WATERSHED RESOURCES LESSON – HUMAN IMPACT SOLUTIONS: STORMWATER FILTRATION



TOPIC: Stormwater Filtration

AUTHOR: BWD

CLASS TIME NEEDED:

- One class period of 45-60 minutes for background research. (See Materials - Online Resources p. 2)
- One class period of 45-60 minutes for Stormwater Filtration Lab.

SUBJECT/GRADE LEVEL: Physical Science/Biology/Earth Science/Environmental Science – 9^{th}-12^{th}

ARKANSAS SCIENCE STANDARDS:

Physical Science – PSI-LS2-7, PSI-ESS3-1
Biology – BI-ESS2-2, BI-ESS2-5
Earth Science – ES-ESS2-2, ES-ESS2-5
Environmental Science – EVS-ESS2-5, EVS-ESS3-1, EVS-LS2-7, EVS-LS4-6

LEARNING PERFORMANCE TARGET(S): (learning expectations for this lesson; combines a science practice, crosscutting concept and core idea embedded in the lesson)

Students will gain functioning knowledge and expertise equipping them to:

- Design an experiment.
- Identify which substances or combination of substances best filter polluted storm runoff.

SCIENCE AND ENGINEERING PRACTICES:

Lab work, Field work, acquire data, graphing, planning and carrying out investigations, analyzing and interpreting data, asking questions and defining problems.

CROSSCUTTING CONCEPTS:

Structure and Function, Stability and Change

CCSS CONNECTIONS: (include mathematical concepts and reading, writing, speaking and listening opportunities in the lesson)

All exist throughout the lesson. ELA/Literacy, Mathematics

MATERIALS:

Runoff Simulator or the following:

Tap water	Clay
Fertilizer	Sand
Soil	Gravel: small & large
Silt	Students bring in 2-liter bottles

Grave Sizes Image Source: webcommunity.club/wp-content/uploads/2018/07/limestone-gravel-sizes-rocks-gravel-sizes.jpg

MATERIALS (continued):

- Research "Green Technology" online.
- Online Stormwater Search Terms: "Common Stream Pollutants Arkansas", "Stormwater Pollution", "Runoff Erosion", "Best Management Practices", "Trees Water Quality", "Low Impact Development"
- Soil Science Society of America/Soils Sustain Website - www.soils.org
  - International Year of Soils Videos - www.soils.org/iys/monthly-videos
- University of Arkansas Department of Agriculture Extension Service (UAEX)
  - Water Quality Webpage - www.uaex.edu/environment-nature/water/quality/
  - Publication FSA9528 "What Is Water Quality?" - www.uaex.edu/publications/pdf/FSA-9528.pdf
- University of Arkansas Community Design Center – uacdc.uark.edu
  - Low Impact Development (LID) Urban Stormwater Runoff - http://uacdc.uark.edu/models/low-impact-development/
  - Low Impact Development (LID): A Design Manual for Urban Areas - uacdc.uark.edu/work/low-impact-development-a-design-manual-for-urban-areas

TEACHER PREPARATION:

Have materials prepared and conduct lesson in a safe location.

BACKGROUND INFORMATION/CONTENT:

Problem Question

What are the best filtration substrate types for storm water runoff?

This lesson provides students with an opportunity to create their own investigation. They are presented with a problem and asked to design an experiment to discover the best way to filter storm water runoff before it enters the stream. Two 2-liter bottles, simulated pollution solution, and sand, silt, clay, and small/large gravel will be needed. Students will be exploring a new wave in residential and commercial development and understand green technology.

Teachers: This is a very basic lab with very basic materials. Research your biome soil type and topography for final comparison. Research the most common stream pollutants in your area to assemble your lab simulated pollutants. Investigate green technology, Low Impact Development methods, and water quality best management practices for discussion.

Students: The students will need information on point and nonpoint pollution (See UAEX Webpage and article in MATERIALS List, above). The students will also need instructions on assembling their filtration column.

Keywords

Substrate: Various materials that make up the layers of earth

Point pollution: Pollution coming from a specific source that can be identified clearly. (Ex. Pipe discharging directly into a stream)

Nonpoint pollution: Pollution from an unknown source that is washed into surface water by rainfall (Ex. Runoff from a cow pasture or parking lot)

Filtration: The removal of substances in water by moving through porous layer

7E'S Stormwater Runoff Filtration

Elicit

Brainstorm ideas for how to deal with storm runoff from a store parking lot. What might happen if the trash, oil, antifreeze, gas, etc. is washed directly into a creek? What might happen to the living things in the creek? Show pictures of parking lots or agricultural areas draining.

1. Explain to students that they are to design a filtration system to filter nonpoint pollution from a parking lot at a busy shopping center. The shopping center is trying to be more sustainable and wants to filter their storm water runoff before it enters the creek. Discuss what parking lot islands with planting beds and drains would look like.

2. Model the correct filtration column assembly.
   a. Students bring to class two empty 2-liter bottles rinsed and with the labels removed.
   b. Cut bottle one in half. Top for a funnel and bottom for collection of filtered water.
   c. Cut the top off bottle two and discard. Puncture the base of bottle two several times to allow the water to slowly leak into the collection base of bottle one.
   d. Take the base of bottle one and place under the bottom of bottle two for filtered water collection.
   e. Invert the top of bottle one (funnel) and place into the top of bottle two.
   f. Layers of substrate will be assembled in the bottle two base.

3. The filtration materials are made available to students in the classroom.
   a. Obtain soil, sand, clay, small gravel, large gravel and place in containers in the classroom.

Engage

Student teams organize thoughts and ideas, then plan filtering structure and predict outcome.

Explore

4. Teams collect desired materials to layer into bottle filtration assembly.
   a. Prepare a simulated pollution sample.

5. Combine water (tap/chlorinated) and fertilizer.

6. Collect 20 ml of simulated pollution and use a testab water quality kit (includes instructions) to determine levels of phosphate and chlorine.

7. Prepare the filtration column with layers and complete assembly.

8. Pour solution into the top funnel piece and then remove bottom piece with filtered solution.

9. Perform water quality tests on filtered solution to obtain data on pollution levels.

10. Compare before-filtration levels to after-filtration levels.

11. Repeat procedure with four different filtration setups to determine best system. Perform four to five replications per design.

Explain

12. Write-up the lab, stating objectives, hypothesis, procedures, results (graphs of data), and conclusion.

13. Each group presents their findings and suggestions.

Elaborate

Discuss importance of protecting water quality in local streams. Use a local store parking lot and its proximity to water to describe possible solutions in detail.

Evaluate

Assessment will be performed through grading lab write-up and group presentation.

Extensions

After their investigation, students can research current sustainability practices used by green technology and Low Impact Development. Students may want to explore if their system can filter other types of pollutants as well.