

TEACHER OVERVIEW

Water Quality
9th — 12th Grade

Nature Vision Student Packet

The materials contained within have been created by Nature Vision, an environmental education nonprofit organization that brings programming to schools and local greenspaces for over 70,000 PreK-12th grade students each year in King and Snohomish Counties. This work from home curriculum materials packet is designed to foster an understanding of the importance of water and its integral role in supporting life and shaping our planet. Packets can be completed either independently, or with the help of an adult caregiver. Each day of the week offers materials building on previous days learning, offering a variety of activities including art, writing, and field exploration.

These materials are provided to you by City of Auburn Utilities, City of Bothell, City of Lynnwood, and grants from King County Flood Control District, and King County Wastewater Treatment Division. Learn more by visiting:

- City of Auburn Utilities: https://www.auburnwa.gov/city_hall/public_works
- City of Bothell: <http://www.bothellwa.gov/surfacewater>
- City of Lynnwood: <https://www.lynnwoodwa.gov/Home>
- King County Flood Control District: <https://www.kingcounty.gov/services/environment/water-and-land/flooding/flood-control-zone-district.aspx>
- King County Wastewater Treatment Division: <https://www.kingcounty.gov/depts/dnrp/wtd.aspx>

Thanks to Cascade Water Alliance for providing the accompanying series of student packets: Ecosystems, Watersheds, and Humans and Water. To learn more please visit: <https://cascadewater.org/>.

This unit supports NGSS Performance Expectations across various disciplines, as well as supporting K-12 Integrated Environmental and Sustainability Standards. These are listed at the bottom of this page. Teachers will be supplied with PDF formats of materials to be emailed to families, or teachers may print and send to students to complete at home.

Students begin with a basic understanding of how stormwater moves through our environment. Next, students learn the ways that agriculture, industry, and pet waste can impact our freshwater. Lastly, students consider the work we can do to minimize the impact of stormwater on our water quality.

If you have any further questions or concerns regarding this packet, please email our Office Coordinator at info@naturevision.org.

Grades 9-12

Supports NGSS Performance Expectations: HS-LS2-7, HS-LS4-6, HS-ESS2-5, HS-ESS3-4, HS-ETS1-2, HS-ETS1-3.

| Grades 9-12 |
|----------------------------------|
| Day 1 - Stormwater Basics |
| Day 2 - Yards and Agriculture |
| Day 3 - Industrial Contamination |
| Day 4 - Pet Waste |
| Day 5 - Stewardship |

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PARENT/CAREGIVER OVERVIEW

Water Quality
9th — 12th Grade

Welcome to Nature Vision's student packet for home use. Nature Vision is an environmental education nonprofit organization that brings programming to schools and local greenspaces for over 70,000 PreK-12th grade students each year in King and Snohomish Counties. We are excited to be offering this version of our programming directly to students at home!

This packet is designed to be completed over the course of one week, with each day focusing on a different aspect of environmental science and stewardship. The majority of these materials can be completed independently, but we thought it would be important to provide background information for any adults who may be helping to complete or answer questions. We've included the basic learning objectives for each day along with some vocabulary.

These materials are provided to you by City of Auburn Utilities, City of Bothell, City of Lynnwood, and grants from King County Flood Control District, and King County Wastewater Treatment Division. Learn more about caring for our water by visiting:

- City of Auburn Utilities: https://www.auburnwa.gov/city_hall/public_works
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- King County Wastewater Treatment Division: <https://www.kingcounty.gov/depts/dnrp/wtd.aspx>

Challenge yourself to post all the things you are doing with your friends and family to prevent pollution and protect our water!

- City of Auburn Utilities: Tag @auburnwa and include the hashtag #auburnwa
- City of Bothell: Tag @BothellWaUSA and include the hashtag #PugetSoundStartsHere
- City of Lynnwood: Tag @LynnwoodWA and include the hashtag #Lynnwood
- King County Flood Control District: Tag @KingCountyDNRP
- King County Wastewater Treatment Division: Tag @kingcountywtd

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*Please contact info@naturevision.org with any questions or concerns
Stay connected with Nature Vision! Follow us for updates @naturevisionorg*



NOTE: Students may require support in reading directions and/or completing some tasks.

Unless otherwise noted, images courtesy of freepik.com

PARENT/CAREGIVER OVERVIEW: DAY 1

Stormwater Basics

Background Information: Stormwater is any precipitation that falls on the earth or water from snow/ice melt. As it moves over the earth it is either absorbed into the earth, or it becomes runoff as a result of not being absorbed. Stormwater runoff leads to increased instances of flooding and higher rates of pollution in our freshwater streams, rivers, lakes, and more. Therefore, runoff must be well-managed to avoid these issues.

Learning Objectives: Students will consider the impact of stormwater, runoff, and non-point source pollution on their environment and vice versa.

Main Activity: Surface Mapping and Neighborhood Reflection

- **Overview:** Students explore their neighborhoods to find how water is directed and what contaminants it may carry with it
- **Parent/Caregiver Tasks:** Provide supervision while student is outdoors

Optional Activity: How's My Waterway?

- **Overview:** Students visit the Environmental Protection Agency (EPA) website to research the water quality of the body of water nearest to them
- **Parent/Caregiver Tasks:** Provide supervision and/or permission for student

Optional Activity: Stormwater Stewardship Challenge

- **Overview:** Students complete a daily stewardship challenge related to pollution prevention
- **Parent/Caregiver Tasks:** If possible, help the student share their work on social media

PARENT/CAREGIVER OVERVIEW: DAY 2

Yards and Agriculture

Background Information: The runoff from yards, gardens, and agriculture can cause environmental problems. Some specific problems are pesticides, which can poison our water, and excess fertilizers, which impact the level of plant life and oxygen available in freshwater. Scientists are currently working on ways to minimize the impact from farms and agriculture on our waterways.

Learning Objectives: Students will explore the process of testing and designing solutions for agricultural runoff.

Main Activity: Design a Farm Runoff Experiment

- **Overview:** Students design an experiment to test the quality of water in a stream that is next to a farm
- **Parent/Caregiver Tasks:** None

Optional Activity: Farms, Wetlands, and Rivers Article

- **Overview:** Students read about real-world experiments involving water quality testing near farmland and the role that wetlands can play in keeping that water healthier
- **Parent/Caregiver Tasks:** None

Optional Activity: Stormwater Stewardship Challenge

- **Overview:** Students complete a daily stewardship challenge related to pollution prevention
- **Parent/Caregiver Tasks:** If possible, help the student share their work on social media

PARENT/CAREGIVER OVERVIEW: DAY 3

Industrial Contamination

Background Information: The Duwamish River has been impacted by the pollution from various industries for over a century. As a major industrial waterway for the city of Seattle, it has been contaminated by both point and non-point source pollution and declared a superfund site for the EPA. This means the Duwamish River is one of the most polluted waterways in the nation and a top priority for cleanup efforts.

Learning Objectives: Students will learn about the current state of the Duwamish River by interpreting a timeline of events and organizations that have impacted it. They will then consider the complications of restoring a habitat after contamination.

Main Activity: Duwamish River Timeline Interpretation

- **Overview:** Students review an abbreviated timeline of events impacting the Duwamish River and consider the complications around cleanup
- **Parent/Caregiver Tasks:** None

Optional Activity: River Restoration Model

- **Overview:** Students model the issues of habitat restoration from physical changes to an environment and the chemical contamination of that environment
- **Parent/Caregiver Tasks:** Provide supervision and help gather materials

Optional Activity: Stormwater Stewardship Challenge

- **Overview:** Students complete a daily stewardship challenge related to pollution prevention
- **Parent/Caregiver Tasks:** If possible, help the student share their work on social media

PARENT/CAREGIVER OVERVIEW: DAY 4

Pet Waste

Background Information: Pet waste is a major source of contamination in our urban and suburban waterways. Wild animal waste is a natural part of the environment. The amount of waste as well as diets of our domesticated animals leads to greater amounts of fecal bacteria entering our waterways via storm drains.

