

DRAIN RANGERS

Investigating Polluted Stormwater Runoff
in Elementary Grades



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INTRODUCTION

Polluted stormwater runoff is the number one threat to the water quality of Puget Sound. Our salmon and other aquatic life 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 runoff 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 four- week unit begins with students researching the issue of polluted stormwater runoff using the performance task. 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. Content about polluted stormwater runoff, 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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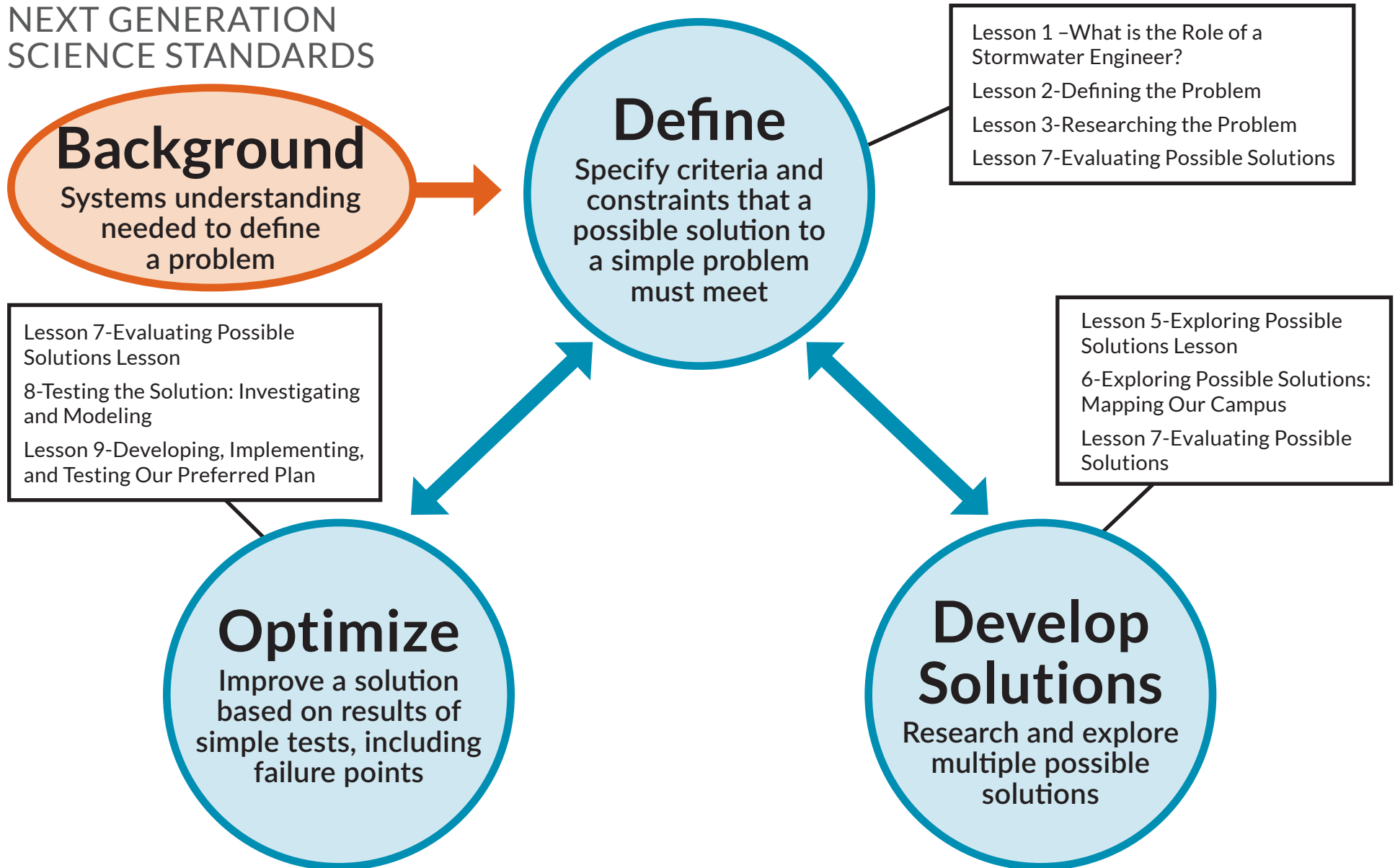
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Engineering Design

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	
<p>3-ESS3-1. Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.*</p> <p>[Clarification Statement: Examples of design solutions to weather-related hazards could include barriers to prevent flooding, wind-resistant roofs, and lightning rods.]</p> <p><i>*This performance expectation integrates traditional science content with engineering through a practice or disciplinary core idea.</i></p>	Lessons 1, 2, 11, 12
4-ESS2 Earth and Space Standard Two: Earth's Systems	
<p>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.</p> <p>[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 form of weathering or erosion.]</p>	Lessons 1, 2, 3, 4, 5, and 6
4-ESS2 Earth and Space Standard Two: Earth and Human Activity	
<p>4-ESS2-2. Analyze and interpret data from maps to describe patterns of Earth's features.</p> <p>[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.]</p>	Lessons 3, 4, 5, 6, 7, 12
5-ESS3 Earth and Space Standard Three: Earth and Human Activity	
<p>5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.</p>	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 p. 23 (task p. 18)	Performance Task: Help Protect our Waterways Information essay	Summarizing What is stormwater? How does stormwater get polluted? What actions can we take to keep stormwater clean?	Stormwater Videos Essential Questions Performance Task Let's Visit Stormville! Article
2-Videos and Presentations p. 24	Explore stormwater runoff and pollution View videos and/or have presenters come to class	Summarizing	Stormwater videos Community presenters Questions
3-Watershed Model p. 27	Develop a model of a watershed	Compare contrast What is a watershed? Humans impact on watersheds	Glossary Paper Vis a vis markers Spray bottles Student Journal
4-Schoolyard System Model p. 35	Draw and label the part of the schoolyard Observe water flow	Observation Systems and system Models- diagrams Water (matter) flow through a system	Student Journals Clipboards
5-Four Raindrops p. 41	Simulation of the movement of water in developed and non-developed landscapes	Develop models (simulation) Analyze and interpret data Construct explanations	Colored paper Stopwatch Poker Chips Student Journals
6-Engineering Design and Define the Problem p. 61	Introduction to Engineering Design Defining the Problem	Summarizing Problem Solving Stormwater Runoff and Pollution Engineering Design: Define the Problem	<i>Runoff: Special Report video</i> Power Point Journal pages
7-Research the Problem p. 65	Observation Finding evidence of water movement in the schoolyard Identifying pervious and impervious surfaces	Finding Evidence Recording accurately	Power Point Bottles of water Schoolyard Stormwater Legend Student drawings from Lesson 4 Clipboards Journal page



Lesson	Activities	Concepts/Skills	Resources
8-Understand Stakeholders p. 70	Define Stakeholder Explore the points of view of the various stakeholders: Stakeholder Matrix	Finding Evidence Point of View Evaluation Stakeholder	Stakeholder table List of stakeholders Internet access
9-Explore and Compare Possible Solutions p. 75	Research engineering solutions Jigsaw activity of solutions Evaluate solutions	Compare/Contrast Evaluation Stormwater runoff Solutions Engineering Design: Explore Multiple solutions	Power Point possible solutions 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 p. 80	Complete Project Planning worksheets in small groups Plan test of solution Implement Education outreach project and test	Engineering Design: Develop a plan Optimize- Test the Solution	Drain Ranger Solution pages Project Planning tip sheets Project Planning worksheets and graphic organizer Seattle Utilities Rainwise pages
10B- Develop, Implement and Test the Plan: Schoolyard Solutions p. 89	Complete Project Planning worksheets in small groups Plan test of solution Implement plan and test solution.	Engineering Design: Develop a plan Optimize- Test the Solution	Video- 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 p. 96	Analyze test data from surveys, investigations or models and identify improvements Reflect on accomplishments	Analyze and interpret data Construct explanations, Communication	Journal pages 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 assessment performance tasks. The curriculum can be done in its entirety or just by doing one to several of the lessons. Here are some possibilities:

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 Elementary

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 2: “Video 2-Drain Rangers channel” <https://www.youtube.com/channel/UC4MI0TNPRaFJz7m11e7bDDAg>
- ◆ “15 Minutes to the River” video <https://www.youtube.com/watch?v=GrBEEjjjaY>
- ◆ Sources of Stormwater Pollution Illustration 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 storm water pollution, students will read an article, interpret a diagram, and watch a video, 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

Day2 (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: Sources of Stormwater Pollution Drain Ranger Curriculum Resource
Source: <http://www.sjcfcl.us/stormwater/media/WatershedWeeklyProof.pdf>

Video: Fifteen Minutes to the River: Explaining Stormwater Runoff
1 min. 49 sec. - <https://www.youtube.com/channel/UC4MI0TNPRaFJz7m11e7bDAg>

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.



My Notes

Source	What Stormwater is	How stormwater gets polluted	What we can do to keep the water clean
Video: Fifteen minutes to the River: Explaining Stormwater Runoff			
Article: Let's Visit Stormville			



My Notes

Source	What Stormwater is	How stormwater gets polluted	What we can do to keep the water clean
Illustration: Sources of Stormwater Pollution			

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. Over half of the land in our state is covered by forests. When rain falls in a forest, most of the water is soaked into the ground, evaporated back into the air, or absorbed by trees.

The forest acts like a sponge, capturing and holding the rain water before it can enter streams and lakes. But when forests are 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 in pipes and ditches to local streams, lakes, and Puget Sound.

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 treated, the pollution in stormwater can enter directly into nearby streams, lakes, or Puget Sound. The pollution can then harm animals in the water or make playing and swimming in it unsafe for people.

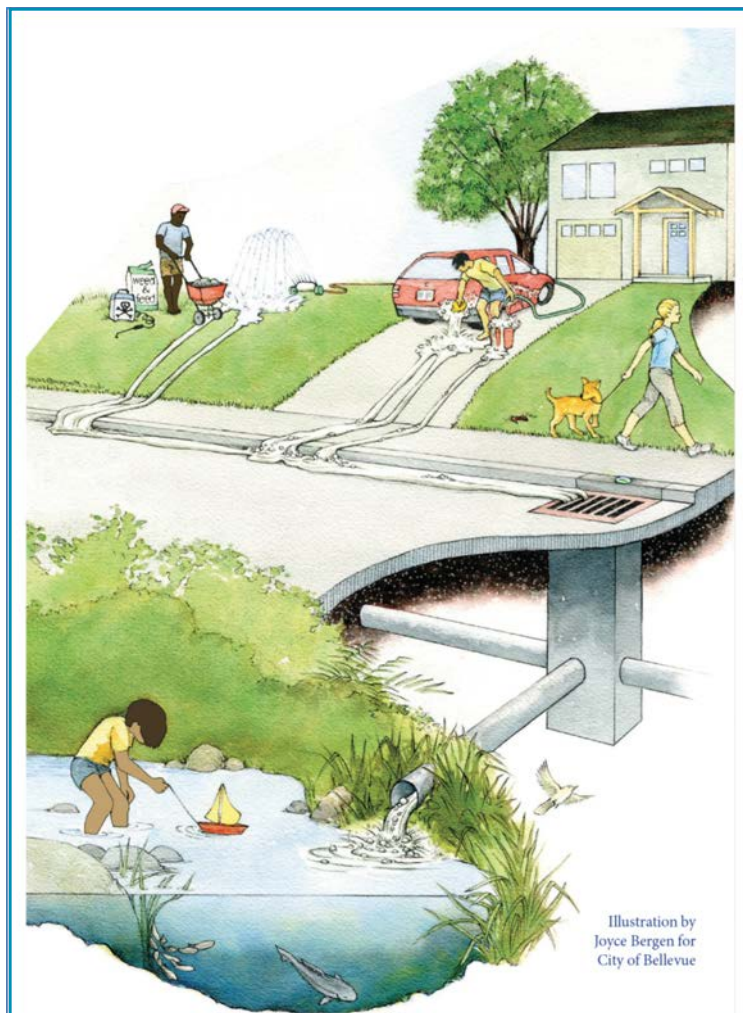
75% of all pollution in Puget Sound comes from stormwater runoff that starts in our neighborhoods.

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

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

Stormville is a typical town located near a beautiful lake. 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?

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





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 directly into our waterways.

Soap, oil, and other pollutants in the wash water are harmful to fish and other animals that live in the water. These pollutants can destroy the protective covering on fish and injure or even kill them and their eggs. Even biodegradable soap pollutes water because it needs to go

through soil to properly break down.

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.



Pet Waste

No one wants to swim in poop! Dog poop carries harmful bacteria and diseases that can make people very sick. Beaches 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 melts into the stormwater. The polluted stormwater flows into nearby storm drains and then into waterways like streams, lakes, or Puget Sound. Too much poop in the water means people can't swim, walk, or play in the water and

they can't harvest shellfish to eat.

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

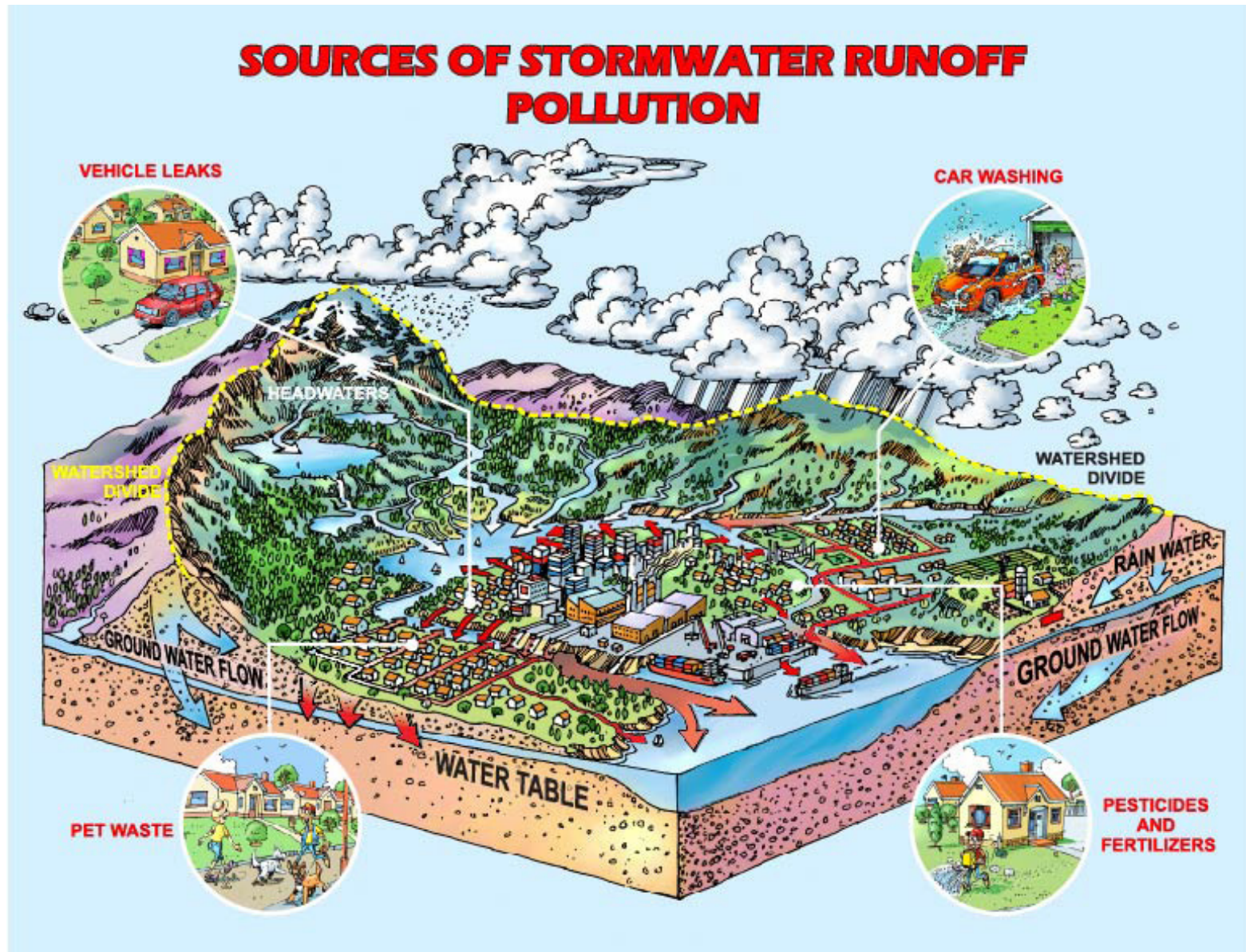
Many people use fertilizers and pesticides to improve their green lawns and flower gardens. However, stormwater runoff can carry these chemicals into storm drains and waterways.

People use pesticides to kill unwanted plants and bugs in their yards. But when pesticides get into a lake or stream, they harm good fish and wildlife 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.

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 rivers, lakes and streams. Thank you for helping stop stormwater pollution!





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 list on the Puget Sound Starts Here website: <http://www.pugetsoundstartshere.org>. Be sure to ask them for any questions or prep you should do for the presentation. AND/OR have students view the **Lost in Puget Sound** video: <http://www.seattlechannel.org/videos/video.asp?ID=5917>
For younger students there is, Drain Rangers Videos 1-4 <https://www.youtube.com/channel/UC4MI0TNPRaFJz7m11e7bDAgm> or, “Polluted Runoff” video <https://www.youtube.com/watch?v=TV-abXQXdBQ&feature=youtu.be>
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 Elementary

Setting Indoors

Lesson 2 (60 minutes)

Materials

- ♦ Videos 1-4 of Drain Rangers channel: <https://www.youtube.com/channel/UC4MI0TNPRaFJz7m11e7bDAg>
- ♦ Videos such as Lost in Puget Sound <http://www.seattlechannel.org/videos/video.asp?ID=5917>
- ♦ Rodney Raccoon “Polluted Runoff” video for younger students <https://www.youtube.com/watch?v=TV-abXQXdBQ&feature=youtu.be>
- ♦ Journal pages
- ♦ Resources from presentations or websites

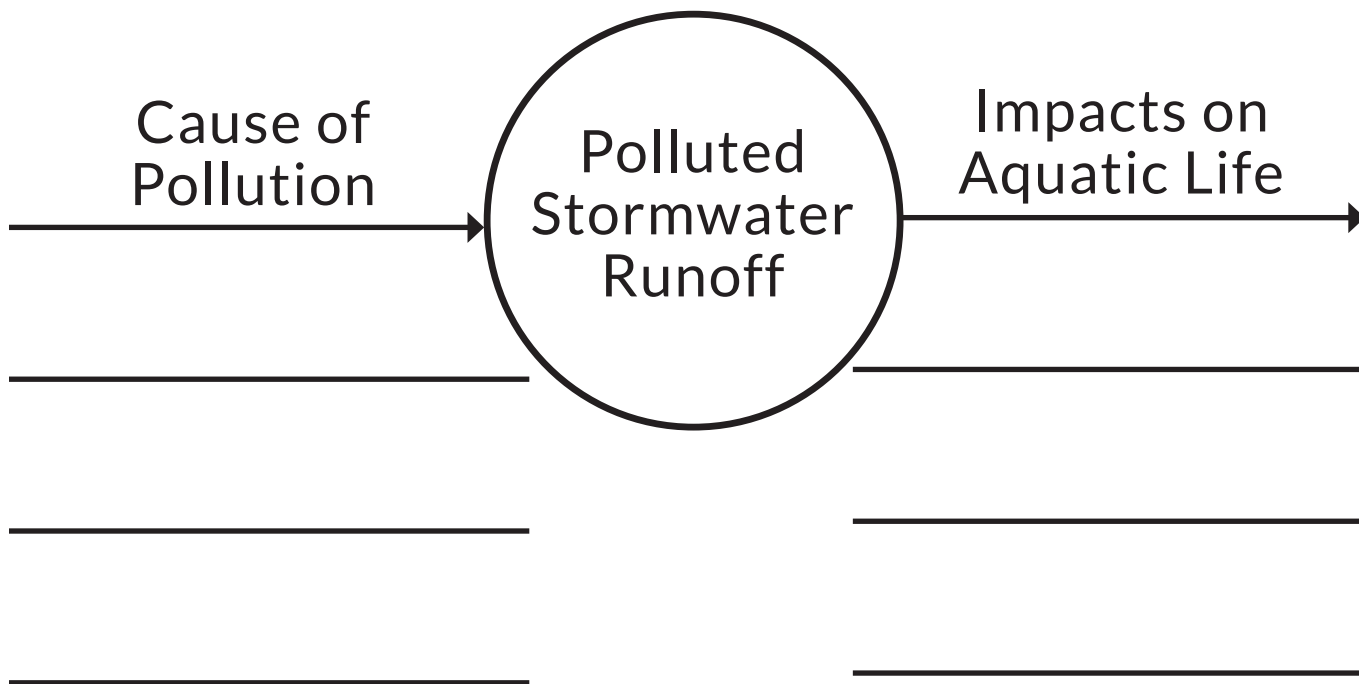
Teacher Note: Pollution and Solutions student page should be the last page of the student journal so students can keep notes as they see videos, read articles, or develop models.

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



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)



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

We all live in a watershed. 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 creek or stream 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 Longfellow Creek in Seattle is in the Longfellow Creek 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 at: <http://water.epa.gov/type/watersheds/>
- ◆ Watershed poster
- ◆ U.S. Geological Survey, Science in your Watershed <http://usgs.gov/sec/index.html>
- ◆ One 8 ½ x 14 inch of white paper for each student
- ◆ One 8 ½ x 11 white sheet of paper for each student
- ◆ Three different colors of nonwaterproof markers; vis-à-vis or Crayola brand work great
- ◆ Several spray bottles of water; 1 for every 3-4 students
- ◆ Watershed video <https://www.youtube.com/watch?v=f63pwrMXkV4>
- ◆ Watershed Power Point



Watershed Model

Introduction

As you create your mini-watershed, use non-waterproof markers because you want them to "bleed". This will simulate how rain moving through a watershed - the runoff - can carry wastes further downstream.

Activities / Procedure

1. Ask students to describe in the picture in their minds when you hear the word "watershed". Below are the directions for how the students will create the model. There is a nice video of what a watershed is at: <https://www.youtube.com/watch?v=f63pwrMXkV4>
2. Crumple the piece of 8 ½ x 11" paper into a tight ball. Gently open the paper but don't smooth it out. Tape it onto the 8 ½ x 14" piece of paper, forming a base for your model. The highest points of the paper represent mountaintops, and the lowest wrinkles represent the valleys. The watershed boundaries are defined by the elevation of the land, with the highest elevation points marking the boundary of a watershed.
3. Note the directions: north, east, south and west on the base of your model.
4. Pick a marker and highlight the highest points on the paper. These will correspond to mountain ridgelines.
5. With the second marker, mark an "x" where you would like to build a house and live.
6. With the last marker, mark four or five places that will represent where additional people are: farms, houses, factories, shopping centers, hospitals, schools, etc.
7. Use the water bottle to lightly spray the finished model. The spray represents precipitation falling into the watershed.
8. As students are creating their watershed models ask the following discussion questions:
 - Besides the water turning color, 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 lakes, rivers, or streams form on your model?

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.



Watershed Model

- What direction is most of the water draining on your model?
- Did you place your house in a stable and secure location? Why or why not? Were there any other 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?
- Seeing the rainwater "wash" over the houses, shopping centers, farms, and the water "change color", how might pollutants near the top of the watershed affect land near the bottom of the watershed?
- Our area is dry in the summer followed by heavy rains in the fall. Think about your model. What does this mean for pollution runoff reaching streams and rivers in the fall in the watershed?

Extension: Have students make one watershed rural and one watershed urban. Draw in ponds, yards, buildings, cars, etc. Compare the 2 after the rain

9. After the discussion, have students define what a watershed is in their journals.
10. Students then compare their model watershed to the watershed they live in using the box and T chart or Venn Diagrams and answer questions about the comparison.

Extensions

Look at a topographic map of your neighborhood and trace the ridge lines, creeks and rivers in your school's watershed (contact your local natural resource conservation district to obtain a map). Create a model of your school's watershed out of clay, with high points for mountains and low points for creeks, rivers, bays, wetlands. Construct different land uses (farms, cities, and industrial areas). Place the land uses in actual places found in your watershed or choose to place them where they would have the least impact on water quality/quantity and on salmon habitat.

Science

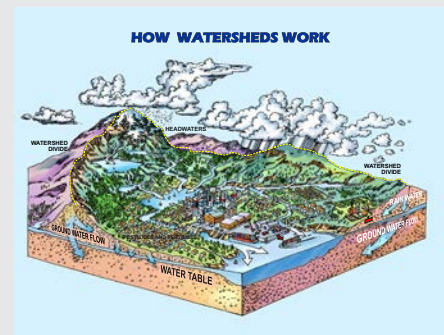
Grades 3 - 5

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.





Watershed Model

Acknowledgment

Developed by **Erica Baker, Pacific Education Institute**

Adapted from the Project WET activity: ***Branching Out***

Other Websites Watershed Lessons

- Forests of Washington Watershed Model
http://www.pltwa.com/uploads/2/7/8/2/27828107/finding_out_about_watersheds.pdf

Videos about Watersheds-

- <https://www.youtube.com/watch?x-yt-cl=85114404&v=QOrVotzBNto&x-yt-ts=1422579428>

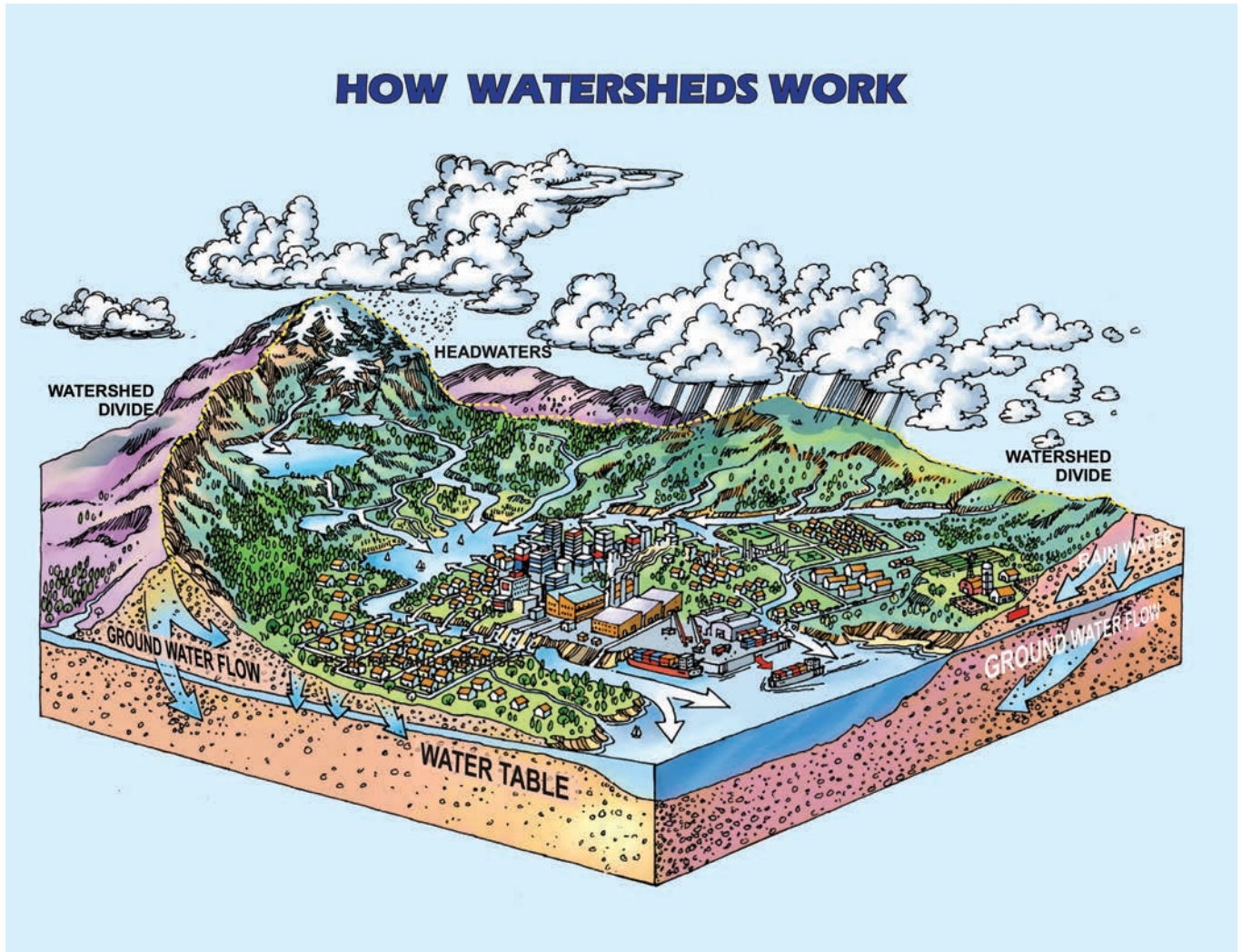
Other Watershed Models

- Enviroscope



Watershed Model

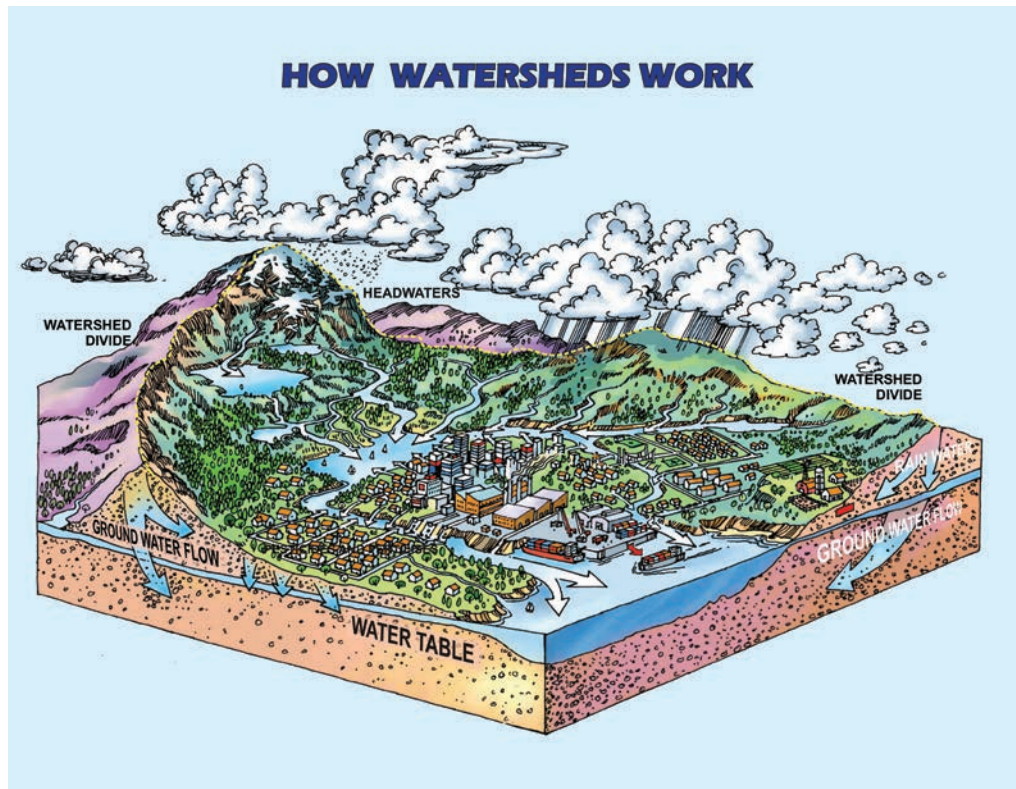
STORMWATER RUNOFF JOURNAL



Name _____



Watershed Model



Define a watershed



Watershed Model Comparison

SIMILARITIES

--

DIFFERENCES

Watershed Model	Real Watershed



-
1. How is the model like the watershed you live in? How is it different?
 2. What about the watershed is not represented in the model?
 3. What is the main purpose of the watershed model? What is the model trying to show?
 4. How could you improve the model of the watershed?



Introduction to Water in the Schoolyard

Overview

In this lesson students develop a model of the schoolyard system by drawing and labeling the parts of the schoolyard and identify water inputs and outputs along with evidence of human impacts on the system. This model will be used again in Lesson 7: Research the Problem.

Objectives

Students will:

- 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.

Teacher Note: Decide ahead of time what area of the school campus the students draw and label. Ideally it would include an area where they can see evidence of erosion and deposition, pervious and impervious surfaces, and water flow for Lesson 7. Students revisit this area in Lesson 7 to gather evidence of stormwater runoff in their schoolyard.

Science

Grades Elementary

Setting Outdoors/indoors

Lesson 4(45-50 minutes)

Materials

- ◆ Clipboards
- ◆ Student journals
- ◆ Pencils
- ◆ Optional: large poster paper for the group draw



Drawing of an area showing the parts of the system. The red dots are impervious surfaces and the blue dots are pervious surfaces. Labeling pervious and impervious surfaces occurs in Lesson 7.

Vocabulary:

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 on the student journal page about water in the schoolyard system (you may want to do the questions first to get students observing their area).

Science

Grades Elementary

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.

Introduction to Water in the Schoolyard



8. Back inside have students work in partners to share their drawings, adding parts to their drawing that the partner may 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 Elementary
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?

A large, empty rectangular box with a thin black border, intended for a student to draw and label a schoolyard system.



Schoolyard System Water Questions

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 1 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



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 called “Four Rain Drops teacher’s activity” to help explain how to run the activity here: <https://www.youtube.com/channel/UC4MI0TNPRaFJz7m11e7bDAg>

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 just 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

Science

Grades Elementary

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)
- ♦ Soils for Salmon Reading <http://www.soilsforSalmon.org/pdf/SoilsforSalmonLIDrev9-16-04.pdf>
- ♦ Video for teachers to explain the activity here: <https://www.youtube.com/channel/UC4MI0TNPRaFJz7m11e7bDAg>



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 Elementary

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. Modelling water droplets in forests and an urban setting helps students conceptualize the scale of the differences.

Background

4.5 million people live in the Puget Sound region. Before the development of the many cities and towns, where most of these people reside, this region was heavily covered in forests. Large areas of this forest 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 trees 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 rivers, lakes and the Puget Sound. In the forest, about half of the water either evaporates or is absorbed by trees. Another one-third of the rain water is absorbed into the soil and slowly makes its way downhill, through the soil, to 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 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 rivers or lakes. 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.

For more information see: <http://www.soilsforsalmon.org/why.htm>

This is a lesson where students contrast the water cycle in a forested landscape versus an urbanized landscape, and how these differences can affect the health of natural water bodies such as lakes, rivers and the Puget Sound. In the lesson, the students themselves model the process of rain moving through these different landscapes, record data on the amount and rate of water entering a creek, and graph these data to compare the different landscapes. At the end of the lessons, students will be able to explain both why and how urban development can have impacts on waterways like creeks and lakes.

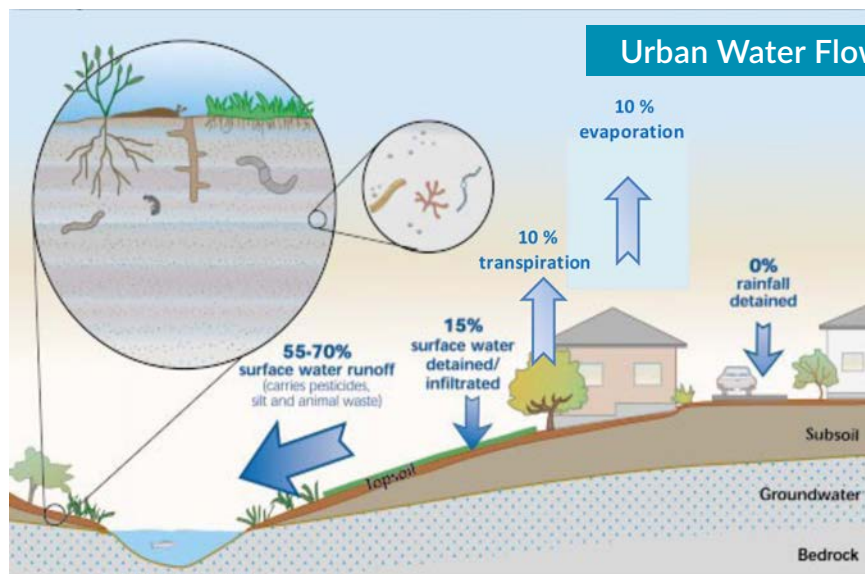
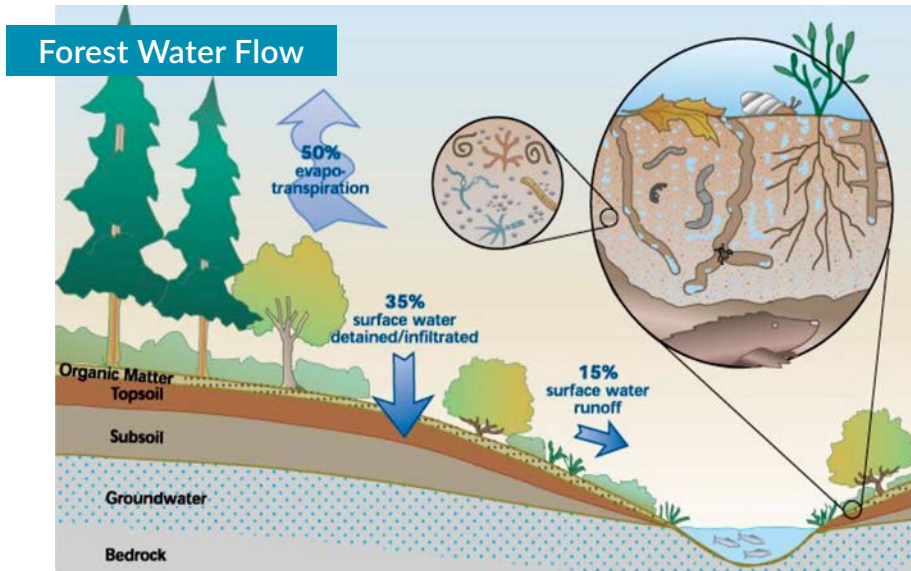
The Relationship Between Soil and Water: How Soil Amendments and Compost Can Aid in Salmon Recovery, King County Department of Natural Resources. Fall 1999.

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

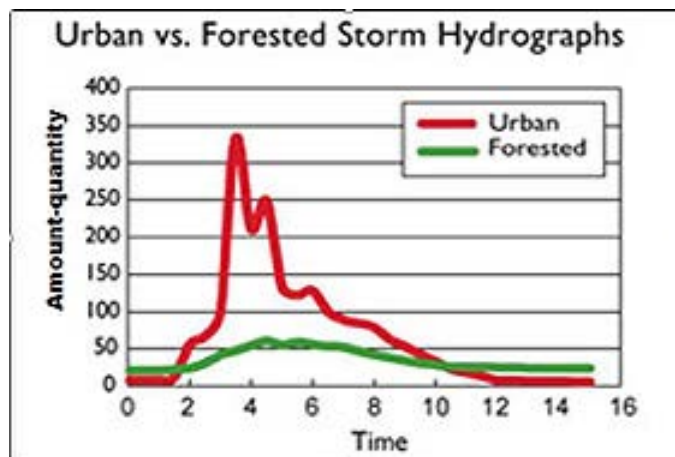
LESSON 5 - FOREST RUNOFF VS URBAN RUNOFF



NATIVE FOREST/SOIL



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





Procedure

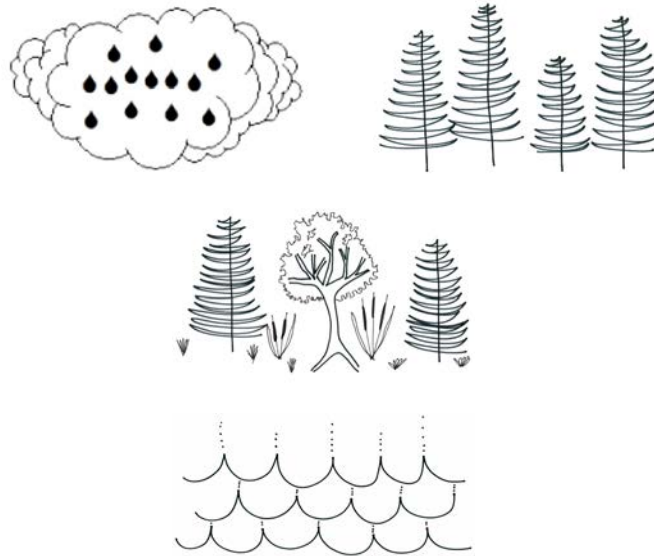
PART ONE: Model of Rain Moving through a Forest - See diagram next page

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.
 - **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 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.



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 so 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 the 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 western Washington forest, about 15% of the drops that fall from the sky will reach the creek. Time to reach creek: In a forest water moves very slowly – several days, weeks, months. In an urban setting, nearly 55-70% of the drops that fall from the sky will reach the creek. Time to reach creek: In an urban setting we have pipes, gutters, downspouts, and other conveyance structures that allow runoff to reach the creek in a matter of minutes or hours.
 - Quality: refer to the various types of pollution that raindrops picked up and brought to the creek.

LESSON 5 - FOREST RUNOFF VS URBAN RUNOFF

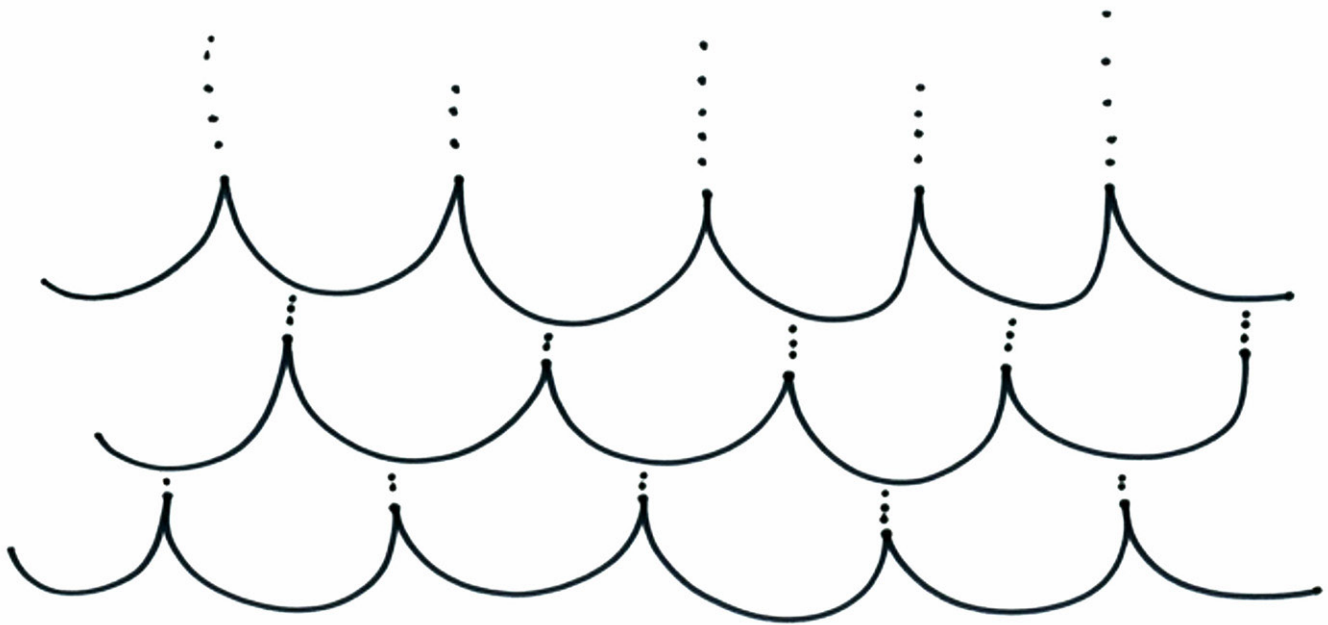


5. Have students think of solutions that an engineer could design to help water in an urban watershed flow more like the water in a forested watershed. What could an engineer design to have less water flow into creeks in an urban watershed?
6. Have students think about how natural wetlands tend to trap 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



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

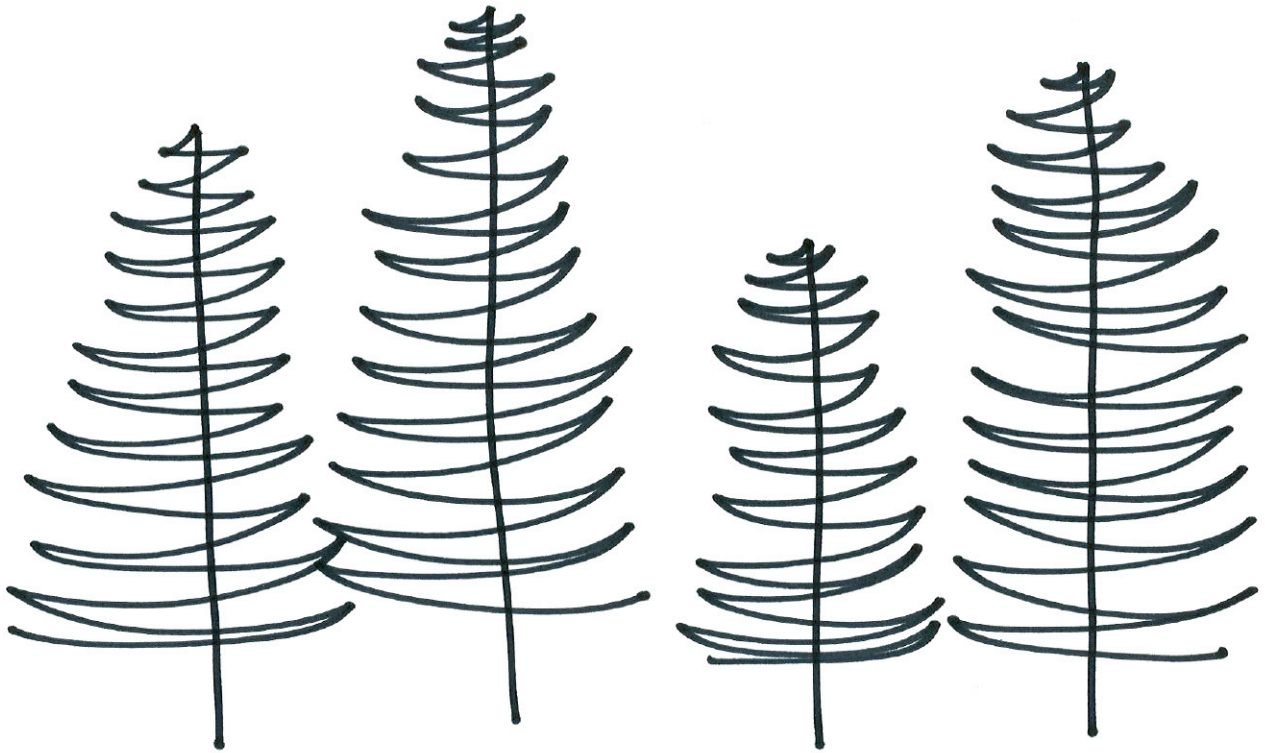
Template of pollution cards to make multiple copies put on bright colored paper and cut up.



the creek



forested wetland



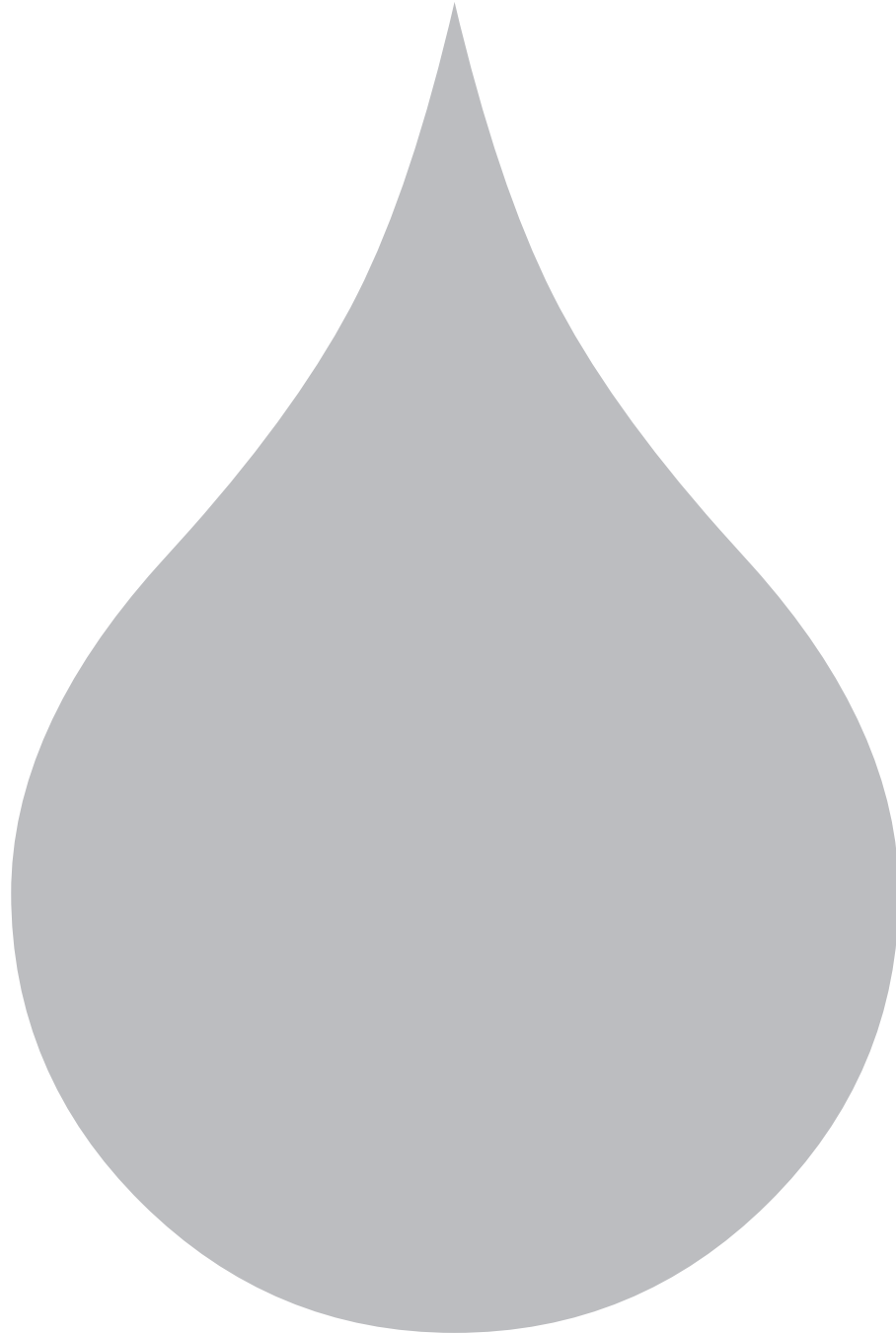
forest



**urban/
suburban**

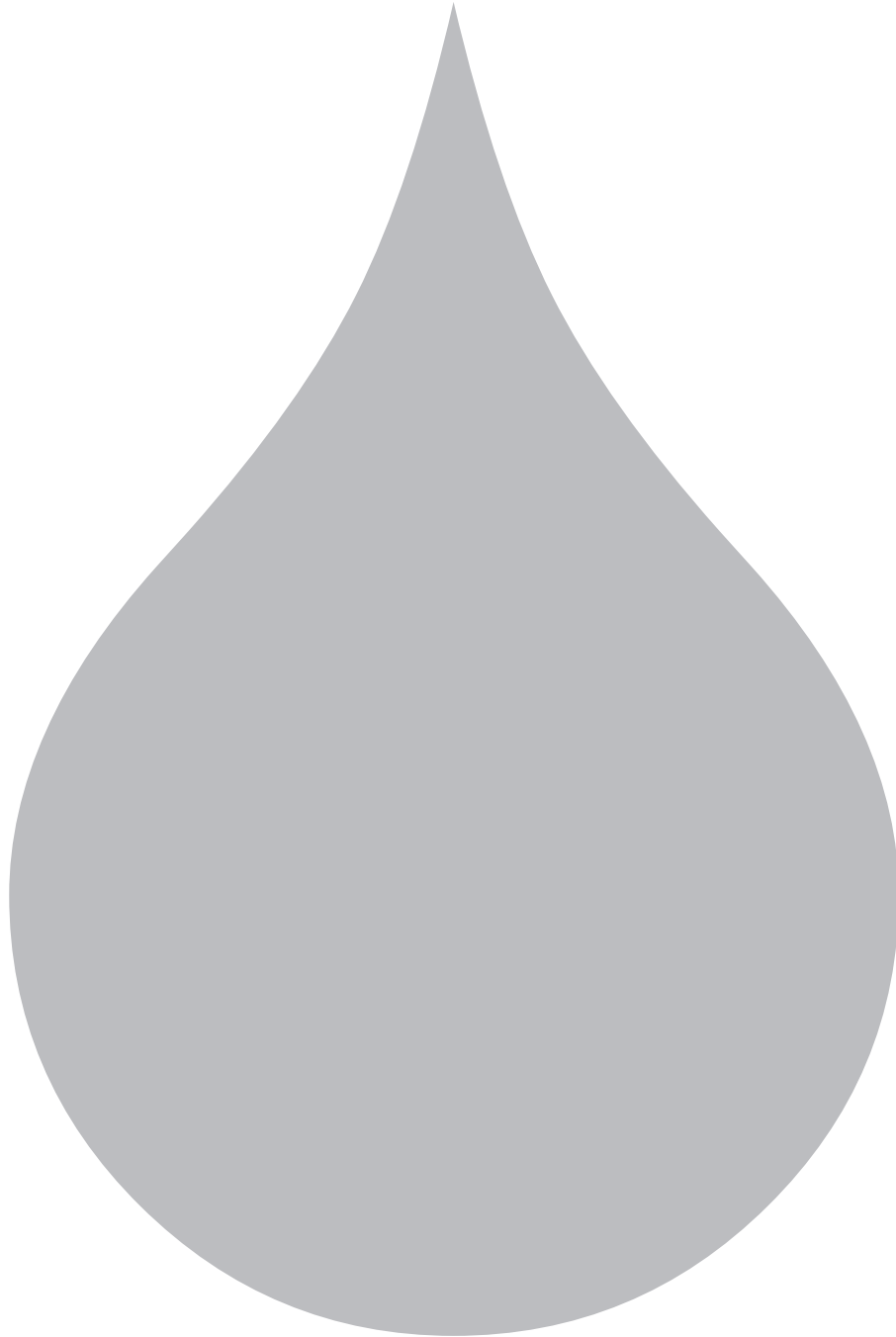


evaporation



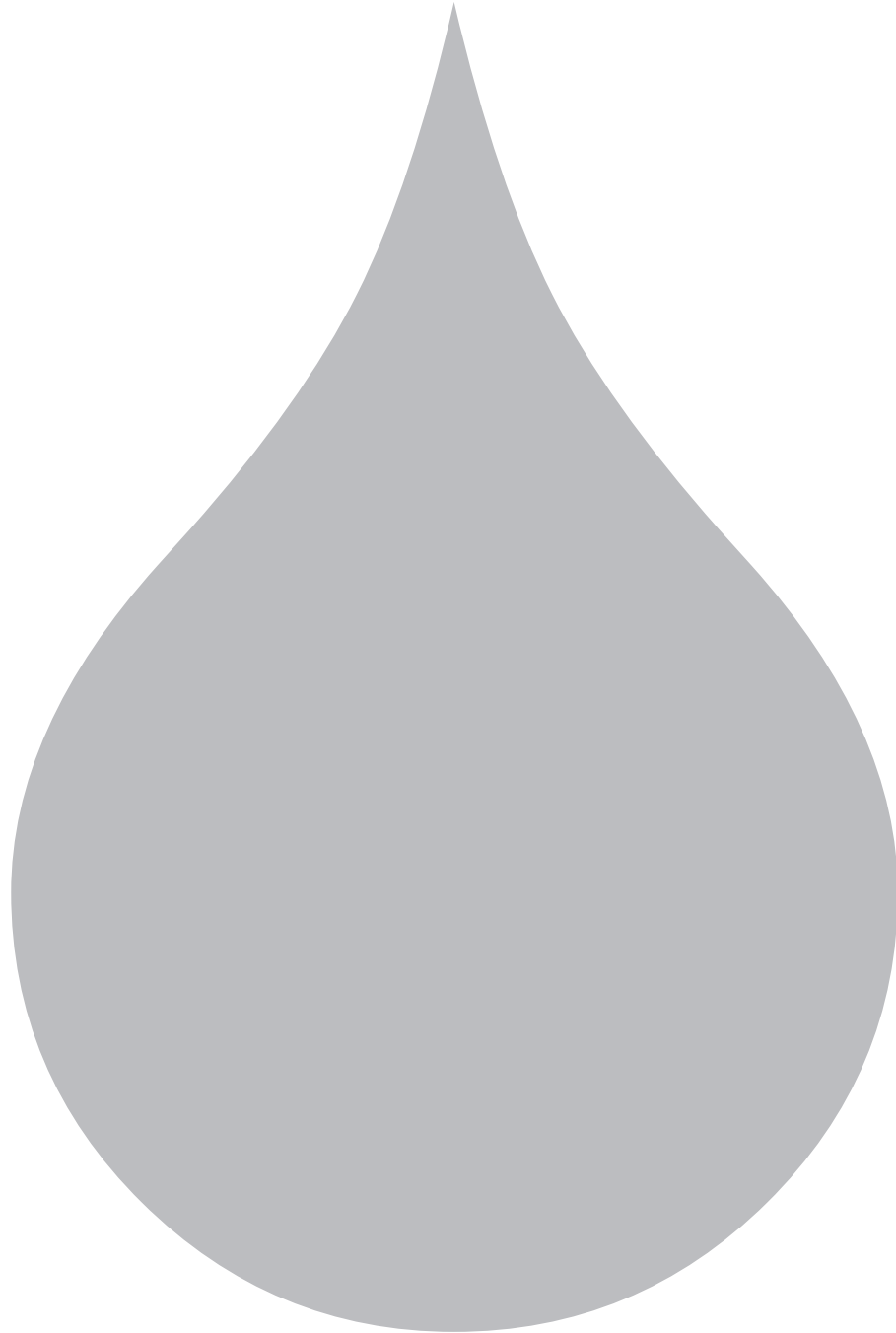


transpiration



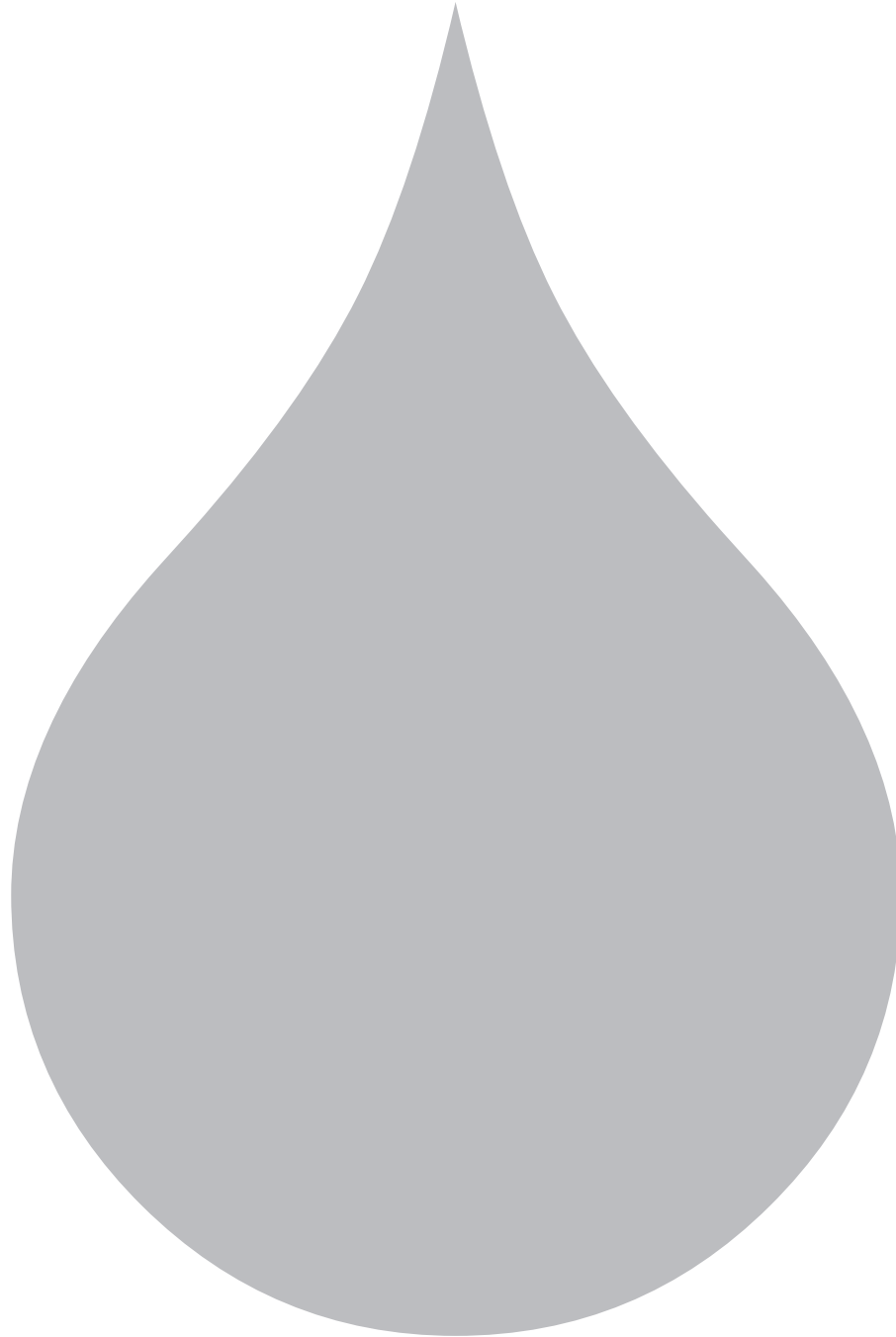


infiltration





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: _____

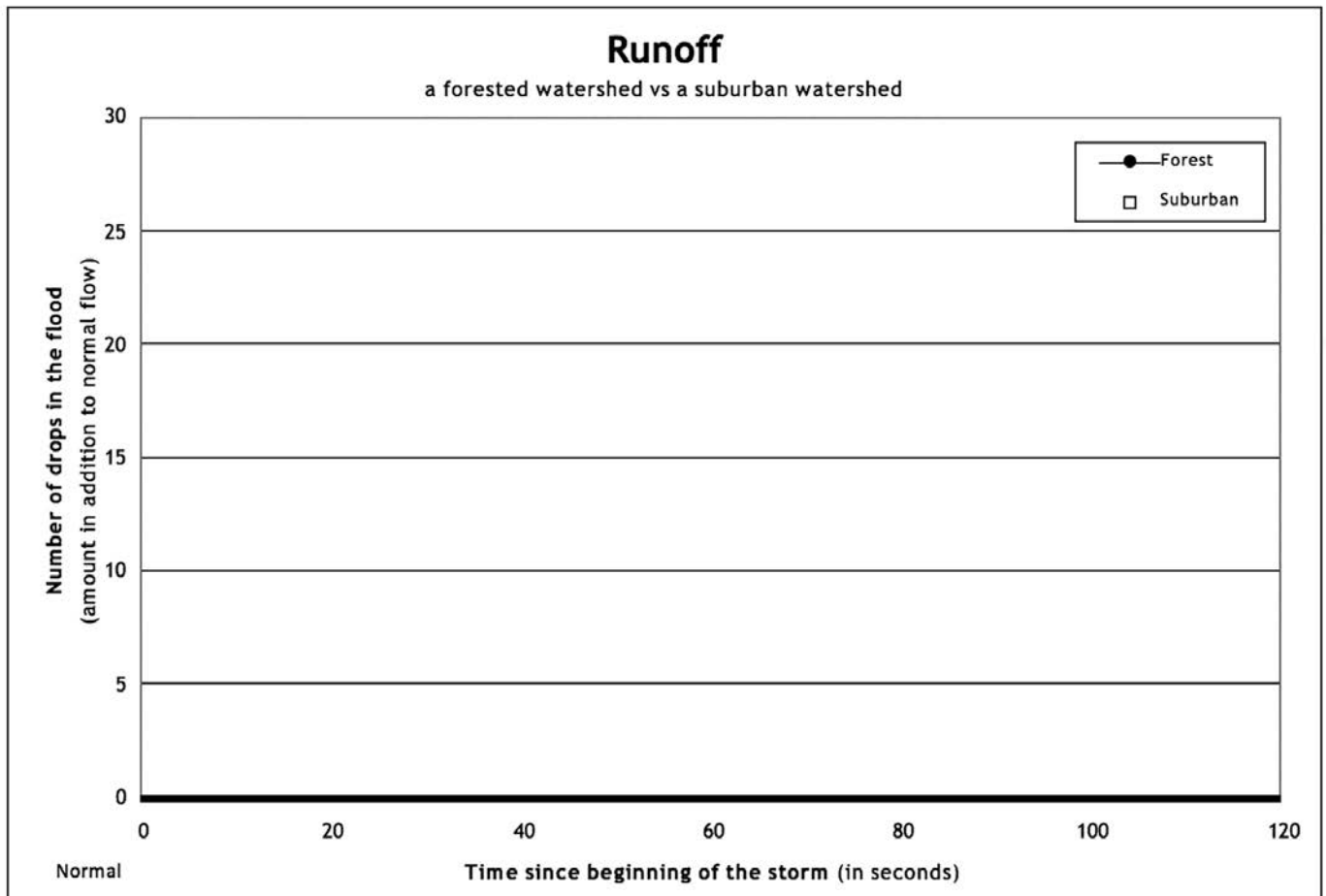
Total number of raindrops that actually reached the creek:

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



4. DISPLAY THE DATA USING A HYDROGRAPH

- a. hydro = _____ graph = _____
- b. 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.”
- c. 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.”



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 3 from Drain Rangers channel: <https://www.youtube.com/channel/UC4MI0TNPRaFJz7m11e7bDAg> and then skip to Step 5. Otherwise you can watch Video 4 or <http://www.eie.org/engineering-everywhere/curriculum-units/dont-runoff> if you would like students to have more in depth information about engineering design
2. Share with students the Engineering Design process. Use the Power Point 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 Elementary

Setting Indoors

Lesson 6 (45-50 minutes)

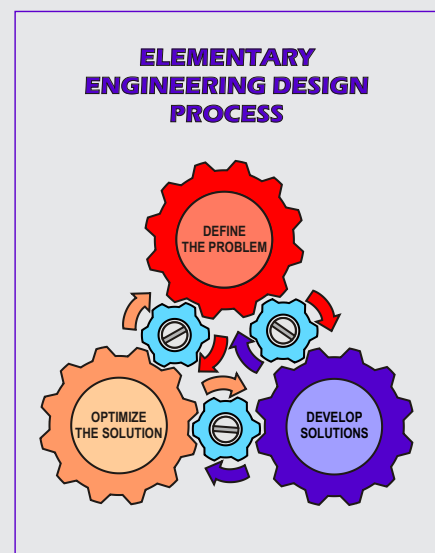
Materials

- ♦ Video 3 from Drain Rangers channel
- ♦ Video- Runoff: Special Report - <http://vimeo.com/84964332>
- ♦ Power Point
- ♦ Journal pages

Vocabulary

Optimize

Stakeholders





Engineering Design and Define the Problem

Teacher Note: These are the steps you will be going through with your students during Lessons 6-12. 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 Power Point provided to have students compare language.



Adapted from **Runoff: Special Report** <http://vimeo.com/84964332>
by Patricia Otto, Pacific Education Institute

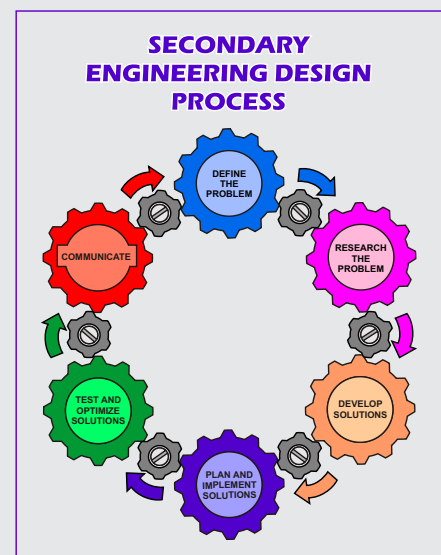
- Explain that even though the video uses different words they are talking about the same process. The chart below is an example of sharing the differences in language

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 Elementary
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 to 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 not that too much stormwater runoff is also a problem. Students' definition 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 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 creeks, streams, rivers, lakes and Puget Sound.



Defining the Problem

1. Define the problem facing your community.

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

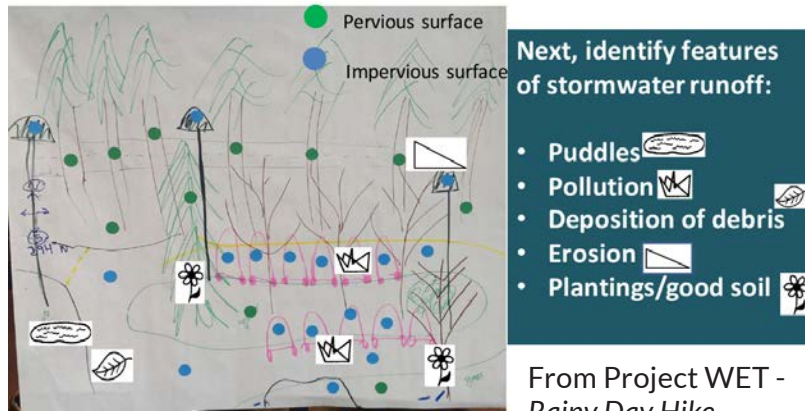
3. List things we still need to find out about.

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.



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 Elementary

Setting Outdoors

Lesson 7 (45-50 minutes)

Materials

- ◆ Power Point 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
- ◆ **Optional Lesson:** A permeability field study- Soils as Sponges <http://www.pltwa.com/soils-assponges-fi-and-assessment.html>

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 Power Point 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 Power Point 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 Elementary
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 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.
- Do a permeability study of the various land surfaces on the school campus. See *Soils as Sponges* lesson <http://www.pltwa.com/soils-as-sponges-fi-and-assessment.html>



Research the Problem



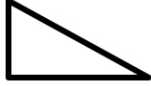

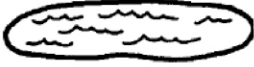




LIST OF FEATURES (evidence)
and their impact on stormwater runoff on the schoolyard campus

Feature	Impact of Stormwater Runoff



Schoolyard Stormwater

LEGEND

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



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 Elementary

Setting Indoors

Lesson 8 (45-50 minutes)

Materials

- ♦ Student Journals
- ♦ Puget Sound Starts Here Website: <http://www.pugetsoundstarts here.org/Facts.aspx>

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 Elementary

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



Activities (continued)

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 Puget Sound Starts Here website <http://www.pugetsoundstartshere.org/Facts.aspx>

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

<p>How are you connected to this school?</p>
<p>Why do you care about stormwater runoff in our community?</p>
<p>What are your top priorities for cleaning and reducing the polluted stormwater runoff in our community?</p>
<p>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?</p>
<p>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?</p>
<p>Are there any concerns you have about changes to this site?</p>

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 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 Power Point of the 14 solution ideas listed. 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 Elementary

Setting Indoors

Lesson 9

(two 60 minute classes)

Materials

- ◆ Power Point of Possible Solutions
- ◆ Drain Rangers Solution Pages
- ◆ Journal Pages
- ◆ Links to local governments for assistance on website

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

<p>Pollution Prevention - Community Outreach Solutions</p> <p>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)</p> <ul style="list-style-type: none"> • Cars: <ul style="list-style-type: none"> - Fix that leak - Use car wash • Natural Yard Care: <ul style="list-style-type: none"> - Limit fertilizers, herbicides, and pesticides - Plant trees and/or native plants - Improve Soils with compost • Pets: Scoop the poop • Pick up litter 	<p>Schoolyard Solutions (several items are in both columns):</p> <ul style="list-style-type: none"> • 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 14 solutions for them to become an expert on. 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 Stormwater solutions comparison sheet and enter the 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 peoples' 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 Elementary

Setting Indoors

Lesson 10a (2-3 classes)

Materials

- ◆ Drain Ranger Solution pages
- ◆ Journal pages
- ◆ 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 Elementary
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 Elementary
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.)

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

Not feeding birds
and ducks when
visiting parks

Fix Car Oil Leaks

Reduce Lawn

Use Natural
Fertilizer & Limit
Synthetics in
Your Yard

Wash Car at
Carwash or on
Lawn

Install Rain
Gardens

Clear Storm Drains

Put nothing down
Storm Drains



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 Environmental Project (THEN)	AFTER PARTICIPATING in the Stormwater Project (NOW)
1. I know that urban stormwater runoff is the major cause of pollution in our creeks, rivers, lakes, and Puget Sound.	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 Puget Sound 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



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

2. Describe two ways you can help the Puget Sound.

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 Elementary

Setting Outdoors

Lesson 10b (2-4 classes)

Materials

- ◆ Drain Ranger Solution pages
- ◆ More solution information – Seattle Utility Rainwise Program – (information on right hand sidebar - each solution is separate)
- ◆ Journal pages
- ◆ Materials for implementation of plan
- ◆ Video - Drained: *Urban Stormwater Pollution*
<http://vimeo.com/51603152>
- ◆ Materials to test the solution
- ◆ Video 3 - Drain Rangers channel:
<https://www.youtube.com/channel/UC4MI0TNPRaFJz7m11e7bDAg>



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 the video Drained: *Urban Stormwater Pollution* <http://vimeo.com/51603152> . 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 Elementary
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.



Planning Worksheet

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?



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 the video <http://vimeo.com/51603152> 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 Elementary

Setting Indoors

Lesson 11 (45-50 minutes)

Materials

- ◆ Data collected
- ◆ Journal pages
- ◆ 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 should 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. Teachers could share samples from the Salish Sea Research Conference so students see this as a way research is communicated in the real world.
 - 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.
2. Check the website for where you can share what your class has done.

Science

Grades Elementary

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 undergroundwater 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.

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

STORMWATER POLLUTION PROBLEM SOLUTION PAGES

Solution: Use a Commercial Car Wash



Problem

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 connect directly to our local streams, lakes, and wetlands. Dirty wash water pollutants can cause problems for us, our pets, and our environment. For example, soaps contain solvents that remove the protective coating on fish gills and amphibians which can harm or even kill them. Oil causes heart problems and death in young salmon. Heavy metals in wash water like copper damage the fine sense of smell that salmon need to detect and escape from predators.

Benefits

Millions of gallons of water are used to wash vehicles in our area each year. Commercial car wash facilities use far less water which helps conserve water for streams. Commercial facilities also filter and recycle their dirty wash water and send it to the sewer for treatment. This prevents pollution like soaps, solvents, oils, and heavy metals that are washed off of cars from reaching our streams.

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 driver 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 and may

Solution

Commercial car wash facilities use far less water than washing at home and they recycle the water. They use the appropriate cleaners to help maintain your vehicle (dish soap is like washing your car with sand paper), and they capture the harmful wash water and send it to the sewer system for proper treatment and disposal.



- require 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.
- **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:

Learn more about what you can do to prevent polluted stormwater runoff by visiting pugetsoundstartshere.org

STORMWATER POLLUTION PROBLEM SOLUTION PAGES



Solution: Don't Drip and Drive - Fix that Leak

Problem

A few drips of oil or another fluid from your car may not seem like a big deal, but thousands of vehicles are leaking throughout the region. That adds up to a big problem! 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 streams, lakes, and wetlands.

Benefits

According to the Washington State Department of Ecology, over 7 million quarts of motor oil and other automotive fluids wash into our streams, lakes, and Puget Sound 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 even death in some species. 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 \$5.00 for a new gasket to thousands of dollars for major repairs.
- **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

Solution

Vehicle leaks are the single largest source of pollution in our streams, so fixing leaks can have a huge impact on the health of our local waters. Even a small leak can have a big impact over time. Leaks also impact the life of a vehicle, so repairing leaks right away will help keep vehicle running longer.



leaks (www.fixcarleaks.org), and some rocks to hold the paper down. Repair materials depend on the cause of the leak.

- **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 and repair the leak.



MORE INFORMATION:

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STORMWATER POLLUTION PROBLEM SOLUTION PAGES



Solution: Avoid Pesticides

Problem

Some people think they need to use chemical pesticides to keep their lawns and gardens healthy and make them grow faster, but these products are unnecessary and can cause a lot of damage to us, our pets, and our environment. The suffix of pesticide, “-cide” means to kill, so while you may be killing a bug or a plant you don’t want in your yard, you are also killing important bugs and plants we need to survive. Plus, when it rains, these toxic chemicals are washed into streams where they can harm or kill fish and wildlife.

Benefits

By keeping pesticides out of our streams, we allow wildlife to thrive. Scientists have found over thirty pesticides in our streams and lakes that cause problems for plants and animals like us. Fish also eat small beneficial macroinvertebrates (stream insects) which can be killed by pesticides when they reach local streams.

Considerations

- **Cost** - Pesticides and fertilizers are more expensive than natural grass seed, compost and mulch. Residents save money by not purchasing chemical products.
- **Maintenance** - Maintaining a lawn and garden without chemicals requires people to mow higher (1-2inches), water deeply and infrequently (1 inch of water a week), pull weeds before they go to seed, overseed once a year, topdress with compost, and occasionally aerate to improve root development and water penetration.
- **Materials needed** - The natural way to maintain a really green healthy lawn is to rake, spread grass

Solution

There are many things you can do before applying harmful chemicals. First, is to select pest-resistant plants and pull weeds in the spring before they go to seed. Second, is to identify any problems before treating because issues could be due to incorrect mowing, pruning, watering, or soil conditions, and that scary insect could actually be a beneficial bug that eats problem pests.



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:

Learn more about what you can do to prevent polluted stormwater runoff by visiting pugetsoundstartshere.org

STORMWATER POLLUTION PROBLEM SOLUTION PAGES



Solution: Scoop the Poop, Bag it, and Place it in the Trash

Problem

Pet waste, like human waste, is raw sewage and contains bacteria and diseases like E. coli and Giardia that can make animals like us sick. When it rains, pet waste left in our yards and public spaces gets washed into our storm drains and sent directly to the nearest lake, stream, or wetland without treatment. This sends lots of nutrients from our pet waste 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, forcing beaches to close and contaminating shellfish beds, an important source of food and money for Washingtonians.

Benefits

Picking up pet waste protects people and pets from being infected by harmful bacteria and diseases in our homes, yards, and public spaces. Proper disposal also prevents waste from being washed into our streams and lakes when it rains, keeping our beaches and shellfish beds clean and open for everyone to enjoy. Keeping the excess nutrients from pet waste out of the water helps reduce harmful algal blooms which further contaminate our beaches, shellfish, and rob our waterways of the oxygen that fish and other aquatic life need to survive.

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 or scoop may be desired.
- **Maintenance** - Scooping waste requires the pet

Solution

The great news is that it's easy to protect ourselves and our local streams, simply scoop the poop, bag it up, and place it in the trash.



owner to pick up the pet waste and place it in the trash on a regular basis.

- **Materials needed** - Bags to collect and dispose of the waste and sometimes a small scoop or extended shovel are preferred to collect the waste.
- **Time needed** - Scooping pet waste and placing it in the trash may take an extra minute of time.



MORE INFORMATION:

Learn more about what you can do to prevent polluted stormwater runoff by visiting pugetsoundstartshere.org

STORMWATER RUNOFF PROBLEM: SOLUTION PAGES

Solution: Pick Up Litter



Problem

Litter is what we call trash and dangerous items that are left on land or in water and are not disposed of properly. A large amount of litter is found in parking lots, yards, and along roadways. This litter makes its way into local streams and lakes through storm drains and can impact the environment for years to come. For example, floating pieces of plastic tangle themselves around fish and wildlife, causing harm and even death. Plastic litter can eventually break down into tiny pieces called *microplastics* and float or sink. The floating pieces can be mistaken for food by wildlife and make them sick. Sinking plastic can smother habitat and release toxic chemicals into the water, causing problems for fish and wildlife.

Benefits

Picking up litter helps in a variety of ways. First, picking up a can or bottle may help keep people from thinking it's OK to toss their trash on the ground. Second, people also feel better about themselves and their surroundings when outdoor spaces are clean and free of trash. Finally, proper disposal of trash keeps our streams and lakes clean and healthy for fish, wildlife, and us!

Considerations

- **Cost** - Gloves, a bag, and grabbing tool might be needed to complete this work. Gloves range from \$2.00-15.00. Bags costs \$.04-.05 per bag. A one-time cost for a grabbing tool may be desired.
- **Maintenance** - Placing trash and recycling can in convenient spots is a great way to

Solution

The great news is that it's easy to protect ourselves and our local streams and lakes by simply picking up litter and placing it in the trash.



encourage people to pick up after themselves. These cans will need to be emptied on a regular basis. Hand collection is also a good idea and should be conducted on a regular basis as well such as weekly, biweekly, or monthly.

- **Materials needed** - Basic materials include trash cans, bags, gloves, and a grabbing tool.
- **Time needed** -Time will depend on the size of the area you are cleaning up and the amount of litter left onsite. Emptying trash cans typically takes a minute or two.



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STORMWATER RUNOFF SOLUTION PAGES

COMPARISON SHEET



Before selecting a solution, you must consider the resources available and existing site conditions.

Resources- it is important to review your available resources before selecting the appropriate solution:

- **Cost** - Costs will vary depending on the size, materials used, equipment needed, conditions of the area you are converting, and whether you hire someone to do the work or do it yourself.
- **Installation-** will depend on the size, plants, permits, and current conditions of the site.
- **Maintenance** - During the first two to three years, any plants will need to be watered during the dry months, mulch will need to be placed around plants, and weeds will need to be removed. Inspections should be conducted seasonally and after large storm events to remove sediment, weeds, and replace plants as necessary.

Site conditions- it is important to assess the property for soil type, slope, amount of space available, and proximity to buildings or neighboring properties before selecting the appropriate solution:

- **Slopes-** whether the land is flat or hilly matters when you are installing certain features.
- **Space limitations-** the amount of space you have available will determine what can be placed onsite.
- **Soil conditions-** soil conditions are important when trying to allow the water to soak into the soil.
- **Light conditions-** trees and other vegetation need varying degrees of light throughout the day.

	Bioswale	Compost	Plant Trees	Disconnect Downspouts	Rain Garden	Install Cistern	Porous Pavement
Cost	\$	\$	\$	\$	\$\$	\$\$	\$\$-\$\$\$
Installation	Moderate	Easy	Easy	Easy	Moderate	Complex	Complex
Maintenance	Moderate	Low	Low	Low	Moderate	Moderate	Moderate-High
Steep or hilly slopes	Moderate Only	Flat-Steep OK	Flat-Steep OK	Moderate-Steep OK	Flat-Moderate OK	Flat OK	Flat-Moderate OK
Limited space	OK	OK	Sometimes OK	Sometimes OK	Not OK	Not OK	OK
Soil conditions	Well-Moderately Draining	Well-Poor Draining	Depends on species	Well-Moderately Draining	Well-Moderately Draining	N/A	Well-Moderately Draining
Light conditions	Partial sun OK	N/A	Depends on species	N/A	Full sun-shady	N/A	N/A
Water quality benefits	yes	yes	yes	yes	yes	no	yes
Flow control benefits	yes	yes	yes	yes	yes	yes	yes



MORE INFORMATION:

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STORMWATER RUNOFF PROBLEM SOLUTION PAGES



Solution: Install Bioswale

Problem

Rain falling on hard surfaces like roofs, driveways, sidewalks, parking lots, roads, and compacted soils runs off quickly into the nearest storm drain. This drain takes the water in pipes to the nearest lake, stream, or wetland. This fast moving water causes soil erosion in our streams, 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 our environment.

Benefits

Bioswales slow down stormwater runoff reducing the amount of water entering the storm system which helps reduce soil erosion and flooding. The soil and plants act like a filter and remove some of the pollution carried by the stormwater runoff before it reaches local streams. The soil also cools the water as it soaks in, helping to lower stream temperatures, and protecting habitat for salmon and other wildlife.

Considerations

- **Cost**- Costs will vary depending on the size, materials used, site conditions, and whether you hire someone to do the work or do it yourself. Roadside bioswales are generally cheaper than traditional pipe systems.
- **Time needed** - Time will depend on the size, plants, permits, and current conditions of the site.
- **Maintenance** - During the first 2-3 years, the plants will need to be watered during the dry months, mulch will need to be placed around plants, and weeds will need to be removed. Inspections should be conducted seasonally and after large storm events to remove sediment, weeds, and replace plants as necessary.

Solution

A bioswale, also called a vegetated swale, is a shallow ditch that contains soils and plants that act like a sponge to help capture and soak up more stormwater runoff. A bioswale also slows down stormwater runoff, allows some of the water to soak into the soil, and filters out some of the pollution that the water collected along the way.



- **Materials needed** - For installation, you will need equipment to construct the swale like; shovels, rakes, measuring tape, wheelbarrow, stakes, string, plants, mulch, rocks, and seed for the grass portions.
- **Location** - Bioswales perform very well in a variety of locations. Because they are narrow, they are ideal in small areas, along roads, and in parking lots. They should be avoided in areas that are completely flat or very steep because some slope is needed so the water will move, but not too much or the water will pass through too quickly to provide any water quality benefit and possibly cause erosion and flooding.



MORE INFORMATION:

Learn more about what you can do to prevent polluted stormwater runoff by visiting pugetsoundstartshere.org

STORMWATER RUNOFF PROBLEM SOLUTION PAGES



Solution: Add Compost to Soils

Problem

Poor draining soils do not allow water to pass through which causes ponding, flooding, and allows water to run off rather than soak in. Plants can also drown if the soils do not drain. Unhealthy soils have fewer beneficial living organisms, are often compacted, offer little nutrients to plants.

Benefits

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 streams. Healthy soil cools stormwater as it passes through which provides cooler water for local streams 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, wheelbarrow, container, rake, and water hose.
- **Mulching** - Materials from your yard are free, otherwise compost from a store ranges from \$5.00 per bag to \$25.00 per small pickup truckload.
- **Maintenance** - Experts estimate that mulch and compost should be added each year in either spring or fall so some on-going maintenance will likely be necessary.
- **Time** - The time required depends on the size of your yard .
- **Design** - A day is typically all is necessary to determine where the materials should be placed.
- **Labor** - A few hours to a day will be needed for the initial work.

Solution

Compost is decaying organic material that you can use to fertilize plants. Adding compost to soil helps balance it's pH making it healthy for plants and the beneficial living organisms that live in the soil. It also provides nutrients that plants need to grow. A teaspoon of healthy soil contains about 4 billion living organisms! Compost also creates larger spaces between particles that allow air, water, and plant root growth into the soil.



MORE INFORMATION:

Learn more about what you can do to prevent polluted stormwater runoff by visiting pugetsoundstartshere.org

STORMWATER RUNOFF PROBLEM: SOLUTION PAGES



Solution: Plant Trees

Problem

When people develop an area of land for homes, buildings, roads, etc. they often cut down most or all of the trees. This drastically changes the way water flows across the land and increases the amount of stormwater runoff. This increased runoff causes local flooding and erosion stream banks.

Benefits

Trees capture stormwater when it rains and slow it down, reducing local stream flooding and erosion of stream banks. Trees planted along a stream provide shade and cool the water temperature which is important for fish. Trees drop leaves and other nutrients into the stream which feed the small underwater insects that fish and other insects eat. They can also provide nutrients for other aquatic animal and plants. Trees 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. Trees help clean our air and absorb carbon dioxide which help reduce air and water temperatures.

Considerations

- **Cost** - The cost of trees 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, provide water and nutrients for your new trees. Wood mulch should be placed around the tree annually (being careful not to put it close around the trunk) to slow the growth of weeds and help keep

Solution

Trees catch rainfall on their leaves and needles, slowing it down and allowing much of it to evaporate back into the air. Tree roots also loosen the soil, creating more space for water to soak in, absorb groundwater and transpire it through their leaves or needles back into the air. Trees have other benefits too: cooling our homes and buildings in summer and blocking 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.



moisture in the soil.

- **Materials needed** - Basic materials include gloves, a shovel, and a tree.
- **Time needed** - It typically takes 5 to 10 minutes to plant a tree. The maintenance will vary depending on the year, seasonal conditions, and number of trees planted.



MORE INFORMATION:

Learn more about what you can do to prevent polluted stormwater runoff by visiting pugetsoundstartshere.org

STORMWATER RUNOFF PROBLEM SOLUTION PAGES

Solution: Disconnect Downspouts



Problem

Rain that falls on a roof is carried through rain gutters to downspouts along the outside of the building. Home and other building downspouts are often connected directly to the stormwater pipes under the street. These pipes take this stormwater from our roofs quickly to the nearest lake, stream, or wetland. In large rain storms, this stormwater runoff can contribute to local flooding and stream bank erosion.

Benefits

Disconnecting downspouts can reduce the amount of stormwater rushing into streams during rainstorms. Reducing the flow of water helps protect streams from erosion and flooding.

Considerations

- **Cost** - Costs for disconnecting a downspout range from \$50 to over \$1000, based on materials used and size of the area to where the water will flow.
- **Time needed** - Disconnecting the downspouts is fairly simple, but time will vary based on where you decide to direct the water.
- **Maintenance** - During the first year, the downspout should be checked during and after large rainstorms to ensure the diversion is working and water collection is functioning properly. After that, it should be checked twice a year and maintained as necessary.
- **Materials needed** - connection elbow, water diversion path materials (rocks, pipe, etc.), collection unit (rain barrel system or cistern), plants (if needed).
- **Other** - Homeowners should check with their local

Solution

Disconnecting downspouts from the stormwater pipes and diverting the water to be collected or absorbed into the soil reduces stormwater runoff. The downspout water can be sent to a cistern for collection or away from the house to a landscaped area that will allow the water to soak into the soil. This landscaped area can be a rain garden, large lawn, or natural vegetated space.



public works department before disconnecting their downspouts. They must also be able to answer these questions:

- Can they direct stormwater runoff to a place that can collect and absorb a large amount of water during rainstorms? Can they direct runoff to rain garden, cistern, or large lawn/landscaped area? Can the water get there safely? Is there adequate pipe, splash block, swale, or way to move water away from the house or building to the soil?
- What happens in a bad storm? Can water overflow safely without flooding neighbors or sidewalks? Are there steep slopes or landslide prone areas in the neighborhood? Does water pool in the yard during winter months?



MORE INFORMATION:

Learn more about what you can do to prevent polluted stormwater runoff by visiting pugetsoundstartshere.org

STORMWATER RUNOFF PROBLEM: SOLUTION PAGES



Solution: Rain Gardens

Problem

Rain falling on hard surfaces like roofs, driveways, sidewalks, parking lots, roads, compacted soils runs off quickly into the nearest storm drain which takes the water in pipes to the nearest lake, stream, or wetland. This fast moving water causes soil erosion in our streams, 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.

Benefits

Rain gardens slow down stormwater runoff reducing the amount of water entering the storm system which helps reduce soil erosion and flooding. The soil and plants act like a filter and remove some of the pollution carried by the stormwater runoff before it reaches local streams. The soil also cools the water as it soaks in, helping to lower stream temperatures, and protecting habitat for salmon and other wildlife.

Considerations

- **Cost** - Costs will vary based on size, site conditions, and materials. Hiring someone to design and install the garden will increase cost.
- **Location**- rain gardens can only be located where the soil drains well enough to allow the water to filter through.
- **Maintenance needed** - During the first 2-3 years, the plants will need to be watered during the dry months, mulch will need to be placed around plants, and weeds will need to be removed. Inspections should be conducted seasonally and after large storm events to remove sediment, weeds, and replace plants as necessary.
- **Materials needed**- Materials will depend again on the type of garden, but a typical list would include equipment to dig the site, rocks, compost, plants, irrigation or watering hose, and mulch.
- **Permits**- some cities and counties require you to check with them before disconnecting any downspouts. They may need to see the rain garden plans to be sure it can handle the amount of water being directed to it.
- **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.

Solution

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



MORE INFORMATION:

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STORMWATER RUNOFF PROBLEM SOLUTION PAGES



Solution: Install a Cistern

Problem

Rain or snow that falls on roofs is carried through rain gutters to downspouts along the outside of homes or buildings. These downspouts are often connected directly to the stormwater pipes in the street. These pipes take stormwater quickly to the nearest lake, stream, or wetland causing soil erosion in our streams, and higher water temperatures in the summer months. The water also picks up chemicals and heavy metals from roof materials and deposits them into our streams.

Benefits

Cisterns or a series of rain barrels slow the flow of stormwater by capturing the water for later use. Using cisterns and rain barrels and then releasing the water onto your lawn also allows polluted runoff from roofs to be filtered out by soils on-site before entering streams or lakes.

Considerations

- **Cost** - Cisterns and rain barrels vary greatly in cost depending on the material that they are made of, how big they are, and whether a homeowner installs it themselves or hires someone else, etc. Homeowners need to shop around for materials and plan carefully to find a cistern that meets their space, capacity needs, and site conditions.
- **Maintenance** - Property owners should choose a dark colored tank and place it in a shaded area to limit algae growth. Some tanks can be installed underground, in crawl spaces, or under porches but these are more expensive, harder to install, and harder to repair/maintain. Once or twice a year, the condition of a cistern and the water in the cistern should be checked. The filter

Solution

Disconnecting downspouts from stormwater pipes in the street and connecting the downspout to a cistern or multiple rain barrels allows the water to be collected and used or released later to reduce local flooding and stream bank erosion.



should be cleared of any debris at the beginning and end of the rainy season.

- **Materials needed** - Level location near a downspout, a solid base, a safe place to allow the water to flow from the tank that must be away from homes, buildings, structures, and neighbors.
- **Other** - Some cities have hazard areas that do not allow residents to disconnect their downspouts, so homeowners should check with their local public works department before disconnecting their downspouts and installing a cistern.



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STORMWATER RUNOFF PROBLEM SOLUTION PAGES



Solution: Install Pervious Pavement

Problem

Types of pavement, like asphalt and concrete, are called “impervious surfaces” because they don’t let the rain soak into the soil. Instead rain runs off of these surfaces and into our storm drains. In big storms, stormwater runoff can contribute to local flooding and stream erosion. These impervious surfaces also deposit millions of pounds of pollution into our streams and Puget Sound every year.

Benefits

When water is allowed to soak into the soil, it is slowed down and reaches streams 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 streams. The soil also cools the water and helps lower stream temperatures which is better for salmon and wildlife that live in our streams and Puget Sound.

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 at least annually to prevent spaces from clogging with dirt and debris. Permeable pavers may need to be mowed to keep plants in between them from getting too large.
- **Materials needed** - Porous pavement or pavers,

Solution

Homeowners can reduce stormwater runoff impacts by choosing pervious pavement options for their driveways, sidewalks, and patios (like porous asphalt, pervious concrete, and permeable pavers) that let the rain soak through into the soil.



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 to weeks and maintenance should take a few hours annually.
- **Site conditions** - the soils need to be able to drain the water fairly quickly to prevent puddles and potential flooding.



MORE INFORMATION:

Learn more about what you can do to prevent polluted stormwater runoff by visiting, pugetsoundstartshere.org .