



Sultana
EDUCATION
FOUNDATION

CHANGING CHESAPEAKE

An Investigation of the Chesapeake Bay Watershed



Name: _____

School: _____

Teacher: _____



About the Changing Chesapeake Program

In 2021, Sultana Education Foundation partnered with ShoreRivers, the Chesapeake Bay Trust, and Kent County Public Schools to design and implement a Meaningful Watershed Educational Experience (MWEE) for Kent County's 4th grade students. This initiative, known as Changing Chesapeake, encourages students to learn about the Chesapeake Bay watershed and examine how human activities have impacted the watershed over the past four centuries.

Implemented on a county-wide scale, the goal of Changing Chesapeake is to measurably improve understanding of watershed-related issues in Kent County and to encourage students to participate in action projects that lead to improved water quality, restored habitat, and increased public awareness of issues facing the Chester River, Sassafras River, and Chesapeake Bay.

Welcome to Changing Chesapeake

Welcome to the Changing Chesapeake program. Over the next few weeks, you will be working with your teachers and staff from Sultana Education Foundation to learn about how human activity has changed the land and water quality in the Chesapeake Bay watershed over the past 400 years.

The sections in this booklet will help you learn more about what a watershed is and how it works. Besides working in this book, your class will take some fun field trips with Sultana Education Foundation to explore your local watershed and learn about issues affecting the health of our waterways today.

We look forward to seeing you soon!

Sincerely,

Chris Cerino
Vice President

Jackie Doerr
Director of Science Programs

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Changing Chesapeake Partners



Our Local Watershed

DIRECTIONS: Read the article below, then answer the questions on the following page.

Turner's Creek and the Chesapeake Bay Watershed

Turner's Creek is part of a watershed. A watershed is the area of land that drains into a body of water. This body of water may be a river, lake, stream, or even an ocean. Hills and mountains form the boundaries of most watersheds. The watershed for the Chesapeake Bay is huge and covers thousands of square miles of land. When water falls onto a watershed as rain or snow, the water flows from the land into small creeks, such as Turner's Creek. Turner's Creek then flows to the Sassafras River, which drains into the Chesapeake Bay.

Let's imagine the effect that polluted water may have on a watershed. When polluted water flows into a watershed, it can move to rivers and streams. Near Turner's Creek, for example, there are lots of farm fields and homes. In the spring, farmers use fertilizer to help the crops grow and homeowners apply fertilizer so that they can have a nice green lawn. When it rains, some of this fertilizer washes off the land and flows into a river or another body of water like Turner's Creek. The extra fertilizer then causes too much algae to grow, which can be harmful to fish, crabs, and underwater grasses.



To understand how this water moves, let's follow the path of water as it flows off the nearby farms and homes and into Turner's Creek. After a rainstorm, the water gets pulled downhill by the force of gravity. When water is flowing quickly, it brings other materials with it such as soil, trash, and fertilizer. The water will stop flowing when it reaches sea level. In Maryland, you reach sea level when you are at the Chesapeake Bay.

When part of the land in a watershed becomes polluted, the pollution affects many areas. By taking care of a small local watershed, people can also protect large bodies of water downstream such as the Chesapeake Bay!

What is a Watershed?

DIRECTIONS: After reading the article on the previous page, answer the questions below.

1. What is a watershed?

2. What watershed do you live in?

3. How did Turner's Creek become polluted?

4. What are some effects of a polluted watershed?

Reflection

DIRECTIONS: Reflect on some things YOU can do to help improve the health of the Chesapeake Bay. How would those actions help the Bay?



What Do YOU Want to Know About Watersheds?

DIRECTIONS: Here is an image of the Chesapeake Bay Watershed. Examine the map and read the text to learn about how the Bay gets its water.



Image Credit: United States Geological Survey

The Chesapeake Bay gets its fresh water from thousands of rivers and streams within its watershed. A watershed is an area of land that drains to a common body of water. The watershed of the Chesapeake is very large and includes parts of six states: Maryland, Virginia, Pennsylvania, New York, West Virginia, and Delaware. It also includes all of Washington D.C. Look at the map above and find the white line that is drawn around the Bay. This is the boundary of the Chesapeake Bay watershed. The land inside the boundary covers 64,000 square miles and is home to more than 18 million people. If you live in Kent County, then YOU are one of those people, and every action that you take on land impacts the water quality of the Bay downstream!

Chesapeake Bay Watershed Activity

DIRECTIONS:

1. Trace the blue dashed line of the Chesapeake Bay watershed boundary.
2. Label each state with their initials (NY, PA, MD, etc.).
3. Put a star where we live on the map.

MAP LEGEND

New York (NY)
 Pennsylvania (PA)
 West Virginia (WV)
 Maryland (MD)
 Delaware (DE)
 Virginia (VA)
 District of Columbia (DC)