Learning Objectives: Students will explore the negative impacts of pet waste on our region's freshwater. They will also consider ways they can help to reduce these impacts.

Main Activity: Dog Waste Informational Campaign

- **Overview:** Students review a "Dog Waste Feasibility Study," answer questions, and create a poster to remind neighbors of the impact dog waste has on our water
- **Parent/Caregiver Tasks:** None

Optional Activity: What To Do With The Poo?

- **Overview:** Students research best management practices for their communities, learning that each city wants pet waste to be handled in different ways
- **Parent/Caregiver Tasks:** Provide supervision and/or permission for student

Optional Activity: Stormwater Stewardship Challenge

- **Overview:** Students complete a daily stewardship challenge related to pollution prevention
- **Parent/Caregiver Tasks:** If possible, help the student share their work on social media

PARENT/CAREGIVER OVERVIEW: DAY 5

Stewardship

Background Information: Stewardship is the act of caring and being responsible for the environment and our natural resources.

Learning Objectives: Students will use what they have learned this week to consider ways that they can act as stewards of our freshwater. They will also learn about ways that scientists and community members are working to restore and protect our freshwater resources.

Main Activity: Be a Water Warrior!

- **Overview:** Students describe the ways that they care for clean water
- **Parent/Caregiver Tasks:** none

Optional Activity: King County Protect and Restore

- **Overview:** Students research local stream restoration possibilities and learn about the work being done in King County to restore stream habitats
- **Parent/Caregiver Tasks:** Provide supervision and permission for student to research online and explore a nearby stream habitat

Optional Activity: Stormwater Stewardship Challenge

- **Overview:** Students complete a daily stewardship challenge related to pollution prevention
- **Parent/Caregiver Tasks:** If possible, help the student share their work on social media

PARENT/CAREGIVER OVERVIEW: VOCABULARY

DAY 1

Impervious: Does not allow water to soak in

Non-point source: Multiple small sources of pollution

Pervious: Does allow water to soak in

Point source: One main source of contamination

Runoff: Stormwater that does not soak into the ground

Stormwater: Any water from precipitation

DAY 2

Anoxic: Insufficient oxygen levels to support living things

Controlled variable: An experimental element which is constant and unchanged throughout the course of the investigation

Dependent variable: The variable being tested and measured in an experiment, and is 'dependent' on the independent variable

Eutrophication: The process of excess nutrients making freshwater uninhabitable due to algae growth and depleted oxygen

Hypothesis: What you believe will happen

Independent variable: What the experimenter changes or controls and is assumed to have a direct effect on the dependent variable

Variable: Factor of an experiment

DAY 3

Dredged: Clean out a harbor, river, or other area of water by scooping out mud, weeds, and debris

Environmental Protection Agency: Government agency responsible for our impact on the natural world

Industrial contaminants: Pollutants that are from manufacturing and industry

Superfund site: A designation of the most polluted areas in the U.S.

Urbanized: Densely populated and a highly developed, a city

DAY 4

E. coli: A bacteria commonly found in the intestines of humans and other animals, some strains of which can cause severe food poisoning

Fecal bacteria: Single-cell organisms, or bacteria, found in feces or fecal matter

Watershed ecosystem: The plants and animals that rely on freshwater moving through a particular watershed

DAY 5

Best Management Practices: Methods that have been determined to be the most effective and practical means of preventing or reducing non-point source pollution to help achieve water quality goals

Environmental impact: The effect, good or bad, that actions have on the environment

Stewardship: The act of caring for natural resources and the environment

DAY 1

Stormwater Basics

As part of the hydrologic cycle, water is recycled and falls as precipitation on the Earth. This water is called **stormwater**, any water that the earth receives as precipitation or ice/snow melt.

Pervious



Impervious



Surfaces that allow water to be absorbed are called **pervious**. In places like these, water soaks into the soil where it is filtered, then it is stored to become available for plant and animal life when needed. However, humans have developed urban landscapes and covered much of the pervious land. As a result, stormwater behaves differently in our neighborhoods and cities than it would out in the wilderness. Streets, sidewalks, buildings, and any other surface that water cannot be absorbed into are called **impervious** surfaces. Humans have built more and more areas full of impervious surfaces, which has led to increased stormwater **runoff**.

Since water cannot be absorbed in these developed areas, this runoff moves along the surface until it reaches a storm drain. Storm drains direct the water into a series of pipes that eventually empty into nearby lakes, streams, rivers, and even the ocean. Wastewater is filtered and treated after leaving the sewer pipes connected to our homes and businesses, but stormwater runoff is not filtered or treated before it is sent back out into the waterways.



Stormwater runoff is a major contributor of **non-point source** pollution in our freshwater. Non-point source pollution refers to small amounts of contamination that come from many different places that combine to create a larger negative impact. In contrast, **point source** pollution is a lot of contamination that comes from a single place, such as factories. Non-point source pollution is generally considered a more challenging issue because there is not a single cause to address, but instead many small sources being carried by our stormwater.

Take a moment and think of some of the things that may be picked up and carried along as the runoff travels to the drains and out into our waterways...

Vocabulary

- Impervious:** Does not allow water to soak in
- Non-point source:** Multiple small sources of pollution
- Pervious:** Does allow water to soak in
- Point source:** One main source of contamination
- Runoff:** Stormwater that does not soak into the ground
- Stormwater:** Any water from precipitation

Main Activity

Surface Mapping and Neighborhood Reflection

Now that you've spent some time thinking about pollution, let's take the opportunity to explore your own neighborhood (if possible)!

Materials: Paper, writing utensil, drawing materials

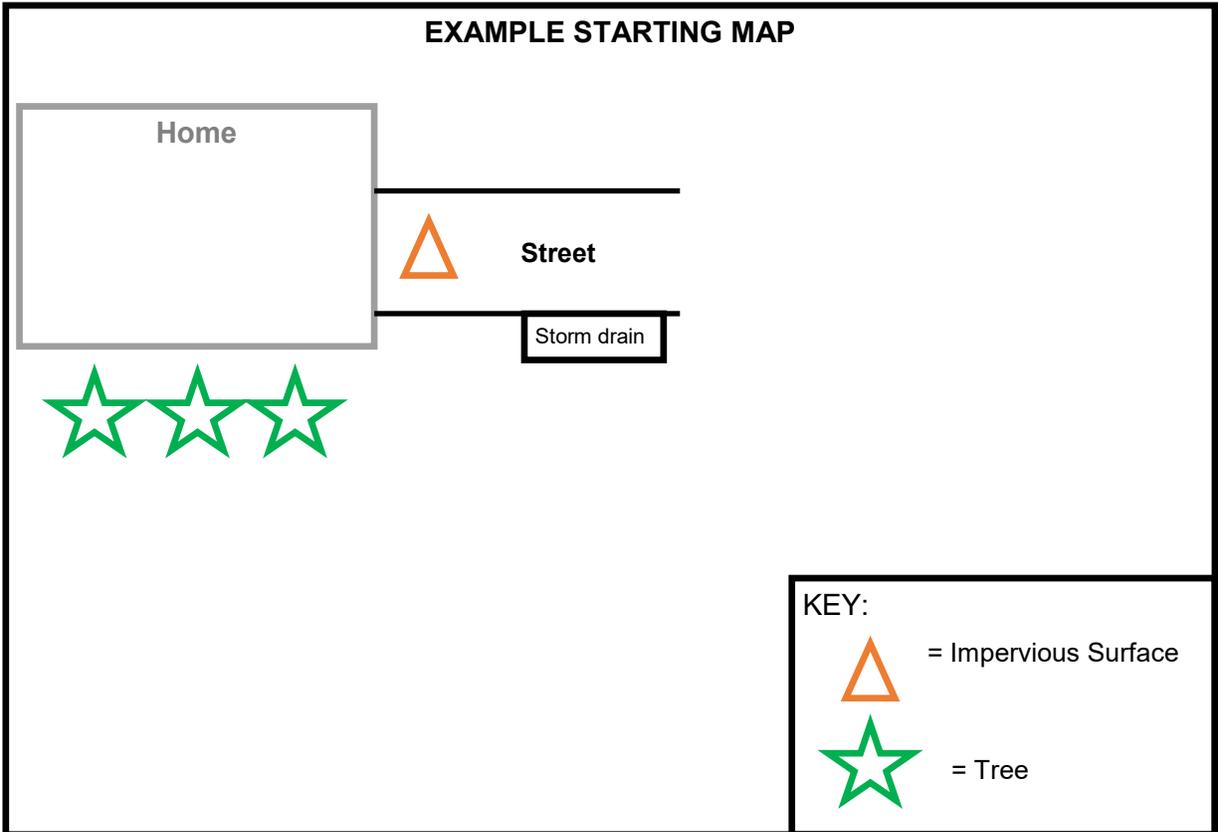
When we think of human contamination, we often think about litter. Litter is certainly a big deal, but there are many other materials that are washed into our waterways through stormwater runoff. Some types of litter typically include:

