

Wonderful Watersheds

*A river or lake is not isolated. The entire valley is reflected in its waters.
It's part of a system: the watershed.*

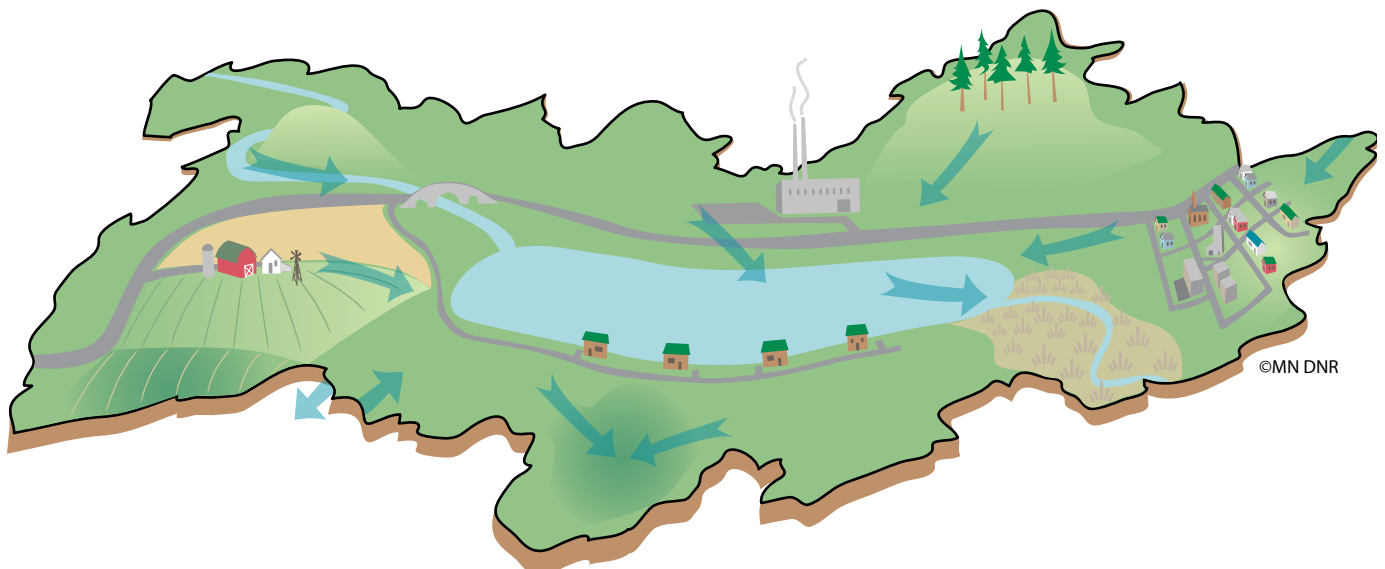


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Chapter 3 • Lesson 3

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Wonderful Watersheds

Minnesota Academic Standards

- ☉ Lesson *introduces* this Benchmark.
- ☐ Lesson *partially* addresses this Benchmark.
- Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, 5

I. Reading and Literature

B. Vocabulary Expansion:

Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading. ☐

III. Speaking, Listening, and Viewing

A. Speaking and Listening

Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussion in large and small groups. ●

Math

Alignment to the 2007 Minnesota Academic Math Standards coming soon.

Grade 3

V. Spatial Sense, Geometry, and Measurement

C. Measurement:

Benchmark 1—The student will identify lines of symmetry in geometric shapes. ☐ (Identify direction water will flow in a watershed).

History and Social Studies

Grades K – 3

V. Geography

A. Concept of Location:

Benchmark 2—Students will use maps and globes to locate places referenced in stories and real life situations. ☐

Benchmark 4—Students will name and use directional words to describe locations of places in the school and community. Students will locate places by using simple maps, and understand that maps are drawings of locations and places as viewed from above. ☐

B. Maps and Globes:

Benchmark 1—Students will locate places by using simple maps and understand that maps are drawings of places as viewed from above. ☐

C. Physical Features and Processes:

Benchmark 2—Students will explain and use introductory geographical terms. ☐

Grades 4 – 8

II. Minnesota History

G. Post-World War II to the Present:

Benchmark 4—Students will identify and describe significant land use changes in Minnesota, issues related to land use, and analyze the impact of those changes and issues. ☐

V. Geography

C. Physical Features and Processes:

Benchmark 2—Students will describe and locate major physical features in their local community and analyze their impact on the community. ☐

D. Interconnections:

Benchmark 2—Students will analyze how the physical environment influences human activities. ☐

D. Interconnections:

Benchmark 1—Students will recognize changes over time in nearby landscapes, resulting from human occupation. ●

Science

Grade 3

I. History and Nature of Science

A. Scientific World View

Benchmark 1—The student will explore the use of science as a tool that can help investigate and answer questions about the environment. 🗎

B. Scientific Inquiry

Benchmark 2—The student will participate in a scientific investigation using appropriate tools. 🗎

IV. Life Science

C. Interdependence of Life

Benchmark 2—The student will know that changes in a habitat can be beneficial or harmful to an organism. 🗎

Grade 4

I. History and Nature of Science

A. Scientific World View:

Benchmark 1—The student will explore the uses and effects of science in our interaction with the natural world. 🗎

Benchmark 2—The student will discuss the responsible use of science. 🗎

Benchmark 3—The student will recognize that evidence and logic are necessary to support scientific understandings. 🗎

III. Earth and Space Science

A. Earth Structure and Processes:

Benchmark 1—The student will identify and investigate environmental issues and potential solutions. 🗎

B. The Water Cycle, Weather and Climate:

Benchmark 1—The student will describe the water cycle involving the processes of evaporation, condensation, precipitation and collection. 🗎

Benchmark 2—The student will identify where water exists on earth. 🗎

Grade 5

III. Earth and Space Science

A. Earth Structure and Processes:

Benchmark 3—The student will describe how waves, wind, water and ice shape and reshape the Earth's surface. 🗎

Benchmark 5—The student will explore the interaction of the lithosphere, atmosphere, biosphere, hydrosphere and space. 🗎

Environmental Literacy Scope and Sequence

Benchmarks

- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:

www.seek.state.mn.us/eemn_c.cfm

Chapter 3 • Lesson 3

Wonderful Watersheds

Grade Level: 3-5

Activity Duration: one or two class periods

Group Size: any

Subject Areas: Language Arts, Science, Social Studies, Expressive Arts

Academic Skills: comparison, experimentation, modeling, observation, recording data

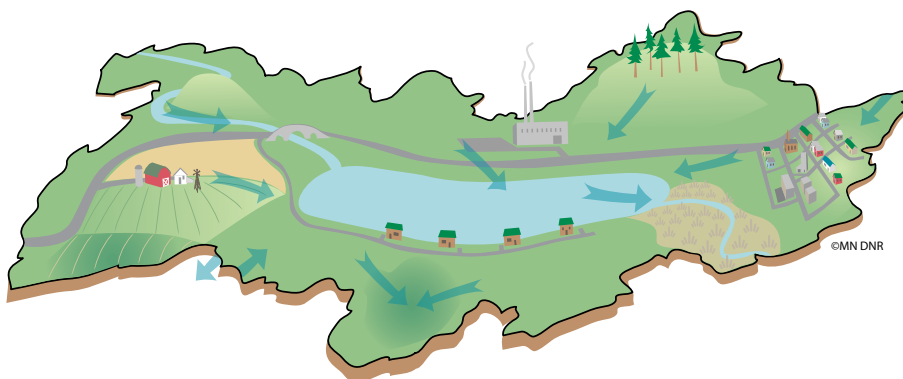
Setting: indoor or outdoor gathering area with tables