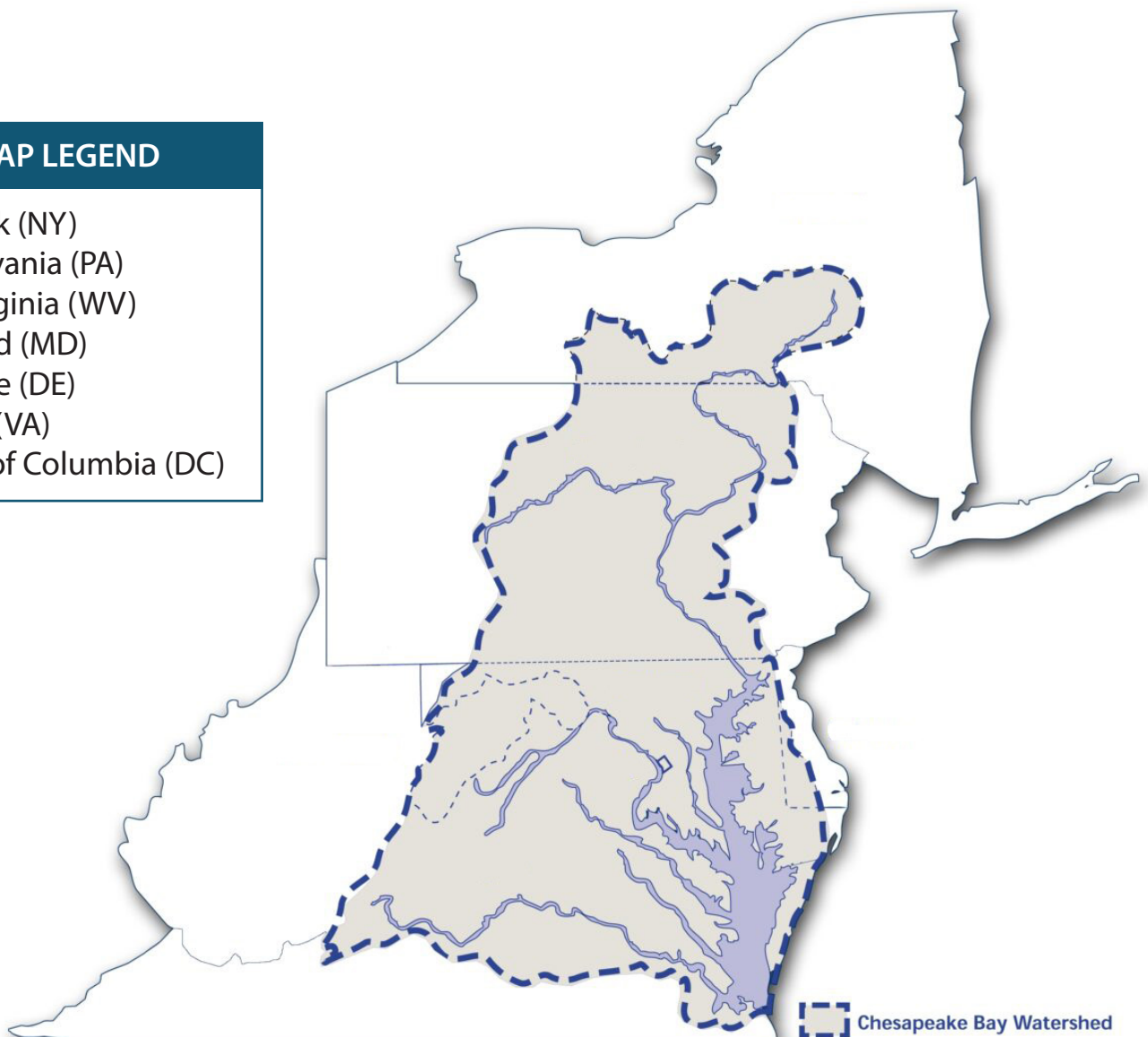


Image Credit: Watershed map courtesy Environmental Protection Agency

Building a Watershed Model

MATERIALS

- Two pieces of paper
- Spray bottle
- Blue, red, green, brown markers

DIRECTIONS

1. Take one sheet of paper and crumple it up in your hands. Open the paper up, but don't flatten. The high places are hills, the low spots are valleys, and the wrinkles are streams and valleys.
2. With a blue marker, draw on the paper where you think the streams and rivers would be.
3. Place the paper on your empty desk. With the spray bottle, spray a fine mist over the watershed model, enough to make water flow down the "hills."

When you sprayed water on the paper, what happened to the marker and why?



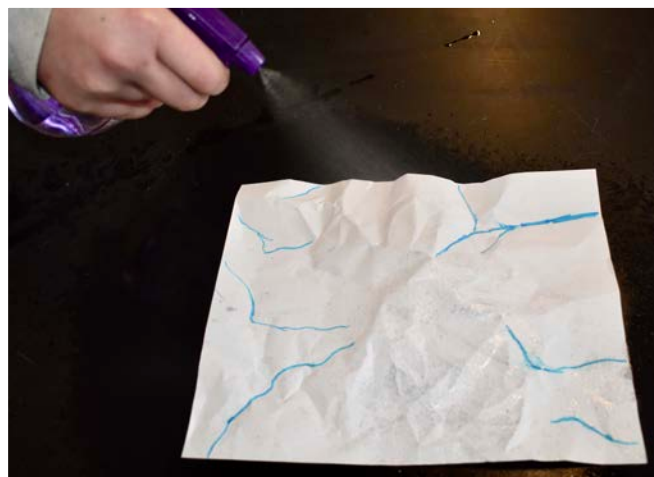
Building a Watershed Model *(Continued)*

DIRECTIONS

1. Now do the same thing with the second piece of paper. Crumple it, then open it up and place it on the desk.
2. Draw in the streams and rivers with a blue marker.
3. Next, use a brown marker and draw along the tops of the hills.
4. With a green marker you can draw in trees, grass, crops, or pasture land.
5. Use a red marker to draw towns, houses, or businesses.
6. Place the "watershed" on your empty desk. Spray it with water and observe how it flows.

This time when you sprayed the paper with water, what happened?

