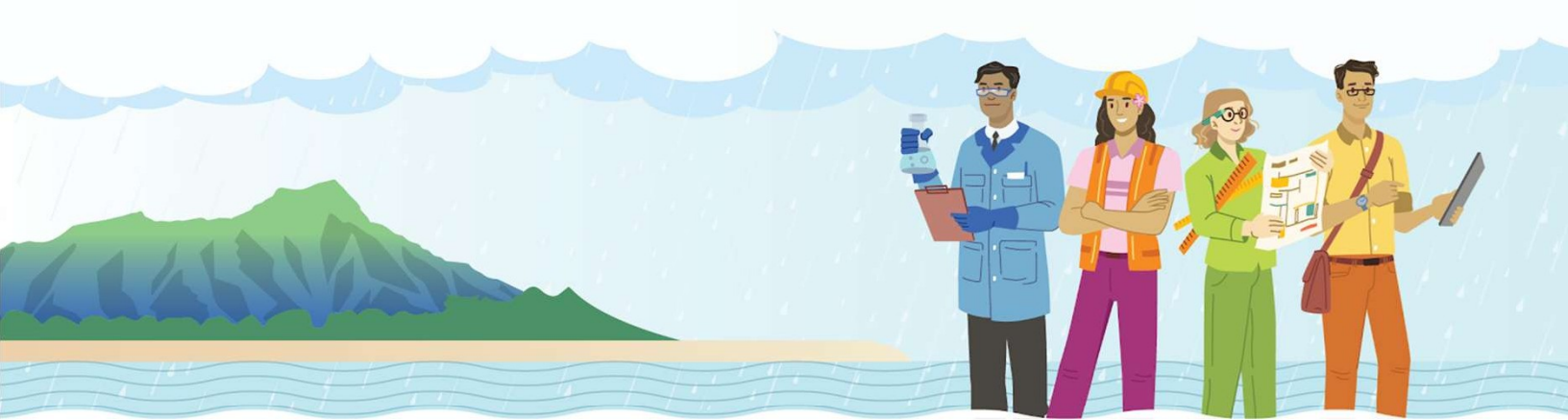




How Does the Rain Flow?

Storm Water Career: All

All Careers Full- Course Lesson Plan #: 2 of 15

Next Lesson Plan Title (Full-Course): Storm Water in the Community

Select Career Short-Course Lesson Plan #: 2 of 6

Next Lesson Plan Title (Short-Course): Varies on Selected Career (Table 1)

SUMMARY

In this lesson, students will learn methods professionals use to reduce the impact of runoff. Using this knowledge, they will explore and notate observations on a site map.

FOCUS & GOALS

In practicing storm water management, students will:

- Learn methods professionals use to reduce impacts of storm water runoff
- Develop skills in observation and mapping

MATERIALS NEEDED

- Storm Water BMP Matching Game (cards & board)
- Individual student worksheets and maps (double-sided)
- Classroom/group shared maps and figures (double-sided)
- Colored pencils
- For PBL: Map of site to assess (topographic preferred), clipboards, camera (optional)

LEARNING OBJECTIVES

- List, describe, and compare solutions for managing storm water runoff
- Explain non-structural and structural BMPs
- Describe how solutions that mimic nature can capture, store, and filter water
- Identify pollutant sources, storm flow paths, and control measures
- Create a sitemap for a storm water pollution plan
- Assess site conditions for storm water issues and solutions

VOCABULARY

Best Management Practice (BMP) - BMPs are a broad term encompassing resource use techniques recognized as the most practical and effective means of controlling or treating related pollutants.

Biomimicry - The design and production of materials, structures, and systems that are modeled on biological entities and processes.

Nonpoint Source Pollution - Pollution that originates from numerous, diffuse sources rather than a single, identifiable point, and is carried into waterways by runoff.

Urbanization - The process of making an area more urban.

Background

In our previous lesson, we introduced the storm water cycle and examined how storm water flows within our communities, emphasizing its impacts on the environment and public health. We also discussed the roles of various professionals tasked with assessing these impacts and developing effective solutions. In this lesson, we will delve deeper into the complexities of storm water management, exploring both the challenges and the potential strategies for mitigation.

Storm water runoff has been identified as a significant contributor to water pollution, particularly in urban and developing regions across the United States. According to the Office of Water at the U.S. Environmental Protection Agency (EPA), nonpoint source pollutants found in storm water runoff include a variety of contaminants. These can range from natural particles like soil and sediments to harmful substances such as oil, grease, detergents, fertilizers, and pet waste. Additionally, heated water from urban areas exacerbates the issue, increasing the temperature of water bodies and disrupting aquatic ecosystems.

Urbanization significantly intensifies storm water runoff due to the prevalence of impervious surfaces—man-made structures that prevent water from soaking into the ground. As a result, the volume of storm water runoff can increase dramatically. Research indicates that when 10 to 20 percent of land is covered by impermeable surfaces, the volume of runoff can double compared to natural areas. This increased runoff not only contributes to water pollution but also raises the risk of flooding in urban environments.

To address these challenges, municipalities are employing a range of innovative solutions to retrofit landscapes and reduce the prevalence of impervious surfaces. Their goal is to prevent untreated, polluted storm water from entering rivers, streams, and oceans. By adopting designs that mimic natural processes—collectively known as biomimicry—cities are implementing features such as rain gardens, green roofs, and naturescaping. These strategies can significantly reduce storm water runoff and facilitate better water management.

Moreover, cities are increasingly adopting Best Management Practices (BMPs) to combat storm water pollution. BMPs encompass a wide array of strategies aimed at minimizing the impacts of storm water runoff. Examples include community action initiatives, planting trees, installing rain barrels and dry wells, creating wet holding ponds (also known as retention basins), and utilizing porous or pervious pavement. Other approaches consist of establishing riparian buffers, implementing pollution prevention strategies, and deploying trash capture technologies and filtration systems.

In addition to traditional gray infrastructure, which involves constructed systems like pipes and ditches, green storm water infrastructure (GSI) offers a nature-based approach that integrates natural elements to enhance water quality and reduce flooding. These GSI are often utilized in Low Impact Development (LID), another critical initiative aimed at preserving water quality by managing storm water runoff through sustainable planning and engineering practices.

Compliance with regulatory frameworks is crucial in storm water management. The Clean Water Act mandates certain facilities to acquire a National Pollutant Discharge Elimination System (NPDES) permit. When the EPA is not the permitting authority, state or territorial agencies are responsible for regulating storm water discharges from industrial activities. Facility managers must develop a Storm Water Pollution Prevention Plan (SWPPP) to outline storm water management practices and ensure compliance with applicable regulations.

The SWPPP serves as a comprehensive document detailing storm water-related activities at a facility, identifying potential pollution sources, and outlining measures to prevent pollutants from entering storm water discharges. It is dynamic and should be periodically updated to reflect changes in operations or environmental conditions. The development or revision of an SWPPP involves several key steps: forming a storm water pollution prevention team, assessing potential pollution sources, selecting appropriate storm water control measures, and establishing procedures for routine inspections and maintenance.

In this lesson, students will finalize their SWPPP team, known as the Storm Patrol, by sharing their researched insights about storm water professionals and assigning roles within the team. They will then learn about various BMPs and their benefits both as pollution control measures and broader community benefits. Then they will explore a hypothetical mock site and then a real pre-selected project site to create a facility map where they will identify potential pollution sources, marking the completion of Step 2 in the SWPPP development process. Finally, they will consider the BMPs they learned about to determine effective control measures for their site/facility to mitigate pollutant discharge during storm events, fulfilling Step 3 of the SWPPP framework.

Future lessons will build upon this foundational knowledge, equipping students with specialized skills to analyze their sites within the broader community context, calculate flow rates and impacts, monitor discharges, and design effective solutions. By applying these skills, students will work collaboratively to address identified storm water challenges and implement appropriate control measures, fostering a more sustainable approach to storm water management.

I. Storm Water BMPs Matching Activity:

NOTE: To create the BMP cards, print and cut out the squares with the text descriptions. To create the board, print and tape long edges together.

1. Distribute a set of BMP cards facedown for each student. Students shuffle the cards and take turns drawing a card from the deck and reading the description of the BMP to the rest of the group. The student reading the card should ask the rest of the group how they think this is beneficial.
2. Students then review the BMP board and determine which picture matches the description. Students should discuss if they have seen similar BMPs in their community and discuss what to look for when trying to locate them.

