Think Water

Watersheds

A Thinkified Lesson

About ThinkWater

ThinkWater is a national project sponsored by the USDA and designed by educators, scientists and activists based on research that shows that thinking (metacognition) is a critical and missing component in education. Our vision is a nation of Water Thinkers. Our work in water education includes (1) training formal and informal educators to integrate thinking skills into lessons as a means to increase engagement and deep understanding in water topics and (2) modifying existing water education lessons into “thinkified” lessons. To “Thinkify” a lesson means to add meaningful structure to the information (dsrp) and use research-proven pedagogical techniques (MAC).

Learn more about ThinkWater at: thinkwater.cabreraresearch.org or contact: Laura Cabrera, PhD lac19@cornell.edu

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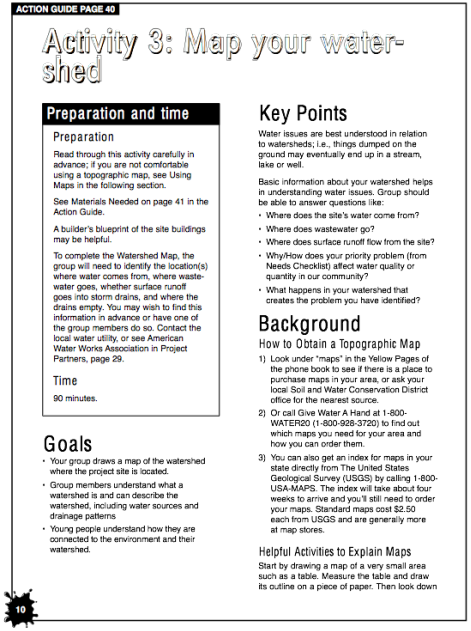
Map Your Watershed: Original



ACTION GUIDE PAGE 40

Activity 3: Map your water-shed

Preparation and time

Preparation

Read through this activity carefully in advance; if you are not comfortable using a topographic map, see Using Maps in the following section.

See Materials Needed on page 41 in the Action Guide.

A builder's blueprint of the site buildings may be helpful.

To complete the Watershed Map, the group will need to identify the location(s) where water comes from, where waste-water goes, whether surface runoff goes into storm drains, and where the drains empty. You may wish to find this information in advance or have one of the group members do so. Contact the local water utility, or see American Water Works Association in Project Partners, page 29.

Time

90 minutes.

Goals

- Your group draws a map of the watershed where the project site is located.
- Group members understand what a watershed is and can describe the watershed, including water sources and drainage patterns
- Young people understand how they are connected to the environment and their watershed.

Key Points

Water issues are best understood in relation to watersheds; i.e., things dumped on the ground may eventually end up in a stream, lake or well.

Basic information about your watershed helps in understanding water issues. Group should be able to answer questions like:

- Where does the site's water come from?
- Where does wastewater go?
- Where does surface runoff flow from the site?
- Why/How does your priority problem (from Needs Checklist) affect water quality or quantity in our community?
- What happens in your watershed that creates the problem you have identified?

Background

How to Obtain a Topographic Map

1) Look under "maps" in the Yellow Pages of the phone book to see if there is a place to purchase maps in your area, or ask your local Soil and Water Conservation District office for the nearest source.
2) Or call Give Water A Hand at 1-800-WATER20 (1-800-928-3720) to find out which maps you need for your area and how you can order them.
3) You can also get an index for maps in your state directly from The United States Geological Survey (USGS) by calling 1-800-USA-MAPS. The index will take about four weeks to arrive and you'll still need to order your maps. Standard maps cost $2.50 each from USGS and are generally more at map stores.

Helpful Activities to Explain Maps

Start by drawing a map of a very small area such as a table. Measure the table and draw its outline on a piece of paper. Then look down

10

The following slides present a modified version of this lesson that incorporates all of the content knowledge and learning objectives but infuses thinking skills (dsrp) throughout and uses research-proven pedagogical approaches (MAC). For your reference, you can download the old lesson but it is not necessary. All the information you need is provided in the following slides.

Access an interactive version of this “Thinkified Lesson” at: http://thinkideas.cabreraresearch.com/maps/1400

Overview of MAC LessonBook

MAC stands for

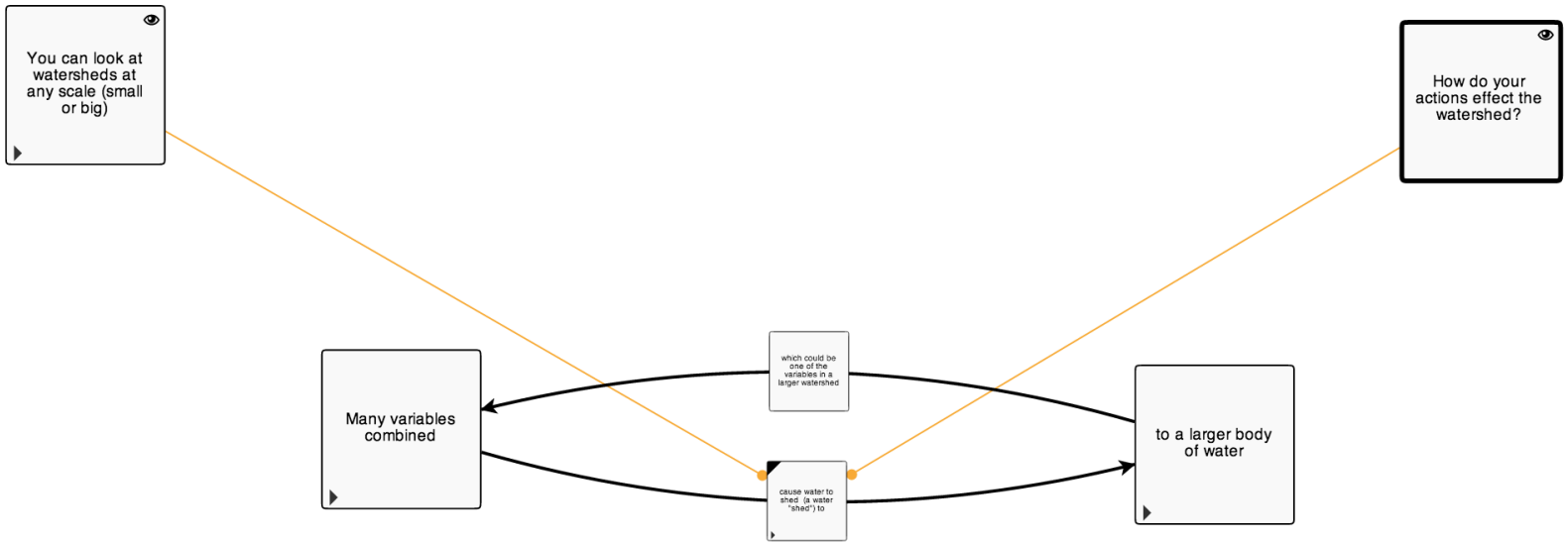
- **Map** the concepts you want students to know
- **Activate** these concepts using a variety of experiential, visual, tactile approaches
- **Check** that the activities led to deep understanding of the concepts in the map

MAP IT (K = I × T)

Knowledge is equal to	Information and	Thinking (structure)
The focus of all learning is to create a change in Knowledge (K). In order to build knowledge learners must use the processes of thinking (T) to meaningfully structure content information (I). There are four universal ways knowledge is structured.	**The information required in this lesson is autogenerated from your IdeaMap. It includes the following:** Can you trace a single droplet?, How do your actions effect the watershed?, Many variables combined, You can look at watersheds at any scale (small or big), _____?, _____?, altitude/topography, cause water to shed (a water "shed") to, drinking water, lakes, microscopic!, municipal water systems, non-point source polution, oceans, plants and animals, point source polution, pollution, puddles, septic tanks, soil and biosolids, to a larger body of water, waste water, waste water treatment plant, water use, waterbodies, waterways (ditches, streams, rivers)), weather/climate, wells, wetlands, where does the water come from?, where/how does the water flow?, which could be one of the variables in a larger watershed, your country, your neighborhood, your state, your town, your yard.	**The thinking skills required in this lesson are autogenerated from your IdeaMap. It includes the following thinking skills:** 43 Distinctions, 7 Systems, 2 Relationships, 2 Perspectives, 2 Relationship Ideas, 1 Relationship System, 1 Perspective System