- Pet waste
- Pollutants from cars like oil, exhaust and brake dust
- Soap from car washing
- Oil
- Fertilizer
- Pesticides
- And many more...

We know that freshwater is a limited resource. It is very difficult to move entire regions towards environmentally-friendly stormwater management, but often a few small changes around us at home can make a big difference and inspire others to do the same.

With adult supervision, take some time to look around your home or even your block or street. In the space below, draw a simple map of your area. On the map, draw which surfaces are pervious and impervious. Once you have your surfaces mapped out, take a close look and see how many possible sources of pollution you can find. While working on this activity, ask yourself: *Which of these are likely to travel over impervious surfaces to a storm drain?*

If you're unable to go outside, you can make observations from a window or balcony or use your previous experiences as a reference.



Now that you've identified some potential problems, list some of the things you can do to help.

If pollution continues to flow into our lakes and streams, the water we have left may become unusable for us and the plants and animals that rely on it. So what can we do to stop this pollution? *Remember, it's often small changes that have the biggest impact over time. Some of the best solutions are simple.*

Optional Activity

How's My Waterway?

This EPA website provides information for you to learn the condition of local streams, lakes, and other bodies of water anywhere in the US. See if your local waterway was checked for pollution, what was found, and what is being done. The source of this information is the US Environmental Protection Agency (EPA) database of state water quality monitoring reports provided under the Clean Water Act.

With adult permission, access the EPA's "How's My Waterway Map" by clicking on this link: <https://watersgeo.epa.gov/mywaterway/>. Answer the questions below using the information on the website.

Materials: Computer/phone/tablet, internet connection, writing utensil

Locate the water closest to your home. What types of pollution, if any, have been found?

What projects and partnerships are in place to address the issue, if any?

Optional Activity

Stormwater Stewardship Challenge for Day 1

A public service announcement (PSA) is a message created and circulated with the purpose of raising awareness on an issue with the public. A PSA contains important information in just a few sentences, making it different from a lengthier news article. A PSA aims to influence a behavior or attitude change with the public by providing new facts in a creative and brief campaign for easy recall.

Materials: Writing utensil

Create a public service announcement highlighting the concerns of stormwater pollution and the impact of runoff to our waterways. The PSA should raise public awareness on this water quality issue. Remember that this should educate the public by providing new information, or it should remind citizens why they should take action. Recall news articles or PSAs you might have read before. What key messages were included to encourage the public to care?

Consider the following for an effective PSA and write one in the space below:

- *Captivating and interesting title* – The title should be easy to understand and engage the audience quickly
- *Few sentences describing the problem and the potential solutions* – Keep it simple! This is not a news article. A PSA should be short.
- *A public place for your PSA to be viewed by the members of your community*
- *Optional: Include an engaging illustration to further the understanding of your audience in regards to the problem and possible solutions*

To share your work, post your challenge to Facebook and/or Instagram (**with an adult**) so other people in your community can learn, too! Don't forget to tag @naturevisionorg in your post! Do you live in Auburn, Bothell, Lynnwood, or King County? Use the hashtags and tag the city or county group below. They want to see all the work you are doing to keep our water clean!

- If you live in City of Auburn: Tag @auburnwa and include the hashtag #auburnwa
- If you live in City of Bothell: Tag @BothellWaUSA and include the hashtag #PugetSoundStartsHere
- If you live in City of Lynnwood: Tag @LynnwoodWA and include the hashtag #Lynnwood
- If you live in King County: Tag @KingCountyDNRP and @kingcountywtd

DAY 2

Yards and Agriculture

The lawns, gardens, and farms in our communities create stormwater runoff issues due to the various chemicals used to promote plant growth (e.g. fertilizers) and limit weeds and insects (e.g. pesticides). When these chemicals enter our water sources, they make it difficult for plants and animals to survive. Specifically, nitrogen-based fertilizers are a large problem because they disturb the balance of nutrients in our freshwater, leading to a process called **eutrophication**.

Eutrophication occurs when our stormwater runoff has an excess of nutrients after it enters our ponds, lakes, and streams, causing algae to reproduce rapidly. The increased algae population forms a thick layer on the surface of the water, blocking the sun for other water plants. This causes these sunlight-restricted plants to die, stop photosynthesizing, and eventually produce less oxygen in the water. As the algae uses the nutrients in the water, it too eventually dies and is broken down by bacteria. With a large source of energy from the decomposing algae, the bacteria reproduce quickly using up most or all of the remaining oxygen in the water. At this point, it becomes **anoxic**, meaning there is no longer enough oxygen to support plant or animal life.

Excess Nutrients > Algae Bloom > Decomposition/Bacteria > Anoxic Water > Dead Zone

Being able to read oxygen levels and trace the source of nitrogen in our water is an important part of managing our stormwater. Scientists do this by conducting water quality testing experiments. However, before they can perform these experiments, they need to design them. Designing an experiment to help scientists collect data and answer important questions is the first step in being able to learn more about the world and how we can care for the environment.

When designing and conducting experiments, there are some important things to be aware of. First, you need a question that you want to answer, and a **hypothesis**. This is an explanation for a phenomenon based on limited knowledge or observations that you will seek to prove or disprove with your experiment. In other words, what do you think the answer to your question is (before using your tests to prove it)? This is your starting point!

Next you need to identify a way to test that hypothesis using **variables**. Variables are the different parts of your experiment including what you will measure, change, and observe to test your hypothesis. Experiments have **independent variables**, or changed variables, which are the factors that you will change in your experiment. Alternatively, there are **dependent variables**, or measured variables, that you will observe and measure to test your hypothesis. Lastly, there are **controlled variables**, like a scientific constant, that you will keep the same during multiple tests to make sure that your results are accurate.

Let's talk through an example of this. If you wanted to test if people preferred ice cream or broccoli, you could design an experiment. Begin by creating a hypothesis. For example: "I believe that people prefer to eat ice cream." Next, each participant is given either broccoli or ice cream, making food the independent variable. Participants are then told that they will have 5 minutes to eat as much or as little as they would like, meaning the controlled variable is a set time of 5 minutes. Experimenters would then measure how much ice cream participants ate, and how much broccoli participants ate, thus meaning the dependent variable is the amount consumed. Depending on how much of each item is consumed by participants, you would either prove or disprove your hypothesis. This experiment can be repeated multiple times to see if the results are consistent with different groups of people.

