2) Investigating Your Watershed

Overview

Before studying environmental issues, students must understand the concept of "watershed" and be competent in the skills of mapping and journaling. Then, students will be prepared to conduct investigations into three selected environmental issues of the Potomac and Chesapeake Bay Watersheds: Waste Management, Erosion & Runoff, and Ecosystem Diversity (Units 3, 4, and 5).

Lesson Planner

Use the table below for lesson planning purposes.

Time Required	Refer to Individual Activities
Key Concepts/Terms	Watershed, Cycles
Prerequisites	Water Cycle
Setting	Classroom, Outdoors

Learning Objectives

After completing this unit, students will be able to…

- understand the concept of "watershed;"
- know their "watershed address", i.e. where they live with respect to water and land features;
- read basic cultural and geographic information on a topographic map;
- create a map of their schoolyard or neighborhood that shows environmental, as well as cultural features; and
- use journaling to express personal connections to the watershed through words and drawings.

Background Information

We all live in a watershed, the area of land from which rain and melting snow drain into a river, stream, or other body of water. Watersheds come in all shapes and sizes, and may cross county, state, and even international borders. For example, Hard Bargain Farm is in the Accokeek Creek watershed, which is part of the Potomac River watershed and the larger Chesapeake Bay watershed.

Continued on next page

Unit Table of Contents

The table below lists the activities and documents in this unit and gives a brief description of the main ideas and the setting for each activity.

There are multiple activities for many learning phases of the unit. Teachers may choose to use one or more activities from any one phase.

2.1 A Sprinkle a Day

A Model of a Watershed

Overview

Students will use a model to understand the concept of watershed, observing that surface water flows downhill and that the direction of flow is dependent on the landforms along the way. Students will predict and observe how runoff can erode and carry soil, trash, and other matter off the land and into our water bodies (lakes, streams, rivers, and eventually the Chesapeake Bay).

Lesson Planner

Use the table below for lesson planning purposes.

Time Required	15-30 minutes
Key Concepts/Terms	Water Cycle, Watershed, Landforms, Pollution, Land Use
Prerequisites	Understanding Of The Water Cycle (for help with this see *Ways of a Watershed* or *Water Cycle* on the HBF Website: www.fergusonfoundation.org.)
Setting	Outside, Small Group/Whole Class

Learning Objectives

After completing this activity, students will be able to…

- Define the term "watershed;"
- Use a model of a landscape to show an understanding of the term "watershed;" and
- Identify and describe how pollution can get into our waterways through runoff.

Materials Required

For this activity, you will need…

- Shower Curtain, Tarp, or Large Plastic Trash Bag
- Sprinkler Can or Large Spray Bottle
- Water
- Powdered Kool-Aid™ or Colored Water (With Eyedropper); these work best with white or clear tarps/bags
- Bits of Trash and Soil
- *Optional*: Buckets, Boxes and other objects of related size (see Evaluation phase of this lesson plan)

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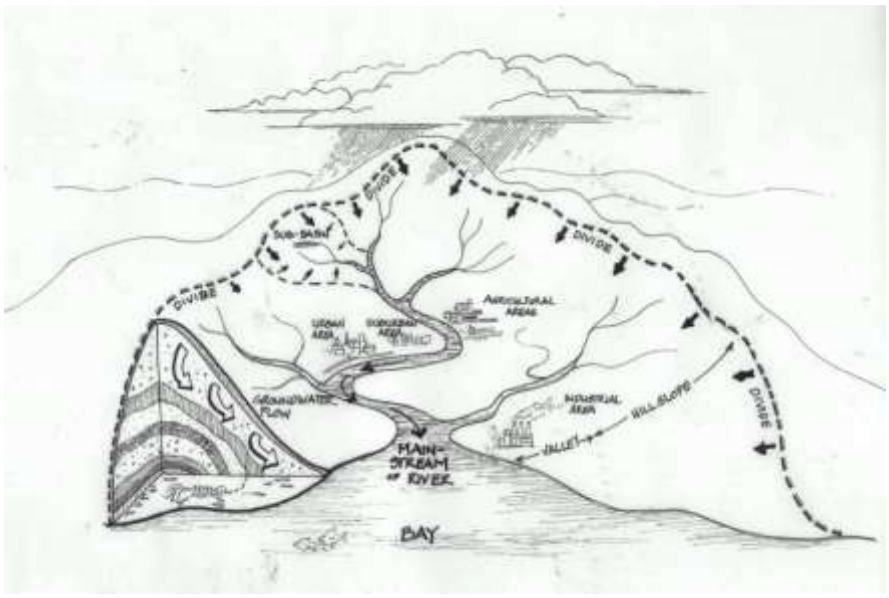
Background Information

What is a watershed?

A watershed is all of the land that drains runoff (from precipitation) into a body of water, such as a creek, river, lake, bay or ocean. The boundary of a watershed is the ridgeline of high land surrounding it, like the edge of a bowl. Another term for watershed is "drainage basin."

As rainwater and snowmelt run downhill, they carry whatever is on the land, such as oil dripping from cars, trash and debris on streets, or exposed soil from construction or farming to the nearest water body.



Our Local Watershed

Everyone lives, works and plays on land that drains to a body of water, like a creek or river. Our local watershed may lead to a tiny creek, but that eventually drains into a river, bay or ocean.

We live in the Potomac or Patuxent River Watersheds, which includes parts of Maryland, Virginia, Pennsylvania, West Virginia, and all of Washington, DC. The Potomac and Patuxent River Watersheds are part of the larger Chesapeake Bay Watershed (see ***Watershed Address***, pg. 2-40).

Continued on next page

Background Information (continued)

Runoff and Land Use

The table below shows different land uses and problems associated with them.

Land Use	Watershed Problems
Agricultural	• Exposed soil washes off the land, causing sedimentation, which clogs gills, smothers eggs and interferes with underwater photosynthesis. • Excess fertilizers, herbicides, and pesticides can wash off the land in runoff and pollute our water bodies.
Cities/Towns	• Impervious surfaces, such as concrete, asphalt, and rooftops prevent runoff from gradually sinking into the ground. This stormwater moves quickly, causing erosion and carrying pollutants and trash items to nearby water bodies.
Construction	• Clearcutting of forests and plants for building purposes exposes soil. This soil, if not protected, erodes and ends up in our water bodies, leading to sedimentation which clogs gills, smothers eggs and interferes with underwater photosynthesis.

Procedure

Follow the steps in the table below to conduct the activity. **Sentences in bold are suggestions for what teachers might say to students.** *Items in italics are possible student answers to questions.*

Phase	Step	Action
Engage	1	Take your class outdoors and set up your "watershed," as follows: Under the plastic tarp/shower curtain, place objects such as a chair, backpacks, or buckets to create ridgelines. (Alternately, a student can be placed under the tarp, lying on his/her back with one knee slightly bent upwards.)
	2	**Say: "Imagine that this area is an area of land. What does this look like?"** *It looks like a hill or mountain. We call the high points on our land ridgepoints.*

Continued on next page

Procedure (continued)

Phase	Step	Action
Explore & Explain	3	**"Now that we have identified our mountain, what other landforms can we find on our model? What is your hypothesis about what will happen if it were to rain on this landscape?"** *Students should find valleys, and should be able to show areas where streams, rivers and lakes will form.*
	4	**"We need to review the parts of the water cycle. Who can tell me one part?"** *Students should continue volunteering until you have discussed PRECIPITATION, CONDENSATION, EVAPORATION, and RUNOFF.*
	5	**"This activity will focus on RUNOFF – what happens when precipitation hits the land. How is our model different from real land?"** *Our land covering is plastic, which means that no water will be able to seep through it, as it can with soil/grass.* **"Do we have areas on the real land that water can't seep through? How do you think this affects runoff?"** *Concrete, asphalt, roofing, etc. are all impermeable, meaning that water can't pass through them. These materials make the runoff move over the land faster, causing more erosion when it hits soil.*
	6	**"We are going to create a rainstorm over this landscape. Remember your hypothesis about what will happen, and observe the water closely."** Use the watering can/spray bottle to "rain" about a gallon of water slowly over the entire landscape.
	7	**"Were your hypotheses supported? What did you observe happening with the water? Did it travel in particular paths?"** *Students should be able to show where the water traveled and where it collected. They should be able to explain that water must travel downhill (gravity), so the path the water takes depends on the shape of the land.*

Continued on next page

Procedure (continued)

Phase	Step	Action
Explore & Explain	8	**"A WATERSHED is an area of land that sheds water (from rain/snow, etc.) into a stream, river, lake, bay or ocean. For example, all of the land that sheds water into this small lake is its watershed** (point one lake out on your landform & show them the boundary of the land that would drain into this "lake")**. Can you find any other watersheds?"** *Students should be able to find many small watersheds on your landform, though it may take a little guidance from you in the beginning.* Sprinkle more water over the landform to confirm student understanding and explanations.
	9	**"Watersheds can be small – all the land that drains to a creek or river, like the Potomac; or larger – all the land that drains into a huge bay, like the Chesapeake. The larger watersheds can have a number of small watersheds in them, as the smaller streams, creeks and rivers lead all their water into larger bodies of water."**
	10	**"Are you standing in a watershed right now?"** *Yes, ALL LAND is in some watershed, as it will drain water into the nearest water body. Students should know the water body nearest to their school.*
	11	**"What are different ways we use the land?"** *Student answers should include: farming, business, housing, streets, factories/industry; landfills, gardening, schools, etc. For each use, discuss associated pollution.* Sprinkle small amounts of the Kool-Aid™ over different areas to represent pollution associated with these different land uses as students say them: soil from farming; herbicides, pesticides, fertilizers from lawns, farms, gardens; disturbed soil from construction sites; litter and chemicals on streets; trash from the landfill (make sure this one is mentioned).