Vocabulary: best management practices, erosion, groundwater, nonpoint source pollution, percolation, point source pollution, ridgelines, riparian habitat, surface runoff, water pollution, watershed

Internet Search Words: land use practices, nonpoint source pollution, point source pollution, riparian zone, watershed, watershed education, watershed outreach

Instructor's Background Information

What is a watershed? When you think of something that sheds water, you usually think of a raincoat or an umbrella. But a watershed also catches water. Turn an opened umbrella upside-down and you'll form a clearer picture of how a watershed works. A **watershed** is an area of land that catches precipitation (rain, sleet, and snow) that flows and drains into a body of water such as a wetland, stream, river, lake, or groundwater. A watershed can also be compared to a bowl, a dishpan, or a tub. A watershed is a well-defined area that drains into a water body—and the water can collect below the ground or on the surface.



A watershed is an area of land that drains into a body of water. Every place on earth has its watershed, and we all live within a watershed.

Summary

Students investigate watersheds in three dimensions. They'll make a watershed model, "rain" on their models using a spray bottle, observe where the surface water travels, and determine how the water cycle is related to a watershed. Simulating various land use practices and adding "pollutants" to the models will demonstrate how activities on land can impact water quality in lakes and rivers. Students will then test the effectiveness of various strategies for Best Management Practices (BMPs) to prevent or reduce the effects of nonpoint source pollution on water quality in their watershed models. Learning how a watershed works helps students see how their actions can impact water quality in local lakes and streams as well as in waters many miles away, and can help them identify how human activity on land can impact water quality over time.

Student Objectives

The students will:

- 1 Describe how water moves through a watershed by referring to the water cycle.
- 2 Describe how pollution moves through a watershed.
- 3 Demonstrate how water pollution is related to land use practices.
- 4 List at least four Best Management Practices for land use that can improve water quality.
- 5 List at least two ways their own daily actions impact fish habitat.



There are a variety of effective substitutes for these items. Ask parents or volunteers to provide some of the everyday items.

Take students outside to collect leaves, small rocks, grass clippings, litter, soil, small twigs, and other materials for their watershed models.

If each student will be making their own model, provide materials for each student. As an alternative, you can have three or four students work as a group—they can then share the materials. Ask the students to measure and use the necessary materials.

As an alternative to using aluminum foil and the underlying materials, you can use a mixture of plaster, sand, and rocks to mould the watershed topography in the bottoms of the boxes or roasting pans.

Materials

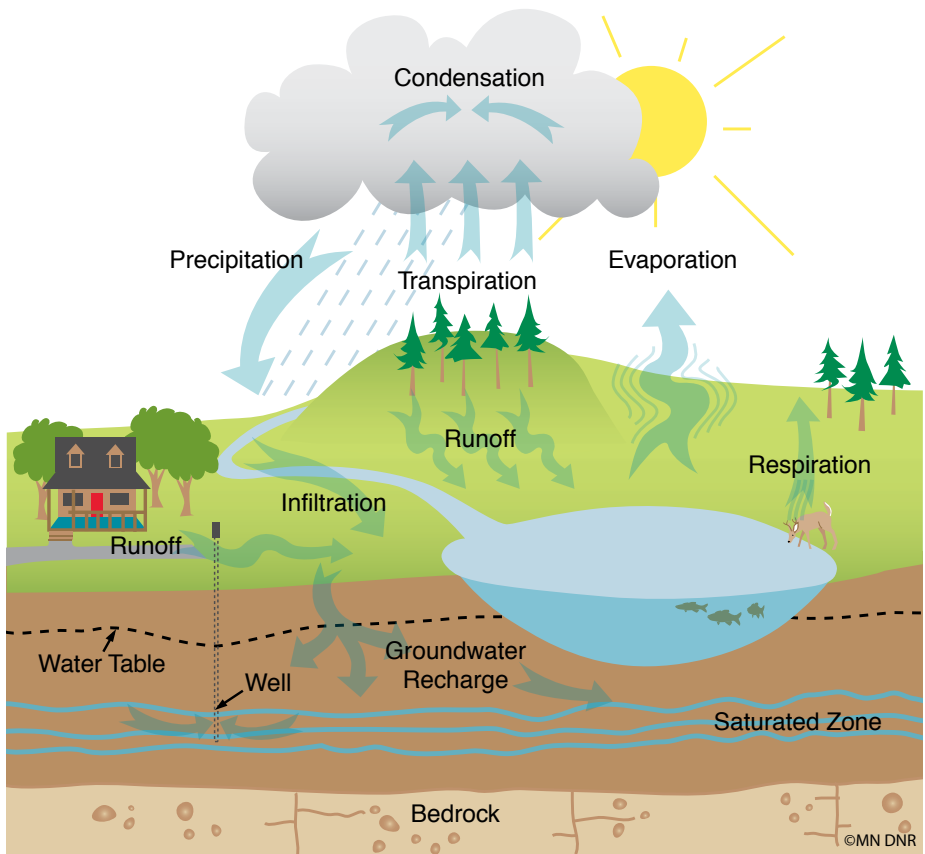
- **Watershed Model Sheet** to project on a screen or interactive whiteboard or distribute
- Scissors
- Plastic storage boxes, foil roasting pans, or cardboard boxes (lined with plastic); students may bring these from home
- *Heavy* aluminum foil, three-foot-long sheets
- Rocks (various sizes), crumpled paper balls, small boxes or containers, or dense clay soil—place in bottom of the boxes or pans (under the foil) to form hills and valleys (watershed topography)
- Small toy buildings, vehicles, building blocks, farm animals, model trees, or other items—use these to build model communities
- Light-colored cellulose sponges cut into half-inch-thick strips, enough for several strips for each student or group
- Light-colored felt approximately six inches square, one per student or group
- Scissors, one per student or group
- Brightly-colored unsweetened powdered drink mix, three different colors, one teaspoon per color
- Watercolor paint set and brush
- Food coloring, several drops
- Sand or sediment, dirt, or dried coffee grounds, one tablespoon
- Cocoa powder or powdered ice tea, one tablespoon
- Colored sugar, one tablespoon
- Vegetable oil, one teaspoon
- Leaves, grass clippings (short lengths), chocolate sprinkles, parsley flakes, dried basil flakes, or small paper scraps, two tablespoons of each
- Small plastic bags to hold each dry “pollutant”
- Spray bottle filled with water
- Newspapers for covering work areas
- Paper towels
- Bucket of water or access to sink
- Science notebook
- Pencils or pens

Everyone lives within a watershed. Schoolyards, backyards, farmyards, parking lots, homes, neighborhoods, towns, and cities are part of a watershed. If you travel anywhere, you're in a watershed. Most of us drink water that comes from somewhere within a local watershed, and we all depend on the quality of our local water. Although people in rural areas often draw their water supply from local wells (groundwater), public water supply systems (drawn from surface water or groundwater) are more prevalent in urban towns and cities. In the United States, most people receive drinking water from groundwater sources. And wildlife, especially fish, depends on the quality of our lakes, rivers, and streams, too!

