Understanding the Urban Watershed

A Curriculum Guide for the Classroom

A compilation of successful lessons and activities

Fairmount Water Works

Supported in part by the *Green Schools, Clean Waters* Initiative of the Philadelphia Water Department

ACKNOWLEDGEMENTS

Philadelphia Water Department
Fairmount Water Works Interpretive Center
Partnership for the Delaware Estuary
Environmental Protection Agency
Philadelphia Parks and Recreation
Schuylkill Action Network
Eco Express
George W. Nebinger School Principal and Staff

This curriculum guide grew out of the Education and Outreach programs of the Fairmount Water Works / Philadelphia Water Department. It was tested as a pilot project during the academic year 2012-13 in partnership with the George Nebinger School Faculty and Principal, made possible with partial funding from the Environmental Protection Agency and administered by the Partnership for the Delaware Estuary. An advisory committee comprised of the PDE, PWD, FWWIC, and Eco Express was formed to review and revise content.

This Understanding the Urban Watershed Curriculum Guide is best used with its companion online teacher toolbox of resources and the table-top hands-on model. The Lessons and Activities herein are meant to enhance lessons already being taught in the classroom by any classroom teacher. The Lessons and Activities take a interdisciplinary, hands-on approach to learning and are aligned with the Common Core State Standards for grades K through 8. The online resource "tool box" allows for quick classroom access to videos, websites, reading lists as well as materials, diagrams and background information to help teachers create hands-on as well as project-based learning opportunities for their students.

Environmental Education (EE) increases public awareness and knowledge about environmental issues and provides the participants in its programs the skills necessary to make informed environmental decisions and to take responsible actions. EE is based on objective and scientifically sound information and does not advocate a particular viewpoint or a particular course of action. EE teaches individuals how to weigh various sides of an issue through critical thinking, problem solving and decision making skills on environmental topics. EE covers the range of steps and activities from awareness to action with an ultimate goal of environmental stewardship. EE involves lifelong learning; its audiences are of all age groups, from very young children through senior citizens. EE can include both outdoor and in-classroom education, in both formal and informal settings.

— EPA Definition of Environmental Education

THE MISSION OF THE FAIRMOUNT WATER WORKS

To foster stewardship of our shared water resources by encouraging informed decisions about the use of land and water. We educate citizens about Philadelphia's urban watershed, its past, present and future, and collaborate with partners to instill an appreciation for the connections between daily life and the natural environment. Administered by the Philadelphia Water Department, the Fairmount Water Works Interpretive Center and its partners transform the way people think and live by making them aware of how individual actions on the land impact the quality of water for all living things.

Core Values

- We care about ***Clean Water*** for all living things. We recognize that clean water starts with each individual's actions and we nurture a sense of personal responsibility for the conservation of our watersheds and the health of the planet.

- We take a ***Personal Approach*** to guide visitors in thoughtful exploration of our historic site and to engage their intellect. Every visitor is warmly greeted and treated with courtesy.

- We believe that ***Collaboration*** is the way to bring creative people, sound science, and great ideas together to cultivate excellence in all we do. We accomplish this by developing ***Strategic Partnerships*** with those individuals and groups who share our values and aspirations.

- We provide ***Experiential Learning*** that engages all visitors in understanding the concepts that pervade our messages, programs, and exhibits. Our approach is both "hands on" and "minds on," for all audiences, recognizing that people come to us through different "gateways."

- We value the ***History*** that has shaped our lives, informs our messages, and inspires our future. Our National Historic Landmark setting, exhibits, and programs celebrate Philadelphia's past and the engineering marvel that was and is the Fairmount Water Works.

- We care about ***Our People***, value their individual contributions and seek to attract and retain the very best staff, volunteers, and advisors.

THE URBAN STORY

This is intended to be a practical guide for K-8 educators interested in making a connection for their students between one of the most fundamental elements in all living things—water—and the complexities and responsibilities associated with accessing it, using it, cleaning it up and returning it to our waterways and managing it as a city.

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 "hum" along on a daily basis in order to ensure public health or the balanced ecology of our streams.

Historically, the development of the urban water supply system in Philadelphia, essential to the life and economy of the city, was born out of necessity and inventiveness. Characterized as one of the most successful public water systems in America, Philadelphia's public system grew out of problems related to public health and industrialization.

Individuals have the ability to protect the quality of our waterways for all living things and to advocate for a healthy environment. The activities that follow will help your students gain a greater understanding of their connection to the urban watershed and the urban water use cycle. Urban 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 and healthy ecosystems.