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Procedure (continued)

Phase	Step	Action
Explore & Explain	12	**"We are going to make it rain again. What do you think will happen to the soil, chemicals, and trash?"** *It will be carried in the water that is moving over the land.*
	13	"Rain" on your landform again. **"What did you observe?"** *The soil, trash, and chemicals ended up in the water body.* **"Where would the people living in this land area get their drinking water?"** *From the river* **"Is it safe to drink? Is it good for things living in the water?"** *No*
	14	**"Why are watersheds important? Why should we care about them?"** *We all live in a watershed and we all affect the quality of the land and water in it. We get drinking water from it; other things live in it and use it, many of which we eat; we use the water for recreation; etc.*
Evaluate	15	Provide students with a tarp or plastic bag and assorted items from which they will create a landscape where all runoff will flow in one direction, thus forming a watershed.

Vocabulary

Understanding of the following terms is useful in this activity.

Term	Definition
Condensation	When water turns from gas to liquid
Evaporation	When surface molecules of water turn from liquid to gas
Impervious	Not allowing entrance or passage; impenetrable
Precipitation	Hail, mist, rain, sleet, and/or snow
Runoff	An overflow of rainfall or snowmelt that cannot be absorbed by soil and vegetation
Watershed	All the land that, when it precipitates, drains water into a waterway, such as a creek, river, lake, bay or ocean

2.2 Crumpled Paper Watershed

A Model of a Watershed

Overview

Students will use a model to create a watershed. By observing how surface water flow is determined by the shape of the land, students will visually and dramatically observe the physical characteristics of a watershed, and investigate the impacts of human land use decisions.

Lesson Characteristics

Use the table below for lesson planning purposes.

Time Required	15-30 minutes
Key Concepts/Terms	Watershed, runoff, landforms, pollution, land use, water cycle
Prerequisites	Understanding of The Water Cycle (for help with this see *Ways of a Watershed*, or *Water Cycle* on the HBF Website: www.fergusonfoundation.org.)
Setting	Indoors (on a desk or table), Individual/Student Pairs

Learning Objectives

After completing this activity, students will be able to…

- Define the term watershed;
- Use a model to show an understanding of the term "watershed;" and
- Describe how pollution can get into our waterways through runoff.

Materials Required

Provide the following materials per group or individual:

Student Sheets – Crumpled Paper Watershed, pg. 13
- 2 pieces of plain scrap paper (8.5 X 11)
- Spray bottle
- Water
- Water-based markers (blue, brown, and black)

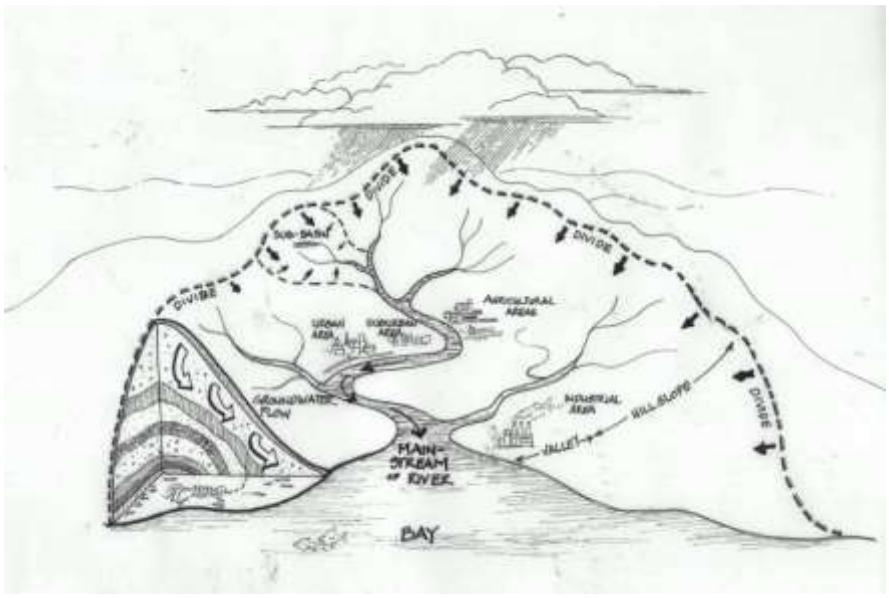
Continued on next page

Background Information

What is a watershed?

A watershed is all of the land that drains runoff (from precipitation) into a body of water, such as a creek, river, lake, bay or ocean. The boundary of a watershed is the ridgeline of high land surrounding it, like the edge of a bowl. Another term for watershed is "drainage basin."

As rainwater and snowmelt run downhill, they carry whatever is on the land, such as oil dripping from cars, trash and debris on streets, or exposed soil from construction or farming to the nearest water body.



Our Local Watershed

Everyone lives, works and plays on land that drains to a body of water, like a creek or river. Our local watershed may lead to a tiny creek, but that eventually drains into a river, bay or ocean.

We live in the Potomac or Patuxent River Watersheds, which includes parts of Maryland, Virginia, Pennsylvania, West Virginia, and all of Washington, DC. The Potomac and Patuxent River Watersheds are part of the larger Chesapeake Bay Watershed (see ***Watershed Address***, pg. 2-40).

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Procedure

Follow the steps in the table below to conduct the activity. **Sentences in bold are suggestions for what teachers might say to students.** *Items in italics are possible student answers to questions.*

Phase	Step	Action
Engage	1	**Say: "Please clear off your desks completely as this activity will get them a bit wet."**
	2	**"What happens to rainwater after it falls? Where does it go?"** *Student answers should include the concept that some rain goes into the ground and some runs downhill.*
	3	Pass out ***Student Sheets – Crumpled Paper Watershed*** (pg. 13), one sheet of 8.5 X 11 paper, and markers to each student/group.
Explore	4	This activity can be conducted in two different ways, as detailed below: Teacher-directed: You can work through the instructions on the ***Student Sheets*** as a class, with the teacher giving instructions orally and demonstrating the steps as necessary, or Self-Directed: Students can read and follow the instructions on the ***Student Sheets*** at their own pace, with the teacher monitoring student progress throughout the activity and giving assistance where necessary.
Explain	5	Discuss student results, and answers to the questions in the *Analyze Your Data and Draw Conclusions* section of the ***Student Sheets.***
Elaborate	6	Ask students to create models of a watershed using other materials such as modeling clay or aluminum foil.
Evaluate	7	Use completed ***Student Sheets*** for evaluation.

Continued on next page

Vocabulary

The following terms are useful in this activity.

Term	Definition
Landform	A physical feature, such as a hill, mountain, valley, plateau, river, lake, etc.
Ridge	The high points of a range of hills or mountains
Runoff	An overflow of rainfall or snowmelt that cannot be absorbed by soil and vegetation
Tributary	A stream feeding into a larger stream, lake, etc.
Watershed	All the land that drains water into a creek, river, lake, bay or ocean. The watershed is named for the body of water into which it drains

Student Sheets – Crumpled Paper Watershed

Objectives

By the end of this activity, you should be able to …

- Define the word "watershed;"
- Understand how to tell where the boundaries of a watershed are; and
- Understand how runoff affects our water quality.

Set Up Experiment #1

Follow the instructions below to set up the experiment.

1. Crumple up the piece of paper your teacher gave you, and then smooth it back out most of the way. It should still be a bit crumpled, showing small ridges (high points) and valleys (low points).
2. Imagine that this paper is a section of land, and find the ridgelines (the tops of the fold-lines).
3. Use a washable blue marker (not permanent) to color along the ridgelines on your "land."

Make Your Hypotheses

You are going to "rain" on your landform. Answer the following questions to make your hypotheses before conducting the experiment.

1. What do you think will happen to your land when it "rains?"

   _____

2. What will happen to the blue ridge lines you colored?

   _____

3. Where will the "rainwater" travel?

   _____

Continued on next page

Student Sheets – Crumpled Paper Watershed

Run the Experiment

Follow the directions below to conduct the experiment.

1. Use a spray bottle of water to create a "rainstorm" over your land. You want to create gentle sprays of mist.
2. Observe what happens after every misting.
3. As your "rainfall" accumulates, observe the pathways where the excess "rainfall" travels.

Record Your Observations

In the space below, record your observations about what happened (Use words and pictures if you wish).

Analyze Your Data and Draw Conclusions

Answer the following questions or complete the activities to analyze and draw conclusions about your data.

