SECTION 1.4 INTRODUCTION

1.4 Explore

2 class periods ▶*

A Case Study: Watersheds in Michigan

Overview

Students have learned about watersheds in *Sections 1.2* and *1.3* but they have not had to apply it to a new context. In this section, students learn that water flows from areas of high elevation to areas of lower elevation in a watershed in Michigan. Students use raised relief maps of Michigan and trace a two-dimensional map of movement of water within a small watershed of their own choosing, then through major watersheds in Michigan to the Atlantic Ocean.

Targeted Concepts, Skills, and Nature of Science	Performance Expectations
Water entering a watershed travels from higher to lower elevations.	Students should be able to predict that water moves from higher to lower elevations in a watershed so long as natural conditions prevail.
Nested watersheds are smaller watersheds that are part of larger watersheds. Watersheds define the flow of water from an area into a river system and the flow of river systems into lakes and oceans.	Students should be able to understand that a large watershed is made up of and fed by many smaller nested watersheds, also called sub-watersheds.
Students can read raised relief maps and know the difference between three-dimensional and two-dimensional maps.	Students should be able to identify high and low areas on a raised relief map by feeling the differences in the elevations. Students should be able to tell that using a relief map is more useful than a two- dimensional photograph of the same area.
A watershed is an area of land on which water falls. Some of the water is absorbed and some is runoff as it drains across the land's surface and into a river system.	Students should be able to correctly define terms such as *runoff*, *watershed*, and *groundwater*.

Materials		
1 set	per classroom	laminated photographs of a variety of watersheds
1	per group	washable transparency markers
1	per group	raised relief map of the state of Michigan
1	per group	conventional paper map of Michigan

Activity Setup and Preparation

Students will compare a geographic location on a paper map with the same point on a raised relief map to observe differences between two-dimensional and three-dimensional maps. Demonstrate how to locate a high point on the raised relief map.

Locate six or eight high elevations and trace watersheds for these points before students begin the activity so that you will understand any difficulties students may encounter in tracing watersheds.

Students should be able to see elevation markings on a paper road map such as:

- Grand Rapids, "El. 657 ft.,"
- Mount Pleasant, "El. 770 ft.,"
- Detroit, "El. 600 ft.," and
- Mount Arvon, "El. 1979 ft." (Mount Arvon is the highest elevation in Michigan. It is located just east of L'Anse, MI, in the Upper Peninsula.)

When it comes to group use of the raised relief map, make certain that each student in each group traces a different path to a river.

Homework Options

Reflection

- **Science Content:** Find out about the watersheds in your area. Draw a map of the boundaries of these watersheds. Mark any lakes and the rivers into which the watersheds flow. *(Answers will vary.)*
- **Science Content:** How does the information gathered from the map study help to answer the *Big Question: How does water quality affect the ecology of a community? (Student answers will vary. However, their answers should begin to reflect that they are developing an understanding that as water moves from one place to another, it might carry materials from one area to another and therefore, affect the land into which materials are being carried.)*

Preparation for 1.5

- **Science Content:** Use the raised relief map to focus on the Rouge River watershed. Trace the path that water from this watershed takes to the Detroit River. Think about how water from the Rouge River watershed might affect the Detroit River. *(Answers will vary but students may say that materials put into the river up on one of the branches flow into the Detroit River.)*

SECTION 1.4 IMPLEMENTATION

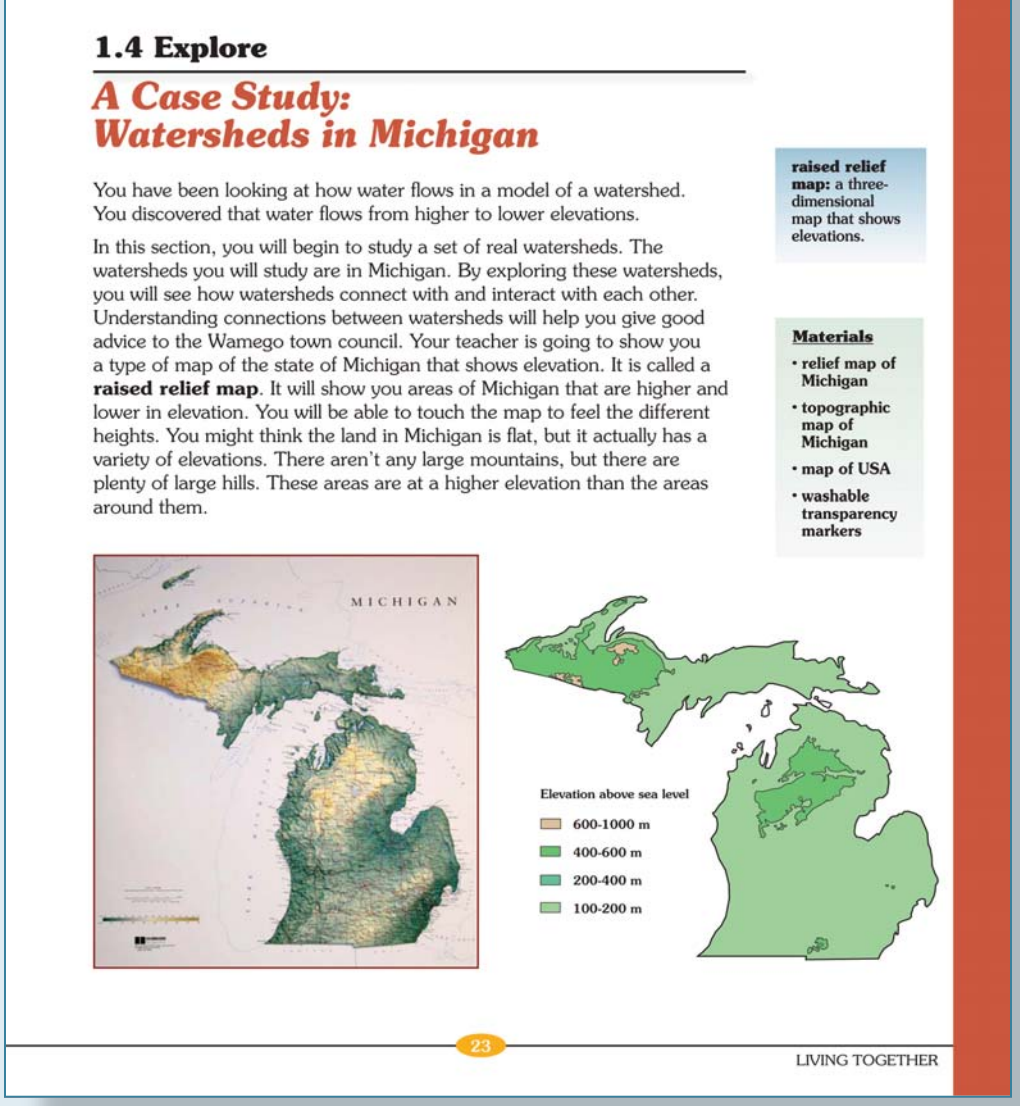
2 class periods ▶*

1.4 Explore

A Case Study: Watersheds in Michigan

10 min.

Students apply what they have learned about watersheds to a new context.



1.4 Explore

A Case Study: Watersheds in Michigan

You have been looking at how water flows in a model of a watershed. You discovered that water flows from higher to lower elevations.

In this section, you will begin to study a set of real watersheds. The watersheds you will study are in Michigan. By exploring these watersheds, you will see how watersheds connect with and interact with each other. Understanding connections between watersheds will help you give good advice to the Wamego town council. Your teacher is going to show you a type of map of the state of Michigan that shows elevation. It is called a **raised relief map**. It will show you areas of Michigan that are higher and lower in elevation. You will be able to touch the map to feel the different heights. You might think the land in Michigan is flat, but it actually has a variety of elevations. There aren't any large mountains, but there are plenty of large hills. These areas are at a higher elevation than the areas around them.

raised relief map: a three-dimensional map that shows elevations.

Materials
- relief map of Michigan
- topographic map of Michigan
- map of USA
- washable transparency markers

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LIVING TOGETHER

Engage

Have students think back to the model in *Section 1.2* that made them first consider how water flows over and around land. Then draw their attention again to the diagram of the watershed on page 21 in the student text.

TEACHER TALK

"Let's look at the diagram of the watershed on page 21. Think about how water moved in your model. What was the most consistent thing you observed in the model-watershed activity?" *(Water flows from higher to lower elevations.)* Did you see any models where water flowed differently?

Now think about a real-life situation. If a city is high on a hill and there is a river below it, in what direction do you predict groundwater around and under the city will flow?" *(Downward, away from the city to the river).*"

*A class period is considered to be one 40 to 50 minute class.

Engage

Project a transparency of a conventional two-dimensional road map of the Great Lakes area without using that name. Ask students to point out the lakes that surround Michigan. Some students may know these as the Great Lakes.

Guide and Assess

Ascertain if students understand that the Great Lakes are parts of watersheds by asking where they think the water in the Great Lakes comes from. Have students look at the map on page 25 in the student text.

TEACHER TALK

"Let's connect what you saw in your model to this real-world situation. Where do you think the water in the Great Lakes comes from? *(Students should be able to relate the water in the Great Lakes to rainfall or precipitation and some might be able to give the correct answer—watersheds.)*

If the water in the lakes comes from watersheds, what can you conclude about the elevations of the Great Lakes and the elevation of the land around them? *(The land around the Great Lakes is at a higher elevation than the lakes themselves.)*"

META NOTES

Because this is a new situation, it may take students a few minutes to transfer the concept they learned from their model to a real-life situation and risk answering questions.

Guide

Transition students toward the relief-map activity by asking them to describe different kinds of maps they might have seen. Then ask one member from each group to pick up a conventional map and a relief map of Michigan from the supply station.

To draw students' attention to the characteristics of a relief map, suggest that they run their hands over the relief map and the conventional map. Ask students to quickly tell one difference between the relief map and the conventional map. Students should be able to say that the relief map has raised areas and the conventional map does not have raised areas. Relate the raised areas on the relief map to "elevations."

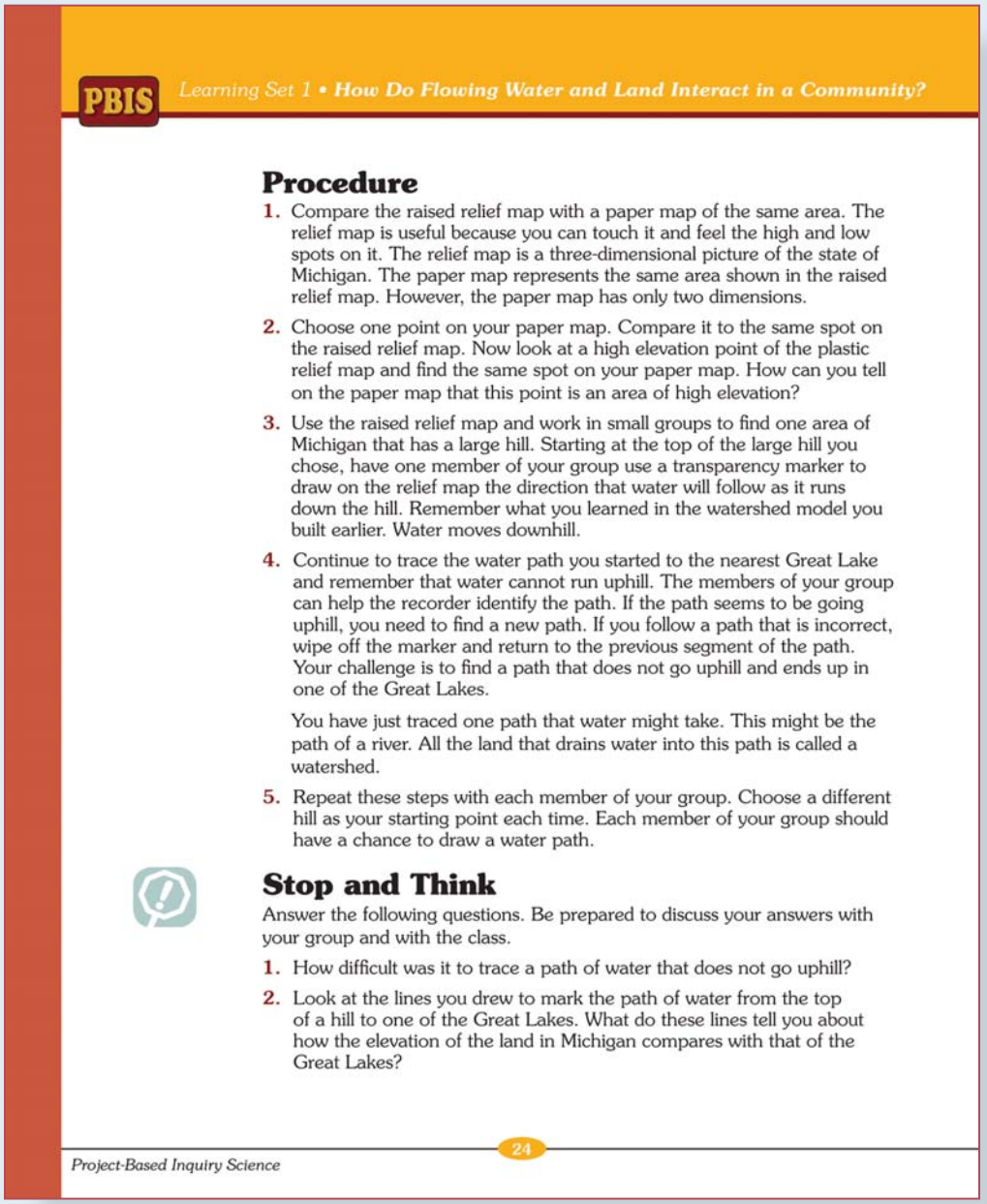
TEACHER TALK

"This may be the first time you have ever looked at a relief map. How is it different from a road map? What do you think the raised areas on the relief map signify? How is it like the model that you built? *(Relief maps have raised areas that indicate elevation; conventional road maps mark some places with elevations in feet above sea level, but they are not raised.)*"

Procedure

30 min.

Students use a relief map to track water flow in a real watershed.



PBIS Learning Set 1 • How Do Flowing Water and Land Interact in a Community?

Procedure

1. Compare the raised relief map with a paper map of the same area. The relief map is useful because you can touch it and feel the high and low spots on it. The relief map is a three-dimensional picture of the state of Michigan. The paper map represents the same area shown in the raised relief map. However, the paper map has only two dimensions.
2. Choose one point on your paper map. Compare it to the same spot on the raised relief map. Now look at a high elevation point of the plastic relief map and find the same spot on your paper map. How can you tell on the paper map that this point is an area of high elevation?
3. Use the raised relief map and work in small groups to find one area of Michigan that has a large hill. Starting at the top of the large hill you chose, have one member of your group use a transparency marker to draw on the relief map the direction that water will follow as it runs down the hill. Remember what you learned in the watershed model you built earlier. Water moves downhill.
4. Continue to trace the water path you started to the nearest Great Lake and remember that water cannot run uphill. The members of your group can help the recorder identify the path. If the path seems to be going uphill, you need to find a new path. If you follow a path that is incorrect, wipe off the marker and return to the previous segment of the path. Your challenge is to find a path that does not go uphill and ends up in one of the Great Lakes.

   You have just traced one path that water might take. This might be the path of a river. All the land that drains water into this path is called a watershed.
5. Repeat these steps with each member of your group. Choose a different hill as your starting point each time. Each member of your group should have a chance to draw a water path.

Stop and Think

Answer the following questions. Be prepared to discuss your answers with your group and with the class.

1. How difficult was it to trace a path of water that does not go uphill?
2. Look at the lines you drew to mark the path of water from the top of a hill to one of the Great Lakes. What do these lines tell you about how the elevation of the land in Michigan compares with that of the Great Lakes?

Project-Based Inquiry Science 24

Get Going

Make sure that students understand the activity procedures. Have students summarize how they will study the relief map. Their summary might be as follows:

1) Compare the relief map and the conventional map.
2) Choose a location on the conventional map. Find the same location on the relief map.
3) As a group, select a large hill on the relief map. With a marker, trace the direction water will follow down from that hill.

META NOTES

On an overhead, show students how to follow and mark a possible river path to one of the lakes. It may be one that you have worked out previously.

4) Track the water down through its watershed to the nearest Great Lake. Do not start back up any hills.

5) Each group member chooses a different hill and traces his or her own path to one of the Great Lakes.

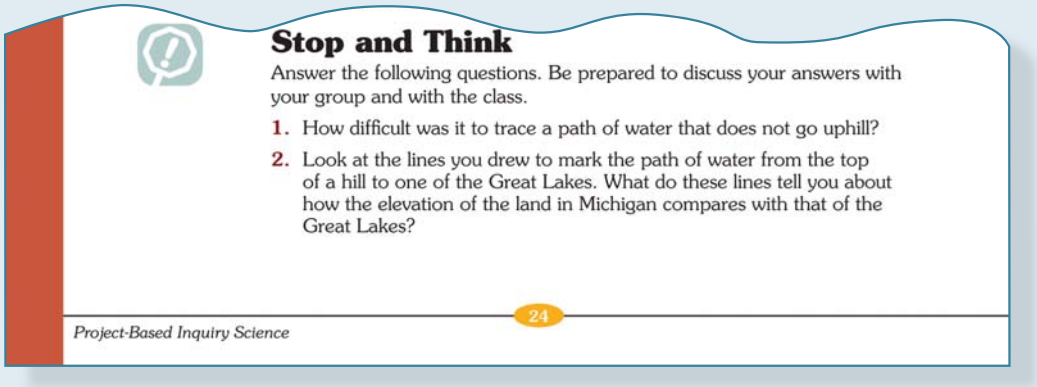
Monitor the groups' progress by asking if some students have difficulty finding a clear river path downward. Ask them if they are sure their pathways always travel downhill. You might supply selective hints from the paths you previously tracked yourself. If too many students in a group are trying to find pathways that lead into Lake Michigan, you might ask if anyone tracked a watershed that leads into Lake Huron or Lake Erie. You can also ask if anyone found a watershed that seems to empty into more than one lake. If it looks like the majority of the class needs more time, give the groups extra time.

◇ Evaluate

Encourage students to relate their findings on the relief map activity in terms of *watersheds* and *elevations*. Listen for students to describe their findings in these terms. Listen for them to describe water moving from higher to lower elevations.

△ Guide

When each group appears finished, tell students to prepare to answer the *Stop and Think* questions at the bottom of page 24.



Stop and Think

Answer the following questions. Be prepared to discuss your answers with your group and with the class.

1. How difficult was it to trace a path of water that does not go uphill?
2. Look at the lines you drew to mark the path of water from the top of a hill to one of the Great Lakes. What do these lines tell you about how the elevation of the land in Michigan compares with that of the Great Lakes?

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Project-Based Inquiry Science

Stop and Think

10 min.

Have a class discussion on the questions. During the discussion, students might relate the relief map to their models from *Section 1.2*.

1) Some students may say that it was very difficult to find a path that did not go uphill at some point. This might be a result of the size of the relief map. Encourage students who may have been able to work around difficulties in using the raised relief map to share how they used the map.

2) The Great Lakes are at a lower elevation than that of the land in Michigan. Ask students to consider how this is different from or similar to their models.

TEACHER TALK

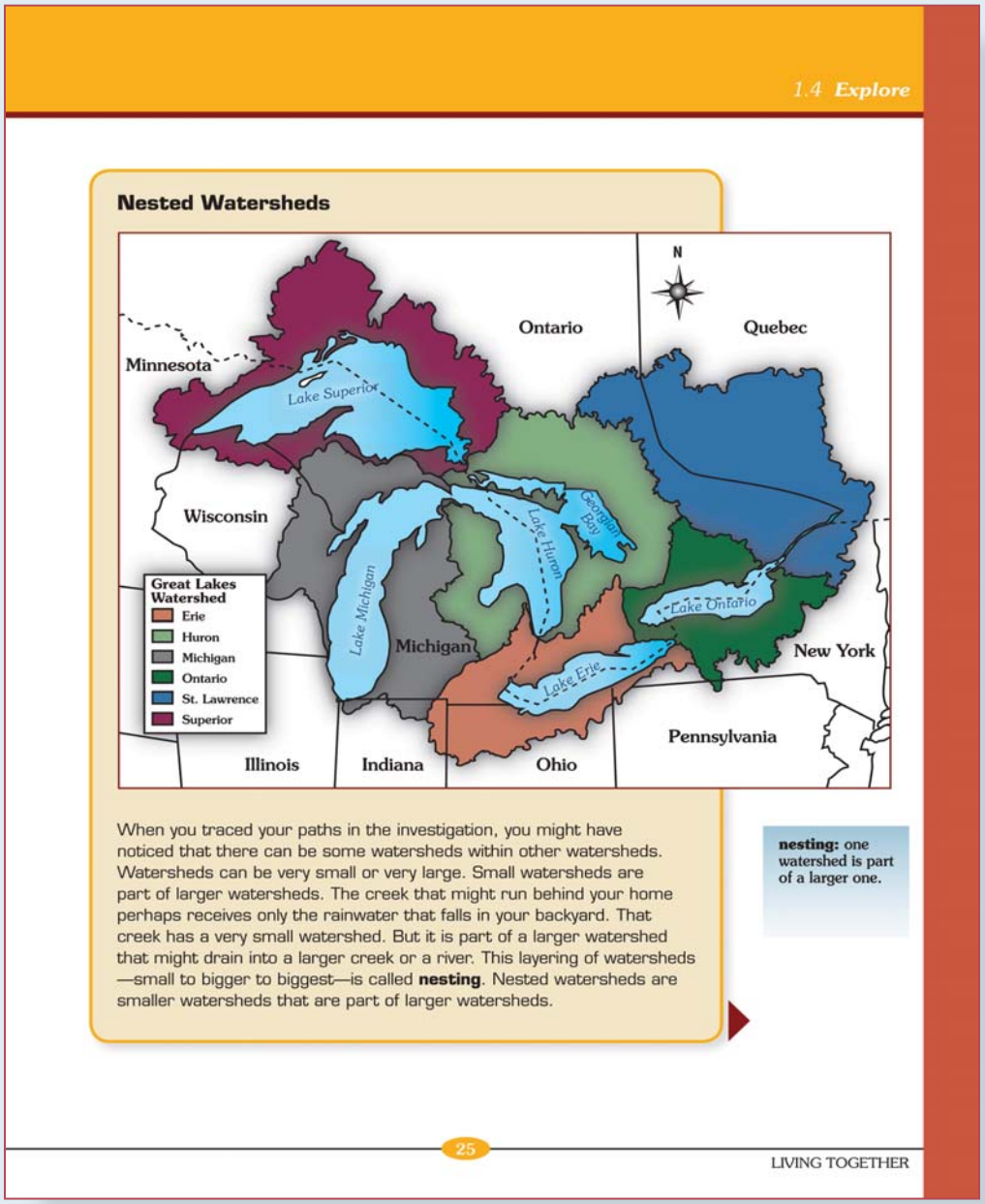
"Think back to your model watershed. Were there any places where water flowed uphill? *(There should not have been.)*

Where was there the most trouble with finding a clear pathway for water to flow? *(Probably toward the highest areas.)*

Did you find any places where water might move in opposite directions? *(When water moves in separate directions from about the same area of land, this area is called a divide.)*

Based on your model and the elevations you found on the relief map, why does water flow into the Great Lakes from land in Michigan? *(The land in Michigan is elevated above the lake and water flows from higher to lower elevations.)*"

NOTES



Nested Watersheds

10 min.

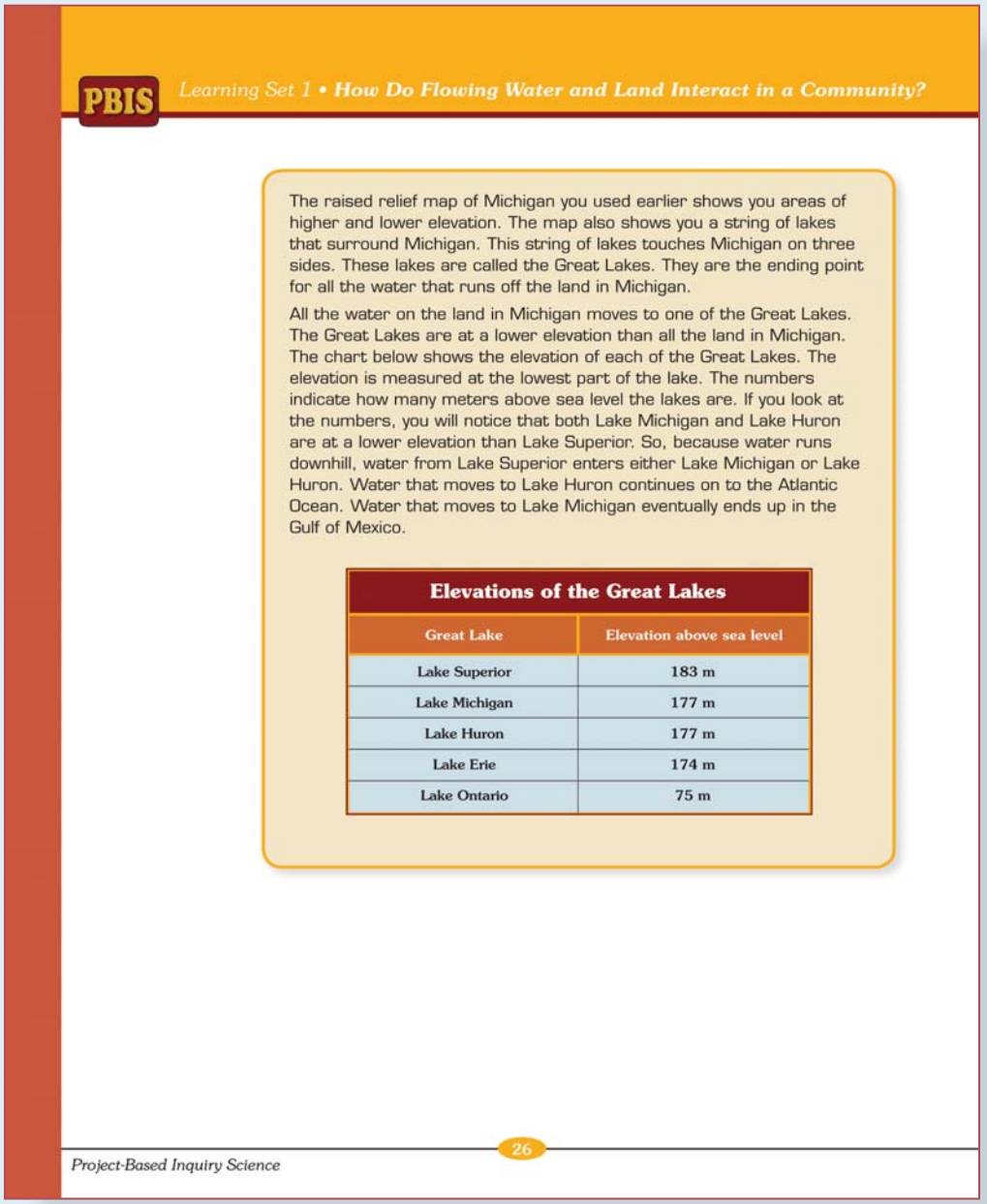
Students are introduced to nested watersheds and learn that small watersheds flow into larger ones.

△ Guide

Build on students' experiences with the watersheds on the relief map by having them look at the map on page 25. Be sure that they observe and voice that the Great Lakes fill with water from all the surrounding areas, including Canada.

TEACHER TALK

"In the last activity, each student traced a water path on the relief map. Each path represented a separate watershed. Were some of these watersheds right up against each other? What does that tell you about where watersheds are found? *(Every part of land on Earth is part of a watershed.)* Small watersheds feed into larger watersheds. These small watersheds are called nested watersheds.*)*"



The raised relief map of Michigan you used earlier shows you areas of higher and lower elevation. The map also shows you a string of lakes that surround Michigan. This string of lakes touches Michigan on three sides. These lakes are called the Great Lakes. They are the ending point for all the water that runs off the land in Michigan.

All the water on the land in Michigan moves to one of the Great Lakes. The Great Lakes are at a lower elevation than all the land in Michigan. The chart below shows the elevation of each of the Great Lakes. The elevation is measured at the lowest part of the lake. The numbers indicate how many meters above sea level the lakes are. If you look at the numbers, you will notice that both Lake Michigan and Lake Huron are at a lower elevation than Lake Superior. So, because water runs downhill, water from Lake Superior enters either Lake Michigan or Lake Huron. Water that moves to Lake Huron continues on to the Atlantic Ocean. Water that moves to Lake Michigan eventually ends up in the Gulf of Mexico.

Elevations of the Great Lakes

Great Lake	Elevation above sea level
Lake Superior	183 m
Lake Michigan	177 m
Lake Huron	177 m
Lake Erie	174 m
Lake Ontario	75 m

△ Guide

Help students analyze their findings with a series of questions:

TEACHER TALK

"According to the map, where do watersheds in this part of Canada first empty into? *(Into the Great Lakes.)*

Think about water moving into the Great Lakes. For this to happen, how would you describe the elevation of all the land in watersheds around the Great Lakes, both in the United States and Canada? *(The land around the Great Lakes must be higher than the Great Lakes themselves.)*"

What's the Point?

From your work with your watershed model, you discovered that water always flows from higher to lower elevations. You used this knowledge to trace the path of water from higher elevations to lower ones on a map of a real watershed. You also discovered that there are often many smaller watersheds nested in a larger watershed.

The watershed you explored was in the state of Michigan. You are using a map of Michigan because you are going to study a river in Michigan as a model of how the water quality in a river affects the ecology of the river and its watershed. This will help you understand how the water quality in Crystal River could affect the ecology in its watershed.

Water always flows from higher to lower elevations.

△ Guide

Draw students attention to differences in the elevations of the Great Lakes by having them turn to the chart on page 26.

META NOTES

As water travels from Lake Erie to Lake Ontario, it's elevation drops about 99 m by the time it reaches Niagara Falls.

TEACHER TALK

"Look at the elevations of the lakes themselves in the chart on page 26. Lake Erie is near Lake Ontario. In what direction does the water flow—from Erie to Ontario or from Ontario to Erie? *(From Erie to Ontario.)* Think about what you have learned about the effect elevations have on how water flows. Why do you think it flows that way? *(Because Lake Erie is at a higher elevation that Lake Ontario.)*

Think about the overall direction that water from the Great Lakes is moving. As water moves through the path from Lake Huron to Erie to Ontario, it is moving in an easterly direction and eventually reaches the Atlantic Ocean. Water moving from Lake Superior moves into Lake Michigan and eventually down the Mississippi to the Gulf of Mexico."

Assessment Options

Targeted Concepts, Skills, and Nature of Science	How do I know if students got it?
A watershed is an area of land on which water falls. Some of the water is absorbed and some is runoff as it drains across the land's surface and into a river system.	**ASK:** During a heavy rainfall, think about why a major city would probably have more runoff or absorbed water? **LISTEN:** Students should be able to say that a large city would have more runoff than absorbed water because of all the solid surfaces such as streets and highways and parking lots. **ASK:** What is the relationship between absorbed water and groundwater in a watershed? **LISTEN:** Absorbed water soaks into the ground and travels through a watershed as groundwater.
Water entering a watershed travels from higher to lower elevations.	**ASK:** Lake A is 52 feet above sea level. Lake B is 111 feet above sea level. They are connected by a river. Why won't Lake A flow into Lake B? **LISTEN:** Students should be able to tell that Lake A is at a lower elevation than Lake B and therefore will not flow into Lake B, but Lake B will flow into the connecting river and then into Lake A.

Targeted Concepts, Skills, and Nature of Science	How do I know if students got it?
Nested watersheds are smaller watersheds that are part of larger watersheds. Watersheds define the flow of water from an area into a river system and the flow of river systems into lakes and oceans.	**ASK:** What does it mean that watersheds are nested? **LISTEN:** Students should voice the fact that all land is part of a watershed and small watersheds each feed into a larger watershed. **ASK:** What probably supplies most rivers, one large watershed or many nested watersheds? **LISTEN:** Most rivers are probably supplied by more than one watershed.
Students read raised relief maps and know the difference between three-dimensional and two-dimensional maps.	**ASK:** What does a raised relief map show that a conventional road map cannot show? **LISTEN:** Students should report that a raised relief map depicts higher elevations by actually molding parts of the map into raised shapes representing the higher elevations. Conventional road maps merely print the elevation of certain points across a state. **ASK:** How would a conventional road map indicate the elevation of Mt. Arvon, which is 1979 feet above sea level and the highest point in Michigan? **LISTEN:** Students should indicate that the high point would be written on a road map as: Mt. Arvon El. 1979 ft.

Teacher Reflection Questions

- Did students have a difficult time applying the idea of water flowing from a higher to a lower elevation in a new situation? Would students benefit from an elevation drawing or a topographic map of the state of Michigan for determining the pathway of a water path during the activity? Maybe half the groups should have a topographic map and half should have the relief map.
- Are some students confused by the fact that the St. Lawrence River travels northeast on its way to the Atlantic but does not travel up in elevation? Do they confuse going north with ascending in elevation?
- Were there time management issues during the relief map activity? How could these be improved?