinking water supply over 200 years ago. The tap water that we rely on originates from the Schuylkill and Delaware Rivers. The Philadelphia Water Department (PWD) is responsible for making the water clean and safe to drink and for collecting it after we have used it. This used or waste water is cleaned once more and returned to the river. We call this the urban water use cycle; it connects all Philadelphians to the rivers and gives us one big reason to care about protecting this resource. It is viewed as a public responsibility – to supply it, clean it up, and protect it at its source.

Like most old cities, Philadelphia has a combined sewer system—that is, one pipe is used to carry both sewage and stormwater into our rivers, the Schuylkill and the Delaware. Excessive rain overwhelms the system, forcing the water department to send raw sewage into rivers and creeks. In the last decade, Philadelphia has had the most rain ever recorded and as a result, the delicate ecological balance in our water is at stake. This unit will focus on sustainable, renewable and affordable solutions that our students will not only participate in and adapt for life.

Content Objectives

Lesson 1: The Water Cycle

The unit begins with a KWL (What do we KNOW, what do we WANT to know, and what have we LEARNED) to set the tone, access student's prior knowledge and begin a guiding Anchor Chart that will follow the student's pattern of thinking throughout the unit (using a new color marker for each day you add something to the chart). What do we know about water?

First, it is helpful to reflect upon the value of water in our own lives and develop a thorough understanding of how the natural water cycle, the hydrologic cycle, functions and interacts with the natural world. Our earth has a very efficient method of cycling water through the atmosphere

and the land, as evidenced through the natural water cycle. Earth's water is finite, meaning that the amount of water in, on, and above our planet does not increase or decrease. It is important to gain this understanding before exploring subsequent lessons which address human interaction with the natural world, the growth of cities, and how people adapted and innovated to meet the challenge of providing clean water as the population grew.

Using NewsEla articles, YouTube videos, a picture book, and hands-on experiments, students will learn about the urban water use cycle and how this is different and similar to the natural water cycle. They will explore their individual connection to it as well as their human impact on it. They will then develop a basic understanding of safe and reliable urban drinking water supply system, infrastructure and management of our drinking supply.

Lesson 2: Water Around the World

Of all the water that exists on our planet, roughly 97% is saltwater and less than 3% is freshwater. Most of Earth's freshwater is frozen in glaciers, ice caps, or is deep underground in aquifers. Less than 1% of Earth's water is freshwater that is easily accessible to us to meet our needs, and most of that water is replenished by precipitation—a vital component of the water cycle, affecting every living thing on Earth.

Water connects all living things on Earth. Yet, from Cape Town to Flint, Michigan, and from rural, sub-Saharan Africa to Asia's megacities, there's a global water crisis. Today, 771 million people, or 1 in 10, lack access to safe water. People are struggling to access the quantity and quality of water they need for drinking, cooking, bathing, handwashing, and growing their food. Without clean, easily accessible water, families and communities are locked in poverty for generations. Children drop out of school and parents struggle to make a living. Women and children are the most affected, children because they're more vulnerable to diseases caused by dirty water and women and girls because they often bear the burden of carrying water for their families.

The global water crisis is a global health crisis. Today, nearly 1 million people die each year from water, sanitation and hygiene-related diseases which could be reduced with access to safe water or sanitation. Every two minutes a child dies from a water-related disease. Access to safe water and sanitation contributes to improved health and helps prevent the spread of infectious disease. It means reduced child and maternal mortality rates. It means reduced physical injury from constant lifting and carrying heavy loads of water.

This lesson provides students with a broader understanding of water from a global perspective. Using NewsEla articles, YouTube videos, and hands-on experiments, students will learn about the global water crisis. They will do independent research, along with a cooperative learning presentation to present their findings to the class.

Lesson 3: The Water Treatment Process

Wastewater treatment is the process of collecting wastewater and removing pollutants before returning the clean final outflow to a body of water. Today all public water suppliers are regulated under the Federal Safe Drinking Water Act to keep tap water safe by monitoring and

testing the water continuously. The agencies that are involved in regulating the safety of our tap water are the Environmental Protection Agency (EPA) and the state's Department of Environmental Protection (DEP) or Environmental Quality. These agencies monitor the laws and regulations established by the Safe Drinking Water Act. Drinking water utilities monitor and report on the results of about 100 parameters on a consistent basis.

Proper drainage is as important to Philadelphia's public health as providing pure, safe drinking water. Sewers carry away excess rainwater, preventing flooding in streets and basements in all but the most extreme storms. They also carry disease-causing human and industrial wastes away from built up areas. In the City's present system, three treatment plants treat the sewage before discharging the waste into the Delaware River. The treated effluent is cleaner than the river itself. The system has 3,000 miles of sewer pipes, ranging in size from 8 inches in diameter to 24 feet square. The Philadelphia Water Department (PWD) uses a variety of scientific tests to determine the quality of the water before it is determined safe to drink. Measures of pH, alkalinity and chlorine are some measures of the quality of a sample.

This lesson will provide students with an opportunity to understand the water treatment process, differentiating between the wastewater and the stormwater systems. They will understand how water is treated and recycled over and over again in our city's treatment plants using videos, articles, experiments and collaborative discussions.

Lesson 4: Water in our World: A Philadelphia Story

Historically, the development of the water supply system in Philadelphia was born out of necessity and inventiveness. Characterized as one of the most successful public water systems in America, Philadelphia's public water system grew by meeting the challenges related to public health and industrialization.

Just as Philadelphia developed a collective drinking water supply system to ensure the public health of its citizens, it also developed ways to collect and dispose of its waste or used water. Our local streams and creeks were historically used for drainage to carry away wastewater. Eventually, the stream system was converted to sewer infrastructure after they became polluted.