1. Explain how your hypotheses were or were not accurate.

2. How did the "rainfall" travel over your land?

Continued on next page

Analyze Your Data and Draw Conclusions (continued)

3. Where did the water collect? Explain why this happened.

4. Find an area on your land where water collected. This is a lake, and you get to name it! My lake is Lake _____.

5. Look for the major stream running into your lake. Name this stream as well. My stream is called _____.

6. This stream may have several tributaries (small streams which run into the larger stream). How many does your stream have? _____

7. With your finger, trace your stream all the way back up to where it starts at the top of the ridge. (This should be a path of blue ink.) When you reach the top, this is the edge of the watershed for your stream and lake.

8. Trace the entire edge of the watershed with your finger, by following the ridgeline. This will be something like tracing the edge of a bowl.

   All of the inside, downward-sloping area you have just outlined is the watershed for your stream and lake.

9. Draw a picture of your watershed below. Label your stream and lake.

10. How many other watersheds can you find on your "land?" _____

11. How would you define the word "watershed?"

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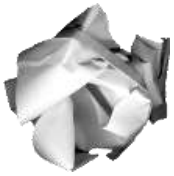
Student Sheets – Crumpled Paper Watershed



Set Up Experiment #2

Follow the instructions below to set up the second experiment.

1. On a fresh sheet of paper, draw some of the ways people use the land. Include a house/community, farm, factory, and some streets/highways.

2. Using the color key below, color your areas with markers.

Use this color…	To Represent…	What Might be on this Land that You Wouldn't Want in the Water?
Brown	Farms	
Red	Landfills & Factories	
Black	Houses & Streets	

3. Crumple this paper, and smooth it in the same way you did the first one.
4. Use the blue marker to trace the ridgelines on this paper.

Make Your Hypotheses

Make hypotheses about what you think will happen when you "rain" on your land this time.

Run Your Experiment

Gently mist your new land with water from your spray bottle. Observe what happens, and how the water travels.

Record Your Observations

Record your observations (in words and pictures) here.

Continued on next page

Analyze the Data and Draw Conclusions

Answer the following questions to analyze and draw conclusions about your data.

1. What happened in your second experiment?

2. What do you think the colors could represent in real life?

   - Brown = _____
   - Red = _____
   - Black = _____

3. Where were the colors in the end?_____

4. Where are you in this watershed? What kinds of pollution do you think you add to the watershed?

Continued on next page

Checking For Understanding

Circle the letter of the correct answer for each of the following questions to show you understand the information in this activity.

1. Choose the best description for the **watershed** of a stream:

   a. the water of a stream and all the tributaries that feed into it, including wetlands

   b. all the land that slopes toward the stream and drains rain and melting snow into the stream

   c. a large wet area of land that completely surrounds the stream.

2. You are hiking along a trail in a hilly countryside. You know that you have reached the watershed of a different stream because:

   a. the ground changes from soggy soil to dry forest

   b. you can see another stream

   c. you are standing on a high spot and the land starts to slope downward again.

2.3 Mapping Basics

An Introduction to Topographic Maps

Overview

In this introduction to topographic maps, students learn the concept of scale, and how to identify political boundaries, cultural features, waterways, contour lines, and land uses.

Lesson Planner

Use the table below for lesson planning purposes.

Time Required	45 minutes to one hour
Key Concepts/Terms	Scale, political boundary, cultural feature, map key, land use, impervious cover
Prerequisites	None
Setting	Indoors, Small Group

Learning Objectives

After completing this activity, students will be able to…

- Locate political boundaries and cultural features;
- Understand scale and use it to determine distances and areas; and
- Describe land use and how it affects waterways.

Materials Required

The following materials are required, per group, to complete this activity:

- Topographic maps in at least two different scales: 1:24,000 (USGS quadrangle map) and another with either a larger or smaller scale.
- Plastic transparency sheets to lay over the maps (use acetate or overhead transparencies)
- Markers (wet-erase/overhead markers work well)
- Rulers

Background Information

The *smallest* scale map has the *largest* land area. A 1:24,000 scale map, also called a quadrangle, is a *larger* scale than a 1:250,000 scale map. The scale is actually a fraction, and a larger denominator (bottom) of a fraction means a smaller number value. For example, ¼ as a quantity is smaller than ½. Another way to think of this is as a blow-up: a larger blow-up (larger scale) shows less area. For further information, refer to ***What is a Topographic Map?*** And ***Reading Topographic Maps***, pg. 2-25.

Continued on next page

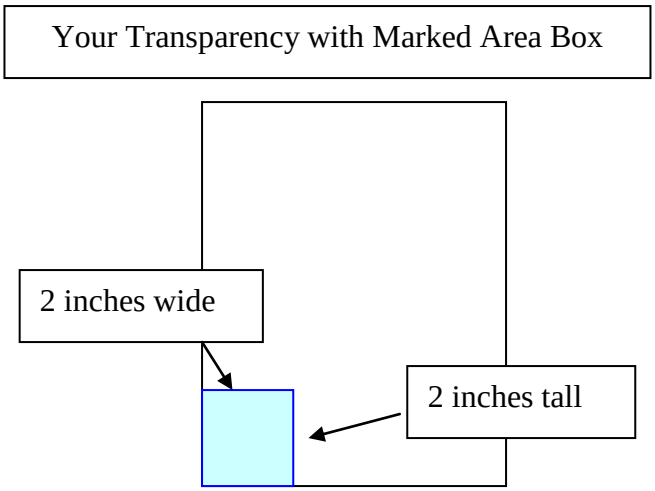
Procedure

Follow the steps in the table below to conduct the activity. **Sentences in bold are suggestions of what a teacher might say to students.** *Items in italics are possible student responses.*

Phase	Step	Action
Engage	1	Give each group of students one large scale (1:24,000) and one small scale (1:250,000) map of the same geographic area. **Say: "Locate your position on the _____** (insert Title of the smallest scale map you are using)**."** Using an overhead projector and transparency of your smallest scale map, model this for students. **"Now, locate your position on the _____ map** (insert the Title of the larger scale map you have chosen to use)**."** Demonstrate this step on the overhead as well. **"Which map shows a greater area? Which shows greater detail?** Explain that a *larger* scale map shows *greater* detail. A *smaller* scale map makes areas look smaller.
Explore	2	<u>Understanding scale</u> Ask students to find the <u>scale</u>, usually found at the bottom of the map. Explain that this tells you the ratio between distance in real life, and how much space that distance equals on the map. Using a sheet of plastic overlay, a ruler and marker, ask them to measure a specific <u>distance</u>, such as ten miles, and draw a line that length on the plastic. Model this on your overhead transparency. Have students practice measuring other distances on the map using the plastic overlay.

Continued on next page

Procedure (continued)

Phase	Step	Action
Explore	3	Estimating Area Using the corner of the transparency as a right angle, make a square using the distance line on the map as a guide. For example, if your line was two inches (representing one mile) long, you would measure two inches in from the corner of your transparency along the bottom and one adjacent side. You would then measure and mark the other two sides of the square on the transparency, as shown in the diagram below. Your square will be two inches on a side, representing one square mile. Using the ruler, divide the square into quarters or other units, to aid in measuring area more accurately.  Model this on your overhead transparency. Allow students time to practice using this square to estimate areas on the map.

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Procedure (continued)

Phase	Step	Action
Explore	4	Understanding Map Symbols Give students the ***Topographic Maps Symbols*** sheets, and ask students to find: • their current location; • cultural features, such as buildings (black)and roads (red) ; • political boundaries (black), such as county or state lines; • waterways (blue); and • urban areas (usually red or purple [more recent update of red]).
	5	Looking at Land Use Using the subdivided square, ask students to estimate the percentage of total area of the map that is urban. Explain that urban areas have a lot of **impervious** cover, like rooftops, sidewalks, and roads. Water cannot pass through these surfaces into the ground, so it runs off them, gaining more and more speed, and carrying more and more pollution that it picks up as it goes.
	6	Looking at Contour Lines Ask students to find the contour interval, usually located at the bottom of the map. Explain that this tells you the height difference of the land between one line and the next. These lines are at regular intervals, such as 20 feet, so the closer together contour lines are on your map, the steeper the slope of the land in real life. Point this feature out on your overhead transparency, and point out an area where the land is more steep, and one where it is less steep, so students can see the difference. Choose a point on the map and ask students to estimate its altitude by finding a contour line with a number on it (elevation) and counting lines to the one nearest the point.

Continued on next page

Procedure (continued)

Phase	Step	Action
Explain	7	The following questions are from the ***Student Sheet – Mapping Basics***, pg. 2-30. You can either cover these orally, or have students complete the sheets and then discuss the answers. **What parts of this map are actually visible, in real life or a photo? What parts are not actually visible?** *Buildings and roads, but not political boundaries. Waterways and probably land use, but not contour lines.* **In which direction does water flow in the streams and rivers? How can you tell?** *Water flows downhill, so the direction will depend on the shape of the land. It may help to pick one stream or river and have students answer the question specifically for that stream/river. Streams get wider as you go farther downstream where they empty into larger bodies of water.* **Which areas of the map have the most impervious cover?** *Green or white areas indicate vegetation, allowing rainwater to soak into the ground. Red or purple areas are developed, with impervious surfaces.* **Considering land use and direction of river flow, what area of the map is most threatened by flooding? Trash and litter pollution?** *Students should support their conclusions with information from the map.*
Elaborate	8	Use other maps and satellite images to explore land use and changes over time.
Evaluate	9	Performance assessment: ***Student Sheet – Mapping Basics*** (pg.30)

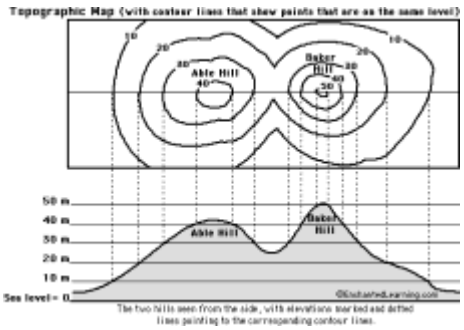
Continued on next page

Vocabulary

Understanding of the following terms is useful in this activity.

Term	Definition
Scale	The ratio of distances on the map to actual distances on the ground. A scale of 1:24,000 means that one inch on the map represents 24,000 inches (2000 feet) on the ground
Political boundary	The boundary line of a political division, such as a city, county or state
Cultural feature	An icon on the map that represents a manmade structure, such as a building, dam, road or bridge
Map key	A section on a map that explains what the symbols and colors represent
Land use	The way land is used, usually by humans, such as for agriculture, forests, housing, and commercial buildings
Impervious cover	A surface that will not absorb rainwater, such as asphalt, roofs, and parking lots

What is a Topographic Map?



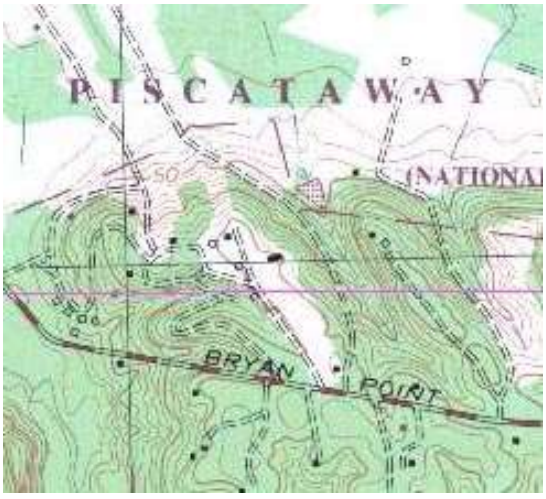
A map is a representation of the Earth, or part of it. The distinctive characteristic of a topographic map is that the shape of the Earth's surface is shown by contour lines. Contours are imaginary lines that join points of equal elevation on the surface of the land above or below a reference surface, such as mean sea level. Contours make it possible to measure the height of mountains, depths of the ocean bottom, and steepness of slopes.

A topographic map shows more than contours. The map includes symbols that represent such features as streets, buildings, streams, and vegetation. These symbols are constantly refined to better relate to the features they represent, improve the appearance or readability of the map, or reduce production cost.

Consequently, within the same series, maps may have slightly different symbols for the same feature. Examples of symbols that have changed include built-up areas, roads, intermittent drainage, and some lettering styles. On one type of large-scale topographic map, called provisional, some symbols and lettering are hand drawn.

Reading Topographic Maps

Interpreting the colored lines, areas, and other symbols is the first step in using topographic maps. Features are shown as points, lines, or areas, depending on their size and extent. For example, individual houses may be shown as small black squares. For larger buildings, the actual shapes are mapped. In densely built-up areas, most individual buildings are omitted and an area tint is shown. On some maps, post offices, churches, city halls, and other landmark buildings are shown within the tinted area.



The first features usually noticed on a topographic map are the area features, such as vegetation (green), water (blue), and densely built-up areas (gray or red).

Many features are shown by lines that may be straight, curved, solid, dashed, dotted, or in any combination. The colors of the lines usually indicate similar classes of information: topographic contours (brown); lakes, streams, irrigation ditches, and other hydrographic features (blue); land grids and important roads (red); and other roads and trails, railroads, boundaries, and other cultural features (black). At one time, purple was used as a revision color to show all feature changes. Currently, purple is not used in our revision program, but purple features are still present on many existing maps.

Various point symbols are used to depict features such as buildings, campgrounds, springs, water tanks, mines, survey control points, and wells. Names of places and features are shown in a color corresponding to the type of feature. Many features are identified by labels, such as "Substation" or "Golf Course."

Topographic contours are shown in brown by lines of different widths. Each contour is a line of equal elevation; therefore, contours never cross. They show the general shape of the terrain. To help the user determine elevations, index contours are wider. Elevation values are printed in several places along these lines. The narrower intermediate and supplementary contours found between the index contours help to show more details of the land surface shape. Contours that are very close together represent steep slopes. Widely spaced contours or an absence of contours means that the ground slope is relatively level. The elevation difference between adjacent contour lines, called the contour interval, is selected to best show the general shape of the terrain. A map of a relatively flat area may have a contour interval of 10 feet or less. Maps in mountainous areas may have contour intervals of 100 feet or more. The contour interval is printed in the margin of each U.S. Geological Survey (USGS) map.

Bathymetric contours are shown in blue or black, depending on their location. They show the shape and slope of the ocean bottom surface. The bathymetric contour interval may vary on each map and is explained in the map margin.

Source: USGS Topographic Map Symbols,
https://pubs.usgs.gov/gip/TopographicMapSymbols/topomapsymbols.pdf

Topographic Map Symbols

BATHYMETRIC FEATURES

- Area exposed at mean low tide; sounding datum line***
- Channel***
- Sunken rock***

BOUNDARIES

- National
- State or territorial
- County or equivalent
- Civil township or equivalent
- Incorporated city or equivalent
- Federally administered park, reservation, or monument (external)
- Federally administered park, reservation, or monument (internal)
- State forest, park, reservation, or monument and large county park
- Forest Service administrative area*
- Forest Service ranger district*
- National Forest System land status, Forest Service lands*
- National Forest System land status, non-Forest Service lands*
- Small park (county or city)

BUILDINGS AND RELATED FEATURES

- Building
- School; house of worship
- Athletic field
- Built-up area
- Forest headquarters*
- Ranger district office*
- Guard station or work center*
- Racetrack or raceway
- Airport, paved landing strip, runway, taxiway, or apron

CONTROL DATA AND MONUMENTS – *continued*

Vertical control

- Third-order or better elevation, with tablet
- Third-order or better elevation, recoverable mark, no tablet
- Bench mark coincident with found section corner
- Spot elevation
- Roadside park or rest area
- Picnic area
- Campground
- Winter recreation area*
- Cemetery

COASTAL FEATURES

- Foreshore flat
- Coral or rock reef
- Rock, bare or awash; dangerous to navigation
- Group of rocks, bare or awash
- Exposed wreck
- Depth curve; sounding
- Breakwater, pier, jetty, or wharf
- Seawall
- Oil or gas well; platform

CONTOURS

Topographic

- Index
- Approximate or indefinite
- Intermediate
- Approximate or indefinite
- Supplementary
- Depression
- Cut
- Fill
- Continental divide

Bathymetric

- Index***
- Intermediate***
- Index primary***
- Primary***
- Supplementary***

PROJECTION AND GRIDS

- Neatline (39°15′ / 90°37′30″)
- Graticule tick (55′)
- Graticule intersection
- Datum shift tick

State plane coordinate systems

- Primary zone tick (640 000 FEET)
- Secondary zone tick (247 500 METERS)
- Tertiary zone tick (260 000 FEET)
- Quaternary zone tick (98 500 METERS)
- Quintary zone tick (320 000 FEET)

Universal transverse mercator grid

- UTM grid (full grid) (73)
- UTM grid ticks* (69)

MINES AND CAVES

- Quarry or open pit mine
- Gravel, sand, clay, or borrow pit
- Mine tunnel or cave entrance
- Mine shaft
- Prospect
- Tailings
- Mine dump
- Former disposal site or mine

LAND SURVEYS

Public land survey system

- Range or Township line
- Location approximate
- Location doubtful
- Protracted
- Protracted (AK 1:63,360-scale)
- Range or Township labels R1E T2N R3W T4S
- Section line
- Location approximate
- Location doubtful
- Protracted
- Protracted (AK 1:63,360-scale)
- Section numbers 1 - 36
- Found section corner
- Found closing corner
- Witness corner WC
- Meander corner MC
- Weak corner*

Other land surveys

- Range or Township line
- Section line
- Land grant, mining claim, donation land claim, or tract
- Land grant, homestead, mineral, or other special survey monument
- Fence or field lines

MARINE SHORELINES

- Shoreline
- Apparent (edge of vegetation)***
- Indefinite or unsurveyed

RIVERS, LAKES, AND CANALS – *continued*

- Perennial lake/pond
- Intermittent lake/pond
- Dry lake/pond
- Narrow wash
- Wide wash
- Canal, flume, or aqueduct with lock
- Elevated aqueduct, flume, or conduit
- Aqueduct tunnel
- Water well, geyser, fumarole, or mud pot
- Spring or seep

RAILROADS AND RELATED FEATURES

- Standard guage railroad, single track
- Standard guage railroad, multiple track
- Narrow guage railroad, single track
- Narrow guage railroad, multiple track
- Railroad siding
- Railroad in highway
- Railroad in road
- Railroad in light duty road*
- Railroad underpass; overpass
- Railroad bridge; drawbridge
- Railroad tunnel
- Railroad yard
- Railroad turntable; roundhouse

RIVERS, LAKES, AND CANALS

- Perennial stream
- Perennial river
- Intermittent stream
- Intermittent river
- Disappearing stream
- Falls, small
- Falls, large
- Rapids, small
- Rapids, large
- Masonry dam
- Dam with lock
- Dam carrying road

SUBMERGED AREAS AND BOGS

- Marsh or swamp
- Submerged marsh or swamp
- Wooded marsh or swamp
- Submerged wooded marsh or swamp
- Land subject to inundation Max. Pool 431

SURFACE FEATURES

- Levee
- Sand or mud Sand
- Disturbed surface
- Gravel beach or glacial moraine Gravel
- Tailings pond Tailings Pond

ROADS AND RELATED FEATURES

Please note: Roads on Provisional-edition maps are not classified as primary, secondary, or light duty. These roads are all classified as improved roads and are symbolized the same as light duty roads.

- Primary highway
- Secondary highway
- Light duty road
- Light duty road, paved*
- Light duty road, gravel*
- Light duty road, dirt*
- Light duty road, unspecified*
- Unimproved road
- Unimproved road*
- 4WD road
- 4WD road*
- Trail
- Highway or road with median strip
- Highway or road under construction
- Highway or road underpass; overpass
- Highway or road bridge; drawbridge
- Highway or road tunnel
- Road block, berm, or barrier*
- Gate on road*
- Trailhead*

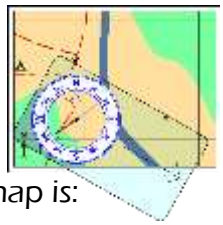
TRANSMISSION LINES AND PIPELINES

- Power transmission line; pole; tower
- Telephone line
- Aboveground pipeline
- Underground pipeline

VEGETATION

- Woodland
- Shrubland
- Orchard
- Vineyard
- Mangrove

Student Sheet – Mapping Basics



1. Comparing a 1:24,000 and a 1:250,000 SCALE map, the LARGER SCALE map is:

   a. 1:24,000

   b. 1:250,000

2. What are the scales of the maps you are studying?

   _____ _____

3. Using the plastic overlay, draw a line representing the scale, and measure several distances:

   a. From _____ to _____ is _____ miles.

   b. From _____ to _____ is _____ miles.

   c. From _____ to _____ is _____ miles.

4. List some *cultural* features you find on your map:

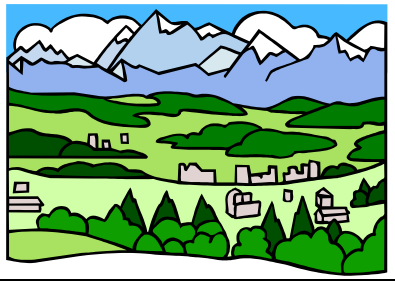
_____

5. List some *political* features on you find on your map:

_____

6. List the names of some of the *waterways* you find on your map:

_____



Continued on next page

7. Find an *urban* area on your map, and describe it in terms of cultural or political features.

_____

_____

8. Create a square on the plastic overlay, and use it to measure *impervious* surfaces (These are land uses that don't allow rainwater to sink in, and will be gray, red or purple on your map, representing *urban* areas.)
9. Estimate the percentage of impervious surface you see on your map. _____%
10. What is the contour interval on your map? _____
11. Find the area of highest and lowest elevation on your map:
    a. Highest point is _____ at _____ feet above sea level.
    b. Lowest point is _____ at _____ feet above sea level.
12. What parts of this map are actually visible if you were looking at the land in real life or a photo?
    _____
13. What parts are not actually visible?
    _____
14. In which direction does water flow in the streams and rivers? How can you tell?

_____

_____

15. Which areas of the map have the most impervious cover?

_____

16. Which areas are threatened by flooding? Explain why.

_____

17. Which areas are most vulnerable to trash and litter pollution? Explain why.

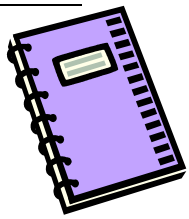
_____

2.4 Journaling

Improving Observation Skills

"The strongest memory is weaker than the palest ink."

Overview



This lesson plan introduces students to the skill of journaling, which will help in observation skills and data collection, and will provide personal connections to the natural world. Journaling will be used throughout the activities in the curriculum.

Lesson Planner

Use the table below for lesson planning purposes.

Time Required	15 minutes to 1 hour
Key Concepts/Terms	Observation
Prerequisites	None
Setting	Classroom or Outdoors, Individual

Learning Objectives

After completing this activity, students will be able to…

- Create a journal page that includes detailed observations;
- Format journal pages to accurately record time, season, place and other details, to allow detailed recollection at a later time;
- Use journaling as a tool in collection of scientific data; and
- Use journaling to create and recall a "sense of place" that connects them in personal ways to the natural world.

Materials Required

The following materials are required, per student, to complete this activity.

- Paper or Notebook
- Pencil or Pen, Colored Pens or Pencils for Drawing

Continued on next page

Background Information

Journaling can fulfill two purposes:

- Observations, especially of nature, can be enhanced and improved by recording them in written or other form. Scientists use journals to record details accurately.

- Developing a "sense of place," that can connect students to the environment in powerful and effective ways, leading to greater appreciation for the natural world.

Journals have been used for centuries, by explorers such as Lewis and Clark, and great minds such as Thomas Jefferson, Henry David Thoreau and Aldo Leopold. In these journals, they recorded discoveries about themselves and their environment in remarkable literary styles.

Artists keep detailed sketch books as a reference for their final work. Creating a sketch concentrates attention on details that are easily overlooked when thinking just in terms of the written word. The most interesting and useful journals combine words and sketches to communicate observations, thoughts and feelings.

Continued on next page

Procedure

Follow the steps in the table below to conduct the activity. **Sentences in bold are suggestions for what teachers might say to students.** *Items in italics are possible student answers to questions.*

Phase	Step	Action
Engage	1	<u>One Minute Exercise</u> Choose an event in which all the students recently participated, such as a classroom activity or school event. Without discussing or recalling any details, allow students one minute to write or draw a picture about the event. Compare the writing and drawings as a class or in small groups. Questions for students: **"How easy was it to remember all of the details?"** **"Did anyone else remember things differently?"** **"If you read your own writing or viewed your drawing 10 years from now, would you have enough information to be able to return to the same location and have a similar experience?"** *As the students discuss their perspectives, emphasize how important it is to record the details of our experiences while they are fresh in our minds. Explain that a journal is a structured way to record our experiences, in order to remember details accurately, and to remember our experiences and how we felt about them.*

Continued on next page

Procedure (continued)

Phase	Step	Action
Explore	2	Five Minute Exercise: Journaling in the classroom *The purpose of this exercise is to learn which details are important both to record data scientifically and also to capture "a sense of place"(a connection to a moment in time, place and state of mind that forms a powerful, positive memory).* Ask students to write and/or draw for five minutes, creating a journal entry that will capture this room and everything in it at this moment in time. When time is up ask students to *categorize*, with a partner, the types of information they recorded. For example, one category could be time: did they record the time of day, date, or season of the year? Possible other categories: • location, such as room number, place in the room, city, state or country, etc. • description of the room • people in the room • objects, plants, animals in the room • objects or persons seen outside the room • temperature, smells, textures, colors • impressions of the atmosphere or feelings in the room • personal expressions of sleepiness, hunger, boredom, happiness • descriptions of activities, personal or by others Discuss results and create a class master list of important types of information to include in journal pages.
	3	Format for Journal Pages: Give students copies of the ***Blank Journal Page***, pg. 2-38. Discuss list of items in small blue box on the ***Blank Journal Page***, and compare to the class master list. Make any additions you/the class feel(s) necessary.

Continued on next page

Procedure (continued)

Phase	Step	Action
Explore	4	<u>Engaging Students in Drawing</u> • Students might be intimidated by drawing. Start small and simple—a leaf, for example. • Sketch or trace the shape of a leaf, or hold the leaf above the paper and trace its shadow as it falls on the page. Alternately, make a leaf rubbing. • Add details, such as veins or lobes. Use a finger to measure distances between details to keep the drawing sections in perspective. • Look carefully at colors, to see gradations and differences in color. • Look for shapes within shapes, such as triangles between veins. • Use cross-hatching or stronger pencil strokes to show shadows or depth.
	5	<u>Drawing Practice on a Natural Object</u> • Choose an easy specimen, one with which the students are familiar, such as a stuffed mammal, shell, preserved insect or fish. • Let students observe the specimen, and handle it if possible. Texture is easier to feel than describe. • When they are ready to begin drawing, place specimen where they can view it, but ask them to draw it in the position as they see it. Each student will see a slightly different perspective. • Point out identifying characteristics, such as the number of legs, or shape or a body part. • Ask students to draw these features as you describe them. Use simple descriptions of relative size of body parts, to help students keep their drawings in perspective. • Point out that scientists use characteristics such as these to classify and identify study specimens.
	6	<u>Ten Minute Homework Exercise:</u> Journaling Outside the Classroom. **"Choose a place where you will be undisturbed for ten minutes. Create a journal entry, using words and drawings, to describe what you see, hear, feel, and smell. Include enough information so that someone reading your journal will feel as if they were right there with you when they read it."**

Continued on next page

Procedure (continued)

Phase	Step	Action
Explain	7	Classroom Activity: Analyzing Ten Minute Homework Exercise (See ***Student Sheet -- Analyzing Ten Minute Exercise,*** pg. 39.) Pair students to exchange homework exercises. The purpose is to think about the kinds of information recorded, and which are important to record data scientifically and also to capture the "sense of place." Lead a class discussion of analysis results: **"What details were objective recordings of scientific data?"** **"Were they accurate and descriptive?"** **"What details were most important to make the reader feel like he/she was right there with the journalist?"**
Elaborate	8	• Assign additional journaling, either as homework, or as a classroom exercise. • Create opportunities for students to share their journal entries, such as in a school newspaper or with another class. • Read together excerpts from journals written by famous persons, such as Lewis and Clark.
Evaluate	9	Performance Assessment: Journal Entries You can have the class discuss/decide on important criteria for all journal entries and then create a rubric, as a group, for evaluating them.