Ben Franklin's adage that we do not know the value of water until the well is dry speaks to our goals. Ultimately, the activities in this guide will encourage students of all ages to discuss, assess, calculate and evaluate the worth of water.

WHY LEARN ABOUT WATER?

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. It is every human's most basic need and yet it is rarely discussed or even considered in most developed regions. In an age where potable (drinkable) water simply appears from the tap, it is quite possible for a person to be unaware of where that water originated or how it was made to be safe enough to drink.

This disconnect becomes a problem when water resources are threatened, making urban water education vital. Urban watershed education helps re-connect us 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. Once "consumers" begin to understand that they have an impact on this precious natural water resource, they can make informed decisions about the best way to take care of these resources.

Simply put, effective urban water education is essential to transforming the way people think and live by making them more aware of how individual actions on the land impact the quality of water for all living things.

INNOVATION AND SOLUTIONS: A CAPTIVATING STORY

This guide presents a variety of ways to help you engage your students in the fascinating and yet complex narrative, with its twists and turns, describing the story of the urban water system. As with any good story, it has a theme, a plot—with conflict and struggle as well as resolution, interesting characters, and a familiar setting. The style and tone of how you tell the story is up to you, but the content is compelling and real. The only difference between this narrative and the one found in a book is that it has no ending. It is up to your students to write the next chapters and to pass it on.

ABOUT THIS URBAN WATERSHED CURRICULUM

It is designed as a series of thematic units that build on each other, starting with the personal perspective. Ultimately, the learning experience will provide students with the broadest view of the development of urban water delivery systems and help them become active participants in 21st – century solutions to urban water issues. The final thematic unit, focused on stewardship, will be project based at the school or in the neighborhood community. Students, faculty, administrators, families and community members will help shape it to be sustainable and valuable.

Each thematic unit includes broad learning objectives, a "What You Should Know" section to begin to inform the educator, and a series of lessons with activities to follow. Each lesson provides activities to be done in and around the classroom in an open and flexible style, knowing that the classroom teacher will be able to make the appropriate connections to student learning styles, subject areas and assessment tools.

HOW TO USE THIS GUIDE

This guide is designed to draw upon the expertise and creativity of the teacher practitioner as well as the student experience. Learning begins in the classroom or in the after-school environment but should spread beyond the building walls to the urban environment itself.

The activities are presented in sections to help students explore water in their own home, neighborhood or community and the city as a whole. Ideally, activities within each section should be done sequentially. Each activity suggests appropriate age-ranges and subject areas. They should take, on average, one or two class periods and can be integrated into what is already being taught in the classroom.

Check out resourcewater.org, our online teacher toolbox of resources for your classroom to complement your lesson plans -- useful videos, books, websites, funding opportunities for projects and more.

Thematic Unit 1: Water in Our World

OBJECTIVES:

First we (you and your students) must develop an understanding of the value of water in our lives and the way the natural water cycle (the hydrologic cycle) functions. It is important to embrace this basic level of appreciation before exploring subsequent thematic units, which address the growth of cities, and how people adapted and innovated to meet the challenge of providing clean water as the population grew.

LESSONS:

1. Water for Life (or My BFF)
2. The Natural Water Cycle
3. Landforms and Watersheds
4. Ecology of Waterways: Diverse and Abundant Communities
5. Plants, Trees and other Buffers
6. Wetlands and Wildlife: Nature's Filters
7. Life Aquatic: The Ecology of Microscopic Organisms and Macro-Invertebrates

Thematic Unit 2: Drinking Water and You

OBJECTIVES:

Students will learn about the **urban water use cycle** and how this is both 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 develop a basic understanding of safe and reliable urban water systems, infrastructure and management of drinking water (supply). Prominent cities like Philadelphia approached access to a clean drinking water supply as a civic responsibility for the public good.

LESSONS:

1. My Daily Water Use Log
2. Water for the Federal City: Civic Responsibility for the Public Good
3. Technology and Innovation: Engineering a Public Water System
4. Clean Water and Public Health: Consider the Source
5. Public Drinking Water Treatment Process Explained
6. Testing the Waters: Making it Safe

Thematic Unit 3: Down the Drain, or Out of Sight, Out of Mind

OBJECTIVES:

Just as cities developed a collective drinking water supply system to ensure the public health of its citizens, they also develop ways to collect and dispose of its waste or "used" water. Students will discover that it was no small task to engineer an effective system of drains and pipes to carry human and industrial waste away from where people lived.