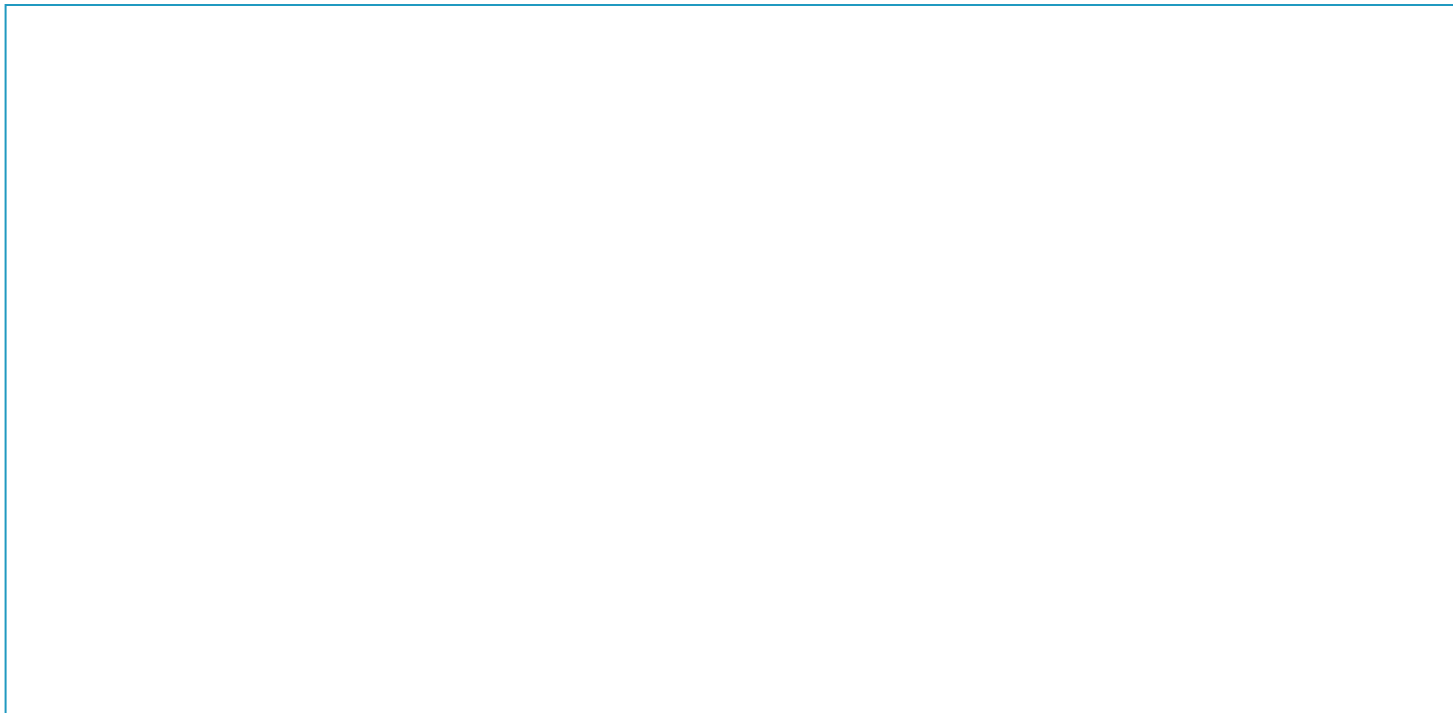
Think about how this relates to real life situations. What happens to pollution on the ground when it rains?



Reflection

DIRECTIONS: Take this space to reflect on what you have learned so far about watersheds and the Chesapeake Bay.

In the space below, draw a picture of you in your local watershed!



John White's 1585 "The Manner of Their Fishing"



Image Credit: Colorized engraving by Theodor de Bry, based on a watercolor painting by artist John White.

Life in the Bay, Then & Now

DIRECTIONS: With your class, look at the painting of the Native Americans fishing (on left page), then answer the questions below.

What are three different ways that Native Americans are catching fish?

What is happening in the middle of the canoe?

Identify three different animals that are shown in the water:

REFLECTION: What do you think your life would have been like if you lived here hundreds of years ago?

Where Were Native American Towns Located?

DIRECTIONS: Read the article below and follow directions in the last paragraph.

In 1608, the Native American towns lining the shores of the Chesapeake Bay were found in areas that had easy access to food sources. Settlements were often located near oyster bars or at the heads of rivers and streams where migrating fish could be caught as they swam up the Bay to spawn. Arrow arum (tuckahoe) and wild rice were harvested from nearby marshes, and corn, beans, and squash were grown in the area's rich soils. The forests surrounding the Bay were home to deer, wild turkeys, and other animals that were hunted for their meat and furs, while the trees themselves produced chestnuts, walnuts, and acorns. In a way, the environment acted as a huge supermarket, providing local tribes with everything they needed to survive.

It was also important for towns to be located in areas that could be easily defended from raiding tribes. Warfare between Native American nations often involved quick raids that took the enemy by surprise; as a result, village sites surrounded by water or set upon high bluffs were often chosen because they made it difficult for enemies to approach without being spotted. Placing towns near the water also made it easy for people to travel up and down the river, which was important for hunting, fishing, collecting food from the marshes, and trading with other Native communities on the Bay.

Take a look at the map of the Sassafras River on the next page. The map shows where important natural resources were located, as well as fertile soils where crops could be grown. Places where Native American settlements might have been found are labeled A, B, C, D, and E. Work with your classmates to carefully look at each site and decide which area would be the best place to build a Native American town. Be ready to explain your choice to the rest of the class!



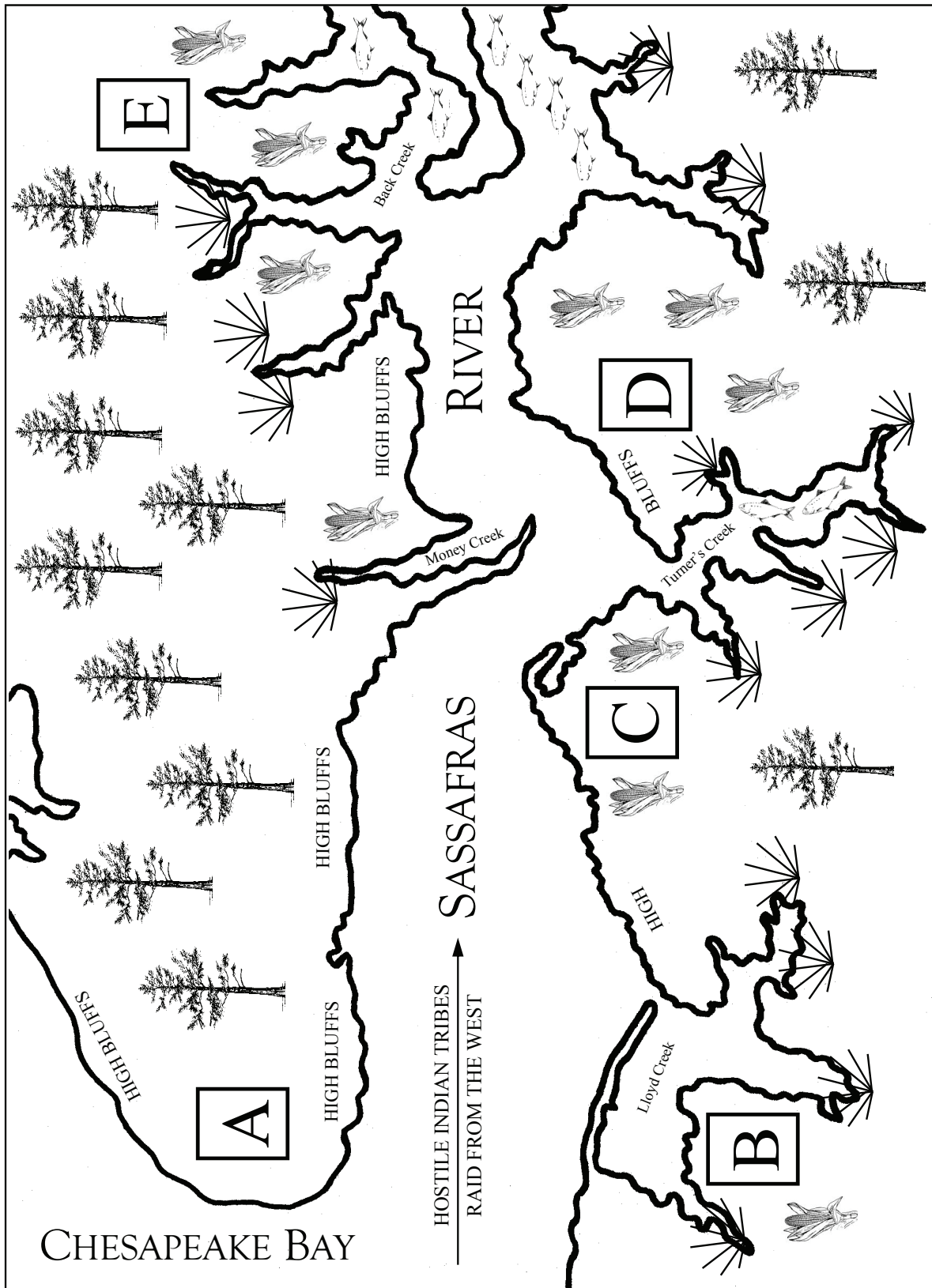
Arrow arum was harvested from the marshes and the roots were eaten.



The Native Americans grew corn in the area's rich soils.



Whitetail deer were hunted for their meat and furs.



MAP KEY:

-  = tuckahoe
-  = forest
-  = spawning fish
-  = fertile soils

Where Were Native American Towns Located? (Continued)

DIRECTIONS: Carefully study the map of the Sassafras River, then list the pros and cons of each site on the chart below. When you are finished, decide which of the five sites would have been the best location for the town.

SITE	PROS	CONS
A		
B		
C		
D		
E		

Where Were Native American Towns Located? (Continued)

DIRECTIONS: After listing the pros and cons of each site from the map of the Sassafras River, pick the site where you think the Native American town should be located. In the space below, explain why you picked that site.

[illegible]

Image Credit: Engraving by Theodor de Bry

Life on the Chesapeake Bay in the 18th Century

DIRECTIONS: Read the article about Life on the Chesapeake Bay in the 1700s with your class, then answer the questions on the next page.



Life in the Chesapeake Bay area was very different in the 1700s from the way people live today. There were no cars, cell phones, televisions, computers, or any electricity. When people traveled over land, the few dirt roads that did exist became very muddy after a hard rain, making it hard to get very far. To cover long distances, most people traveled on sailboats. The waters of the Chesapeake were a lot like the highways of today, and ships like the schooner SULTANA (shown above) were used in much the same way that large trucks are used in modern times. Ships were used to carry people from one town to another, to deliver cargo such as wheat or tobacco, to defend cities in times of war, and to deliver mail. Since people were so dependent on the Bay and its rivers, nearly everyone in the 18th century lived along the water. Most homes had small gardens where people could grow their own food, and residents also harvested fish, crabs, and oysters from the Chesapeake to add to their diets. Another major difference between then and now was that the land in America was owned by Great Britain, and Maryland was one of 13 British colonies. Much has changed in the past 250 years!

DIRECTIONS: Read the article on the previous page, then answer the questions below.

What are some modern devices that didn't exist in the 1700s?

How did people travel long distances in the 1700s?

What are some ways that ships were used in the 1700s?

What country owned the colony of Maryland in the 1700s?

REFLECTION: What do you think your life would have been like if you lived in the Chesapeake Bay area in the 1700s?

Watersheds & Land Use

Prior to Arriving

What do you already know about the Chesapeake Bay watershed?

What is one new thing you'd like to learn about the Bay during the field trip today?

Digital Map Questions

What kind of land use is dominant on the Eastern Shore?

What has happened to the population in the area over time?

Captain John Smith's 1612 Map of the Bay

DIRECTIONS: Examine the map (John Smith, 1612) with your class, then answer the following questions.



Why is this map “sideways” compared to other maps?

How has the number of people changed in the last 400 years?

What are some other ways the Bay and its watershed have changed?

Modern Map of the Bay

DIRECTIONS: Examine the map with your class, then answer the following questions.



Image Credit: Satellite image, National Oceanic Atmospheric Administration

Describe the water inside the red oval. What might have led to the water looking so brown?

How does cloudy water impact the Chesapeake Bay and the animals that live there?

Runoff Model

DIRECTIONS: After using the watershed runoff model, answer the following questions.



Where did the water go when it landed on the model?

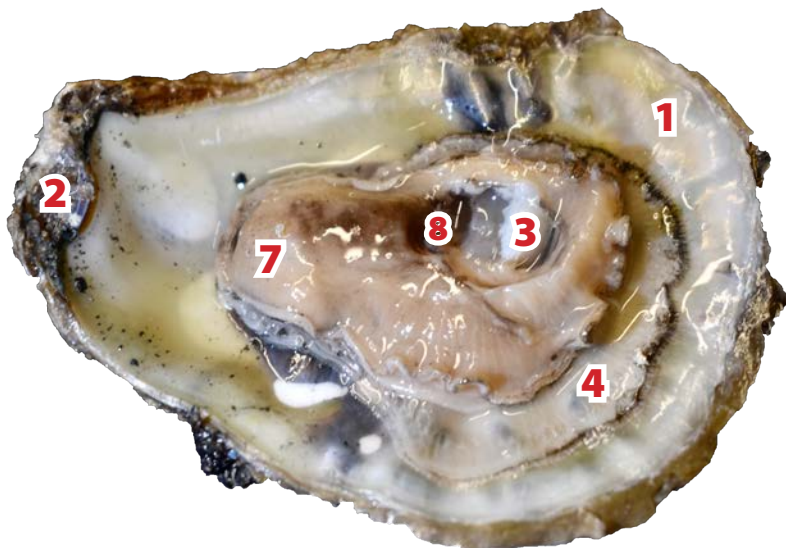
What are three types of pollution that you added to the model?