Water Cycle and the Watershed

Water is continuously in motion in every watershed. The sun warms water on the earth in oceans, lakes, streams, and rivers. The warming causes water to evaporate and rise into the air, where it condenses to form clouds. Precipitation falls back to earth from clouds in the form of rain, sleet, or snow. Gravity causes water to run downhill from high ground to low ground, into hills and valleys, or to seep into the ground. This water cycle repeats continuously.

The water that flows directly over the surface of the land into a lake, stream, or river is called surface runoff, and it carries sand and sediment as it flows. Runoff can cause erosion, the gradual wearing away of soil and rock surfaces by natural forces such as flowing water, wind, and ice. Erosion also occurs when human and animal activities disturb the soil and the vegetation that holds soil in place. Impermeable surfaces, such as pavement, roofs, and patios deepen the effects of erosion because they prevent water from soaking into the ground—normally, soil and vegetation slow the rate of flow and allow filtration of sediments. When runoff flows rapidly over the hard surfaces, sediment runs quickly into wetlands, ponds, streams, lakes, and rivers. Eventually the water flows into oceans, seeps into the ground, or evaporates.



The water cycle connects clouds, lakes, rivers, groundwater, soil, plants, and animals—including fish and people.

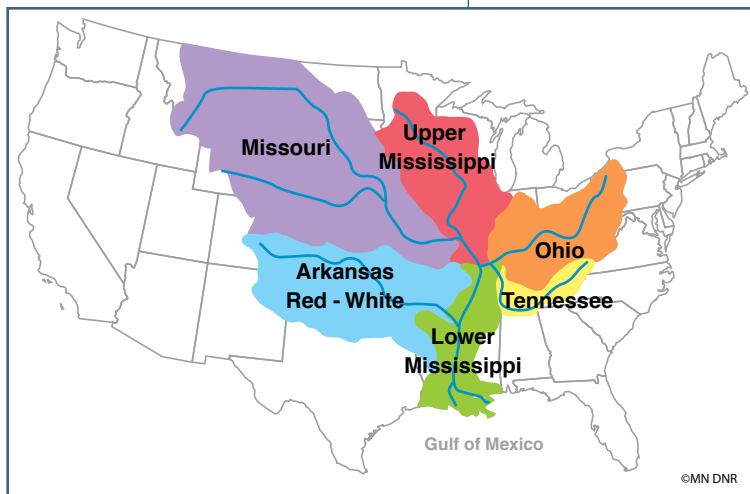


The removal of vegetation exposes underlying soil and rock to the elements. This accelerates erosion. Pavement and other non-porous materials also hasten erosion.

Some of the precipitation that falls to earth seeps directly into the soil. This process is known as **percolation** or **infiltration**. Water seeps down through the soil and into groundwater aquifers. Aquifers are sand, gravel, or rock formations below the earth's surface—they're porous and saturated with water. The water within an aquifer's cracks and porous materials is known as **groundwater**. The water obtained from many wells is groundwater from an aquifer. Groundwater may eventually resurface in a spring, and flow into a nearby water body. Water is always moving—this means that water bodies aren't isolated. They're part of a larger system: a watershed. The water cycle, in turn, connects all the elements and water bodies of a watershed, including groundwater, tiny streams, and large rivers.

How Large Is a Watershed?

Scope and size are integral to the understanding of how watersheds work. Watersheds exist in all shapes and sizes. Some are very large, such as the Mississippi River Basin, the largest watershed in the United States. Others are as small as a single acre draining into a schoolyard pond.



Where Does Minnesota's Water Flow?

Apart from the Red River (which flows into western Minnesota from North Dakota and proceeds northward into Manitoba, Canada), no major water bodies flow into Minnesota. Minnesota is situated upstream from almost everywhere else. All of Minnesota's waters flow out of the state, too. Minnesota watersheds drain water into rivers and streams that flow northward to Hudson Bay, eastward to the Atlantic Ocean, or southward to the Gulf of Mexico.

The Mississippi River watershed basin.

Where does the Mississippi River begin? The commonly accepted source of the Mississippi River is northern Minnesota's Lake Itasca. The length of the Mississippi River has been disputed, but it flows (according to staff at Lake Itasca State Park) approximately 2,552 miles from Lake Itasca to the Gulf of Mexico. It's the fourth longest river in the world. The Ojibwe called it *Messipi* or "Big River." It was also known as the *Mee-zee-see-bee* or the "Father of Waters."

Mexico. Approximately 34 percent of Minnesota's area drains to Hudson Bay. Nine percent flows through the Laurentian watershed basin and into Lake Superior. Approximately 57 percent of the land drains to the Mississippi River. The people of Minnesota have a responsibility to use water resources wisely and protect water quality for everyone who lives downstream.

It's said that a raindrop that falls into Lake Itasca will arrive at the Gulf of Mexico in approximately 90 days. But the Mississippi is more than a river flowing between banks. All of the land draining into the river is part of the Mississippi River watershed basin. This watershed drains 41 percent of the continental United States. The watershed includes 31 states and two Canadian provinces, draining a total area of between 1,200,000 and 1,800,000 square miles. Early Europeans who mapped the backwaters and tributaries of the main river referred to the Mississippi as "a gathering of waters," and in reality, any raindrop that falls within this watershed is a source of the Mississippi River.