Common Core Standards
No standards selected

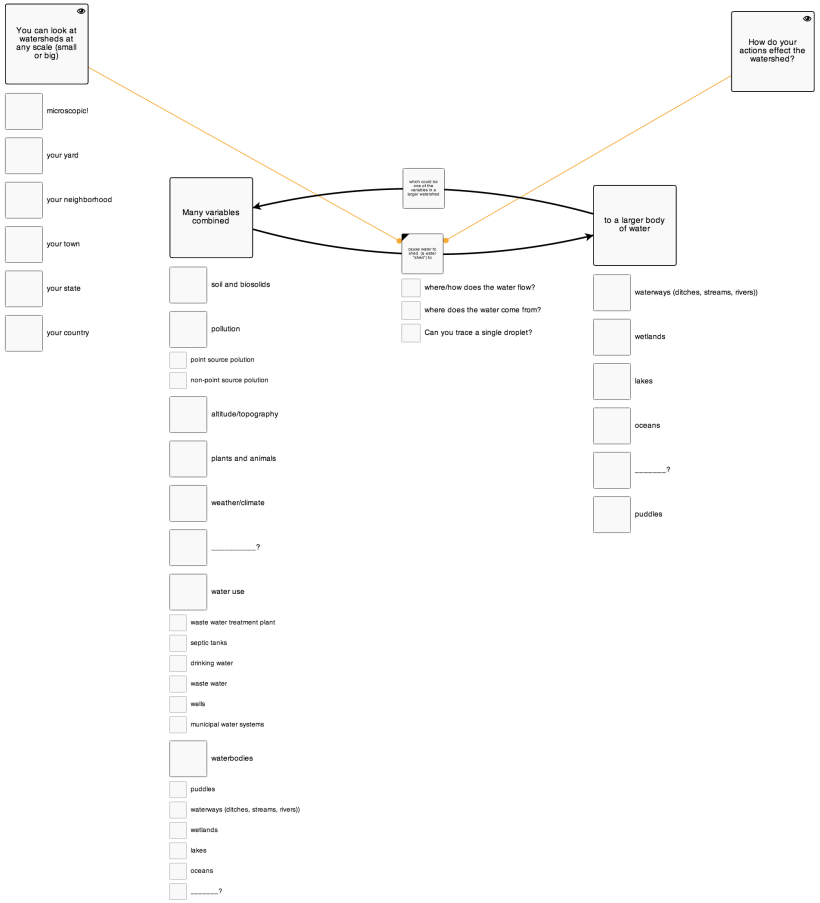
MAP IT



To interact with these maps in a presentation mode in ThinkIdeas, click the following **link.**

[X] I plan to make this map explicit to students

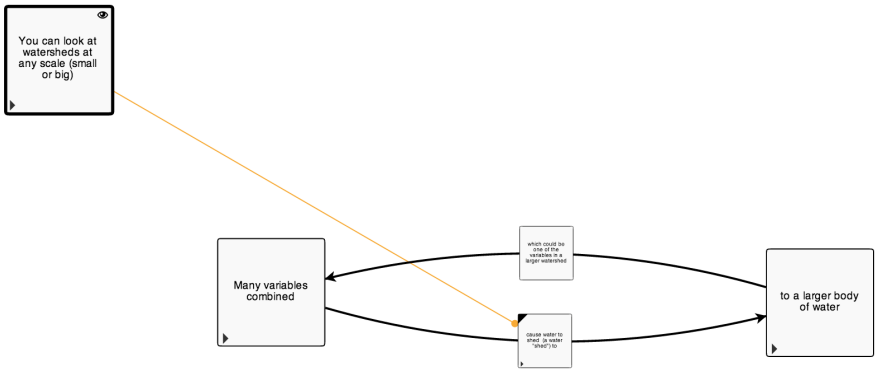
MAP IT


You can look at watersheds at any scale (small or big)
microscopic!
your yard
your neighborhood
your town
your state
your country
Many variables combined
soil and biosolids
pollution
point source polution
non-point source polution
altitude/topography
plants and animals
weather/climate
_____?
water use
waste water treatment plant
septic tanks
drinking water
waste water
wells
municipal water systems
waterbodies
puddles
waterways (ditches, streams, rivers))
wetlands
lakes
oceans
_____?
which could be affected by variables in a larger watershed
cause water to shed (a water TRACTS)
where/how does the water flow?
where does the water come from?
Can you trace a single droplet?
to a larger body of water
waterways (ditches, streams, rivers))
wetlands
lakes
oceans
_____?
puddles
How do your actions effect the watershed?

ACTIVATE IT

Activity 1: What is a Watershed?

- Students review what a watershed is by building a physical model of the concept.
- First, assess **prior knowledge** about watershed by having students identify different ‘bodies of water’ like ponds, lakes, streams, oceans etc. and ‘variables’ like soil, topography, plants etc.(Represent “body of water” and “many variables combined” with two large ThinkBlocks. Use small ThinkBlocks to represent types)
- Facilitate a discussion to have students understand that a watershed is the combined effect of a bunch of variables that cause water to "shed" into a body of water. Notice that the body of water where the water ends up can also be part of a larger watershed and so on, and so on. (Use 2 medium sized ThinkBlocks labeled as “a watershed - causes water to ‘shed’” and “which could be one of the variables in the larger watershed”)
- Facilitate a discussion with the students to have them understand that a watershed can be looked at from the perspective of scale. A watershed can be microscopic or as large as (or larger than!) your entire state. (Use a large ThinkBlock and label “Scale”)



ACTIVATE IT

Activity 2: Mapping a Watershed (5 steps)
Use the activity guide for sample 5 steps.

Materials: map printouts, different color dry erase markers, 4 blank transparencies per student.

Step 1: Choosing a Map based on Scale

- Have each student/team choose a map of an area and print it out (use Google maps, hand-drawn, etc.)

- Discuss and understand the scale of the area each student chose (ex. yard, neighborhood, state, etc.)

ACTIVATE IT

Activity 2, Step 2: Add combined variables in your area on your map

- Have each student/team lay a blank transparency over the map and use a black dry erase marker, have each student/team draw the variables that are present in their chosen area. These can be things like hills (topography), forests (plants), roads, houses, etc.

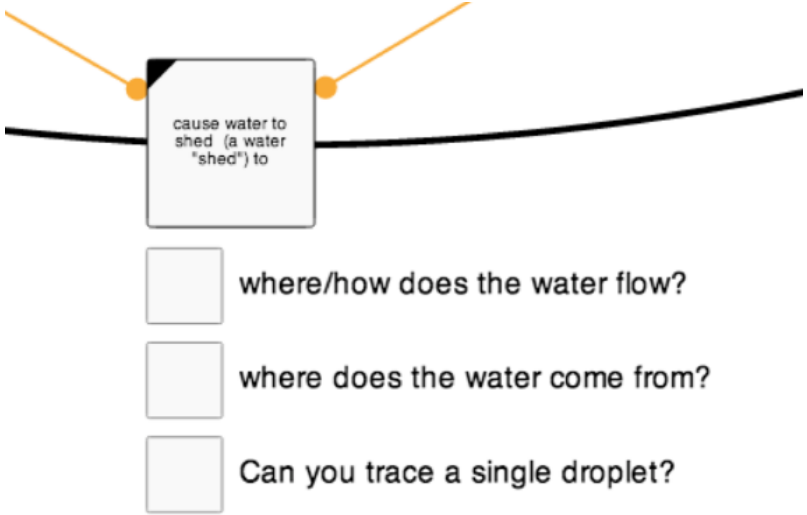
- Using a blue marker, draw the sources of water (another type of variable) on the same transparency. These can be things like rainwater (weather), streams, lakes, rivers, (body of water), atmospheric water and evaporation.

