

Investigating Polluted Stormwater Runoff in Eastern Washington



PEI PACIFIC
EDUCATION
INSTITUTE



DRAIN RANGERS

Investigating Polluted Stormwater Runoff in Elementary Grades 3-5

Developed by



Funded by



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INTRODUCTION

Polluted stormwater runoff is unfiltered water that reaches our aquifers, streams, lakes, and rivers. Surfaces such as streets, parking lots, and driveways do not allow rain to soak into the soil, therefore it runs off into storm drains without the benefit of filtration. Animals that live on the land and in the water depend on clean water for their survival. The purpose of the Elementary Stormwater Curriculum is to develop an understanding of the serious issues facing our community from stormwater pollution and to share specific actions we can take to improve the quality of our water. In this unit, students will be introduced to a problem-solving model where they think like an engineer and explore ways to solve the problem of polluted stormwater runoff.

The three to four week unit begins with students researching the issue of stormwater pollution using the English Language Arts performance task model. Students practice and apply Common Core ELA standards including reading, listening, research, and writing when they read and view complex materials, take notes, and synthesize their learning through research questions and an essay. Students build background knowledge through this research process that is foundational to the engineering solutions process making up the remainder of the unit.

After learning more about stormwater runoff, students will practice and apply the Engineering Design process by exploring and comparing possible solutions to improve the quality of stormwater runoff in their community. Students will learn about watersheds, map a portion of their school campus, and use the engineering design process to develop, implement, and test a plan to improve stormwater runoff by reducing the pollution in the water. As a culminating activity, students will create an outreach project where they inform the community of polluted stormwater runoff and steps that we can all take to improve water quality.

The lessons in this unit are specifically designed to meet classroom requirements of the Common Core and Next Generation Science Standards. Students also practice and apply Common Core ELA standards through reading, writing, research, and speaking activities. Stormwater pollution, engineering design, and literacy skills are integrated throughout the unit so that students can practice and apply the new standards with relevant content.

Polluted stormwater runoff is one of many environmental problems our students will face. By equipping our students at a young age with the problem solving tools of the engineer and the verbal and written skills of an effective communicator, we are preparing these students to solve the difficult and challenging environmental issues that affect our present and our future.



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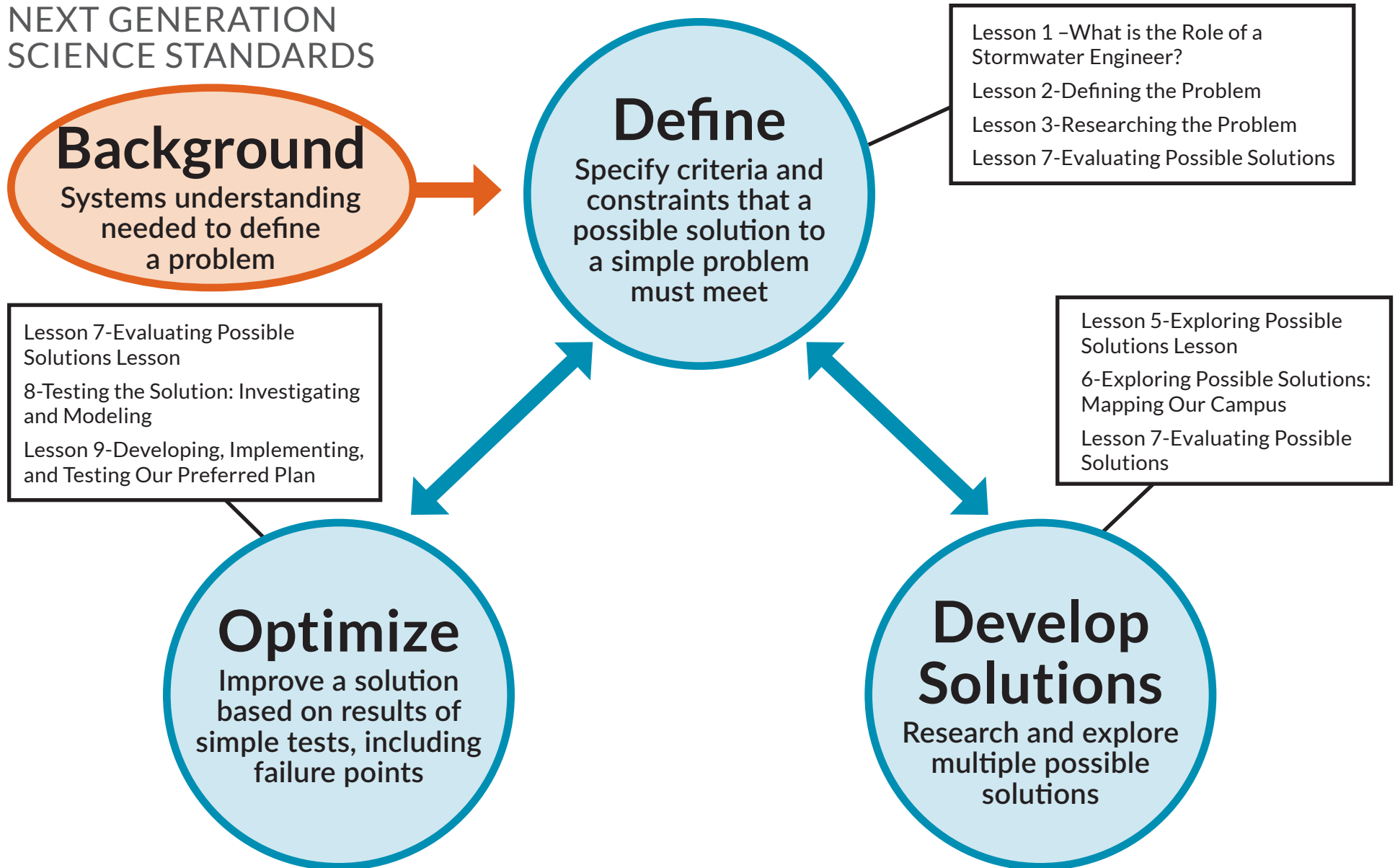
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Engineering Design

NEXT GENERATION SCIENCE STANDARDS





Curriculum for grades 3-5

NEXT GENERATION SCIENCE STANDARDS ALIGNMENT

Students who demonstrate understanding can:	Correlated Content in Drain Rangers
3-ESS3 Earth and Space Standard Three: Earth and Human Activity	
3-ESS3-1. Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.* <i>[Clarification Statement: Examples of design solutions to weather-related hazards could include barriers to prevent flooding, wind-resistant roofs, and lightning rods.]</i> <i>*This performance expectation integrates traditional science content with engineering through a practice or disciplinary core idea.</i>	Lessons 1, 2, 11, 12
4-ESS2 Earth and Space Standard Two: Earth's Systems	
4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. <i>[Clarification Statement: Examples of variables to test could include angle of slope in the downhill movement of water, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow.] [Assessment Boundary: Assessment is limited to a single for of weathering or erosion.]</i>	Lessons 1, 2, 3, 4, 5, 6
4-ESS2 Earth and Space Standard Two: Earth and Human Activity	
4-ESS2-2. Analyze and interpret data from maps to describe patterns of Earth's features. <i>[Clarification Statement: Maps can include topographic maps of Earth's land and ocean floor, as well as maps of the locations of mountains, continental boundaries, volcanoes, and earthquakes.]</i>	Lessons 3, 4, 5, 6, 7, 12
5-ESS3 Earth and Space Standard Three: Earth and Human Activity	
5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.	Lessons 1, 2, 9



Sample Calendar

	Monday	Tuesday	Wednesday	Thursday	Friday
Week 1	1-ELA Performance Task-Stormwater Pollution Part 1 Performance Task: Research Questions	1-Stormwater Pollution Part 2 Performance Task: Informational Essay	2-Videos and Presentations	3-Watershed Model	4-Schoolyard System Model
Week 2	5-Four Rain Drops Simulation Model	6- Engineering Design and Define the Problem	7-Research the Problem	8-Understand Stakeholders	9- Explore and Compare Possible Solutions →
Week 3	9- Explore and Compare Possible Solutions (continued) →	10A or 10B- Develop, Implement, and Test the Plan →			11-Evaluate the Solution and Communicate
Week 4					
	Depending on the type and scope of solution project this could go into 4 weeks to implement Schoolyard Solutions →				



Lesson Overview

Lesson	Activities	Concepts/Skills	Resources
1-ELA Performance Task: Stormwater Pollution	<ul style="list-style-type: none"> Performance Task: Help Protect our Waterways Information essay 	<ul style="list-style-type: none"> Summarizing What is stormwater? How is stormwater polluted? What actions can we take to keep stormwater clean? 	<ul style="list-style-type: none"> Stormwater Videos Essential Questions Performance Task Let's Visit Stormville! Article
2-Videos and Presentations	<ul style="list-style-type: none"> Explore stormwater runoff and pollution View videos and/or have presenters come to class 	<ul style="list-style-type: none"> Summarizing 	<ul style="list-style-type: none"> Stormwater videos Community presenters Questions
3-Watershed	<ul style="list-style-type: none"> Develop a model of a watershed 	<ul style="list-style-type: none"> Compare & contrast What is a watershed? Human impact on watersheds 	<ul style="list-style-type: none"> Glossary Paper Vis a Vis markers Spray bottles Student Journals
4-Schoolyard System Model	<ul style="list-style-type: none"> Draw and label the part of the schoolyard Observe water flow 	<ul style="list-style-type: none"> Observation Systems and system Models- diagrams Water (matter) flow through a system 	<ul style="list-style-type: none"> Student Journals Clipboards
5-Four Raindrops	<ul style="list-style-type: none"> Simulation of the movement of water in developed and non-developed landscapes 	<ul style="list-style-type: none"> Develop models (simulation) Analyze and interpret data Construct explanations 	<ul style="list-style-type: none"> Colored paper Stopwatch Poker Chips Student Journals
6-Engineering Design and Define the Problem	<ul style="list-style-type: none"> Introduction to Engineering Design Defining the Problem 	<ul style="list-style-type: none"> Summarizing Problem Solving Stormwater Runoff and Pollution Engineering Design: Define the Problem 	<ul style="list-style-type: none"> Video 6 Lesson 6 PowerPoint Student Journal
7-Research the Problem	<ul style="list-style-type: none"> Observation Finding evidence of water movement in the schoolyard Identifying pervious and impervious surfaces 	<ul style="list-style-type: none"> Finding Evidence Recording accurately 	<ul style="list-style-type: none"> Lesson 7 PowerPoint Bottles of water Schoolyard Stormwater Legend Student drawings from Lesson 4 Clipboards Student Journals



Lesson	Activities	Concepts/Skills	Resources
8-Understand Stakeholders	<ul style="list-style-type: none"> Define Stakeholder Explore the points of view of the various stakeholders: Stakeholder Matrix 	<ul style="list-style-type: none"> Finding Evidence Point of View Evaluation Stakeholder 	<ul style="list-style-type: none"> Stakeholder table List of stakeholders Internet access
9-Explore and Compare Possible Solutions	<ul style="list-style-type: none"> Research engineering solutions Jigsaw activity of solutions Evaluate solutions 	<ul style="list-style-type: none"> Compare/Contrast Evaluation Stormwater runoff Solutions Engineering Design: Explore Multiple solutions 	<ul style="list-style-type: none"> Lesson 9 PowerPoint Drain Rangers Solution pages Possible Stormwater Solutions Table Evaluating Possible solutions table List of agencies for support
10A- Develop, Implement, and Test the Plan: Pollution Prevention Outreach	<ul style="list-style-type: none"> Complete Project Planning worksheets in small groups Plan test of solution Implement Education outreach project and test 	<ul style="list-style-type: none"> Engineering Design: Develop a plan Optimize- Test the Solution 	<ul style="list-style-type: none"> Drain Ranger Solution pages Project Planning tip sheets Project Planning worksheets and graphic organizer
10B- Develop, Implement and Test the Plan: Schoolyard Solutions	<ul style="list-style-type: none"> Complete Project Planning worksheets in small groups Plan test of solution Implement plan and test solution. 	<ul style="list-style-type: none"> Engineering Design: Develop a plan Optimize- Test the Solution 	<ul style="list-style-type: none"> Video 8 - Drained: Urban Stormwater Pollution Investigation examples Model examples for stormwater runoff solutions Materials for testing solutions Seattle Utilities Rainwise pages
11-Evaluate the Solution and Communicate	<ul style="list-style-type: none"> Analyze test data from surveys, investigations or models and identify improvements Reflect on accomplishments 	<ul style="list-style-type: none"> Analyze and interpret data Construct explanations, Communication 	<ul style="list-style-type: none"> Student Journals Graphing website



This curriculum is designed to go through engineering design as described in the Next Generation Science Standards and integrate with English Language Arts

Unit Length	1 – What is the Role of a Stormwater Engineer ELA-Performance Task	2 – Videos and Presentations	3 – Watershed Model Or 5 – Four Raindrops	6 – Engineering Design and Define the Problem	7 – Research the Problem (Draw Schoolyard First)	9 – Explore and Compare Possible Solutions	10A – Develop, Implement, and Test the Plan: Pollution Prevention Outreach	11 – Evaluate the Solutions and Communicate
2 Days	✓							
3-5 Days	✓	✓		✓		✓		
5-6 Days with Outdoor Component	✓		✓	✓	✓			
2 Weeks	✓		✓	✓		✓	✓	✓

Stormwater Pollution



Overview

Students are introduced to the problem of stormwater pollution by doing an English Language Arts Performance Task.

Objectives

Students will:

- describe what stormwater is, how stormwater gets polluted, and how we can keep stormwater clean by responding to 3 research questions
- record pollution sources and possible solutions in their journals

Procedure

Follow the directions as described in the performance task “Stormwater Pollution,” with these possible deliveries of the task:

- Deliver performance task as described at the beginning of the unit doing both the research questions and the essay over 2 days. Students could have an opportunity to rewrite their essays at the end of the unit.
- Deliver the performance task as described after students have gone through Lessons 2-5.
- Deliver the performance task and just have students do the 3 research questions to learn about Stormwater Pollution to start the unit. Have students write their essay after you have done more or all of the lessons.

Science

Grades 3-5

Setting Indoors

Lesson 1 (Two Class Periods)

Materials

- ♦ Computers for Internet Access
- ♦ Stormwater Pollution Performance Task Parts 1 and 2 Student Directions
- ♦ Stormwater Pollution Performance Task Teacher Directions and Scoring Rubrics
- ♦ Let's Visit Stormville Reading
- ♦ Video 1
www.franklincd.org/drain-rangers
- ♦ The Culprits Diagram

Common Core ELA Standards

- ♦ W #2: Write informative/explanatory texts to examine a topic and convey ideas and information clearly.
- ♦ W #4: Produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience.
- ♦ W #7: Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.
- ♦ W #8: Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources.



TEACHER DIRECTIONS & SCORING RUBRICS

Stormwater Pollution Task Overview

Grades 3, 4, 5 (180 minutes Approximate Time)

Task Overview

Part 1 (60-90 minutes):

Ultimately tasked with writing an essay on stormwater pollution, students will read an article, interpret a diagram, and watch a video, while taking notes on these sources. They will then respond to three research questions addressing the research skills of locating information, selecting the best information, and providing evidence to support an idea or opinion.

Part 2 (60-90 minutes):

Finally, students will work individually to compose an essay on addressing stormwater pollution, referring to their notes and the sources as needed.

Teacher Note: You may want to provide support for grade 3 students by only using one reading along with the video. Allow all students to view the video more than once and provide opportunity for students to share notes.

Student Task: Parts 1 and 2

Students are given the texts, research, and any additional information about the essay.

Day 1 (Approximately 60-90 minutes)

1. Initiate the testing session.
2. Alert the students when 15 minutes have elapsed.
3. Alert the students when there are 5 minutes remaining in Part 1.

Break

Day 2 (Approximately 60-90 minutes)

1. Initiate the testing Part 2.
2. Allow students to access the sources and their note from Part 1.
3. Alert the students when 30 minutes have elapsed.
4. After students have been writing for 80 minutes, alert them that there are 10 minutes left to complete their essays.
5. Close the testing session.

Scorable Products: Student responses to the constructed and selected response questions in part 1 and the essay in part 2 will be scored.



TEACHER DIRECTIONS & SCORING RUBRICS

Stormwater Pollution Task Overview

Scoring Rubrics:

Question #1	Claim 4 Research, Target 2
Question #2	Claim 4 Research, Target 3
Question #3	Claim 4 Research, Target 4
Essay	Informational Writing Rubric

Informational Essay Traits and Scoring Guide:

4 – Points	Statement of Purpose/Focus
4 – Points	Organization
4 – Points	Elaboration of Evidence
4 – Points	Language
2 – Points	Conventions



TEACHER DIRECTIONS & SCORING RUBRICS

Stormwater Pollution Task Overview

1. What is stormwater runoff? Be sure to name your source. (Claim 4, Target 2)

Analyze/Integrate Information Rubric (Claim 4, Target 2)	
2	<ul style="list-style-type: none"> The response gives sufficient evidence of the ability to gather, analyze, and integrate information within and among multiple sources of information.
1	<ul style="list-style-type: none"> The response gives limited evidence of the ability to gather, analyze, and integrate information within and among multiple sources of information.
0	A response gets no credit if it provides no evidence of the ability to gather, analyze, and integrate information within and among multiple sources of information.

2. What do you learn in the article about types of stormwater pollution that you don't learn in the diagram? (Claim 4, Target 3)

Use Evidence Rubric (Claim 4, Target 3)	
2	The response gives sufficient evidence of the ability to distinguish relevant from irrelevant information such as fact from opinion.
1	The response gives limited evidence of the ability to distinguish relevant from irrelevant information such as fact from opinion.
0	A response gets no credit if it provides no evidence of the ability to distinguish relevant from irrelevant information such as fact from opinion.

3. Defend this statement using information from two of the sources. Be sure to name your sources. "We can make a difference in keeping our water clean and healthy." (Claim 4, Target 4)

Use Evidence Rubric (Claim 4, Target 4)	
2	The response gives sufficient evidence of the ability to cite evidence to support arguments and/or ideas.
1	The response gives limited evidence of the ability to cite evidence to support arguments and/or ideas.
0	A response gets no credit if it provides no evidence of the ability to cite evidence to support arguments and/or ideas.

Informative/Explanatory Writing Rubric (Grades 6-11)				
Score	4	3	2	1
Statement of Purpose/Focus	<p>The response is fully sustained and consistently and purposely focused:</p> <ul style="list-style-type: none"> controlling or main idea of topic is clearly communicated, and the focus is strongly maintained for the purpose, audience, and task 	<p>The response is adequately sustained and generally focused:</p> <ul style="list-style-type: none"> controlling or main idea of a topic is clear, and the focus is mostly maintained for the purpose, audience, and task 	<p>The response is somewhat sustained and may have a minor drift in focus:</p> <ul style="list-style-type: none"> controlling or main idea of a topic may be somewhat unclear or the focus may be insufficiently sustained for the purpose, audience, and task 	<p>The response may be related to the topic but may provide little or no focus:</p> <ul style="list-style-type: none"> controlling or main idea may be confusing or ambiguous; response may be too brief or the focus may drift from the purpose, audience, or task
Organization	<p>The response has a clear and effective organizational structure, creating a sense of unity and completeness:</p> <ul style="list-style-type: none"> consistent use of a variety of transitional strategies to clarify the relationships between and among ideas effective introduction and conclusion logical progression of ideas from beginning to end; strong connections between and among ideas with some syntactic variety 	<p>The response has an evident organizational structure and a sense of completeness, though there may be minor flaws and some ideas may be loosely connected:</p> <ul style="list-style-type: none"> adequate use of transitional strategies with some variety to clarify the relationships between and among ideas adequate introduction and conclusion adequate progression of ideas from beginning to end; adequate connections between and among ideas 	<p>The response has an inconsistent organizational structure, and flaws are evident:</p> <ul style="list-style-type: none"> inconsistent use of transitional strategies and/or little variety introduction or conclusion if present may be weak uneven progression of ideas from beginning to end; and/or formulaic; inconsistent or unclear connections among ideas 	<p>The response has little or no discernible organizational structure:</p> <ul style="list-style-type: none"> few or no transitional strategies are evident introduction and/or conclusion may be missing frequent extraneous ideas may be evident; ideas may be randomly ordered or have an unclear progression
Elaboration of Evidence	<p>The response provides thorough and convincing support/evidence for the controlling idea and supporting idea(s) that includes the effective use of sources (facts, and details).</p> <ul style="list-style-type: none"> comprehensive evidence from sources is integrated; references are relevant and specific effective use of a variety of elaborative techniques (may include personal experiences) 	<p>The response provides adequate support/evidence for the controlling idea and supporting idea(s) and claim that includes the use of sources (facts, and details).</p> <ul style="list-style-type: none"> adequate evidence from sources is integrated; some references may be general adequate use of some elaborative techniques (may include personal experiences) 	<p>The response provides uneven, cursory support/evidence for the controlling idea and supporting idea(s) that includes uneven or limited use of sources (facts, and details).</p> <ul style="list-style-type: none"> some evidence from sources may be weakly integrated, imprecise, or repetitive; references may be vague weak or uneven use of elaborative techniques development may consist primarily of source summary (may include personal experiences) 	<p>The response provides minimal support/evidence for the controlling idea and supporting idea(s) and claim that includes little or no use of sources (facts, and details):</p> <ul style="list-style-type: none"> evidence from the source material is minimal or irrelevant; references may be absent or incorrectly used minimal, if any use of elaborative techniques (may include personal experiences)
Language	<p>The response clearly and effectively elaborates ideas, using precise language:</p> <ul style="list-style-type: none"> vocabulary is clearly appropriate for the audience and purpose effective, appropriate style enhances content 	<p>The response adequately elaborates ideas, employing a mix of precise with more general language:</p> <ul style="list-style-type: none"> vocabulary is generally appropriate for the audience and purpose generally appropriate style is evident 	<p>The response elaborates ideas unevenly, using simplistic language:</p> <ul style="list-style-type: none"> vocabulary use is uneven or somewhat ineffective for the audience and purpose inconsistent or weak attempt to create appropriate style 	<p>The response's vague, lacks clarity, or is confusing:</p> <ul style="list-style-type: none"> vocabulary is limited or ineffective for the audience and purpose little or no evidence of appropriate style
Score	2	1	0	
Conventions	<p>The response demonstrates an adequate command of conventions:</p> <ul style="list-style-type: none"> adequate use of correct sentence formation, punctuation, capitalization, grammar usage, and spelling 	<p>The response demonstrates a partial command of conventions:</p> <ul style="list-style-type: none"> limited use of correct sentence formation, punctuation, capitalization, grammar usage, and spelling 	<p>The response demonstrates little or no command of conventions:</p> <ul style="list-style-type: none"> infrequent use of correct sentence formation, punctuation, capitalization, grammar usage, and spelling 	

• Unintelligible • Insufficient (includes copied text) • In a language other than English • Off-topic • Off-purpose



Task: Stormwater Pollution

Part 1 (Approximately 60 minutes)

Student Directions

Your Task:

The PTA at your school is sponsoring a Stormwater Information Night to help protect our local waters. They have asked each child to write an essay explaining what stormwater is, how stormwater gets polluted, and two actions we can take to keep the stormwater clean. You will read an article, view a video and study a diagram to build your knowledge of pollution in stormwater. Then you will write an essay to share at the Parent Information Night.