LESSONS:

1. The Growth of the City: Population and Wastewater Systems
2. Industrial Revolution and Environmental Devolution
3. Streams to Sewers: Creating an Underground Infrastructure
4. Sinks, Pipes and Mains: Make the Connection
5. Public Wastewater Treatment Process Explained

Thematic Unit 4: Land and Water: A Delicate Balance (or Can't We All Just Get Along?)

OBJECTIVES:

Homes, markets, factories, parks and roadways – these are many of the ways land has been transformed to create our cities and affect water quality. Students will learn how the relationship of land to water is an ecological balancing act, both for humans and for the natural environment. At many points throughout the last two centuries, the balance has been tipped, equilibrium lost. They will discover not only the consequence of pollution (making people sick), but also how public health safety was restored.

LESSONS:

1. The Rain Drain: Stop Trash in its Tracks
2. What's the Point: Exploring Point Source and Non-point Source Pollution
3. Plants and Pavement: Pervious and Impervious Surfaces
4. What is Combined Sewer Overflow?
5. The Clean Water Act: A Policy Solution

Thematic Unit 5: Green Plan for the Future: Playing a Part

OBJECTIVES:

The greatest threat to our water resources in the 21st century is created by stormwater runoff. As students have learned by now, past solutions and innovations for the collective good have moved the story forward. Next they will explore how individuals and communities can play a key role in shaping the future environmental health and well-being of their city. Words like "sustainability," "greening" and "stewardship" will take on greater meaning – a vocabulary that becomes an integral part of our story.

LESSONS:

1. Green Infrastructure: Following Nature's Lead
2. Calculating Rainwater
3. Restoring Urban Waterways
4. A "Model" Schoolyard

Thematic Unit 6: Environmental Stewardship

PROJECT-BASED APPROACH

Green stormwater infrastructure project development and implementation for school and/or neighborhood community

OBJECTIVES:

It is important to the health of our waterways to implement projects that restore and maintain a natural balance between stormwater runoff and infiltration by capturing on the land the first one inch of rainfall. This will reduce both quantity and quality issues related to pollutants in our streams. The Philadelphia Water Department's "Green City, Clean Waters" program encourages Philadelphians to think about various creative and common sense practices for reducing stormwater runoff. These practices, called Green Stormwater Infrastructure (GSI), range from simple to complex.

Common Core State Standards (CCSS)

Turn to page 62 to see how the Lesson plans align with CCSS for Literacy and Math.

Thematic Unit 1:

Water in Our World

Objectives:

First we (you and your students) must develop an understanding of the value of water in our lives and the way the natural water cycle (the hydrological cycle) functions. It is important to embrace this basic level of appreciation before exploring subsequent thematic units about the growth of cities, and how people adapted and innovated to meet the challenge of providing clean water as the population grew.

What you should know:

We use water all the time in our daily lives. We drink it, clean with it, cook with it, water plants, and even swim in it. The tap water that Philadelphians 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 now polluted 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 all a reason to care about protecting them. It is a public responsibility all around – to supply it, clean it up, and protect it at its source.

Water is essential to life and the freshwater resources on Earth are limited. Only about 3% of the water on Earth is freshwater and about 2/3 of that is frozen into icebergs and much of the remaining 1% of available freshwater is being polluted.

The Earth has a very efficient method of cycling water through the atmosphere and the land. As precipitation falls from the sky, it takes one of many different routes: some infiltrates, replenishing ground water, some is taken up by plants keeping them healthy, and some runs into waterways refreshing surface water. The heat from the sun warms the water in oceans and turns it into a gas, causing it to rise back into the atmosphere, a process called evaporation. Transpiration, or "sweating", releases water from plants as a gas into the atmosphere. These steps make up what we call the **natural water cycle**.

Precisely because of the way the **natural water cycle** functions, there is an inseparable connection between water and the land that surrounds it. All of the land that sheds its water to a particular water body when it rains is called a **watershed**. Unfortunately, if waterways are not cared for and become polluted, the wildlife will suffer also.

There are two main ways that what happens on the land can affect the water it drains into. The first way is caused by the hard surfaces that cover our cities and towns (e.g. roads, sidewalks, parking lots, and buildings). These hard, **impervious surfaces** are unable to absorb water, so rain and melted snow run right off them into storm drains. In Philadelphia, 40% of these drains are connected to **separate sewers** that lead directly to our rivers. The other 60% of storm drains are connected to large **combined sewers** that collect both rainwater and sewage. In a heavy rain event, these pipes may get too full of this rainwater-sanitary waste mixture and need to overflow into the rivers.