Watershed Boundaries

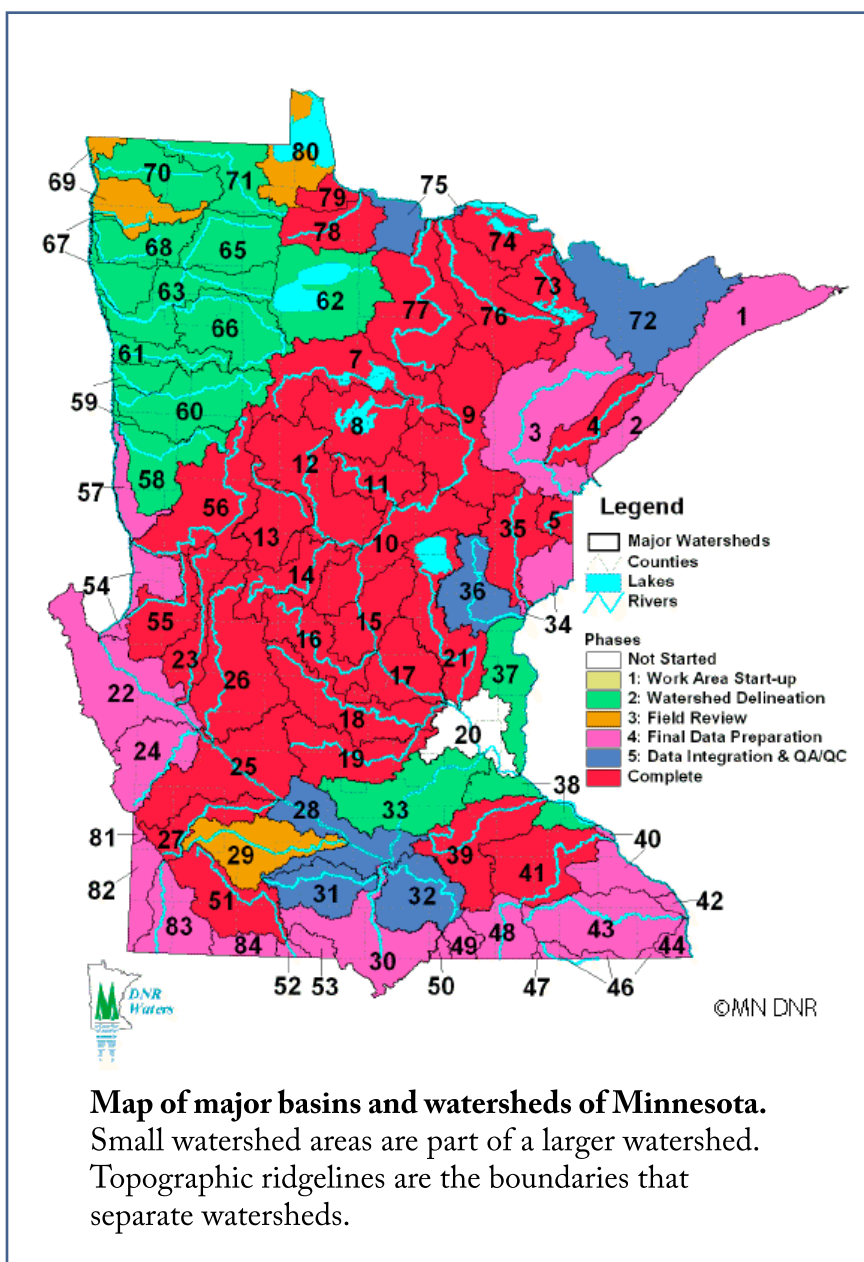
Political boundaries don't define watersheds. Watershed boundaries transcend city, county, state, and international borders. **Ridgelines**, an area's highest elevations, separate one watershed from another.

Many small watersheds can be part of a larger watershed. For example, a small watershed may include a tiny stream that flows into a larger river such as the Mississippi River. All of the land around the tributaries that drain into the Mississippi make up the Mississippi River watershed, but each of those smaller tributaries drain a smaller watershed area within the larger watershed.

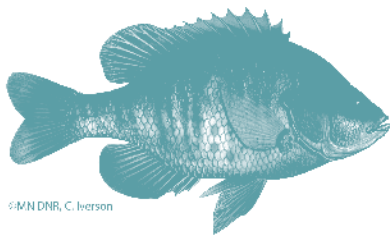
Have you ever watched rain falling on the schoolyard and wondered where it goes? A watershed can be as small as the area that drains into a puddle in a parking lot, or as large as the Mississippi River watershed that drains 41 percent of the continental United States.

Pollution

Water quality is a major concern in any watershed. **Water pollution** is contamination that makes water aesthetically unpleasant, less useful, or harmful to plants, people, fish, and other animals. Water pollution is classified into two categories: **point source pollution** and **nonpoint source pollution**. Both types can travel many miles before turning up in a stream, pond, or lake far from their original sources. Pollution that enters the waterway directly from a specifically identifiable location, such as a drainpipe from a factory or a wastewater treatment plant, is called point source pollution. Pathways that carry contaminants throughout a watershed aren't always obvious. Drain tiles, ditches, storm sewers, paved roads, and shallow groundwater can carry pollutants from residential, industrial, and agricultural areas into lakes, rivers, or wetlands. When we consider pollution, many types of point source pollution usually come to mind. But point source pollution is much less of a problem today, due to regulation, identification, reduction, and clean-up efforts.



Have students locate their local watershed and its boundaries using the Map of Major Basins and Watersheds of Minnesota on the MN DNR website at: www.mndnr.gov/watersheds/map.html. You may wish to have your students use the **Major/Minor Watershed Search area** of the United States Geological Survey (USGS) website, too.



Nonpoint source pollution comes from sources whose locations aren't easily pinpointed. Nonpoint source pollution occurs due to water's continuous motion. As rainfall and snowmelt move over and through the ground, the runoff picks up and carries natural and human-made pollutants. Nonpoint source pollution can also travel long distances in the air and fall to earth in precipitation, such as in the case of acid rain. Nonpoint source pollution is difficult to measure and challenging to regulate and control. This form of pollution is widespread. It results from a variety of human activities on land.

Sources of nonpoint source pollution include the following:

- pesticides, herbicides, and nutrients, such as phosphorous and nitrogen, from fertilizers applied to agricultural lands and commercial and residential areas
- detergents (many dishwashing detergents contain phosphorous)
- grass clippings and leaves
- chemicals resulting from energy production
- engine drippings, such as oil, gas, grease; heavy metals from vehicle tire and brake pad wear
- salt, from irrigation practices and winter road salt
- silt and sediment from disturbed ground at construction sites, agricultural fields, forested lands, culverts, and eroding stream banks
- nutrients and bacteria, such as fecal coliform, from pet and livestock wastes and faulty septic systems
- airborne pollution, including acid rain and dust particles

People's activities definitely have repercussions that affect water, plants, people, fish, and other animals. The effects often occur far beyond the locales where these activities take place.

Land Use Practices

Every activity in the watershed affects water quality. As the population in a watershed increases, human impact increases. Over time, this can affect water quality, in both negative and positive ways.

People often harm water quality by applying excessive amounts of fertilizers to lawns (or apply them just before it rains) or apply fertilizers near wetlands and storm sewers. Fertilizers travel in surface runoff, flowing through storm sewers and into nearby wetlands, lakes, or rivers. The nutrients in the fertilizer (such as phosphorus) spark the growth of algae. These large amounts of algae eventually die and, as bacterial decomposers go to work, they consume the dissolved oxygen that fish and other aquatic organisms need to survive.