Steps you will be following:

In order to plan and write your essay, you will do all of the following:

1. Read an article and study a diagram.
2. Watch one video.
3. Answer three questions about the sources.
4. Plan and write your essay.

Directions for beginning:

You will now watch the video and read the article and the diagram. Take notes because you may want to refer to your notes while writing your essay. You can look at the sources as often as you like.

Source Information:

Article: *Let's Visit Stormville!* Sources: Dallas Stormwater Education for Kids, Chittenden County Vermont Regional Stormwater Education Program, City of Bellevue Stormwater Education Program

Illustration: The Culprits Diagram

Video: Video 1 - "Fifteen to the River"
3 min. 49 sec. - www.franklincd.org/drain-rangers

Use the note-taking graphic organizers to take your notes on the sources.

Teacher Note: You may want to use two of the three resources for grades 3 and 4 and provide more scaffolding for grade 3. Use the task as a teaching tool to develop research and writing skills, not just for assessment purposes.

LESSON 1 - ELA PERFORMANCE TASK

NO DUMPING

DRAINS TO RIVER



My Notes

Source	What stormwater is	How stormwater gets polluted	What we can do to keep the water clean
Video 1:			
Article: Let's Visit Stormville			

LESSON 1 - ELA PERFORMANCE TASK

NO DUMPING

DRAINS TO RIVER



My Notes

Source	What Stormwater is	How stormwater gets polluted	What we can do to keep the water clean
Illustration: The Culprits			

Your notes will not be scored. You may use them to answer questions and to write your essay.

Let's Visit Stormville!

What is Stormwater?

Washington is called the Evergreen State for a reason. Our state is covered by forests and shrub steppe. When rain falls in an area abundant with vegetation, most of the water is soaked into the ground, evaporated back into the air, or absorbed by plants and trees.

The forest and shrub steppe act like a sponge, capturing and holding the rain water before it can enter surface water such as streams, rivers, and lakes. But when vegetation is replaced with hard surfaces, like streets, buildings, and parking lots, the water from the rain runs off because it can no longer soak into the ground.

This rain that does not soak into the ground is called stormwater runoff. Stormwater runoff flows into storm drains which carry the stormwater to dry wells leading to our aquifers or into streams, lakes, and rivers. Most of the time, the stormwater goes into these natural bodies of water without being treated.

What is Stormwater Pollution?

As stormwater flows over land, it can pick up pollution. Some of this pollution we can see, like trash, oil, and dirt. Other pollutants we can't see like chemicals sprayed on lawns, bacteria from pet waste, and chemicals leaked from cars and trucks.

Since stormwater runoff is not cleaned, the pollution in stormwater can enter directly into our aquifers, streams, lakes, or rivers. The pollution can then contaminate our groundwater which many people drink. It can also pollute our surface water, harming animals living in it and making playing and swimming in it unsafe.

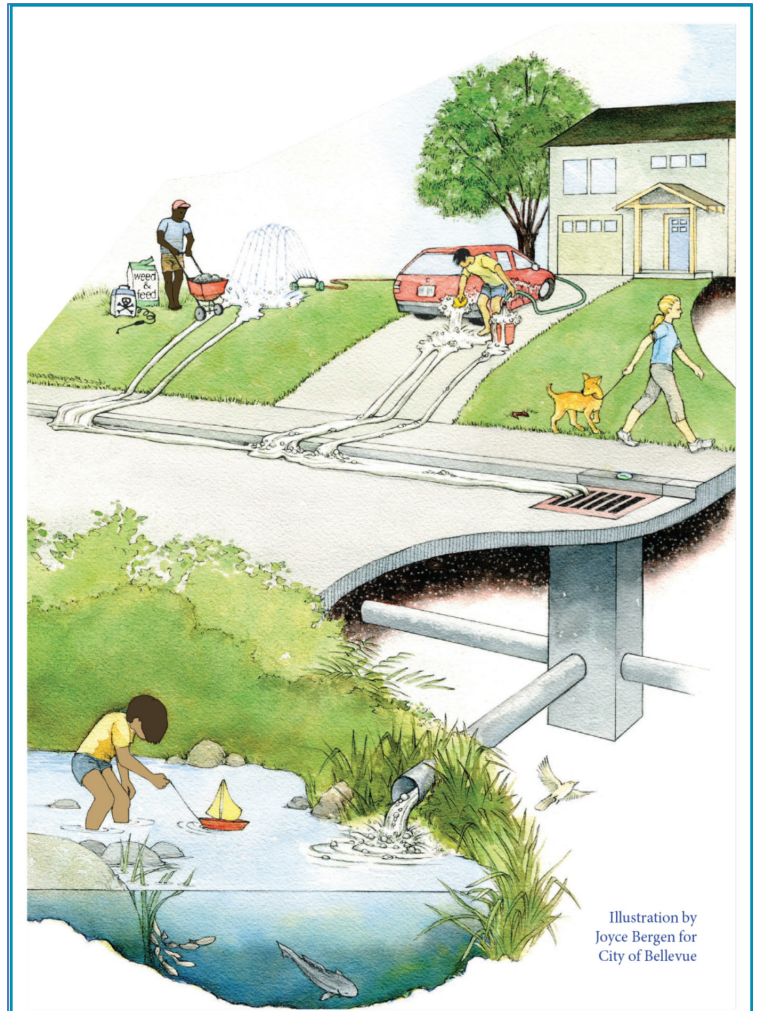
*****There are over 3 billion organisms in one average sized pile of dog waste.*****

What types of pollution can get into storm drains and make our water unhealthy?

Let's learn about three different types of stormwater pollution: washing the car on pavement, pet waste, and yard chemicals.

To help us learn about the different types of stormwater pollution, let's visit Stormville!

Stormville is a typical town located near a beautiful river. The people in the picture live in Stormville and are taking care of their home and car, but they may not realize that they are doing many things that can make water unhealthy. Look at the picture above. What do you see that might cause stormwater pollution?





Car Washing on Pavement

When you wash the family car on pavement, the soap, oil, and other pollutants are washed into the storm drain and go directly into our groundwater or surface bodies of water. Most of the time this water is not cleaned before it reaches these bodies of water.

Soap, oil, and other pollutants in the wash water are harmful to our groundwater which many people drink, as well as to fish and other animals that live in and drink the water. These pollutants can injure

or even kill animals. Even biodegradable soap pollutes water because it may not have time to degrade before it reaches our aquifers, streams, lakes, or rivers.

Here's what you can do!

Suggest that your family take the car to a commercial car wash. These facilities filter the dirty wash water and send it to the sewer treatment plant to be cleaned. Washing your car on the lawn is also a great choice.



Pet Waste

No one wants to swim in poop! Dog poop carries harmful bacteria and diseases that can make people very sick. Shorelines are often closed because bacteria from poop has made the water unsafe to swim.

When it rains, pet waste that is left on the ground can be carried away by stormwater. The polluted stormwater flows into nearby storm drains that lead into aquifers, streams, lakes, or rivers. Too much poop in the water

means people can't swim or play in the water, and it can harm the drinking water for people drinking from the aquifer through a well.

Here's what you can do!

Scoop the poop, put it in bag, and place it in the trash. When walking your pet, take bags with you to clean up their poop.



Yard Chemicals

Many people use fertilizers and pesticides to improve their green lawns and flower gardens. However, stormwater runoff can carry these chemicals into storm drains that lead to aquifers, streams, lakes, and rivers.

People use pesticides to kill unwanted bugs in their yards and herbicides to kill unwanted weeds. When pesticides and herbicides get into an

aquifer, stream, lake, or river, it harms not only animals but people too.

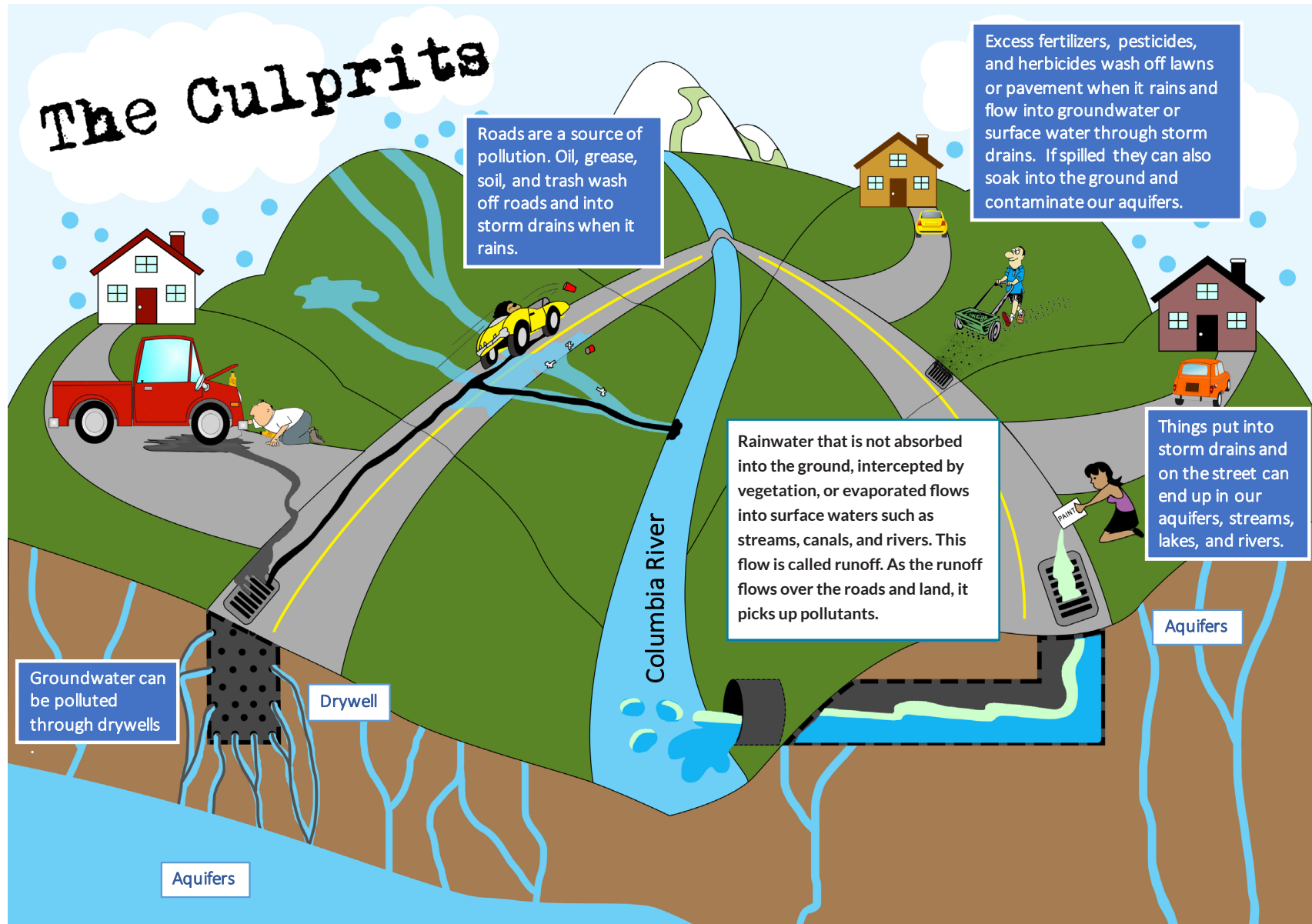
Here's what you can do!

Ask the adults in your household to only use yard chemicals when absolutely necessary. Ask them to read the labels on yard care products and follow the instructions. Also, make sure that any yard chemicals are put away correctly so that they can't leak or spill onto the pavement.

Thanks for visiting Stormville! Take what you have learned from this visit and use it to make good decisions that protect the health of our aquifers, streams, lakes, and rivers. Thank you for helping stop stormwater pollution!

LESSON 1 - ELA PERFORMANCE TASK

NO DUMPING
DRAINS TO RIVER





- [illegible]



Task: Stormwater Pollution

Part 2 (70 minutes)

Student Directions

Your Assignment:

The PTA at your school is sponsoring a Stormwater Information Night to help keep our local waters healthy. They have asked each child to write an essay explaining what stormwater is, how stormwater gets polluted, and two actions we can take to keep the stormwater clean. Write your essay using information from the three sources, naming the sources you use. Your essay will be shared at Parent Night.

You will now have about 70 minutes to review your notes and sources, plan, draft, and revise your essay. While you may use your notes and refer to the sources, you must work on your own. Now read your assignment and the information about how your essay will be scored, and then begin your work.

Essay Scoring

How your essay will be scored:

The people scoring your essay will be assigning scores for:

1. **Statement of Purpose/Focus** – how well you clearly state and maintain your controlling idea or main idea
2. **Organization** – how well the ideas progress from the introduction to the conclusion using effective transitions and how well you stay on topic throughout the essay
3. **Elaboration of Evidence** – how well you provide evidence from sources about your topic and elaborate with specific information
4. **Language and Vocabulary** – how well you effectively express ideas using precise language that is appropriate for your audience and purpose
5. **Conventions** – how well you follow the rules of usage, punctuation, capitalization, and spelling

Word-processing
tools and spell check
are available to you.

Now begin work on your essay.

Manage your time carefully so that you can:

- plan your essay
- write your essay
- revise and edit for a final draft



Task: Stormwater Pollution

ORGANIZING MY ESSAY

Introduction	
What stormwater is	
How stormwater gets polluted	
What can we do to keep stormwater clean: Idea #1	
What can we do to keep stormwater clean: Idea #2	
Conclusion	

Videos and Presenters



Overview

Students synthesize information from videos or classroom presentations about pollution in stormwater runoff. Students identify causes of the pollution and the impacts on aquatic life along with possible solutions.

Objectives

Students will:

- view a stormwater runoff video or have a presentation about stormwater runoff
- record the impact of pollution in stormwater on aquatic life
- record pollution sources and possible solutions in their journals

Procedure

1. Contact local utility for presentation opportunities. See contact list on the Franklin Conservation District resource page: <http://www.franklincd.org/drain-rangers>. Be sure to ask them for any questions or prep you should do for the presentation. AND/OR have students view a stormwater video, also found on that webpage.
2. Have students answer questions provided by the presenter.
3. Have students fill out the graphic organizer to indicate pollution in stormwater impact on aquatic life.
4. *Pollution and Solutions* student page should come last in student journals. Have students begin listing sources of pollution in stormwater runoff and the possible solutions that they heard, saw, or read about during the ELA performance task, during the video, or during the presentation. Teacher Note: students will continue this list throughout these lessons so they have ideas to explore later in Lesson 7.

Science

Grades 3-5

Setting Indoors

Lesson 2 (60 minutes)

Materials

- ♦ Video 2 & 3
www.franklincd.org/drain-rangers
- ♦ Student Journals
- ♦ Resources from presentations or websites

Teacher Note: Pollution and Solutions student page should be the last page of the student journal so students can keep notes as they see videos, read articles, or develop models.

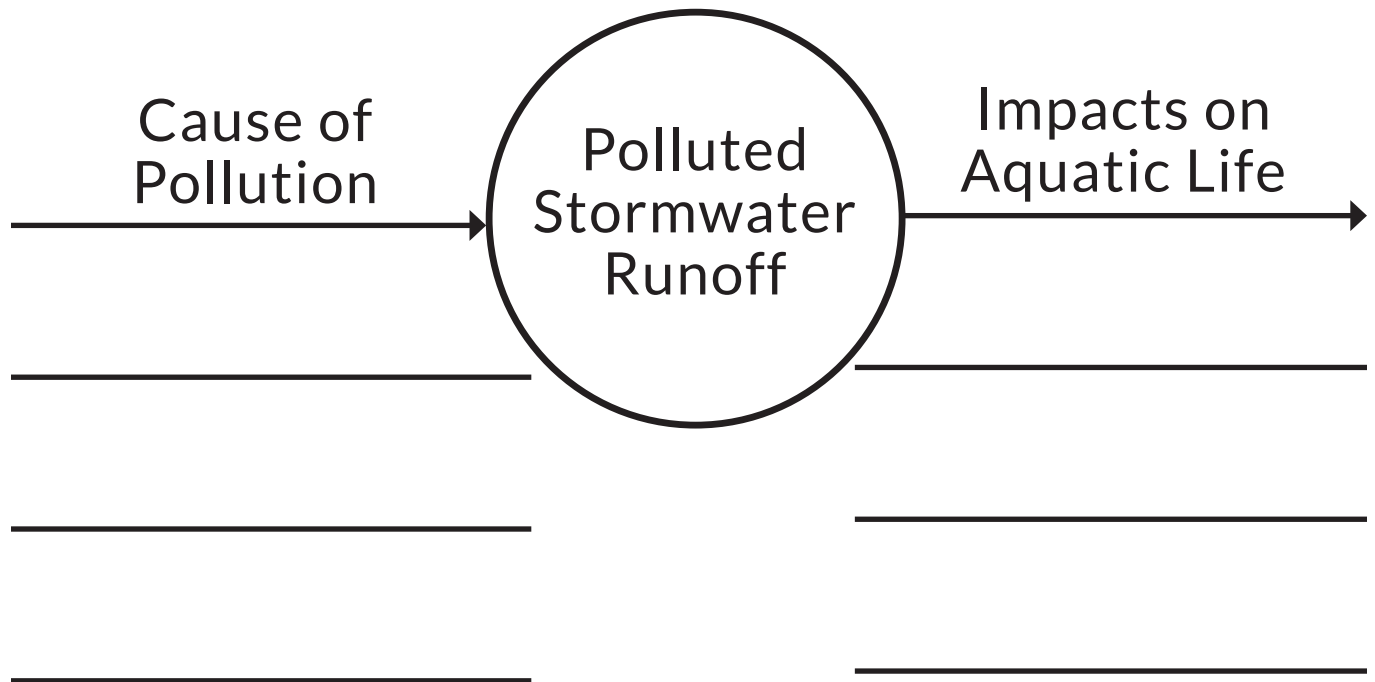
Common Core ELA Standards

- ♦ R #7: Integrate and evaluate content presented in diverse media and formats including visually and quantitatively, as well as in words.
- ♦ S/L #1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly



Videos and Presenters

On the graphic organizer, explain one cause of stormwater pollution and the impact of this pollution on aquatic life.





Pollution and Solutions

Sources of Pollution in Stormwater Runoff	Possible Solutions Mentioned

(This page goes on the back of the journal)

LESSON 3

Watershed Model



Overview

Students develop a watershed model that shows the basic shape (geography) of a watershed, how water flows through it, and the impact people can have on both water quality and water quantity. Then, students compare the similarities and differences between their watershed and the model they built.