Where did the pollution end up after the model was sprayed with water?

What can be done to decrease the amount of pollution that ends up in the water?

Oyster Dissection

DIRECTIONS: Working with Sultana Education Foundation staff, use the Word Bank at the bottom of the page to label the parts of an oyster.



1. _____

2. _____

3. _____

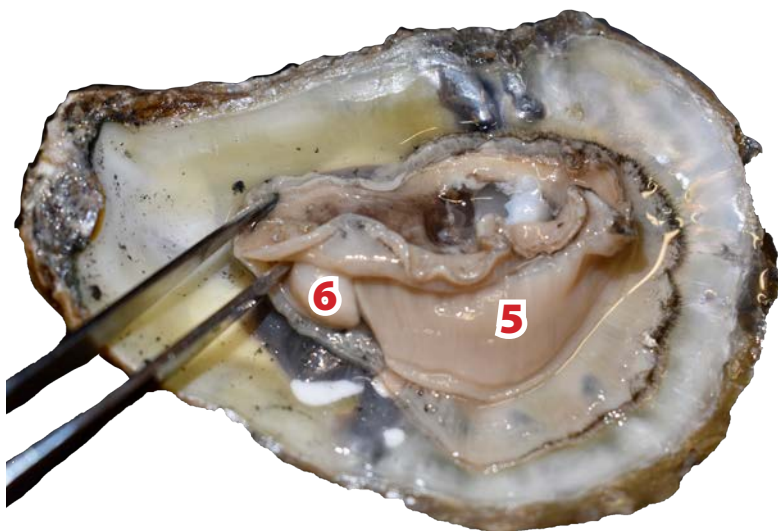
4. _____

5. _____

6. _____

7. _____

8. _____



Word Bank

Gills

Stomach

Hinge

Heart

Mantle

Palps

Shell

Adductor Muscle

Oyster Dissection (Continued)

DIRECTIONS: After dissecting an oyster, answer the following questions.

What are three important jobs oysters have in the Chesapeake Bay ecosystem?



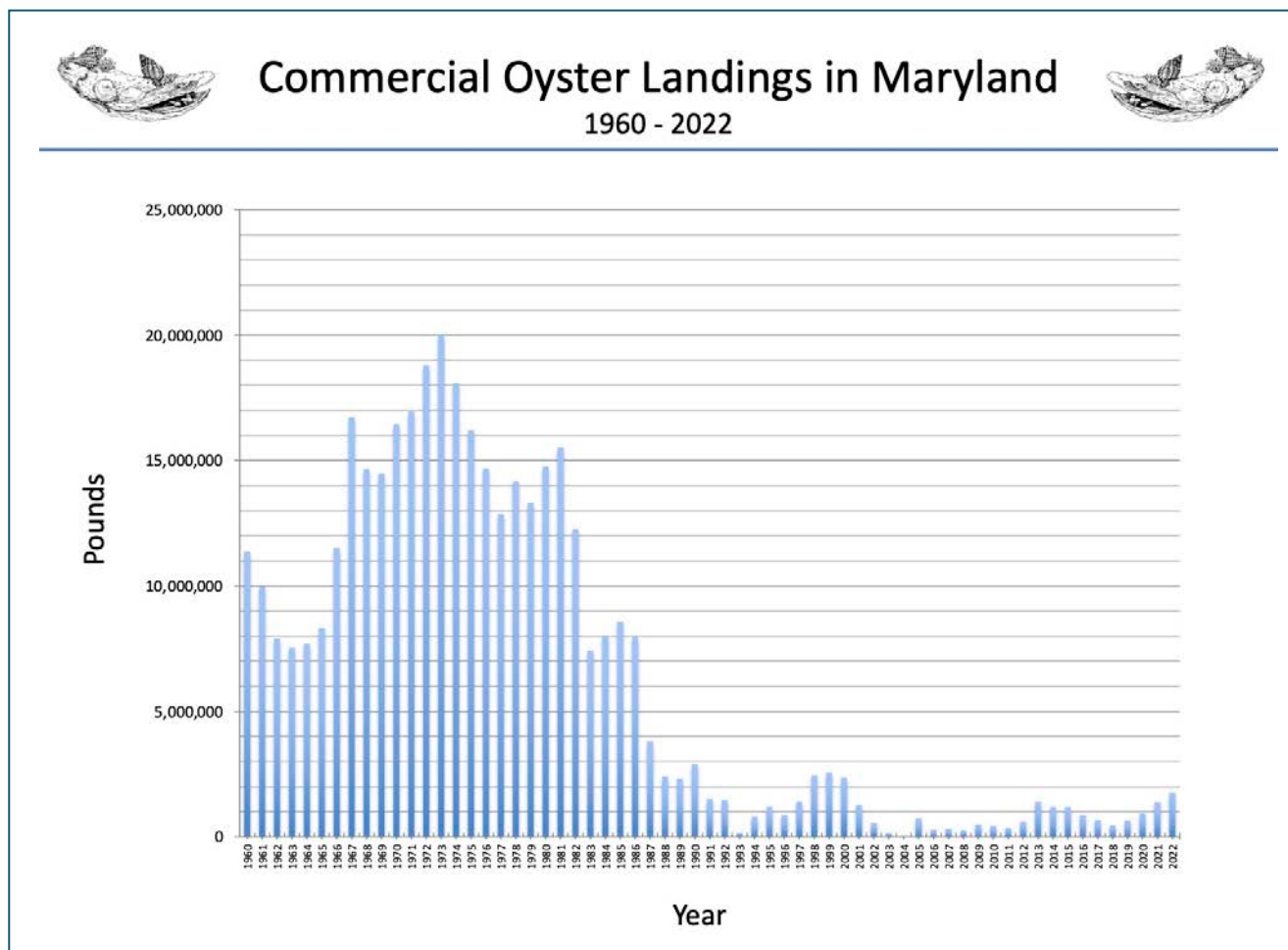
What was your favorite part about dissecting an oyster?