Blank Journal Entry Page

Name:

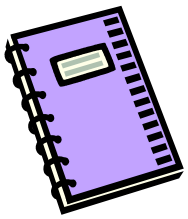
Time:

Location:

All Journal Entries Should Include:

1. **Time**: date, day, time, season of the year
2. **Location**: immediate vicinity, larger area
3. **Body of the Journal Entry**: what you observe with all of your senses. This should be details such as:
   - Who is here with you?
   - Why are you here right now?
   - What do you see, feel, smell, hear, taste?
   - What activity do you see?
   - How does it relate to your purpose?
   - Is your habitat changing as you observe it?

Student Data Sheet for Analyzing the Ten Minute Exercise



"Pretend that you have found the journal of an unknown scientist who visited an exotic location. You are going to make a presentation to your colleagues at the Natural History Society, and tell them about the unknown journalist's adventure. Using only data recorded in the journal entry from the *Ten Minute Homework Exercise*, answer these questions:"

Where did he/she go?

When was he/she there?

How long was he/she there?

Who was there with him/her?

What animals did he/she see? (Humans are animals)

What did they look like?

What were they doing?

Describe the habitat.

What measurements did he/she take?

What scientific instruments did he/she use? (Clocks and thermometers are scientific instruments. Counting is a measurement.)

Describe the weather.

Did it change while he/she was there?

How did he feel while he/she was there?

What do you think made him/her feel that way?

What other information did he/she record?

What details were objective recordings of scientific data?

Were they accurate and descriptive?

What details were most important to make the reader feel like he/she was right there with the journalist?

2.5 Watershed Address

Mapping the Potomac River Watershed

Overview

By mapping the outlines of the Potomac River watershed, students will learn where they live in terms of streams, rivers and the Chesapeake Bay. Their watershed address will be defined in terms analogous to the more familiar political boundaries.

Lesson Planner

Use the table below for lesson planning purposes.

Time Required	30 - 40 minutes
Key Concepts/Terms	Watershed
Prerequisites	Mapping Basics, Water Cycle
Setting	Classroom, Individual/Small Group

Learning Objectives

After completing this activity, students will be able to…

- Locate where they live in the Chesapeake Bay watershed;
- Understand the extent of the Potomac River watershed; and
- Explain their personal connection to the Chesapeake Bay by tracing the waterways from their nearest stream to the Bay.

Materials Required

The following materials are required to complete this activity.

- ***Student Sheet – Chesapeake Bay Watershed Map*** (pg. 2-43)
- Markers/Pens
- *Optional:* Topographic Maps and/or labeled aerial photos to use as student references.

Procedure

Follow the steps in the table below to conduct the activity. **Sentences in bold are suggestions for what teachers might say to students.** *Items in italics are possible student answers to questions.*

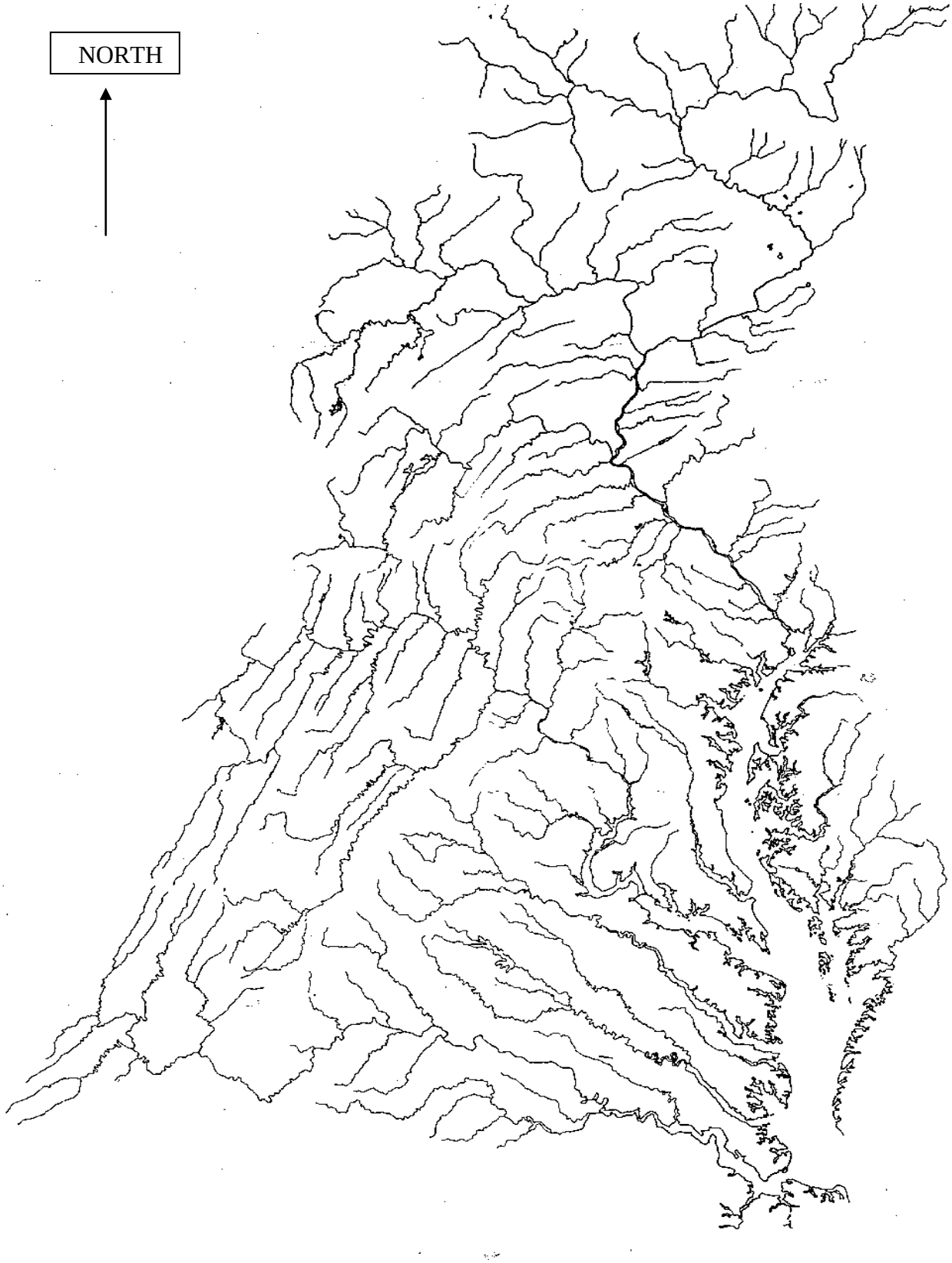
Phase	Step	Action
Engage	1	Identify the school's political address: Ask students to write their home or school address. Identify each component of the address, from largest to smallest political division: country, state, (county), city, street, house number. For example, the address of Hard Bargain Farm would be: USA, Maryland, Prince George's County, Accokeek, Bryan Point Road, 2001)
Explore	2	Hand out ***Student Sheets – Chesapeake Bay Watershed Map,*** pg. 2-43. Explain that this map shows all the tributaries that drain into the Chesapeake Bay. Have students find and label the following on their maps: • **Chesapeake Bay** • **Atlantic Ocean** • **Potomac River** • **Susquehanna, Rappahannock, York and James Rivers** • **Washington, DC** • **Approximate location of our school** It will be helpful here to have a transparency or large poster version of the blank map to find the locations listed above with students. Use the ***Teacher Answer Key***, pg. 2-44, if necessary, for student self-correction.
	3	**We are going to outline the watershed of the Potomac River, which is a sub-watershed of the Chesapeake Bay.** **Locate Point Lookout and Smith Point, the north and south points of land where the Potomac River empties into the Chesapeake Bay. Mark each with a dot.**
	4	**Trace a line, over the land, from Point Lookout around to Smith Point, without crossing any lines (streams and rivers).**

