Map



Description automatically generatedGrade Level: 5th adaptable 4th-8th

UNIT 2

**STORMWATER**

Teacher Guide

**Earth Sciences:** The Roles of Water in Earth’s Surface Processes, Natural Resources, Human Impacts on Earth Systems

**Engineering Design:** Defining Problems, Developing Possible Solutions

Explore Chapter: 2 WHY THE SALISH SEA IS SPECIAL

A picture containing logo

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A drain cover on the ground

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**Table of Contents**

**Background for the Teacher 2**

**Sources and Further Learning 4**

**Unit Overview 5**

**Storyline and Terms for the Teacher 6**

**Lesson 1 – What patterns do we notice in animal migration? 7**

**Learning Targets and Terms for the Teacher 7**

**Teacher Prep Lesson 1 8**

**Materials and Weblinks for Lesson 1 9**

**Class Session Guide Lesson 1 11**

**Lesson 2 – How can we test water to see if it is safe for aquatic life? 14**

**Learning Targets and Terms for the Teacher 14**

**Teacher Prep Lesson 2 15**

**Materials and Weblinks for Lesson 2 14**

**Class Session Guide Lesson 2 15**

**Lesson 3 - How can we design a solution for clean stormwater?**

**Learning Targets and Terms for the Teacher 17**

**Teacher Prep Lesson 3 18**

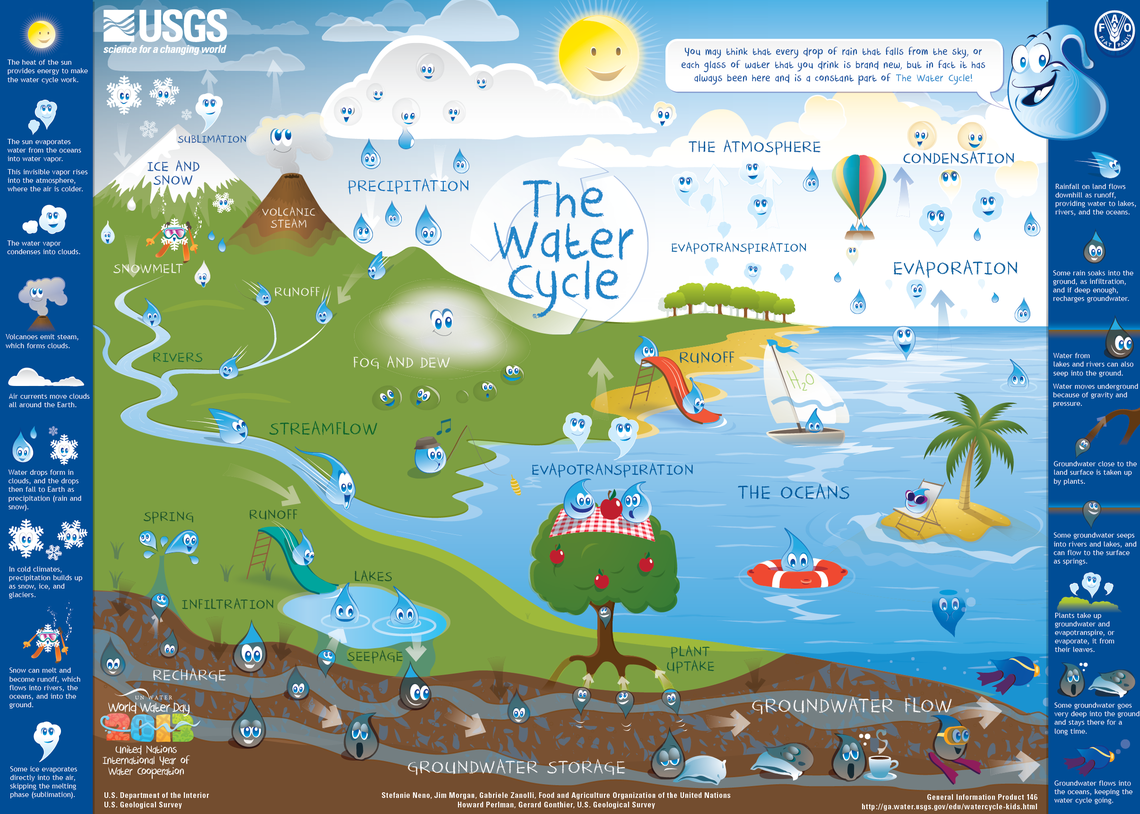
**Materials and Weblinks for Lesson 3 19**

**Class Session Guide Lesson 3 20**

**Background for the Teacher**

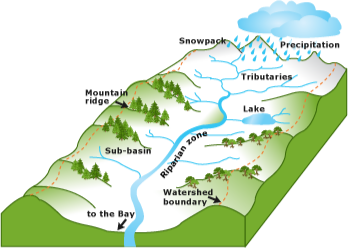
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Water that evaporates from the land, ocean, and waterways rises to the sky where cold air condenses it to droplets, snow, or sleet that falls to the ground and seeps in until it saturates the land and no more can be absorbed. This may happen very slowly on slopes covered with a thick layer of soil with many plants and trees or very quickly on rock or pavement-covered hillsides with few plants. It then rolls downhill, gathers into streams which merge into rivers, then arrives at an estuary where the freshwaters meet the sea.   
  
 You know this as the water cycle that we all had to memorize in school, usually from diagrams with arrows pointing from one phase of water to the next – evaporation, condensation, precipitation, saturation, and around again. This unit takes a more exploratory approach, building on the experience of a cloud forming before their eyes in unit 1 to following that water from “snow caps to white caps”. Of course, there is room for a diagram and here we interact with a less simple, more engaging one by the USGS:



As water flows from the mountain crests and ridges and gathers in the valley below, it is being “shed” by the hillsides into one gathering place, such as a river, lake, or estuary, where the fresh river water meets the salty sea.

One area, bounded by hill crests and ridges, shedding water to a common body of water is called a *watershed*. The Salish Sea can be defined as one great watershed, but so can individual drainages within this greater bioregion. These are called sub-basins.



Watershed diagram by

A vegetated watershed, with forests, meadows, wetlands, salt marsh, and seagrass beds, will slow and absorb the running water, prevent flooding, prevent erosion, keep streams and rivers clear, and even chemically change and absorb pollutants like a sponge, cleaning the water for wildlife and people.