The second way water pollution occurs is from different types of pollution that get washed into waterways in a rainstorm. Rainwater rushes over our streets and carries with it the animal waste, litter, fertilizer, and oil that someone has left behind. This combination problem of too much polluted water running off our streets and into storm drains is called **stormwater runoff**.

Looking for ways to change the way water is collected, captured or runs off the land is one of the best ways to mitigate this stormwater runoff pollution problem. By integrating more natural surfaces into the urban landscape (hardscape), more water will be allowed to collect and infiltrate slowly into the ground. Specially engineered projects designed to manage stormwater make up what is called **Green Stormwater Infrastructure**. By planting street trees, installing stormwater planters and green roofs, starting a community garden, or attaching a rain barrel to homes, this water can renew and replenish our waterways and, at the very least, will prevent harmful pollutants from ever getting into them in the first place.

One way to determine the health of our waterways is for scientists to observe nature itself by using **biological indicators**. Biological indicators are plant and animal species that tell us, by their very nature, about the health of an **ecosystem**. In the Schuylkill River, scientists will look at species like the American Shad, a delicate fish species, to infer how healthy or polluted the water is. Other species that can be used as indicators include the Great Blue Heron and macro-invertebrates like the Mayfly.

Another way to help ensure the protection of our waterways is to help citizens understand their connection to the **urban water use cycle**. Like the **natural water cycle**, this cycle relies on a process to enable river water to become the city's tap water, and then, through another process, returns it back to the rivers. The Philadelphia Water Department begins the cycle by pumping water out of the Schuylkill and Delaware Rivers to one of three Drinking Water Treatment Plants where the water is made safe to drink. This water is then distributed to the city where it is used in homes, schools and businesses. As the water is used, it becomes dirty again and must be collected as wastewater by the PWD to be treated once more. Sewage treatment takes place at

three different Water Pollution Control Plants. Once it is cleaned, the effluent (water that is cleaner than the river itself) is sent back to the Delaware River. This cycle allows the PWD to provide Philadelphians with plenty of potable (drinkable) water without compromising the health of our rivers.

It is also important to begin any stewardship effort by nurturing a basic appreciation for our natural resources.

"Because environmental education, like much education, often fails to acknowledge the crucial role of emotions in the learning process, activities that both inform the mind and engage the heart proved to be a powerful and effective combination… Helping children fall in love with earth is what we do. Because people protect what they love, this is a powerful prescription for stewardship and ultimately, we hope kinship."

- *MK Stone and Z Barlow (eds) Ecological Literacy: Educating Our Children for a Sustainable World. San Francisco, CA: Sierra Club Books (2005). P 116.*

Sequence of Lessons

1. Water for Life (or My BFF)
2. The Natural Water Cycle
3. Landforms and Watersheds
4. Ecology of Waterways: Diverse and Abundant Communities
5. Plants, Trees and other Buffers
6. Wetlands and Wildlife: Nature's Filters
7. Life Aquatic: The Ecology of Microscopic Organisms and Macro-Invertebrates

Lesson 1: Water for Life (or My BFF)

All living things need water to live and all living things contain a certain percentage of water. From the President of the United States to the clams at the beach, everything living in this world needs water to survive. Although this is true, there is another part to this story. There are aspects of water that may not seem integral to life itself, but without which our world would be transformed into a dry, thirsty environment around us. Consider living without rivers and lakes or the summer thunderstorms that refresh the air.

VOCABULARY

Water *(noun and verb)*

Collect in a notebook or post in the classroom as many definitions as you can find to describe this word. Write as many sentences as possible using the word. See who can write the most. Research and post the word "water" in many languages.

ACTIVITIES

a. Compare how much water exists in a variety of everyday living things. Have students choose anything from the mundane (something related to what they bring everyday for lunch) to something outside their school that they can see or pass by. (K-5)

b. Write a love letter to water. Illustrate it. (K-5)

c. Write a story using rivers as symbolism. Discuss such terms as flow, rhythm, light, grace, fluidity or even rushing, raging and flooding. Use the landscape as metaphor. (6-8)

d. Survey the landscape paintings of 19th century "plein air" artists. Analyze composition and color before having students copy a master's work or create their own outside. (3-8)

e. Research, collect and compare data related to how much water we use as individuals, in manufacturing and in agriculture by assigning one item to each student (e.g. a shower, a hamburger, growing soybeans on a family farm) also called your "Water Footprint." Chart and graph. (6-8)

CONSIDER AND DISCUSS

- What is a water footprint?
- Where there is water there are life forms:

  When we explore other planets, water is the first indication that there is life. Find articles that describe the most recent space expeditions.