Starting Question: "Do people prefer ice cream or broccoli?"

Hypothesis: "People prefer to eat ice cream."

Independent/Changed Variable: Type of food given to consume.

Dependent/Measured Variable: How much of each food is consumed.

Control/Constant Variable: The amount of time available to eat.

In this case, the amount of time participants had to eat acts as a control or constant. We measure the dependent variable (i.e. how much of each food is consumed) and the independent/changed variable (i.e. the type of food provided). If after totaling up the amount of each food consumed by participants the results found that a total of 3 pounds of ice cream and 1.5 pounds of broccoli were consumed, then it would prove the hypothesis that "People prefer to eat ice cream."

Vocabulary

Anoxic: Insufficient oxygen levels to support living things

Controlled variable: An experimental element which is constant and unchanged throughout the course of the investigation

Dependent variable: The variable being tested and measured in an experiment, and is 'dependent' on the independent variable

Eutrophication: The process of excess nutrients making freshwater uninhabitable due to algae growth and depleted oxygen

Hypothesis: What you believe will happen

Independent variable: What the experimenter changes or controls and is assumed to have a direct effect on the dependent variable

Variable: Factor of an experiment

Main Activity

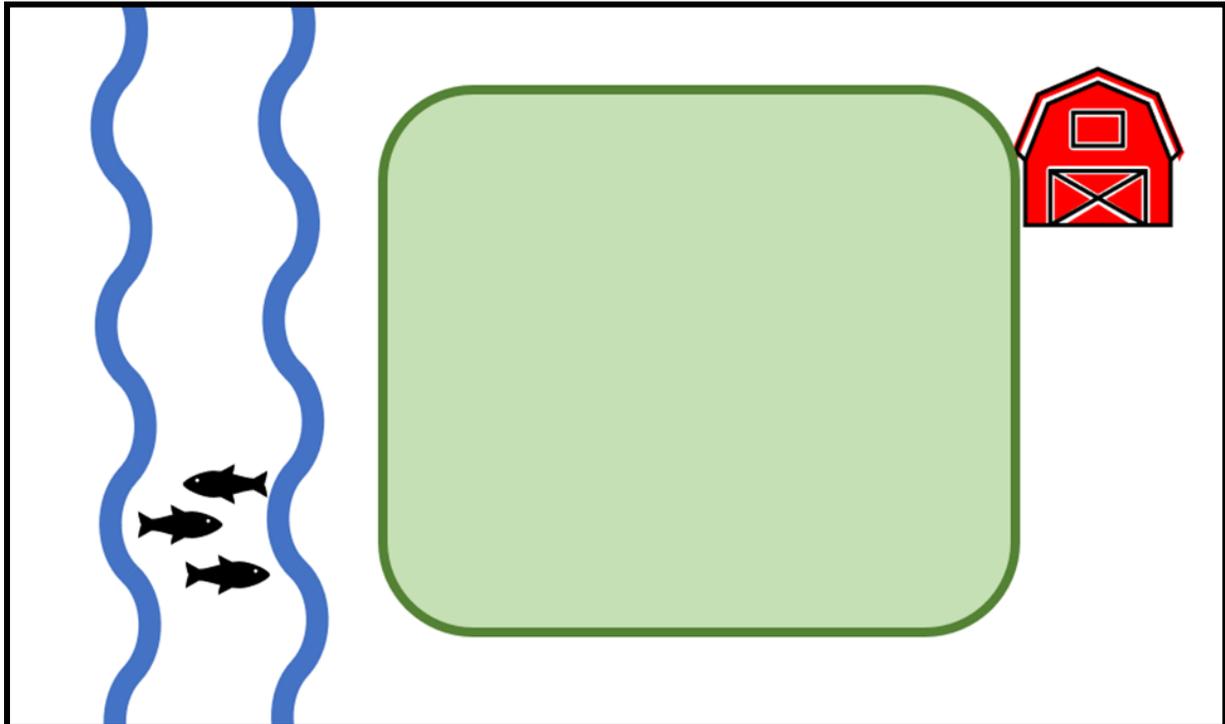
Design a Farm Runoff Experiment

Imagine that you are an environmental consultant reviewing agricultural impacts on water quality. You are working with a local wheat farm that uses a nitrogen-based fertilizer to grow their crops. Additionally, there is a small salmon-bearing stream directly next to this wheat farm. You are tasked with determining if this stormwater runoff may have an effect on the fish population.

Materials: Writing utensil, paper, computer/phone/tablet, internet connection

Design an experimental procedure to discover the quality of this water. Assume that you have access to any equipment that you might need, the farm, and the stream, both upstream and downstream of the farm. Considerations for your experiment design:

- What are the variables?
- At what site(s) will you be conducting your sampling?
- How many trials will you conduct?



Independent Variable (*what will you change*):

Dependent Variable (*what will you measure*):

Hypothesis (*what do you believe the answer to your question is*):

Materials (*what do you need for your experiment*):

Scope (*timeline*):

Method (*how will you perform your experiment*):

Follow up: After conducting your experimental procedure, you find that there is a significant amount of nitrogen runoff from the farm's fertilizer. What suggestions or alternatives can you pose to the farmer to decrease the environmental impact of the farm while maintaining wheat production?

Optional Activity

Farms, Wetlands, and Rivers Article

Wetlands help us to filter our water and make sure that runoff has an opportunity to soak into the soil. Historically, many farms near wetlands have focused on draining the wetlands near them so that they will be productive. In recent years, many farms have begun experimenting with ways to incorporate wetlands into their land management strategies. The following article from The Nature Conservancy details some of the work being done at one Midwestern farm to explore these possibilities to benefit both farms and freshwater resources. After reading this article, answer the follow up questions.

Source: <https://blog.nature.org/science/magazine/can-a-wetland-help-a-farm/>

Can a Wetland Help a Farm?

In the heart of the Midwest's Corn Belt, a family farm is experimenting with ways to keep its nearby rivers clean.

*Article by: Jenny Rogers
Spring 2018*

On a farm in the heart of Illinois, nearly a decade and a half of experiments are unfolding. For six generations, the land's owners, the Franklin family, have farmed their 250 acres along the Mackinaw River—a tributary to the Illinois River, which itself joins the Mississippi. The Mississippi has long struggled as fertilizer runoff from farms polluted its water and fed dead zones downstream in the Gulf of the Mexico.

Since 2014, the Franklin family has worked with researchers from The Nature Conservancy, the University of Illinois at Champaign-Urbana and elsewhere to test ways to reduce the amount of fertilizer washing into local rivers. Krista Kirkham, an aquatic ecologist for TNC in Illinois, talks about discoveries made there.

Q: In the Corn Belt of the Midwest—home to Franklin Farm—water polluted with fertilizer and eroded soil is a big challenge for farmers and conservationists. The Nature Conservancy first tried to address this in an earlier experiment, right?

A: Yes. For many years, we had worked with landowners in one watershed, about 10,000 acres, and compared water quality and biodiversity in an adjacent watershed where we didn't put any best management practices.

Q: Practices like planting grasses to prevent soil erosion into creeks. What did you learn?

A: Well, after doing a lot of water chemistry analysis, we didn't see any changes in water quality after seven to eight years. We needed a new direction: We had to address tile drainage.

Q: What's that?

A: It's a series of perforated pipes underground meant to facilitate drainage. Historically this area was very, very wet and to make it amenable to farming you have to drain the water out. We've now moved on to the idea of using wetlands to intercept that drainage.

Q: In other words, you want to filter the water farmers are draining from fields. How do you study that?