The wastewater was now encapsulated in pipes and as the city's population continued to grow, valleys that were once cut through with natural waterways, were leveled to accommodate the growing need for housing. Now, in about 60% of Philadelphia, these pipes carry human wastewater and stormwater from runoff in the same pipe, and are called a *combined sewer*. In newer parts of the city, raw sewage and stormwater runoff are separated in two different pipe systems. There are many component parts of the underground sewer system that make up our urban watershed system. They all fit together to keep the city's wastewater flowing, relying on gravity to keep everything moving downhill.

This lesson provides students with the context to understand their own individual role in the global water crisis. The ideas and concepts are brought directly to their own neighborhoods as they learn the history of water in their city and how the growing population of Philadelphia has led us to various water related problems we will learn about in the next lesson.

Lesson 5: The Problems

When trash, chemicals, and other types of pollution reach our waterways, the delicate ecological balance suffers. Trash creates a risk for wildlife that might mistake it for food. Chemicals, such as motor oil and pesticides, can be toxic to those same animals. Fertilizers can cause algae to grow out of control and hog the oxygen supply in the water. Too much animal waste can introduce unhealthy levels of bacteria into the water system. These all can affect the health of our waterways.

Before we can work at reducing pollution in our waterways in our final lesson, we need to identify the various sources of pollution. Sometimes it is easy to tell the source—something dumped directly into the water would be considered point-source pollution. Other times it is not as obvious—some kind of waste deposited on the land makes its way into the water indirectly and you cannot identify its source – this is considered nonpoint source pollution.

In Philadelphia, below ground, we have two types of sewer systems that - in total - are 3,000 miles long of underground pipes. In areas with combined sewers, a single pipe carries both *stormwate*r from streets, houses, and businesses as well as *wastewater* from houses and businesses to a water treatment plant. In areas with separate sewers, one pipe carries stormwater to the city's streams while another carries wastewater to a water treatment plant.

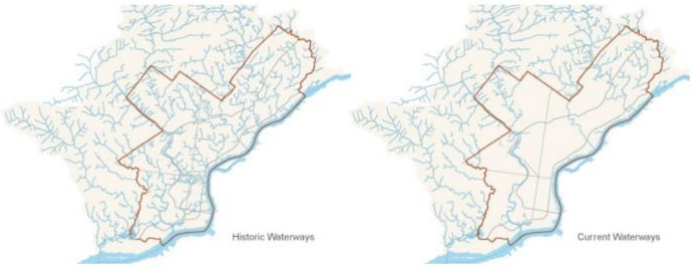
During dry weather, the combined sewer system conveys waste water through pipes to treatment plants, which have the capacity to treat all the sewage entering the system. However, when flow in the sewer increases as a result of heavy rainfall and/or rapid snowmelt, the treatment plants may not be able to process the wastewater fast enough. When this happens, to avoid overwhelming the system, the sewer pipes have to discharge combined sewage into nearby water bodies from combined sewer outfalls (164 of them) to prevent backflow, and protect homes and neighborhoods, and wastewater plants from flooding.

Some of the water is absorbed through pervious surfaces—such as vegetated areas with uncompacted soil, sand, or gravel that allow the passage of water. Other water, called stormwater, flows over impervious surfaces—such as rooftops, sidewalks, and streets that obstruct natural infiltration.

Impervious cover exacerbates the problem of stormwater when runoff flows directly into the nearest storm drain without being mitigated. If untreated before entering our waterways (including the Schuylkill and Delaware rivers, which we use as sources of drinking water), this contaminated water can have a detrimental effect on water quality.

Additionally, the more impervious surfaces there are in the city, the more polluted stormwater enters the sewer system, increasing the total volume of water the city's infrastructure network must handle. Of the 283 linear miles of streams that once existed in Philadelphia to carry runoff to the Schuylkill and Delaware Rivers, only 118 miles still remain today. With 73% of our historic waterways piped to date, the current day map of Philadelphia’s creeks and streams looks disturbingly bare. Today, as our city’s population continues to grow, the biggest source of water pollution is the pollutants that run off the land during rainfall or snow melt, into the nearest streams.

This lesson will provide students with an opportunity to see how the problems of water pollution have developed over time and where we are today. Using articles, lesson experiments, group work, independent work and videos, all students will be able to access and understand the content in their own ways.



Philadelphia's waterways then and now

Lesson 6: The Solutions

In 1989, Congress passed an amendment to the Clean Water Act that required municipal operators of sewer systems to develop infrastructure that would reduce nonpoint source pollution and combined sewer overflows during rain events. In order to keep stormwater runoff from polluting our waterways, the Environmental Protection Agency (EPA) implemented practices that change the way water runs off the land by absorbing or holding water, rather than having it rush into our creeks and rivers at high speeds and volumes.

These practices that mimic the natural water cycle and therefore help mitigate, or reduce the impact of stormwater were formerly called Best Management Practices (BMPs) but now are referred to as Green Stormwater Infrastructure (GSI). We know that trees and plants are especially good at absorbing these large volumes of water, so they have become the basis for many of these projects. Due to the success of implementing GSI throughout Philadelphia, the PWD has become a model for other cities to emulate.

Changing an urban streetscape to an urban landscape is one of the long-term goals of water quality protection, specifically the transformation of streets, rooftops and parking lots, or impervious surfaces, to green roofs, tree trenches, rain gardens and porous paving.