What was your least favorite part about dissecting an oyster?

How would a healthy oyster bar be important for fish and crabs?

Oysters and the Chesapeake Bay

DIRECTIONS: Look at the graph below and answer the following questions.



Looking at the graph, what has happened to the number of oysters in the Chesapeake Bay over time?

How may the health of the Bay be affected by having fewer oysters?

Reflection

DIRECTIONS: Reflect on some things YOU can do to help improve the health of the Chesapeake Bay. How would those actions help the Bay?

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Modern Land & Water Use



Today, the Chesapeake Bay watershed is home to more than 18 million people - including you! The land and water within the watershed is used in many different ways. Check out the photographs above and think about ways that you use the land and water in your own community.

DIRECTIONS: Examine the pictures on the previous page, then answer the following questions.

List five different ways that the water and land within the Chesapeake Bay watershed is used today.

1. _____
2. _____
3. _____
4. _____
5. _____

What kinds of pollution might run off from towns to the Chesapeake Bay?

What kinds of pollution might run off from farms to the Chesapeake Bay?

What kinds of pollution might come from cars and motorboats?

The Impact of Erosion on Shorelines

DIRECTIONS: Read the article then answer the questions on the following page.

Erosion is the process that occurs when rocks, sand, or soils are moved from one place to another. Rivers erode rocks and soil from their banks and carry them downstream. The pieces of rock that are moved by gravity, wind, weather, and water are called sediments.

Sometimes you can see erosion happening, such as during flash floods and hurricanes. Or perhaps you have seen that water in a nearby creek appears muddy after a storm. However, most of the time you can see only the evidence left behind by hundreds, thousands, or even millions of years of erosion. Grains of sand are blown by the wind a few feet at a time. Over time, these little changes add up!

Along the shorelines of the Chester and Sassafras Rivers, you can find places where waves have caused erosion. In the top picture, the trees along the shore of Eastern Neck Island have had the soil beneath them washed away. In the lower photo, the sandy bluffs on the Sassafras River have eroded back as waves crash into them, causing trees along the edges to fall into the river. Over years, erosion changes the size of islands and the shape of the shoreline.

Erosion is a slow process, but sometimes people make it happen more quickly. Clearing trees for houses and farm fields exposes soils to wind and rain and makes them easier to erode. On the other hand, when people plant trees they can help slow down erosion, as the roots help to hold the soils in place.



DIRECTIONS: Read the article on the previous page, then answer the questions below.

What is erosion?

What do you call pieces of rock that have been moved by gravity, wind, or water?

What is one cause of erosion on the Chester and Sassafras River?

What happened to the soil beneath the trees at Eastern Neck Island?

How does tree planting slow the rate of erosion?

Modeling How Water Causes Erosion

MATERIALS

- One flat plastic container
- One cup
- Potting soil

Make a prediction about what will happen to the soil when the water is poured.

DIRECTIONS

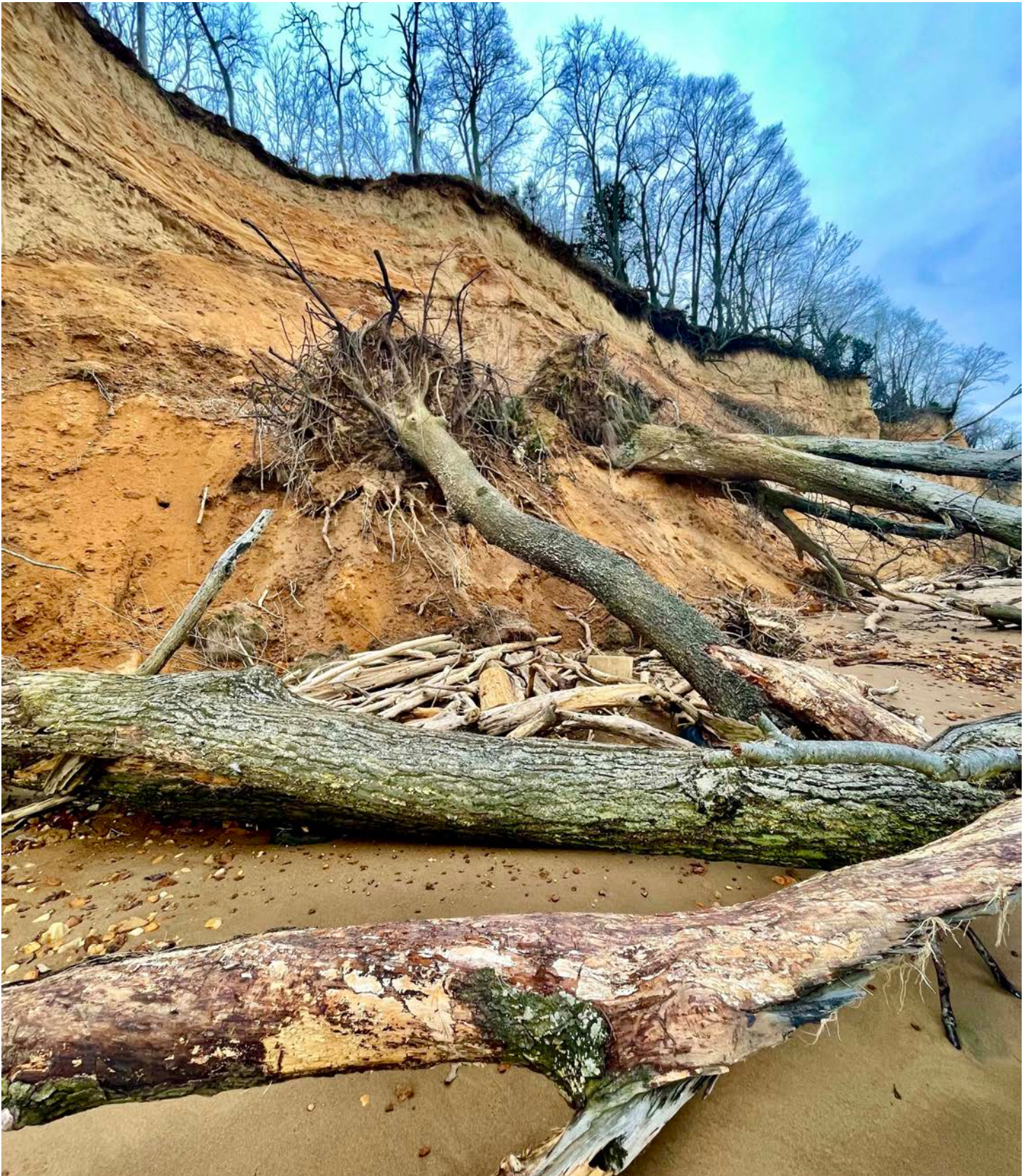
1. Have one student hold up one end of the plastic container so it is slanted.
2. Pour the soil into the high end of the container.
3. Pour the water onto the soil and observe what happens as it flows down the container, then answer the questions below:

How did the flowing water move the soil?