Continued on next page

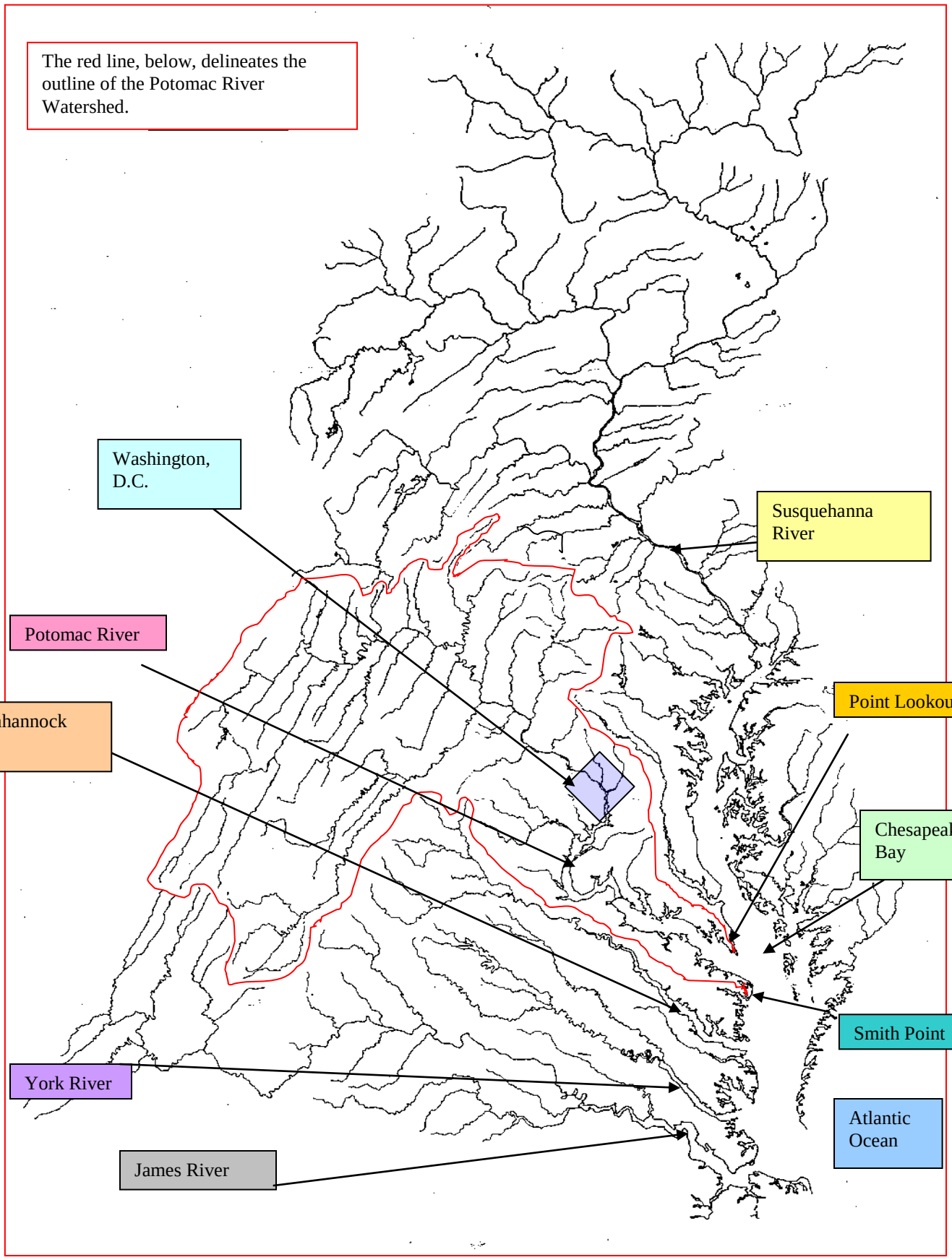
Procedure (continued)

Phase	Step	Action
Explain	5	**What does this area within the traced line represent?** *The tracing has outlined the Potomac River watershed. The line shows the high points of land around the Potomac River. All of the land inside this line runs downhill to the Potomac. All of the land outside of this line runs downhill to another creek, stream, river or bay.*
Explore	6	**What is the nearest stream to our school?** Using the reference maps if necessary, ask students to trace that stream as it flows into a larger stream or river, and then the next body of water, etc., until they reach the Chesapeake Bay. Using a transparency or oversized poster, have students model this so others can see and follow along on their individual maps. **What is your "watershed address", beginning with the nearest creek and ending with the bay or Atlantic Ocean?** *Example: Hard Bargain Farm's watershed address is:* *Hard Bargain Farm,* *Accokeek Creek watershed,* *Potomac River watershed,* *Chesapeake Bay watershed,* *Atlantic Ocean watershed*
Elaborate	7	<u>Reflection or Journal Entry</u> Ask students to imagine that a piece of trash is dropped in their schoolyard. Write a story that describes its journey as a heavy rainstorm washes it into the Chesapeake Bay.
Evaluate	8	<u>Performance Assessment</u> • completed maps • correct "watershed address"

Student Sheet – Chesapeake Bay Watershed Map



Teacher Answer Key – Chesapeake Bay Watershed Map



2.6 Mapping Your Surroundings

Creating Schoolyard Maps

Overview

Using skills learned in "Mapping Basics," students will create a manual GIS (Geographic Information System). Starting with a base map of the schoolyard, students will create transparent overlays, each of which contains specific information. These will be used, in various combinations, to investigate environmental issues and find solutions.

Lesson Planner

Use the table below for lesson planning purposes.

Time Required	Classroom: 30 minutes to 1 hour Outdoors: 30 minutes to 1 hour
Key Concepts/Terms	Mapping, Scale, Land Use, Permeability
Prerequisites	Students should have completed ***Mapping Basics***, pg. 2-19.
Setting	Classroom and Outdoors, Small Group

Learning Objectives

After completing this activity, students will be able to…

- Create map layers showing specific features and types of information;
- Interpret maps and layers to investigate environmental issues and record data; and
- Plan a course of action guided by map data.

Continued on next page

Materials Required

The following materials are required to complete this activity.

Per Group

- Several Different Maps, such as a topographic map, a road map, and a tourist map
- Colored Markers (permanent, for the transparencies)
- Drafting Tape (this is similar to masking tape, but will not tear the base maps when removed)
- Soil Permeability Testing Kit:
  - A Can with both ends removed (see ***Schoolyard Habitat Project Guide***, U.S. Fish and Wildlife Service)
  - 100 mL measure
  - Stopwatch
- *Optional:* Copies of the ***Manual GIS Overlay Data Assignments***, pg.2-51, for each group of students

Per Student

- ¼ Inch Graph Paper
- 2-3 Copies of a Base Map of the Schoolyard
- Transparent overlays: clear plastic sheets the same size as the base map

Background Information

GIS (Geographic Information System) is a way to collect and analyze data. On computers, we can create layers on a base map that show political boundaries, topography, land use, cultural features such as houses or schools, and many other types of information.

This process can be done manually by students. Using a base map that shows a few important features drawn to scale, such as buildings and roads, students can create overlays, which show other information they gather themselves. For instance, they may draw existing streams and storm drains. Another layer may show vegetation, such as trees, shrubs and grassy areas. By choosing the layers, and consequently the specific information, students can analyze water flow and runoff patterns, natural habitat areas, and many other factors. Using this data, they can investigate environmental problems, research solutions, and form an action plan.

Note: base maps can be obtained in several ways, including:

- Schoolyard maps may be available from the school district.
- Aerial photographs and topographic maps may be obtained from US Geological Service. (See ***Teacher Resources,*** pg. 2-52).
- Maps may be drawn by hand, making sure that relative distances are preserved. Distances could be paced off or measured with a measuring tape or wheel. Label important features such as buildings, driveways and fences.

Procedure

Follow the steps in the table below to conduct the activity. **Sentences in bold are suggestions of what a teacher might say to students.** *Items in italics are possible student responses.*

Phase	Step	Action
Engage	1	Map the Classroom Preparation: measure the outer dimensions of the classroom, and several of the larger features. a. On ¼ inch graph paper, ask students to make a map of the classroom. Use the scale of ¼ inch equals 1 foot or floor tile. b. Tell them the dimensions of the room and ask them to first count off and draw the outline of the room. Model this step on a transparency/poster of graph paper. Then assist them in drawing a few of the prominent features, such as the door position and width, and the size of a table or desk. This will help them add new features to scale. c. Allow them 5-10 minutes to add whatever details they wish. d. With a partner, ask students to compare maps, and discuss (2-3 minutes) their similarities and differences. e. With the whole class, briefly discuss differences in their maps, to make the point that maps are designed to show specific types of information. One student may have included who sits where in the room. Another may have concentrated on the arrangement of furniture. A third may have noted windows and doors. Each map showed what was most important to the designer.
	2	Comparing Purposes of Maps • Collect several maps that show very different information. For instance, a topographic map, a road map, and a tourist map showing points of interest. • Discuss similarities (*all are drawn to a scale, and probably show major roads and communities*). • Discuss differences (*topographic maps show elevation, tourist maps show museums or parks, and so on*). • Conclude with students that maps are designed for specific purposes.