- Have students/teams discuss how the areas they chose affect the variables that exist, like topography, climate, bodies of water, etc.

ACTIVATE IT

Activity 2, Step 3: Draw path of drops - Watershed

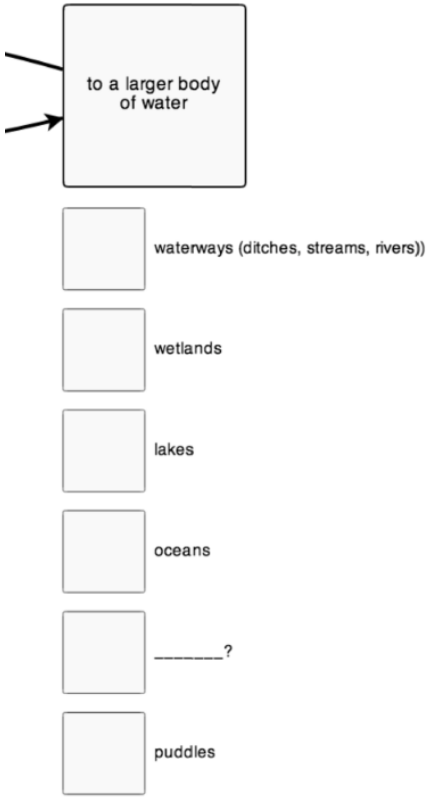
- Using another blank transparency, have students/teams place it on top of the previous transparency and map.
- Using different colors, draw the paths of up to 5 drops placed in different locations on the map.
- Have students understand the impact of the variables on the flow of the water. Such as, water flows down hills, along sides of roads, around obstacles like houses.
- Re-emphasize that a watershed is the sum total of all the flows that are being affected by the combined variables. (Refer back to conceptual model from activity 1)



ACTIVATE IT

Activity 2, Step 4: Find the Endpoint(s) Body of Water

- Through discussion, have students/teams explore where the water in their map ends up.
- Have students/teams find and draw this larger body of water on their maps using a different color marker. (This body of water may not be on the map, eg. downstream lake; if so have the students draw an arrow in the margin and label it.)
- Again, emphasize that a watershed is the sum total of all the flows which drains into the larger body of water.

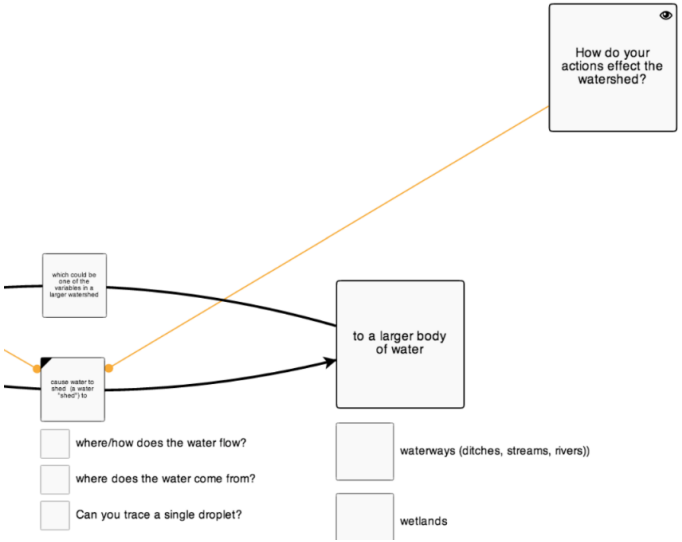


ACTIVATE IT

Activity 2, Step 5: Taking Perspective

- Using another blank transparency, have students/teams place it on top of the previous transparencies and map.

- Using a different colored marker, have students/teams discuss and label where and how they can affect the watershed. eg. usage, pollutants, construction etc.

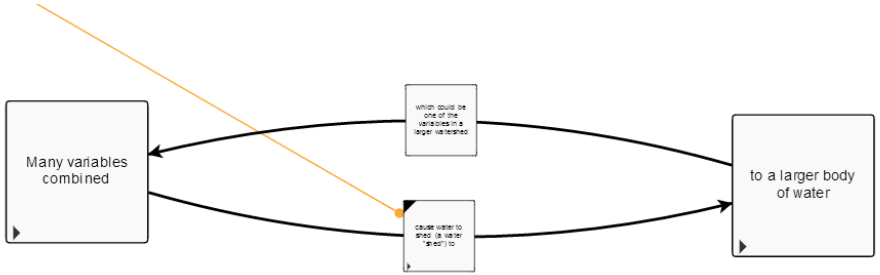


ACTIVATE IT

Activity 3: Distinguishing the key ideas of a watershed

- The teacher should now use different student maps to show watershed at different scales and how the endpoint body of water at one scale becomes a part of the combined variables at a larger scale.

- For example, if one student's map is of his backyard where the watershed ends in a stream (endpoint body of water), this stream becomes a source of water (variable) in another student's map based on a larger scale.