Impervious surfaces (such as asphalt, concrete, and metal and composition rooftops) keep water from soaking into the soil and keep plants from purifying the waters. They act more like a cookie sheet than a sponge, allowing water to move faster to the sea. This water can then wash with it pollutants, like: soaps and detergents from washing cars and boats, fetillizers and pesticides from lawn care and farms, road film (rubber tire and copper break particles, oil and fuel, antifreeze, and more), and industrial wastes.

This water, called *stormwater*, eventually lands into the rivers, estuaries, and sea. *S*cience is showing that stormwater is affecting salmon and killer whale survival by disrupting oxygen absorption, immune response, and many other health issues among many other species. Read this EPA article to better understand stormwater quality issues: <https://www.epa.gov/salish-sea/freshwater-quality>

A diagram of a fish life cycle

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How toxins move from stormwater into sealife. Image by WA Dept. of Ecology.

There is great hope in results seen from biofiltration. Biofiltration is the directing of stormwater runoff to soils planted with beneficial native plants that reduce the toxin and sediment load, purifying the water before it is returned to the stream, river, or bay.

In this unit your students will observe a storm drain to spark wonder about just what is flowing from our communities to the sea. From here they will find out what makes up a watershed by modeling one, discover what happens with and without biofiltration, and design an investigation to test out waterway near your school. Results from their study will be used in unit 8 as they choose a project to improve the environment in your own community.

Reaching out and building a relationship with a local watershed conservation expert will add value to this unit and help shoulder the load of materials, expertise, and scientific inquiry organization. You can find willing experts in our Marine Experts Map on the Junior SeaDoctors website: www.juniorseadoctors.org/map, as well as connecting with your local tribe or First Nation through your district’s indigenous liaison.

Sources

Padilla Bay National Estuarine Research Reserve. 1989. The Estuary Guide Level 2 (4th-8th grades). *Ecology Publications and Forms*. Washington State Department of Ecology. Lacey, WA. Available online at <https://ecology.wa.gov/Water-Shorelines/Shoreline-coastal-management/Padilla-Bay-Reserve/Education-programs/Teachers-resources>

USGS.

WA Dept. of Ecology.

Further Learning and Classroom Resources

NOAA. N.D. Watershed in a Box lesson plan. Estuary Education Resources, Watershed in a Box. Available online at <https://coast.noaa.gov/estuaries/curriculum/watershed-in-a-box.html>

NOAA Estuary Education Resources. Available online at <https://coast.noaa.gov/estuaries/curriculum/>

**Unit Overview**

How can we gather and communicate evidence about how the geosphere, biosphere, and hydrosphere interact?

**Anchoring Phenomenon:** Water flowing from the school parking lot into a storm drain

**Research Challenge:** How can we measure whether our local storm water is healthy for aquatic life?

**Engineering Challenge** How can we design a solution for clean stormwater?

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| **Lesson 1 - 4** days  What happens to water when it rains? | **Lesson 2 - 5** days  How can we test water to see if it is safe for aquatic life? | **Lesson 3 – 5** days  How can we design a solution for clean stormwater? |
| Session 1  What do we wonder about water running into a stormdrain?  Session 2  In what states of matter does water exist?    Session 3  What do we notice about water running through the watershed to the sea?  Session 4  What does water mean to Coast Salish peoples? What is one way Coast Salish peoples explain how water moves through Earth’s surfaces. | Session 1  What kind of water quality does aquatic life need to be healthy? Is clean water a human right or responsibility?  Session 2  How can we be water protector allies? What testable question, hypothesis, and procedure will guide our local stormwater quality research?  Session 3  How can we carry out water quality testing in our local stormwater?  Session 4  What is the best type of graph to show our water quality results as a picture and decipher what they mean?  Session 5  How can we communicate our water quality results and conclusions to others? | Session 1  How can our scientific research inform stormwater solution design?  Session 2  What types of stormwater filtration designs yield the cleanest water?  Session 3  What are other scientists doing to clean stormwater in our community and elsewhere? |
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| **UNIT 2: STORMWATER STORYLINE**  Students will consider gratitude for and responsibilities to water and figure out how to identify and support safe water quality for people and aquatic life. They will first wonder at water flowing from your school parking lot into a storm drain and develop an essential question related to determining if local stormwater is safe for living things. Learning the cultural significance of water to Coast Salish people will connect strengths of both Western and Indigenous Science, pulling together for clean water.  Students will gather clues to answer their essential question together in Explore Teams by modeling the water cycle in action, where water exists in the world, and how it travels through a model watershed, eroding sediments and picking up nutrients and pollutants on its way to the sea. Then students will learn about these nutrients and pollutants and what levels are safe for aquatic life.  Now students are equipped to embark on their own, authentic process of science, by forming one testable question for the class and individual hypotheses about the outcome that will guide their research on stormwater in your own community. With the help of a web interactive and an online tutorial, you will guide research design for your class to test water quality in a stream or stormwater outfall near your school. Exact research design is up to you and your class. A few ideas are to compare water quality:   * In a river or stream before and after it passes through your town * In stormwater before and after it passes through a raingarden or natural or constructed wetland * In collected rainwater vs. the stormwater outfall pipe that drains to a bay or river   Students will argue using evidence in a Get CERIAs (claim, evidence, reasoning, implications, and applications) forum, suggesting solutions for improving stormwater quality in the applications step. The next, optional step is to provide a design challenge for Explore Teams to engineer a solution for clean stormwater. You will guide the engineering process and provide materials and support for a fun competition: which design yields the cleanest water? | **TERMS FOR THE TEACHER**  A picture containing text, sign  Description automatically generated**Assessment**- a chance to measure overall growth through a pre- and post-assessment for each unit. **A picture containing object, mirror  Description automatically generated**  **Background research**- includes the Explore the Salish Sea book, articles, videos, games, songs, and expert guests.  Shape  Description automatically generated with low confidence**Essential question** – The overarching question that drives the background research, games, activities, and authentic inquiry for each unit.  Checkbox Checked with solid fill  **Formative Assessment** – opportunity to check for student understanding and misconceptions.  **Games-** games are used to introduce and reinforce concepts through play. Instructions are included.  **Diagram  Description automatically generatedMind Map** – Draw a model with the problem in the center circle and clues to solving it connected to it, grouped by related ideas.  **Shape  Description automatically generated with low confidenceModel** – A physical, mathematical, or conceptual representation of an object, process, or event**Text  Description automatically generated**  **Team Read** – The equitable division of a large piece of literature among teammates, each getting summarized individually, and then synthesized into one summary. This allows each student to feel that they have contributed an important piece of background research, while accommodating individual reading levels.  A picture containing sign, dark  Description automatically generated**Team Talk** –Each student shares ideas with their Explore Team for 1 uninterrupted minute to ensure equitable sharing and give a voice to students who may not speak out in a full-class discussion. The Science Communicator reports a summary to the class. This symbol is also used when students communicate their science with the class or greater community.  **A picture containing text, sign, dark  Description automatically generated**A picture containing icon  Description automatically generated**Tribal Knowledge** - Work with your district’s Tribal or First Nations Liaison, if you have one, to invite a cultural outreach or natural resources employee from a local tribe or First Nation to meet with your class and share *what they deem appropriate* about the topic.  **Wonder** – a phenomenon, problem, or discrepant event that sparks curiosity in students and initiates exploration  *Icons in this curriculum are from "https://www.flaticon.com/ free-icons/chemistry" title="chemistry icons">Chemistry icons created by Freepik - Flaticon</a>* | |
| **LEARNING TARGETS LESSON 1:** Understand that all of the water on the planet makes its way to the land, groundwater, lakes, rivers, estuaries, the sea, and clouds, and it continually cycles through all of those locations over time.Know at least four steps of the water cycle.Understand that water can be in solid, liquid, and gaseous states.Know that erosion causes sediments and other substances to be transported from land into water sources.Know what a watershed is and what the local watershed encompasses.   **TEACHING WITH THE 5 E’s FOR A COHERENT STORYLINE – LESSON**  ENGAGE activity: Students wonder about water draining into a stormdrain in the school parking lot and develop an essential question.  **Practice**: Asking questions  EXPLORE activity: Students model the water cycle and areas where water exists in the world.  **Practice:** Developing and using models.  EXPLAIN activity: Students hear a Jamestown S’Klallam explanation for the behavior of rainclouds by storyteller, Roger Fernandez  **Practice**: Obtaining and Evaluating Information  ELABORATE: activities: Students create a webmap of their own community’s watershed.  **Practice**: Developing and Using Models  EVALUATE activity: Formative assessment  **Practices**: Evaluating and Communicating Information | | **NGSS PERFORMANCE EXPECTATIONS**  Three Dimensions of NGSS  blue=Practice orange=DCI green= Crosscutting Concept  GRADE 5  [5-LS2-1](https://www.nextgenscience.org/dci-arrangement/5-ls2-ecosystems-interactions-energy-and-dynamics)Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.  [5-ESS3-1](https://www.nextgenscience.org/pe/5-ess3-1-earth-and-human-activity) Obtain and combine information about ways individual communities use science ideas to protect the Earth’s resources and environment.  **BRITISH COLUMBIA SCIENCE CURRICULUM**  **If using this content for grades 4 or 6-8:**  [MS-PS1-2](https://www.nextgenscience.org/pe/ms-ps1-2-matter-and-its-interactions). Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.  [MS-LS2-3](https://www.nextgenscience.org/pe/ms-ls2-3-ecosystems-interactions-energy-and-dynamics). Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.  [MS-ESS2-4](https://www.nextgenscience.org/pe/ms-ess2-4-earths-systems). Develop a model to describe the cycling of water through Earth’s systems driven by energy from the sun and the force of gravity  Collect and analyze evidence to explain the safety level of the stream for salmon. | |

