Program on Water Quality
Community Science for Middle School

Duke NICHOLAS SCHOOL OF THE ENVIRONMENT
DUKE UNIVERSITY MARINE LAB

DUML COMMUNITY SCIENCE

UNC INSTITUTE OF MARINE SCIENCES

GO WITH THE "STORMWATER" FLOW

Stormwater Runoff Lesson Plan

Anna Windle & Alaina Young
Master of Environmental Management '18
Duke Marine Lab Community Science Initiative

Program on Water Quality
Community Science for Middle School

Duke NICHOLAS SCHOOL OF THE ENVIRONMENT
DUKE UNIVERSITY MARINE LAB

DUML COMMUNITY SCIENCE

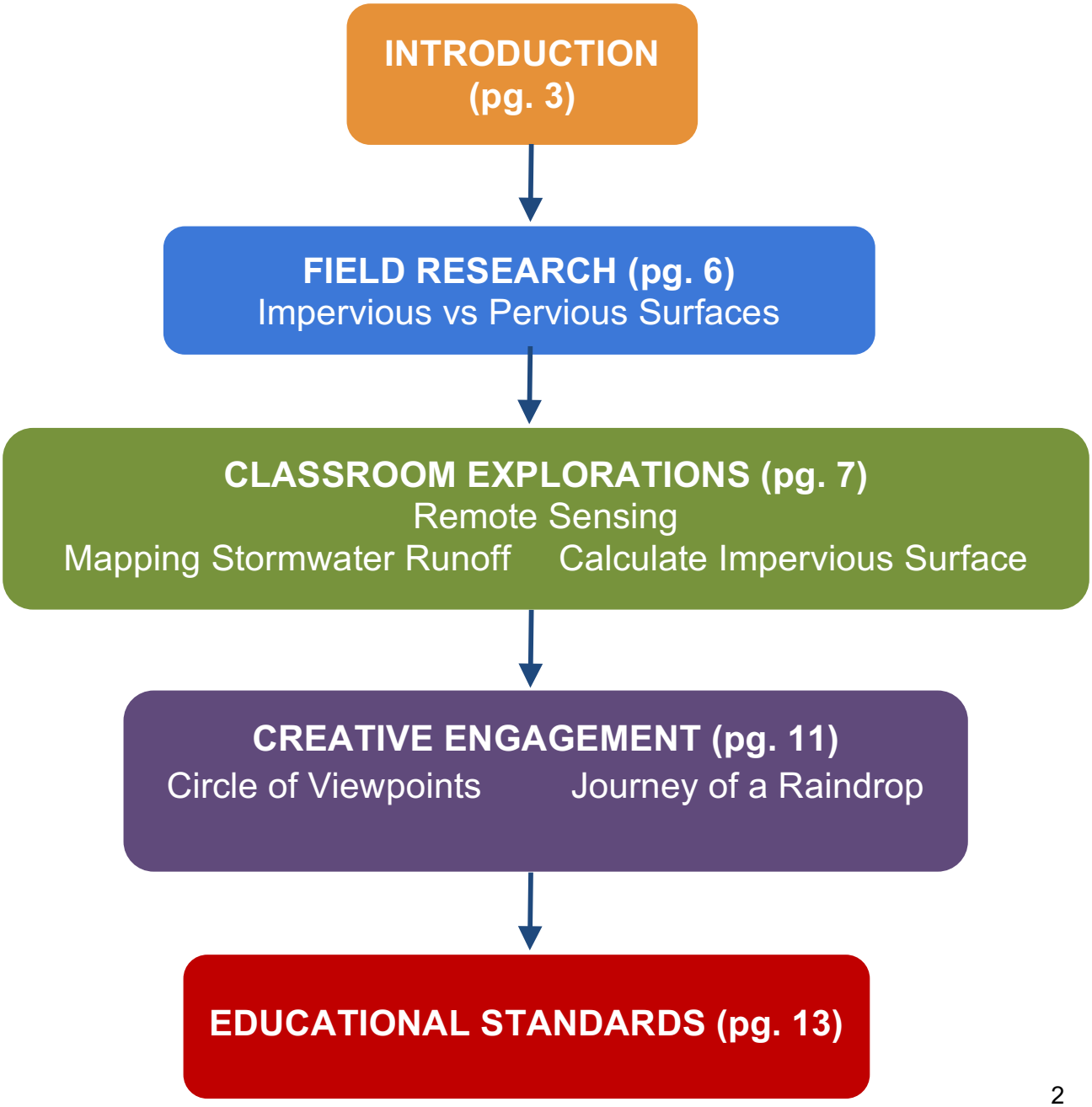
UNC INSTITUTE OF MARINE SCIENCES

The ocean is dependent on the surrounding land (or **watershed**) for a continuous supply of clean water. Water that falls onto land in the form of rain or snow is called stormwater, and it travels in various paths through the watershed to eventually get to the ocean. As stormwater moves over different surfaces, it picks up pollutants like marine debris or chemicals, which ends up in our water. Some surfaces allow for stormwater to infiltrate, which can therefore serve as a buffer for pollution; the North Carolina salt marsh ecosystem plays a key role in preventing pollutants from entering the ocean. Yet some surfaces, like pavement, does not impede flow. Converting these surfaces into those that allow infiltration, like by planting rain gardens or using more porous surfaces for walkways and driveways, can serve to lessen the impacts of stormwater runoff on the environment.

Our lesson plan serves to introduce students from grades 6-8 to the concepts of stormwater runoff and have them consider how to lessen its effects. We aim to stress connectivity between different components of a watershed, as well as the students' connections to their local environment. This lesson plan links students with local researchers and new technology in order to spur creative thinking. Activities are locally focused in order to inspire students with experiential-based learning in their schoolyard and community. It is our goal to provide educators with hands-on exploration activities to get students to consider important water quality issues in a way that integrates into existing curriculum.

This lesson plan is just one component of the Community Science Program on Water Quality. This program combines community science at Duke University Marine Lab with environmental literacy activities in order to connect middle school students to water quality issues in their local communities. This program is meant to be interdisciplinary in nature in order to allow students to explore and discover how water quality impacts them and the community.

A ROADMAP FOR DUML'S COMMUNITY SCIENCE PROGRAM IN STORMWATER RUNOFF



INTRODUCTION