What would happen if you kept pouring water for a long period of time?

How could you slow down the erosion caused by moving water?







Erosion on the Sassafras River

DIRECTIONS: Look at the photograph on the previous page of the bluff on the Sassafras River with your class, then answer the questions below.

What happened to the trees at the bottom of the bluff?

This bluff is located on the Sassafras River. What do you think caused all the erosion?

If you came to this same location 100 years ago, how would it have looked different from what it looks like now?

If you came to this same location 100 years in the future, how would it look different from what it looks like now?

Paddling the Creek

DIRECTIONS: After using your observations skills while paddling, answer the following questions.

List any plants and animals you saw while paddling on Turner's Creek.

What are some signs you saw that show people have been in the area?

What do you think this area looked like hundreds of years ago?

What signs of erosion did you notice?

How does erosion impact water quality and plants/animals that live in the water?

Water Chemistry & Aquatic Life Survey

TURBIDITY: Turbidity is the measure of the clarity of a given sample of water. Water that has a lot of sediment in it is murky, or turbid. Water with small amounts of algae and sediments will be clearer.

Turbidity is measured in centimeters (cm) using a Secchi Disk. The higher the measurement, the farther light can travel, which is important for underwater plants to survive.

What turbidity level did you measure? Do you think that's a good number?

DISSOLVED OXYGEN: Dissolved oxygen measures the amount of oxygen in the water that is available for animals to breathe. What dissolved oxygen level did you measure? Most apex predators need dissolved oxygen levels to be at least 6 parts per million in order to survive.

Based on this information, is there enough dissolved oxygen in your water sample at Turner's Creek to support aquatic life?

What are some animals you caught in the seine net? Does the ecosystem seem healthy?

Schoolyard Survey

School: _____

Group Members: _____

What watershed is our school in?: _____

1. Where does your school roof drain water into? (*circle one*)



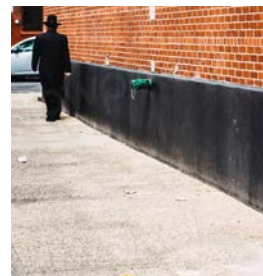
Trees, shrubs,
unmowed grass



Rain barrels



Mowed grass



Bare soil, concrete,
blacktop



Storm drain

2. Where does runoff from the parking lot go? (*circle one*)



Bioswale



Rain garden

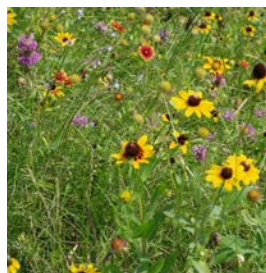


Permeable pavers



Storm drain

3. Look for patches of bare soil and signs of erosion such as areas where rainwater has carved or washed out vegetation. Which of these does your schoolyard have? (*circle one*)



Very little erosion or
bare soil



Several patches of
bare soil or erosion



Mostly bare soil and
impervious surfaces

Schoolyard Survey

4. Does your school use any of these best practices of indoor water usage? *(circle all that apply)*



Use eco-friendly cleaning products



Use automated sinks that turn off



Have a water bottle refill station



Environmental green team at school



Use low-volume flushing toilets

5. Does your school have any transportation practices to conserve fuel? *(circle all that apply)*



Bike racks at school



"No Idle" signs in school parking lot



Electric charging stations at school

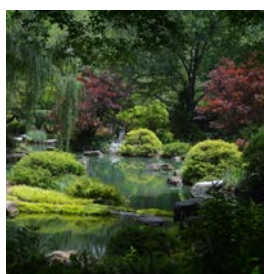


Most students ride bus, walk, or carpool

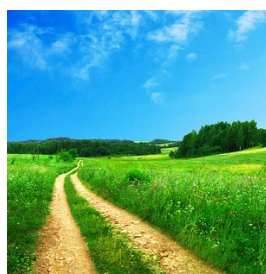


Most teachers walk or carpool

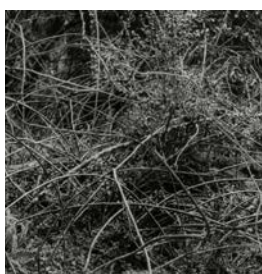
6. Which of the following animal habitats does your school have? *(circle all that apply)*



Woodlands with lots of plants and trees



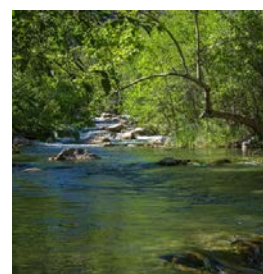
Tall grassy fields or meadows



Thick brush and bramble



Dead trees or rotting logs on ground



Streams or body of water

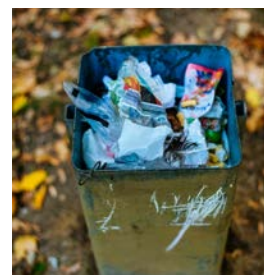
7. Which of these methods does your school use for removing waste? *(circle one)*



Compost & recycling



Only recycling



Only trash

Schoolyard Survey (Continued)