Procedure (continued)

Phase	Step	Action
Explore	3	Preparing to Map the Schoolyard *Make a base map of your schoolyard either by drawing it yourself or tracing/copying another map. Draw a heavy rectangle around the perimeter of the area of interest, to use as a reference for the clear overlays, before reproducing it to create student copies.* • Divide students into groups of 6. (Each completed map uses 6 overlays. This is a jigsaw-style cooperative activity, where students become experts in a specific aspect of the project, and then share their knowledge with their group members.) • Distribute base maps to each student and help with orientation by asking them to identify key features. • Assign each member of the group one overlay category/task. (See ***Manual GIS Overlay Data Assignments***, pg. 2-51).
	4	Mapping the Schoolyard (Outside) • Have all the students that are working on the same category join together to work on that topic (ex: all students assigned Traffic Pattern Data form a new group while gathering that data). So, if there are four groups, there will be four students working together on each topic. These students will later rejoin their original group to compile their data/overlays and discuss their findings. • Outside, each student should record their specific data on their copy of the base map. It is important that each student record the data on an individual map, as each will be rejoining their original group, and will need the data.

Continued on next page

Procedure (continued)

Phase	Step	Action
Explore	5	Assembling the GIS (Back in the Classroom) • Have students reform the original groups, with one expert on each of the six topics in each group. Each student should now have a base map with their data drawn on it to share with their group members. • Distribute a clear plastic overlay to each student. Ask students to lay the plastic on top of the base map and secure edges with two or more small pieces of drafting tape. Using permanent markers, have them label the transparency with their name and date. • Ask students to draw a dot or small circle at the four corners of the heavy rectangle. This will ensure that the overlays will match up when they are reassembled. • Students should trace their drawn data onto their transparency, from the base map they used outside. The group will end up with six transparent overlays for the base map, each showing different data.
Explain	6	Assemble each group's manual GIS by removing each plastic sheet from its base map, and then laying them one on top of each other, making sure the corner marks are lined up. Have students explain their findings. This can be done within each group, or as a class, using the overlays and the overhead projector. Have students use the overlays over the base map in different combinations to see how the data relate to one another. Discussion Questions: • **What did students find?** They should explain their drawn data using words. • **When different overlays are combined, do the students notice any correlation between different categories?** *(For example, between where vegetation is present/absent and water flow patterns?)* • **Do students see any areas of particular concern?**
Elaborate	7	Investigating Environmental Issues in the Schoolyard Use the manual GIS maps to look at the schoolyard, and investigate possible problems. (See *Issue Investigation Framework, Unit 6.)*

Continued on next page

Procedure (continued)

Phase	Step	Action
Evaluate	8	Performance Assessment: manual GIS maps created by students

Vocabulary

Understanding of the following terms is useful in this activity.

Term	Definition
GIS	Geographic Information System. A computer system that links geographic reference data to series of data that can range from land use to population density to income levels. By using overlays, GIS allows users to create maps with specific types of information.
Impervious	A surface that does not allow water to soak in, such as asphalt
Land use	The type of activity conducted on a specific piece of land, with emphasis on how such use impacts the permeability of the surface and runoff from the surface
Manual GIS	Creating maps by hand that focus on specific data, by using clear plastic overlays on a base map
Overlay	A clear plastic sheet that can be laid on top of a base map, and used to record a specific type of data, such as roads and trails
Permeability	The rate at which water passes through soil; high permeability means rain water quickly soaks into the ground
Topography	A study and mapping of surface features such as mountains, rivers and roads

Manual GIS Overlay Data Assignments

MAPPING CATEGORY	WRITE WITH…	HOW TO MAP THIS DATA
TRAFFIC PATTERN	**Black** markers	Draw the roads, parking lots, and pathways on your map. Use different symbols to show how each is used. Examples could be by cars and trucks, bicycles, people walking, or animals.
WATER FLOW/ TOPOGRAPHY	**Blue** markers	Draw the streams and any areas where water flows on your map. Draw arrows to show where water flows when it rains.
PLANTS	**Green** markers	Create symbols to show trees, shrubs, grass, flower beds, etc. Outline the different areas of plant life on your map.
SOILS AND SURFACES	**Purple** markers	Create symbols to show different surfaces on your map. Examples of different surfaces include hard packed soil, loose sand, asphalt, pebbles, grass, etc. Do permeability tests on each type of surface that isn't concrete or pavement (see directions for permeability testing below). How to Conduct Soil Permeability Tests a. Place the can on the soil to be tested. Gently twist and push until the can is about 1 inch into the ground. b. Measure 100 mL of water. c. Pour the water all at once into the can and use a stopwatch to time how long it takes for the water to disappear. d. Record the results in seconds. If water is still present after two minutes, stop timing and record the surface as "IMPERVIOUS."
SUN AND SHADE	**Orange** markers	Create a scale from 1 (bright sun) to 5 (complete shade). Noting time of day, record a sun/shade rating for each part of the schoolyard.
NEARBY LAND USE	**Red** markers	Record how land is used in each direction from the schoolyard.

Recommended Books

Arnosky, J. 1982. **Drawing From Nature**. Lee and Shepard Books, New York: Lothrop.

Brooks, M. **Drawing with Children**.

Carter, Jimmy. 1988. **An Outdoor Journal: Adventures And Reflections**. Bantam Books, Toronto ON.

Cole, Joanna. **The Magic School Bus at the Waterworks**. 1986. Scholastic, Inc.: New York, NY.
An eccentric teacher takes her class on a fieldtrip adventure starting in the rain clouds and traveling through the city waterworks – teaching important science concepts along the way. Ages 6-9.

Dorros, A. **Follow the Water from Brook to Ocean**. 1991. Harper Collins Publishers, Inc.: New York, NY.
Water is always flowing, from a brook to a stream, to a river to the ocean. Read and find out more about how water shapes the earth and why it is important to keep out water clean. Ages 4-8.

Ecosystem Matters: Activity and Resource Guide for Environmental Educators, 1995. United States Department of Agriculture Forest Service, Rocky Mountain Region.

Hinchman, Hannah. 1991. **A Life In Hand: Creating The Illuminating Journal**. Peregrine Smith Books, Salt Lake City UT.

Leopold, Aldo. 1966. Essay entitled "The Alder Fork" in: **A Sand County Almanac**. Ballantine Books, New York, NY.

Lowenstein, S. 1987. "A Brief History Of Journal Keeping." Pp. 87-97 in **The Journal Book** (T. Fulwiler, ed.). Boynton/Cook Publishers, Portsmouth NH.

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Recommended Books (continued)

Rackliffe, K.S. 1998. **Wild Days: Creating Discovery Journals.** Karen Skidmore Rackliff Publ., Salt Lake City, UT.

Remsen, J. V. Jr. 1977. "On Taking Field Notes." **American Birds**. 31:946-953.

Sobel, David. 1998. **Mapmaking With Children: Sense of Place Education for the Elementary Years.** Heinemann, Portsmouth, NH

Schoolyard Habitat Project Guide, 1999. U.S. Fish and Wildlife Service. Chesapeake Bay Field Office. Annapolis, Maryland. (Located on the Teacher Institute Flash Drive) www.fws.gov/ChesapeakeBay/schoolyd.htm

Schoolyard Habitats: A How-to Guide for K-12 School Communities, 2001. National Wildlife Federation. www.nwf.org/How-to-Help/Garden-for-Wildlife/Schoolyard-Habitats/Create/How-To-Guide.aspx

Online Resources

National Oceanic & Atmospheric Administration (NOAA)
Many resources for teachers including background information, lesson plans and professional development opportunities. On the teacher pages, check out the Oceans and Coasts section, particularly the great interactive water cycle activity and estuaries section. www.education.noaa.gov

MERLIN On-line: Map Maryland Your Way.
Interactive mapping tools allow you to select a specific area and type of map to view. Includes aerial photography and topo maps.
http://geodata.md.gov/imaptemplate/?appid=a8ec7e2ff4c34a31bc1e9411ed8e7a7e

United States Geological Survey: *on-line map resources available at* https://www.usgs.gov/products/maps/overview

National Geographic: *on-line maps, atlas and ordering information at:* http://mapmaker.nationalgeographic.org/?ls=000000000000

Watershed Information Network
A great resource for in-depth information regarding the concept and functions of watersheds AND current news on what is happening in the field. www.epa.gov/owow/watershed/

Interstate Commission on the Potomac River Basin
Superb reference site for facts, figures, maps, history, etc. for the Potomac Watershed and other regional sub-watersheds. www.potomacriver.org

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Online Resources (continued)

Know Your Watershed
Maintained by the Conservation Technology Information Center, this site emphasizes a registry of watershed partnerships working to meet local goals – a community clearinghouse for watershed groups and events.
www.ctic.purdue.edu/Know%20Your%20Watershed/

Surf Your Watershed
This EPA website provides a service to help you locate, use, and share environmental information about your place in the watershed – school, home, business, etc. cfpub.epa.gov/surf/locate/index.cfm

Science In Your Watershed
This USGS site offers current, real-time data and scientific information such as streamflow organized by watershed. water.usgs.gov/wsc/

AFF website—Kids' Zone: *Ways of a Watershed and The Water Cycle at* fergusonfoundation.org/hard-bargain-farm/activities-lessons-links/