- Water in rituals/Rivers as sacred:

  We have rituals that include water to connect us with the spiritual world. Have your student's name at least two faith-based rituals. Find images or written descriptions. Find examples of secular rites of passage that use water. For younger students, talk about their own personal rituals around water, usually related to bath or shower time.

SUGGESTED READINGS

Kephart, Beth. Flow: The Life and Times of Philadelphia's Schuylkill River (Philadelphia: Temple U Press, 2007)

Rodriguez, Susan. Travels with Monet (Glenview, IL: Crystal Productions, 2010).

ASK THE QUESTION

How do we know the worth of water?

Lesson 2: The Natural Water Cycle

Technically called the "hydrologic" cycle, the natural water cycle is the ultimate sustainable process. As human beings we absolutely depend on getting and using clean, safe fresh water to sustain us. We can't make new water on the planet, so the water we do depend on exists in a closed system, an endless loop from land to sky and back again. Getting students to understand this fundamental concept will serve as the foundation for any study of the topic of water and will help them explore and understand the value of water in their world.

VOCABULARY

Hydrology *(noun, from Latin hydrologia)*
A science dealing with the properties, distribution, and circulation of water on and below the earth's surface and in the atmosphere.

ACTIVITIES

a. Create simple icons on cards depicting each stage and place in the proper order on a pre-drawn circle. With younger students, write a script and perform a play demonstrating the natural water cycle (consider calling it "Birth of Small Cloud"). (K-2)
b. Seek out the root of the word "evaporation" to discuss vapor and states of matter. (3-5)
c. Read *Water Dance* by Thomas Locker aloud to students and discuss the images and first-person style of narration (e.g. "I am rain"). Have students write additional lines of poetry elaborating on the statements (e.g. "I am rain, and I give life." or "I am rain, I fall from the sky and make rivers."). (2-5)
d. Memorize/review the different stages of the hydrological cycle by creating a song, a poster, or a computer graphic. (4-8)