This introduction activity is designed to (i) introduce the concept of a watershed and connections between its multiple components and to people; and (ii) introduce concepts related to stormwater runoff through a demonstration involving a watershed model of their school. Students will revisit these concepts in their exploration activities, where they will apply their conclusions in the field and to aerial imagery.

Objectives

At the end of this activity students will:

- Create a model watershed
- Understand the process of stormwater runoff
- Apply watershed concepts to create connections to stormwater runoff
- Explore connections to marine life and humans

Activity Plan (~30 minutes)

1. Class discussion with pictures: Present pictures of different components of a watershed (on provided cards- in Appendix folder). Ask students to predict if each is part of the local watershed and how it is connected to water.
    a. Define a *watershed*: “A watershed is the area of land where all of the water that falls in it and drains off of it goes to a common outlet”.
2. Small group discussion: Break up class into groups of 3-4 students. Ask each group to consider “How do you benefit from living in a watershed?” “How are the different components connected?” Report back to the class.
3. Define new words:
    a. *Infiltration*: the downward entry of water into the soil.
    b. *Impervious surface*: a hard area that doesn’t allow water to seep into the ground. Instead, the water runs off the impervious surface, picking up many types of pollution in the process, and then flows into a storm drain or a nearby body of water.

    c. *Stormwater runoff*: water from rain or melting snow that “runs off” across the land instead of seeping into the ground.
4. Watershed Model Demonstration: As a whole class, design a watershed model of your schoolyard. (Use https://serc.carleton.edu/eslabs/drought/2a.html as a reference)
    a. Crumble pieces of newspapers into different shapes to represent different buildings and the terrain. Optionally, use different objects found in the classroom to create features (stapler, cups, boxes).
    b. Ask class to make a prediction about where the water will flow if it were to “rain” over the landscape.
    c. Spray “rain” (blue food coloring in water) onto the model to see where it flows from different points. Spray just enough “rain” over the model to see how the water interacts with the model landscape.
    d. Discuss how this model represents a real watershed and where real rain flows to.
    e. Soak up water or replace plastic on model. Add “vegetation” (green cut up sponge) to the model and repeat demonstration. Discuss how vegetation can act as a buffer and allow for infiltration.