II. Site Assessment & Mapping Site BMPs Activity (Mock Site Track):

1. Share with students how proper site mapping contributes to better storm water management and pollution prevention.
2. Provide each student with the *Mock Site Assessment & Mapping Site BMPs Activity* worksheet with associated topographic maps and surface type figure sheets. These represent a hypothetical school campus site.
3. Have them work on them as you present the following:
 - Conduct a review of topographic maps, guiding students in identifying high and low points that influence how water flows across the landscape.
 - Discuss how elevation affects rainwater movement, emphasizing areas where water is likely to accumulate during rainfall events.
 - Demonstrate on the map where to draw arrows indicating rain flow directions based on terrain features. Present various scenarios that illustrate different topographies.
 - Ask students to practice drawing these arrows on their map as you model this process.
4. Introduce various surface types (e.g., concrete, asphalt, landscaped areas, bare soil) found at sites using visual aids.
 - Explain their characteristics—such as permeability or imperviousness—and discuss their impacts on storm water runoff quantity and quality.
5. Instruct students to review the *Surface Types of Mock Site* map provided, noting areas with different land usage patterns.
6. Present common infrastructure used in storm water management, such as drainage systems and retention basins, by sharing examples from your local area or relevant case studies.
 - Utilize the mock site points of view (POV) included in the *Images of Mock Site Areas*, which showcases infrastructure within the mock site. Match the A,B, C, D labels for the images to the areas marked on the map. These visuals will help students understand practical applications for effectively managing runoff.
 - Instruct students to mark the various types of infrastructure on their mock site map using the provided symbology.
 - Encourage students to correlate the marked areas on the map with the corresponding POVs, reinforcing their understanding of where each type of infrastructure is located and its function in managing storm water runoff.
7. Facilitate discussions about potential sources of pollution present at typical sites (e.g., storage facilities or loading docks).
8. Review what BMPs are from the previous activity and examine options available for reducing runoff while improving overall water quality based on what they have identified earlier from their maps.
9. Ask students to collaborate as they brainstorm strategies utilizing components identified within their mapped sites aimed toward maximizing pollution.

Adaptations and Resources

Project Based Learning Track:

Tips to Prepare

- Obtain a map of the selected project site (e.g. facility or school). Acquire a photocopy of an outside map, ensuring to enlarge it as much as possible for clarity. It's important to modify the map by whitening out or covering any extraneous information to focus on the relevant features. Whether you use a pre-existing

school map or draw a simple hand-crafted version, the map should clearly mark major buildings, walkways, driveways, and dining areas to facilitate navigation.

- Prior to the mapping exercise, make sure to plan for adequate adult supervision for each student group as they explore the area.
- Outline a specific walking route that highlights key elements pertinent to the Site Investigation, such as rain gutters, drains, and potential safety hazards.
- If needed, take the time to educate students on how to interpret the map from a “bird’s eye view,” as understanding how to read the map will be crucial for an effective assessment.
- Ask student to bring a copy of their site map, a clipboard with note paper and writing instrument, camera (optional for documentation), and rain gear (if conducting during a rain event).

After conducting Activity I, have students share about the storm water issue they researched and noted in Section 1 of their workbook. As a team, students should have already select an issue to address and a physical site for their project.

1. Share with students that as Storm Patrol managers, they need to understand the sources of pollutants on their site, the flow of storm water, and the infrastructure used to convey and treat the water.

Objective: Conduct a walk-through of a facility to map storm water flows and existing controls and pollutant sources.

2. Provide students the SWPPP Site Assessment worksheet and discuss the following items:
 - Areas where water can soak into the ground (pervious, permeable)
 - Identification of Activities Exposed to storm water
 - Inventory of Materials and Pollutants
 - Areas with Spill or Leak Potential
 - Presence of Non-storm water Discharges (conduct assessment during dry days)
3. Track and observe how storm water flows through the facility (conduct during wet/rainy days, if possible)
 - Identify discharge points
 - Note the direction of storm water flow
4. Provide students the Project Site Assessment: Making a SWPPP Map and Project Site SWPPP Map Checklist worksheets and have them create a custom map of their site. The site map should show the direction of storm water flow throughout the facility and potential pollution sources.
5. Instruct students to consider where additional BMPs can be useful to fulfill their purpose of preventing polluted runoff.
 - Consider Structural BMPs and Non-Structural BMPs
6. When students return to the meeting area, discuss their assessment notes and go over what was found to complete Section 2 of their Storm Patrol Project Workbook.



Activity-Centric Learning Track:

Conduct Activity I and, if plausible, use the SWPPP Site Assessment worksheet to audit your program's site and then lead a discussion based on steps 7 and 8 of Activity II.

Tips to Truncate Lesson:

- Eliminate or assign the Project Based Learning Activity as homework.
- As homework, have students consider additional BMPs for their site.
- Following their walk through, have students use their notes to finalize their maps at home.

Tips to Extend Lesson:

- Students take home a BMP card and research examples of their implementation.
- Students add to their map details surrounding their site. Where storm water flows onto sites and where are receiving waters. Notating areas of added impacts or treatments.

Resources:

- US EPA, *Developing Your Storm Water Pollution Prevention Plan*, https://www.epa.gov/sites/default/files/2021-03/documents/swppp_guide_industrial_2021_030121.pdf
- EPA, *Stormwater Management Stormwater Best Management Practices (BMPs)*, <https://www.epa.gov/npdes/national-menu-best-management-practices-bmps-stormwater>
- U.S. Department of Agriculture (USDA), *Natural Resources Conservation Service – Water*, <https://www.nrcs.usda.gov/conservation-basics/natural-resource-concerns/water>