Objectives

Students will:

- define a watershed as, “an area of land that drains to a particular body of water”
- demonstrate using their model that pollutants can cause water quality problems within a watershed downstream of the source of the pollution that can affect fish and wildlife
- compare their model to the watershed they live in

Background

No matter where you live, you live in a watershed. That’s because everywhere rain falls or water flows over the land is part of a watershed. A watershed is the entire area from which water drains into a particular surface water body. Watersheds can be big or small. The Columbia River in the Western United States has a watershed that is 258,000 square miles. The biggest watershed in the country is the Mississippi River, which drains all the land between the Rocky Mountains and the Appalachian Mountains. Watershed boundaries are defined by the elevation of the land, with the highest elevation points “ridges” marking the boundary of a watershed. These ridges are also called “divides”. The Continental Divide of the U.S. for example, is in the Rocky Mountains. All the rain and snow falling on the west side of the divide flows into the Pacific Ocean. All the rain and snow falling on the east side of the divide, sooner or later ends up in the Atlantic Ocean. Your local aquifer, stream, or river is a watershed and all the water falling on your schoolyard drains into that body of water. For example all the water dropping on the land that flows into Crab Creek near Beverly is in the Lower Crab watershed. All water is connected. Simple choices in our daily activities affect the quality of water that we drink and the water that fish and other wildlife rely on.

Science

Grades 3 - 5

Setting Indoors

Lesson 3 (45-50 minutes)

Materials

- ♦ Map of local watershed - maps are available through cities, counties, or conservation districts OR Surf Your Watershed: <https://cfpub.epa.gov/surf/locate/index.cfm> OR State Wide WRIA Finder: <https://waecy.maps.arcgis.com/apps/webappviewer/index.html?id=996e6b21ae394cc3a3b63c6da0c3aa0a> OR U.S. Geological Survey's Science in your Watershed: <https://water.usgs.gov/wsc/>
- ♦ One 8 ½ x 11 inch white paper for each student
- ♦ One 8 ½ x 11 inch blue paper for each student (can substitute with white paper if blue is unavailable)
- ♦ Three different colors of non-waterproof markers; Vis-à-Vis brand work great
- ♦ 1-2 bottles of water
- ♦ Video 4
www.franklincd.org/drain-rangers
- ♦ Lesson 3 PowerPoint
www.franklincd.org/drain-rangers

****Extension****

Enviroscape Model: Students can observe point and non-point pollution on a large hands-on watershed model.

To schedule a presentation, contact the Franklin Conservation District on the Drain Rangers webpage:

www.franklincd.org/drain-rangers



LESSON 3

Watershed Model



Introduction

Define a watershed as the entire land area from which water drains into a particular water body. Explain that students will be creating their own models of watersheds. Have students record this definition in their journals.

Activities / Procedure

1. Demonstrate for students how to build their model watersheds. The white paper represents the land and the blue paper represents the ocean. First, crumple the white paper into a ball and gently open the paper, but don't smooth it out. Keeping the blue paper flat on their desks, have the students glue the corners of the white paper to the blue paper so that a mountain is formed. The corners do not need to line up perfectly.
2. Explain that the land is separated into watersheds by mountains and valleys. The highest points of the paper represent mountaintops where the watersheds begin and the lowest wrinkles represent the valleys. Valleys bring watersheds together, and valleys are where natural bodies of water form.
3. Using the blue marker, have students trace the highest points on the paper. These will correspond to mountain ridgelines. Point out that their models are made of many nested watersheds, each separated by mountain peaks.
4. Explain to students how rain can wash pollution from the watershed into rivers, lakes, and streams, and eventually the ocean. When people pollute one watershed, the pollution moves downstream and affects people and wildlife far away.
5. Explain to students how storm drains affect the watershed. Storm drains carry polluted runoff from the land to the nearest body of water. Discuss several ways to prevent pollution on the watershed.
6. Next, students should add several features to the white paper, the land, such as buildings, farms, and roads. Students should consider where best to place these features in order to prevent pollution. Have students use a specific color marker for each feature. For example:
 - Red for buildings
 - Green for farms
 - Black for roads

Science

Grades 3 - 5

Setting Indoors

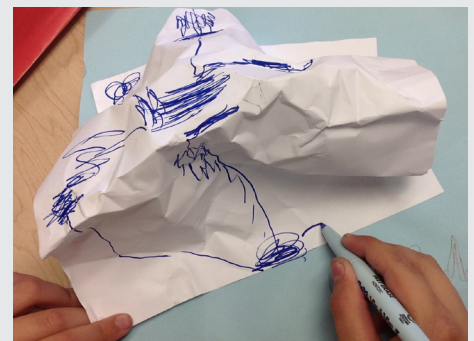
Lesson 3 (45-50 minutes)

Common Core ELA Standards

- ♦ R#4: Interpret words and phrases as they are used in text, including determining technical connotative, and figurative meanings, and analyze how specific word choices shape meaning and tone.
- ♦ S/L #1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly.

Acknowledgments

- ♦ Developed by Erica Baker, Pacific Education Institute; Adapted from the Project WET activity: Branching Out



Watershed Model



7. Use the water bottle to lightly spray the finished model. The spray represents precipitation falling into the watershed.
8. As students are observing their watershed models ask the following discussion questions:
 - Other than the water turning colors, what happened when water was sprayed on your watershed model?
 - What happened to the water that fell on ridge tops? What path did the water follow?
 - Visualize your model as an “actual land form”. Did any streams, lakes, or rivers form on your model? What direction is most of the water draining on your model?
 - Did any of the water soak into the groundwater or aquifers?
 - Were any buildings in the way of the path of the water? What might happen to buildings that are in the way of a raging river or a crumbling hillside? How does the flow of water through a watershed affect our choice of building sites?
 - When the rainwater “washes” over the buildings, farms, and roads it changes color. This represents the water picking up pollution from the watershed. How might pollutants near the top of the watershed affect land near the bottom of the watershed?
 - In many parts of Eastern Washington it is generally dry, with occasional heavy rains. Think about your model. What does this mean for pollution runoff reaching streams and rivers during heavy rainfall in the watershed?
9. Have students look again at the map of their local watershed, and compare their model to the map. Use the graphic organizers and answer the questions in their journal to guide their comparison.

Science

Grades 3 - 5

Setting Indoors

Lesson 3 (45-50 minutes)

Glossary

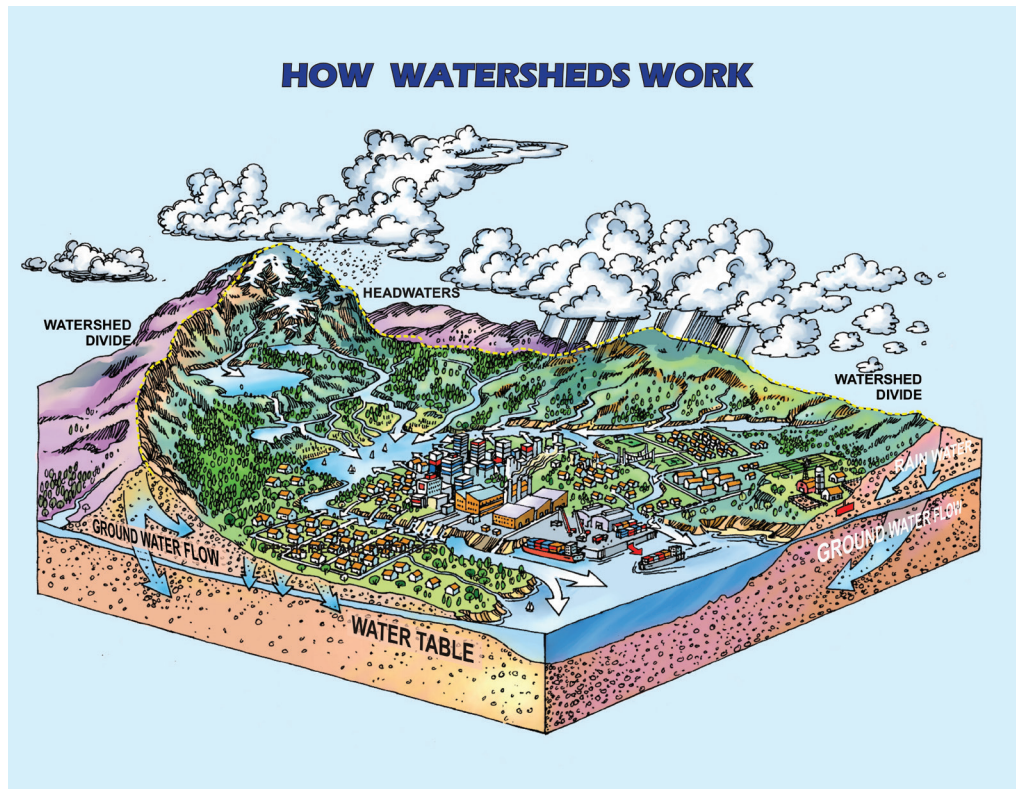
- ♦ **Aquifer:**
A layer of sand, gravel and clay below the earth's surface with enough water for people to withdraw for use (through wells and springs). Rainwater soaks into the ground and fills aquifers.
- ♦ **Pollutant:**
Any substance in water that harms water quality.
- ♦ **Surface Water:**
Water found above the land, including oceans, estuaries, lakes, rivers, streams, and ponds.
- ♦ **Watershed:**
The entire land area from which water drains into a particular surface water body such as a lake, stream, or river.
- ♦ **Stormwater or Stormwater Runoff:**
Rain that falls on streets, parking areas, sports fields, gravel lots, lawns, rooftops or other developed land and flows directly into nearby creeks, lakes, rivers, and Puget Sound. This runoff carries pollutants to these waterways.
- ♦ **Headwaters:**
Where a creek, stream, river begins – the source of that waterway.



Stormwater Runoff Journal

Your name: _____

Watershed Model



Define a watershed

Watershed Model Comparison



SIMILARITIES

--

DIFFERENCES

Watershed Model	Real Watershed



- # Watershed Model



Objectives

- use drawings as a model of a system
- identify the parts of the system
- identify inputs and outputs to the system in terms of water
- describe water's role in the system
- find evidence of human impacts to the system

Science

Grades 3-5

Setting Outdoors/indoors

Lesson 4 (45-50 minutes)

Materials

-

Vocabulary:

Drain Rangers Curriculum - Elementary

LESSON 4 - SCHOOLYARD SYSTEM MODEL:

Introduction to Water in the Schoolyard



Activities

Procedure: Drawing and labeling the schoolyard system

1. Tell students that they are going to look at an area of their schoolyard as a system and record the parts of that area. Remind students that their schoolyard is part of the watershed.
2. Inform students that their task is to draw and label the parts of the school campus in a given area (this includes the parking lot, sidewalks, buildings, etc.). They are answering the question, "What are the parts of the schoolyard system?"

Additional options for drawings are below:

- a. Students make a bird's eye view drawing.
 - b. Students use a google maps image and just label.
 - c. Make a class drawing that is projected.
 - d. Student drawings are scanned so they can be projected.
 - e. Students take photos and then label parts.
3. Review the rules for going outside with students.
 4. Brainstorm with students the level of details you would like in the drawing. Tell students they are just going to draw and label one area on the schoolyard, and they are specifically going to observe evidence at the how water flows through the system
 5. Remind students that they are looking at this part of the schoolyard as a system. Systems have parts that interact. Matter cycles through systems and energy flows through systems. When we look at a system there are various inputs and outputs, matter, and energy going into and out of the system. Today they are only going to be thinking about water inputs and outputs. Let students know that they will be revisiting this area of the schoolyard later to examine further what is going on in terms of stormwater runoff.
 6. Students should take a good 20-30 minutes drawing and labeling their system. If students go too quickly ask them to put in more details.
 7. Have students answer the questions in the student journal about water in the schoolyard system (you may want to do the questions first to get students observing their area).
 8. Back inside have students work in partners to share their drawings, adding parts to their drawing that the partner may

Science

Grades 3-5

Setting Outdoors/indoors

Lesson 4 (45-50 minutes)

Common Core ELA Standards

- ♦ R #7: Integrate and evaluate content presented in diverse media and formats including visually and quantitatively, as well as in words.
- ♦ S/L #1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly.

LESSON 4 - SCHOOLYARD SYSTEM MODEL:

Introduction to Water in the Schoolyard



have but they didn't notice. Students could then also share in groups adding information.

9. *Optional* group draw. Have students draw their schoolyard system as a group on poster board or flip chart paper. This will be used to continually add information as gathered.

Think, Pair, Share:

10. Have students think about and list any interactions between living things and non-living things. Have them share with a partner and then make a class list of interactions.
11. Ask students to think about the watershed that they have learned about. In pairs, have students list the inputs and outputs to this system in terms of water. What other inputs and outputs are there? Again, do a think, pair, share to make a class list. If doing a group drawing these inputs and outputs could go on sticky notes on the drawing.
12. In a similar way have students make lists of all the ways humans impact this environment and share out making a class list.

Science

Grades 3-5

Setting Outdoors/indoors

Lesson 4 (45-50 minutes)

Student Journal Page



Location or area ON THE SCHOOL SITE: _____

Draw and Label the Schoolyard System

What are the parts of the system?

1. What are the parts of the local system?

2. List the places, from this spot, where you can SEE water.

3. What is the role of water in the schoolyard system?

4. Are there places where the water is moving? If yes, where is it traveling to? And why?

5. Is the water beneficial? If so, how?

LESSON 4 - SCHOOLYARD SYSTEM MODEL



Schoolyard System Water Questions, continued

6. Is the water harmful? If so, how?

7. Are humans impacting this schoolyard system? Identify evidence of how humans are impacting this schoolyard system?

8. Describe one interaction between living and non-living part of the system.

9. The schoolyard system is in a watershed. Identify inputs and outputs of water to the schoolyard system.

Water Inputs	Water Outputs

LESSON 5 - FOREST RUNOFF VS URBAN RUNOFF

Four Rain Drops



Overview

Students simulate the movement of water droplets in an undeveloped and a developed watershed and graph the results. There is a video to help explain how to run the activity on the Drain Rangers webpage: www.franklincd.org/drain-rangers

Objectives

Students will:

- compare how water moves through a forested watershed (undeveloped) and an urbanized watershed (developed)
- learn that an equal amount of rainfall creates very different amounts of stormwater runoff depending on the amount of forest trees vs urban development
- explore impacts to land and aquatic habitat caused by increased amounts of runoff
- think of ways to control or reduce the amount of stormwater runoff in urban watersheds

Activities

Card Assembly

The following is a more accurate distribution of cards, but to simplify for younger students you could do 25% (1/4 of the class) for each Evaporation, Transpiration, Infiltration, and Surface Runoff at the beginning. Tape/staple two sheets together back to back with words facing out.

Green (for 28 students)	Yellow	# of Cards
Evaporation	Evaporation	3
Evaporation	Surface Runoff	3
Transpiration	Transpiration	2
Transpiration	Surface Runoff	4
Infiltration	Infiltration	3
Infiltration	Surface Runoff	5
Surface Runoff	Surface Runoff	4
Forest	Urban/Suburban	1
Forested Wetland	Urban/Suburban	2
Creek	Creek	1

Developed with Suzi Wong-Swint, Snohomish County Department of Public Works

Drain Rangers Curriculum - Elementary

Science

Grades 3-5

Setting Indoor/Outdoors

Lesson 5 (45-50 minutes)

Materials

- ♦ 28 sheets of green paper
 - 6 Evaporation
 - 6 Transpiration
 - 8 Infiltration
 - 4 Surface Runoff
 - 1 Forest
 - 2 Forested Wetlands
 - 1 Creek
- ♦ 28 sheets of yellow paper
 - 3 evaporation
 - 3 Surface Runoff
 - 2 Transpiration
 - 4 Surface Runoff
 - 3 Infiltration
 - 5 Surface Runoff
 - 4 Surface Runoff
 - 3 Urban/Suburban
 - 1 Creek
- ♦ A stop watch or watch with second hand
- ♦ Poker chips/paper slips with pollution labeled on them (dog waste, pesticides, herbicides, fertilizer, dirt)
- ♦ Handout or projection of the forest and urban water cycle diagram and hydrograph (optional)
- ♦ Video 5 - How to Play Four Raindrops
www.franklincd.org/drain-rangers

LESSON 5 - FOREST RUNOFF VS URBAN RUNOFF

Four Rain Drops



Activities

Other Preparation

This lesson can be done in either a classroom (or other indoor space) or outside. If doing this lesson indoors, it is best to clear an aisle way in the room where students can move freely from one side of the room to another.

***Figuring out numbers of cards if class size is different than 28 students.**

- If you have just a few (2-4) students more than 28 add additional pairing of cards in this order (yellow/green)
 - ♦ 1 - Evaporation/Evaporation
 - ♦ 2 - Infiltration/Infiltration
 - ♦ 3 - Surface Runoff/Surface Runoff
 - ♦ 4 - Transpiration/Transpiration
- If you have a few (2-4) less students, remove card pairs in the reverse of the order listed above (e.g., remove the Transpiration/Transpiration card pairing first, then the Surface Runoff/Surface Runoff)

You will still use one of the forest, wetland, and creek cards, however the ratio of the “rain drop” cards will need to be adjusted with the number of students. Here is how to pair the green cards and yellow cards (green/yellow) if you have a class size that is much different than 28 students.

Here are the percentages needed (round up or down as needed).

Evaporation/Evaporation	10% of raindrop card pairs
Evaporation/Surface Runoff	15% of raindrop card pairs
Transpiration/Transpiration	10% of raindrop card pairs
Transpiration/Surface Runoff	15% of raindrop card pairs
Infiltration/Infiltration	15% of raindrop card pairs
Infiltration/Surface Runoff	20% of raindrop card pairs
Surface Runoff/Surface Runoff	15% of raindrop card pairs

Science

Grades 3-5

Setting Indoor/Outdoors

Lesson 5 (45-50 minutes)

Common Core ELA Standards

- ♦ R #4: Interpret words and phrases as they are used in text, including determining technical connotative, and figurative meanings, and analyze how specific word choices shape meaning and tone.
- ♦ R #7: Integrate and evaluate content presented in diverse media and formats including visually and quantitatively, as well as in words.
- ♦ S/L #1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly.
- ♦ **Vocabulary:**
 - Evaporation
 - Transpiration
 - Infiltration
 - Surface Runoff
 - Wetland
 - Watershed

LESSON 5 - FOREST RUNOFF VS URBAN RUNOFF



Making Connections

Many people do not realize how much the surface runoff portion of the water cycle is affected by the land use (mature forests or highly urban) or that several hundred stormwater detention ponds (artificial wetlands) have been constructed throughout our community to contain and slow down the flow of stormwater. Modeling water droplets in forests and an urban setting helps students conceptualize the scale of the differences.

Background

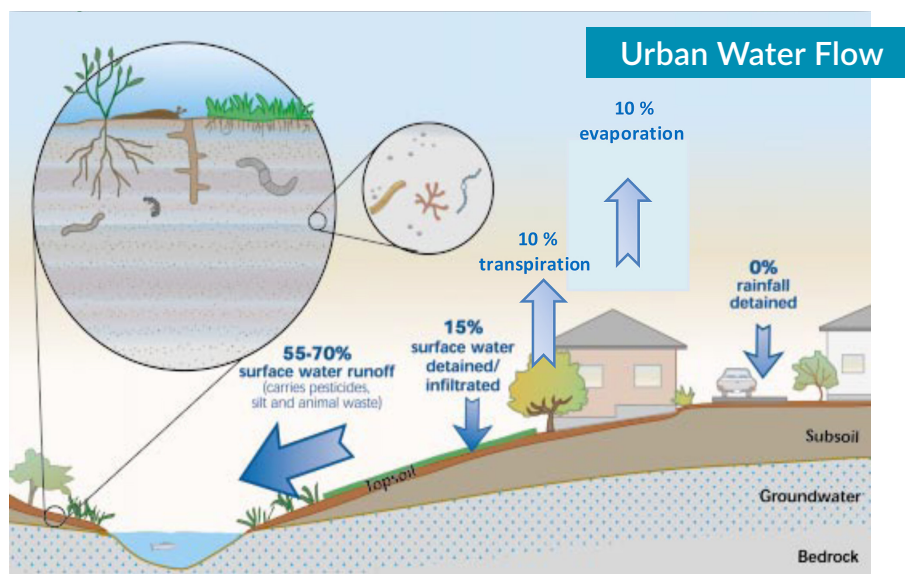
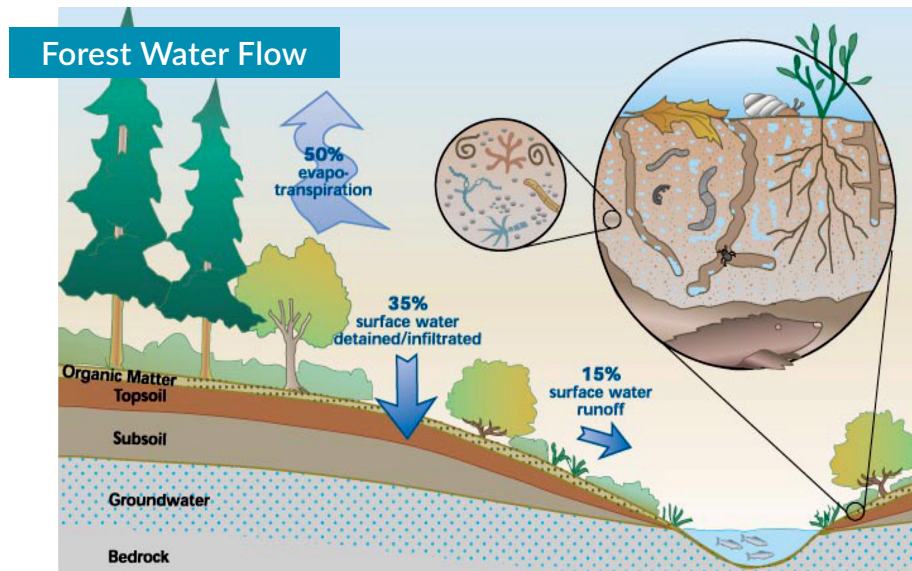
Over 6 million people live in the Columbia River watershed. But before the development of the many cities and towns where most of these people reside, this region was heavily covered in grasslands and shrub steppe. Large areas of this vegetated land have been replaced with what is called impervious surfaces. These are surfaces such as pavement and concrete where the rain water is not able to soak into the ground.

This combination of less vegetation and more impervious surfaces creates changes in the way that rain water moves through the land, and also how it enters natural waterways such as aquifers, streams, rivers, lakes and eventually the Columbia River. In areas of vegetation, about half of the water either evaporates or is absorbed by plants. Another one-third of the rain water is absorbed into the soil and slowly makes it way downhill, through the soil, to aquifers and waterways. In a forested landscape, only about 15% of rain water flows over the surface of the land to enter a nearby waterway after a rain storm.

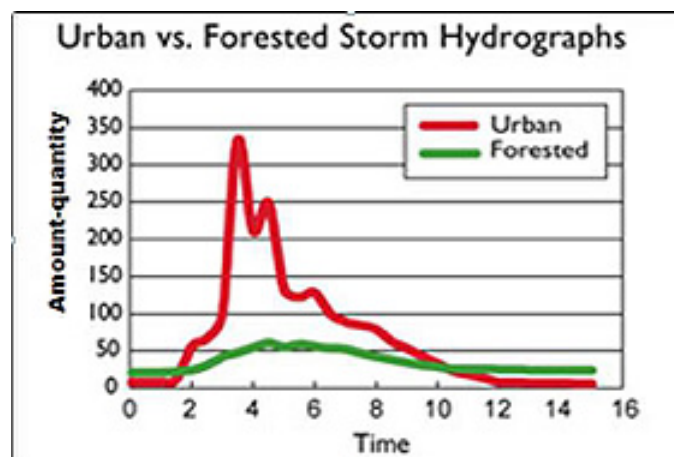
Urban development changes the amount and the speed at which rain water enters natural waterways. Without trees and plants to slow down and absorb the rain water, or easy access to soil, about two-thirds of the rain water flows over the surface of the land to enter nearby streams, rivers, or lakes and has little opportunity to soak into the soil and eventually the aquifer. This, “surface runoff,” also reaches these natural waterways much more quickly in an urban landscape. Finally, as the rain washes over streets and lawns, it picks up pollution that is then carried into waterways.

LESSON 5 - FOREST RUNOFF VS URBAN RUNOFF

NATIVE FOREST/SOIL



<http://www.soilsforsalmon.org/pdf/SoilsforSalmonLIDrev9-16-04.pdf>



LESSON 5 - FOREST RUNOFF VS URBAN RUNOFF



Procedure

PART ONE: Model of Rain Moving through a Forest - See diagram next page

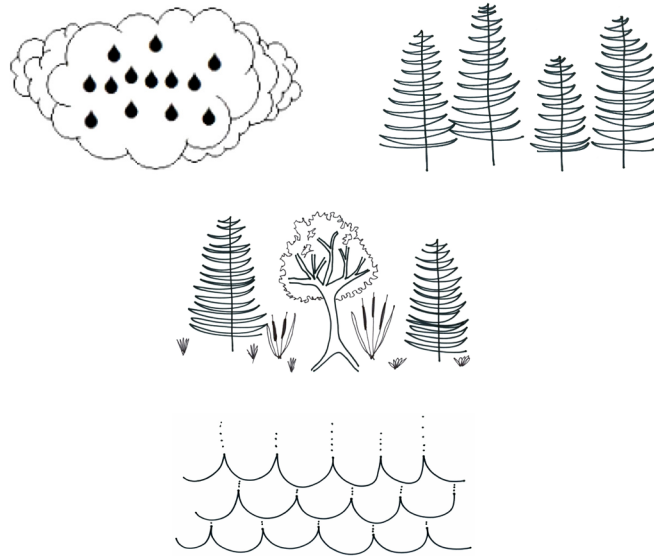
Simulation of Forest Runoff: there is very little surface runoff and it travels very slowly

1. Explain to students that they will be participating in a role-playing activity where most of them will represent rain drops while a few students represent features on the land where the rain falls, such as trees, wetlands, and a creek.
2. Select one person to be “The Creek.” Have that person stand on one side of the room.
3. Select one person to be “The Forest.” Have that person stand on the opposite side of the room.
4. Select two people to be “Forested Wetlands.” Have these people stand about half way between “The Forest” and “The Creek.”
5. Randomly pass out the “Evaporation,” “Transpiration,” “Infiltration,” and “Surface Runoff” cards to each remaining student. All students should have their cards with the green side facing out – **this first part uses the green side of the cards.**
6. Have the “rain drop” students gather, in a group, at the side of the room away from the forest to create a “cloud.” Tell students that they are in a cloud and about to rain on the forest.
7. Then, have the wind blow and have the “raindrops” rain on the forest. Lead students through the role-playing activity, explaining the movement of each type of raindrop in the order below. Call each group out of the cloud separately as they rain on the forest:
 - **Evaporation:** Raindrops fall on the tree leaves and are there long enough for the sun to shine on them so they evaporate. Send this group back to the cloud.
 - **Transpiration:** These raindrops first hit the trees, make it to the ground and soak into the soil. The raindrops are then absorbed by trees and then the trees “sweat” water vapor out through their leaves. When trees “sweat” is it called transpiration. The water then evaporates off of the leaves. Send this group back to the cloud. Take time to have students think about the amount of time it really might take a drop to get from the top of a 200 foot tall fir tree to the ground, you want them to think about dripping from branch to branch and it might take a few hours – and there is so much time for evaporation to occur.
 - **Infiltration:** Raindrops first hit the trees, make it to the ground and soak into the soil. They are not absorbed by trees, but instead flow slowly through the soil towards the creek. These raindrops only move an inch or two a day. These students can move towards the creek, but because they are moving slowly through the soil, they can only take one tiny step every 30 seconds (or another way that will have students move very slowly). (Make sure these students move slowly enough that they do not reach the creek during this role play.)
 - **Surface Runoff:** All that remain are “Surface Runoff” drops. Explain how these drops do not soak into the soil, but have to seep slowly over the forest floor through lots of dead leaves and twigs. In addition, each rain drop will be trapped in a wetland for a while, so when these drops pass through the wetland they need to stop for a 10 second delay before they can continue flowing to the creek.
8. **BEFORE** the “Surface Runoff” raindrops start moving to the creek, explain to students that we will be measuring how many rain drops reach the creek and how many seconds it takes for those raindrops to reach the creek. Then time how long it takes for all of the “Surface Runoff” drops to reach the stream. Count the number of drops that reach the stream. Record these data on the whiteboard for later use.

LESSON 5 - FOREST RUNOFF VS URBAN RUNOFF



Diagram of placement of the cloud, forest, wetland, and creek (not to scale)



Procedure

PART TWO: Model of Rain Moving through an Urban Watershed

Simulation of Urban Runoff: lots of surface runoff and it travels very quickly

1. Have all the rain drops return to the cloud station. Explain that you have returned to the same watershed and that there have been a few changes in the past five years. Some of “The Forest” has been cleared to build homes and roads. Flip over “The Forest” card to the yellow side so it says, “Urban/Suburban.”
2. Describe how the wetlands in the middle of the watershed have also been clear for homes and roads. When you flip over the Wetland card, tell students that the wetlands are still there, that there are rules about not building in the middle of most wetlands, but even when the rules are followed, the wetlands don’t work quite as well as they used to. Flip over all the “Forested Wetland” cards so they say, “Urban/Suburban.”
3. Point to “The Creek” which is still at the bottom of the watershed. Flip over the creek’s card (it will still be a creek).
4. Go over the differences between the urbanized landscape and the forested landscape. These main differences are less trees and more impervious surfaces where rain cannot soak into the ground.
5. Ask students if they can think of human activities that may introduce some pollution on top of the surfaces of the pavement and the lawns. Scatter the poker chips/slips of paper with different types of pollution around the floor near the house (where the forest and the wetland originally were).
6. Have all the rain drops flip their cards over to the yellow side. Ask students if they notice if some of their cards have changes (some change, some do not).
7. Lead students through another role-playing activity, explaining the movement of each type of raindrop in the order below. This part of the role-play should emphasize the differences in how the raindrops move due to the replacement of the trees and wetland with homes and roads. Call each group out of the cloud separately as they rain on the forest:

LESSON 5 - FOREST RUNOFF VS URBAN RUNOFF



- **Evaporation:** Use the same role playing as in the first model, but make note that there are now less trees. Also, make note of how many less students are in this group compared to the first model. Send this group back to the cloud.
- **Transpiration:** Use the same role playing as in the first model, but make note that now there are less trees AND less soil available in to which the rain can soak. Also, make note of how many less students are in this group compared to the first model. Send this group back to the cloud.
- **Infiltration:** Use the same role playing as in the first model, but make note that now there is less soil available in to which the rain can soak. Also, make note of how many less students are in this group compared to the first model. This group can move slowly towards the creek. (Make sure these students move slowly enough that they do not reach the creek during this role play.)
- **Surface Runoff:** All that remain are “Surface Runoff” drops. Make note of how many more raindrops are in this group and quickly review why (less trees, more impervious surface). Like in the first model, this group will move towards the creek, but with two important differences:
 - Since there is no more wetland, they are not delayed for 10 seconds at the wetland. They can also walk faster this time because there are no dead leaves or twigs in their way.
 - They need to pick up pollution (poker chips/slips of paper) as they travel to the creek.

PART TWO: Model of Rain Moving through an Urban Watershed

Simulation of Urban Runoff: lots of surface runoff and it travels very quickly

8. BEFORE the “Surface Runoff” raindrops start moving to the creek, explain to students that we will be measuring how many rain drops reach the creek and how many seconds it takes for those raindrops to reach the creek. Have the students walk quickly to the creek picking up poker chips/slips of paper along the way. Point out that the wetlands are no longer able to slow the rain drops (can’t give time penalties). Time the trip and count the number of rain drops reaching the creek. Record these data on the whiteboard for later use.
9. Have students look at their poker chips/slips of paper. What was on them? How does this simulate what really happens in the urban system?

PART THREE : Graphing and Discussing Our Results

1. Have students return to their desks. Using the worksheet, review what a watershed is. Ask students to copy the data from the board into questions 2 and 3.
2. As a group, plot the data from each model into the graph, following the instructions on the worksheet.
3. Ask students if their graph looks like the example hydrograph provided in this lesson.
4. Ask students how does urbanization change the amount of water that reaches the creek, how does it change the timing, how does it change the quality:
 - **Quantity:** In a mature forest, about 15% of the drops that fall from the sky will reach the creek. In an urban setting, nearly 55-70% of the drops that fall from the sky will reach the creek.
 - **Time to reach creek:** In a forest, water moves very slowly – it takes several days, weeks, or even months to reach the creek. In an urban setting we have storm drains and pipes, gutters, downspouts, and other conveyance structures that allow runoff to reach the creek in a matter of minutes or hours.

LESSON 5 - FOREST RUNOFF VS URBAN RUNOFF

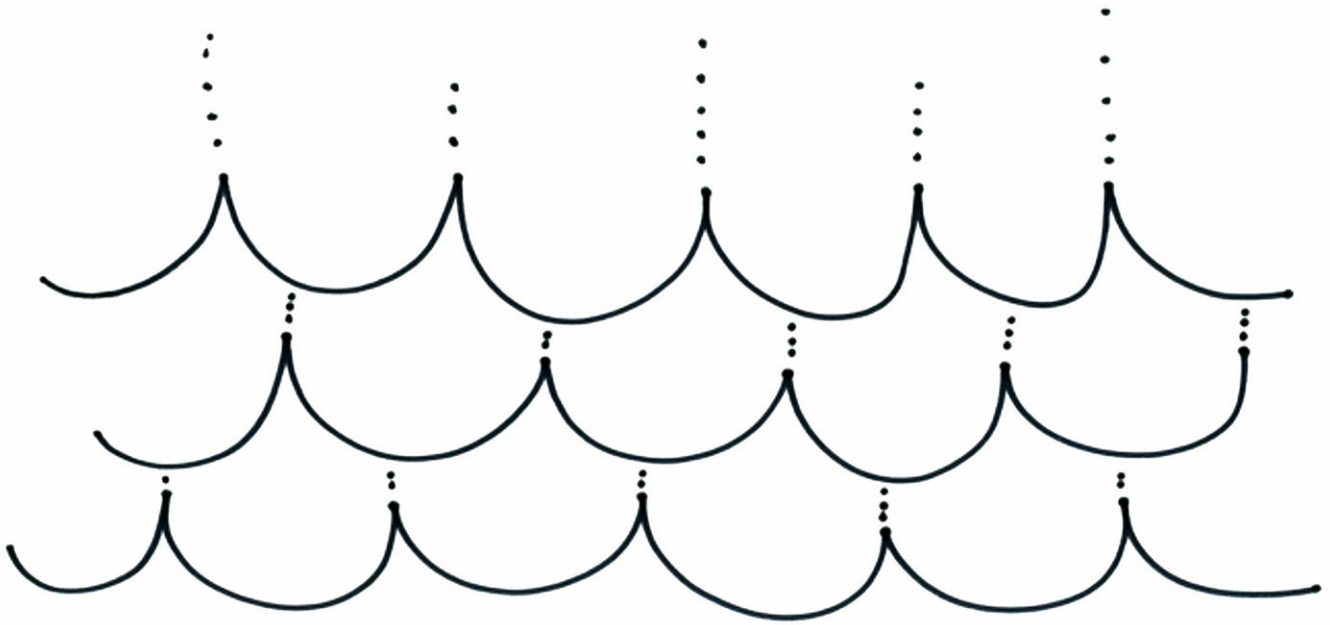


- Quality: This term refers to the various types of pollution that rain drops picked up and brought to the creek. In a forest, plants and soil filters out pollutants before they reach the creek. In an urban watershed, pollution is conveyed to the creek via stormwater runoff.
5. Have students think of solutions that an engineer could design to help water in an urban watershed flow more like the water in a forested watershed. What could an engineer design to have less water flow into creeks in an urban watershed?
 6. Have students think about how natural wetlands tend to trap many pollutants and prevent them from migrating downstream. What happens to pollutants in urban systems? What are ways to prevent pollution from entering wetlands and creek
 7. Have students answer questions 5-7 in their journals.



Pet Waste	Pesticides
Herbicides	Fertilizer
Soil (Dirt)	Pollution from Cars

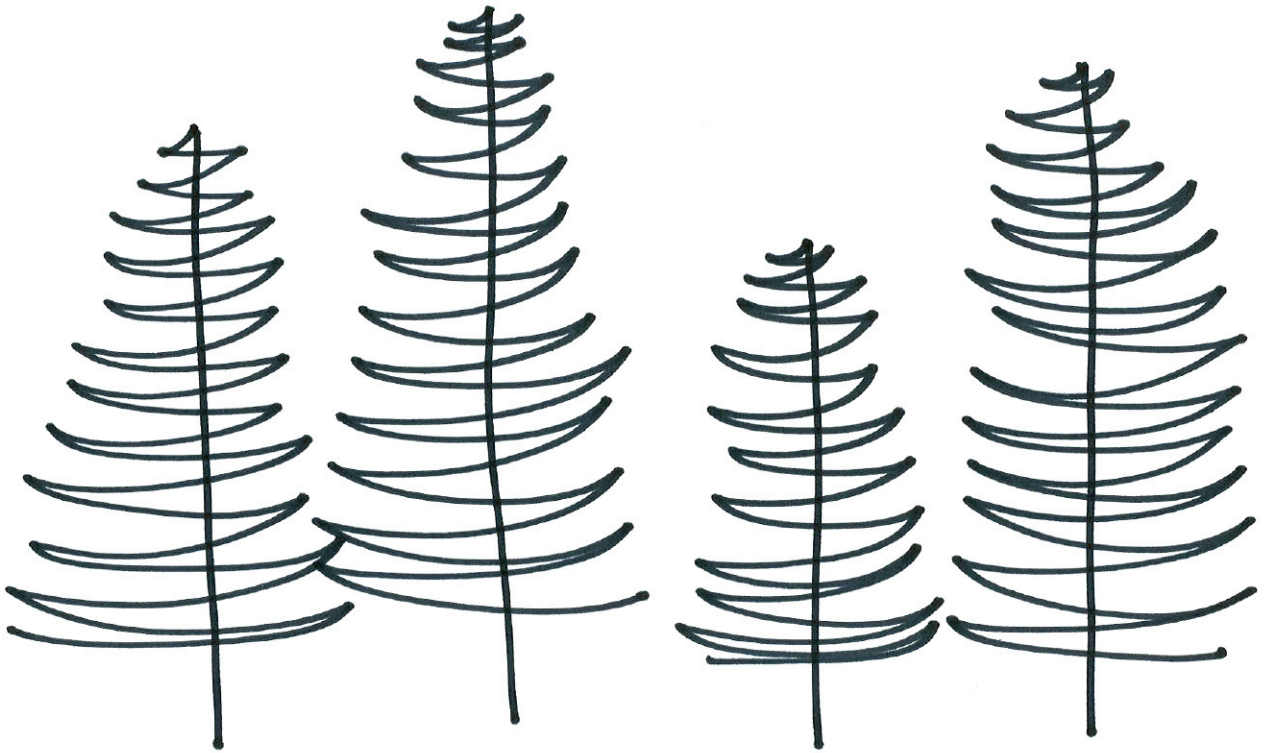
Template of pollution cards to make multiple copies put on bright colored paper and cut up.



the creek



forested wetland



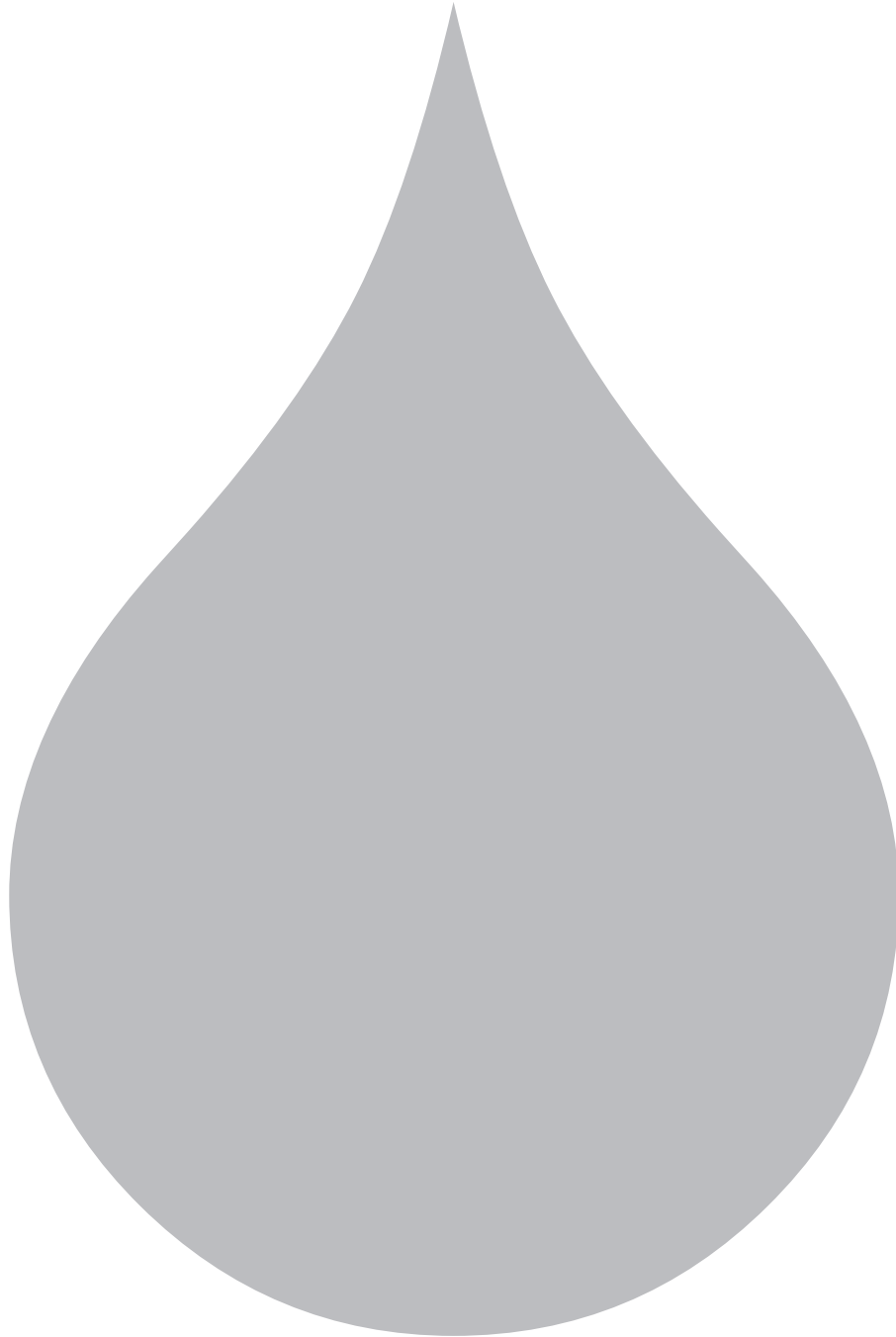
forest



**urban/
suburban**

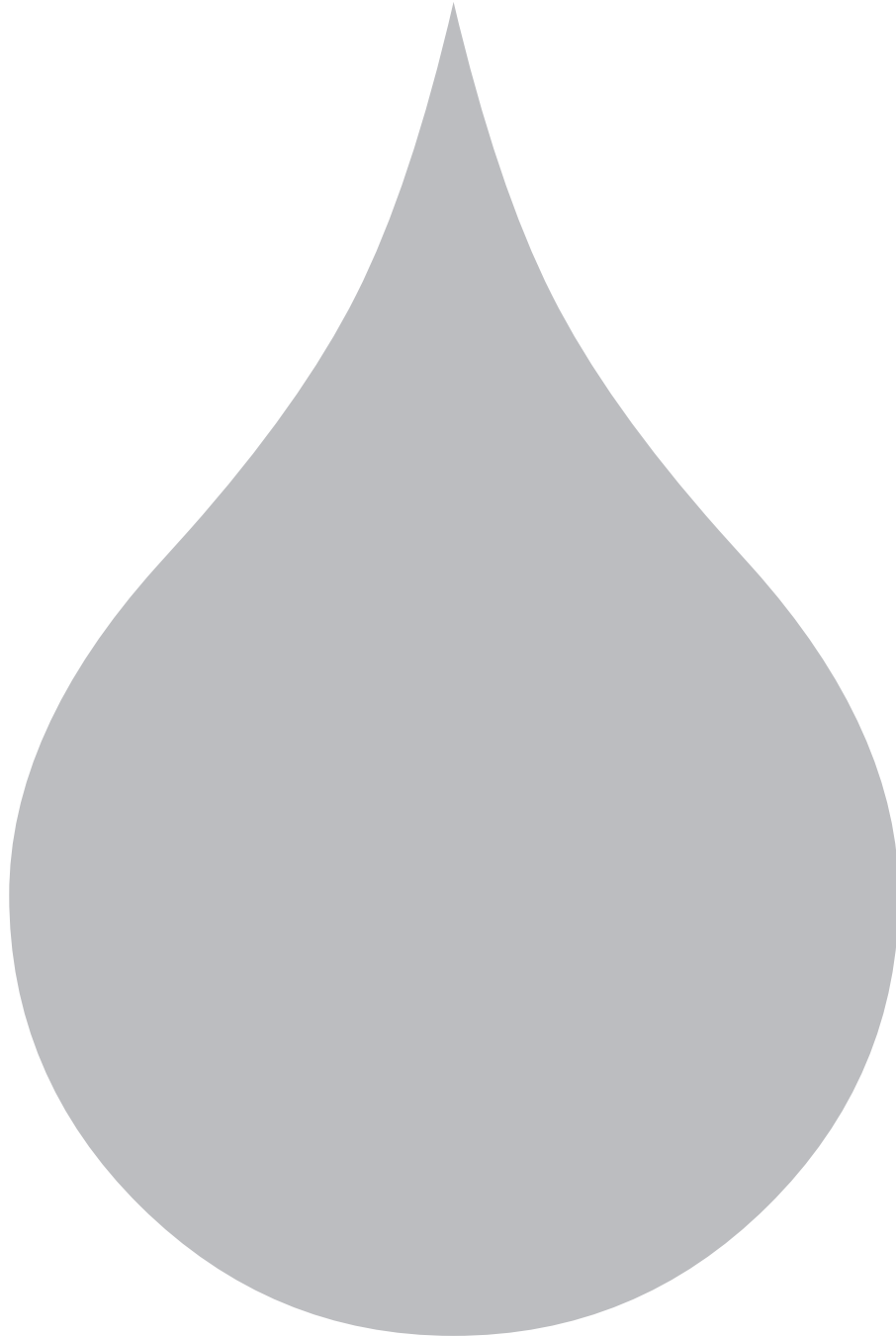


evaporation



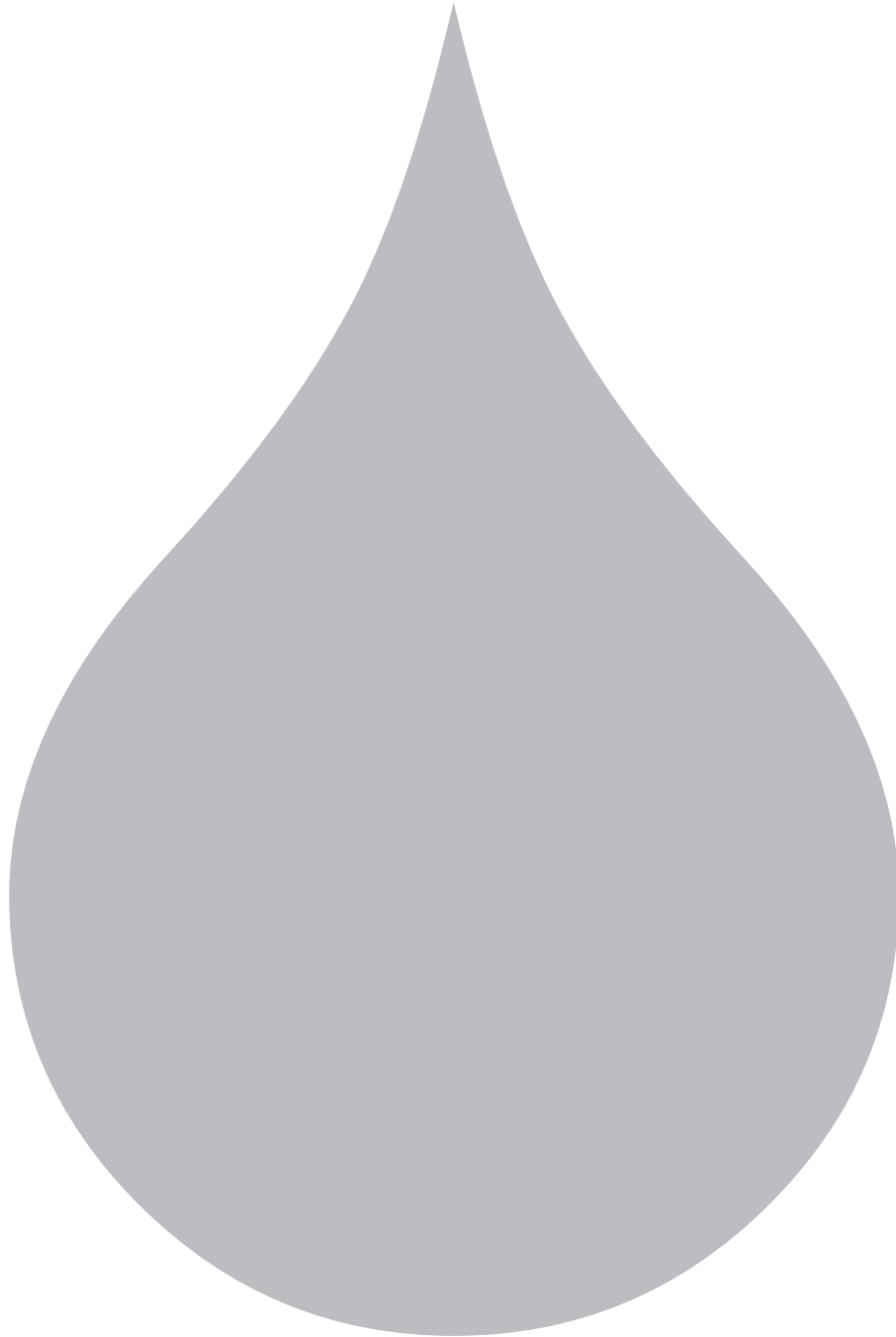


transpiration



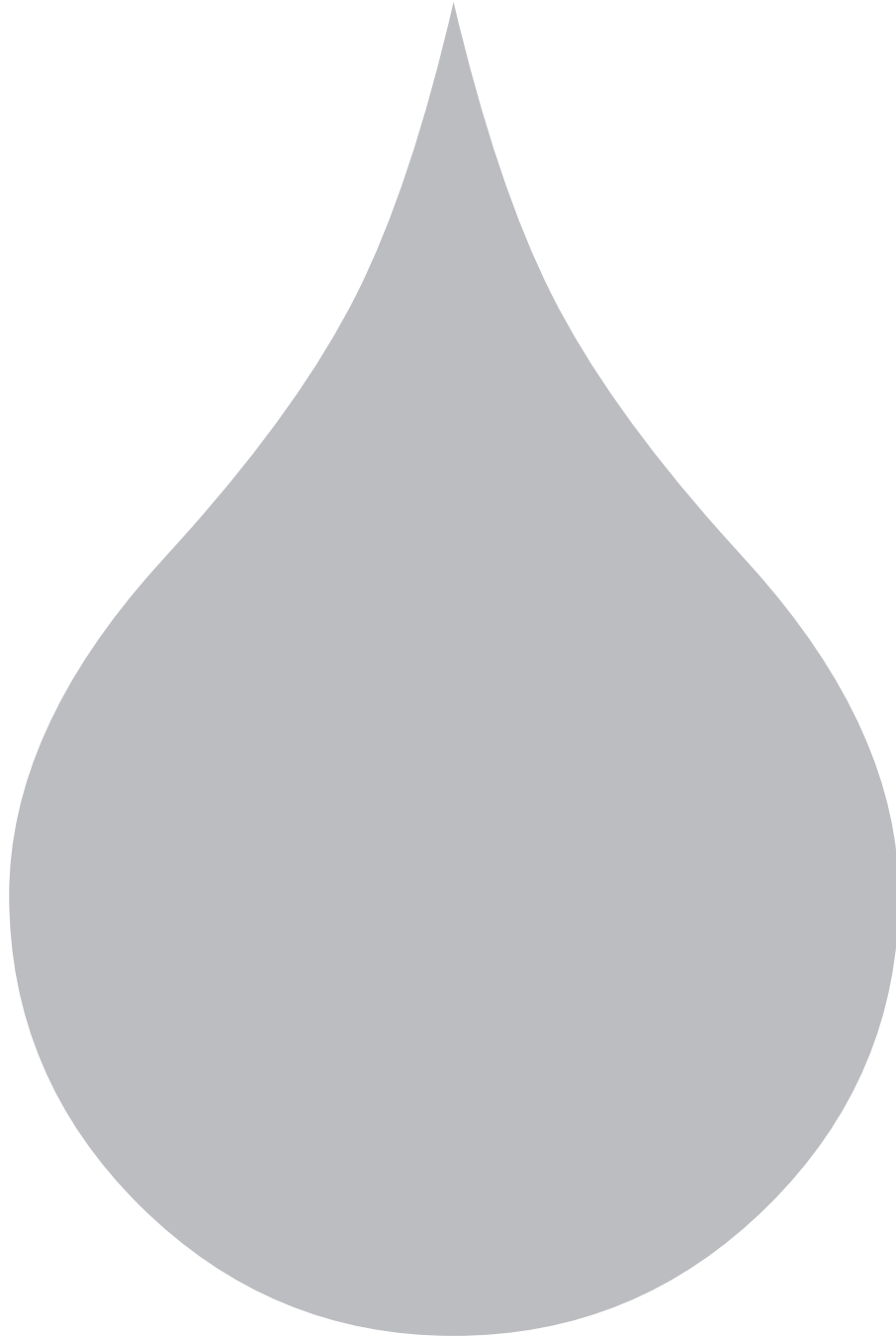


infiltration





surface runoff



Student Journal Page



1. A **WATERSHED** is all the **LAND** (from the ridgetop down to the bottom of the valley) that surrounds and drains to a creek, river, lake or other water body. Watersheds can be covered by trees or they can be filled with urban things like schools, homes, & roads. Most watersheds are a combination of both.

2. DATA GATHERED FROM THE FORESTED WATERSHED

Let's create a model watershed out of students and see how rain runs off the land in a forested watershed.

In a forested watershed I observed:

Total number of raindrops: _____
(the number of students minus the forest, creek, wetland)

Total number of raindrops that actually reached the creek:

Actual length of time for all the raindrops to reach the creek:

3. GATHERED FROM THE SUBURBAN WATERSHED

In a suburban watershed I observed:

Total number of raindrops: _____

Total number of raindrops that actually reached the creek:

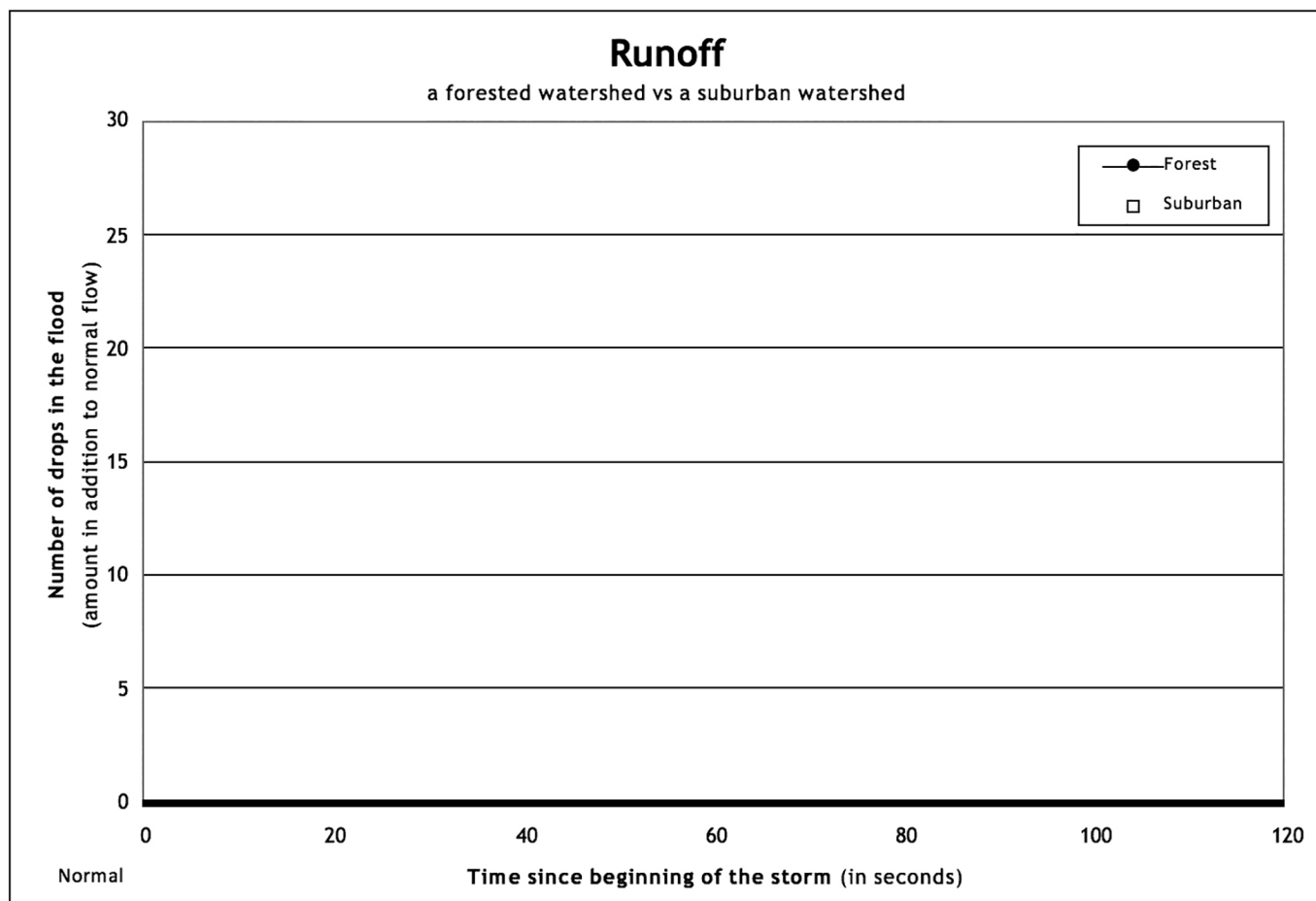
Actual length of time for all the raindrops to reach the creek:

LESSON 5 - FOREST RUNOFF VS URBAN RUNOFF



4. DISPLAY THE DATA USING A HYDROGRAPH

- hydro = _____ graph = _____
- Graph the data for the forested watershed:
 - Find the point on the graph where the number of raindrops that reached the creek intersects with the number of seconds it took for those raindrops to reach the creek.
 - Use a • symbol to show where this point is on the graph.
 - Draw a **solid** line that curves from 0,0 point on the graph (the bottom left corner), to the • point, and then back down to the bottom of the graph. Your line should be in the shape of an upside “U.”
- Graph the data for the urbanized watershed:
 - Find the point on the graph where the number of rain drops that reached the creek intersects with the number of seconds it took for those raindrops to reach the creek.
 - Use a □ symbol to show where this point is on the graph.
 - Draw a **dashed** line that curves from 0, 0 point on the graph (the bottom left corner), to the • point, and then back down to the bottom of the graph. Your line should be in the shape of an upside “U.”



- ## Drain Rangers Curriculum - Elementary

LESSON 6



Engineering Design and Define the Problem

Overview

Students will use all the information from the Stormwater Pollution Performance Task (Lesson 1), videos, and watershed model to define the stormwater runoff problem in their community.

Objectives

Students will:

- be introduced to Engineering Design as described in the Next Generation Science Standards
- come up with a statement about the stormwater pollution problem in their community
- determine things they need to know to research solutions to the stormwater pollution problem

Activities

Procedure:

1. Explain to students that they use Engineering Design to find and evaluate solutions to the stormwater runoff problems. Have them watch Video 6 from the FCD Website and/or Video 7 if you would like students to have more in depth information about engineering design.
2. Share with students the Engineering Design process. Use the Lesson 6 PowerPoint if you wish.
 - Define the problem
 - Research the problem
 - Understand stakeholders
 - Explore and compare (evaluate) possible solutions
 - Develop a plan
 - Implement the plan
 - Test and optimize the plan
 - Communicate

Science

Grades 3-5

Setting Indoors

Lesson 6 (45-50 minutes)

Materials

- ♦ Video 6 & 7
www.franklincd.org/drain-rangers
- ♦ Lesson 6 PowerPoint
- ♦ Student Journals

Vocabulary

Optimize

Stakeholders

LESSON 6



Engineering Design and Define the Problem

Teacher Note: These are the steps you will be going through with your students during Lessons 6-11. As students go through this process they will be using the practices of an Engineer. Remember the steps do not always happen sequentially.

Activities

Procedure:

- These steps have slightly different names than were shared in the video. Use the Lesson 6 PowerPoint provided to have students compare language.



Adapted from **Runoff: Special Report** <https://www.youtube.com/watch?v=3zmp4UXomaU> by Patricia Otto, Pacific Education Institute

- Explain that even though the video uses different words they are talking about the same process. The chart below is an example of sharing the differences in language

Engineering Design Terms in NGSS	Engineering Design Terms used in Video
1. Define the Problem	1. Identify
2. Research the Problem	2. Investigate
3. Explore and evaluate possible solutions	3. Imagine
4. Plan	4. Plan
5. Implement	5. Create
6. Test	6. Test
7. Optimize	7. Improve
8. Communicate	8. Communicate

Science
Grades 3-5
Setting Indoors
Lesson 6 (45-50 minutes)

Common Core ELA Standards

- R#4: Interpret words and phrases as they are used in text, including determining technical connotative, and figurative meanings, and analyze how specific word choices shape meaning and tone.
- R #7: Integrate and evaluate content presented in diverse media and formats including visually and quantitatively, as well as in words.
- S/L #1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly.



Engineering Design and Define the Problem

5. Explain to students that they will be working together (as individuals, teams, and as a class) on a project to improve the quality of stormwater runoff on their school campus or their neighborhoods. They will be planning the project using Engineering Design.

Define the Problem:

6. Tell students that they are going participate in Engineering Design as they evaluate solutions to stormwater pollution in their community. First, they need to define the problem. Instruct students to use the information they learned through the Stormwater Pollution Performance Task, the watershed model, and the four raindrops simulation, to define the problem facing their communities and write it in their journals. Students **may only** identify stormwater pollution as the problem and note that too much stormwater runoff is also a problem. Students' definitions should be similar to the following: *The problem is pollution in stormwater runoff (quality) and too much stormwater runoff (quantity).*
7. Post the Problem Statement up so everyone knows the problem they are going to help solve.
8. Ask students:
 - a. What actions can we take to encourage people to change their behavior to improve the quality and quantity of stormwater runoff in our community?
 - b. What actions can we take to improve the schoolyard to help decrease the pollution in stormwater runoff from the schoolyard?
9. Have students do a pair share of what they **already know** and continue their list on the back page of their journals of the sources of pollution in stormwater runoff and possible solutions that they remember from the information they have learned through this new video. Then make a class list under the Problem Statement.
10. Now have students list things they **still need to know and will need to research**.
11. Give students time to list things they already know and need to know in their Student Journals.
12. Tell students that they will be investigating the schoolyard system that they drew earlier to identify where water may be picking up pollution and flowing into storm drains and our aquifers, streams, rivers, and lakes.

Activities (continued)



Defining the Problem

1. Define the problem facing your community.

2. List things we already know about pollution in stormwater runoff.

3. List things we still need to find out about.

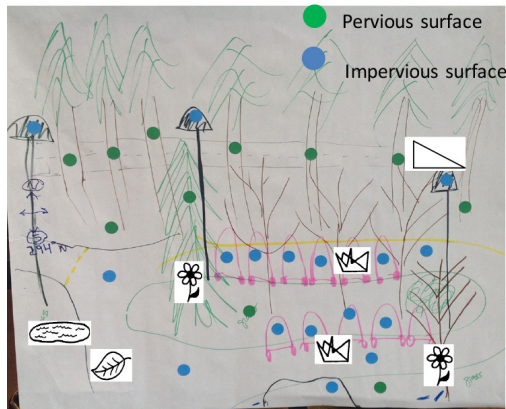
LESSON 7

Research the Problem



Overview

Students investigate (find evidence of) how water flows through their schoolyard including identifying pervious and impervious surfaces and possible quality and quantity stormwater runoff problems.



Next, identify features of stormwater runoff:

- Puddles 
- Pollution 
- Deposition of debris 
- Erosion 
- Plantings/good soil 

From Project WET -
Rainy Day Hike

Teacher Note: This lesson may be best when it is raining or after it has rained. This is also the perfect opportunity to bring in a community partner (informal educator from local government or non-profit) to help lead this lesson. These local experts will be able to point out and explain features on the schoolyard landscape.

Objectives

Students will:

- identify features in their schoolyard system that impact water flow and the collection of pollution in that system
- identify pervious and impervious surfaces on the schoolyard

Activities

Procedure:

Stormwater Runoff Schoolyard Survey- Looking for too much water (quantity) and pollution (quality) in the schoolyard that could impact stormwater runoff.

Science

Grades 3-5

Setting Outdoors

Lesson 7 (45-50 minutes)

Materials

- ♦ Lesson 7 PowerPoint with photos of pervious and impervious surfaces, and erosion and deposition
- ♦ Brick or piece of concrete and sponge (enough for small groups of students)
- ♦ 2-3 water bottles each with equal amounts of water for outdoor demonstration of pervious and impervious surfaces
- ♦ Schoolyard Stormwater Legend page (1 for every 2 students, laminated would work nicely)

Student drawings from Lesson 4: The Schoolyard as a System

- ♦ Clipboards and pens
- ♦ **Optional:** Sticky dots in 2 different colors

Vocabulary

Pervious
Impervious
Erosion
Deposition
Permeability

Research the Problem



1. Tell students that they are now **Researching the Problem**. Explain to students that they are going to do a survey of the site they visited before (Schoolyard System) in terms of stormwater runoff. They are going to look for evidence of how the water flows on the site, and evidence of pollution, and record those on their drawings of the schoolyard system.
2. Set-up a demonstration for the class to observe pervious and impervious surfaces. Review definitions of pervious and impervious surfaces, then, present students with a brick and a sponge. Tell them you will pour 5mL of water (approx. one tablespoon) onto each surface. Ask them to predict the behavior of the water. After pouring the water, ask them to identify which surface was pervious and which was impervious (adapted from the “My Place in Puget Sound” curriculum).
3. View Lesson 7 PowerPoint photos of pervious and impervious surfaces. Ask students to make inferences about where the water goes that hits impervious surfaces.
4. Now review the terms, erosion and deposition, using the Lesson 7 PowerPoint slides provided.
5. Give students the Schoolyard Stormwater Legend to use on their drawings. Colored sticky dots are nice to use for pervious and impervious surfaces.
6. Review the rules for going outside with students.
7. Take students outside and do a demonstration about pervious and impervious surfaces asking students to predict what will happen to the water when you pour it on 2-3 various surfaces (pavement, grass, mulch, bushes) that they will encounter on their section of the schoolyard.
8. Have students locate any storm drains in their site and add them to their diagram if they hadn’t already.

Science
Grades 3-5
Setting Outdoors
Lesson 7 (45-50 minutes)

Common Core ELA Standards

- ◆ R#4: Interpret words and phrases as they are used in text, including determining technical connotative, and figurative meanings, and analyze how specific word choices shape meaning and tone.
- ◆ W #7: Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.
- ◆ S/L #1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others’ ideas and expressing their own clearly.

Research the Problem



9. Have students use the Stormwater Legend to record evidence of the following:

- Pervious surfaces
- Impervious surfaces
- Erosion
- Deposition
- Puddles or soggy areas
- Litter or pollution
- Plantings and mulch that would slow water down
- Moving water

Teacher Note: the legend is in the journal, but may be easier to have it separate and laminated so students can refer to it when looking at the original drawing. Students also could put legend symbols on sticky dots ahead of time to just stick onto their drawings. Or, symbols could be numbered so students could put numbers on drawings for each legend item.

10. Back in the classroom, have students use the Schoolyard Stormwater Legend to add these features to their group drawing or class drawing, if they did one.

11. Debrief with students.

- Was there any evidence that you found today that surprised you?
- Describe where water went when it left your site.
- Where did you see the greatest absorption of the water?
- Where was there standing water?
- Did you find any sources or potential sources of pollution?
- What water ran over impervious surfaces? Did this water have a way to be cleaned by soil and plants or did it go directly into a drain?

12. Summarize by making a class chart with students of the possible stormwater runoff quality and quantity problems on their site. Have students record the possible problems in their journals.

13. Extensions:

- Use a campus map to have students identify stormwater runoff problems throughout the campus.

Research the Problem



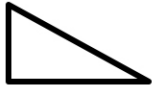





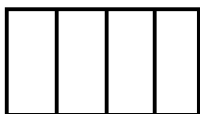


LIST OF FEATURES (evidence)
and their impact on stormwater runoff on the schoolyard campus

Feature	Impact of Stormwater Runoff



LEGEND

	Pervious surface
	Impervious surface
	Erosion
	Deposition of materials leaves, soil, twigs
	A puddle or soggy area shows where water collects.
	Unnatural materials, such as litter, oil, dog poop, and chemicals.-Pollution
	Plants and mulch to slow water down
	Water Flowing Direction
	Storm Drain



Understand Stakeholders

Overview

Students identify various people and groups (stakeholders) that are interested in stormwater. They will interview a stakeholder or analyze information from the web to understand this group's priorities and advice on what type of project they should do.

Objectives

Students will:

- identify stakeholders
- obtain information from a stakeholder (interview or website) to help plan and implement a stormwater project in their community

Teacher Note: Invite a stakeholder (possibly a person from your jurisdiction who works with stormwater) to visit the classroom or connect with the stakeholder that already visited your classroom. See the resources link. There is also a website option if a person is not available-see step 5 below.

Activities

1. Define *stakeholder* with the students: A stakeholder is a person or group that is interested in or has opinions about a problem—in this case, polluted stormwater runoff. Stakeholders are people who would be listed in response to the question: *Who cares?* Explain why it is important to find out what stakeholders care about (e.g., so we can do our project in a way that makes them happy—or at least doesn't raise objections!). Stakeholders can also help us identify solutions and constraints (limits) to what we can do with our project.

Science

Grades 3-5

Setting Indoors

Lesson 8 (45-50 minutes)

Materials

- ♦ Student Journals
- ♦ Drain Rangers Resource list
www.franklincd.org/drain-rangers

Vocabulary

Stakeholder

Understand Stakeholders



Activities

2. Remind students of all the people they have heard about being interested in stormwater. Have students generate a list of potential stakeholders related to their project to improve the schoolyard or neighborhood in terms of stormwater runoff. Start with pairs, then make a class list. Have students develop the list while also thinking about why those people/groups care. Here's a list of possible stakeholders:

- Teachers
- Students
- The Principal
- District staff
- The custodian
- Grounds crew
- Parents
- Landscapers
- Neighbors
- Homeowners
- Local businesses
- Developers
- City, county, and state stormwater/surface water management
- Local environmental groups
- Salmon

Science

Grades 3-5

Setting Indoors

Lesson 8 (45-50 minutes)

Common Core ELA Standards

- ♦ W #7: Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.
- ♦ S/L #1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly.

Understand Stakeholders



3. Tell students that _____ stakeholder is going to visit their classroom, and they need to have questions ready for their visit so they can find out ideas, criteria, and constraints for their project. Either have students generate their own questions or use some of the ones below.
 - How are you connected to this school?
 - Why do you care about stormwater runoff in our community?
 - What are the biggest challenges with stormwater runoff?
 - If you could ask every person to do just one thing about polluted stormwater runoff what would it be?
 - What are your top priorities for cleaning and reducing the polluted stormwater runoff in our community?
 - If you were to recommend an outreach project for us that would influence people's behavior choices what would it be? What outcomes (criteria) would make this type of project successful? How could we measure the success of that type of project? What are some of the limits (constraints) for such an information campaign?
 - Is there an easy project (under \$200) to reduce stormwater runoff in the schoolyard that you would recommend? How would we measure the success of this project? What might be a challenge for this type of project?
 - Are there other projects you would recommend for this school site if we had more time and/or money? Any criteria or constraints this project must meet? What challenges are there for this type of project?
 - Are there any concerns you have about changes to this site?
 - Could your organization help? If so, what skills do you have that could help the project?
4. Before the speaker comes, have students come up with informational introductions telling the speaker what they know about stormwater and why they want to do a project that either reduces stormwater runoff from the schoolyard or changes behavior in community members to stop pollution at its source.
 - 1-2 students could read their Performance Task essay.
 - Students could develop a brief statement about wanting to do a project.
5. **Website option:** Students look up their local stormwater/surface water utility or agency and find the answers to questions above. Or use the Franklin Conservation District website <http://www.franklincd.org/stormwater>

Some of these questions might need to change, such as:

- What behavioral changes does the website ask citizens to make?
- What sorts of projects does the website recommend?
- Does the website share any goals it might have for managing stormwater runoff?

Understand Stakeholders



Stormwater Runoff - STAKEHOLDER LIST

Stakeholder	Why they care

NOTES on the Stakeholder Visit



How are you connected to this school?

Why do you care about stormwater runoff in our community?

What are your top priorities for cleaning and reducing the polluted stormwater runoff in our community?

If you were to recommend an outreach project for us that would influence people's behavior choices what would it be? How could we measure whether people's behavior changed?

Is there a project to reduce stormwater runoff in the schoolyard that you would recommend? How would we measure the success of this project? What might be a challenge for this type of project?

Are there any concerns you have about changes to this site?

LESSON 9

Explore and Compare Possible Solutions



Overview

Students explore and compare multiple solutions to the stormwater runoff problem in their community that will reduce pollution in stormwater runoff.

Objectives

Students will:

- explore multiple solutions to the polluted stormwater runoff problem in their community
- evaluate multiple solutions in their community that will reduce pollution in stormwater

Teacher Note: At the end of this lesson the class decides whether they are going to do a pollution prevention outreach solution or a schoolyard solution. Outreach solutions proceed to lesson 10A and schoolyard solutions proceed to lesson 10B.

Activities

Procedure: Create a Possible Solutions list

1. Tell students that they are going to explore and compare solutions to reduce pollution in stormwater runoff.
2. Have them review the Pollution and Solutions list they created during the past lessons at the back of their journals for sources of pollution and possible solutions. Have students add any other ideas they have.
3. Review student project options: a community outreach solution(s) to encourage people to change their behavior (this is pollution prevention); or a schoolyard solution(s), or both.

Teacher Note: Students will pick the topic to explore in this lesson. They will determine the best method (brochure, poster, etc. in lesson 10).

4. Share the Lesson 9 PowerPoint of Possible Solutions. Add any other solutions they came up with.

Teacher note: This is a great opportunity to connect with local governments if they didn't do so in Understanding Stakeholders, to learn more about support and/or materials.

Science

Grades 3-5

Setting Indoors

Lesson 9

(two 60 minute classes)

Materials

- ♦ Lesson 9 PowerPoint of Possible Solutions
- ♦ Drain Rangers Solution Pages
- ♦ Student Journals
- ♦ Local Utility Contacts
<http://www.franklincd.org/drain-rangers>

Common Core ELA Standards

- ♦ S/L #1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly.

Explore and Compare Possible Solutions



Pollution Prevention - Community Outreach Solutions

Informational outreach to influence behavior choices: brochures, videos, posters, website etc. to inform and convince people in the community to change behavior (The class could do more than one of these behaviors)

- Cars:
 - Fix that leak
 - Use car wash
- Natural Yard Care:
 - Limit fertilizers, herbicides, and pesticides
 - Plant trees and/or native plants
 - Improve Soils with compost
- Pets: Scoop the poop
- Pick up litter

Schoolyard Solutions

(several items are in both columns):

- Planting trees and/or native plants
- Improving soils
- Rain gardens
- Disconnect downspouts
- Rain barrel or cistern
- Porous pavement

5. Use a jigsaw strategy for students to learn about the various solutions. Separate the class into groups of 3, giving each group of students one of the solutions on which to become an expert. Tell students to fill out one row of the Possible Stormwater Solutions Table.

Teacher note: You may change the group size so that fewer solutions are explored.

6. Students could present their solution to the whole classroom or do the modified jigsaw activity described here:
 - Instruct students that they will need to talk with someone who had a pollution prevention outreach solution and someone who had schoolyard solution.
 - A student finds a student who explored a different solution. Each student shares their solution information and both students record their information on their table.
 - Students do a 2nd round of sharing and recording. This time they need to find someone who had the opposite type of solution (pollution prevention or schoolyard pollution). Now students have learned about 3 solutions.
7. List all the possible solutions on the board.

Narrow the solutions list to 3 or 4.

8. Next, as a class have students narrow their list to 3 or 4 possible solutions for their Community Outreach or Schoolyard Solutions.

Explore and Compare Possible Solutions

**Procedure: Compare Solutions**

9. Once the class has narrowed the solutions to 3 or 4, have students compare those 3-4 solutions using the Evaluating Possible Solutions Table in their journals for whether or not they could do the project in the community outreach or schoolsite.
 - Students will need to get the information on those solutions from those students who were experts. Rearrange groups of students so one student from each possible solution is in a group or have those students present their solutions to the whole class and students take notes.
-

Teacher Note: the class could develop their own table with their own headings.

10. Tell students for any of the solutions that there are constraints or limitations such as money, time, people needed, etc. In order to decide on difficulty level (constraints), have students think about the Possible Stormwater Solutions sheet and Evaluating Possible Solutions Table. Ask the following questions:
 - How much time would it take? Could I start tomorrow?
 - What materials do I need?
 - Do we need to get people's permission to start or post posters, website, etc? How easy are they to contact?
 - What is the cost?
 - Do we need parent volunteers?
 - Do we need computer time?
 11. Upon completion of the Possible Solutions Table, have students work together to compare and rank the different solutions, considering different criteria such as feasibility and student interest along with impact on pollution in stormwater runoff.
 12. Facilitate a process for students to collaborate as a class, discussing and deciding upon the best possible solution(s) for the problem (reducing pollution in stormwater runoff on school campus or community). After discussion, the class should vote or reach consensus by combining several possible solutions.
 13. Since it will be the focus of the actual project, a Solution Statement should be clearly written and posted on the wall with the Problem Statement.
-

Teacher Note: At end of this lesson the class should have decided whether they were going to do a pollution prevention outreach solution or a schoolyard solution. Outreach solutions proceed to lesson 10A and schoolyard solutions proceed to lesson 10B.



Possible Stormwater Solutions

Polluted stormwater runoff solution	Description of solution	How does this solution reduce pollution in stormwater runoff?	What resources do you need to complete this solution (time, money, materials, other people, etc.)?
Pollution Prevention: Informing people to influence behavior choices			
Schoolyard solution			
The solution my group researched			



Evaluating Possible Solutions Table

What is the solution?	Benefits – How will this solution prevent pollution in stormwater?	Drawbacks (high maintenance, high cost, difficult to install, needs school district OK, etc.)	What would the stakeholders (students, city, teachers, neighbors, etc.) like or not like about this project?	What is the cost and difficulty level of this project?	Can you <i>really</i> do this project? (circle one)
				Cost: Difficulty:	No Maybe Yes
				Cost: Difficulty:	No Maybe Yes
				Cost: Difficulty:	No Maybe Yes
				Cost: Difficulty:	No Maybe Yes

Pollution Prevention Outreach



Overview

Students develop the steps to their schoolyard solution project plan including whom to contact, people who can help, how this helps solve the problem, and materials they will need. Before implementing their plan students develop a method to test their solution, or how they will measure if their solution was successful. Students implement their plan following the steps they outlined, and then test their solution using investigations and/or models.

Objectives

Students will:

- plan steps for their solution project
- create outreach materials sharing a message of stormwater pollution prevention
- plan how they will test their outreach solution using surveys or other feedback
- implement the test of their solutions

Solutions: Pollution Prevention Outreach

Develop a Plan and Create Pollution Prevention Materials

1. Tell students that since they have chosen to prevent pollution in stormwater runoff by providing information to change personal behaviors of others in their community, they now need to plan an outreach product such as a brochure, website, poster, presentation, etc. to use to reach out to their audience. Explain that this is a campaign to get people to do something positive for the watershed in which they live.
2. Ask students if they are familiar with any ad campaigns that try and get people to do something. Purchase a specific product would be one, but students may have heard of behavior change campaigns to stop bullying, or prevent forest fires, “litter and it will hurt,” etc.
3. Decide ahead of time or have the class decide whether they will do a poster, website, brochure, presentations, skits etc. In groups, let them choose which problem from the Solution Pages they will choose and which part of each solution they will address in their pollution prevention education campaign.

Science

Grades 3-5

Setting Indoors

Lesson 10a (2-3 classes)

Materials

- ♦ Drain Ranger Solution pages
- ♦ Student Journals
- ♦ Materials for Pollution Prevention Outreach

Pollution Prevention Outreach



4. Have students read over the Outreach Tip sheet, and turn and talk with their neighbor about the information.
5. Go over the two planning sheets with students. Have students choose a pollution prevention topic they wish to address to prevent pollution in stormwater runoff at the source (solve the problem) using the Stormwater Project Planning Worksheet.
6. Next, have students use the graphic organizer to plan the message they will present.
7. Finally, students get to create webpages, brochures, presentations, skits, PowerPoints, Posters, etc.

Design a Test

1. Discuss with students that they will need to know if their outreach efforts actually were successful in changing their audience's behavior. Explain that in order to know whether or not their campaign is successful, they will need to test how well their outreach worked.
2. In developing the test, students need to consider what behavior or knowledge changes they want (criteria) and use questions or otherwise measure the audience's responses that will address if their project reached its behavior or knowledge goal.
3. Share these three ideas of what students could do to test their Pollution Prevention Education Campaign:
 - a. Students create a card or web page that would ask those who saw posters, brochures, presentations, website etc. to now commit to a personal action. Students could tally the responses to count how many people were persuaded by their outreach materials. See example of "Make Your Mark: Personal Action Plan".
 - b. Students could create a before and after survey of polluted stormwater runoff knowledge.
 - c. Students could create or use a "Looking Back Survey" if they do a presentation or skit for their outreach. See example of Looking Back Survey.

Science

Grades 3-5

Setting Indoors

Lesson 10a (2-3 classes)

Common Core ELA Standards

- ♦ S/L #1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly.

Pollution Prevention Outreach



Design a Test (continued)

4. Ask students if they have any other ideas and include them in a list.

If students use surveys:

1. Students could use their surveys immediately with their larger audience or they could pilot their survey by presenting their campaign to parents or other classes and then giving the parents/classes the survey. Piloting their campaign and survey would allow students to optimize (improve) their solution (campaign).
2. After developing their surveys, students should make any changes to their solution plan from insights/feedback they obtained from the surveys.

Implement Plan and Test the Solution

1. Now students implement their pollution prevention outreach campaign by distributing their educational materials (posters, advertising the website, doing presentations etc.) as planned.
2. Students test their solution by using the surveys, pledge cards, pre-post tests, etc., they created to collect data on whether their pollution prevention outreach was successful.

Science
Grades 3-5
Setting Indoors
Lesson 10a (2-3 classes)

Pollution Prevention Outreach



TIP SHEET!

Stay positive.

Combatting pollution will take time and energy from everyone. Remember to be optimistic!

Be friendly.

No one is hurting the environment on purpose. Help others understand and find motivation to change.

Consider your audience.

Your message might need to change depending on who is listening.

Tell people why it's important.

Show how their actions impact themselves, their environment, and their communities.

Tell people what they can do.

Advise on how to improve, not on what is being done wrong.

Use visuals and models.

Seeing is believing - a picture is worth a thousand words. Help your audience visualize the problem.

Test your message.

What's working? What isn't? Be flexible and test your message with classmates, teachers, and family.



Stormwater Project Planning Worksheet

What Personal Behavior are you trying to change?

What might be the something keeping people from changing their behavior?

Who is your audience?

What does your audience need to know, and how will you convince them to change?

Who do you need to contact? (examples: for distribution of posters, arranging presentation, hosting website, etc.)

What tools and materials do you need? (pens, markers, paint, computer, etc.)

How will you know your project worked?



BASIC INFORMATION AND POSITION

(Solution description and behavior you are trying to change?)

REASONS

(What do they need to know and what's in it for them to change behavior?)

SUPPORT

(Facts, examples, quotes...)

CONCLUSION

(Restate your position in a different way.)



Pollution Prevention Outreach

Sample of pledge card students could develop:

Make Your Mark
Personal Action Plan



Plant native trees,
Shrubs and other
Plants

Properly dispose
of pet waste

Do not feed birds
and ducks when
visiting parks

Fix car oil leaks

Reduce lawn
chemicals

Use natural
fertilizer & limit
synthetics in your
yard

Wash car at
carwash or on lawn

Install rain
gardens

Clear storm drains

Do not put
anything down
storm drains

Pollution Prevention Outreach



Example of a Looking Back Survey

Project: _____ School: _____

Grade: _____ Teacher: _____

Read each sentence below and circle the ONE answer that best fits:	BEFORE PARTICIPATING in the stormwater project (THEN)	AFTER PARTICIPATING in the stormwater project (NOW)
1. I know that urban stormwater runoff is the major cause of pollution in our aquifers, rivers, lakes, and streams.	1. Strongly agree 2. Agree 3. Neither agree nor disagree 4. Disagree 5. Strongly disagree	1. Strongly agree 2. Agree 3. Neither agree nor disagree 4. Disagree 5. Strongly disagree
2. I know about the main groups or people (the stakeholders) who care about the stormwater runoff.	1. Strongly agree 2. Agree 3. Neither agree nor disagree 4. Disagree 5. Strongly disagree	1. Strongly agree 2. Agree 3. Neither agree nor disagree 4. Disagree 5. Strongly disagree
3. I can help solve the stormwater pollution problem through my everyday actions such as scooping my pet's waste, fixing car leaks, fertilizing with natural compost.	1. Strongly agree 2. Agree 3. Neither agree nor disagree 4. Disagree 5. Strongly disagree	1. Strongly agree 2. Agree 3. Neither agree nor disagree 4. Disagree 5. Strongly disagree
4. I want to do something to help and protect the environment through solving the pollution stormwater runoff problems.	1. Strongly agree 2. Agree 3. Neither agree nor disagree 4. Disagree 5. Strongly disagree	1. Strongly agree 2. Agree 3. Neither agree nor disagree 4. Disagree 5. Strongly disagree

TURN OVER THIS PAGE 

Pollution Prevention Outreach



1. List two ways stormwater runoff becomes polluted in your community.

2. Describe two ways you can keep the stormwater clean.

Thank You for filling out this survey!!

Schoolyard Solutions



Overview

Students develop the steps to their schoolyard solution project plan, including whom to contact, people who can help, how this helps solve the problem, and materials they will need. Before implementing their plan students develop a method to test their solution, or how they will measure if their solution was successful. Students implement their plan following the steps they outlined, and then test their solution using investigations and/or models.

Objectives

Students will:

- plan steps for their schoolyard solution project
- plan how they will test their solution using investigations or models
- implement the class solution plan following the steps outlined
- implement the test of their solution

Solutions to Decrease Stormwater Pollution: Schoolyard

Develop a Plan

1. Guide students to work collaboratively in teams to design a Project Plan. Students may need to research and gather additional information from books, web resources, and teacher-developed materials.
2. As they determine and record the project details on the Stormwater Project Planning Worksheet students will include the following:
 - process
 - materials needed
 - limitations/possible challenges
 - test of the solution
 - short term and long term maintenance
 - contacts (both for approval and assistance)

Science

Grades 3-5

Setting Outdoors

Lesson 10b (2-4 classes)

Materials

- ♦ Drain Ranger Solution pages
- ♦ Student Journals
- ♦ Materials for implementation of plan
- ♦ Materials to test the solution
- ♦ Video 8
<https://www.franklincd.org/drain-rangers>

Schoolyard Solutions



Teacher Note: The students can also determine costs and potential timelines, if desired. Otherwise, the teacher will need to organize and plan those aspects of the project, sharing them with students during the development of the Master Plan in the next step.

3. Once teams have completed their plans, facilitate a whole class discussion and/or have students share their plans. Then compile a project plan for the whole class, or Class (Master) Plan, soliciting input from all teams.

Teacher Note: A blank digital or paper copy of the Stormwater Project Planning Worksheet can be projected onto the board and used to create the Master Plan. (In other words, the Master Plan is the compilation of the different student teams' Project Plans.)

Design a Test

1. Watch Video 8: Drained - *Urban Stormwater Pollution*. Discuss how the researchers at WSU tested whether or not rain gardens were working. Emphasize that they used a model.
2. Brainstorm with students about how they will know if their schoolyard solution is successful. Ask students, "How will you know if your project is actually successful in reducing the amount of stormwater runoff or pollution in stormwater runoff? What sort of "test" could you use? Explain that students could either directly investigate their solution or they could build a model as the WSU researchers did in the video to show how their solution plan worked.

Science
Grades 3-5
Setting Outdoors
Lesson 10b (2-4 classes)

Common Core ELA Standards

- ♦ R #7: Integrate and evaluate content presented in diverse media and formats including visually and quantitatively, as well as in words.
- ♦ S/L #1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly.

Schoolyard Solutions



Examples for testing solutions through investigations.

Students could do pre/post investigations or with and without investigations.

- Test how rain gardens work through models: <http://www.pugetsoundstartshere.org/DrainRangers.aspx>
- Test an area for erosion or deposition before and after planting on a slope or measure an area with and without plantings.
- Sogginess-Footprint test for soil saturation, or other before and after, or on similar sites with and without the solution.
- Puddle sizes before and after solution.
- Test water absorption rates, where student could pour the same amount of water in an area and compare the time to absorb (or amount that runs off) before and after.
- Measure roof's surface area and calculate or measure how much rainwater plantings/rain garden or cistern/rain barrels are intercepting. (Or just use area to express improvement- the amount of raining falling on sq. feet is now collected/absorbed).
- For Tree plantings go to www.treebenefits.com to find out how much water your tree(s) intercepts today and as it grows.
- Observational data such as water flowing over gutters, flooding in surrounding areas, or play fields no longer soggy.
- Test permeability of soils before and after improvement-Soils as Sponges.
<http://www.pltwa.com/soils-as-sponges-fi-and-assessment.html>

Examples for testing solutions through models.

Students create a model and use the information either to show their solution was successful or to improve (optimize) their solution.

- Model of soil columns and how they filter pollution in stormwater-see example Soil Columns as Models.
- Model soil and plantings by using plastic buckets, putting a pipe in the bottom; then layering gravel, rock and mulch, then putting in some plants.
- Stream table model or watershed model with and without plantings or with and without larger rocks to show effects on erosion and using plantings or rocks as the solution.
- Model of a green roof and planning an urban community
http://eie.org/sites/default/files/dont_runoff_2014_01.pdf,
http://eie.org/sites/default/files/engineeringnotebookdontrunoff2014_1.pdf

Schoolyard Solutions



Design a Test (continued)

3. Students plan the test of their solution including their question, materials needed, data tables created.

Teacher Note: students could build a model before they implement their solution and that model information could inform their solution plan and help them optimize (improve) their solution. Students would then use data from their test of the model to improve their plan. For example: investigating soil columns' ability to absorb water could be used to inform the plan for types of soil to use for a rain garden or soil improvement solution.

Implement Plan and Test the Solution

1. Students implement their Schoolyard Solution plan to decrease pollution and/or quantity of runoff in their schoolyard using the steps of the class master plan.
2. Students test their solution by either investigating or using a model to show whether or not their plan was successful.

1. What is the solution (include location in the schoolyard)? How will it help solve the stormwater problem?

2. What tools and materials do you need?

3. What are the major steps to this project?

Schoolyard Solutions



4. Who do you need to tell about your project before you begin?

5. Who might be able to help with the project? How would they help?

6. What could prevent the project from getting done (barriers)?

7. Does anything need to be done to make sure your project keeps working now and in the future? If so what needs to be done and who is going to do it?

8. How will you know if your project is successful?



Soil Columns as Models

These columns model the natural absorption of pollution in stormwater runoff by plants, soils, and rain gardens.

From Stormwater Curriculum, Tahoma School District

Materials: 4 clear plastic cups per group, 3 cups clean sand, 3 cups gravel, 1 paper towel sheet per group, push pins, 1 large bucket of water, 2 cups soil, ruler, sharpies

Model for testing plantings, soil enhancements, or rain gardens

1. Rain gardens and pervious concrete models: <http://www.pugetsoundstartshere.org/DrainRangers.aspx>
2. Watch Video 8 - Drained: Urban Stormwater Pollution. Have students respond to the question, “What did the researchers do to test if rain gardens were working?”
3. Tell students that they will make water filters today to **model** how water is cleaned when it goes into the ground of native plantings, soil improvements, and rain gardens, rather than directly flowing into our rivers and streams.
4. Model how to make a water filter by using clear plastic cups, clean sand and gravel and soil. In the bottom on one of the cups poke holes with the push pins.

Teacher Note: You will probably want to make the cups with the holes for everyone.

5. Lay a circle of paper towel in the bottom of the cup. Add 1 inch of gravel and 1 inch of sand. This is the soil column filter. Explain that this is like the mulch, soil and plant roots that were used to construct in the planting or rain garden. The mulch is the first filter for the water entering the rain garden. Then the water soaks through the soil and in between the plant roots. The water infiltrates this soil, absorbing pollutants in the process.
6. Use another cup as the reservoir and fit the first cup inside. Mix water and the dirt in one cup. In our model, the dirt represents pollutants like oil, dog poop, and lawn chemicals. Dirt can also be a problem because the dirt may smooth over salmon eggs. Pour the dirty water back and forth between the two remaining cups to mix it and to talk about pollutants.
7. Next, pour the water slowly through the filter. Watch the clarity of the water as it comes out of the filter and into the cup. The filter is catching particles of dirt and cleaning the water. Pour the “cleaned” water through the filter several times to see the effect on removing pollutants continues.
8. Now have students make their own soil columns and filter the “dirty” water.
9. Ask students to talk in their groups about how the water was cleaned. Discuss how the soil and plantings, mulch, or rain gardens act as filters for pollutants that are in stormwater; pollutants like oil, dog poop, and lawn chemicals.



Overview

Students will evaluate their solutions by analyzing the data from surveys, models, and other tests they used. Students will then discuss improvements to their project (optimize), reflect on their accomplishments, and communicate their accomplishments in some way to the school or the community.

Objectives

Students will:

- analyze data from surveys, models, or other test to evaluate their solution
- discuss ways to improve their stormwater pollution project
- reflect on their accomplishment
- communicate their project in some way or put their project on a website

Activities

Procedure: Test the Solution – Analyzing Data and Improvement to Solution

1. Have the class analyze data from the surveys and/or models to test their solution.
2. Have students record the data and create graphs and/or charts to communicate the information on *Testing the Solution* page.

Teacher Note: Graphing website given for ideas for working with graphs with students

3. Have students construct explanations and/or summaries of their results on the *Testing the Solution* page.
4. Students then reflect on how their test could be improved.
5. Let students know that engineers continually improve (optimize) the solutions to problems. Do a think, pair, share with students to discuss what they could have done to improve their solution to the polluted stormwater runoff problem. What did they learn about engineering from testing their solution?

Science

Grades 3-5

Setting Indoors

Lesson 11 (45-50 minutes)

Materials

- ♦ Data collected
- ♦ Student Journals
- ♦ Graphing Skills websites:
http://harvardforest.fas.harvard.edu/sites/harvardforest.fas.harvard.edu/files/publications/pdfs/Colburn_Schoolyard%20Graphing%20Manual_2009.pdf
<http://harvardforest.fas.harvard.edu/sites/harvardforest.fas.harvard.edu/files/data/k12/Colburn%202009%20Graphing%20Exercises.pdf>

Vocabulary

Optimize



Reflect on Accomplishments

1. Have students reflect on the project using the *Project Summary* page.
 - Who are the team members that you worked with to complete this project?
 - What is the Problem that you worked to solve?
 - Why is this Problem important for your school and the surrounding community?
 - Who were the stakeholders or people that you worked with? What did they do?
 - What are two or three of the most important things that you learned about stormwater runoff and your schoolyard and community?
 - i. What did you enjoy about the project?
 - ii. What did you do well during the project?
 - iii. What was difficult or not enjoyable about the project?
 - iv. What could you do better during the next project?

Communicate to Others

1. Have students communicate to others in the school or community.

Here are some ideas:

- Students could rewrite their essays from the ELA Performance Task.
- Students could highlight their project on a project website.
- Students could write an article for the school newspaper.
- Students could write a blog or develop a website.
- Students could develop posters about their projects to be displayed in the school hallway and/or at an evening school event—perhaps a school science fair, a choir concert or class play, etc.
- Students could contact local jurisdictions and ask if their results could be posted on that jurisdiction’s website.
- Student results could be posted at the local library and/or community center.
- Students could share their project with local media or a letter to the editor.
- Students could be presenters at a local event and share their project with attendees.

Science

Grades 3-5

Setting Indoors

Lesson 11 (45-50 minutes)

Common Core ELA Standards

- ♦ R #7: Integrate and evaluate content presented in diverse media and formats including visually and quantitatively, as well as in words.
- ♦ S/L #1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others’ ideas and expressing their own clearly.



Testing the Solution

Results of tests and/or surveys:

Explanation or Summary of Test Results:

How could this survey, model, test be improved?



Solution for Polluted Stormwater in My Community

Ideas on improving my solution:

More ideas after talking with my neighbor:

More ideas after hearing the class discussion:



Project Summary

Who are the team members that you worked with to complete this project?

What is the Problem that you worked to solve?

Why is this Problem important for your school and the surrounding community?

Who were the stakeholders or people that you worked with? What did they do?

What are two or three of the most important things that you learned about stormwater runoff and your schoolyard and community?

What did you learn about engineering by implementing this project? What skills did you use?



Glossary of Stormwater Terms

Aquifer: An area where water is stored under the ground, in the soil. When rain water soaks into the ground, it can fill an aquifer. This underground water is called groundwater (see definition below). This water can then be withdrawn for human use through wells and springs.

BMP: This stands for Best Management Practice. A Best Management Practice is a behavior or action that a person performs that protects the health of the environment.

Deposition: The process where sediment, soil, and rocks are moved and collect on another part of the landscape.

Detention pond: A small, man-made pond that collects the rain water that runs off of hard surfaces in developed areas, such as streets and buildings. The detention pond temporarily stores this rain water and releases it gradually back into the environment, usually over a few hours or days.

Dry Well: A drainage pit lined with loose stonework for the leaching of liquid wastes.

Erosion: The carrying away or displacement sediment, soil, rock, and other solids, usually by wind, water, or ice by down-slope movement in response to gravity or by living organisms. (OSPI)

Evaporation: The process where water becomes a gas (vapor) from a liquid.

Filtration: A process where water moves slowly through the soil, removing pollutants that are in the water.

Groundwater: the water found underground in the cracks and spaces in soil, sand and rock. Groundwater is found in aquifers. (groundwater.org)

Habitat: An ecological or environmental area that is inhabited by a particular species. It is the natural environment in which an organism lives or the physical environment that surrounds a species population. (OSPI)

Headwaters: The area where a creek, stream, or river begins - the source of that waterway.

Impervious surface: A type of land or ground covering that is hard and prevents rain water from soaking into the soil. Common impervious surfaces include, but are not limited to, roof tops, walkways, patios, driveways, parking lots, buildings, concrete or asphalt paving, gravel roads, and hard-packed dirt.

Infiltration: A process where water moves slowly through the soil.

Model: In science models are used to represent a system. They can be diagrams, physical replicas, mathematical representations, analogies, and computer simulations. (Next Generation Science Standards- Appendixes).

Native Plants: Plants that occur naturally in a certain region and are adapted to that climate.

Nonpoint source (NPS) pollution: A type of water pollution which occurs when rain runs off farmland, city streets, construction sites, suburban lawns, roofs, and driveways before entering the waterway. This is pollution that does not come from a single source, or point. Instead, this pollution comes from many different sources, and is collected as rain water runs over the surface of the land.

Optimize: Improving a design to make the design function better, cost less, be more efficient or other criteria. This involves trading off less important features for those that are more important. (Next Generation Science Standards- Appendixes)



Pervious Surface: A type of land surface that allows water to soak in.

Pollutant: A substance introduced into an environment that has undesired, harmful, or destructive effects on organisms and/or resources in the environment. (EPA)

Polluted stormwater runoff: The byproduct of stormwater runoff and the pollutants in the environment through which it runs. Pollution makes the stormwater unclean and harmful to the organisms in the waterway.

Retention: The process of collecting and holding storm water runoff.

Riparian: Describes the area of land directly next to river, lake or other body of water, such a shoreline or river bank.

Rain Garden: A garden with spongy soils and plants which is used to collect and filter stormwater.

Stakeholder: Individuals or groups with interests related to an issue or outcome.

Storm drain system: The system of gutters, pipes, streams, or ditches used to carry surface and storm water from surrounding lands to rivers, lakes, or the Puget Sound.

Stormwater: is precipitation (rain, snow, or hail) and ice melt. Stormwater can soak into the soil (infiltrate), be held on the surface and evaporate, or runoff and end up in nearby streams, rivers, or other water bodies.

Stormwater Engineer: A person who designs solutions for problems created by too much surface water runoff and pollution in stormwater.

Stormwater Runoff: Water from rain, or other precipitation, that is not absorbed into the ground. Instead, the water runs off the surface of roofs, streets and lawns and enters natural waterbodies, such as rivers, lakes and Puget Sound, either directly or through storm drains. Also see definition of runoff above.

Surface water: Water found about the land, including oceans, estuaries, lakes, rivers, streams, and ponds.

Surface Runoff: Water from rain, or other precipitation, that is not absorbed into the ground. Instead, the water runs off the surface of roofs, streets and lawns and enters natural waterbodies, such as rivers, lakes and Puget Sound, either directly or through storm drains.

Swale: A shallow, line-shaped depression in the ground, like a canal, that can collect water. Swales can be man-made and are usually less than 30 cm deep.

Transpiration: The process by which water evaporates from plant tissues.

Toxic: Poisonous or otherwise directly harmful to life.

Water Filter: A device to remove pollutants or unclean substances from water.

Watershed: The entire land area from which water drains into a particular surface water body.

Wetland: An area covered by shallow water most of the time, where vegetation grows that is adapted to the wet conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.



Solution Pages to Follow

Problem: Runoff from Agriculture

Solution: Keep Runoff from Waterways



Lack of vegetation on streambanks can lead to erosion. Overgrazed pastures can also contribute sediment to local waterbodies. Using too much fertilizer and pesticide can cause those chemicals to be carried to streams harming aquatic organisms and causing algae blooms. Livestock in streams can pollute waterways with bacteria making them unsafe for human contact.

Solutions:

- Plant the banks of waterways
- Keep livestock away from streambanks
- Store and apply manure away from waterbodies
- Move animals regularly to graze different areas to prevent soil erosion
- Apply fertilizers and pesticides according to best practices to reduce pollution, visit www.onlyraindownthedrain.com/agriculture

WATER QUALITY BENEFIT

Planting vegetation along waterways allows water runoff to soak into the ground. This filters out pollutants and stops sediment from reaching the stream making the water cleaner and clearer for aquatic organisms. Keeping livestock away from waterways reduces harmful bacteria getting into waterways along with reducing the sediment entering the waterways. Storing and applying manure away from waterbodies also reduces harmful bacteria from getting into the waterways. Overgrazing an area leads to sediment getting into waterways. Moving animals regularly allows vegetation to grow and prevents soil erosion.