**TEACHER PREP LESSON 1**

* Review unit plan, student journal, and slideshow together. Revise these as desired and appropriate for your community and ecosystem, especially the watershed map.
* Print student journals on 8.5 x 14” paper, booklet fold, in-color if possible. If you choose to print so each journal page is on a full sheet of 8.5 x 11” paper, change settings in the Word document. It is automatically set to print in booklet fold on 8.5 x 14” paper as is.
* Connect with a community partner who can support water quality testing in a local waterway in Lesson 2. Plan ahead for a field trip to conduct the testing or arrange for the partner to collect the water samples and bring them in for students to test. If you elect to procure your own water quality testing materials, provide a thermometer and order a test kit that includes tests for dissolved oxygen, nitrogen, phosphorus, pH, and turbidity. Hach and LaMotte are two common companies for simple, color-indicator test kits.
* Invite a visit by an indigenous knowledge holder from the tribe or First Nation upon whose territory your school resides. This might also be your community partner for the forage fish survey. See suggestions for developing partnerships with local tribes and First Nations in [A Note About Indigenous Knowledge here](https://ucdavis.box.com/s/sbuff9hbyz3gq3fcwn58au1nwfq4jq1w).
* Review unit vocabulary (see student journal pp.5-6) and consider ways you will weave the use of these words naturally through the lessons. Students will define them opportunistically as they become familiar through use.
* Print, cut, fold, and place [Pearls of Wisdom](https://ucdavis.box.com/s/yv7wjrqconqjprrzh87nw3dr63kx1cqi) into a shell or other container for students to draw from, if you choose to include this practice of inspiration.
* Decide on Explore Teams composition. It works best to have mixed ability groups, where students may contribute their individual strengths to the team and support one another where needed. If you haven’t already, label spots at each table with Explore Team titles (see student journal p.5). When switching roles, students can rotate seats within their own team or find their new role in their new team.
* Decide to make your own watershed models or arrange for a watershed expert, such as a conservation district (WA) to bring in an interactive model to demonstrate.

Session 1

* Print Stormwater [pre-assessment](https://ucdavis.box.com/s/z0mq7ne27hovb2z38huumy2dszxzkad2) or prepare to administer electronically.

Session 3

**Water Cycle Model**

* Gather materials and place into a bin, one set per Explore Team, plan for an assistant to help with lighting a match and dropping it into the jars.

Session 4

* Queue the Roger Fernandez story about why rainclouds stay in Western Washington

**Watershed Model**

* [Read instructions](https://ucdavis.box.com/s/25nqrllcxz50jr7eahm0izgmk4ou5ueg) and gather materials for modelling a watershed.

Session 5

* Consider supporting students to create a webmap of their watershed. [Read instructions](https://ucdavis.box.com/s/x5lmnqk51jebixni7r7j8h01kevuofdv) and prepare for individual or partner work on laptops or tablets with internet connection.
* Read [Stormwater Heatmap background article](https://www.geekwire.com/2022/first-of-its-kind-stormwater-heat-map-lights-up-pollutants-fouling-waters-in-washington-state/)

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| **MATERIALS LESSON 1**  Session 1 ENGAGE   * Internet connection, computer, projection * Stormwater slideshow * Stormwater student journal * Stormwater pre-test   **Storm Drain Visit**   * A storm drains in your school parking lot or nearby * Safety gear for having students in the parking lot * Preferably during or just after a rain shower   Session 2 ENGAGE continued  Session 3 EXPLORE  **Model the Water Cycle in Action**  *For each Explore Team:*   * 1 L glass beaker or Mason quart jar, 3-4 ice cubes, aluminum foil or plastic baggies to cover jar, hot water, one match   **Web Map and The Nature Conservancy Stormwater Heatmap**   * Computers, 1 per student or 1 per pair of students   Session 4 EXPLAIN   * Link to Roger Fernandez rainclouds story   EXPLORE  **Watershed Model**   * This may be a purchased or borrowed model, models students make, following guidelines in the Build Your Own Watershed Models link, or even one made by simply crumpling paper or aluminum foil then adding food coloring to represent various pollutants. Materials are listed in the web link.   Session 5 ELABORATE   * [Web map instructions](https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/ERwvJkvp5PZJo3NIvJmpLvIBDoTk0i4Rmmt3pTuknKm3eA?e=k62UjK) and computer access * The Nature Conservancy’s [Stormwater Heatmap](https://www.stormwaterheatmap.org/) * Your selected [formative-assessment](https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EarJRZsbPItHuouzA77U9HgBdDi_WD6VwY18qSIw4w-7vg?e=QCoSup) materials | WEBLINKS:  Stormwater Slide Deck  <https://pacificeductioninstitute.sharepoint.com/:p:/s/Program/EWJ-LpWNXh1JrBv64AA3GW8Bd5icXAgHmsS2mSrvFHtM7g?e=N3WpZL>  Stormwater Student Journal  <https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EYbPaY_men1AluzQixPP2VgBJD5OVG6-qNK10R550gWjDw?e=fMe6pv>  Stormwater Heatmap article by GeekWire  <https://www.geekwire.com/2022/first-of-its-kind-stormwater-heat-map-lights-up-pollutants-fouling-waters-in-washington-state/>  Stormwater Pre-assessment  <https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/ERFNPHl4xQFJnjivT81zGZsBxlfhBqGVQuuj4Bt8PmLZFw?e=dXePH0>  Other phenomenon options to spark wonder  <https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EeY06tiJqY9GrTnld1TZFR0BbWLqTeUr4jrS12UJvUxPVA?e=DiUyCi>  Coho salmon gasping in a Burien creek video-1 min  <https://vimeo.com/>[111234620](https://vimeo.com/111234620)    Developing an Essential Question, article by Scholastic  <https://www.scholastic.com/teachers/articles/teaching-content/essential-questions/>  Roger Fernandez story-why water stays on the west side of the mountains  <https://www.youtube.com/watch?v=2AQ4Y0sTndM>  Model the Water cycle in Action activity  <https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EYhHGnk6A7NGgDks9Yvax8wB6XnVlsed2bjwneTmzDWhvw?e=gim2Dj>  Water Cycle Dance video (for teacher)  <https://www.instagram.com/p/Bs1qr2xB69x/>  Discover how clouds form video  <https://www.youtube.com/watch?v=44GH2gs8avo>  USGS Water Science School and Water Cycle diagram by Howard Perlman, USGS and resources (excellent resource)  <https://www.usgs.gov/special-topic/water-science-school>  USGS Water Cycle and resources in Spanish (and 60 other languages)  <https://www.usgs.gov/special-topic/water-science-school/science/el-ciclo-del-agua-water-cycle-schools-spanish?qt-science_center_objects=0#qt-science_center_objects>  Enviroscape Watershed Model (borrow from a local conservation organization)  <https://www.enviroscapes.com/product/watershed-nonpoint-source-model/hands-on-models>  Build your own watershed models  <https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EUT2Wp0UgARDnV4q8TNx9UsB6ZcbtnHLpZuUTGYWfyM4iQ?e=A9fCzL>  How to make a watershed Web map in ArcGIS online  [https://ucdavis.box.com/s/x5lmnqk51jebixni7r7j8h01kevuofdv](https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EXzyWoMtL-lFppdd3XZC1zABPjqvpHRnI0qpaceaOlGZhg?e=z2ipU2)  The Nature Conservancy Stormwater Heat Map  <https://www.stormwaterheatmap.org/>  Formative Assessment  <https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EarJRZsbPItHuouzA77U9HgBdDi_WD6VwY18qSIw4w-7vg?e=8FeTsf> |

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| TIME | **TEACHER GUIDE LESSON 1: WHAT HAPPENS TO WATER WHEN IT RAINS?** |
| Session 1  1 min  6 min  20 min  18 min  5 min | **ENGAGE**   1. Invite one student to draw and read a [**Pearl of Wisdom**](https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EYtMJn2GRyBNvGm85yVCP3UBNh9bmUt97Vc89yb_mkB7Lw?e=gr8E9I)(inspirational quote) from those in your shell or bowl. 2. Direct students to form Explore Teams using the guide on **journal p3,** rotating roles from the previous unit, as in **slide 4**. Remind them that each role is equally as essential for their Nature Detective work. 3. Administer [Stormwater pre-assessment](https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/ERFNPHl4xQFJnjivT81zGZsBxlfhBqGVQuuj4Bt8PmLZFw?e=7jDBRo), **slide 5**, to provide a baseline of student content and skill knowledge for measuring student growth. 4. Distribute student journals and have students write their names on the front. Invite them to read *Explore the Salish* *Sea* Ch.2 Why the Salish Sea Is Special, **slide 6**, then free-write on **journal p4**. 5. Direct students to highlight or circle unfamiliar vocabulary words on **journal p5** and add any more they are unsure of from the chapter. You can return to these opportunistically to write or draw definitions as kids pick up their meaning through repetitive use in context. |
| Session 2  25 min  15 min  10 min | **ENGAGE**   1. **Wonder**: Bring students to a storm drain on the school campus, preferably after a rain, **slide 7.** Bring a bucket of water to pour on the street above the drain if it hasn’t rained. Observe, listen to thoughts, questions, comments. Repeat student thoughts to clarify, but don’t teach; allow them to wonder. If you can’t bring students to a stormdrain, show **slide 8**.   *Note for teacher*: most stormwater drains go straight to a stream or a bay without the water being treated.   1. Either outside or back in class, students should then write and/or draw about what they wonder on **journal p6.** When finished, hold a **Team Talk**, **slide 9** (1 min per student) within each Explore Team to share thoughts about the storm drain and the salmon. Science Communicators share out summaries of their **Team Talk** to the class. 2. Shape     Description automatically generated with low confidenceGuide the formation of an [Essential Question](https://www.scholastic.com/teachers/articles/teaching-content/essential-questions/) as a class, **slide 10**, from what they want to know. Guide it to be related to stormwater and its effects on aquatic life. Have students write the question on **journal p7**. Example questions: Where does stormwater go? What is in stormwater? Is stormwater polluted? Ask students what kinds of clues they will need to answer their question. The journey will begin with water! |
| Session 3  5 min  5 min  10 min  30 min | **EXPLORE**   1. Text     Description automatically generatedRemindstudents of their essential question. Ask if they think they should know something about where water comes from to solve their mystery. Let them know this requires Background Research, **slide 11**. Guide the [Model the Water cycle in Action](https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EYhHGnk6A7NGgDks9Yvax8wB6XnVlsed2bjwneTmzDWhvw?e=qbQJh2) activity. To review the water cycle, demonstrate the [water cycle dance](https://www.instagram.com/p/Bs1qr2xB69x/), **slide 12.** 2. Have the Science Communicators report to the class on Team observations and connections between the cloud formation they witnessed in the jar and the weather. 3. Introduce the idea of the water cycle. Introduce the vocabulary: evaporation, condensation, precipitation, and saturation then lead them in the water cycle song, **slide 12**. 4. Show **slide 13** then ask students to complete activities on **journal** **pp9-10** as a formative assessment). If desired, print the water cycle diagram on larger paper for students. |
| Session 4  5 min  35 min   1. in | **EXPLAIN**   1. Invite students to listen to Roger Fernandez, Lower Elwha S’Klallam Tribe, tell why rain clouds stay in Western Washington: <https://www.youtube.com/watch?v=2AQ4Y0sTndM>   **EXPLORE**   1. Ask what hillsides do with the water that falls on them. (They shed it!), **slide 14**. Introduce the term *watershed*. Students may model awatershed with one of the following options: a) Enviroscape model (provided by visiting expert), b) students [build their own watershed models](https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EUT2Wp0UgARDnV4q8TNx9UsB6ZcbtnHLpZuUTGYWfyM4iQ?e=ulwnsc) (indoors, student-led, hands-on), c) students model your community’s own watershed outdoors (map it first- see Cartography Time below), using sand or soil, toy items listed in the DIY watershed activity, plastic bags or sheets (pavement). Discuss observations. 2. Hold a **Team Talk**: What are the boundaries of our own watershed? (within Explore Teams, 1 min per student, Science Communicator shares with class). Complete **journal p11.** (replace with a local map). |
| Session 5  25 min  10 min  15 min | **ELABORATE**   1. **Cartography Time!** Invite students to create a web map of your own watershed in pairs or individually. [Web map instructions here](https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/ERwvJkvp5PZJo3NIvJmpLvIBDoTk0i4Rmmt3pTuknKm3eA?e=bkawYV).Print instructions for students or make them available electronically. When maps are complete, save them as image files or print them out. Esri has made ArcMap accounts free to schools. If you utilize the free account and have students log in, they will be able to save their maps to add to them later. They can build a web map without logging in, but it won’t be saved when they quit. 2. Display one of the student’s web maps, **slide 15**, and hold a whole-class discussion on what the terrain is like in your watershed, what is upstream and downstream from your school, how much of it is natural, how much is built and paved, and how it compares to the watershed model you made and observed. 3. Encourage students to predict where the stormwater might be in greatest need of cleaning up in your watershed. Introduce The Nature Conservancy’s [Stormwater Heatmap](https://www.stormwaterheatmap.org/). Have students explore the map, then zoom in to your own watershed and investigate various water quality components by selecting them in the menus on the left of the screen. Invite students to compare their predictions to the data shown in the Stormwater Heat Map. Allow this activity to spark wonder at if and/or how the stormwater is treated in your community and if the treatment is effective.   **EVALUATE**Checkbox Checked with solid fill   1. Select and administer a [formative-assessment](https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EarJRZsbPItHuouzA77U9HgBdDi_WD6VwY18qSIw4w-7vg?e=GVglIk). |

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| **LEARNING TARGETS LESSON 2:** Understand the importance of clean stormwaterUnderstand that water can be tested to determine if it is healthy for living creatures to consume or live in.Know how to apply the process of science to to assess water quality in a local community.  * Make science-based claims from student data and background research as to whether or not local stormwater is healthy for living organisms.   **TEACHING WITH THE 5 E’s FOR A COHERENT STORYLINE – LESSON**  ENGAGE activity: Develop a testable question about stormwater quality in your community.  **Practice**: Asking questions and defining problems  EXPLORE activities: Design and conduct an investigation to compare stormwater quality before and after treatment and/or to determine if it is safe for aquatic life.  **Practice:** Planning and carrying out investigations  EXPLAIN activity: Create a class graph of water quality testing results. Compile cultural knowledge into a picture or map.  **Practice**: Using mathematical and computational thinking. Analyzing and Interpreting Data  ELABORATE / EVALUATE  activity: Compare outcomes of this investigation to similar studies or traditional knowledge of Coast Salish communities. Argue using evidence and suggest implications and applications of this knowledge in a Get CERIAs Forum.  **Practice**: Constructing Explanations and Designing Solutions. Communicating and Evaluating Information. | **NGSS PERFORMANCE EXPECTATIONS**  Three Dimensions of NGSS  blue=Practice orange=DCI green= Crosscutting Concept  GRADE 5  [**5-ESS3-1**](https://www.nextgenscience.org/dci-arrangement/5-ess3-earth-and-human-activity)**.** Obtain and combine information about ways individual communities use science ideas to protect the Earth’s resources and environment.  **BRITISH COLUMBIA SCIENCE CURRICULUM**  **If using this content for grades 4 or 6-8:**  [**MS-ESS3-3**](https://www.nextgenscience.org/pe/ms-ess3-3-earth-and-human-activity). Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. |

**TEACHER PREP LESSON 2**

Work with your community science partner to have them guide or provide materials for the water quality investigation your students will design.