A: Well, that's how the farm work got started. We really needed to make sure we had a place to study wetlands—to make sure they're effective AND TO learn how big they need to be to be effective.

Q: When the experiments at Franklin Farm began, what was the plan?

A: When we first started this project, the questions were, "Are wetlands good at reducing nitrogen and phosphorus runoff? And, if they are good, how big do they need to be to see any significant reduction?" So, ideally, you don't want a massive wetland because that takes a lot of ground out of production [and] that's a tough sell to producers.

Q: At Franklin Farm, you ended up building three sets of wetlands of varying sizes to test the filtering effect. What did you find?

A: Over the years we've been able to monitor the inlets and outlets of all of these different cells that we have on the farm. And to make a long story short: Yes, wetlands are quite effective at reducing nitrate levels and particularly orthophosphorous levels—the biological component of phosphorous.

Q: Which is great, because when those chemicals pollute drinking water they can cause health problems for people, especially kids. How do the wetlands work though?

A: In the simplest terms, people define wetlands as "nature's kidneys" and that's somewhat true. Really, you're giving water a chance to slow down and interact with the sediment, where bacteria will do the work for you.

Q: And, the Franklin Farm research has shown, the wetlands don't need to be huge to make a big difference, right? You monitored wetlands the size of 3 percent, 6 percent and 9 percent of nearby farm fields.

A: Right, we found, regarding nitrate, that even at the smallest wetland, we're seeing a reduction of 12 to 24 percent. Then, it's 36 to 44 percent. At 9 percent, we see a little more reduction but it's a much less of a jump. That told us we don't even need a big one to see some pretty significant results and that's really encouraging.

Today the water experiments continue on the farm, joined with efforts to plant cover crops or restore unfarmed areas to native habitats. Researchers give regular tours to other farmers and researchers to share their findings and method.

Follow-Up Questions:

What question were researchers most interested in studying at the beginning of this experiment?

How are the farmers incorporating wetlands into their farming practices?

What are the benefits of including wetland areas in land management strategies?

How could this knowledge help farmers and conservationists in other parts of the country and the world?

Optional Activity

Stormwater Stewardship Challenge for Day 2

A comic strip is an entertaining way to share a narrative when words alone are not enough. A comic strip is divided into squares to communicate pieces of a story. There can be multiple squares in a comic strip, each one portraying illustrations, characters, and captions to depict specific events.

Materials: Writing utensil, coloring materials, computer/phone/tablet, internet connection, paper (optional)

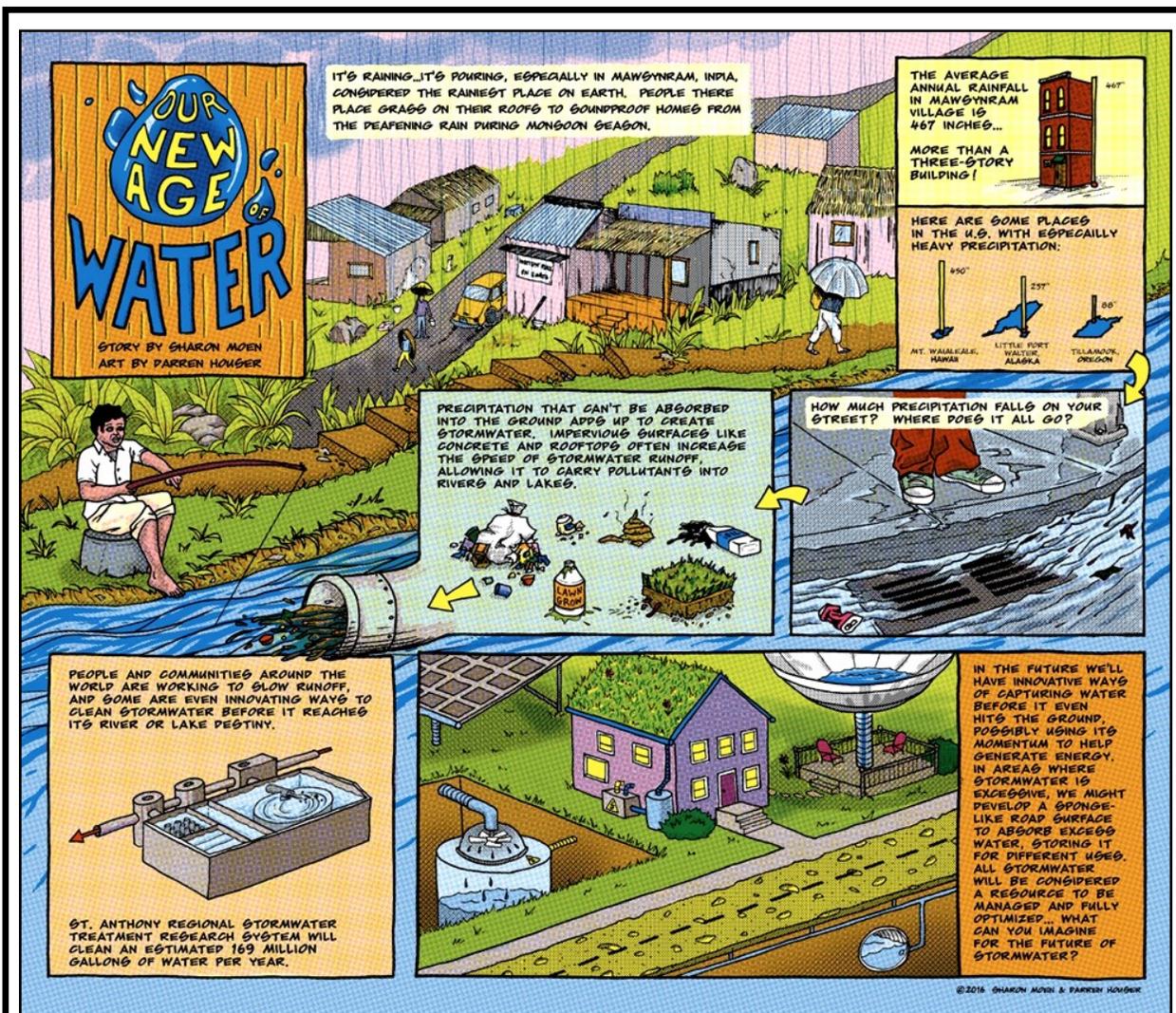
The purpose of comic strips is to entertain the reader with illustrations and words to tell a story. A comic strip is split into squares, with each square containing specific pieces of artwork, characters, and captions to narrate events of the story. Create an entertaining comic strip in the boxes below that narrates a story about stormwater runoff pollution and storm drains! The comic strip should include illustrations and captions to highlight a story of your own design.

Create your own comic strip in the boxes below! Things to consider for your comic strip:

- Storyline and story events – *described through your illustrations and captions*
- Main characters
- Supporting characters
- Setting
- Tone – *funny, serious, upbeat, etc.*

There is also an example on the next page.

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| | | |



Source: NOAA

To share your work, post your challenge to Facebook and/or Instagram (*with an adult*) so other people in your community can learn, too! Don't forget to tag @naturevisionorg in your post! Do you live in Auburn, Bothell, Lynnwood, or King County? Use the hashtags and tag the city or county group below. They want to see all the work you are doing to keep our water clean!

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- If you live in King County: Tag @KingCountyDNRP and @kingcountywtd

DAY 3

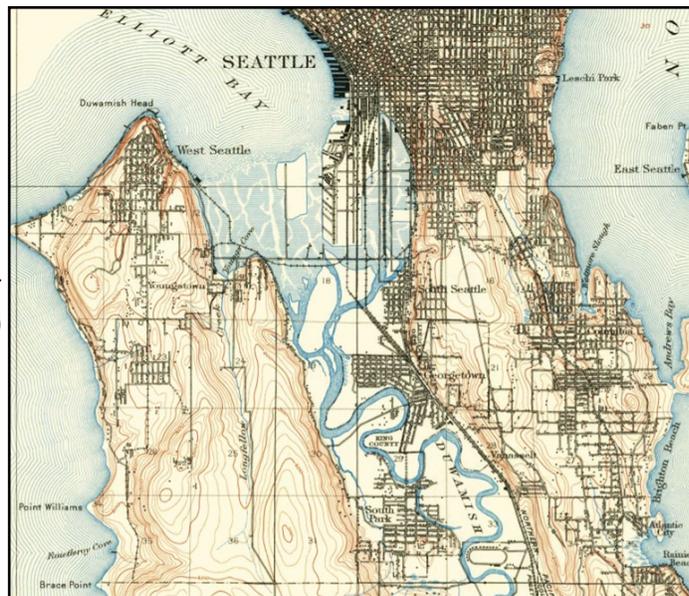
Industrial Contamination

Human beings impact our water quality in dramatic ways. We've learned about how our cities impact stormwater runoff, about non-point source pollution, and about how our yards, gardens, and farms can negatively impact water quality when we use fertilizers and pesticides. Alongside those sources is one of the largest culprits of contamination: the various chemicals that we use to operate vehicles and industrial machinery.

Communities that are close to major industrial areas experience much higher levels of pollution in their air and water. One of the most dramatic shifts in our local water quality resulted from the negative impacts on the Duwamish River over the past 100 years. Beginning in 1913, the Duwamish River was **dredged** and shaped to become the Duwamish waterway, a main thoroughfare and the backbone of Seattle's industry. This industry included cargo handling and storage, marine construction, ship and boat manufacturing, asphalt manufacturing, paper and metals fabrication, and food processing. The **industrial contaminants** became so common that the **Environmental Protection Agency** (EPA) named the Duwamish waterway a **superfund site** , meaning that it was one of the most highly polluted areas in the country and a priority for cleanup.

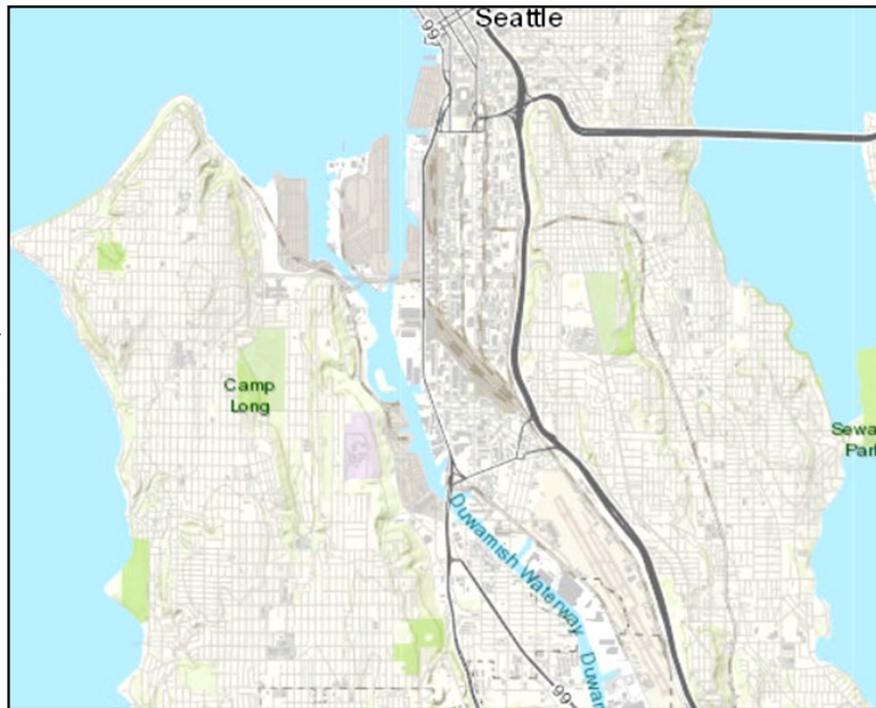
Here you can see a map of Seattle and the Duwamish River in 1908. The image on the next page shows a map of Seattle and the Duwamish River in 2020. Not only was the course of the river altered, but this area has become much more densely **urbanized** , and numerous industries began operating along the edge of the newly constructed waterway.

Duwamish River
(1908)



Source: <https://catalog.data.gov/dataset/usgs-1-62500-scale-quadangle-for-seattle-wa-1908>

Duwamish River
(2020)



Source: Google Maps

One of the more complicated aspects of the cleanup process was determining responsibility for the environmental issues from the gasoline, oil, debris, and other pollutants that made their way into this body of water. Because of the impacts of point and non-point source pollution, it was difficult to say that any one particular organization was responsible. Contamination had come from the stormwater runoff from city streets, overflow from wastewater treatment facilities, and the various industries along the river such as asphalt production and airplane manufacturing. As a result, the City of Seattle, King County, and other various businesses needed to work together, along with members of the community to tackle this problem.

With adult permission, you can learn more by visiting and watching “Citystream: History of the Duwamish River” by following this link:

<https://www.seattlechannel.org/CityStream/segments?oid=x21250>

Vocabulary

Dredged: Clean out a harbor, river, or other area of water by scooping out mud, weeds, and debris

Environmental Protection Agency: Government agency responsible for our impact on the natural world

Industrial contaminants: Pollutants that are from manufacturing and industry

Superfund site: A designation of the most polluted areas in the U.S.

Urbanized: Densely populated and a highly developed, a city

Main Activity

Duwamish River Timeline Interpretation

The following abbreviated timeline from the Duwamish River Cleanup Coalition (DRCC) details many of the key events to date that have impacted this water way. After reading the timeline answer the questions that follow.

Materials: Writing utensil

The following information is found in full at this URL: <https://www.duwamishcleanup.org/timeline>. **Please obtain adult permission to click on links in this timeline.**

October 14, 1913: *The process of straightening the Duwamish River begins, with twenty million cubic yards of mud and sand are moved to fill the river bends and deepen the main channel for shipping. With the river straightened and dredged to become a navigable waterway, the landscape quickly fills with concrete factories, shipping terminals, and wrecking yards.*

May 9, 1917: *The Boeing Company is formed and begins production in the “Red Barn” on the Duwamish River.*

1937: *Duwamish Manufacturing Company begins using the site now called Terminal 117 to produce asphalt.*

September 9, 1958: *King County voters approve the creation of an agency to build a regional sewage treatment system. 11 Combined Sewer Overflows are installed to discharge untreated overflows of sewage and stormwater into the river.*

1991: *City of Seattle and King County settled with the federal government for damages to public natural resources from the city and county’s combined sewer overflows. This settlement included cleanup at the Duwamish/Diagonal CSO.*

1993: *The Duwamish/Diagonal sediment cleanup project begins. Over the next few years, many dangerous contaminants of concern are found on the site.*

December 2000: *EPA signs an agreement with the Lower Duwamish Waterway Group – made up of Boeing, City of Seattle, King County, and the Port of Seattle – to fund investigation of waterway contamination and evaluate cleanup alternatives.*

September 2001: *The legacy of 100 years of industry along with the discharge of 11 combined sewer overflows and 200 storm drains leads to EPA declaring the area a Superfund site, contaminated with over 40 chemicals above recommended levels for human health.*

June 2003: *Five areas along the Duwamish River were identified as Early Action Areas, based on the high risks to people or wildlife in and around the river. With this designation, cleanups and studies were scheduled for these areas.*

November 2003: Cleanup begins at Duwamish/Diagonal Combined Sewer Overflow and Storm Drain, the first Early Action Area. On Day 3, the project was shut down due to violations of environmental regulations reported by DRCC to King County and EPA. Over the following 3 months, due to “messy” dredging and poor operator skill, this project would violate water quality standards measuring suspended sediments on nearly 50% of the days they were dredging in the river.

2007: Cleanup at Early Action Areas is delayed because of recontamination of sites from upland sources of PCBs. With this discovery, there is need to develop a plan for controlling these sources before cleanup began. The Department of Ecology discovers that sources of PCB pollution are not adequately controlled to protect the Slip 4 cleanup area. EPA and Boeing later implement a system that treats stormwater draining into Slip 4 from Boeing Field, allowing the cleanup to proceed.

2007: As a result of DRCC/TAG and the community working together, using their voices to advocate for a cleanup that benefits all, the Port of Seattle determines that the T117 site will be changed from an industrial site to a public access habitat site. As a result, a revised cleanup plan is needed.

November 2007: The investigation of the extent, distribution, and risks caused by toxic pollution in the river sediments is completed. The Remedial Investigation or “RI” report is released and includes results of sampling in the river, maps of chemicals found in the river bottom, information on risks to the environment and human health, and identification of ongoing sources of pollution.

2009: The Duwamish Valley Vision and Map is developed through a series of community workshops, interviews, and surveys with over 500 Duwamish Valley residents, workers, business owners, industrial leaders, youth, elders, recreational visitors, fisherman, and homeless constituents. The result is a vision of the community’s aspirations, providing a road map for the work ahead.

2010: Potentially Responsible Parties for the cleanup propose six alternatives for EPA’s consideration. DRCC/TAG determines that these all stop short of providing enough cleanup to prevent cancer, reproductive, developmental, and other health risks to people most exposed to the river’s pollution. DRCC/TAG’s assessment includes an environmental justice review and fact sheet. Learn more: <http://duwamishcleanup.org/superfund-info/documents-and-reports/phase-2-riverwide-cleanup-plan/>

October 2012: EPA involves Duwamish River communities in the Superfund Job Training Initiative (SuperJTI) program. The program provides community members with skills and certifications to work on the Duwamish River Superfund site. Learn more here: <https://cumulis.epa.gov/supercpad/SiteProfiles/index.cfm?fuseaction=second.Cleanup&id=1002020#bkgground>

February 28, 2013: EPA releases the Proposed Plan for the cleanup of the Duwamish River. Over the next 105 days, DRCC/TAG, in partnership with EPA and the community, hold five (5) public hearings and 16 unconventional public meetings; present 25 times in the community; and hold five (5) other events. And the results are staggering:

- 1300 attend public hearings, public meetings, and more.
- Over 2300 comments in 10 different languages are collected and submitted! Learn more about this work here: <https://www.duwamishcleanup.org/superfund-info/early-action-areas/>

February 2013: EPA conducts and releases an Environmental Justice Analysis of the cleanup option after DRCC/TAG's request. The intention is to examine whether the remaining burdens would be fair or would inequitably impact vulnerable communities.

December 2014: EPA's Final Record of Decision on the Superfund cleanup is released.

2015: Cleanup of Boeing Plant 2 is completed.

May 31, 2016: City workers remove the last of the PCB-contaminated soils from the streets adjacent to Terminal 117.

October 2016: Released the Community Involvement Plan - A Community Involvement Plan (CIP) provides an overview on the outreach tools and techniques that we will use throughout a cleanup of a polluted site. This update of the Lower Duwamish Waterway CIP is based on inputs from local residents, tribal leaders, community organizations, businesses, government representatives, and other stakeholders

August 2019 - EPA releases the Institutional Control Implementation and Assurance Plan (ICIAP) prepared by Public Health – Seattle & King County (Public Health) (EPA) under a Cooperative Agreement (2017–2021). As a “living road map” to guide the work of the EPA's Duwamish Seafood Consumption IC Program, this ICIAP will be updated based on evaluation, monitoring, and community input throughout the cleanup process of the Lower Duwamish Waterway Superfund site. More information about King County- Public Health Fun to Catch Toxic to Eat Program - The purpose of this program is to protect the health of fishing communities, especially pregnant women, nursing moms and young children, from the contaminated seafood in the Duwamish River Superfund Site. Public Health — Seattle & King County leads the Program work for the US Environmental Protection Agency (EPA). This program is part of EPA's plan to clean up the Duwamish River.

Timeline Questions:

Who were the major contributors of contaminants/pollution to the Duwamish?

What role did city, state and federal government play in contamination and cleanup?

What role did local community members play during cleanup/restoration?

What difficulties/setbacks made this process so long and involved?

Optional Activity

River Restoration Model

Restoring a habitat is complicated, especially when significant changes to the environment have taken place, or where high levels of contamination exist. However, not all changes to our environment present the same issues when it comes to cleanup. In this activity, you will explore the process of restoring physical changes (e.g. dam creation, or the straightening of the Duwamish River) in comparison to chemical contamination (e.g. stormwater runoff and industrial contaminants).

Materials: large aluminum pan or plastic container, spoon, dirt/gravel, food coloring or drink powder, spray bottle

Make sure you have adult support and permission when gathering materials and be very careful when participating in this project in a way that is clean, careful, safe, and respectful. Be careful not to clog drains with soil, and if possible perform this activity outside.

Follow these steps to build your river restoration model, and answer the questions:

1. Fill one third of a large aluminum pan or plastic container with dirt/gravel. Create a river channel using your hands or a spoon.
2. Using a spray bottle, spray small amounts of water on the soil and notice how it flows downhill in watersheds. Record what you observe, such as direction of flow, pooling, etc.
3. Create a physical barrier to this water, for example a small dam, or blockage. *How have you changed the flow of water?*

4. *In order to return the "river" to its original state, what would you need to do?*

5. Predict how well you will be able to restore this environment to its original functions and try it out. *Were your predictions correct? What was difficult or surprising about this process?*

6. Place small amounts of different colors of powdered dyes around your model to represent solid pollutant sources (e.g. industrial chemicals, oils, fertilizers, and pesticides).
7. Predict how well you will be able to remove the various pollutants and return the river to its normal functions. *Were your predictions correct? What was difficult or surprising about this process?*

8. *When restoring the model with only physical changes to the environment, what did you need to consider for the cleanup process?*

9. *When restoring the model with chemical contamination, what did you need to consider for the cleanup process?*

10. *What did you find surprising or interesting comparing the physical changes to the chemical changes?*

Optional Activity

Stormwater Stewardship Challenge for Day 3

Stewardship, which we'll talk more about later in the packet, can take on many different forms. Helping others understand why certain issues matter and what role each of us can play is a practice of stewardship. Today we have powerful tools like phones, print media, and the internet that allow us to broadcast ideas worldwide in seconds. Historically, methods were much simpler. Looking back at early human history, members of the community taught one another, created cultural norms, and established guidelines through stories. Every culture in humanity has relied on the passing down of oral traditions in the form of tall tales, fables, and myths that teach of that culture's customs and morality.

Materials: Writing utensil

Using what you have learned about stormwater and pollution so far, write a short fable on the next page to help teach others about something they can do to help protect our waterways. Remember, this fable doesn't need to be set in ancient times or look anything like other stories and oral traditions you've heard. Feel free to have fun with this and make it unique! Share your fable with someone else and use the story to help them understand stormwater and how they can help prevent pollution.

To share your work, post your challenge to Facebook and/or Instagram (**with an adult**) so other people in your community can learn, too! Don't forget to tag @naturevisionorg in your post! Do you live in Auburn, Bothell, Lynnwood, or King County? Use the hashtags and tag the city or county group below. They want to see all the work you are doing to keep our water clean!