CONSIDERATIONS

Cost - The cost of planting vegetation along waterways will vary, but once established plants will continue to help filter runoff and clean water. Keeping livestock away from waterways could put some areas off limits decreasing pasture area. Applying fertilizers and pesticides according to best practices should save the amount of chemicals needed and therefore lower costs.

Time needed - Depends on options chosen.

Maintenance - Keeping livestock away from waterways requires continued monitoring. Moving livestock regularly requires a schedule and people to move the animals. Vegetation along streams would need to be maintained properly.

Materials needed - Plants to vegetate waterways, a location to store manure away from waterways, fertilizers, and pesticides.

MORE INFORMATION: To learn more about what you can do to prevent polluted stormwater runoff by visiting www.onlyraindownthedrain.com.



Problem: Erosion from Construction Entering Waterways Solution: Erosion Control



Stormwater runoff from construction activities can have a significant impact on water quality. As stormwater flows over a construction site, it can pick up pollutants like sediment, debris, and chemicals and transport these to a nearby storm drain system and directly to an aquifer, stream, river, or lake.

Polluted stormwater runoff can harm or kill fish and other wildlife. Sedimentation can destroy aquatic habitat, and high volumes of runoff can cause stream bank erosion. Debris can clog waterways and potentially reach the ocean where it can kill marine wildlife and impact habitat.

Solutions:

- Divert water runoff away from disturbed or open areas
- Install silt fences, vehicle mud removal areas, vegetative cover, and other sediment and erosion controls
- Prevent soil erosion by minimizing disturbed areas during construction projects, and seed and mulch bare areas as soon as possible

WATER QUALITY BENEFIT

By taking measures to reduce water runoff from construction sites that flow into waterways, the amounts of sediment, debris and chemicals that enter waterways can be reduced and even eliminated from these sites. This prevents erosion from entering waterways keeping water clean, clear, and cooler for aquatic organisms including fish, and other wildlife.

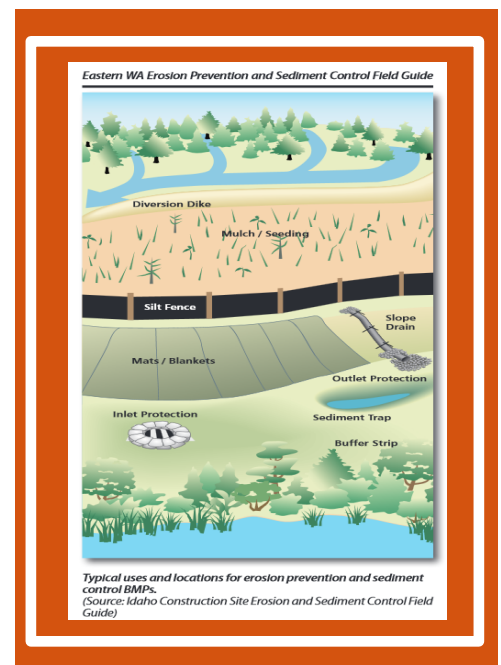
CONSIDERATIONS

Cost - The cost of implementing erosion control on a construction site will vary with site and type of control needed.

Time Needed Time to build erosion controls including planting, installing fences, mulching, time to plan.

Maintenance - Diversion of water and installation of erosion controls must be maintained particularly after rainstorms.

Materials needed – Depends on the size and scope of project.



MORE INFORMATION: To learn more about what you can do to prevent polluted stormwater runoff by visiting www.onlyraindownthedrain.com.



Problem: Chemicals and Debris Going Down Storm Drains

Solution: Only Rain Down the Drain



Storm drains move water away when it rains so areas don't flood. Storm drains don't filter out anything, but go directly to aquifers, streams, rivers, and lakes. Putting anything other than water down a storm drain causes pollution in our waterways. Trash, motor oil, grass clippings, and other items put down storm drains all pollute our waterways making them unhealthy and affecting our drinking water and harming fish and wildlife.

Solutions:

- Never dispose of motor oil or other chemicals down a storm drain.
- Pick up litter and leaves that may clog a storm drain.
- Sweep streets and driveways rather than using a hose.
- Mark storm drains to remind others that only rain goes down the drain.

WATER QUALITY BENEFIT

Stopping pollution at its source by not allowing trash, oil, lawn clippings, and other items into storm drains keeps our waterways cleaner and healthier for us as well as fish and wildlife. By marking storm drains people are reminded not to pour anything down the drain and are therefore more likely to help keep our waters clean!

CONSIDERATIONS

Cost - Travel expenses to recycle oil and dispose of chemicals properly. Brooms or leaf blowers to sweep debris off sidewalks and driveways.

Time needed - Time to recycle oil and dispose of chemicals properly. Time to sweep. Time to mark storm drains.

Maintenance - Making sure storm drain remain clear of debris such as leaves and removing debris from sidewalks and driveways so it doesn't end up in storm drains. Remarking storm drains when faded or missing.

Materials needed:

- Brooms or leaf blowers for sweeping
- Stickers to mark storm drains



MORE INFORMATION: To learn more about what you can do to prevent polluted stormwater runoff by visiting www.onlyraindownthedrain.com.



Problem: Dirty Car Wash Water

Solution: Use a Car Wash or Wash Your Car on the Lawn



Washing your car in your driveway, on the street, or in a parking lot sends gasoline, oil, heavy metals, solvents, soap, and other harmful pollutants into our storm drains. Most storm drains are connected to our local aquifers, streams, lakes, or even the Columbia River. These pollutants cause all kinds of problems in our waterways. For example, soaps contain solvents that remove the protective coating on fish gills and other amphibians which can harm or even kill them. Oil can cause heart problems and death in young salmon. Heavy metals in wash water like copper take away the protective hairs on salmon they need to detect and escape predators.

WATER QUALITY BENEFIT

Commercial car wash facilities recycle their dirty wash water and send it to the sewer for treatment. This prevents pollution like soaps, oils, and heavy metals that are washed off of cars from reaching our aquifers, streams, and lakes. By washing cars on lawns or other pervious surfaces the polluted wash water from the car can soak into the soil and be cleaned.

Remember, Only Rain Down the Drain.



CONSIDERATIONS

Cost - Commercial car washes are more expensive than washing your car at home.

It can cost from \$2.00 to \$15.00 for a commercial car wash, depending on whether the owner is using a self-serve or automated facility.

Maintenance - The amount of maintenance needed to keep a car clean depends on whether the car owner uses a self-serve or automated car wash, how much the car owner drives, and the road conditions they drive on (gravel/dirt roads create more dirt on vehicles-thus, more washing).

Materials needed - For self-serve car wash facilities, owners can use the brushes and soap/ wax provided at the facility or they can bring their own supplies. Some car owners prefer to hand dry their vehicles, so towels would be needed for this effort.

Time needed - Using a commercial car wash is faster than washing your car at home. This usually takes 10 to 30 minutes for self-serve car washes and 5 to 10 minutes for automated car washes.

MORE INFORMATION: To learn more about what you can do to prevent polluted stormwater runoff by visiting www.onlyraindownthedrain.com.



Problem: Vehicle Leaks

Solution: Don't Drip and Drive – Fix That Leak



A few drips of oil or another fluid from your car may not seem like a big deal, but there are thousands of vehicles that are leaking around Eastern Washington. That adds up to a big problem! These fluid leaks like oil, grease, and antifreeze, are toxic to people, wildlife, and plants. When it rains, these pollutants are carried by stormwater into our aquifers, streams, lakes, and rivers.

WATER QUALITY BENEFIT

According to the Washington State Department of Ecology, over 7 million quarts of motor oil and other automotive fluids wash into our aquifers, streams, lakes, and rivers every year.

The Northwest Department of Marine Fisheries (NOAA) has tested the impacts of oil and other petroleum based products on young fish. They found that many of these products caused heart problems and death in fish. By fixing leaks and removing these toxic products from our streams, we will help to protect and preserve the environment for our fish, wildlife, and ourselves.



CONSIDERATIONS

Cost - The cost of repair depends on the cause of the leak. Costs can range from five dollars to thousands of dollars.

Time - For an owner to check a vehicle themselves, they will need to place the sheet of paper under the vehicle immediately after driving and leave it there for a few hours. If they see a leak, they will need to take the sheet out, check any leaks against the leak color chart and then schedule an appointment with their mechanic to confirm/repair the leak.

Maintenance - Vehicle owners should have their cars checked and maintained regularly, about once per year. This can be done by the vehicle owner or a mechanic.

Materials needed - Testing for leaks: Vehicle owner can test their cars for leaks using a large sheet of white paper (usually 5 feet square), a color chart of leaks (found on www.fixcarleaks.org), and some rocks to hold the paper down. Repair: materials depend on the cause of the leak.

MORE INFORMATION: To learn more about what you can do to prevent polluted stormwater runoff by visiting www.onlyraindownthedrain.com.



Problem: Toxic Yard Chemicals in Runoff

Solution: Using Fertilizers and Chemical Pesticides Properly



Some people think they need to use chemical fertilizers and pesticides to have a beautiful lawn and garden, but these products need to be used properly so chemicals don't get washed into local waterways. The extra nutrients from fertilizers can cause our drinking water to become polluted and algae to grow too much causing harm to fish and wildlife. Pesticides can cause waters to become so polluted that people can no longer drink it or fish from it. So with your lawn and garden try these options:

- Fertilize sparingly; September is the best time to apply and use a slow-release formula.
- Go natural; Mow your lawn at a higher level and leave grass clippings on the lawn.
- Don't use chemicals near wells or waterways (75 feet buffer).
- Don't apply fertilizers and pesticides when rain is predicted.
- Don't leave yard chemicals on pavement.

WATER QUALITY BENEFIT

Over thirty pesticides can be found in our waterways and cause problems for us, the environment, and our wildlife. Fish eat small macroinvertebrates (aquatic insects), but these important insects can be killed by pesticides. By keeping pesticides out of our waterways, we allow more wildlife to thrive. Chemical fertilizers send lots of unneeded nutrients into our aquifers, streams, lakes, and the Columbia River. All these extra nutrients can cause lots of algae to grow – this is called an “algae bloom.” This algae takes oxygen out of the water that fish and other aquatic life need to survive. By removing the chemical fertilizers from our waterways we can stop these harmful algae blooms.



CONSIDERATIONS

Cost - Pesticides and fertilizers are far more expensive than natural grass seed, compost and mulch, so residents would save money by not purchasing chemical products.

Maintenance - Maintaining a lawn and garden with fewer chemicals requires weed-pulling and application of mulch and compost.

Materials needed - The natural way to maintain a really green healthy lawn is to rake, spread grass seed, spread compost and occasionally thatch (take out small plugs of soil with a machine) your lawn. This requires purchasing compost, grass seed, and occasionally renting a thatching machine.

Time needed - Properly maintaining your lawn requires a few hours in the spring and fall. Pulling weeds is more time consuming than spraying pesticides initially, so more time might be needed to maintain the same look for your lawn initially.

MORE INFORMATION: To learn more about what you can do to prevent polluted stormwater runoff by visiting www.onlyraindownthedrain.com.



Problem: Pet Waste

Solution: Scoop The Poop, Bag It, And Place In The Trash



Pet waste, like human waste, is raw sewage and contains harmful bacteria and diseases that can harm humans, pets, and the environment. When pet waste is left in our yards and public spaces it also gets washed into our storm drains which connect directly to the nearest lake, stream, wetland, aquifer or groundwater without treatment. This waste pollutes our local water bodies and then travels to rivers where it causes bigger problems. The great news is that it's easy to protect ourselves and our local waters, simply *Scoop the Poop, Bag it Up, and Place it in the Trash*.

WATER QUALITY BENEFIT

While pet waste is a human health issue, it also sends lots of nutrients into our streams and lakes which can cause too much algae to grow. This algae takes oxygen out of the water that fish and other aquatic life need to survive.

The harmful bacteria and diseases in pet waste can make the water unhealthy for people and other animals. There are over 3 billion organisms in one average sized pile of dog waste.

Picking up pet waste keeps it out of our waterways, which is cleaner and healthier for animals, including humans.



CONSIDERATIONS

Cost - Any bags can be used for picking up waste, but many choose to purchase rolled bags for \$0.04-\$0.50 per bag. Also a one-time cost for a shovel may be desired.

Maintenance - Scooping waste requires the pet owner to scoop the pet waste and place it in the trash.

Materials needed - Bags to collect and dispose of the waste and sometimes a small shovel or extended shovel are needed to collect the waste.

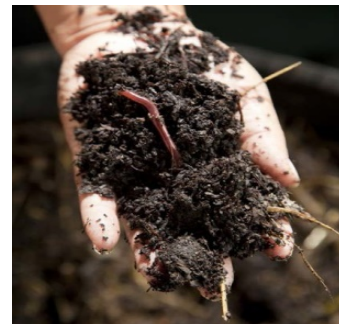
Time needed - Scooping pet waste and placing it in the trash may take an extra minute of time.

MORE INFORMATION: To learn more about what you can do to prevent polluted stormwater runoff by visiting www.onlyraindownthedrain.com.



Problem: Poor Soil

Solution: Add Compost to Soil



Soil is a mixture of living and non-living parts. The balance of these parts are important and greatly impact what can survive there. Unhealthy soils have fewer living organisms, are often compacted, offer little nutrients to plants, and can't absorb water well. A teaspoon of healthy soil contains about 4 billion living organisms! These organisms protect your soil and plants by:

- Creating larger spaces between particles that allow air, water, and plant root growth into the soil
- Recycling nutrients and making them available to plants
- Storing water until plants need it
- Protecting plants from pests and diseases

WATER QUALITY BENEFIT

Healthy soil absorbs more water which reduces stormwater runoff. It also acts as a filter and cleans pollutants out of water as it passes through, leaving cleaner water to enter back into our groundwater and surface water. Healthy soil cools stormwater as it passes through which provides cooler water for local waterways and a healthier environment for the wildlife that live there. Healthy soil provides essential nutrients to plants which improves their health and helps them resist pests and disease.



CONSIDERATIONS

Cost - Purchasing equipment might be necessary to complete this solution. Equipment might include a shovel, bin, and water hose.

Mulching - Materials from your yard are free, otherwise compost or mulch from a store ranges from \$5.00 per bag to \$25.00 per truckload.

Maintenance - More mulch and compost should be added each year so come on-going maintenance will be necessary.

Time - The time required depends on the size of your yard.

Design - A day to a week is necessary to design and plan your yard.

Labor - A few hours to a day will be needed for the initial work.

MORE INFORMATION: To learn more about what you can do to prevent polluted stormwater runoff by visiting www.onlyraindownthedrain.com.



Problem: Clearing Land for Development

Solution: Plant Native Plants



When people develop an area of land putting in homes, buildings, roads, etc. they often take away most or all of the plants. This drastically changes the way water flows across the land increasing the amount of stormwater runoff. Plants catch rainfall on their leaves and needles, slowing it down and allowing a lot of it to evaporate back into the air. Their roots also loosen the soil, allowing more water to soak in, and they absorb groundwater and transpire it through their leaves or needles back into the air. Plants have other benefits too: cooling our homes and buildings in summer and slowing cold winds in winter, cleaning our air while moving carbon dioxide (a greenhouse gas) from the atmosphere back into the soil, and making our towns and cities pretty while providing homes for birds and other wildlife.

WATER QUALITY BENEFIT

Plants capture stormwater when it rains and slow it down, reducing stream flooding and erosion of stream banks. Native plants placed along a stream provide shade and cool the water temperature which is important for fish. Plants drop leaves and other nutrients into the stream which feed the small underwater insects that fish and other insects eat. They also provide nutrients for other aquatic animals and plants. Trees growing along streams eventually fall or drop large branches into streams. These branches or tree trunks create important spots for fish and other wildlife to rest, hide, and hunt.



CONSIDERATIONS

Cost - The cost of native plants varies greatly depending on the size and species. Seeds are often less than \$1.00, small trees can typically range in cost from \$2.00 to \$25.00, and large trees can range from \$25.00 to thousands of dollars.

Maintenance - For the first 2 to 5 years it's recommended to provide water and nutrients for your new plants. Mulch made of wood should be placed around the plant annually (being careful not to put it close around the trunk) to slow the growth of weeds and help keep moisture in the soil.

Materials needed - Basic materials include gloves, a shovel, and plants.

Time needed - It typically only takes 5 to 10 minutes to plant a tree. The maintenance will vary depending on the year, seasonal conditions, and number of native plants planted.

MORE INFORMATION: To learn more about what you can do to prevent polluted stormwater runoff by visiting www.onlyraindownthedrain.com.



Problem: Too Many Impervious Surfaces

Solution: Install Porous Pavement



Conventional pavement, like asphalt and concrete, are called “impervious surfaces” because they don’t let the rain soak into the soil. Instead they collect rainfall, and funnel it to storm drains. In big storms, stormwater runoff can contribute to local flooding and stream erosion. Homeowners can help reduce these impacts by choosing porous pavement options (also called permeable or pervious pavement) that let the rain soak through into the soil for driveways, sidewalks, and patios. These permeable options include; porous asphalt, porous concrete, and interlocking pavers.

WATER QUALITY BENEFIT

When water is allowed to pass through soil, it is slowed and reaches waterways much later than if it were to travel quickly through storm drains. The living organisms in the soil filter the water reducing the amount of pollution reaching local waterways. The soil also cools the water which helps lower water temperatures which is better for salmon and wildlife that live in our streams, rivers, and lakes.



CONSIDERATIONS

Cost - Cost varies greatly depending on size of area, type of material chosen, use of area you are converting (driveway, patio, sidewalk, road, etc.), and whether you are hiring someone to do the work or doing it yourself.

Maintenance - Porous pavement needs to be cleaned annually to prevent porous spaces from clogging with dirt and debris. Interlocking pavers may need to be mowed to keep plants in between them from getting too large.

Materials needed - Porous pavement or pavers, subgrade materials (sand, pebbles, etc. that go underneath the pavement), equipment, and maintenance materials.

Time needed - Design can take days to weeks, construction can take days or weeks and maintenance should take a few hours annually to maintain.

Mulching - Materials from your yard are free, otherwise compost or mulch from a store ranges from \$5.00 per bag to \$25.00 per truckload.

Maintenance - More mulch and compost should be added each year so come on-going maintenance will be necessary.

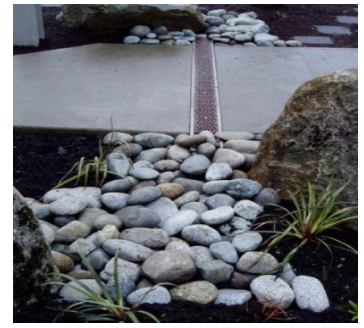
Design - A day to a week is necessary to design and plan your yard.

MORE INFORMATION: To learn more about what you can do to prevent polluted stormwater runoff by visiting www.onlyraindownthedrain.com.



Problem: Local Flooding Erosion and Pollution

Solution: Build Rain Gardens



Rain falling on hard surfaces like roofs, driveways, sidewalks, parking lots, roads, and compacted soils runs off quickly into the nearest storm drain which takes the water in pipes to the nearest aquifer, lake, stream, or river. This fast-moving water causes soil erosion in our waterways, and higher water temperatures in the summer months. The water also picks up pollution on these surfaces that is harmful to us, our pets, and fish and wildlife.

Rain gardens are shallow bowl shaped gardens that can hold runoff from these hard surfaces. They have healthy soils with lots of compost to help capture more water and allow it to slowly soak into the soil. Rain gardens are landscaped with plants that work best with the amount of sun, soil, and water the garden receives.

WATER QUALITY BENEFIT

Rain gardens offer many water quality benefits. By slowing and filtering stormwater runoff, rain gardens can reduce flooding of waterways, reduce soil erosion, lower water temperatures, and reduce the amount of pollution reaching our waterways. This makes our waters cleaner and healthier for wildlife.



CONSIDERATIONS

Cost - Costs will vary based on size, site conditions, and materials. Hiring someone to design and install the garden will increase cost.

Watering - Plants will need watering for first 2 to 3 years.

Mulch - Approved mulch for rain gardens will need to be placed as a weed and moisture barrier.

Weeding - Weeds will need to be pulled to keep them from overtaking the rain garden.

Plant replacement - Any plants that aren't surviving well after the first 1 to 2 years should be removed and replaced.

Materials needed - Materials will depend again on the type of garden, but a typical list of materials would be equipment to dig the site, rocks, compost, plants, irrigation or watering hose, and mulch.

Time needed - Time will depend on the size and the types of plants chosen, but an owner should expect to spend a day to a week designing and calculating the rain garden, a few days to a few weeks constructing the rain garden, and couple of hours each month for the first 1 to 3 years of establishment maintaining the site.

MORE INFORMATION: To learn more about what you can do to prevent polluted stormwater runoff by visiting www.onlyraindownthedrain.com.