Materials

- Watershed component pictures (in appendix)
- Large aluminum roasting pan
- Newspaper
- Masking tape
- Plastic wrap
- Blue food coloring
- Blocks of wood or a notebook to lift one end of tray
- Green sponge

FIELD RESEARCH: Impervious vs. Pervious Surfaces

This activity is designed to reinforce the concepts of impervious surfaces and stormwater taught in the introduction activity by letting students explore their schoolyard in order to make predictions about and test different surfaces.

Objectives

At the end of this activity, students will be able to:

- Identify impervious and pervious surfaces
- Make hypotheses about how water will flow on different surfaces
- Develop actions the school can take to reduce stormwater runoff

Activity Plan (~ 45-60 minutes)

1. Class discussion on types of outdoor surfaces (i.e. impervious and pervious). Define and list examples of each.
    a. *Impervious surface examples*: Driveways, sidewalks, parking lots, roads
    b. *Pervious surface examples*: Gardens, wetlands, forests, yards
2. Take class outside to "test" their schoolyard surfaces.
    a. Locate an area of grass/vegetation
        - Pour about half a water bottle onto the ground and observe how the water infiltrates or seeps into the ground.
        - Explain how the soil absorbs the water, much like it would absorb rain or stormwater
    b. Locate area of impervious surface (parking lot, sidewalk)
        - Pour about half a water bottle onto this surface and observe how the water flows across and does not infiltrate into the ground as easily.
        - Explain the process of rain or storm water flowing across all impervious surfaces until it reaches a bigger body of water (stream, lake, estuary).

3. Once back in the classroom, break students into small groups. Have students come up with lists of actions the school can take to decrease stormwater runoff and increase water infiltration.
    a. Write up actions in an informative text
    b. Share group's ideas with class

Materials

- Bottles filled with water

CLASSROOM EXPLORATIONS: Remote Sensing (activities)

These activities are designed to introduce students to remote sensing, teach how to analyze data from aerial imagery and apply math concepts to calculate the area of impervious surface.