8. Does your schoolyard have any environmentally friendly components? *(circle one)*

Yes

No

9. Look at your schoolyard map. Where does it fall in the following range? *(circle one)*

1= all concrete

10=totally forested

1 2 3 4 5 6 7 8 9 10

10. Look at your playground. Where does it fall in the following range? *(circle one)*

1= all impervious surfaces

10=all pervious surfaces

1 2 3 4 5 6 7 8 9 10





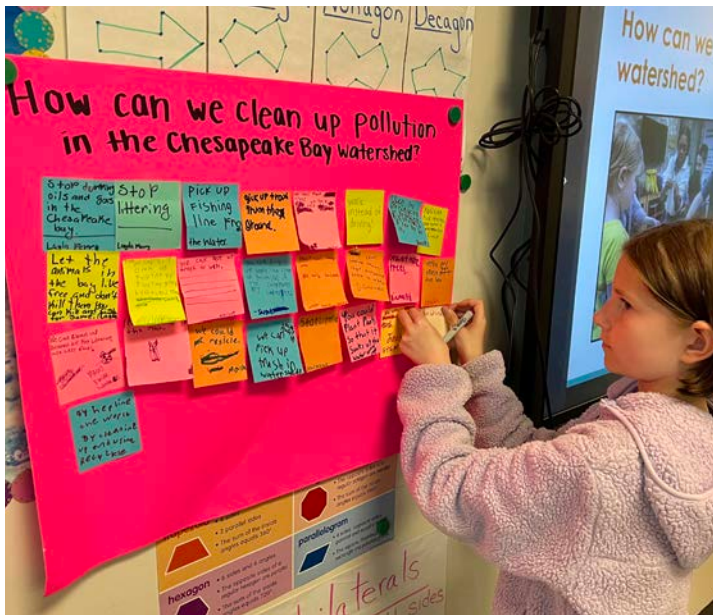
Reflection

Think about erosion, drainage, and waste removal at your school. What areas does your school do well?

What are some things you can do to improve your school and school grounds?

What are some things you can do to improve the health of your home and community?

Planning Your Action Projects



Brainstorm ideas for action projects:

The action project I have chosen is:

How will the action project you have chosen protect or improve our watershed?

DIRECTIONS: Take some time to think about all of the activities you've done during the Changing Chesapeake unit. What have you learned about the Chesapeake Bay watershed? How has the land in the watershed changed over the past 400 years? What are some actions that people can take to improve habitat within the watershed, and why is this important for the critters that live in the Bay?

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Bioswale - a ditch filled with vegetation and stone that collects polluted stormwater runoff, soaks it into the ground, and filters out pollution

Bivalve - a mollusk with two shells joined together by a hinge (e.g., mussel, oyster, or clam)

Dissection - the act of cutting up something to study its internal parts

Dissolved oxygen - the amount of oxygen that is present in water

Erosion - wearing away of the earth's surface by wind or water

Fertilizer - a natural or chemical substance added to soil to make it better for growing plants

Impervious surface - a surface that does not allow the passage or entrance of liquid or water

Land use - the economic and cultural activities (e.g., agricultural, residential, industrial, mining, and recreational uses) that are practiced at a given place

Permeable paver - a type of pavement that allows rainwater to pass through it into the ground below

Pervious surface - a surface that allows the passage or entrance of liquid or water

Population - the total number of people or animals living in a specific area

Rain garden - a garden with native plants placed in a low spot that collects rainwater from buildings or surfaces, and helps to filter pollutants while also creating shelter for animals

Runoff - anything that drains away, such as excess rainwater that is not absorbed by the earth

SAV's (submerged aquatic vegetation) - a rooted plant that grows completely underwater

Sediment - pieces of rock that are moved by gravity, wind, and water

Tributary - a river or stream that flows into a larger body of water

Turbidity - a measurement of how clouded or murky a liquid is because of stirred-up particles or sediment

Watershed - the area of land that drains water into a body of water

Word Search

DIRECTIONS: Locate each glossary word from the Word Bank in the word search below. Words can go in any direction and can share letters as they cross over each other.

P	Z	K	E	L	R	K	T	A	B	I	O	S	W	A	L	E	P	G	H
O	X	Y	C	T	J	U	R	M	W	M	Q	G	Z	T	A	E	D	V	T
P	L	T	A	T	B	B	N	S	M	N	S	D	H	K	R	D	I	X	Y
U	Y	D	F	P	X	Y	U	O	Y	Z	Y	N	M	M	E	D	S	G	N
L	Y	N	R	T	J	Y	J	V	F	H	T	H	E	H	B	E	S	V	Z
A	R	S	U	I	G	V	R	M	S	F	F	A	S	N	C	I	O	T	U
T	A	E	S	A	N	U	H	B	Y	E	B	R	N	A	K	Q	L	R	D
I	T	D	S	E	C	K	O	O	Z	L	E	C	F	B	B	J	V	A	D
O	U	I	U	H	V	D	N	P	E	T	J	R	W	Y	T	N	E	I	V
N	B	M	O	B	R	L	T	P	A	W	U	E	F	E	N	O	D	N	O
Y	I	E	I	J	T	S	A	W	Y	S	J	Z	K	L	L	N	O	G	R
L	R	N	V	N	I	V	M	V	S	W	L	I	X	K	D	O	X	A	Y
A	T	T	R	J	E	Z	Q	U	I	Z	N	L	O	R	M	I	Y	R	N
N	L	B	E	R	W	K	O	F	Y	B	R	I	S	Q	U	T	G	D	O
D	Y	V	P	P	K	I	N	S	X	J	C	T	M	A	A	C	E	E	I
U	L	N	M	G	V	Y	T	I	D	I	B	R	U	T	V	E	N	N	S
S	Q	Q	I	R	D	K	Z	V	A	N	K	E	O	P	N	S	R	W	O
E	J	I	E	B	M	I	W	S	A	H	V	F	Y	D	A	S	P	Q	R
F	R	P	L	C	Q	L	J	Q	G	L	R	Y	O	B	J	I	M	T	E
O	L	K	C	X	O	L	L	A	F	X	S	G	E	X	I	D	H	Y	U

Word Bank

Erosion	Sediment	Fertilizer	Dissection	Impervious surface
Watershed	Turbidity	Land use	Permeable paver	Pervious surface
Tributary	Dissolved oxygen	Population	Bioswale	
Runoff	SAVs	Bivalve	Rain garden	





About the Foundation

Founded in 1997, the Sultana Education Foundation is a private non-profit organization dedicated to providing unique, hands-on educational opportunities that promote stewardship of the Chesapeake Bay's historic, cultural, and environmental legacies.



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