In June of 2011, The City of Philadelphia and the Environmental Protection Agency entered into a Consent Order and Agreement, thereby officially committing to the implementation of green stormwater infrastructure in Philadelphia. The Water Department's plan to fulfill this commitment, "Green City, Clean Waters," is a 25–year plan aimed at adopting a 'green' approach to stormwater management. This program encourages property owners to implement different projects on their land to help capture the first one inch, or first flush, of stormwater that carries the most pollutants. The more of these GSI we have on our land, the healthier our waterways will be.

This final lesson will provide students with the opportunity to access their prior knowledge and develop ideas for sustainable solutions. Using Greta Thunberg as an inspiration, students will take action and develop a plan for a *Green City, Clean Water* project in their own school. They will research and reach out to local organizations currently working on water quality issues in

our city. Hopefully, students will be motivated to be the change makers our city's future is depending upon, as climate change continues to bring drastic and devastating consequences to the delicate balance we all depend upon in Philadelphia and beyond.

Teaching Strategies

Notice and Wonder:

Students will take a look at an image or graph and make observations based on what they see. This is an excellent strategy for students who may struggle and also for students who are learning English. They can also write questions based on what they see. These questions can be answered immediately or students can store them for later.

Project Based Learning:

PBL uses a central question or problem statement as impetus for students to explore content and design a solution. Teachers pose a central conflict, and then students gather information, research and work in teams to create a solution. This paper includes an extensive description of PBL above.

Turn and Talk:

Students will have 3-5 minutes to turn to their nearest neighbor to discuss a question giving each person a chance to share their ideas and ask questions of others. This skill only allows them to hear new perspectives and learn from the ideas of their peers, allowing for social and academic growth.

Lesson Experiments:

Students conduct simple lab experiments to support evidence of basic scientific principles. Students should use this to gain content knowledge, but also enhance their science process skills.

Videos:

Students watch videos to allow visual representations of information to solidify and enhance comprehension of a new task or skill. Video content comes from a variety of media sources including YouTube and Vimeo.

Articles:

Students practice reading and comprehension skills by summarizing what they read and providing evidence to support their ideas. Students will be able to analyze images and print to gain a deeper understanding of the content and share their ideas with their classmates in small groups, then present to the class in a whole class discussion.

Classroom Activities

Water Pollution In Our World Curriculum Lesson Plans

Lesson 1: The Water Cycle

Objectives

I can describe all parts of the Water/ Hydraulic System.

Essential Questions

- What is a water footprint?
- Why should I care about water?
- Is water a finite resource? How do you know?

Introduction

- KWL anchor chart: What do you KNOW about the water cycle?
- What do you WANT to know?
- What have we LEARNED?

Activity

Whole Group: Watch the video *The Water Dance.* Which words/ feelings does the book use to describe water?

Read: NewsELA article: *The Water Cycle*- Highlight vocabulary.

Watch: Video *What is the Water Cycle?* Discuss.

Independent Work: Writing: Describe the water cycle in Chronological Order.

Discussion Questions:

- How is the water cycle related to climate?
- How does the water cycle affect Earth's physical geography?
- What is a glacial retreat and how is it affecting your life?

Turn and Talk: Play the *Water Cycle Dice Board Game* with a partner

Lesson Experiment 1:

In class experiment. Review the Water Cycle with *The Great Aqua Adventure* YouTube video, stopping at 3:15 to do experiment.

1. Pour hot water into a cup and cover with plastic.

2. Place ice cubes on top and observe.

3. Students create two drawings. One in the beginning and another after 5 minutes, focusing

on how the hot water has changed.

What does the hot water/ ice represent?

Resources

Vocabulary:

- hydraulic
- precipitation
- Condensation
- Surface runoff
- Groundwater
- Transpiration
- Evaporation
- Solid
- Liquid
- Vapor

Media:

Read

- Newsela article: The Water Cycle

Watch

- YouTube video: Read Aloud- The Water Dance by Thomas Locker
- What is the Water Cycle video

Play

- Water Cycle Dice Board Game

Practice

- YouTube video: The Great Aqua Adventure: Experiment

Experiment Materials

- Clear plastic cups
- Plastic Wrap
- Hot Water
- Ice cubes

Lesson 2: Water Around the World

Objectives

Students will be able to describe the distribution of water on Earth.

Students will be able to create a model of an urban watershed and define its parts.

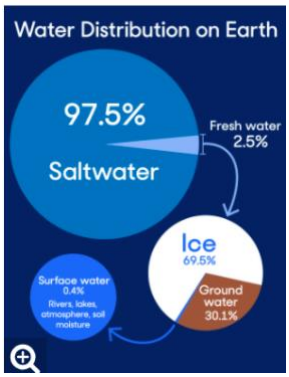
Students will be able to explain that water is a valuable and finite resource. Without clean water we would not have life on earth as we know it.

Students will be able to define the global, national and local issues related to water consumption and pollution.

Essential Questions

- How much of the earth's water is available to consume as freshwater?
- What are the health related implications of water related diseases?

Introduction



What do you NOTICE/ WONDER?

Activity

Watch:

- Sustainable Development Goals Explained video.
- Why Care About Water video. Discuss.
- What do you NOTICE/ WONDER?

Read:

- World Wide Water Facts. Discuss.
- Newsela article, **10 Interesting Facts About Water**. Discuss. Add to the KWL chart.

Discussion Questions:

- How much of the Earth's water is freshwater and where is it found?
- Why is water a limited resource?
- How is water naturally cleaned over time?