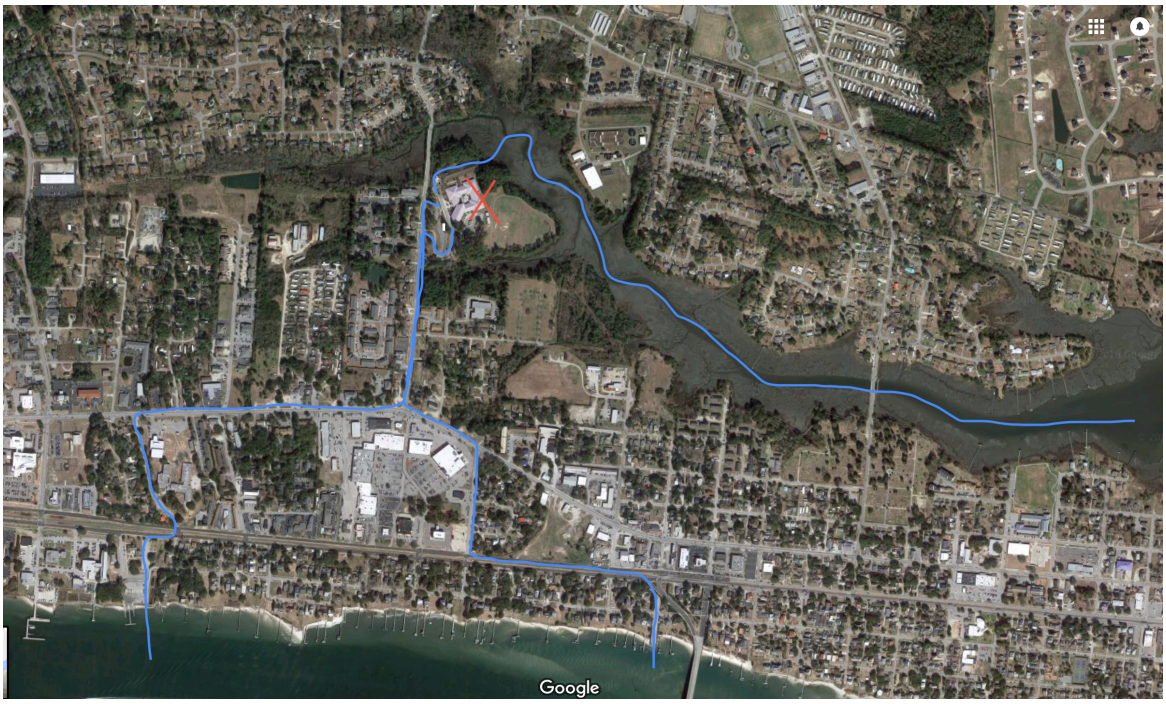
Objectives

At the end of this activity, students will be able to:

- Analyze an aerial photo
- Predict the flow of stormwater from their school into a nearby water body
- Understand that water transports pollutants and how this impacts water quality
- Calculate the area and percent of impervious surfaces from aerial imagery
- Convert between map units and real units

Activity Plan # 1: Mapping Stormwater Flow (~10-15 minutes)

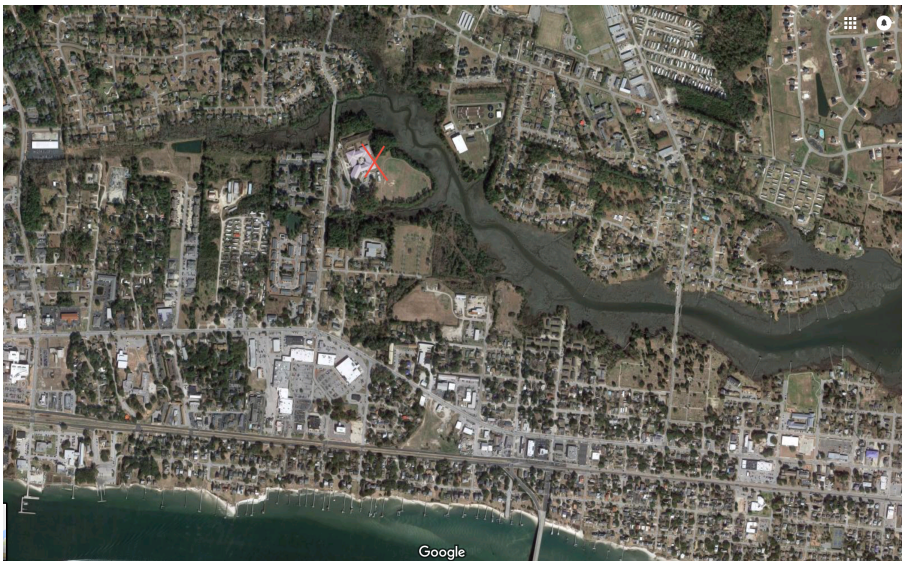
1. Break students into small groups. Provide laminated aerial images from Google Maps of the schoolyard and surrounding town. Scale does not matter.
2. Instruct students to draw paths of predicted stormwater flow from their school to the nearest body of water using a dry erase marker.
    a. Example:



3. Discuss how connecting impervious surfaces allow for long distance transport of stormwater directly to our streams, lakes, and oceans.
4. Discuss the type of pollutants the water can pick up on its journey to a water body, and why it's bad for water quality
    a. Marine debris- entanglement, ingestion from marine life
    b. Grass clippings- increases turbidity
    c. Dog poop- introduces bacteria
    d. Vehicle gas and oil- impact marine life