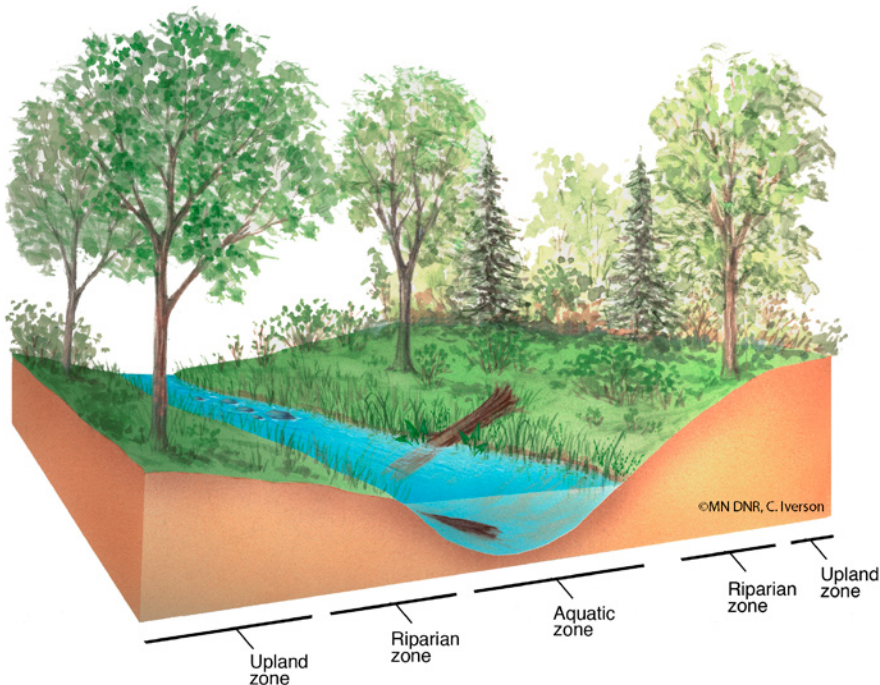
Other examples of harmful land use practices include:

- incorrectly installed or maintained silt fences at construction sites result in excessive erosion or runoff
- altering a watershed's natural water flow
- improper disposal of toxic materials such as paint, batteries, and

household chemicals

- dumping used oil, leaves and grass clippings, and car washing detergents into storm sewers
- failing to pick up and properly discard pet wastes
- improper use and excessive application of fertilizers, herbicides, and pesticides
- inadequate detention or containment of runoff from impervious surfaces, such as pavement and rooftops

Water quality also suffers with the removal of **riparian habitat**, the green corridor of native trees, shrubs, and grasses growing along lakes, rivers, ponds, or streams. Riparian areas are important in controlling nonpoint source pollution. Plants in a riparian zone work like a filter strip to prevent contaminants from reaching the water. The vegetation aids in removing excess nutrients and sediment from surface runoff and shallow groundwater before the sediment reaches the water body. The roots of shoreline plants, especially trees, also work to hold soil in place, reducing erosion and stabilizing stream banks. Riparian vegetation also slows the flow of floodwaters, reducing downstream flood peaks or high water levels that floods might otherwise reach. Shoreline vegetation also provides shade for water bodies, optimizing light and temperature conditions for aquatic plants and animals.



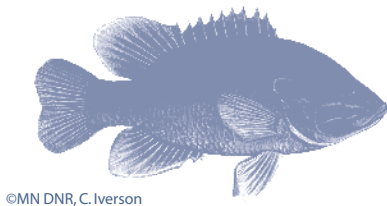
The riparian zones of lakes and riverfronts include plants on the land along the shore as well as in the water along the shore.

Some land use practices that cause riparian habitat loss include poor forestry practices, construction and development, and overgrazing. When riparian plants are removed, water moving through the disturbed habitat erodes away shoreline sediments. The effects of this erosion include: siltation and sedimentation of the lake or river bottom (which changes the substrate or bottom of the water body and covers plants), increased turbidity (decreased clarity of the water), fluctuating water levels, water temperature changes, and the loss of invertebrates and insect, frog, and fish eggs.

Shoreland Habitat Restoration

Positive actions on land, such as preservation or restoration of native vegetation on shorelines and throughout the watershed, ensure a diverse plant community with healthy aquatic and upland habitats. Shoreline degradation, erosion, and increasing development pressures have prompted Minnesotans to take action. We now recognize how our activities can affect the health of the shoreland:

- replacing native vegetation with lawns that extend to the water's edge destroys habitat for native animals
- removing native vegetation—from upland trees to underwater plants—destroys natural cover and water quality protection
- chronic overuse of fertilizers, herbicides, and pesticides contaminates water and disrupts natural processes



©MN DNR, C. Iverson



Shorelines that lack native vegetation—like this one—are susceptible to erosion and other types of pollution. Riparian plants' root systems stabilize the soil and filter nutrients and some pollutants from the water. Plants also prevent the erosion of sediments that reduce water clarity and degrade the quality of the lakeshore habitat.

Fortunately, people have an opportunity to affect positive change. The *Restore Your Shore* PowerPoint presentation on CD, available through the Minnesota DNR Resources, guides property owners through the process of protecting a natural shoreline or restoring a degraded one with a natural buffer zone. The popular book, *Lakescaping for Wildlife and Water Quality*, by Carol Henderson (Minnesota DNR nongame wildlife specialist), Carolyn Dindorf (award-winning soil and water conservationist), and Fred Rozumalski (highly acclaimed landscape ecologist), provided a catalyst to the Minnesota DNR's lakescaping initiatives.

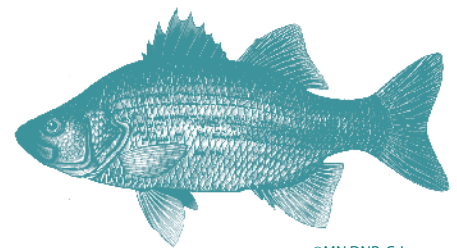


Replanting native plants along disturbed shorelines and in the water reduces erosion and improves water clarity and quality. Riparian plants also restore the quality of lakeshore habitat for aquatic organisms, including fish.

Best Management Practices (BMPs)

Some land use practices improve the health of our aquatic resources. Best management practices are those conservation practices that prevent or reduce nonpoint source pollution and protect water quality. To make good decisions about land use, people must understand how watersheds work, as well as understand natural resources. Some examples of BMPs that protect or restore water quality include:

- restoring shoreline vegetation buffers
- placing farm areas vulnerable to erosion in conservation reserve programs (CRPs) rather than continuing to farm them
- replanting cleared forests
- halting erosion processes with soil conservation practices
- pursuing construction and development projects that preserve shoreline
- constructing settling ponds in areas vulnerable to erosion



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- fencing livestock to prevent access to streams and lakes, where they trample riparian vegetation and increase erosion
- implementing regular septic tank maintenance
- keeping waste, such as used automotive oil, out of storm sewers
- bagging or composting leaves and grass clippings rather than raking them into storm sewers
- recycling used motor oil
- using phosphate-free fertilizers
- reducing the use of toxic household chemicals
- reducing the use of dishwasher detergents containing phosphorous
- reducing the amount of impervious surfaces on private and public property
- erecting silt fencing at disturbed areas
- replanting areas of exposed soil with native vegetation as quickly as possible after disturbance
- placing land in conservation easements or trusts and restricting deeds so that, when a property is sold, only environmentally-friendly land use activities are allowed on that land
- and, of course, water conservation—using less water in our everyday lives

The list of best management practices continues to grow and improve. In the 2002 session of the Minnesota Legislature, state law was amended to include the regulation of phosphorous content in lawn fertilizers applied within the state. The current law prohibits the application of fertilizers containing phosphorus within the metropolitan counties, and limits to three percent by weight (for solids) or 0.3 pound per 1,000 square foot (for liquids) the amount of phosphate in fertilizers applied in the rest of the state (*Minn. Stat. Chapter 18C*).

City planners and developers should consider including areas of pervious, or permeable, surface instead of concrete or asphalt pavement whenever possible. A permeable surface lets rainwater soak through to the ground, reducing the amount of water that enters storm sewers by way of nonporous surfaces such as roads, parking lots, and roofs. Some examples of pervious surfaces include: rain gardens, forests, lawns, green space, green roofs, and parkland. A rain garden is a landscape depression with loose soil, planted densely with flowers, grasses, or shrubs. Storm water runoff from driveways, roofs, and sidewalks is directed into the rain garden, where it's used by plants or seeps into the soil.

A green roof (or garden roof) is an engineered roof system that uses a lightweight soil mixture and plants as final cover rather than shingles or asphalt. Rainwater falling on a green roof is held in the soil or taken up by plants, reducing the volume of storm water entering lakes and rivers. Road builders deflect water from impervious surfaces by installing water bars—small, raised ridges on the road surface that deflect water flow into ditches.



A rain garden catches and holds runoff. This reduces the rate of runoff, slows erosion and keeps pollution and excess nutrients out of wetlands, lakes, streams, and rivers.

Tradeoffs must often be considered in decisions to implement BMPs. Short-term monetary costs must be balanced against the potential long-term costs of degraded water quality in the watershed.

BMPs also include old-fashioned water conservation methods. Rain barrels collect roof runoff from gutters before it can carry sediment and contaminants into lakes and streams, and the rainwater can be used to water flowers and vegetable gardens. Barrels are available commercially or can be made from food grade scrap or wooden barrels. Using less water in everyday activities is important, too. Freshwater is a limited resource that plays a large role in the health of a watershed. (See **Lesson 3:4—Would You Drink This Water?**) Runoff that flows into storm sewers doesn't go to water treatment facilities. It flows directly into lakes and rivers. It's important to remember that it's expensive—and not always possible—to clean the polluted water that flows to water treatment plants. Keeping water clean by not polluting it in the first place is a much more cost-effective way to protect water quality.

Managing Water Resources

Communities across Minnesota have recognized that they must work at the watershed level to solve their diverse water resource issues. Boards of Soil and Water Conservation Districts, Watershed Districts, and the Minnesota DNR work with communities throughout Minnesota using similar basic management tools to mitigate the impacts of development and various other land use practices on water quality: watershed planning, land conservation, aquatic buffers, improved site design, erosion control, wastewater treatment, control of non-stormwater discharge, and watershed stewardship. Depending on an area's land use practices and watershed characteristics, these basic water resource management tools may be applied in different ways or in different combinations. Together they form the foundation for all water quality projects.

Who Protects the Watershed?

As our population continues to grow, and the human footprint on the land becomes larger, it's even more important to understand that everyone must play a role in protecting water quality in their own watershed, and in neighboring watersheds. Our watershed communities are interconnected, and we all live either upstream or downstream from someone else. We can work with federal, state, and local agencies to reduce and prevent pollution that arises from people's activities on land. The Minnesota DNR regulates the type and extent of development permitted near shorelines. Counties or municipalities may adopt and enforce restrictive ordinances regarding zoning or erosion control. County governments have responsibilities—ranging from road construction to hazardous waste management—that impact the local watershed. Every citizen can contribute to these efforts by practicing conservation and BMPs at home, and by making informed choices to change everyday habits and activities that impact the watershed.



When a landowner considers putting a piece of property up for sale, alternatives might include placing the land in conservation easements and trusts, or applying restrictions allowing only environmentally-friendly land uses.

We all share the responsibility for caring for our watersheds and water resources. People can work together to ensure a healthy ecosystem while meeting a community's needs that includes informed means of development using Best Management Practices, areas of native vegetation, natural shorelines, and clean lakes, rivers, and streams to ensure a healthful quality of life. History has shown that people's activities on land have indeed impacted our water quality, and we should heed this lesson.

Procedure

Preparation

- 1 Obtain materials needed to create watershed models.

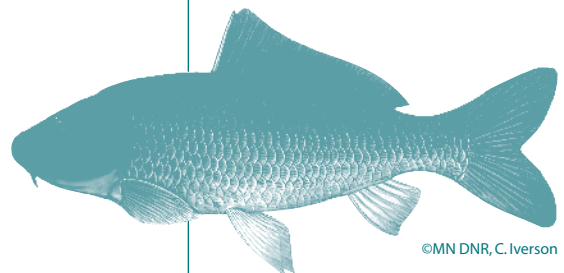
Activity

Warm-up

- 1 Ask students where rain goes after a storm. (Answers should include: into the ground, storm sewers, lakes, rivers, and evaporation into clouds). Then ask students where the water in a nearby lake, river, or stream (name the water body) came from. Guide students to list rain, snow, storm sewers, water that runs downhill on the land, from springs (groundwater), and rain and snowmelt running down streets and sidewalks. Hold up an umbrella or foil roasting pan to demonstrate and define watershed for the students. You may also use the **Watershed Model Sheet** to help describe a watershed. Compare the land draining into the local lake, pond, stream or river to an upside-down umbrella, foil roasting pan, tub, or a dishpan. Explain that a watershed is a well-defined area around the water body.
- 2 Review the water cycle and ask why water is important. Tell students that we all live in a watershed. Where do we get the water that we drink? The water we use every day comes from the watershed where we live. Tell them they will explore how the activities that occur in their watershed affect the quality of the water in the watershed.
- 3 Have students close their eyes. Ask them to imagine what their neighborhood might have looked like 200 years ago, before there were houses, farms, and cars. Who lived on the land? What kinds of things were people doing on the land in the watershed? What do they think the water in the local lakes and streams was like? Why?
- 4 With their eyes still closed, ask students to think about their neighborhood today. What does it look like? Who lives on the land? Which human activities occur in the watershed? What do they suppose the water in the local lakes and streams is like today? Why?
- 5 Have students open their eyes. Have your students brainstorm a list of land use practices that occur in the local watershed. List their ideas on the classroom whiteboard or projection device.

Lesson

- 1 Pass out materials. If you don't have enough space or materials for students to work individually, place students in groups of three or four. If students are working in groups, one group member can gather materials while another fills the water spray bottle or sprinkling can and another covers the work area with newspaper. One student can be designated as the group's recorder and write down observations.
- 2 Have each student or group make a three-dimensional (relief) model of a watershed area surrounding a pond, lake, or stream inside of a plastic-lined box or foil roasting pan. Explain that these watershed models are three-dimensional maps of a watershed. When looking down on the model from above, the viewer can locate various places, land forms, water bodies, and the different ways in which people use land in the watershed.
- 3 Ask students to think about a watershed from 200 years ago, before modern development. First add the rocks and clay to the container. Place the slightly crumpled foil sheet on top, moulding it over rocks or clay soil mounds, creating relief topography and securing it to the edges of the pan. Be careful not to tear or poke holes into the foil. Tell students the watershed models should include some relief (hills, valleys, plains, fields, lakes, and rivers). Students can use permanent markers, felt, small toys, sand, and other materials to represent vegetated areas, wooded areas, open fields, and other features. Strips of dampened sponges and felt can represent vegetation alongside water bodies and wetlands. Ask students to include at least one lake or river in their watershed models. The instructor can crumple and shape a sheet of foil to demonstrate the procedure, or show a pre-prepared model as an example. Remind the students that watersheds come in many shapes.
- 4 Now ask students to look at their watersheds and think about their neighborhoods and communities of today. Have them use permanent markers and small toys, and other materials to map out or draw yards, paved areas, roads, parking lots, and any developed areas with buildings, factories, houses, farms, parks, or other places. Have them lightly sprinkle a bit of sand, dirt, or cocoa powder on any open fields, disturbed ground, or paved areas.



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An example of a completed watershed model.

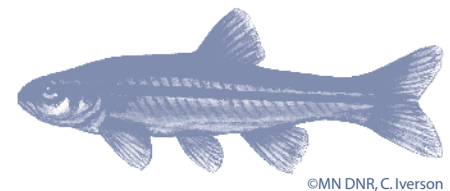
- 5 While the students are creating their watershed models, the instructor should circulate around the classroom to make sure models are being constructed according to directions, and to answer any questions students may have.
- 6 When models are complete and the instructor has approved the design, students may play the role of clouds and “rain” on their watersheds, using a spray bottle to produce the showers. Before raining on the models, the students should be sure that any wetlands or vegetated areas (sponges or felt) are still damp. Have students pay attention to what happens to their model as they rain on the watershed. They should record in their notebooks where the rain falls, how it moves through the watershed, where it collects, and how the rain affects different areas in the watershed. Discuss the students’ observations with them. Are there differences between what happened in the models? For example, did some models show more erosion (movement of sand or soil) than others? Ask students why this might have happened. (Answers include: some models have more exposed or disturbed land, steep hills, pavement, or sparse vegetation). Did the water collect in certain areas? Where? Why?
- 7 Define surface runoff. (Surface runoff is water that runs off the land into a water body.) Remind students that water runs downhill. Discuss why surface runoff carries sediments and other pollutants from the land to lakes, rivers, streams, ponds, and wetlands.
- 8 Define pollution. (Pollution is contamination caused by natural or human-made substances that reduce the useful qualities of any part of the environment’s soil, water, or air.) Is erosion pollution? Define the two categories of pollution: point source and nonpoint source pollution.
- 9 When students understand how water moves through a watershed, tell students the sun is out, and water is evaporating up into the clouds. Use paper towels to dry the watershed models.
- 10 Have students introduce some hypothetical human activities on the land (land use practices) to their watershed and describe them in their notebooks (examples might include: a new housing development under construction in the valley, leaky septic systems detected in one part of town, logging in the forest, grass clippings raked into streets after mowing, a neighbor doesn’t pick up and properly dispose of pet waste.)
- 11 Now students can add “pollutants,” the products of their land use activities, to the appropriate sites on their models. They can use food coloring, watercolor paint, and vegetable oil to represent chemical spills, lawn fertilizer, or oil. They can use colored sugar or packaged drink powder to represent granular fertilizers on farm fields and lawns. They can sprinkle cocoa powder, coffee grounds, or powdered iced tea mix to represent erosion in areas of development or other sites where the ground has been disturbed. They can remove vegetated areas to represent development projects and logging. Chocolate sprinkles can represent waste from pets or livestock. Small leaf pieces, short lengths of grass clippings, dried

herbs, or paper scraps can represent yard waste from mowing or raking lawns, and so forth.

- 12 Have students use their spray bottles or watering cans to rain on their watershed. They should record in their notebooks how the pollutants travel and where they end up. Have students lift the strips of sponge and felt representing vegetation and observe their colors and trapped sediments. What color is the accumulated water in the lakes and rivers in their models? Students will observe that surface runoff carries the pollutant into bodies of water in the watershed. Vegetated areas absorb some of the pollutants. Lakes and rivers will accumulate a variety of pollutants from different areas in the watershed. What effect will these pollutants have on the fish, insects, and other organisms in the water? Students should specify in their notebooks whether the pollutants that end up in the water bodies are nonpoint source pollutants or point source pollutants.
- 13 The sun comes out after the rain, and students may again dry their watershed models. Define and discuss best management practices and have the students devise ways to incorporate some BMPs in their watershed model. They can use various materials, such as pieces of sponge or felt, to represent vegetation buffers and plant restoration projects and reforestation. They can propose better ways to dispose of oil and chemicals, use plain sugar to represent phosphate-free fertilizers instead of the colored drink mix powder, place silt fence barriers around construction sites, conduct septic tank maintenance, and other practices.
- 14 Have students rain on their watersheds with the BMPs in place and record their observations.
- 15 Ask students to write one paragraph that compares what happened in their watersheds before and after human activities on the land, and a second paragraph comparing what happened with human activities in the watershed before and after they added Best Management Practices.

Wrap-up

- 1 Discuss the students' observations with them. Discuss that models and maps are tools that can help us understand what happens in a watershed on a larger scale. Students will have observed that water travels downhill in the watershed and collects in water bodies.
- 2 How is the water cycle related to the watershed? Water is always moving, evaporating into the atmosphere and then condensing into clouds and raining or snowing back down on the watershed. Water flows downhill to lakes, streams and rivers; it can cause erosion and carry pollution. Pollutants can travel to lakes, rivers, and streams from faraway sources. This is called nonpoint source pollution.
- 3 Many of the land use practices they first demonstrated in their models aren't illegal, but all land use activities can impact the cleanliness and quality of the water.
- 4 List activities on land that can be sources of non-point source



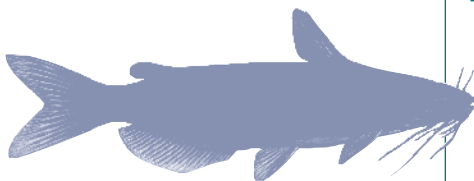
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pollution. Digging one foundation for a house, or paving one street may not greatly impact a stream or river, but all activities in the watershed can accumulate to impact local water quality. Ask students why we should worry about pollution that occurs five miles away. Is your neighborhood highly developed or more rural? Where does the rainwater from your schoolyard, local streets, local ponds and rivers, and driveways go? Where does the rainwater from local farms, fields, or forests go? Where does your drinking water come from?

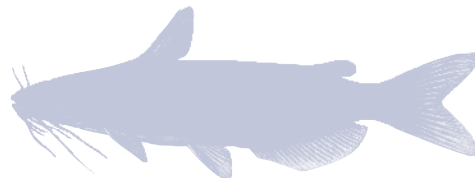
- 5 What can students do to have a positive impact on water quality in their watershed? (Examples include picking up pet waste, properly disposing of litter, raking leaves from sidewalks and streets, turning off running faucets and hoses, washing bikes or cars on the lawn or another permeable surface rather than in the driveway.) What are Best Management Practices? Which BMPs did they use in their watershed models? Were they effective? In real life, who decides if BMPs will be used? (We all do!)

Assessment Options

- 1 Ask students to write two short paragraphs or to draw two illustrations. For Paragraph 1 or Drawing 1: define or make a map illustrating a watershed. Describe or show four activities and land use practices occurring in your watershed that can positively or negatively impact water quality in your local pond, lake, or stream. Who depends on good water quality in that water body? Describe how human land use practices have changed in your watershed over time. For Paragraph 2 or Drawing 2: describe or make a map that illustrates two everyday actions (personal BMPs) that you can take to improve water quality in your watershed. Why is it everyone's responsibility to protect water quality in the watershed?
- 2 Have students make a poster or map illustrating a healthy watershed where people reside. This can be a watershed they create, or a map of the local watershed. The poster or map should promote good land use practices (BMPs). Tell students their poster or local watershed map will be assessed on the following:
 - presence of water bodies
 - arrows showing the flow of water in the watershed, specifically how this movement relates to the water cycle
 - inclusion of Best Management Practices for land use activities
- 3 Assessment options include the Checklist and Rubric on the following pages.



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Wonderful Watersheds Checklist

Possible Points	Points Earned	Points Earned	
	Student	Instructor	
4	_____	_____	Watershed model includes a wetland buffer around the entire perimeter of open water.
3	_____	_____	Student can clearly describe the importance of a wetland buffer.
3	_____	_____	Student can clearly describe how people's activities on land impact water quality.
2	_____	_____	Model includes one or two structures at least six inches from the water's edge.
3	_____	_____	Student can clearly describe how farm animals and pet waste impact water quality.
2	_____	_____	Model includes no access to open water for farm animals.
2	_____	_____	Student can define non-point pollution and point source pollution.
2	_____	_____	Student can define surface runoff and erosion.
3	_____	_____	Can describe three Best Management Practices (BMPs) for land use.
3	_____	_____	Model with BMPs included prevents pollution from entering water bodies, and allows little or no erosion.
2	_____	_____	Can state two reasons why it's everyone's responsibility to protect water quality in their home watershed.
Total Points			
29	_____	_____	Score _____

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

27-29 points = A

Excellent. Work is above expectations.

24-26 points = B

Good. Work meets expectations.

20-23 points = C

Work is generally good. Some areas are better developed than others.

16-19 points = D

Work doesn't meet expectations; it's not clear that student understands objectives.

0-15 points = F

Work is unacceptable.

Wonderful Watersheds Scoring Rubric

Watershed Model Criteria	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Wetland buffer area	Model includes wetland buffer around entire perimeter of open water. Can clearly describe the importance of a wetland buffer.	Model includes wetland buffer around 75% of the open water area. Can describe the importance of a wetland buffer.	Model includes wetland buffer around 50 % of the open water area. Description of the buffer's importance lacks clarity.	Model includes wetland buffer around less than 50 % of the open water area. Can't describe the importance of the buffer.	Model includes no buffer zones or wetlands around water.
Land use practices and structures	Can clearly describe how people's activities on land impact water quality (positive and negative). Model includes one or two structures placed at least six inches from the water's edge.	Can describe some ways that people's activities on land impact water quality. Model includes three to five structures placed at least four inches from the water's edge.	Description of the impact of people's activities on land is unclear. Model includes five or more structures placed one inch from open water.	Can't accurately describe how people's activities on land impact water quality. Model includes one or more structures placed on the edge of open water.	Doesn't attempt to describe the impact of people's activities on water quality.
Farm animals	Can clearly describe the impact of farm animals and pet waste. On model, animals have no access to open water.	Can describe the impact of farm animals. On model, animals have a one-inch access to open water.	Description of animals' impact is unclear. On model, animals have access to 50 % of open water.	Can't accurately describe the impact of animals. Animals have free access to all open water.	No description attempted.
Pollution	Can define non-point and point source pollution. On model, no pollution enters the water.	Can define non-point and point source pollution. A few sources of pollution enter the water.	Can define only one source of pollution. Pollution is trapped in 50% of area; the rest flows to open water.	Can't define non-point or point source pollution. Pollution flows freely through the watershed.	No description attempted.

Score _____ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

- 1 Have students use a topographical map of the local watershed as a guide for making local watershed models. Use the models to demonstrate how water flows in the local watershed. Identify some land use practices that may negatively or positively impact water quality in the watershed.
- 2 Students can take a walking tour of the local watershed and create a map of the area to use to make a model of their local watershed. Show the location of the school on the model. Describe major natural and human-made features in the community. Determine a route from the school to a local water body. Discuss how different types of maps provide different information. Have local land use issues appeared in the news recently? Include all of this information in the watershed models.
- 3 Have students try to find historical photos or stories about land use practices, development, or water quality in their community. Compare the photos and stories to the watershed's current condition. Identify the land-based factors and activities that have changed over time. Infer what this means for water quality in local lakes and streams. Your local watershed district office might have this information.
- 4 Have students look for and bring in newspaper articles about the local watershed area to share with the class.
- 5 Read "Metro Home Owners Harm Waters," an article published in Minnesota DNR *Fish and Wildlife Today*, Spring 1997.
- 6 Interview an organic farmer from your area. Have students explore the definition of an organic farm, how it differs from other farms, and the types of crops grown. Ask about the challenges and the benefits of organic farming.
- 7 Contact the Minnesota Pollution Control Agency (MPCA) about their stream monitoring program, which allows citizens to observe the cleanliness and clarity of streams during various rainfall conditions over an entire open water season (from snow melt to hard freeze).
- 8 Have students research the source of their drinking water. Use local topographical maps to identify the watershed surrounding the source of drinking water. Take a walking tour of the watershed and identify land uses that could impact water quality. Invite someone from the water facility to the class to talk about how their efforts to ensure healthy drinking water. Investigate how treatment plants clean water. Is it more expensive to treat polluted water or cleaner water?
- 9 Find ways to educate the local community about the everyday activities that affect water quality in their watershed. Some possibilities include presenting a watershed play at a local community event, creating and distributing brochures or designing

posters to display at a public location. Students could choose a specific local water quality issue for further research, and determine how the issue relates to activities in the watershed—they could then conduct a public information campaign on that issue.

- 10 Tour the school to investigate how school activities impact water quality. Determine any BMPs that the students and staff can practice at school to reduce impacts on water quality in the watershed.
- 11 Research the many organizations within the Mississippi River watershed—such as the Minnesota DNR Adopt-A-River Program, your local Board of Soil and Water or Watershed District Office, and other organizations working together to improve the quality resources related to your area and the greater Mississippi River Watershed and its major tributaries.
- 12 Almost no water flows into Minnesota from another state or Canada. All Minnesota waters flow out of the state. Have students look at topographical maps to trace the flow of water in their watershed. Does it flow to Lake Superior and through the Great Lakes? To the Mississippi River and on to the Gulf of Mexico? To the Red River and into the southern portion of Lake Winnipeg?

For the Small Fry

K-2 Option

- 1 Where does the water go? Visit the school grounds after a rain and ask students where the water went. They can bring spray bottles along outside to spray “rain” on various surfaces (parking lot, grass, rocks, slopes, and hills) and observe where the water goes. Make the connection that water runs downhill and eventually goes over and through the ground, parking lots, roads, and lawns into your nearby lake, river, or stream.
- 2 Have students create and perform a watershed play. In small groups, students can perform the various roles of the watershed, illustrating how all of the parts of a watershed are connected. Some components to choose from include: rain, groundwater, stream, lake, river, plants, plankton, frogs, fish, birds, farm, cows, golf course, parking lot, lawn, forest, soil, buildings, people, pets, and so forth. Focus on two or three components for the play. As students become more familiar with the concept, you may add components.

Watershed Model Sheet