Session 1

* Review the unit plan, student journal, and slide deck for Lesson 3.
* Practice with your own mock-up of the [How Science Works Web Interactive](https://undsci.berkeley.edu/interactive/#/intro/1), so you are familiar enough with its workings to guide your students’ process of science.
* Review the [Guiding the Process of Science Training](https://www.explorethesalishseatraining.org/lessons/guiding-the-process-of-science/) in Module 1 of Explore the Salish Sea Training (allow 35 min). You don’t need to have research experience to be a wonderful guide! Rather, you need only to have the curiosity to investigate alongside your students’ Explore Teams and make authentic discoveries together. You got this!
* Obtain large, colored construction paper in a variety of colors. Cut in half lengthwise (hot dog, not hamburger 😊), ensuring one strip of a different color for each Explore Team.
* Obtain small sticky notes in 3 colors. Each team will need one of each color. Choose the terms you will use for each type of variable in the students’ research question. Pre-write “CV” for *changed* or *compared variable* (if that is your chosen term) on X number of blue sticky notes, write MV for *measured variable* on X number of green sticky notes, and, leaving room for a list of at least 3 items, write Controlled variables on X number of yellow sticky notes; X being the number of Explore Teams in your class.

Session 2

* Arrange a meeting time and location for the stormwater testing with your community partner. Discuss their testing protocol and share how your class is divided into Explore Teams so they may put the teams to work in the field in a meaningful, organized way.
* Prepare and arrange all field trip forms, chaperones, and logistics well ahead of time. Prepare an honorarium and/or gift ahead of time with your students.
* If possible, invite a Coast Salish knowledge holder to share what they deem important and appropriate about taking care of water with your students. Prepare an honorarium and/or gift ahead of time with your students.
* Print out copies of the scientific article on water quality [Ahern and Campbell 2015](https://ucdavis.box.com/s/f1xsxh548yuc6o8vejz4fhldnlb5qpph)
* Print out a map of the forage fish sites on beaches near you (find the best map for your school location in the weblinks above) – print 1 per Explore Team

Session 3

* Prepare a Google Sheet, Excel spreadsheet, or other graphing program for each team to enter their water quality data. Students will graph their data in their student journals first, then enter it into one class graph that you or a student team has prepared. Generally, the independent (or manipulated or changed) variable will go in column A and the dependent (or responding or measured) variable will go in column B. Here is a sample to start with and modify as you wish.

Session 4

* Display the class graph on a screen for all students to view
* Ensure space to set up chairs in a large circle or oval for the Get CERIAs forum
* Prepare incentives for students to share (stickers, other small prizes, or points)

Session 5

* Review the [Get CERIAs protocol.](https://ucdavis.box.com/s/p42ex5tkinl3yfl2rxuzioi6h6biisws)
* Select a [formative assessment](https://ucdavis.box.com/s/zyxsx4xqudt25j7xz1zwop1benb6dg9v)

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| **MATERIALS LESSON 2**  Session 1 ENGAGE   * Internet connection, computer, projection * Stormwater slideshow * Stormwater student journal   Session 2 EXPLORE  **Testable Question-development:**   * Large strips of colored construction paper, 1 per Explore Team * Colored markers, 1 per Team * 3 sticky notes per Team: * -1 color for the Compared Variable (CV, what is being compared, ie stream location, before vs. after a raingarden) * -1 color for the Measured Variable (MV, what gets measured, ie water temperature), * -1 color for Controlled Variables (Controlled, what is kept the same to ensure the only difference is between the Manipulated variable, i.e. you may choose to keep the date, time of day, sample collection method, time between collection and measuring temp, etc. the same).   Session 3 EXPLORE  **Stormwater Testing**   * Student journals with prepared data tables * Pencils * 1 gal Ziploc bags for journals in case of rain * Field trip letter home with list of outdoor clothing/shoes, permission forms, etc. * Chaperones * Community partner! The community partner will supply the water sampling and testing materials unless you choose to do this on your own. * Water quality kits (to measure pH, nitrates, phosphates, dissolved oxygen, temperature, and turbidity) * Thermometer * Optional: Small fish nets, paintbrushes, and ice cube trays to collect macroinvertebrates, Macroinvertebrate ID cards   EXPLAIN  Class graph   * Prepared Google Sheet, Excel spreadsheet, or other spreadsheet template   Surf Smelt Team Read   * Background Research Reference articles * Team Read template drawn onto poster paper   Session 4 ELABORATE  Get CERIAs Forum   * Chairs set up in a large circle or oval * Water quality graph/s displayed on the screen * Completed Get CERIAs forms (in student journals)   Session 5 EVALUATE   * Formative assessment materials, if any | WEBLINKS: Team Read Template<https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EegFO0oiDLREtk1-s5MB2SgBEkfACrRumWdGi-ml9Mq_Xw?e=dupXcn>EPA My Waterway App (look up watershed boundaries and water quality in your own community)<https://mywaterway.epa.gov/community>Background Research References for students <https://pacificeductioninstitute.sharepoint.com/:f:/s/Program/EhEf2sT1N7ZGolaDoXtEMcMBIhnph6247_xPjuAkcKihoQ?e=PnLgpl>  Environmental Protection Agency (EPA) Water Quality Indicator website  <https://www.epa.gov/national-aquatic-resource-surveys/indicators-used-national-aquatic-resource-surveys> Salish Sea Heroes Spotlight options:Puyallup Watershed Initiative video<https://vimeo.com/207346630>Stormwater treatment facility video 3 min (start at 1:13)<https://www.youtube.com/watch?v=AirQhbZXaLE>How Science Works website<https://undsci.berkeley.edu/article/howscienceworks_01>How Science Works interactive flowchart<https://undsci.berkeley.edu/interactive/#/intro/1>How Science Works simple flowchart in Spanish<https://undsci.berkeley.edu/lessons/pdfs/simple_flow_handout_sp.pdf>How to make a graph in Google Sheets tutorial <https://support.google.com/docs/answer/63824?co=GENIE.Platform%3DDesktop&hl=en>  Formative Assessment  <https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EarJRZsbPItHuouzA77U9HgBdDi_WD6VwY18qSIw4w-7vg?e=qu1CSP> |

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| TIME | **LESSON 2: TEST THE WATERS** |
| Session 1  5 min  30 min  15 min | 1. Follow what students wondered about stormwater in your community to initiate an investigation of your local system. A good investigation requires a great testable question. Narrow down what your students want to know through a **Team Talk**, **slide 16**, **journal p12**, with this prompt: *How could you tell if stormwater entering a stream, lake, or bay in our watershed is healthy for people, pets, and aquatic life?* 2. A close up of a logo       Description automatically generatedAsk students if they need more info to dig up clues to the state of their stormwater, **slide17**. Tell them some clues could be found in the [Student Research References for Stormwater](http://www.juniorseadoctors.com/stormwater) (large orange button in the Stormwater Unit webpage that reads, “Student Research References” under *Background Research)*,distribute printed articles or direct Explore Teams to their online access, **slide 18**, **journal p12**.  * Have every student read the Stormwater article by Skagit Fisheries Enhancement Group, * Icon    Description automatically generatedDivide Water Quality Indicator articles, 1 per Explore Team. Dive within Teams for a **Team Read**, distribute poster paper with Team Read templates. * Remind students of The Nature Conservancy [Stormwater Heatmap](https://www.stormwaterheatmap.org/) from Lesson 1 and provide the url, **slide 19,** invite them to note information they’d like to remember on **journal p13**:  1. Ask the class if they feel ready to design their very own scientific investigation to solve your community’s stormwater mystery. It’s time to put science to work! **slide 19.**   Support students in developing a question, **slide 20, journal p14** that they can test with resources available to you   * Provide a large strip of colored construction paper and 3 sticky notes of differing colors to each Explore Team. They will write their question on the construction paper. * Ask that they start their testable questions with Is, Are, Do, Does, or Will (this will ensure a yes or no answer that can be measured, whereas why or how can be too broad).   \*You may wish to work with a science partner to support this investigation, starting here.  \*Some examples of comparative studies are before vs. after a raingarden or other type of stormwater filtration facility, before and after a stream or river runs through your town, water from a creek vs. water entering a storm drain, or…? Examples of a survey include water quality testing in a local stream or estuary and measuring results of temp, dissolved oxygen, pH, and more against [water quality standards for aquatic life](https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EczVk-MX3CNBql1R2mr_V6wBkrwpXXqID3JV9fONqD1V8Q?e=PaAfNc) (available in Student Research References folder) |
| Session 2  15 min  15 min | 1. Share **slides 22-26** to explain how to identify variables in the research question  * Have all Lab Techs write CV on the same color of sticky note, MV on another color, and Controlled on a third.  1. Support students in forming their hypotheses, **journal p14**.  * Write hypotheses in the *If we \_, then\_ because \_.* format, **slide 27**, **journal p14**. Each may differ. |
| 20 min | 1. Guide the research design (procedure), **slide 28, journal p16-17**, including data table set-up. Consult the [How Science Works](https://undsci.berkeley.edu/article/howscienceworks_01) website, if needed. Provide or describe available materials (water quality test kits or macroinvertebrate nets or screens, etc). Allow students to design. Ensure they repeat the main steps to gather at least 3 replicate samples for each model. Ask students why it is important to run replicate trials of each model. Ensure that they set up a data table that is ready to record data in the field or classroom from field samples brought in. |
| Session 3  Varies | A picture containing deer  Description automatically generated Field Research: Run the investigation! Ensure each Explore Team member takes on the duties of their role for managing supplies, managing the Team, recording data…) |
| Session 4  30 min  20 min | Graph using Google Sheets ([see tutorial,](https://support.google.com/docs/answer/63824?co=GENIE.Platform%3DDesktop&hl=en) if needed) or by hand on paper by having students each add their data to build one class graph. Once all data are in, they can then draw this graph into their journals on journal p16.Invite students to complete the Discussion section of the investigation, journal pp17-19 then let students know how important it is to *communicate* their process of science. If you don’t share it, it may as well not have happened! Let them know they are about to argue…I mean *discuss* their results and what it all means with their “scientific community” (their classmates). Tell them not to worry, they will be well-prepared for their arguments..er..*discussions*, by completing their [Get CERIAs](https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EeY06tiJqY9GrTnld1TZFR0BbWLqTeUr4jrS12UJvUxPVA?e=DetOP9)  forms, slide 29, journal p20. It is important to acknowledge that if students achieve a result that does not support their hypothesis, this does not mean they were “wrong.” There is no such thing as “right” or “wrong” in a result. Science is about discovery, and they may have gotten unexpected results that will lead to more questions to investigate! |
| Session 5  30 min  5 min | A picture containing sign, dark  Description automatically generatedCheckbox Checked with solid fillShow slide 30-it’s time to communicate. Display the class graph. Review [Get CERIAs forum protocol](https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EeY06tiJqY9GrTnld1TZFR0BbWLqTeUr4jrS12UJvUxPVA?e=DetOP9), push aside desks, place chairs into a circle, display the class graph with the projector or on a giant poster paper. Direct students to professionally argue their claims with their ‘scientific community’ and support them with evidence from the graphs. Record their suggestions for applications of their research for use in Unit 8, Salish Sea Heroes.Administer [formative-assessment](https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EarJRZsbPItHuouzA77U9HgBdDi_WD6VwY18qSIw4w-7vg?e=fZp4cc). |