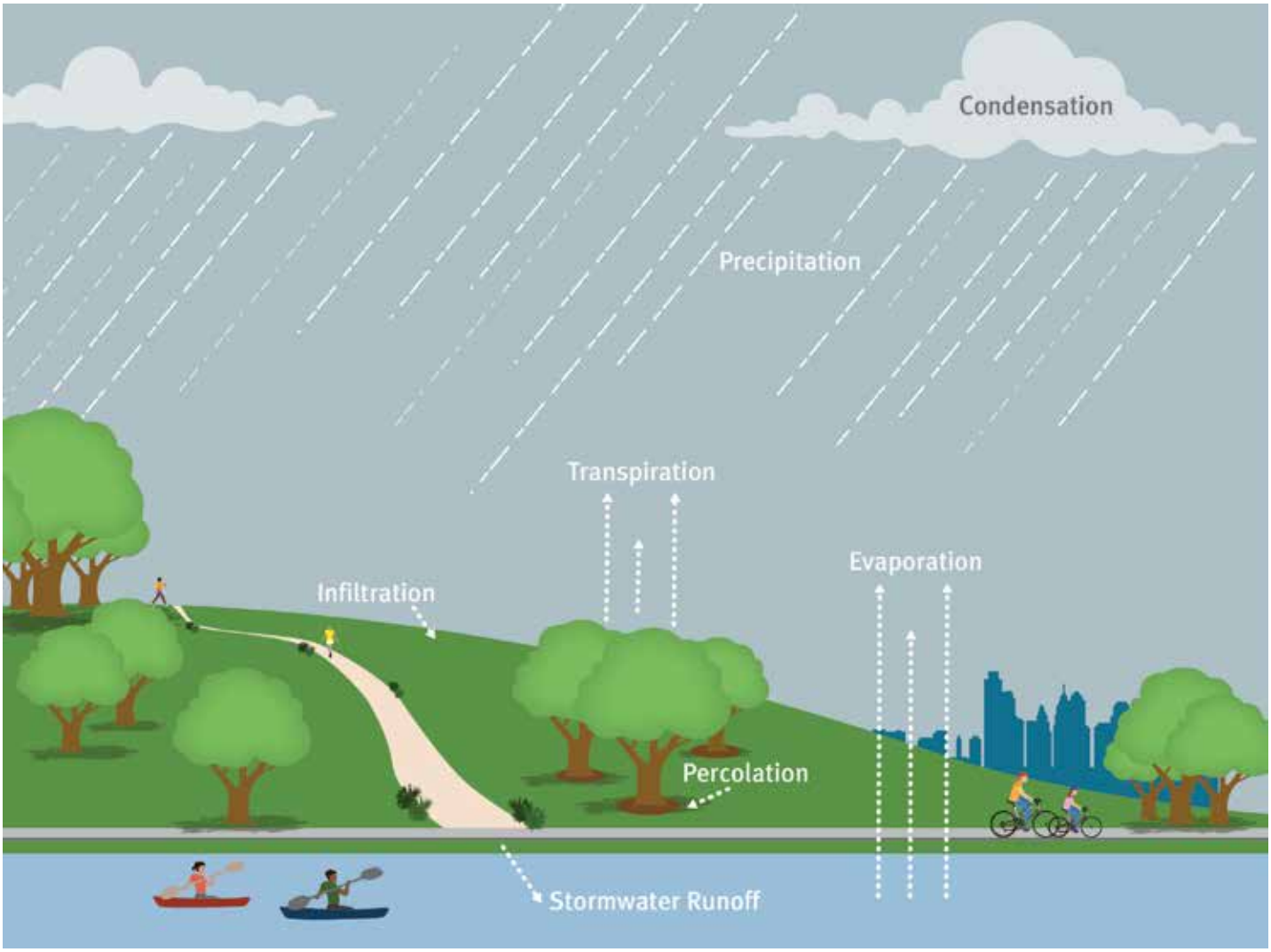
CONSIDER AND DISCUSS

- Water as a finite resource

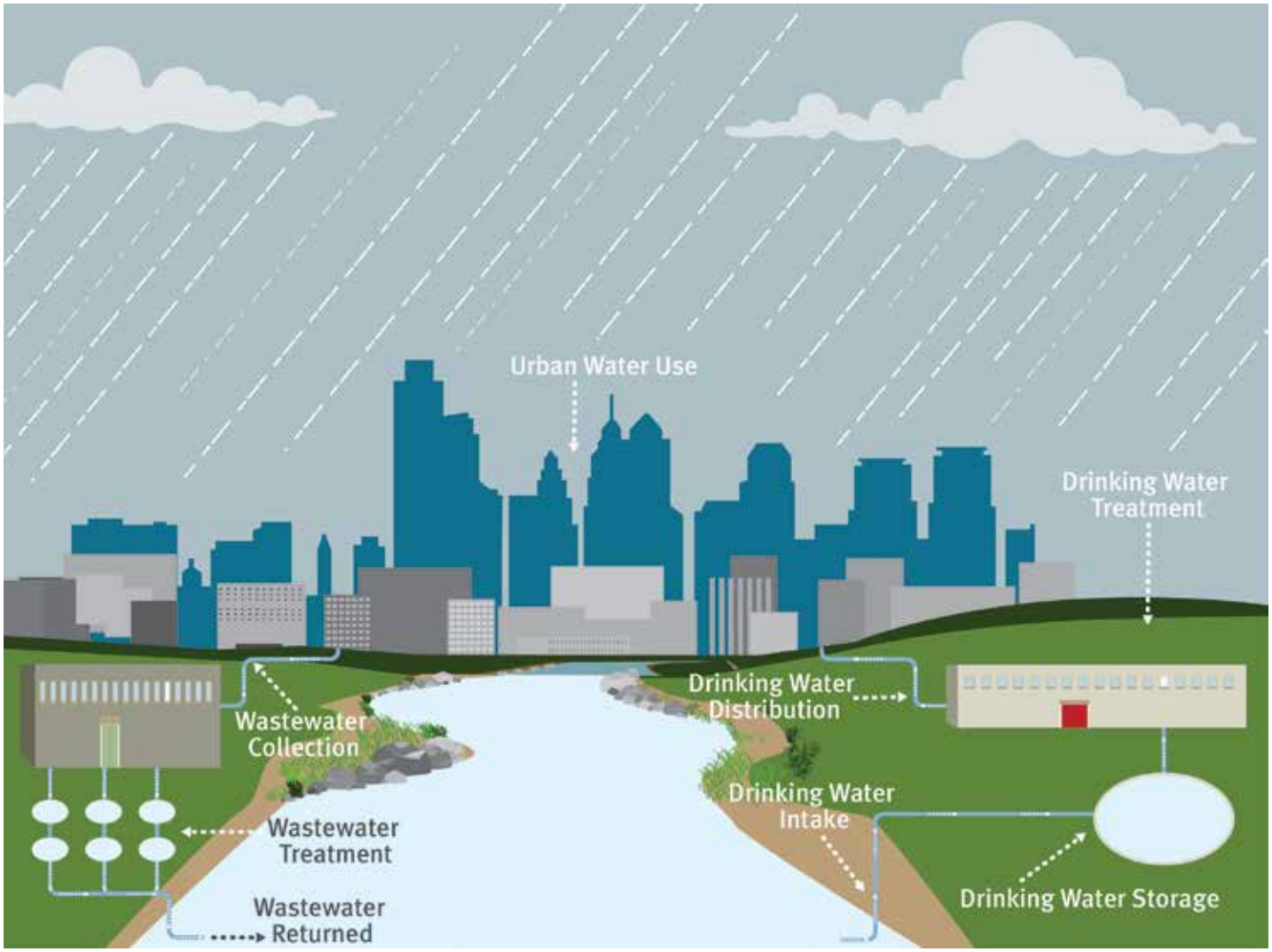
  Fresh water exists in a limited quantity. Approximately 3% of the planet's water is fresh and only 1% of that fresh water supply is accessible—the remaining 2% is trapped in glaciers or rocks underground. We can't make new water!