Materials

- Dry erase markers
- Laminated aerial imagery of schooyard and surrounding town. Can be printed directly from Imagery layer of Google Maps. Works best with labels turned off. Image should include school and closest body of water.
    - Example: Morehead Middle School



Activity Plan #2: Calculating Impervious Surface (~20-30 minutes)

1. Break students into small groups. Provide aerial satellite imagery of areas with high impervious surfaces (e.g. Walmart) from Google Maps with scale bar equaling 200 feet (1 inch).
2. Provide a transparent grid (grid image in Appendix folder, can be printed on transparent/overhead paper) and overlay on map.
3. Have students fill in *Calculating Impervious Surface* worksheet (found in Appendix folder).

Materials

- Transparent 1x1 inch grid (in Appendix folder)
- Dry erase markers
- Remote Sensing: Calculating Impervious Surface worksheet (in appendix folder)

- Aerial images of areas with impervious surface (Ex: Walmart)

CREATIVE ENGAGEMENT: Circle of Viewpoints/ Journey of a Raindrop

This activity allows students to develop a new understanding of stormwater runoff using writing to explore the journey of water from a raindrop to the ocean.

Objectives
At the end of this activity, students will be able to:

- Understand different viewpoints from groups that rely on and are affected by water
- Understand the transport of water, from its origin to the ocean
- Write a creative story about the journey for an imagined raindrop

Activity Plan: Circle of Viewpoints (~15 minutes)

1. Break students into small groups and assign each group a different perspective (fish, fisherman, farmer, tourist, motorist, gardener).
2. Have students think about the importance of a raindrop to each perspective. When might they come in contact with water? Why is water important to their lives? Do they rely on clean water?
3. Have groups share their ideas to the class.

Activity Plan: Journey of a Raindrop (~30 minutes)

1. Have students fill out the Journey of a Raindrop worksheet (in Appendix folder) in order to begin thinking about the perspective of a raindrop.
2. Split students into pairs. Give the class 30 minutes to work individually to draft their creative story.
3. Have students talk about and revise their stories with a partner.
4. As an assignment, have students create a final draft of their story. This can take many forms that is up to the class (blog post, typed paper, handwritten, illustrated)

Materials

- Journey of a Raindrop worksheet (in Appendix folder)
- Pens, markers, chromebooks (for posting blogs)

EDUCATIONAL STANDARDS

Activity Group	Activity Title	Education Standards
1. Introduction	Watershed Model Demonstration	Science 7.P.1 Understand motion, the effects of forces on motion and the graphical representations of motion. Science 7.E.1 Understand how the cycling of matter (water and gases) in and out of the atmosphere relates to Earth's atmosphere, weather and climate and the effects of the atmosphere on humans. EX.7.E.1 Understand the water cycle. MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. MS-ESS2-4 Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.

2. Field Research	Impervious vs pervious surfaces	LA 7.W.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. ELA 7.SL.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation. MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. ELA 7.W.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. ELA 7.SL.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.
3. Classroom Explorations: Remote Sensing	Mapping Stormwater Runoff	EEn.2.4.2 Evaluate human influences on water quality (ground and surface water pollution, wetland and estuary degradation, and salt water intrusion).

		MS.ESS2.C The Roles of Water in Earth's Surface Processes
	Calculate Impervious Surface	Math 7.G Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale. Math 7NS Apply and extend previous understandings of operations with fractions to add, subtract, multiply, and divide rational numbers. Math 7.RP Analyze proportional relationships and use them to solve real-world and mathematical problems. Math 6.RP.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. Math 6.RP.3d Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities. Math 6.G.1 Find the area of right triangles, other triangles, special quadrilaterals, and polygons by composing into rectangles or decomposing into triangles and other shapes; apply these techniques in the context of solving real-world and mathematical problems.

4. Creative Engagement	Circle of Viewpoints	ELA 7.SL.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly. 8.E.1.4 Conclude that the good health of humans requires: monitoring of the hydrosphere, water quality standards, methods of water, treatment, maintaining safe water quality, stewardship and human impact. 6E/M5
	Journey of a Raindrop	ELA 7.W.3 Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences.