Potomac Headwaters PHLOW Leaders Of Watersheds Cacapon Institute

Lesson 1- What are Watersheds?

Upper Elementary

Cacapon Institute
Protecting rivers and watersheds since 1985

Lesson Outcomes:

Students will understand…

- that everyone lives in a watershed
- that there are smaller watersheds within a watershed
- that natural physical features define watersheds
- that the Potomac River Watershed is within the Chesapeake Bay Watershed

Students will be able to…

- Define a watershed
- Investigate the states that compose the Chesapeake Bay Watershed
- Analyze the role the Appalachian Mountains play in the Chesapeake Bay Watershed
- Locate key rivers and the Chesapeake Bay

Duration of Activity & Setting: 50 minutes; Indoors

Vocabulary:

Agriculture, boundary, condensation, continental divide, dissolved, evaporation, fertilizer, headwaters, industry, organism, percolation, pollution/pollutant, precipitation, runoff, substance, sub-watershed, temperature, topography, toxic waste, tributary, watershed, weather

Materials:

"Watershed Diagram" Image
"What is a Watershed" from Cacapon Institute's eSchool
Chesapeake Bay States Puzzle Board
"The Drop in My Drink" by Meredith Hooper
Major Sub-Watersheds Maps

Essential Questions:

1. Where does water go when it rains?
2. What is a watershed?
3. How are natural boundaries created?

Lesson Procedure:

1. Post Essential Question on Board prior to starting lesson
2. Introduce yourself and let the students know that you will be visiting their classroom over the next few weeks to teach them fun lessons about the Chesapeake Bay and how they can create a positive impact for their local waterway. At the end of the education sessions students will be installing a rain garden at the school to help the environment.

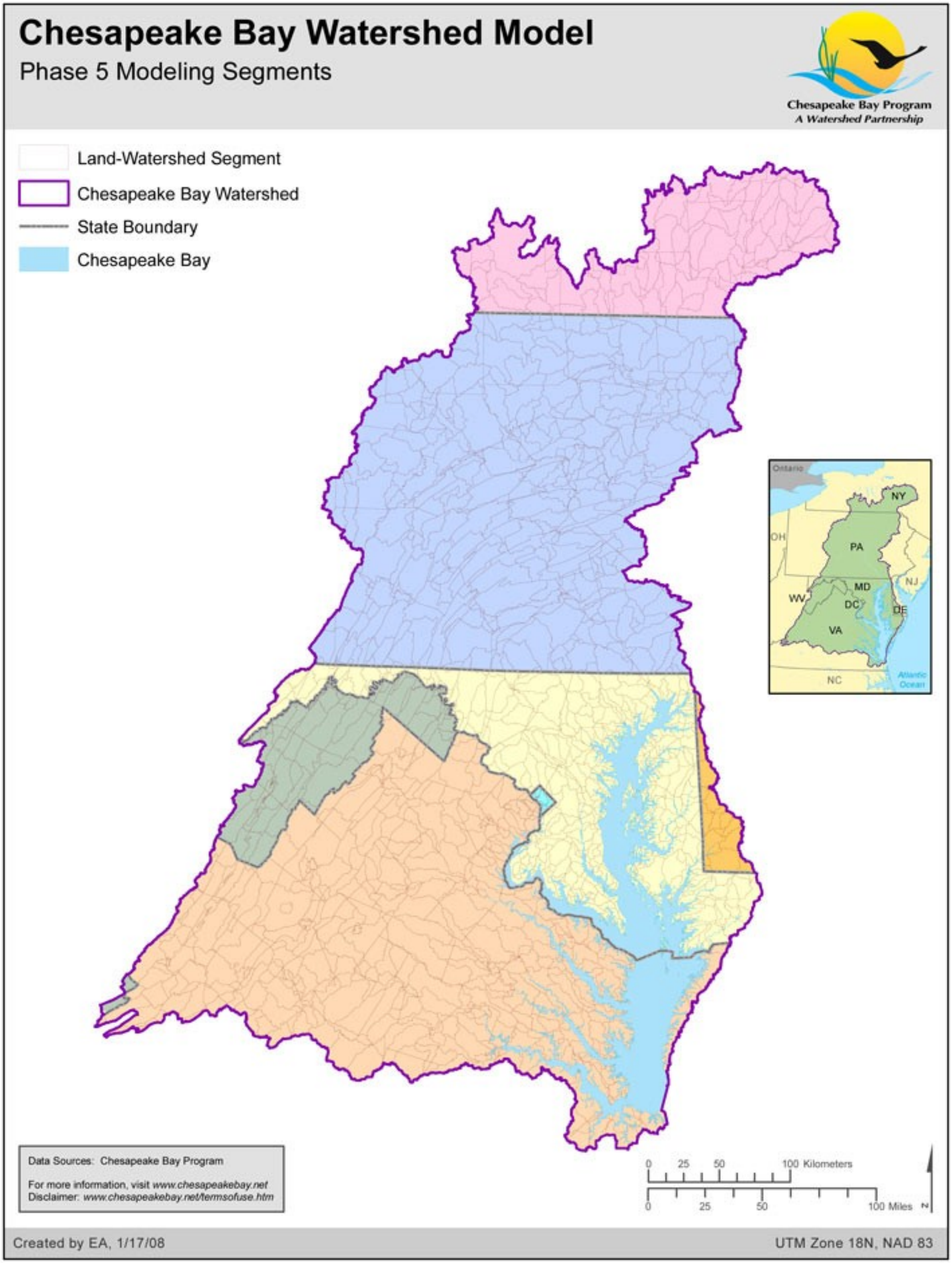
3. Logon to CacaponInsistitute.org. Click on eSchool. Enter the Elementary Classroom. Find the lesson “What is a Watershed?” on the chalkboard.
    a. Press play and read aloud the text to the students. (5-10 minutes)
    b. The video will lead students to the definition of a watershed and how water travels over and under land.
4. At the conclusion of the animated video, ask students to define a watershed in their own words. Place the watershed diagram for students to see. *Definition: A watershed is an area of land that drains into a particular body of water, such as a stream, lake, or bay.*
5. Ask students to describe where water goes when it rains. Relate it to the video and around their school grounds.
    a. This is a perfect opportunity to review the water cycle.
        i. Water in the form of rain, snow, sleet, or hail falls as precipitation to the ground.
        ii. Once on the ground, water can be absorbed, percolate, into the ground, travel over the surface as runoff
        iii. Form puddles that will undergo evaporation and form clouds through condensation
    b. Ask students where they have seen runoff occurring at the school. Does any water percolate into the ground?
6. Ask students: Do you know what large watershed you live in? *Answer: Chesapeake Bay Watershed*
7. Tell students that the Chesapeake Bay Watersheds is composed of multiple states that have rivers leading to the Chesapeake Bay.
8. Using the Chesapeake Bay Watershed Puzzle Poster lead the students in assembling the states that compose the Chesapeake Bay Watershed
    a. Starting from New York and working toward Virginia have students make observations of the state shapes and question what could cause the shapes to be different.
    b. Finally ask students where the Chesapeake Bay would fit on the map. *Add label*
    c. Ask students what ocean the Chesapeake Bay deposits water into. *Answer: Atlantic Ocean-add label*
    d. Ask students what major geographic feature runs from Georgia to Maine and would explain why sections of Pennsylvania, West Virginia, and New York are cut off. *Attach Appalachian Mountains label*
    e. Remind students that points of high elevation (topography) define watershed boundaries. The Appalachian Mountains are the highest point in the area that defines the Chesapeake Bay Watershed and the Mississippi River Watershed.
        i. Can use the bathtub analogy if students seem lost
        ii. Sides of the tub=mountains. All of the water will drain to one point in the tub=Chesapeake Bay in real life. Any water splashed out of the tub will not make it in the drain.
    f. Just like our highway and road system rivers act the same way to move water from one location to another and it is always downhill towards lower points of elevation. Watersheds are named after the river to which all of the water flows. Just by knowing the name of the watershed you know where the final destination for the water will be.
        i. For example: all of the water within the Chesapeake Bay Watershed will end in the Chesapeake Bay. The Potomac River Watershed is all of the land with water

flowing into the Potomac River. The Potomac River is within the Chesapeake Bay Watershed. *Can use measuring cups/Russian nesting dolls as an example.*

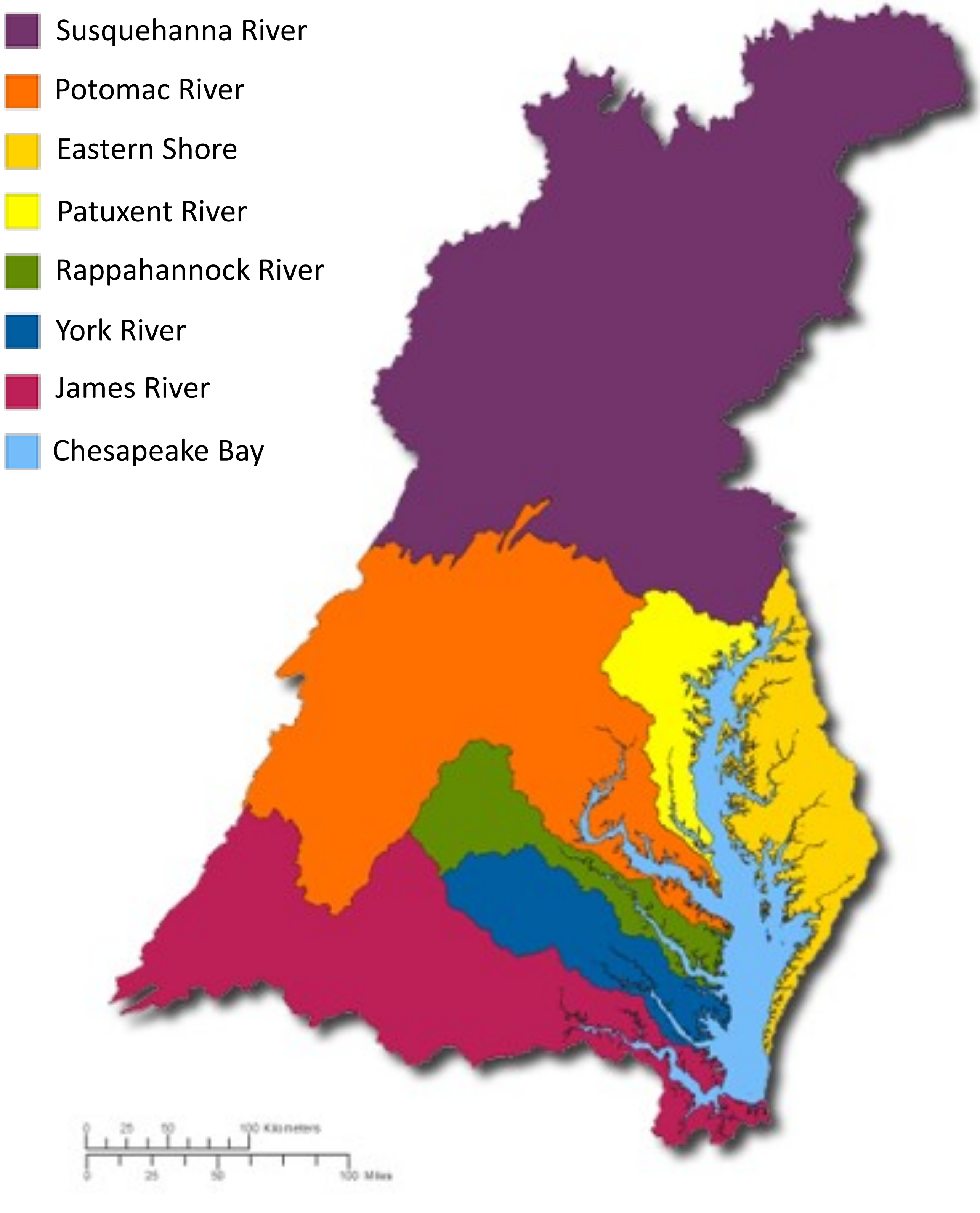
1. The Potomac River Watershed is a Sub-Watershed of the Chesapeake Bay.
2. Show the image of the major sub-watersheds and discuss the major ones and the location they are found within the Chesapeake Bay Watershed.

g. Read excerpt from “The Drop in My Drink” by Meredith Hooper – Looking After Water, Last Page
    i. If time permits, Start from “….Two years ago….” And read through Looking After Water. (5 minutes)

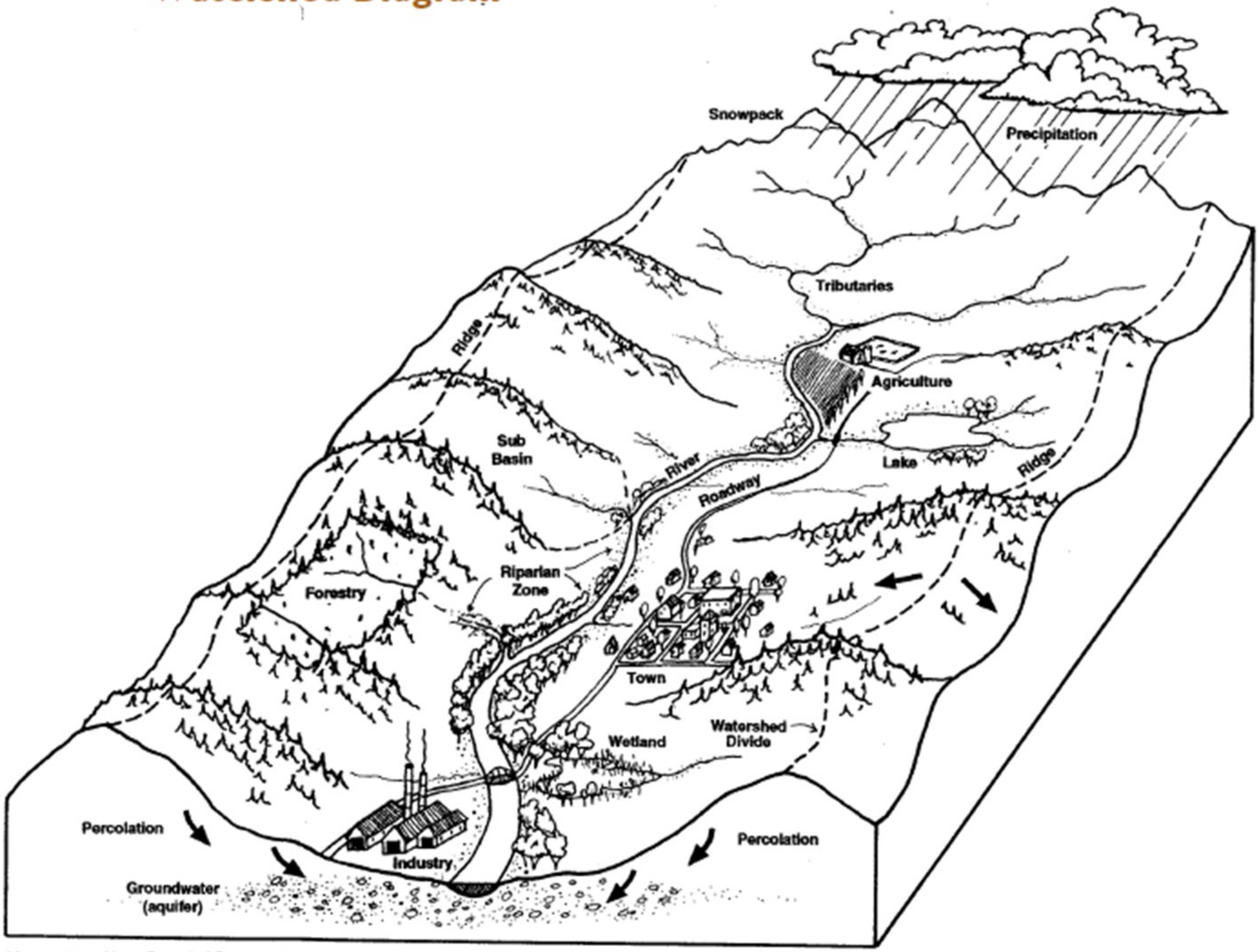
9. Wrap Up:
    a. Ask students to…
        i. Define a watershed
        ii. Describe what watersheds they live in. *Chesapeake Bay Watershed…*
        iii. How does topography relate to watersheds?


Chesapeake Bay Watershed Model
Phase 5 Modeling Segments
Chesapeake Bay Program
A Watershed Partnership
Land-Watershed Segment
Chesapeake Bay Watershed
State Boundary
Chesapeake Bay
Ontario
NY
OH
PA
NJ
MD
WV
DC
DE
VA
NC
Atlantic Ocean
Data Sources: Chesapeake Bay Program
For more information, visit www.chesapeakebay.net
Disclaimer: www.chesapeakebay.net/termsofuse.htm
0 25 50 100 Kilometers
0 25 50 100 Miles
N
Created by EA, 1/17/08
UTM Zone 18N, NAD 83

Major Sub-Watersheds of the Chesapeake Bay



Watershed Diagram



Map courtesy of Lane Council of Governments

Lesson 2- Nutrient Pollution

Upper Elementary

Lesson Outcomes:

Students will understand…

- that there are various forms of pollution that can harm rivers
- that excess nutrients enter the stream from stormwater runoff
- that excess nutrients form algae blooms that are harmful for the organisms living in the stream
- that everyone can play a role in decrease pollution in our streams

Students will be able to…

- Define stormwater runoff pollution
- Investigate the impact excess nutrients have on the aquatic community
- Locate pollution hot spots found in various urban and rural communities

Duration of Activity & Setting: 50 minutes; Indoors

Vocabulary:

Agriculture, algae, aquatic vegetation, erosion, fertilizer, nutrients, organisms, pollution/ pollutant, runoff, rural, sediment, stormwater, topography, toxic waste, urban

Materials:

“Nutrient Pollution” PowerPoint Presentation
“Grade the River” Packets

Essential Questions:

1. What is pollution?
2. Name some forms of pollution that can affect our rivers.
3. What are nutrients?

Lesson Procedure:

1. Post Essential Questions on Board
2. Ask students:
   a. Can you define pollution? *Answer: harmful substances or products in the environment*
   b. Provide some examples of pollution. *Answer: Trash, gasoline, oil, sediment, nutrients/fertilizers, pesticides, toxic chemicals, bacteria*
3. Tell students they are going to be investigating nutrient pollution this week.
4. Open the “Nutrient Pollution” power point and begin.
   a. You can find notes within slides.
   b. Sedimentation and erosion will be covered more in lesson 3
5. Following the PowerPoint pass out the “Grade the Rivers” Packets to groups of students.
   a. Have students work as a group to categorize the rivers from BEST (left) to the WORST (right) along their desks.

b. Remind students to look for things that we have talked about today and last week. Sedimentation, erosion, runoff, riparian buffer, livestock and farm fields leading to nutrient pollution.
c. Have students share their answers and reasoning for the order. Note: there is no one correct answer as long as the students work together to come up with the reasoning for their order choices.

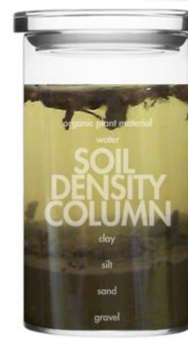
POLLUTION PROBLEMS
Sediment & Nutrients

Ms. Molly Barkman
Watershed Education Specialist
Cacapon Insititute
Potomac Headwaters Leaders of Watersheds
Grow-a-Garden

Cacapon Institute
Protecting rivers and watersheds since 1985

What is Sediment?

- Sediment- loose particles of clay, silt, and sand
  - Sediment = "Soil"



How does Sediment Enter the River?

Stormwater - Rain water

Runoff - Water traveling over the surface of the earth

Pollution - Harmful substances for the environment

Erosion

the slow destruction of soil by water, wind, or other natural causes

How Can Sediment be Harmful to the Bay and Rivers?

Sediments Entering the Chesapeake Bay from Up River

Potomac River

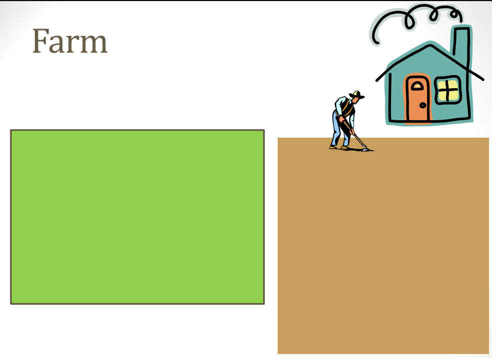
What are Nutrients?

- Nitrogen (N) and Phosphorous (P)
- Occur naturally in water, soil, and air
- Are essential to all plant life
- Fertilizers
  - Aid in the growth of agricultural crops and household plants
  - Are produced by animals (manure)

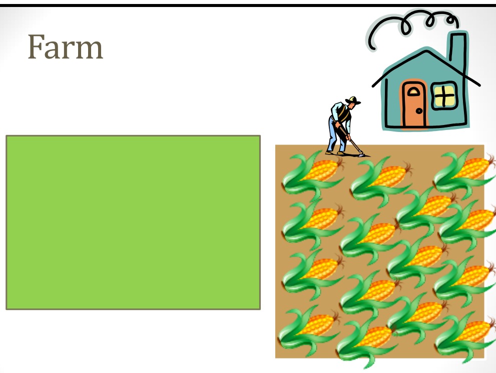
How can Nutrients Become Pollutants to the Bay and its Rivers?

- An excess of nutrients can be harmful
  - Called: Nutrient Pollution or Overnutrification

Farm



Farm



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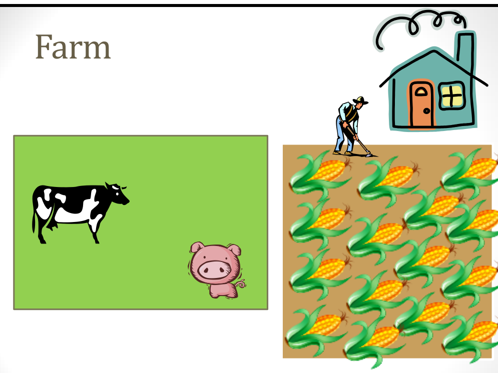

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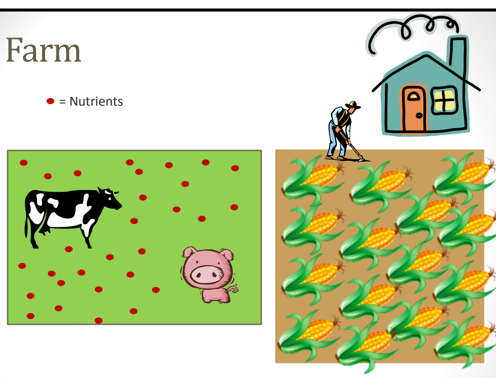

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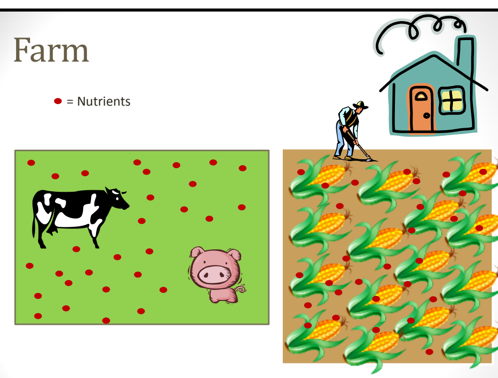
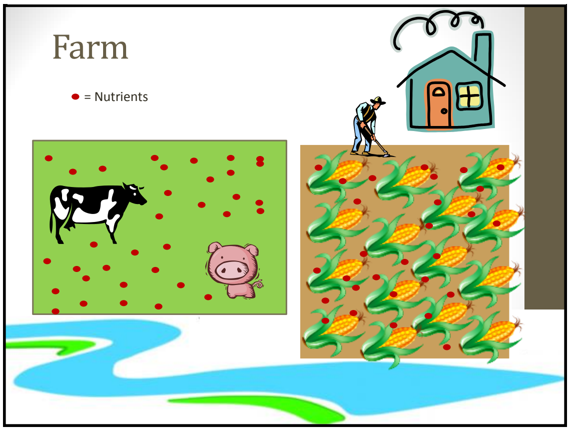
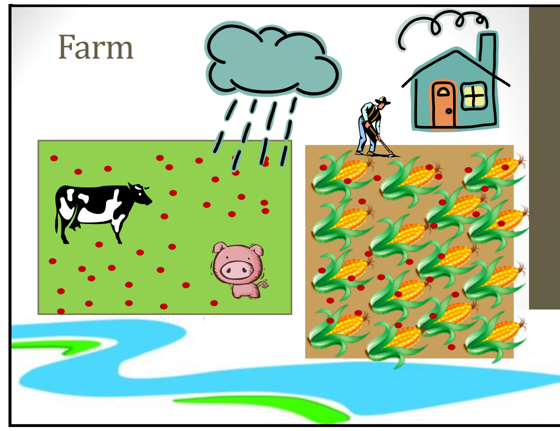



Farm
= Nutrients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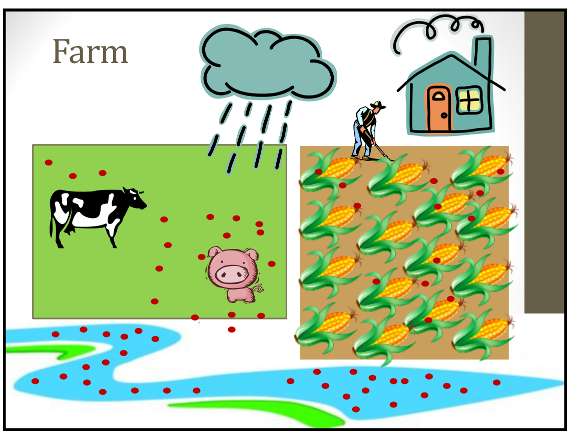
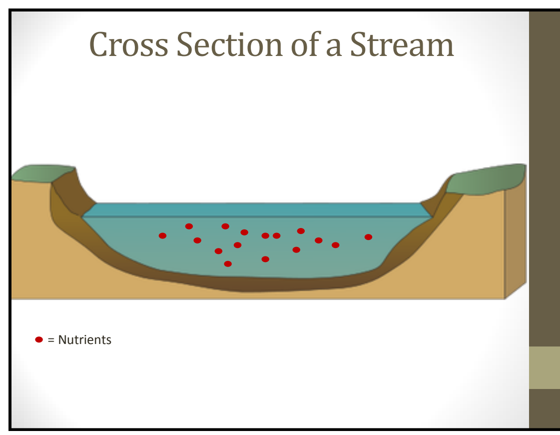
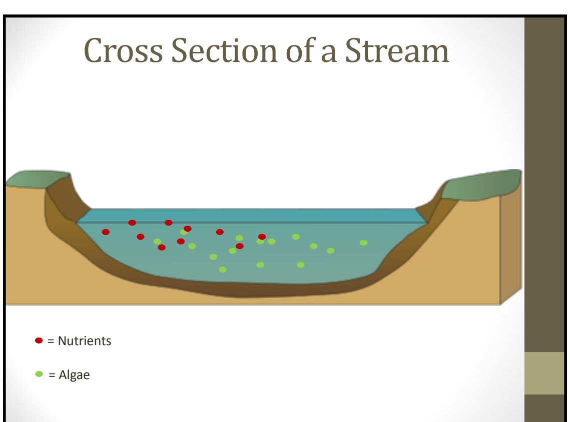
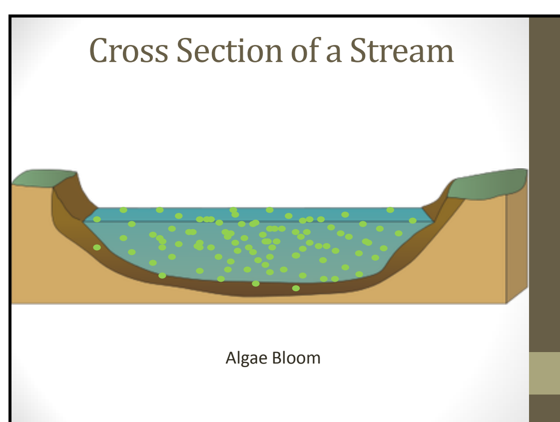
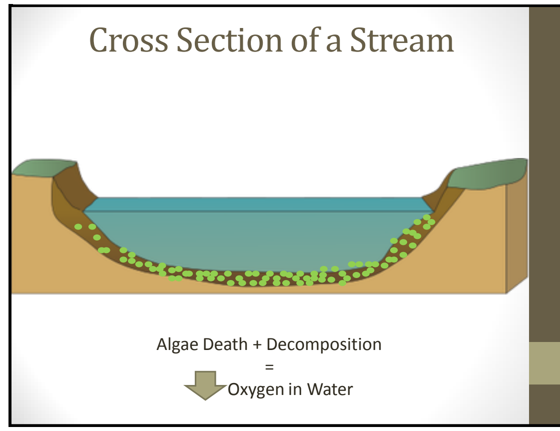

Farm

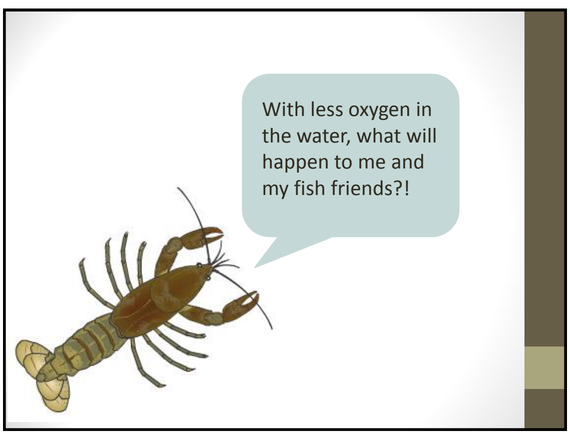

Cross Section of a Stream
= Nutrients

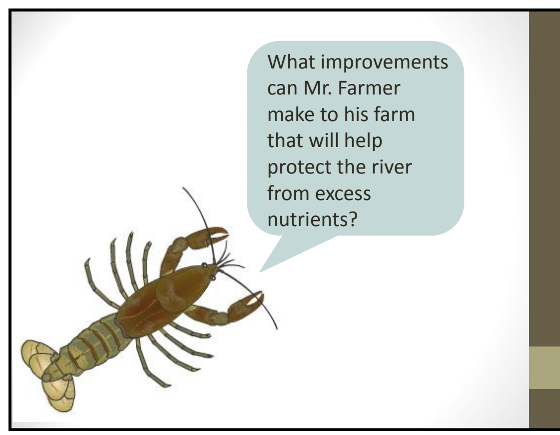

Cross Section of a Stream
= Nutrients
= Algae

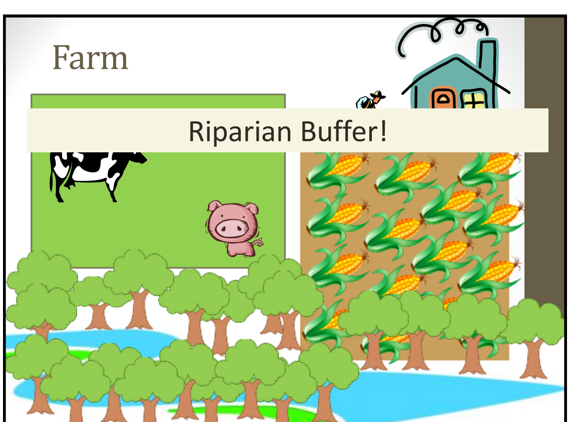

Cross Section of a Stream
Algae Bloom


Algae Blooms


Cross Section of a Stream
Algae Death + Decomposition
=
Oxygen in Water


With less oxygen in the water, what will happen to me and my fish friends?!


What improvements can Mr. Farmer make to his farm that will help protect the river from excess nutrients?


Farm
Riparian Buffer!

Grade the Rivers Activity Packet

Directions:

Print the following photos and cut along dotted line to form a packet of river images showing various pollutant issues faced throughout the Chesapeake Bay Watershed. Students work as groups to arrange the photos from worst condition to the best condition. Students must provide reasoning for the scale based off the information learned in the Grow-a-Garden program.


Google Image


Photo Credit: Corey Dunn


Google Image


Google Image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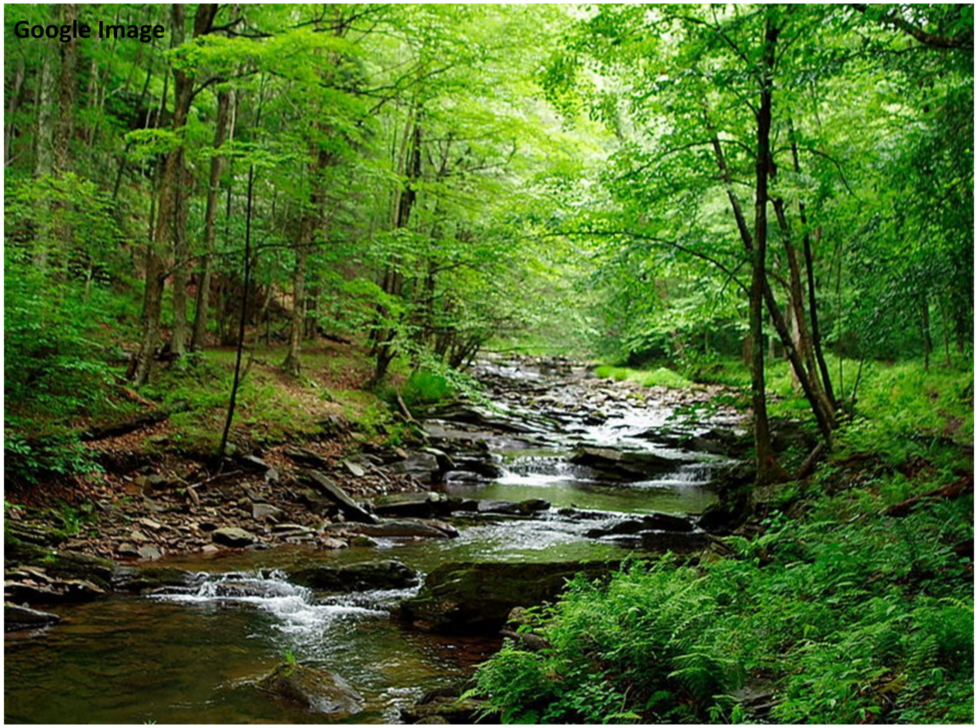
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Lesson 3- Sedimentation & Benthic Macroinvertebrates
Upper Elementary

Lesson Outcomes:
Students will understand…

- that benthic macroinvertebrates (BMIs) are bottom dwelling organisms that don't have a backbone
- that sedimentation from erosion and stormwater runoff negatively affects BMI habitat
- that BMIs are the food source for lager predators, especially fish, in streams
- that certain species are indicators of the health of the stream

Students will be able to…

- Define benthic macroinvertebrate, sedimentation, and erosion
- Investigate how sediment affects benthic macroinvertebrates and their habitats
- Analyze erosion and the role it plays in sedimentation
- Identify streams that are in ideal health for both benthic macroinvertebrates and fish species

Duration of Activity & Setting: 50 minutes; Indoors

Vocabulary:

Aquatic, benthic, benthic macroinvertebrate, erosion, sedimentation, predator, macro, invertebrate, stream bank, insect, metamorphosis, larvae, nymph, niche, tolerance level, prediction, simulation

Materials:

Shallow trays
Sand
Funnel
Cup
Water
Rocks

CI's eSchool – BMI portal
    What is a BMI?
    Sedimentation Blues

Essential Questions:

1. What is erosion?
2. What is a Benthic Macroinvertebrate (BMI)?
3. How does sedimentation decrease the health of our streams?

Lesson Procedure:

1. Post Essential Questions on Board
2. Ask students to review that they learned about pollution last session. Students should remember talking about nutrient pollution and algae blooms
3. Tell students we are going to be discussing erosion, sediment, and talking about creatures that live in streams.
4. Access the overhead projector from the computer and go to www.cacaponinstitute.org
    a. Click on the eSchool tab
    b. Enter the elementary classroom by clicking on the door
    c. Click on the BMI poster on the right wall
        i. Open the activity "What is a BMI?"
        ii. Walk students through each slide reading it aloud and answering any questions students might have.
            1. On the slide with other forms of invertebrates that are included in the BMI grouping provide an example for each grouping
                a. Crustaceans- crabs or Crayfish
                b. Mollusks- clams, oysters, snails
                c. Flatworm- worm that's flat like a planarian
                d. Annelid- aquatic worm (worm that lives underwater)
    d. Ask students: Who can give me the definition of a benthic macroinvertebrate? *Answer: an animal that lives at the bottom of the stream, which can be seen with the naked eye, and does not have a backbone.*
5. Does anyone know what erosion is? *Definition: the process by which the surface of the earth is worn away by the action of water, glaciers, winds, or waves.*
    a. Post the definition on the board.
    b. Tell students they are going to be focusing on erosion by water today.
6. Ask students: If erosion is the wearing away of the earth's surface and we are talking about our local rivers undergoing erosion what material is entering the stream? *Answer: Soil.*
    a. When soil and water mix within a body of water we call that sedimentation. Have the students say the word aloud.
    b. Sedimentation is excess dirt in a stream and we will talk about how that can be harmful
7. Ask students if they want to take part in an experiment?
    a. Set up Tray 1 filled with sand at a large table or desk in the front of the classroom. Be sure to prop up on side of the tray
    b. Ask students to join you around the table. (you might need to perform the experiment twice depending on class size)
    c. Tell students we are going to simulate water erosion on a river in the classroom.
    d. Ask for a student volunteer to draw a stream in the sand with their finger.
    e. Ask another student to help place some large rocks along the side of the stream.
    f. Ask the other students to make a prediction of what is going to occur when water is poured into the river channel.
    g. Using the funnel and cup of water to SLOWLY add water to the river and let students observe the changes in the river.
        i. Have students share their thoughts and observations
        ii. Ask students if simulation went how they thought it would
    h. Tell students they are going to see a different simulation this time. Set up Tray 2. Be sure to have it elevated at one end. Molding the sand to be in two large hills on either

side with a stream in the middle. This model is going to show stormwater runoff from a rain storm and erosion from upland entering the stream

i. Ask students: Can anyone remind us of the definition of stormwater runoff? *Answer: rain water that travels over land and collects different forms of pollution.*
j. We are going to be simulation stormwater runoff pollution and how erosion occurs from it.
k. SLOWLY pour water into the funnel on either side of the hills showing water traveling downhill and moving the sand into the river. *The main river should fill with sand from the runoff*
    i. Have students return to their chairs
    ii. Ask if any student would like to share their thoughts and observations

8. Review erosion and sedimentation.
9. Students are now going to learn about how excess sediment in streams will negatively affect benthic macroinvertebrates.
    a. Returning to the BMI portal, click on "Sedimentation Blues"
    b. Read through the slides with the students.
    c. Ask students if they have any questions.
    d. Refer to the Essential Question and ask: How does sedimentation from erosion affect our rivers? *Answer: Sediment fills in the BMI habitat and decreases the populations leading to less fish in the area and little to no aquatic wildlife*
10. Review essential questions as a wrap up. Let students know the next lesson will be all about the plants and planning their rain garden.

Lesson 4- What is a Rain Garden?
Upper Elementary

Lesson Outcomes:
Students will understand…

- that rain gardens are specifically designed to collected stormwater runoff pollution
- that the plants within the garden are called native plants and adapted for the conditions of the region
- that Fibonacci numbers are found in nature and within the native plants in their rain garden
- that their scale drawings will be used determine the final design of the school rain garden

Students will be able to…

- Define rain garden, native plant, Fibonacci numbers
- Investigate Fibonacci number sequences in native plant species
- Analyze plant conditions, height, and color to create a scale drawing of the school rain garden
- Identify plants that follow Fibonacci numbers

Duration of Activity & Setting: 50 minutes; Indoors

Vocabulary:

Fibonacci numbers, native plant, rain garden

Materials:

Graph paper
Colored pencils or crayons
Rulers
Pencil
Plant list
Pinecones
"Growing Patterns" by Sarah C. Campbell
Laminated Rain Garden images
Laminated Flower Images
Rain Garden Scale Drawing Template Example

Essential Questions:

1. What is the function of a rain garden?
2. What are native plants?
3. Why are scale drawings important for planning a garden?

Lesson Procedure:

1. Post Essential Questions on Board

2. Tell students they are going to be focusing on the planning of their rain garden today. *You can remind students when the planting will to occur.*
3. First we are going to determine what a rain garden is. Ask students: does anyone know what a rain garden is?
    a. Tell students that a rain garden is a shallow impression in the ground designed to collect stormwater runoff from the school grounds. The runoff can come from a downspout or the pavement of a parking lot.
        i. It is helpful to specify with the students for the conditions present at their school. This will vary by project.
        ii. It would be helpful to draw a diagram on the board or show the aerial imagery of the school grounds.
    b. The soil within the garden has been altered to allow water to percolate into the ground more easily.
        i. Most of the time sand will be added to the soil to increase porosity
        ii. It is possible that an underdrain has been added to a project. This allows water to spread evenly throughout the garden. If this is the case there will be a vertical pipe that will allow students to measure the amount of water within the pipe.
    c. The rain garden is filled with native plants. Ask students: What are native plants? *Answer: plants adapted for the soil, water, and temperature conditions of the region*.
        i. You can ask students to provide example of native plants found within the Potomac Watershed.
            1. Examples: maple and oak trees, dogwood, apple trees, etc.
        ii. Ask students what plants would not be native to this region
            1. Examples: orange trees, banana trees, etc.
    d. Show laminated images of rain gardens so students will have an idea of what the garden can look like and how water will collect and drain within 24 hours of a rain event.
4. Ask students if they know of the Italian mathematician Fibonacci?
    a. Tell students that he is known for his number sequences. They are interesting because each number in the sequence is the sum of the two numbers that come before it.
    b. These numbers can be found throughout nature.
    c. Read the book “Growing Patterns” by Sarah C. Campbell to the students.
    d. Write the first 12 numbers in the sequence on the board.
        i. 1,1,2,3,5,8,13,21,34,55,89,144
    e. Ask a student to pass out the pinecones when you reach page 20 in the book.
        i. Have them look at the bottom of the pinecone to see if they can identify their pinecone as a Fibonacci number.
        ii. Have students raise their hand if they need help seeing the spiral pattern.
    f. Have students set aside their pinecones and listen. Read the reminder of the book.
5. Tell students they are going to investigate a few native plants that are going to be present in their rain garden and determine if they follow have a Fibonacci number in their petal structure.
    a. Display the photos of the native plants on the board. Ask students to count the petals.
    b. Does the native plant follow Fibonacci?
6. Ask a student volunteer to pass out the graph paper. Tell students they are now going to be working on their scale drawing of the rain garden.
    a. Students will work with the instructor to get their garden outlined but then they will be able to work on their drawing for the remainder of the class time.
    b. Instruct students to:

i. Write their name at the back of the paper.
ii. Tell students the size of their rain garden
    1. For example 10 feet by 12 feet
iii. Ask students how they would find the total area of their rain garden? Use the formula to find area. Have students write this at the top right hand corner of their paper.
    1. Write the formula on the board. A= l x w
    2. Fill in the formula. A= 10 x 12
    3. Answer. A = 120 square feet
iv. Tell students that each square on their paper represents one square foot.
v. This means that the horizontal line between vertical lines is one foot.
vi. In order to get a length of 10 feet on their paper they will need to count across 10 boxes and drawing the outline for their garden
vii. In order to get the width of 12 feet they will need to count down 12 boxes. Drawing the final outline of their rectangular rain garden.
viii. Be sure to show your example or draw with the students so they can follow you.

c. Pass out the list of the native plants with the height, quantity, and key code to the students.
    i. Tell students the tallest plants need to be located in the middle of their garden.
    ii. They cannot exceed the quantity of plants given per species
    iii. Instruct students to use the code provided for each plant before using colored pencils
    iv. Finally instruct students that one plant is allowed in a one square foot area (one plant per box) and not all boxes will be filled in.
d. Walk around to help students as needed.
e. NOTE: You can use the attached templates for the students to work on a pre-made design and not create their own work. This will help to save on time and still employ the same educational content. Partnering with the math teacher could help to allow students to design their own rain garden design.

2-3 months post installation

Fall 2013 (one summer of growth)

August 8, 2014

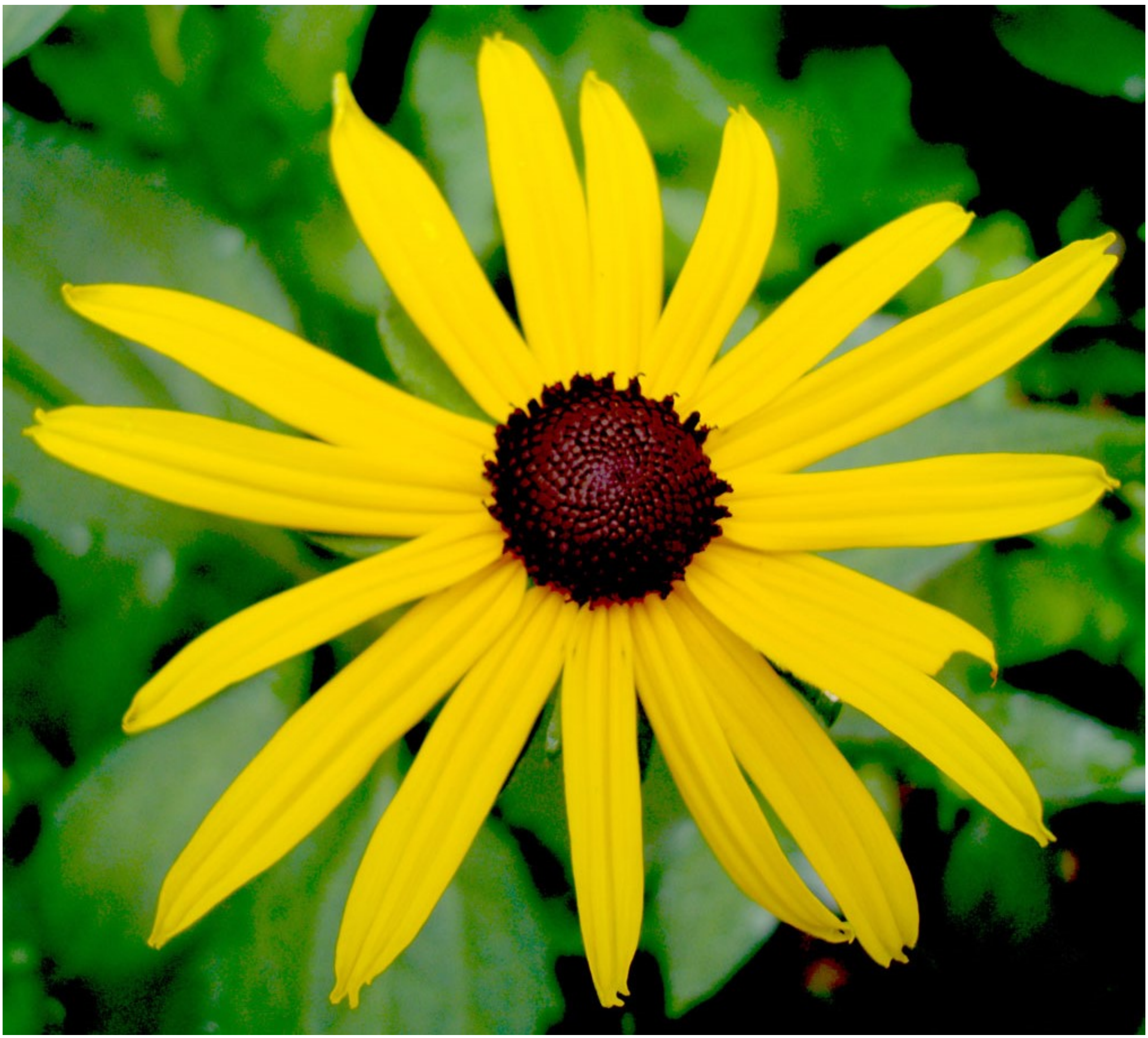

Planting Day– Spring 2013


Post Rain Event


Spring 2014

Purple Coneflower

Black-eyed Susan



Monkey Flower

Cardinal Flower

Great Blue Lobelia

Native Plant Species

Blue-eyed Grass
Height: 1- 1.5'

Eastern Columbine
Height: 0.5-3'

Wild Indigo
Height: 1-3'

Monkey Flower
Height: 1-3'

Tussock Sedge
Height: 1-3.5'

Orange Coneflower
Height: 1.5-3.5'

Soft Rush
Height: 1-4'

Cardinal Flower
Height: 2-4'

Wild Bergamot
Height: 1.5-5'

Boneset
Height: 1-5'

Great Blue Lobelia
Height: 1-5'

Cinnamon Fern
Height: 2-5'

Wild Indigo Hybrid
Height: 3-5'

Swamp Sunflower
Height: 1.5-5.5'

Marsh Hibiscus
Height: 3-6'

Native Plant Species

Common Name	Size	Quantity	Number Added to Garden
Eastern Columbine	Quart	14	
Wild Indigo Hybrid	1 gal.	7	
Wild Indigo	Quart	16	
Tussock Sedge	Quart	6	
Bonset	1 gal.	7	
Swamp Sunflower	Quart	5	
Marsh Hibiscus	Quart	4	
Soft Rush	Quart	7	
Cardinal Flower	Quart	10	
Great Blue Lobelia	Quart	8	
Monkey Flower	Quart	13	
Wild Bergamot	1 gal.	2	
Cinnamon Fern	Quart	5	
Orange Coneflower	Quart	3	
Blue-eyed Grass	Quart	13	

Native Plant Species

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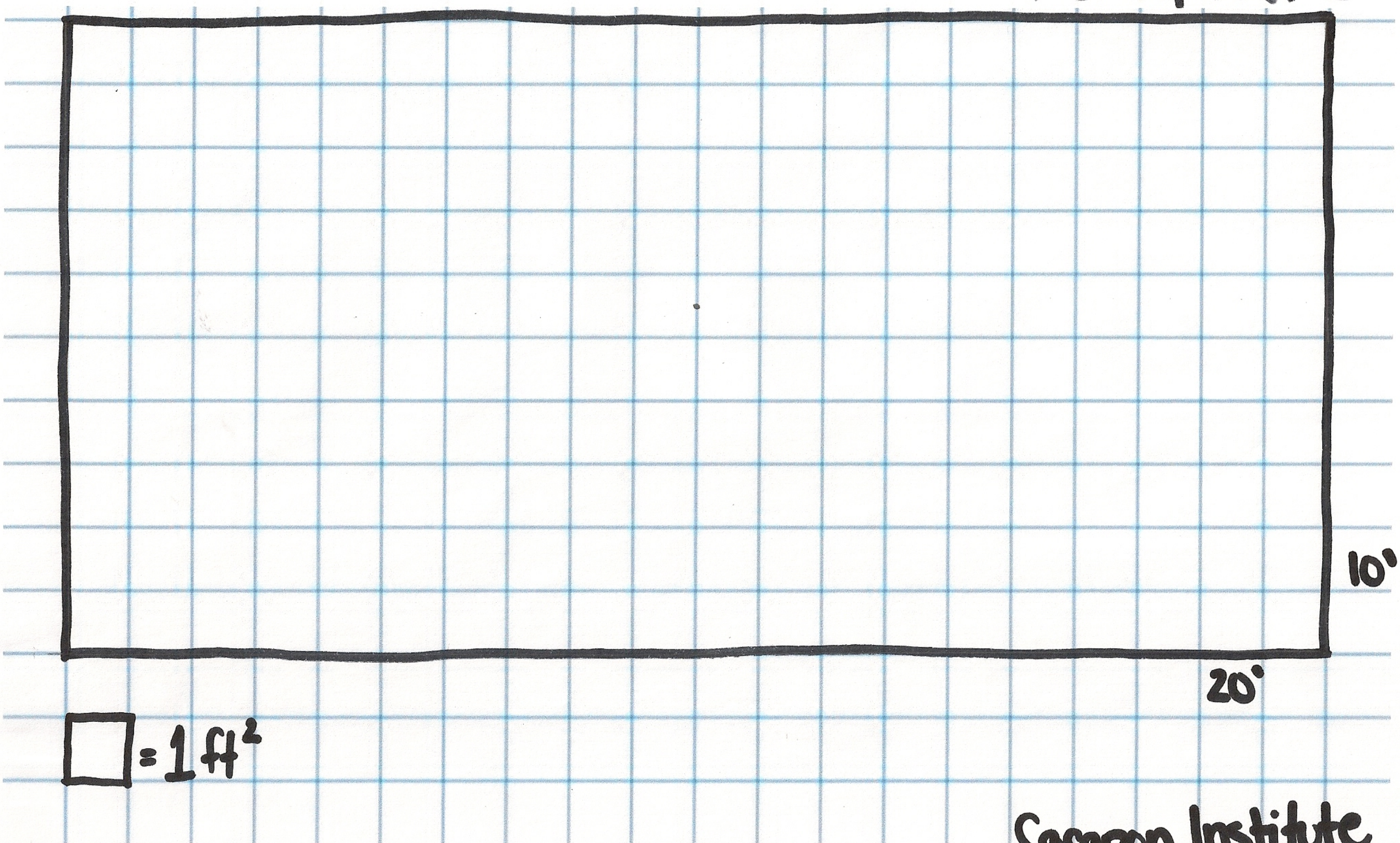
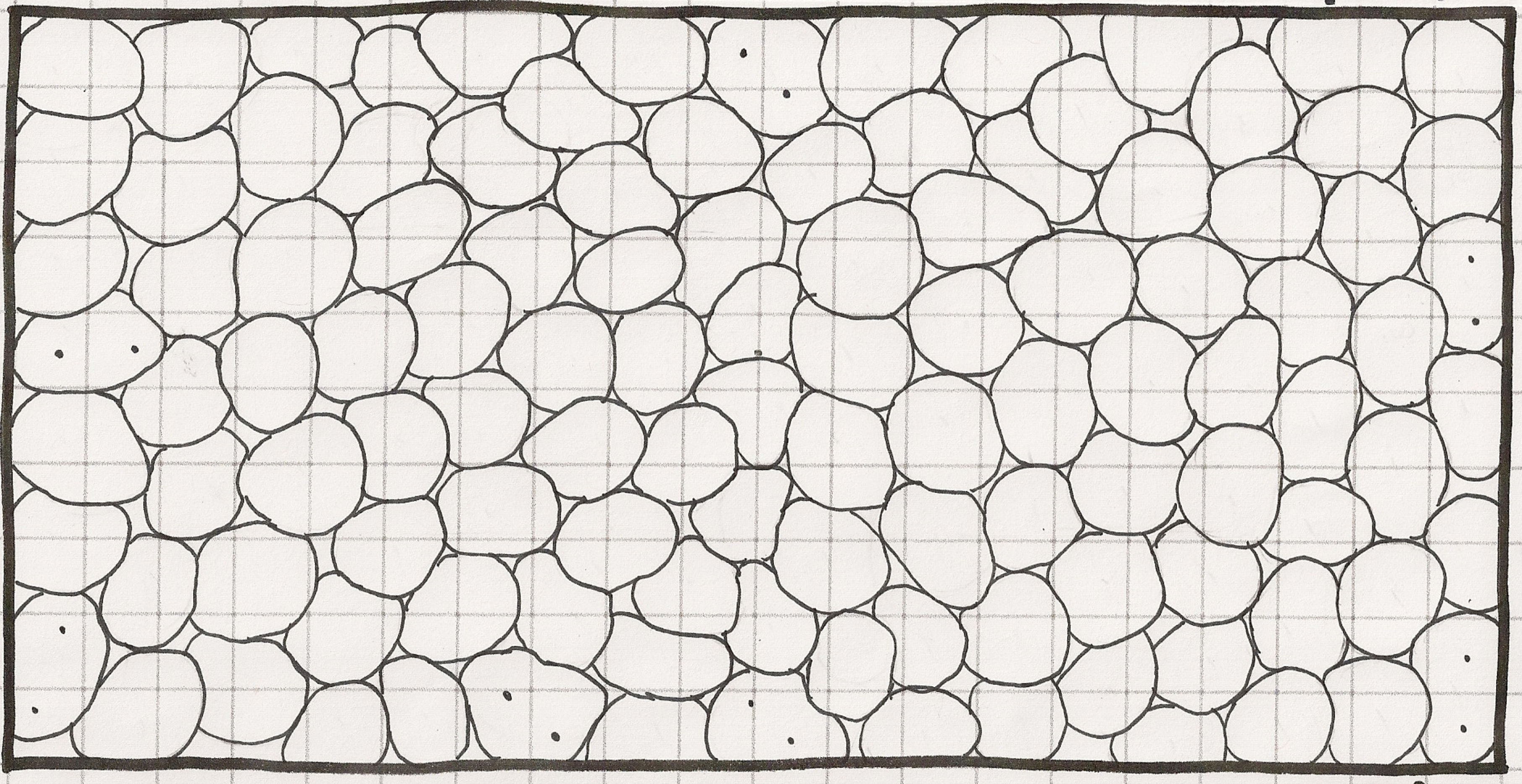
Soft Rush	Quart	7	
Cardinal Flower	Quart	10	
Great Blue Lobelia	Quart	8	
Monkey Flower	Quart	13	
Wild Bergamot	1 gal.	2	
Cinnamon Fern	Quart	5	
Orange Coneflower	Quart	3	
Blue-eyed Grass	Quart	13	

Rain Garden Planting Plan Template



Cacapon Institute

Rain Garden Planting Plan
Template

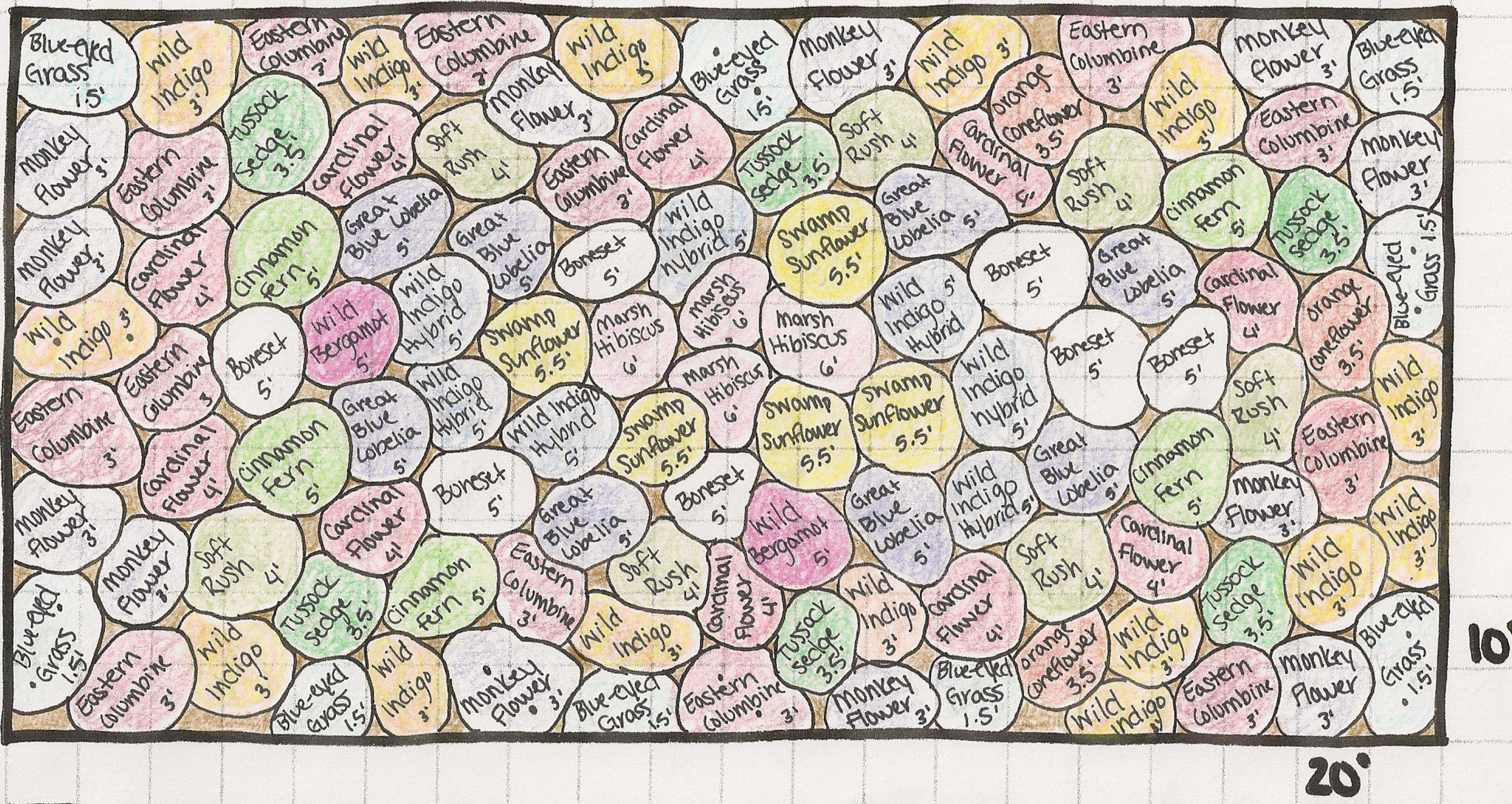


□ = 1 ft^2

120 Plants

Cacapon Institute

Rain Garden Planting Plan Template

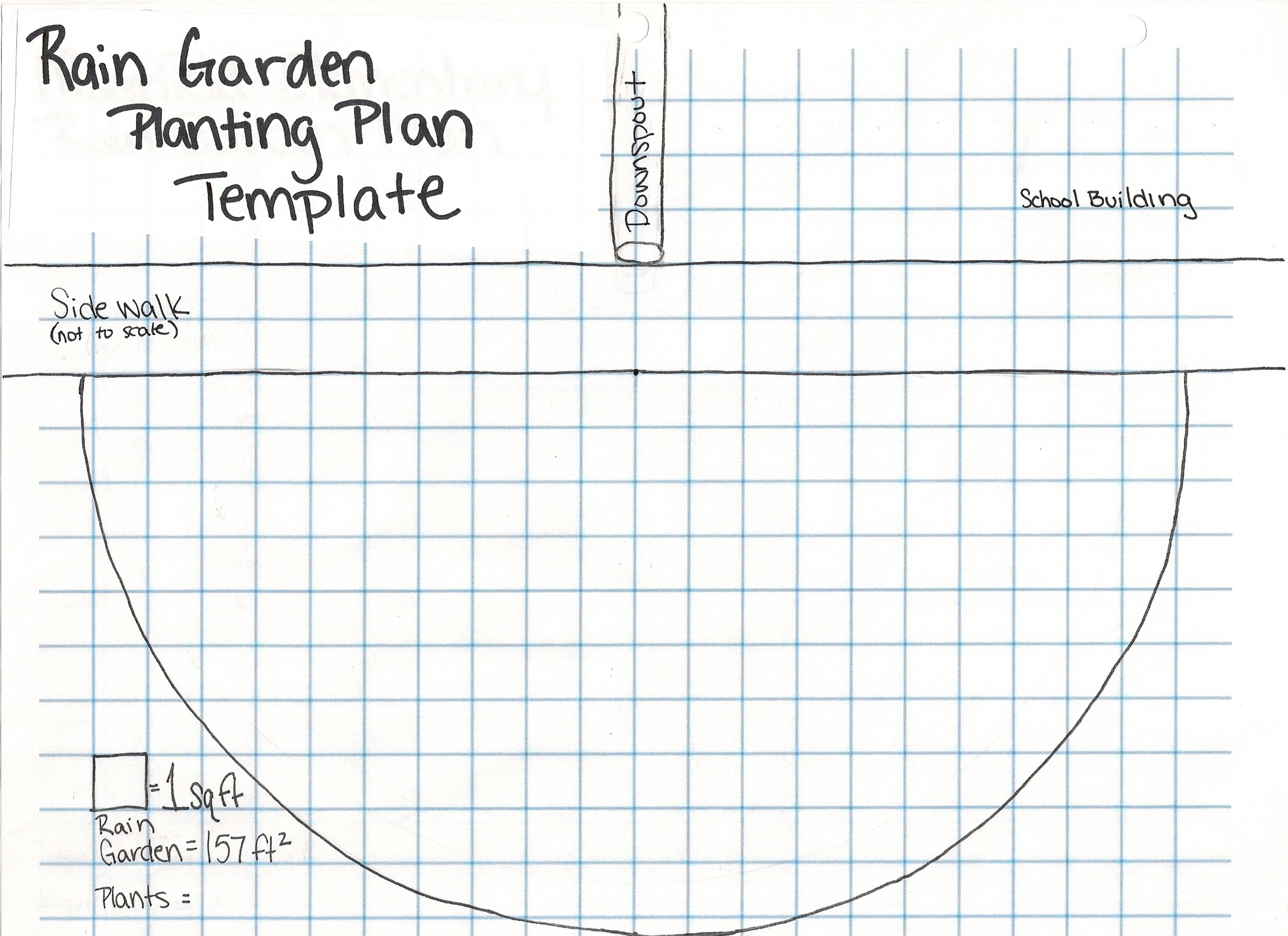


□ = 1 ft^2

120 Plants

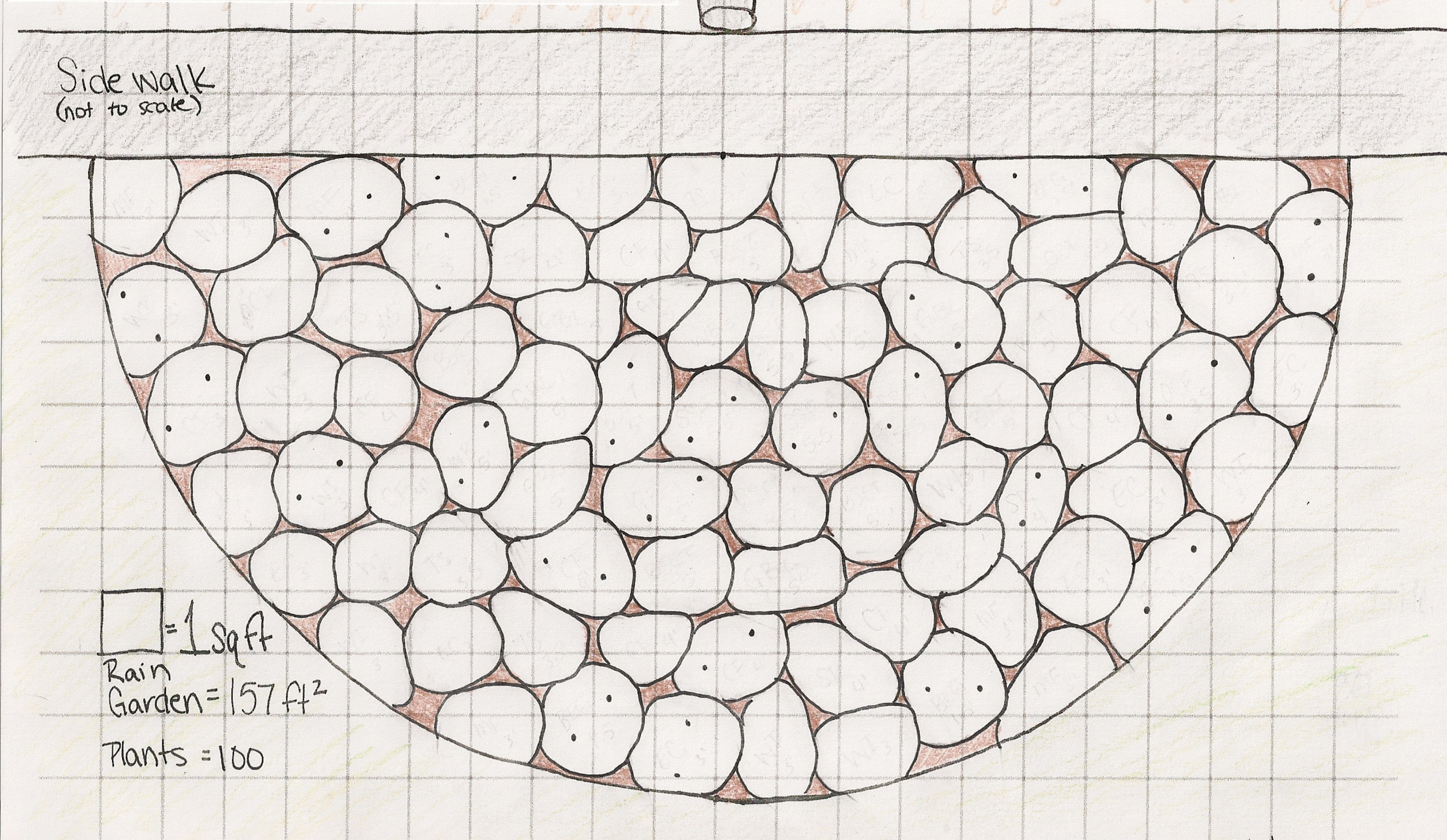
Cacapon Institute

Rain Garden Planting Plan Template



Cacapon Institute

Rain Garden Planting Plan Template



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Rain Garden Planting Plan Template

Downspout

School Building