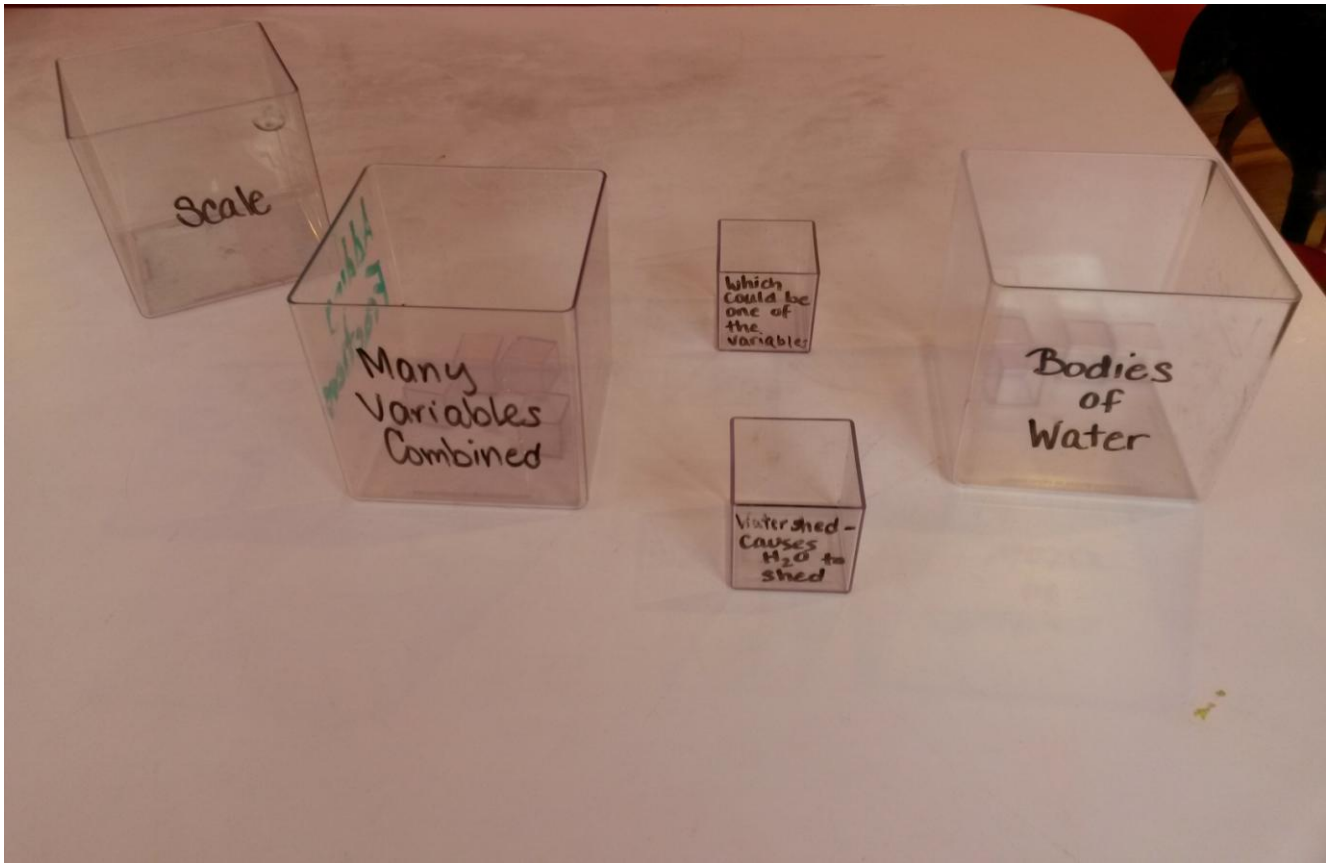
CHECK IT

Activity	Look Fors
What is a Watershed?	● Students should understand and demonstrate that the watershed is the connection between bodies of water and combined variables in the physical model. ● Student should understand and demonstrate that a watershed can be looked at from the perspective of scale in the physical model.
Mapping a Watershed	● Students should be able to distinguish the scale of their chosen area. ● Students should be able to distinguish at least 4 different variables and how they connect in their area. ● Students should be able to distinguish between watershed (sum of flows) from combined variables. ● Students should be able to distinguish between watershed (sum of flows) from body of water (endpoints). ● Students can explain the impact of their actions in relation to watershed (sum of flows) .
Watershed across scales	● Students understand that endpoint body of water at one scale becomes a part of the combined variables at a larger scale.

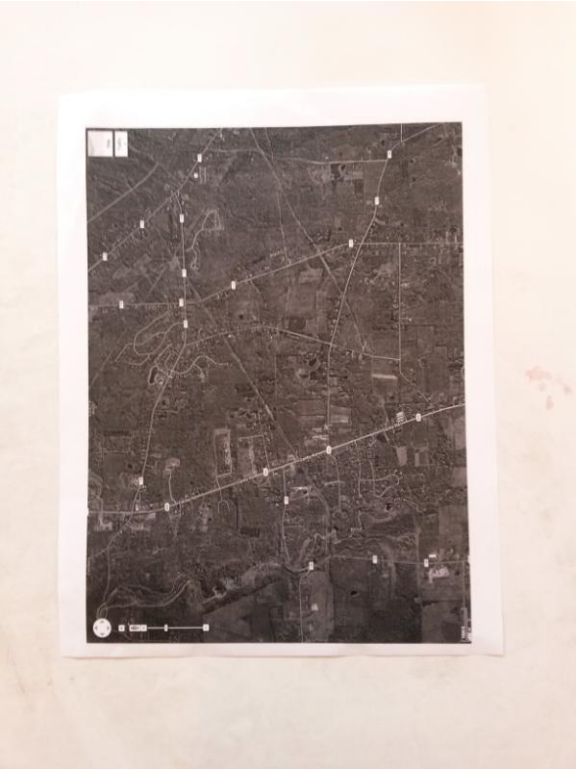
Handout 1: Physical Model

What is a Watershed?

- Build a physical model of the concept of watershed. Use two large ThinkBlocks and label “Many variables combined” and “Bodies of Water”.
- Facilitate a discussion to have students understand a watershed is the combined effect of a bunch of variables that cause water to "shed" into a body of water. Notice that the body of water where the water ends up can also be part of a larger watershed and so on, and so on. (Use 2 medium sized ThinkBlocks labeled as “a watershed - causes water to ‘shed’” and “which could be one of the variables in the larger watershed”)
- Facilitate a discussion with the students to have them understand that a watershed can be looked at from the perspective of scale. A watershed can be microscopic or as large as (or larger than!) your entire state. (Use a large ThinkBlock and label “Scale”)

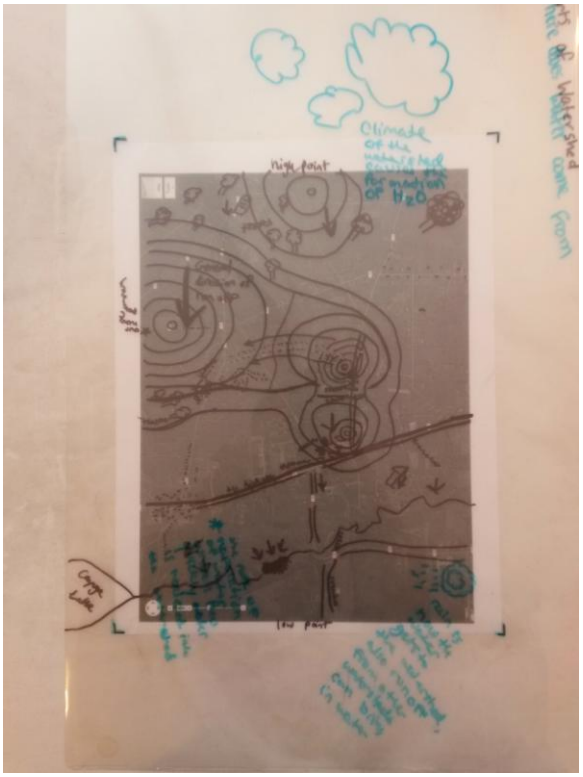


Handout 2: Mapping a Watershed



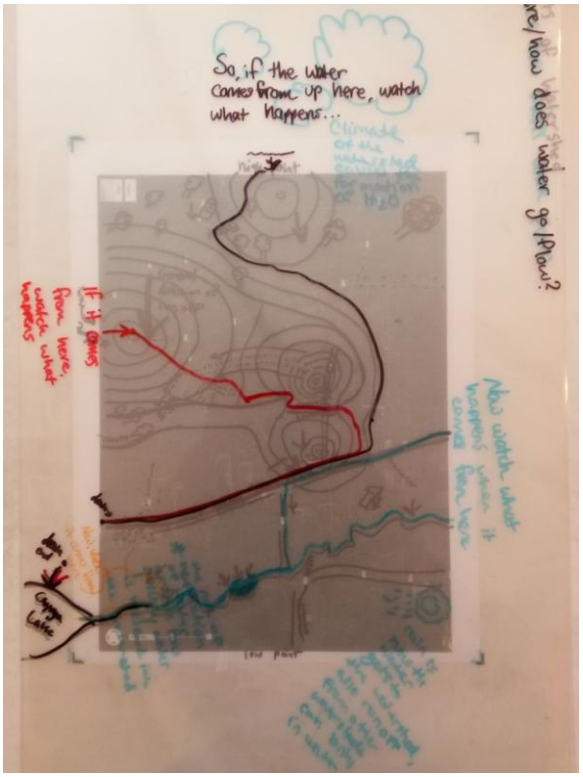
STEP 1:

Choosing a Map based on Scale

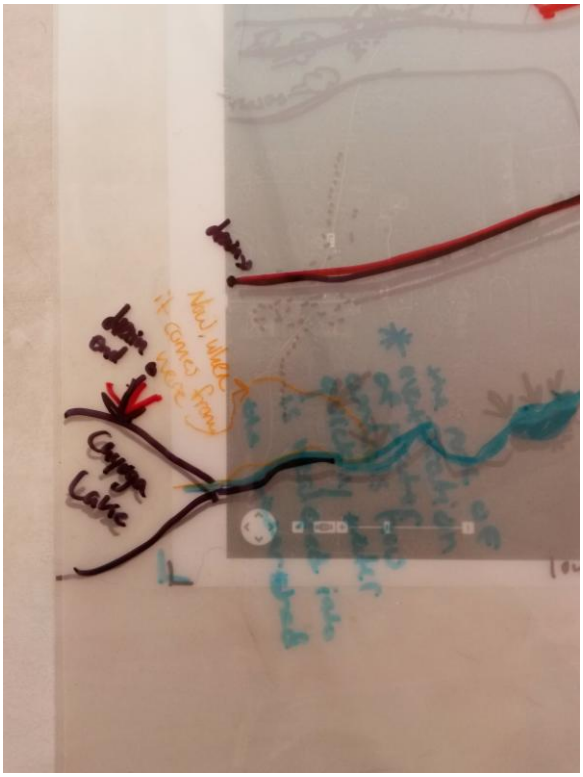


STEP 2:

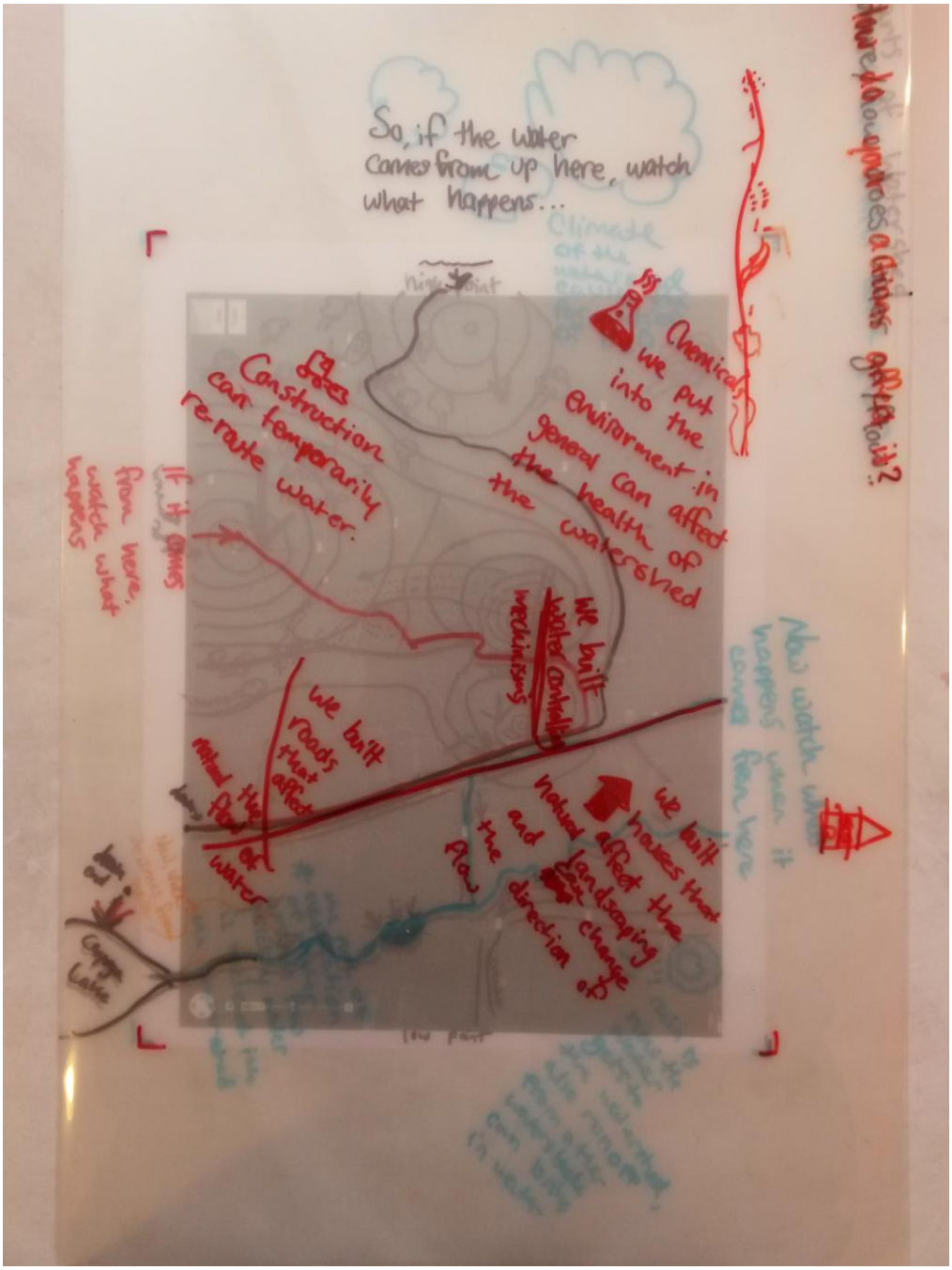
Add combined variables in your area on your map



STEP 3: Draw path of drops - Watershed



STEP 4: Find the Endpoint(s) Body of Water



STEP 5: Taking Perspective

Map Your Watershed, Give Water a Hand
Watershed background information for the Leader

society, to protect water resources for the health of the ecosystem and for ourselves. We may act as individuals by not putting hazardous materials down the drain at home, or we may adopt creative technologies as a society to take care of our natural resources (see the article on Biosolids).

A Focus on Watersheds

A watershed is the area of land where all water drains, or "sheds," to the same river, lake, reservoir or other body of water. Larger watersheds — the Mississippi River watershed, for example — encompass many smaller watersheds, such as the Wisconsin River watershed and the Missouri River watershed.

People understand that it's best to manage environmental issues in a coordinated fashion. Since most natural events and human activities affect the quality of water resources within a local watershed's boundaries, watersheds now seem to be the most sensible unit in which to restore and protect water quality. Focusing on watersheds is particularly appropriate in community service-learning projects. Water ties people and the environment together. Human impact on the landscape in one watershed might well affect aquatic life in a stream, which could change the chemical composition in a lake ecosystem downstream in a second watershed, which might in turn affect the second watershed's local community. Addressing environmental problems using a watershed approach helps young people understand these interconnections between people, communities, and the environment.

The most obvious human interactions with water take place on the surface, yet much of what happens in the watershed is out of sight, in the groundwater. To understand a watershed better, you should know something about the soils, geology and aquifers. See the article on Groundwater. This is especially important when your project deals with wells or groundwater contamination. Give Water A Hand part-

What are biosolids?

Most communities have a wastewater treatment plant that produces biosolids — nutrient-rich organic material that can be used beneficially as compost or fertilizer in gardens or on farms to produce greater crop yields. It's even used to fertilize the White House lawn. Using biosolids helps conserve water and decrease runoff or soil erosion by adding organic matter to soil, which captures water. Some communities package their biosolids in a compost mixture and sell it in local garden stores.

Water pollution

We usually speak of two sources of water pollution, "point source" and "nonpoint source." Point source pollution comes from a specific source, like a discharge pipe at a factory. Because these sources are relatively easy to locate and citizen concern has helped reduce these sources, problems caused by point source pollution have decreased in recent years.

Nonpoint source pollution is associated with sources that aren't so easy to pinpoint — surface water runoff from streets or fields and other sources following rain storms or snow melt. Contaminants that are carried to nearby waterways may include soil sediments, animals wastes, or pesticides. Groundwater may also be affected by nonpoint sources like farms, private sewage systems, improperly capped well pipes and leaky fuel storage tanks. Pollution from nonpoint sources is not only harder to pinpoint, but is more difficult to regulate. One way to reduce this type of pollution is to educate people about when and how to apply fertilizers or pesticides, how to reduce runoff from construction sites, or how to create and protect vegetation buffers along streams.

This is from the Give Water a Hand Leader Guidebook, pp. 10-11.

Activity 3: Map your water-shed

Preparation and time

Preparation

Read through this activity carefully in advance; if you are not comfortable using a topographic map, see Using Maps in the following section.

See Materials Needed on page 41 in the Action Guide.

A builder's blueprint of the site buildings may be helpful.

To complete the Watershed Map, the group will need to identify the location(s) where water comes from, where waste-water goes, whether surface runoff goes into storm drains, and where the drains empty. You may wish to find this information in advance or have one of the group members do so. Contact the local water utility, or see American Water Works Association in Project Partners, page 29.

Time

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Goals

- Your group draws a map of the watershed where the project site is located.
- Group members understand what a watershed is and can describe the watershed, including water sources and drainage patterns
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Key Points

Water issues are best understood in relation to watersheds; i.e., things dumped on the ground may eventually end up in a stream, lake or well.

Basic information about your watershed helps in understanding water issues. Group should be able to answer questions like:

- Where does the site's water come from?
- Where does wastewater go?
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Background

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Helpful Activities to Explain Maps

Start by drawing a map of a very small area such as a table. Measure the table and draw its outline on a piece of paper. Then look down

at it and “map” each item on the table so it appears to be relatively the right size and distance from the others. Now draw a map of the room, showing all the furniture as if you could see it from the ceiling. Next draw the building and grounds as though you could see them from a plane. This is similar to what the group did when it made a site map.

Explain that USGS maps are made from aerial photographs. Imagine what it would be like to fly in a plane over your site. What would you see?

One way to explain different elevations shown on a topographic map is to pretend to walk along a road on a map (or a trail if there is one). Look at your topographic map and determine where on the road the slope be steepest. Figure out how high a particular hill is. Relate that height to something familiar such as a tall building which is ten feet per floor. Are there any cliffs on along the road? Which part of the road would you find the most interesting scenery? Which part of the walk would be the hardest?

If your group needs help reading contour lines, see “Using Topographic Maps” below.

Using Topographic Maps

Topographic maps depict an aerial view of land. They use contour lines to show the elevation of land areas. These lines are sometimes called level lines because they show points that are at the same level or altitude. The ***top*** drawing [at right] is a contour map showing the same hills which are illustrated in profile in the ***bottom*** drawing. On this particular map, the vertical distance between each contour line is 10 feet.

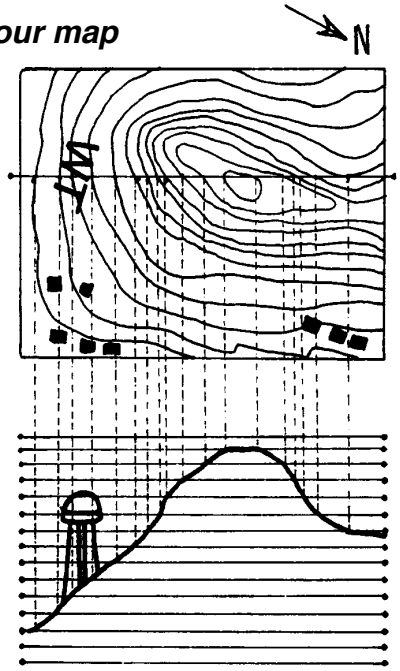
Lines that are close together show steeper slopes. Lines that are far apart show flatter terrain. Streams on topographic maps often intersect the points of a series of Vs or Us in the contour lines where the Vs point up hill. Hilltops are where contour lines connect to form circles or ovals. They are illustrated as the smallest center circle.

USGS maps use brown ink for topographic lines. Every fifth line is an index line which is bolder and gives a number indicating its altitude above sea level. Waterbodies are in blue. Buildings and other human-made structures are in black. Green shading indicates wooded areas. Important roads and survey system marks are in red. Purple features were added from aerial photographs during map revision and have not yet been field checked.

Each map has a scale, which is the relationship between distance on a map and the corresponding distance on the ground. The scale is expressed as a ratio, such as 1:24,000. The smaller the second number, the more detail the map has. You need to make sure you have a topographic map with a small enough scale so that you will be able to find specific streams, buildings and hills on your site. A good choice for local watershed mapping using USGS map scales is 1:24,000 (also known as 7.5 minute quadrangle maps). Your site may be on the edge of a map, or your watershed may cross two map sheets, in which case you may need two or more maps.

Check the date on your topographic map to see how recently it was made. A current, detailed street map can help you fill in new construction and other changes as you map your watershed. You will also need a street map to fill in details that are off the edge of your map. USGS also sells aerial photographs of most areas, and they may be helpful in locating landmarks (such as your school, a patch of woods, or a road).

contour map



3: Map your watershed

1 2 3 4 5 6 7 8

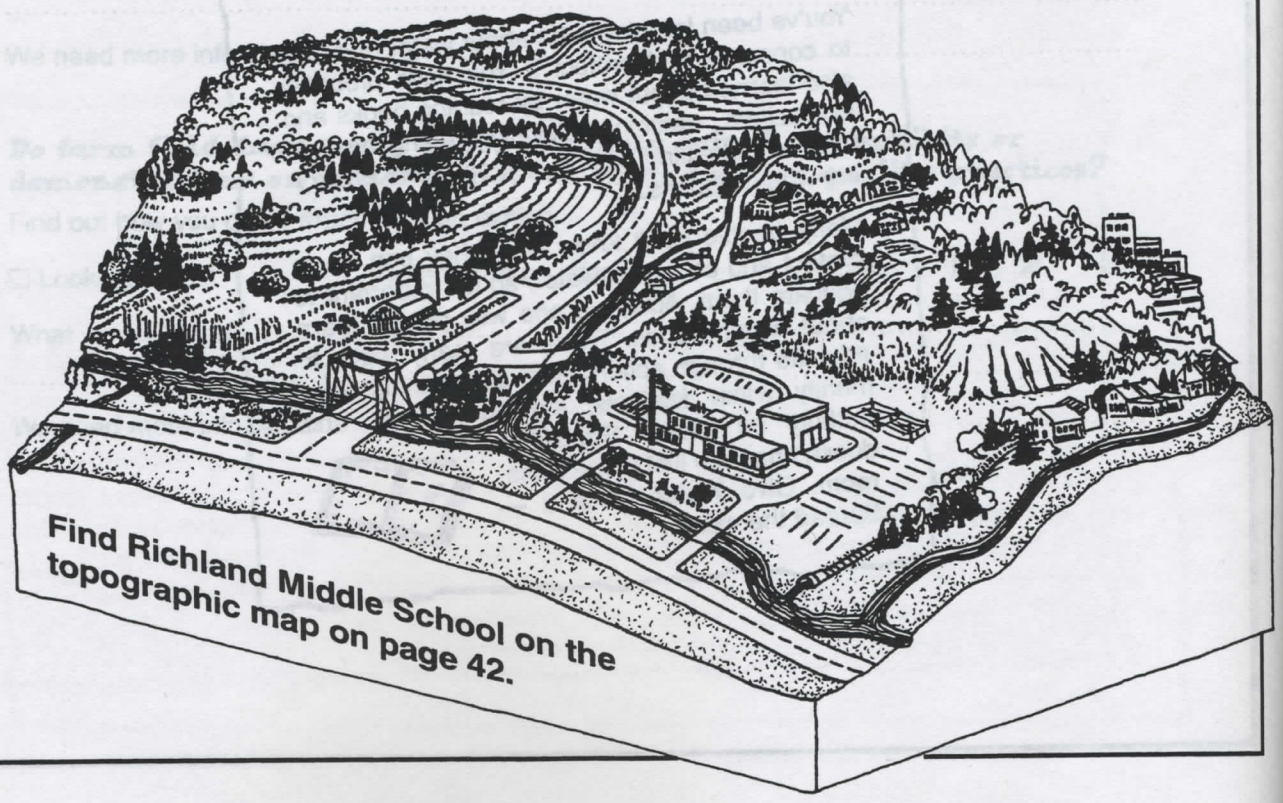
you are here

"To protect your rivers, protect your mountains."

— *Emperor Yu of China, 1,600 B.C.E.*

In step 1, you visited your watershed and noted some of its features. In step 2, you took a closer look, investigating some of the possible water quality concerns at your site. Now it's time to look at the big picture again.

To work on water problems, you should know where your water comes from, where it goes after you use it, and what streams, rivers, lakes or coastal areas are in your watershed. A good tool to help collect and record all of this information is a Watershed Map. This will help you find out what needs to be done in and around your site. It will also help you share what you have learned with your water expert in the next step.



Find Richland Middle School on the topographic map on page 42.

What to do

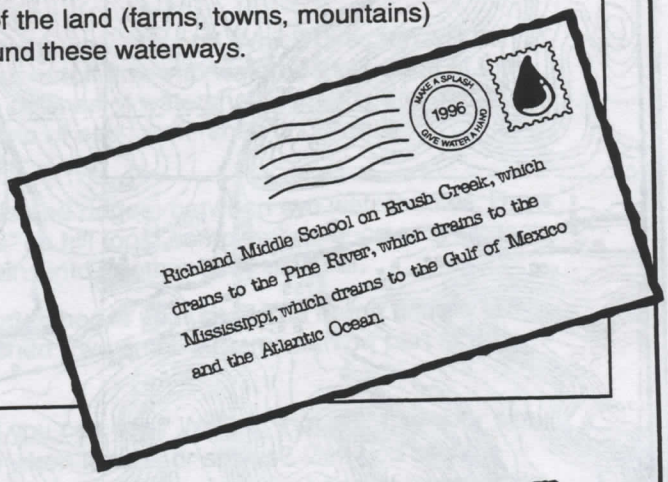
A Collect the following materials:

- Topographic map or maps which include your site and any other maps you have collected of the area,
- a clear sheet of plastic as big as your topographic map (this plastic is called mylar or acetate and is available at art supply stores or office supply stores for a few dollars),
- a piece of cardboard as big as your map,
- thumb tacks,
- dry erase markers & tissues.

B Look at the sample topographic map on page 42. This map includes the watershed pictured on page 40. Can you find this watershed on the map? See Using Maps, page 11 in the Leader Guidebook, if you need to learn more about how to read maps.

Find your ecological address

A mailing address helps the Post Office deliver letters to the right place. An "ecological address" can help you find rivers and streams in your community and help you find ways to work on water issues. Local streams empty into larger streams, rivers or lakes, which may empty into a larger river, which may empty into an ocean, estuary, bay or a lake. Your ecological address includes all of the land (farms, towns, mountains) around these waterways.

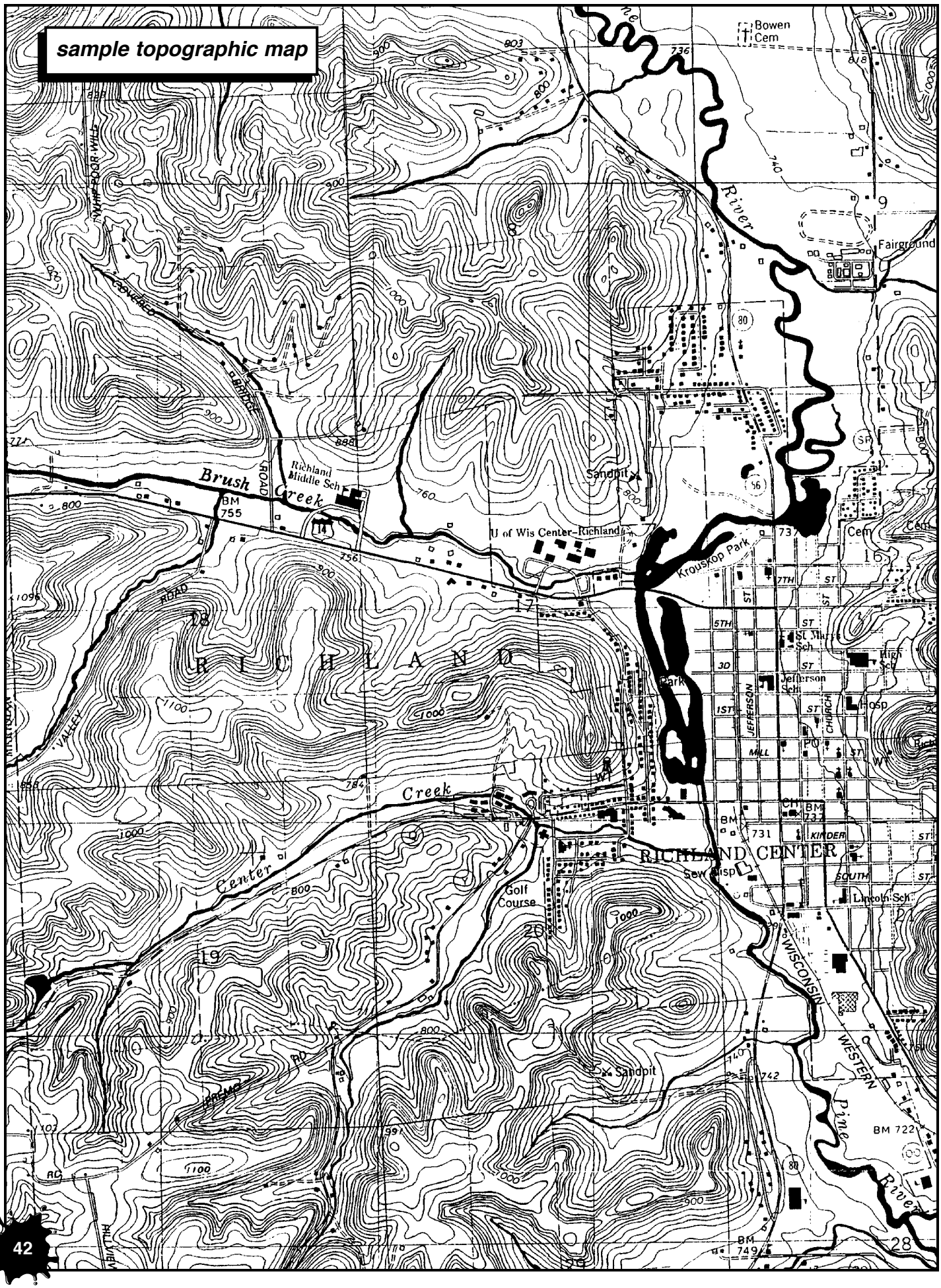


What's a watershed?

You are part of a watershed. This means that everything you do can affect nearby surface water and groundwater, for better or worse. Your watershed is a geographical community that includes all the humans, plants and animals who live in it and all non-living parts, such as rocks and soil. As China's Emperor Yu understood long ago, whatever happens upstream in a watershed affects everything downstream. To improve the water quality of a stream, look at the whole area it drains. Anything dumped on the ground in the watershed can end up in its waterbodies. And anything released to the air can come down again, nearby or thousands of miles away. What's more, we all live downstream, either in our own watershed, or downstream from someone else's.

Think about this: most of us drink water from our local watershed. Although some people get water from elsewhere (Los Angeles gets water from distant mountains, for example), most of us get it from a local well or a nearby lake or river. It may come directly from a private well, but more likely it comes through a government water department or utility. Typically, the utility draws water from a nearby source, treats or cleans it, then pipes it to homes, schools and businesses.

After water is used, it goes down the drain, to a private septic system or through the sewer to a wastewater treatment plant. There it is treated, or cleaned, before it is sent back into local lakes, oceans or rivers. You can help yourself and the public utilities by using less water and by keeping pollutants out of wastewater. You'll also help reduce the money your family pays for water and sewer service.


sample topographic map
Bowen Cem
River
Fairground
Brush Creek
Richland Middle Sch
Sandpit
U of Wis Center-Richland
Krouskop Park
R I C H L A N D
Creek
Center
Golf Course
RICHLAND CENTER
Sewage Disp
Lincoln Sch
WISCONSIN
WESTERN
Pine River
Sandpit
BM 722
BM 749

C Map your watershed:

1 Place the clear sheet of plastic over the topographic map (topo map) of your site and tack both onto the cardboard. If you don't have plastic, make a photocopy of the map and draw on it in pencil.

2 On the topo map, find and mark your site. A road map can help you find things.

3 Find the streams, ditches, marshes, lakes, oceans or rivers closest to your site and mark them in blue on the map.

4 Use the contour lines and numbers on the topo map to find the highest and lowest points around your site. Can you find the high point you visited in the first activity? Mark all the hilltops with an "X."

5 From these "Xs", draw arrows on your map to show the flow of runoff. Which direction will rain or snow flow when it falls on your school? Where does runoff flow into waterbodies? Look at the Completed Watershed Map on page 45. It has the outlines of watersheds already drawn. Look at the arrows showing where water flows. The outline of each watershed is between waterbodies, mostly along the tops of ridges or hills.

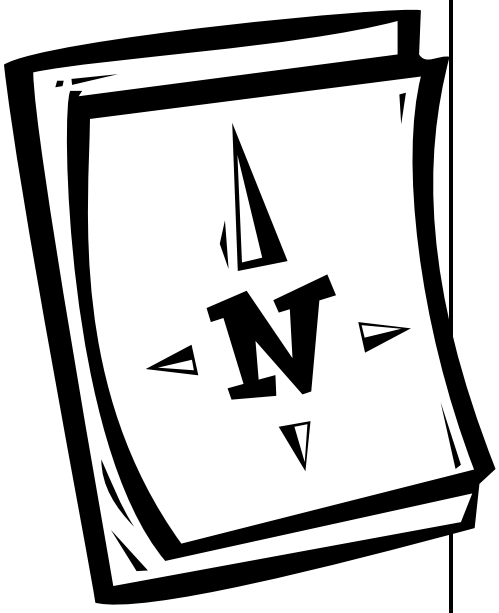
6 On your own map, find the highest ground (the hills and ridges) between two waterbodies. Draw a line along the highest points (connecting the "Xs" on hill tops) completely around your stream, including its mouth — the bottom end where it drains into another body of water.

You have now outlined your watershed. In what watershed is your site? The name usually comes from the main stream or river in the watershed. Two small streams can be part of a larger watershed. Write the name on your map.

D Take map outside. What is the highest point of land you can see? Walk to that point. Is your site at the top or bottom of a hill? Where does water go when it rains or snows? Can you see the nearest waterbody? Can you see hills, mountains, buildings, airports, power lines, railroad tracks or other things that are on the map? Look at your map and find these features. Mark the features you noted in the first activity on your Watershed Map.

Where does your site get its drinking water? The person in charge can help you figure out the answer to this question and the next one. You may also need to call the water utility that pumps water to your site. Find and mark the source or sources if they are on your map. If the source is underground water, it is an aquifer.

Where does your site's wastewater go? Wastewater may be filtered through a septic tank or pumped through underground pipes to a wastewater treatment plant. Find out where your wastewater goes and and mark it if it's on your map.



Psssst ...

Hints for mapping

Think like water. Water always flows downhill, and it always takes the easiest path. If you go outside and look or walk downhill from your school – never going up – you will come to a waterbody sooner or later. It may flow underground in pipes. Look for openings where water enters the storm drains.

In urban areas, streams sometimes flow through pipes underground. If you live in a city or large town, ask an expert if there used to be any streams or wet areas in town. Even water flowing underground through pipes must drain into a body of water at some point. You may want to ask a staff person from the city government to visit and demonstrate how the storm water system handles runoff from your site.

In dry climates, streams and rivers may only flow after snow melt or during the rainy season. Look for dried-up waterways.

Power Words

Altitude How many feet something is above sea level. (The sea is a good place to start because it is nearly the same height all around the world.)

Septic tank An underground storage tank for waste from homes with no sewer line to a treatment plant.

Topographic map A map with lines to show the height or altitude of hills, valleys, and mountains. Each line connects points at the same altitude.

Waterbody A specific area where water is found, such as a stream, river, wetland, pond, reservoir, groundwater, lake, or ocean.

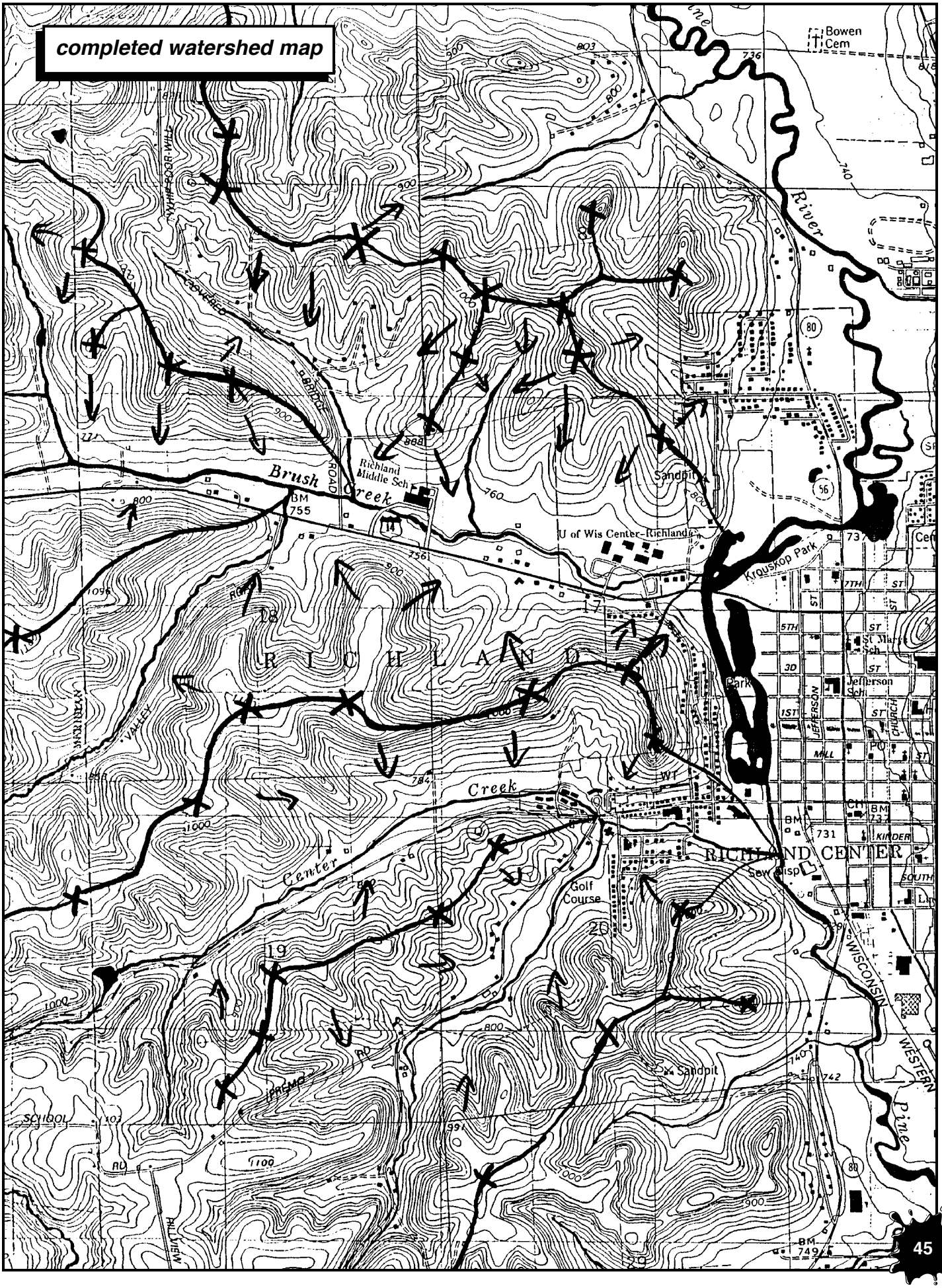
Wastewater treatment plant (sewage) A place where used water (from toilets, washing machines, industries) is pumped to be cleaned and purified before it is returned to local waterbodies.

Watershed An area of land where all water drains, or "sheds," to the same river, reservoir or other body of water.

- Describe your watershed. What kinds of plants and animals live in it? Is it in a city or the country? Tell a story about a rain drop that falls on your site.
- Where does your site's drinking water come from?
- Where does your wastewater go?
- Keep your Watershed Map. You'll need it later.

Before next time...

- Invite one or more experts — possibly your local partner to meet with your group. The person you invite and the information you provide ahead of time are very important. Provide an agenda for the meeting with the date, time and location, and a list of your questions, so your expert will be prepared. In writing up your questions, think about what you need to know. Your Checklist may give you ideas.
- If you need ideas about whom to invite, see "GET PARTNER SUPPORT" on the back cover. If you need more ideas about what questions to ask, the Skills Bank can help you get the most out of interviews (see page 63).


completed watershed map
Bowen Cem
River
Brush Creek
Richland Middle Sch
BM 755
U of Wis Center-Richland
Sandpit
Krouskop Park
RICHLAND
Center Creek
Golf Course
RICHLAND CENTER
Sewdisp
Jefferson Sch
St Marys Sch
WISCONSIN
WESTERN
Pine
Sandpit
17
18
19
20