



Rochester's Water Cycle

Quick Facts

Age: 4th Grade

Length: 20 - 40 minutes

Theme

The water cycle is a natural process that occurs across the globe and is affected by built structures made by humans.

Concepts

Cycles

Human Impact

Natural vs. Made by Humans

Minnesota Academic

Science Standards

4.1.2.1 Engineers design, create, and develop structures, processes, and systems that are intended to improve society and may make humans more productive.

4.2.1.2 Solids, liquids and gases are states of matter that have unique properties.

4.3.2.3 Water circulates through the Earth's crust, oceans and atmosphere in what is known as the water cycle.

4.3.4.1 In order to improve their existence, humans interact with and influence Earth systems.

Outcomes, students will:

1. Be able to identify the components of the water cycle
2. Be aware that natural and built components interact in the water cycle.
3. Understand that human actions have an impact on the water cycle.

Brief Synopsis

Tell the story of the water cycle in Rochester, Minnesota through a modified version of Project WET's incredible journey where students simulate the movement of water within the water cycle by rolling dice and moving from station to station.

Materials

- 9 large pieces of paper labeled with station names
- 9 boxes for dice, about 4 –6 inches on a side

Background

In general, the hydrologic cycle involves water moving through a series of events: precipitation, infiltration, runoff, evaporation, transpiration, and condensation. This occurs naturally across the globe including urban areas. In urban areas, the built environment and humans impact the natural water cycle. This includes using groundwater in our homes which then heads to the wastewater treatment plant before being discharged to the river. Plus rain and snowmelt travel across constructed surfaces like roads and parking lots to the storm sewers before it reaches surface waters. This increase of water runoff decreases infiltration which results in an increase of pollution being carried to our waterways.

Additional background information can be found in chapter 1 of the Rochester Water Primer.



Rochester's Water Cycle

Extensions

- ◆ Discuss different locations around the globe and how the water cycle might be different there.
- ◆ Discuss how humans impacted the water molecules in the water cycle.
- ◆ Have students investigate how water becomes polluted and is cleaned as it move through the water cycle.

Resources

Rochester Water Primer

Project WET

"The Incredible Journey"

Procedure

Warm Up

- ◆ Ask students to identify the different places water can go as it moves around Rochester. Write their responses on the board.
- ◆ Ask students to identify the different places water can go in their home or school. Write their responses on the board.

The Activity

1. Explain to students that they are going to become water molecules traveling through the water cycle in Rochester.
2. Explain the twelve stations that water can move through from your discussion earlier: clouds, river, lake, plants, animals, soil, groundwater, drinking water well, sanitary sewer, wastewater treatment plant, parking lot, and storm sewer. Place these stations throughout your play area.
3. Assign students to a starting station. Have students brainstorm the different places water can go from their station and the conditions that cause the water to move.
4. Provide the corresponding die to each station. Explain that each student takes their turn rolling the die and following the instructions on where it send them next. Stand in line when you get to a station and wait for your turn. Bring attention to the sides that say "stay" which means you go to the back of the line and wait to roll again.
5. Students should keep track of their movements. This can be done by recording their journey in a journal or notepad, remind them to record each stay.
6. Explain that the game will begin and end with a sound cue, this could be a certain word or a whistle.
7. Begin the game and provide enough time for students to travel to as many stations as you can.

Wrap Up

- ◆ Have students use their travel records to write a story about the places they traveled as a water molecule. This should include descriptions of how the water was able to travel from one location to the next, including a change of state if applicable.
- ◆ Students can share their stories with a small group. Students should compare and contrast the differences in their stories and discuss what that means.



Rochester's Water History

Quick Facts

Age: 4th Grade

Length: 20 - 40 minutes

Theme

Humans make choices and create engineering design solutions that impact natural systems.

Concepts

Design

Impact

Choice

Minnesota Academic

Science Standards

4.1.2.1 Engineers design, create, and develop structures, processes, and systems that are intended to improve society and may make humans more productive.

4.1.2.2 Engineering design is the process of identifying problems, developing multiple solutions, selecting the best possible solution, and building the product.

4.1.2.3 The needs of any society influence the technologies that are developed and how they are used.

4.3.4.1 In order to improve their existence, humans interact with and influence Earth systems.

Outcomes, students will:

1. Describe the positive and negative impacts that the designed world has on the natural world.
2. Generate ideas and possible constraints for solving a problem through engineering design.
3. Evaluate solutions, considering the advantages and disadvantages for the engineering solution, and communicate the results affectively.

Brief Synopsis

Following Rochester's 1978 flood disaster, government agencies and community groups took action to prevent a future flooding disaster. Student groups represent some of the people who are likely to work on a flood control project. Each group is provided with a scenario card detailing the group's needs in the flood control project planning.

Materials

- 5 Scenario Cards with map
- 1 class map for recommendation to City Council

Background

Rochester was built on the floodplains created by the South Fork of the Zumbro River and its tributaries. Early settlers depended on the water for many of their daily needs, the City's location next to the river seemed perfect for a growing community. The conflict between a river's need to flood into its floodplain and people's desire to be next to water became a battle that is still fought today.

The July 1978 flood was Rochester's worst flood disaster since the City's founding. A flood control bill for Rochester was approved by Congress with two distinctive projects: the river project by the U.S. Army Corps of Engineers and the reservoir project by the U.S. Department of Agriculture Natural Resources Conservation Service.

Additional background information can be found in chapter 2 of the Rochester Water Primer.



Rochester's Water History

Extensions

- ◆ Have students research what solutions were selected and installed for the flood control project in Rochester and compare to the class' plan.
- ◆ Have students investigate how some of the solutions work and create a presentation or demonstration project.
- ◆ Take a class trip to one of the flood control project installations, such as the Silver Lake Dam or one of the reservoirs.

Resources

Rochester Water Primer

Rochesterstormwater.com

Procedure

Warm Up

- ◆ Ask students to brainstorm any built structure they have seen or heard of in Rochester that impacts the flow of water in the Zumbro River.
- ◆ Ask students to brainstorm advantages and disadvantages of the built structures they are familiar with for both humans and the natural world.

The Activity

1. Split the class into four or five groups. Explain that each group represents some of the people who are likely to work on a flood control project and have to make decisions.
2. Each group will get a scenario card with their group name and what is important to their group.
3. Each group will also receive a map of Rochester (can be on the backside of the scenario card).
4. The students job is to create a flood control plan that meets the needs on their group scenario card.
5. Students will present their flood control plan and add it to the map for the class. (Class map could be on a smart board or a large printed version).
6. This activity will encourage students to find fault in each other's plan because group's may have conflicting needs.

Wrap Up

- After all of the differences and opinions have been voiced, ask students to find the similarities, compromise, and choose a plan that works for all groups to recommend to City Council.



Rochester's Watershed

Quick Facts

Age: 4th Grade

Length: 15 - 30 minutes

Theme

All living things reside in a watershed and can impact the health of the watershed.

Concepts

Interconnectedness

Impact

Choice

Minnesota Academic

Science Standards

4.3.2.3 Water circulates through the Earth's crust, oceans and atmosphere in what is known as the water cycle.

4.3.4.1 In order to improve their existence, humans interact with and influence Earth systems.

Outcomes, students will:

1. Define and identify their local watershed.
2. Identify how water connects different ecosystems.
3. Identify sources of non-point pollution.

Brief Synopsis

It's important for students to understand that they have a watershed address and how human actions can be a source of pollution. Students will build a watershed and learn about unintentional pollution sources.

Materials

- Waterproof tray/tub
- Aluminum foil
- Rocks of various sizes
- Coffee grounds
- Food coloring
- Watering can or spray bottle
- Watershed Maps of Rochester and the Zumbro River

Background

Rochester lies within the South Fork Zumbro River watershed. That means that everything that is left on the land surface in Rochester has potential to be washed into the South Fork of the Zumbro River after each rainstorm or snowmelt.

A watershed is defined as all the land area that drains to a waterway. The boundaries of a watershed are based on topography. The highest elevations surrounding a water body become the boundaries or watershed divides. Water always runs downhill from divides.

Smaller watersheds are nested in larger watersheds, for example the Zumbro River drains into a larger watershed of the Mississippi River. Rochester has several smaller watersheds that are all a part of the Zumbro Watershed.

Additional background information can be found in chapter 3 of the Rochester Water Primer.



Rochester's Watershed

Extensions

- ◆ Brainstorm a list of pollutants that could be caused by humans. Discuss different solutions for each of the pollutants.
- ◆ Research engineering design solutions that help to remove pollutants from land and water.
- ◆ Research what happens to our trash and recycling in Rochester.

Resources

Shangri La Botanical Garden & Nature Center "What is a Watershed?" class.

MPCA interactive watershed maps

Procedure

Warm Up

- ◆ Define a watershed and discuss what it is. Use background information provided to give examples.
- ◆ Discuss that everyone has two addresses: your 'actual' street, city, state address and your watershed address (creek or tributary = street; Zumbro River = city; Gulf of Mexico = State).
- ◆ Have students look at the watershed map with drainage basins of the City of Rochester and have them create their watershed address.

The Activity

1. Explain to students that you'll be building a watershed in class. This can be done as a whole class (more of a demonstration) or students can be divided into groups and have to follow instructions.
2. Take the waterproof tray and place rocks to build hills and mountains in your landscape.
3. Cover the rocks with foil. The foil represents the soil and plants.
4. Use the coffee grounds, food coloring, and other items to represent pollution. Place a little of each in different locations in the watershed and create a story of what is causing the pollution.

On top of this mountain there is a neighborhood of homes. The families that live there use too much lawn fertilizer and some times their trash blows out of the trash cans on windy days.

Over here there is an old man who likes to work on cars outside and sometimes oil and gasoline spills.

Over here is a nice lady who lives alone, but she's not lonely because she has 25 cats who live in her barn. As I'm sure you know, animals go to the bathroom and there is a lot of poo (coffee grounds) from all those cats.

5. After all the pollution has been placed, use the spray bottle or watering can to make it rain across the entire watershed.
6. The students should observe what happens. Where does the water travel? Where does it pool? What happens to the pollutants?

Wrap Up

- Have the students share their observations.
- Discuss positive and negative impacts humans can have on a watershed.



Fishing in Rochester

Quick Facts

Age: 4th Grade

Length: 15 - 30 minutes

Theme

Wildlife populations rely on their habitats for survival.

Concepts

Needs/Survival

Impact

Diversity

Minnesota Academic

Science Standards

4.1.2.1 Engineers design, create, and develop structures, processes, and systems that are intended to improve society and may make humans more productive.

4.3.2.3 Water circulates through the Earth's crust, oceans and atmosphere in what is known as the water cycle.

4.3.4.1 In order to improve their existence, humans interact with and influence Earth systems.

Outcomes, students will:

1. Identify what habitat needs local fish species require to survive.
2. Evaluate the suitability of constructed water bodies in Rochester to supply the habitat needs of local fish species.
3. Discuss how change in a habitat can benefit or harm fish.

Brief Synopsis

Students will learn about components of habitat provided by constructed water bodies in Rochester and determine which fish species are able to survive.

Materials

- Fish cards
- Habitat Cards

Background

Rochester is located in one of the few counties in Minnesota that doesn't have any natural lakes. In the 1930's, Rochester citizens created the city's first lake for a park, Silver Lake, digging by hand and then constructing a dam to back-up river water. A fishing pier and several limestone pathways make fishing access easy. The aquatic plants that live in Silver Lake and Rochester's other constructed water bodies are important in providing food and habitat for many animals such as fish, frogs, birds, and turtles. The area within a lake or pond where aquatic plants grow is called the littoral zone. Other constructed water bodies found in Rochester that are used for fishing include: Foster Arend Lake, Flood Control Project Reservoirs, and Quarry Hill Pond.

Additional background information can be found in chapter 4 of the Rochester Water Primer.



Fishing in Rochester

Extensions

- ◆ Provide students with a blank lake habitat card and have them add the resources their fish species needs.
- ◆ Visit one of the constructed water bodies in Rochester and have students record what resources are available for fish and aquatic animals. Also record which animals are observed at the site.
- ◆ Take students on a fishing field trip.

Resources

Modified activity from MinnAqua Habitat Hideout Lesson and Eagle Bluff ELC Biodiversity Hike Activity.

MPCA interactive watershed maps

Procedure

Warm Up

- ◆ Ask the students to describe where they might find fish in nature. Make a list of locations that the students brainstorm.
- ◆ Ask the students what those fish need from their habitat to survive. Make a list of their ideas.
- ◆ Ask students how changes in the habitat might benefit or harm fish.

The Activity

1. Direct the students' attention to the lake habitat card and discuss the various types of structures present. Also discuss the types of food and other resources present in the habitat that a fish might use.
2. Explain that each student or student group is going to become a fish species that can be found in Minnesota. Their job is to determine if their fish species can survive in Rochester and to explain why or why not.
3. Pass out the fish cards to the students and allow them to determine if their fish species could survive by studying the lake habitat card.
4. Have the students share their findings and discuss how they came to their decision.

Wrap Up

- Ask the students:
 - What would need to change for their fish to live in Rochester?
 - What would need to stay the same for their fish to live in Rochester?
 - How could humans impact the fish's habitat?



Rochester's Geology

Quick Facts

Age: 4th Grade

Length: 30 - 45 minutes

Theme

Water, rocks, and people are closely connected in a karst landscape.

Concepts

Needs/Survival

Interconnectedness

Formation

Minnesota Academic

Science Standards

4.3.1.3 Rocks are an Earth material that may vary in composition.

4.3.2.3 Water circulates through the Earth's crust, oceans and atmosphere in what is known as the water cycle.

4.3.4.1 In order to improve their existence, humans interact with and influence Earth systems.

Outcomes, students will:

1. Identify the major karst landscape features.
2. Understand how water moves through the underground rock layers in Rochester.
3. Discuss Rochester's Water Supply from underground aquifers.

Brief Synopsis

Students will learn how water moves through the karst geology that is below the City of Rochester which provides the city's water supply.

Materials

- Water Drop Card
- Starting line rope or tape
- Limestone Layer cards, including action cards
- Shale Layer cards

Background

In Rochester, the City gets its water from deep underground wells managed by Rochester Public Utilities (RPU). The water is extracted from bedrock aquifers which are large rock formations that hold water. The water is held in small fractures between the particles that form the rock. Fractured limestone and porous sandstone are the aquifer forming rocks in Rochester. Aquifers are a dependable source of water when they are porous (there are spaces for the water to be in) and permeable (the water can move easily through the rock).

As rain water enters the soil layer it reacts with carbon dioxide present in the soil forming a weak acid called carbonic acid. As the water or carbonic acid reaches the underground rock layers it begins to move through the fractures in the rock and create karst landscape features.

Additional background information can be found in chapter 5 of the Rochester Water Primer.



Rochester's Geology

Extensions

- ◆ Watch the video "Mysteries of the Driftless" available on YouTube to explore more about this unique geology.
- ◆ Play game again and compare similarities and differences. Have a student who secretly is a pollutant.
- ◆ Plan a field trip to one of the local caves in the area.
- ◆ Plan an Urban Water Cycle field trip with the City of Rochester and visit a wellhead and water tower.

Resources

Modified activity from Eagle Bluff ELC Chemistry of Karst.

Procedure

Warm Up

- ◆ Ask students to share about interesting rocks they have seen in Rochester.
- ◆ Discuss the unique geology that we have in Rochester that provides us our drinking water.

The Activity

1. Set up the game as shown in the diagram. Explain to the students that they will be working in teams in a relay race style as they pretend to be water that has moved through the soil to form carbonic acid.
2. Have the students lineup in their 4 teams at the starting line. Each player will know it is their turn when they hold the blue raindrop card. To take a turn, each player will enter the limestone layer and pick up one card, then run back to their team and pass the raindrop onto the next teammate. Each teammate takes turn moving through the limestone layer by following the path the previous teammate choose and selected another card adjacent to the card the previous teammate had taken.
3. Action cards are randomly spread out through the limestone layer. If a player picks up an action card, they must follow the directions on the card.
4. The shale layer represents a confining layer which is made of rock that can't be dissolved by water. The only way through the shale is to find a crack to the sandstone layer. Players at the shale layer may only take one card at a time passing the raindrop onto the next teammate until a crack has been found.
5. The first team through crack and into the sandstone layer wins the game.

Wrap Up

- After the game has ended, have all students freeze and gather outside of the play area. Have students take a moment to calm down and observe what happened to the limestone layer after the water moved through.
- Ask students to share and discuss their observations. Students who discovered action cards can explain what they had to do and why.
- Have students imagine if one of the teams was a type of pollution that can be carried by water. What would happen to the water once it reached the sandstone layer?
- Discuss if the students were going to dig a well for drinking water, how far down would they want to dig the well?



Rochester's Wastewater Treatment

Quick Facts

Age: 4th Grade

Length: 15 - 30 minutes

Theme

Water, rocks, and people are closely connected in a karst landscape.

Concepts

Cycle

Impact

Minnesota Academic

Science Standards

4.1.2.1 Engineers design, create, and develop structures, processes, and systems that are intended to improve society and may make humans more productive.

4.3.2.3 Water circulates through the Earth's crust, oceans and atmosphere in what is known as the water cycle.

4.3.4.1 In order to improve their existence, humans interact with and influence Earth systems.

Outcomes, students will:

1. Identify areas in a home where water comes and goes.
2. Understand how water moves through residences and businesses.
3. Discuss how humans can conserve water use.

Brief Synopsis

Students will learn how water moves through residences and businesses before and after it is used by humans.

Materials

- Country "Follow Those Pipes" Coloring Sheet
- City "Follow Those Pipes" Coloring Sheet
- Water Conservation Action Cards

Background

Water consumption is required for everyday life and we have an obligation to be good stewards of the water we use. Wastewater is used water that is generated from residences, commercial buildings, and industrial plants. It is also sometimes called sanitary sewage. In this case, the term "waste" does not mean that the water is thrown away. The goal of the City of Rochester is to return wastewater to the water cycle at the Zumbro River, with as little environmental impact as possible.

After water goes down the drain or the toilet is flushed, where does the water go? Wastewater is carried from homes and business through a network of buried pipes, called a sanitary sewer collection system, to the Water Reclamation Plant in NW Rochester. The water is treated through engineered processes to remove pollutants before the water is returned to the Zumbro River.

Additional background information can be found in chapter 6 of the Rochester Water Primer.



Rochester's Wastewater Treatment

Extensions

- ◆ Plan an Urban Water Cycle field trip with the City of Rochester and tour the Water Reclamation Plant.
- ◆ Watch online videos about the treatment process and the City of Rochester's "Wipes Clog Pipes" (links below)
- ◆ Have students take photos of places where water enters and exits a building (at home or at school).

Resources

[https://](https://www.rochestermn.gov/departments/public-works/wastewater-management/water-reclamation-plant)

[www.rochestermn.gov/
departments/public-works/
wastewater-management/
water-reclamation-plant](https://www.rochestermn.gov/departments/public-works/wastewater-management/water-reclamation-plant)

[https://www.youtube.com/
watch?v=aQkEfcREpUM](https://www.youtube.com/watch?v=aQkEfcREpUM)

[https://www.youtube.com/
watch?v=8isr9nSDCK4](https://www.youtube.com/watch?v=8isr9nSDCK4)

Coloring Sheets Source:

*That Magnificent Ground
Water Connection: A Resource
Book for Grades K-6*

Procedure

Warm Up

- ◆ Have students brainstorm locations in their home or school where they have access to water.
- ◆ Ask students where they believe the water goes after it leaves a house or school building.

The Activity

1. Provide each student with both city and country "Follow Those Pipes" coloring sheets.
2. Instruct students to follow the directions for coloring the pipes and allow time for students to color the rest as they see fit.
3. Discuss where the water goes after it leaves a house and explain that the water is treated or cleaned before it is returned to the Zumbro River.
4. Explain that it is important for people to be aware of how much water they use because it takes a lot of energy to get the water to a building and to clean it afterwards before it can be returned to nature.
5. Pass out the Water Conservation Action cards to each students and have each student read their card aloud.
6. Listening students can decide if that is an action they are willing to take. To show agreement or disagreement have the students do an action, such as stand up or move to a certain area in the room.

Wrap Up

- After all the cards have been shared, have each student select one water conservation action that they will pledge to do this week. Students may write the pledge on their coloring sheet or in another appropriate location.
- Some students can share their pledge with the class.



Rochester's Stormwater Management

Quick Facts

Age: 4th Grade

Length: 30 - 45 minutes

Theme

Humans can install practices that will enhance water quality and quantity.

Concepts

Cycle

Impact

Minnesota Academic Science Standards

4.1.2.1 Engineers design, create, and develop structures, processes, and systems that are intended to improve society and may make humans more productive.

4.1.2.2 Engineering design is the process of identifying problems, developing multiple solutions, selecting the best possible solution, and building the product.

4.3.2.3 Water circulates through the Earth's crust, oceans and atmosphere in what is known as the water cycle.

Outcomes, students will:

1. Understand green infrastructure and engineering solutions for stormwater management.
2. Identify locations where stormwater management practices can be implemented.
3. Discuss how humans impact stormwater.

Brief Synopsis

Students will learn how stormwater is impacted in an urban setting and how green infrastructure and engineering solutions can solve associated problems.

Materials

- Birdseye map of school grounds
- Green infrastructure cards
- Colored writing utensils

Background

In a city, the creation of human habitat leads to lots of hard, or impervious, surfaces like streets, roof tops, and sidewalks. These impervious surfaces prevent infiltration of precipitation, so when it rains or snow melts, this runoff (or stormwater) runs across both natural and constructed surfaces.

When water can't infiltrate, it misses the soil filtration step where microorganisms consume many pollutants. As a result, this change to urban areas causes lost charge and more runoff the moves across the landscape faster. More and faster moving water can cause erosion and can collect pollutants as it moves and transports them to receiving waters.

Today, stormwater pollution is regulated at the federal, state, and local levels. Green infrastructure and engineering solutions are ways that humans can capture and slow stormwater and then remove pollutants and increase infiltration into the ground.

Additional background information can be found in chapter 7 of the Rochester Water Primer.



Rochester's Stormwater Management

Extensions

- ◆ Select one of the green infrastructure practices to install at school. Reach out to City Staff for assistance.
- ◆ Plan an Urban Water Cycle field trip with the City of Rochester and tour Cascade Meadow's Stormwater Management Practices.

Resources

www.rochesterstormwater.com

Procedure

Warm Up

- ◆ Have students review the water cycle, including the human built components that are present in a city.
- ◆ Discuss how stormwater is different from wastewater.

The Activity

1. Divide students into several groups and pass out a green infrastructure card to each team.
2. Instruct students to learn about their green infrastructure example and discuss where at school that it could work.
3. Students can then present their decisions and should add it to a master plan.
4. Alternative option: Set a time for each group to study their first green infrastructure practice, when time is up have group pass their card to another group. Continue until each group has had time to learn about each practice and select a location to install it at school.

Wrap Up

- Students can compare and contrast their stormwater management plan for school. Are there areas where groups want to install more than one practice?
- Ask students if any of these practices could work at their house.