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| LEARNING TARGETS LESSON 3: ENGINEER A STORMWATER FILTRATION SYSTEM Understand that humans can create and test multiple solutions to better treat stormwater using ground surface filtersKnow that the best solution to solve a problem can be recommended to the public using scientific evidence and reasoning.Know that communities can apply the tools and technology tested by science and engineering to solve stormwater problems in a watershed and make water healthy for living organisms. PERFORMANCE TASKS LESSON 3:   * Engineer a model to test the effects of stormwater treatment using water-purifying landscape material, and potentially revise that model based on the outcomes of the experiment. * Compare stormwater filtration system models with peers to determine which solution best solves a stormwater problem.   Use evidence-based recommendations for the best stormwater filtration model to treat local stormwater | NGSS (WSSLS) ADDRESSED Continued  [MS-ETS1-2](https://www.nextgenscience.org/pe/ms-ets1-2-engineering-design) Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.  [**MS-ESS3-3**.](https://www.nextgenscience.org/pe/ms-ess3-3-earth-and-human-activity) Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.  [MS-ETS1-3](https://www.nextgenscience.org/pe/ms-ets1-3-engineering-design) Analyze data from tests to determine similarities and differences among several design solutions to identify best characteristics of each that can be combined into a new solution to better meet the criteria for success.  [MS-ETS1-4](https://www.nextgenscience.org/pe/ms-ets1-4-engineering-design) Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.    TEACHER PREP  Obtain materials that students have suggested for the Design Challenge.  Prepare dirty water for students to run through their various filtration designs.  Work with students to decide on criteria for acceptably clean water.  Prepare a space in your room or outdoors for students to work with dirty water, possibly making a wet mess. |
| NGSS (WSSLS) ADDRESSED  [3-ESS3-1](https://www.nextgenscience.org/pe/3-ess3-1-earth-and-human-activity) Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.  [**5-ESS3-1**](https://www.nextgenscience.org/dci-arrangement/5-ess3-earth-and-human-activity)**.** Obtain and combine information about ways individual communities use science ideas to protect the Earth’s resources and environment.  [**3-5-ETS1-2**](https://www.nextgenscience.org/pe/3-5-ets1-2-engineering-design)Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.  [MS-ETS1-1](https://www.nextgenscience.org/pe/ms-ets1-1-engineering-design) Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. |

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| **MATERIALS LESSON 3: ENGINEER A STORMWATER FILTRATION SYSTEM**  **Preliminary Testing**   * Sand * Soil * Pine/fir needles * Wood chips * Twigs * Cotton balls or batting * Containers to hold filtration materials for testing (same size for all Teams) * Outdoor space to run tests, if possible (your custodians will be grateful) * Watering can or spray bottles * Measuring container to catch water after it has gone through the filtration material * A rubric with water quality criteria * Water quality testing equipment of choice   **Design the Best Stormwater Filtration:**   * Same as Preliminary testing above   **Hope Fest:**   * Videos to show that experts are already on the job, alleviate eco-fear in kids, and inspire hope and ideas for how they can help. * Popcorn 😊   RISK MANAGEMENT:   * Play games in a safe area where students will avoid tripping hazards or a hard fall. * For field work, provide 1-2 adult chaperones per Explore Team. Review Outdoor Classroom rules. * Carry first aid kit and meds for children who need them. * Ensure children and adults come with safe footwear, raingear, sunscreen, lunches or snacks, and reusable FULL water bottles for hydration. * Have the site scouted for potential hazards. | **ONLINE RESOURCES LESSON 3:**  Stormwater post-assessment  <https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EWb7Bn7c92BFoOpS0nHMXe4BNYtjxrJZ8rNnbwwwqMuqDw?e=R0S5nd>  Background Research Repository for students  <https://pacificeductioninstitute.sharepoint.com/:f:/s/Program/EhEf2sT1N7ZGolaDoXtEMcMBIhnph6247_xPjuAkcKihoQ?e=min6by>  Lam et al. article: Investigations into the feasibility of raingardens as a stormwater management solution  <https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EZwhBRkXsB5Kk-45v4XkanMBe1d01JIuXHg8zQYWZXVffA?e=G95tBo>  How Science Works website  [https://ucdavis.box.com/s/p42ex5tkinl3yfl2rxuzioi6h6biisws](https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EcL0uanC_pZDpMChHMEfe4AB5teWFC17L8lT0r-MbvFVJg?e=Im925W)  How Science Works interactive flowchart  <https://undsci.berkeley.edu/interactive/#/intro/1>  How Science Works simple flowchart in Spanish  <https://undsci.berkeley.edu/lessons/pdfs/simple_flow_handout_sp.pdf>  How to make a graph in Google Sheets tutorial  <https://support.google.com/docs/answer/63824?co=GENIE.Platform%3DDesktop&hl=en>  Hope-Fest films  Salish Sea Heroes Spotlight options:  Puyallup Watershed Initiative video  <https://vimeo.com/207346630>  Stormwater treatment facility video 3 min (start at 1:13)  <https://www.youtube.com/watch?v=AirQhbZXaLE> |

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| TIME | **TEACHER GUIDE LESSON 3:**  **ENGINEER A STORMWATER FILTRATION SYSTEM**  **(*This is also an option as a culminating activity in Unit 8*)** |
| Session 1  10 min  10 min | 1. Introduce the **Design Challenge:** What type of materials would work best to improve stormwater filtration in our own watershed? **Slide 30**. Take a few suggestions from the class to get the creativity flowing. 2. Suggest that before starting, it is inspiring and informative to find out what is already being done for stormwater solutions. Conduct a Team Read of stormwater design solution article: [Lam et al. 2011 (raingardens)](https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EcL0uanC_pZDpMChHMEfe4AB5teWFC17L8lT0r-MbvFVJg?e=Im925W) 3. **2 Preliminary Testing** Share that scientists often run tests before their official investigation to try out different ideas. Supply materials, including equally sized and shaped containers that allow water to flow through the bottom, such as medium-sized yogurt containers with holes in the bottom.   Allow Explore Teams to devise comparisons, using **journal p20** for notes. Students may want to compare “pavement” (a metal tray will work) vs. bare soil vs. wood chips over soil, for example. Or bare soil vs. vegetated soil (“plant” the soil with twigs, pine needles, and other vegetation). This session is really a free-exploration of materials without a lot of rules. Students will devise their own guidelines as they go.   1. Clean up and have Science Communicators share results with the class. |
| Session 2  20 min  10 min  20 min | 1. Suggest Explore Teams are ready to build and test stormwater filtration models officially. Duplicate the Scientific Research pages in the student journal for these investigations. 2. Support students with through the process of science all over again as they test their Explore Team’s stormwater filtration design against other Teams’. Make it into a contest, as in the plankton race from Unit 1 or keep it uncompetitive (if you can). 3. Bonus or extra credit: Invite students to draw a landscape-scale application of the winning stormwater filtration design into a printed watershed map from those they made in Lesson 1 of this unit, **journal p22.**      1. Administer post-assessment. |
| Session 3  40 min  10 min  15 min | 1. End with a Hope-Fest of films of Salish Sea Heroes helping improve the watershed in your community or ones nearby, **slide 32. Popcorn party!** 2. **Discuss.** 3. *Optional:*If creating a cohesive Salish Sea Map throughout the Explore the Salish Sea curriculum, draw and label your watershed and/or tested water treatment plants and waterways from the unit into the map. |