Interact:

- Turn and Talk: Divide class into groups of 10. Each student reads and interprets a fact about water and presents to the class.
- Extension Activity: Experiential Learning Experiment - Make Your Own Watershed experiment

Resources

Vocabulary:

- Distribution
- Closed System
- Particles
- Conservation of matter
- Closed System
- Biosphere

Media:

Read

- Worldwide Water Facts, Bureau of Restoration
- Newsela article: 10 Interesting Facts About Water

Watch

- YouTube video: Read Aloud- A Long Walk to Water by Linda Sue Park
- YouTube video: The Great Aqua Adventure Part 2
- Sustainable Development Goals Explained: Clean Water and Sanitation YouTube video
- Why Care ABout Water? National Geographic

Do

- Experiential Learning Experiment: Make Your Own Watershed

Lesson Extensions

- CNN's Fast Fact: FLINT, MICHIGAN

Lesson 3: The Water Treatment Process

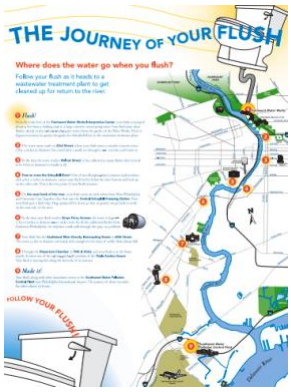
Objectives

I can explain the wastewater treatment process.

Essential Questions

When did Philadelphia start treating its drinking water? How and why? How does that compare to other cities?

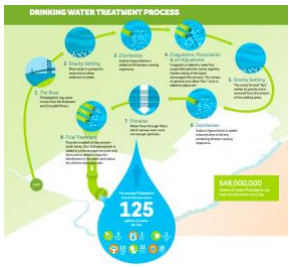
Introduction



- What do you Notice? What do you Wonder?
- What is the name of Philadelphia's Pollution Control center?

Activity

Observe:



- What is the average number of gallons of water used by Philadelphians each day?

Watch:

- *Getting It Clean, Philly's WasteWater Process* video. Discuss. What are the most important steps? How do your actions affect this process?

- *How Green Tools Protects Philly's Waterways* video.
    - What is a tree trench and how are they helpful?
    - What is combined sewer overflow?

Research:

- Use Philly River Cast website to forecast current water quality in Philadelphia.
- Why was this forecast developed for the Schuylkill above the dam?
- Use the PWD's website to locate the city's combined sewer outfalls and any recent overflow events.

Lesson Experiment 1: Investigate sedimentation by using items of varying weight to see how they "settle" in water. Do some float to the top, some sink to the bottom and others float around suspended? Predict, observe and record what happens in a clear glass container. Look at the items under a magnifying glass.

Lesson Experiment 2: The Philadelphia Water Department often conducts taste and odor tests at their central labs. Students conduct *Taste and Odor Tests* using two different samples, such as tap water from two different sources. Record your results. Test again and see if you get the same results. Compare with others using the same samples.

Lesson Experiment 3: Students look up their school's water testing results on the School District's website. Interpret results and compare it to other schools.

Independent Work:

- *Reflect and Write:* If water never leaves the earth, why does that make human caused water pollution such an important issue for us all?

Research:

- Students go to the PWD's *Annual Water Quality Report*, talk about the myriad of parameters that are used (required) to determine if water is safe to drink.
- phillyh2o.info/quality.

Exit Ticket:

- Describe the sequence of events in the water treatment process using Chronological Order Graphic Organizer.
- How many combined sewer outfalls are there along the Schuylkill and Delaware Rivers and why are they numbered?

Resources

Vocabulary:

- Coagulation
- Disinfection
- Filtration
- Flocculation
- Sediment
- Sludge

Media:

Observe

- The Journey of Your Flush image

Research

- Philly River Cast Website
- School District of Philadelphia Water Results by School

Watch

- Getting It Clean: Philly's Waste Water Cleaning Process
- How Green Tools Protect Philly's Waterways
- YouTube video: Water and You: The Water Treatment Process
- Philadelphia Water Department's (PWD) Combined Sewer Overflow Forecast

Write

- Chronological Order Graphic Organizer
- Scientific Method Graphic Organizer

Materials:

- Lesson Experiment 1:
- Magnifying glass (if possible)
- Toilet paper
- Dirt
- Rocks
- Oil
- Container for water
- Water

Lesson 4: Water in Philadelphia

Objectives

Students will learn that our Philadelphia tap water is clean and safe.

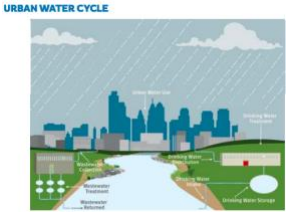
Students will be able to describe the flow of water in Philadelphia.

Students will be able to differentiate between point and nonpoint sources of pollution.

Essential Questions

1. Where does water come from before we use it?
2. Why should we care about how much water we use?
3. Do you know the source of your drinking water?

Introduction



- Notice and Wonder: What do you notice? What do you wonder? How is this image different from the water cycle we saw in Lesson 1?

Activity

Student Activity:

- Make a List: How do people use water everyday? Put these uses into larger categories (e.g. bathing, cooking, cleaning).
- Develop a water use log sheet to be completed in a 24–hour time period. Compare your average water usage to the city's average of 25 gallons a day per person.

Turn and Talk:

- Which activities should we include on our logs?

Independent Work:

- Track and display the data logged. Use bar graphs, pie charts and other visual displays of information. Compare water usage of cities in the United States by

population, geography and climate, and access to supply. Then, compare usage globally.

Watch:

- Vimeo: *Water History: Creek to Sewer*. Discuss. Why were streams in the city buried? Why do streams disappear as you get closer to the city boundary? What is *Green City, Clean Waters*?

Read:

- Where Does Philly's Drinking Water From article together.

Guided Discussion Questions:

- Which two rivers supply water to the residents of Philadelphia?
- How many water treatment centers do we have and which one services your community?
- Is Philadelphia's drinking water safe?

History of Water in Philadelphia Timeline. Discuss.

Exit Ticket:

- What are the 3 main water treatment centers in Philadelphia and where are they located?

Vocabulary:

- Aquifer
- Chlorine
- Clarification
- Coagulation
- Combined Sewer
- Disinfection

- Filtration
- Filtered Water
- Flocculation
- Hygiene
- Ozone
- Raw Water
- Reservoir
- Sediment
- Separate Sewer

Media

Read:

- Article: Where Does Philly's Drinking Water Come From?
- 2019 PWD Drinking Water Quality Report

Watch:

- Vimeo: Water History: Creek to Sewer
- History of Water in Philadelphia Timeline
- (see appendix)

Lesson 5: The Problems

Objectives

Students will be able to describe the reasons why freshwater is threatened.

Students will be able to describe a storm drain and will understand what happens to trash in the streets when it rains.

I can differentiate between point and nonpoint sources of pollution.

Essential Questions

- What are some of the ways a city can deal with an aging infrastructure?
- What is the relationship between trash on my street and in my watershed?
- What are the negative effects on humans?

Introduction

- KWL anchor chart: Add to the what have we LEARNED column.

- Share examples of something overflowing, the bathtub, the sink, a glass of milk or juice. What were the consequences? How did they or someone they know deal with the clean up? How is this related to our waterways during a heavy rainstorm?

Activity

Watch:

- PBS LearningMedia video, *Water Pollutants.* Discuss. What are the four main types of pollutants?

Turn and Talk:

- Why is it so difficult to get rid of most water pollutants?
- What is sediment and why is it so harmful in water?
- What are nutrients and why are they a problem in our water? Why are more plants in the water a problem?
- Which chemicals are harmful to water and why?
- Why do farms use pesticides and how do they contribute to water pollution?

Watch:

- *Water Pollution Causes* video. Discuss. Add to the KWL chart.
- *Nutrient Pollution,* YouTube video. Discuss. Add to the KWL chart.
- *Water Pollution: It's Effects and Preventions* video. Discuss. Add to the KWL chart.
- *The Great Garbage Patch* video. Discuss. Add to the KWL chart.
- *PWD- Pet Waste= Pollution* video.

Turn and Talk:

- What happens when there are too many nutrients in the water?
- Take a walk outside and make note of what and how much trash is nearby. Complete at two different times during the week (Monday morning vs. Friday afternoon) and compare results.
- Assess the condition of nearby storm drains in dry weather and in the rain.

Independent Work:

- Write: Make a list of all the chemicals you have in your house (cleaning sprays, pesticides, paint thinners, oils). How are we contributing to water pollution?

Exit Ticket:

What potential sources of pollution do you see in your neighborhood? What can we do about it?

Lesson Experiment 1: Oil Tanker Spill

1. Fill a cup half way with vegetable oil and cover with plastic, sealing with tape.
2. Place the cup in a bucket of water and let it float. Explain that the bucket is the ocean water and the cup is the oil tanker.
3. Cut a small hole in the cup and watch the oil leak.

   Students predict: Which will work better to clean up the spill, a cotton ball or a sponge?
4. Teacher dips both items two separate times to confirm results.
5. Students write down results and compare predictions to results.

Discussion Questions:

- What are some reasons for a tanker spill?
- How are humans and animals affected by this spill?
- How can humans clean up this spill?
- What are other ways humans cause pollution?

Exit Ticket:

- What are the human impacts of a polluted waterway (health, recreation, aesthetic, etc.)?
- How can your actions restore ecological balance?

Vocabulary:

- Pollutant
- Sediment
- Toxic Chemicals
- Nutrients
- Pathogens
- Contamination

Media

Read:

- Newsela article: Dwindling Freshwater Resources

Watch:

- PBS Learning Media: Water Pollutants

-
- The Great Garbage Patch YouTube video
- Nutrient Pollution YouTube video
- Philadelphia Water Department: Pet Waste= Pollution Video
- Water Pollution: Its Effects and Preventions

Experiment 1 Materials:

- Styrofoam cup
- Plastic wrap
- Vegetable oil
- Tape
- Plastic knife
- Cotton balls
- Sponge water
- Bucket

Lesson Extensions:

An Overview of Clean Water Access Challenges in the US, UNC Environmental Finance Center

Lesson 6: The Solutions: What can YOU do?

Objectives

I can locate and contact local organizations that are making a difference in their neighborhoods and motivate others to do the same.

Essential Questions

- How do laws come about? How are they enforced and protected?
- What are the benefits of a 'green' city?
- What are the long-term benefits for people as well as wildlife of restoring urban streams?

Introduction

Brainstorm and make a list of things that can cause pollution in our waterways.

Now separate this list into point-source and nonpoint source pollutants. Describe the difference.

Activity

Whole Group: Watch the *Types of Green Infrastructure* video. Discuss.

Turn and Talk:

- Make a list of all the different surfaces around home, school, or in the neighborhood, and classify as impervious or pervious.
- Look outside the classroom window. DO you see evidence of any *Green Practices* on the street? Discuss what you see or don't see.

Read:

- *How to Prevent Water Pollution* article. Discuss one thing you can do today.
- *Resources for Block Captains.* How can you make your block *greener and cleaner?*
- *Greta Thunberg Isn't Alone: Meet Other Young Activists Who Are Leading the Environmental Fight.* Discuss. How did they each get started? How old are they? How are they like/different from you?

Watch: Vimeo video, *Welcome Back Otter.* Discuss. Add to the KWL chart.

Independent Work: Read the NewsEla article, *How Can Kids Help the Planet.* Discuss. What can you do right away without much effort?

Write:

- How can you help the planet in terms of Water Pollution?
- Letters to local organizations: Write to a local Philadelphia or PA organization that is focused on water quality issues.

Research:

- Research different types of Green Stormwater Infrastructure and share the pros and cons of each. What systems could work in their schoolyard or around their neighborhood.
- Research local groups and organizations in Philadelphia that are working to make our water safer. Who are they? What are they doing? How can you get involved?

Group Work: Reimagine what your schoolyard, backyard or streetscape may look like by building a model.

Lesson Experiment 1:

Grow simple vascular plants (bean plants work well) in small test tubes by the window or with a grow light and observe and record the emerging root and leaf systems.

Lesson Experiment 2:

Create a very simple stream by filling a plastic container with sandbox sand and 'make it rain' using a spray bottle or other gentle method. You can start with a light rain shower. Watch how channels naturally form. Introduce heavier rain conditions by more aggressive pouring and see how that erodes the 'banks' of the stream. Discuss what could be done to keep the stream from eroding (plants, trees).

Lesson Experiment 3:

Help restore native plant growth in your neighborhood with the native Flower Seed Activity.

Exit Ticket:

- What are ways we can protect our freshwater resources?
- What is green stormwater infrastructure and what are the benefits?
- Why is capturing the first one inch of rainfall on the land so important in this discussion about water quality?

Vocabulary:

- Natural Resource
- Sustainable
- Renewable

Media

Watch:

- Point and Nonpoint Sources YouTube video
- Welcome Back Otter,: Streams to Sewers to Green Again: A Philly Story: VIMEO video

Read:

- Resources for Black Captains, PWD
- Newsela article: Big Questions: How Can Kids Help the Planet?
- How to Prevent Water Pollution article
- Greta Thurnberg Isn't Alone: Meet Some Other Young Activists Who are Leading the Environmental Fight

Research:

- Drink Philly Tap
- GreenFutures

- Litterati
- Philadelphia Horticultural Society
- Alliance for Watershed Education of the Delaware River
- Wissahickon Environmental Center
- Schuylkill Center for Environmental Education
- *PWD's* Green City, Clean Waters Project

Lesson Experiment 1:

- Seeds (bean)
- Flower Pot
- Soil
- Grow Light

Lesson Experiment 2 materials:

- Container
- Water
- Sand

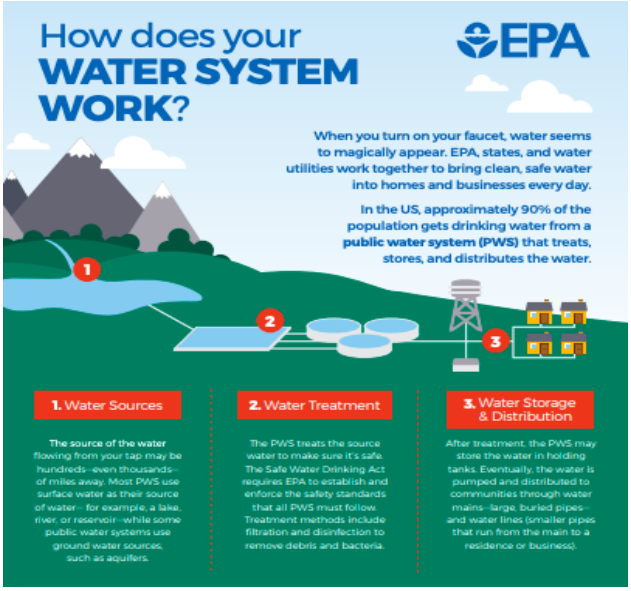
Lesson Experiment 3:

Native Flower Seed Activity

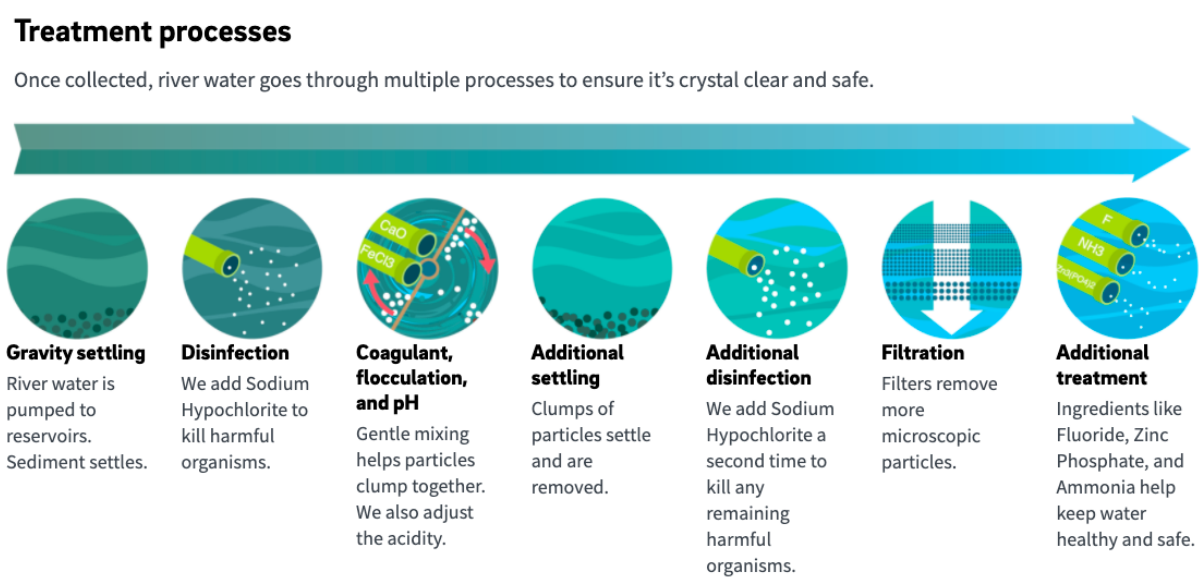
Guiding Questions:

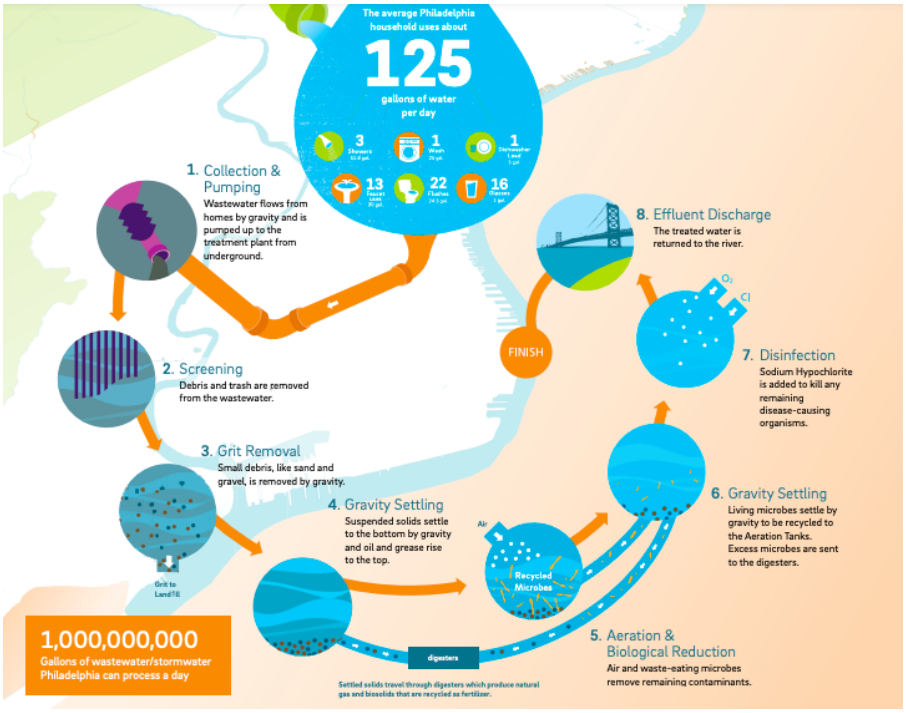
- Why is the value of water?
- Where does our water come from, how did it get there and where does it go?
- What became of Philadelphia's natural streams and valleys?
- What is water pollution?
- How can we keep our water clean?
- How do cities differ from forests with respect to water?
- Where does water go when it rains?
- What is stormwater runoff? Why is it harmful?
- What does it take to treat and deliver drinking water every day?
- How is wastewater cleaned so it can be safely reused or returned to the environment?
- What are some actions we can take to be Clean Water Heroes?
- Can we create sustainable urban design solutions that work with the natural water cycle?
- What are we going to do to protect and sustain water quality in our watershed?

Additional Images:



Water Treatment Process:





Keywords:

Water, water pollution, urban watershed, impermeable sources, climate change, Philadelphia, Middle School Science, hydrologic cycle, distribution of water

Resources

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Appendix

A Timeline of WATER in Philadelphia

1790s-1800s: Yellow fever epidemics resulted in widespread panic, giving rise to the belief that contaminated water supply was the cause. In 1799, a Watering Committee was formed to provide clean water throughout the city.

1801: Philadelphia's first public drinking water system was created, designed and engineered to pump river water from the Schuylkill River at 24th and Chestnut Street to a steam-powered water works structure at Centre Square, where Philadelphia City Hall stands today. From here, it was distributed to the city through wooden pipes made from hollowed out logs to flow to public hydrants, businesses and homes.

1815: New pumping station and reservoir built at “Faire Mount”, the highest point of the city, using cast iron instead of wood pipes. Fairmount Park system is developed and expanded to keep the Schuylkill water clean and to accommodate the city’s growing population and demand for water

1815-1854: The Water Works at Fairmount was the sole pumping station. Construction of Fairmount Dam and Milhouse to harness hydropower of the Schuylkill River to pump water. Traditional breast water wheels were replaced with more efficient hydraulic turbines.

1854: The city boundaries grew, incorporating all the outlying and adjacent districts and their accompanying pumping stations, diminishing the city’s dependence on water from Fairmount.

1860s: The Civil War drives massive industrial development and coal mining and processing; Philadelphia becomes the first major industrialized U.S. city in large part due to the city’s reliable water supply system.

1868: The open land upstream of the Water Works, originally purchased by the city to keep open space to protect its water supply, became Fairmount. It was also expanded to more than 2000 acres with the purchase of land on both banks of the Schuylkill River. The city’s drinking water is now drawn from four separate pumping stations; Shawmont, Belmont, Spring Garden, and Fairmount.

1880s: Typhoid fever spreads to Philadelphia due to industrial and residential pollution of the Schuylkill River, and medical reports recognize contaminated water as the source of the epidemics.

1883: Mill Creek in West Philadelphia was one of many creeks that was piped underground and made an integral part of the city's sewer system.

Mill Creek construction, 1883

1907: After numerous political and financial delays, filtration and chlorination are used for drinking water treatment in an attempt to stop the typhoid epidemics. An immediate and drastic decline in the number of typhoid cases results. Industrial and domestic wastes continually discharged into rivers and streams resulting in deteriorating water quality.

1909: The Fairmount Water Works is decommissioned and water filtration plants were constructed at five other locations using sand filtration systems, which are designed to greatly reduce water-borne diseases.

Fairmount Water Works, view from 1984

1914: A comprehensive *Report on the Collection and Treatment of the Sewage of the City of Philadelphia* is published as a master plan for the City's sewer and sewage treatment system.

1950-1966: Construction of three sewage treatment plants is completed.

1970: The Environmental Protection Agency (EPA) was established by President Richard Nixon, representing a new federal commitment to preserving the environment.

1970: The first Earth Day was celebrated by nearly 20 million Americans. It marked the start of a global environmental consciousness.

1972: The Clean Water Act is introduced. This complex law required that every stream meet designated water quality standards based on type of use.

1974: The Safe Drinking Water Act is introduced.

1975: Present: Increasingly stringent federal and state regulations on water quality drive technological advances in water and wastewater treatment.

2011: Philadelphia Water Department (PWD) creates *Green City, Clean Waters* project, which aims to drastically reduce pollution from stormwater and combined sewer overflows in Philadelphia.

2012: The City of Philadelphia and the Philadelphia Water Department (PWD) sign a partnership with the commonwealth of PA to collaborate on developing Green Infrastructure technologies in Philadelphia including a green design challenge, green streets and next generation techniques.

Key Vocabulary

Absorbency: Capable of taking in/soaking up moisture. Infiltration (noun): The seepage of water into soil or rock.

Coagulation: The process of changing from a liquid to a semi-solid state. (Chemicals are added to the water to bind smaller particles together to encourage them to settle).

Combined Sewer: Sewage (unsanitary waste) collection system of pipes and tunnels designed to also collect surface runoff.

Condensation: The part of the water cycle in which a vapor or gas is converted to a liquid.

Filtration: The act of capturing impurities from the water as it passes through a layer of sand, gravel and charcoal now called rapid sand filtration. Philadelphia first introduced a slow sand filtration process in the early 1900s using sand and gravel only.

Disinfection: The process of introducing a chemical or other product added to kill disease causing organisms.

Evaporation: The process by which liquid changes into vapor.

Flocculation: The formation of small clumps. In this process, water is gently mixed to make sure that the chemicals added in coagulation have bonded and that particles combine to form "floc" which will settle.

Green Stormwater Infrastructure (GSI): Includes a range of soil-water-plant systems that capture stormwater, infiltrate a portion of it into the ground, evaporate a portion of it into the air, and in some cases, release a portion of the captured stormwater slowly back into the sewer collection system. GSI treats stormwater runoff as a resource to be incorporated into the urban environment instead of as a waste product requiring removal and treatment.

Hydraulic Cycle: The process of water circulating on or below the earth's surface and in the atmosphere.

Impermeable Surface: any solid surface that will not allow water to penetrate through such as asphalt, concrete, stone, brick, roofing, or extremely compacted ground like a soccer field.

Infiltration: The part of the water cycle in which water passes through (a substance) by filtering or permeating or penetrating its pores.

Infrastructure: The underlying foundation or basic framework.

Non-Point Source Pollution: A contributory factor to water pollution that cannot be traced to a specific spot; for example, pollution that results from water runoff from urban areas, construction sites and agricultural operations.

Nutrient: A substance or ingredient that promotes growth, provides energy, and maintains life.

Percolation: The part of the natural water cycle in which water moves slowly downward through the porous ground.

Point-Source Pollution: Pollution discharged through a pipe or some other discrete source from municipal water- treatment plants, factories, confined animal feedlots, or combined sewers.

Pollution: The presence in or introduction into the environment of a substance or thing that has harmful or poisonous effects.

Precipitation: The part of the natural water cycle in which rain, snow, sleet, or hail falls from the atmosphere to the ground.

Sedimentation: The process of matter settling to the bottom of a liquid by gravity.

Separate Sewer: A drainage system in which sewage and stormwater are carried in separate pipes and to separate places.

Sewer: An underground conduit for carrying off drainage water and waste matter.

Sludge: Solids that settle by gravity in the wastewater treatment process made up of organic materials such as food, feces, paper fibers, etc.

Source: The point of origin at which something begins its course.

Stormwater Runoff: The part of the water cycle in which water flows off the land into the nearest body of water.

Transpiration: The part of the water cycle in which water that has been absorbed by living things, like by plants and trees and evaporates into the atmosphere.

Water: a colorless, transparent, odorless liquid that forms the seas, lakes, rivers, and rain and is the basis of the fluids of living organisms.

PA State Standards

Science

- **S8.D.1.2.2** Describe potential impacts of human-made processes (e.g., manufacturing, agriculture, transportation, mining) on Earth's resources, both nonliving (i.e., air, water, or earth materials) and living (i.e., plants and animals).
- **S8.A.3.2.1** Describe how scientists use models to explore relationships in natural systems (e.g., an ecosystem, river system, the solar system).

- **S8.D.1.3.3** Distinguish among different water systems (e.g., wetland systems, ocean systems, river systems, watersheds) and describe their relationships to each other as well as to landforms.
- **S8.A.3.1.1** Describe a system (e.g., watershed, circulatory system, heating system, agricultural system) as a group of related parts with specific roles that work together to achieve an observed result.

English Language Arts

- **CCSS.ELA-LITERACY.RI.5.1** Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.
- **CCSS.ELA-LITERACY.RI.5.2** Determine two or more main ideas of a text and explain how they are supported by key details; summarize the text.
- **CCSS.ELA-LITERACY.RI.5.7** Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently.
- **CCSS.ELA-LITERACY.RI.5.8** Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point(s).