ASK THE QUESTION

Have you "seen" the water cycle at work?



NATURAL WATER CYCLE



URBAN WATER CYCLE

Lesson 3: Landforms and Watersheds

All of the land that sheds its water to a particular body of water when it rains is called a watershed. We can think of watersheds as big sinks – because of their slope, the water flows down its sides to the drain. Before we can discuss the urban watershed with students, help them understand this fundamental relationship amongst water, land, and drainage. Scale it up, or scale it down, it is all the same.

VOCABULARY

Topography *(noun, from Greek topographein -- to describe a place; topos, place and graphein, write)*
The art or practice of graphic delineation in detail usually on maps and charts of natural and man-made features of a place or region especially in a way to show their relative positions and elevations

ACTIVITIES

a. Using clay, have students create mountains and a river (hint: create enough slope in both the land and water to allow for "runoff"). Use water or beads dropped as rain on the mountaintop. (K-2)
b. Make a working watershed model, in a carton or plastic bin, of land and water to demonstrate the concept from crumpled paper, foil, paper mache or insulation foam. (3-5)
c. Locate and share varying scales of topographical maps of Pennsylvania, showing the abundance of rivers. Trace the rivers. Compare to a topographic map of the United States. Overlay a watershed map to illustrate the defining nature of a watershed. (6-8)

CONSIDER AND DISCUSS

- The relationship of geography, geology and landforms:

  Name various local and regional natural geological landmarks. Discuss the geological formation of rivers.

ASK THE QUESTION

How do you know you live in a watershed?

Lesson 4: Ecology of Waterways: Diverse and Abundant Communities

There is an integral connection between the health of the river and the diversity of living things in it. Diversity and abundance are the "watchwords" of our scientists who test and monitor fish and wildlife to measure the health of our waterways. A simple walk along the river can give us an idea of how we're doing. How many birds do you see? Can you see turtles of all sizes? Wait for that surprise splash on the surface that tells us—there are fish in there!

VOCABULARY

Ecology *(noun, from Latin hydrologia)*
A branch of science concerned with the interrelationship of organisms and their environments.

ACTIVITIES

a. Choose an activity such as cleaning up the classroom in which every student's participation is essential in meeting the goal: a clean classroom. Give each student a job to do (if one student seems to "take over" talk about invasive species here) to demonstrate interdependence within a community as it relates to the goal. You can even name the students different species and have the classroom become a river. (K-2)
b. Assign a journaling activity for your students during a visit to the nearest waterway. Consider having them document what they observe in 5, 10, and 20-minute intervals. (6-8)
c. Characterize the diversity and abundance of fish species in the river using real data to help students understand the work of aquatic biologists. Set up a simulation of the fish census, characterizing the species into pollution tolerant, moderately tolerant and intolerant. Make simple graphs of the data. (K-8)

CONSIDER AND DISCUSS:

- What is a biological or wildlife indicator? Why do we use wildlife to measure ecological health? Fish, migratory birds, reptiles and amphibians are all visual indicators of the health of our waterways.

ASK THE QUESTION

Why is diversity a positive ecological indicator?

Lesson 5: Plants, Trees and other Buffers

Nature had its own method for filtering pollutants from water long before people began building infrastructure. Plants and trees have a sophisticated and vital role to play in the water cycle related to infiltration and transpiration. Along the banks of our waterways, plants act as buffers by catching sediment, keeping things in place or preventing erosion and by using up nitrogen and phosphorous before they reach our waterways.

VOCABULARY

Riparian *(adjective, Latin, riparius first known use c.1841)* Relating to or living or located on the bank of a natural watercourse (as a river) or sometimes of a lake or a tidewater.

Buffer *(noun)* Something that serves as a protective barrier.

ACTIVITIES

a. Create your own riparian buffer (birds-eye view line drawing of stream bank and river mural). Ask students to imagine their own natural world by populating the stream bank with their own plants and animals. Create pre-cut pieces (bugs, flowers, mammals, trees, etc.) and glue them to the sheet of paper. Use cut flowers and food coloring to demonstrate capillary action. (K-2)

b. Make a model depicting three different kinds of surfaces on a slope with a catch-basin – a planted area, a grassy area (low lawn-type setting) and a paved surface. Use something to represent water such as beads, beans or rice. Predict and compare the runoff of each of the surfaces. (3-5)

c. Research native species and their properties. Create a how-to booklet to accompany a walk in the park for identifying natives/invasives. Make leaf rubbings in the field and display/chart in the classroom. (6-8)

CONSIDER AND DISCUSS

- What other benefits are there to creating and maintaining riparian buffers along our waterways?

ASK THE QUESTION

What happens in a heavy rainstorm if a stream does not have any 'buffer'?

Lesson 6: Wetlands and Wildlife: Nature's Filters

Wetlands can clean stormwater runoff, replenish ground water, reduce flooding risks and provide a home for wildlife. They act like sponges by capturing, storing and releasing water. Much of our natural wetlands have been lost due to urban land development; however, they are one of those tools in the green infrastructure toolbox being used to manage pollution from runoff—both in quantity and quality.

VOCABULARY

Permeable *(adjective)*
Capable of being permeated especially having pores or openings that permit liquids or gases to pass. (opposite: impermeable)

ACTIVITIES

a. Pour a measured quantity of water into sloped foil pans filled with a sponge (wetland), a reusable dishcloth (lawn) and nothing (paved surface), respectively to demonstrate the different properties of land use and wetlands. (K-2)
b. Read aloud Meadowlands: *A Wetlands Survival Story* by Thomas Yezerski. Have students discuss the images, ideas, and narrative of the book. (K-3)
c. Collect images of wetlands throughout the United States and make a photo magazine with captions. (K-5)
d. Research the different kinds of wetlands in the Philadelphia area and the communities they serve. Broaden the scope of research to include other regions and scales of wetlands.. (e.g. New Orleans, Everglades). Turn student research into a newsmagazine and call it something clever and alliterate like "Wetlands World" or write a newspaper article or editorials. (6-8)
e. Research various wetland restoration projects, including their plant species and habitat. Learn what metrics are being used to evaluate the benefits. (6-8)

CONSIDER AND DISCUSS

- Discuss environmental policy and wetlands in current events.
- Plan a field trip – engage an expert to give a tour (preferably during or just after a rainstorm).

ASK THE QUESTION

Do wetlands benefit the urban environment in other ways besides managing stormwater runoff?

Lesson 7: Life Aquatic: The Ecology of Microscopic Organisms and Macroscopic Invertebrates

Fish, migratory birds, reptiles and amphibians, riparian and aquatic plants are important indicators of the health of our waterways. In addition, with the benefits of a microscope, we can examine the diverse world of living things through a new lens. Even the smallest drop of water has a story to tell.

VOCABULARY

Plankton *(noun, From Greek, neuter of planktos drifting, from plazesthai to wander, drift, middle voice of plazein to drive astray; akin to Latin plangere to strike. First known use: 1891)*

The small and microscopic plant and animal organisms that float or drift in sea or freshwater.

ACTIVITIES

a. Create an exhibit of images showing the variety of shapes and sizes of this world of macros and micros. Make an exhibit label that describes the relationship of the organism or plant to water quality. Use pencil, pen and ink and/or watercolors or crayons to create a gallery in your classroom. Scale this activity up or down depending on the age of your students. (K-8)

b. Write a research paper on environmentalists like Dr. Ruth Patrick and Rachel Carson. (6-8)

CONSIDER AND DISCUSS

- Which microorganisms are indicators of the health of a stream?
- How do we use macro-invertebrates as water quality indicators?
- What is a diatom and why do environmentalists care about them?

ASK THE QUESTION

What kind of scientist researches and studies water quality issues?