- If you live in City of Auburn: Tag @auburnwa and include the hashtag #auburnwa
- If you live in City of Bothell: Tag @BothellWaUSA and include the hashtag #PugetSoundStartsHere
- If you live in City of Lynnwood: Tag @LynnwoodWA and include the hashtag #Lynnwood
- If you live in King County: Tag @KingCountyDNRP and @kingcountywtd

Lined writing area for notes or comments.

DAY 4

Pet Waste

The choices we make right in our backyard will have an impact on the health of the Puget Sound. All of the water that runs off our properties flows into storm drains and ends up going directly into local bodies of water. In other words, how we manage pollutants in our homes and yards plays a part in the quality of our water. One source of pollution that has a large impact on the health of our waterways is **fecal bacteria**. Fecal bacteria comes from pet waste, otherwise known as dog poop. If dog waste is not picked up, rain will carry fecal bacteria into the storm drains, rivers, streams, and lakes. A lot of the fecal bacteria we find in our water are there because people do not always pick up after their pets. Since our stormwater systems are connected to our freshwater sources, it's extremely important to remember that storm drains are not sewers.

According to *Live Science* in 2014, "America's 83 million pet dogs produce some 10.6 million tons of dog feces every year." The amount of dog feces that adds up in our country each year is enough to fill a line of tractor trailers all the way from Seattle to Boston!

Some people may not realize that dog waste is such a harmful thing for our watershed, nor why. After all, many wild animals go to the bathroom outdoors and no one picks it up. While that is true, wild animals have a diet that is naturally found in our **watershed ecosystem**, while dogs are mostly fed processed food. Because of their processed diet, dog waste is much different from that of wild animals. For example, dog waste contains higher levels of **E.coli** than most other animals.

According to the Environmental Protection Agency, "A day's waste from one large dog can contain 7.8 million fecal coliform bacteria, enough to close 15 acres of shellfish beds." As this quote suggests, it is incredibly important for everyone to do their part to help with the problem of dog waste.

So, what can be done with dog waste to prevent it from contaminating the watershed?

Tips about pet waste from the Environmental Protection Agency (EPA):

- *Always pick up after your pet* (It should be picked up with a plastic bag and placed in the trash).
- *Avoid walking your pet near streams and other waterways. Instead, walk them in grassy areas, parks or undeveloped areas.*
- *Inform other pet owners of why picking up pet waste is important and encourage them to do so.*
- *Take part in a storm drain marking program in your area to help make others aware of where pet waste and other runoff goes when not disposed of properly.*

Eliminating pet waste as a potential pollutant is a complicated issue. Often when pet owners are picking up their pet's waste, they are not aware of the proper disposal method. Should it be thrown in the trash, composted with the yard waste, publically composted, flushed down the toilet, or something else? Well-intentioned pet owners want to help the environment, but need clear directives of how to handle pet waste. In the following activities, we'll learn more about the best way to dispose of pet waste in order to prevent further contamination of the water in our watershed.

Vocabulary

E. coli: A bacteria commonly found in the intestines of humans and other animals, some strains of which can cause severe food poisoning

Fecal bacteria: Single-cell organisms, or bacteria, found in feces or fecal matter

Watershed ecosystem: The plants and animals that rely on freshwater moving through a particular watershed

Main Activity

Dog Waste Informational Campaign

The article section below encapsulates the complicated backend issues of pet waste that surround proper disposal. After reading, answer a few questions before designing a flyer that informs pet owners how to properly dispose of pet waste and the environmental impact of not doing so. When your flyer is complete, **with parent/caregiver permission**, ask a local veterinarian's office or animal rescue agency (e.g. Seattle Humane Society, PAWS) if you could share your flyer with them so they can post it in their office or give it out to pet owners. This can be shared digitally with them you cannot share in person.

The article excerpt is authored by Aimee Christy from the Pacific Shellfish Institute for Thurston Conservation District, and is available to download here: www.pacshell.org/pdf/PSI_TCCD_FeasibilityStudy.pdf

Materials: Writing and drawing materials

Feasibility Study Anaerobic Digestion and Other Alternatives for Dog Waste Management and Education in Thurston County



Prepared for
Thurston Conservation District
2918 Ferguson St. SW, Bldg 1, Suite A
Tumwater, WA 98512

Prepared by
Aimee Christy
Pacific Shellfish Institute
120 State Ave NE #152
Olympia, WA 98501
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January 3, 2013

...PART 3 - LARGE-SCALE ALTERNATIVES TO DOG WASTE DISPOSAL

While a small-scale digestion project at a local dog park could be a useful tool in public education and engagement, other options exist for more comprehensive pet waste management. This report presents both resources and efforts that are taking place both nationally and internationally to manage dog waste on a large-scale. This field is relatively new and peer-reviewed research data for both anaerobic digestion and composting of dog waste is limited. Adopting new practices for managing pet waste will require ingenuity, testing, and strict monitoring to ensure protection of human health.

Current Disposal Practice

Pet waste, both in quantity and composition, has always posed a challenge in terms of waste disposal. Animal Services estimates that there are 50,000 dogs in Thurston County producing approximately 11 tons of waste per day. A 2007 pet census by the American Veterinary Medical Association revealed 72 million dogs live among humans in the U.S. Dog waste contains an array of harmful pathogens, many of which require very high temperatures to treat.

Until recently, local governments across Puget Sound formulated their own approach to manage dog waste, offering a selection of choices for homeowners (flushing, burying, Doggie Dooley-style backyard “composters”). Now, as part of the Washington Waters and Puget Sound Starts Here Campaigns, a one-size-fits-all recommendation of placing all bagged pet waste in the garbage can (not co-mingled with organic waste) has been adopted. This “Scoop it, Bag it, Trash it” recommendation is easy, straightforward, and protects water quality and human health.

Neither the LOTT wastewater treatment facility nor Silver Springs Organics will directly accept dog waste (personal communication, Lisa Dennis Perez and Samantha Fleischner). For LOTT, sanitary waste requires a great deal of water, energy, and money to process. Dogs produce a sizable quantity of fecal matter that would not be taken into consideration by the facility’s capacity projections, which are based on people and not pets. In addition, LOTT’s waste treatment processes are designed to handle human waste and may not be appropriate for other types of waste that differ in pathogen/microbe content, moisture levels, and overall chemistry. Silver Springs Organics does not, and will not ever, accept dog waste, which would require a Type 4 Feedstock permit, or equivalent.

Composting

According to the Washington State Compost Educators Guide, dog waste is decomposable and will biodegrade like other organic materials when composted or vermin-processed. That said, it is widely agreed upon that backyard composting is not a safe option for disposal and/or treatment of dog waste. Backyard composters rarely maintain “hot piles” that reach temperatures high enough and for a long enough duration to kill pathogens. In one trial from Eugene, Oregon, backyard compost containing dog waste that was composted for a year and matured for another year and a half, resulted in decreased, but positive, levels of fecal coliform, Salmonella, and viable Helminth Ova.

Follow-Up Questions:

The study mentions different possibilities of ways of dealing with dog waste. Name some of the different ways dog waste is currently being disposed of.

Why is backyard composting not currently a safe disposal option?

What do the Washington Waters and Puget Sound Starts Here campaigns recommend doing with dog waste to protect water quality and human health?

Optional Activity

What to Do With the Poo?

As we read in the previous activity, there can be different rules about disposing of pet waste, and these rules depend on where you live. Many people are not sure of the proper disposal method for their pet waste, and the recommendations can differ based on the city, county, or organization providing them. For example, the Environmental Protection Agency considers flushing pet waste in the toilet to be the most environmentally friendly method while our cities, county, and other environmental groups consider bagging pet waste and putting it in the trash to be the best option. In this activity, you will consult your city or county for information about how pet owners in your community should be disposing of pet waste.

Materials: Internet connection, computer/phone/tablet, writing utensil

With adult permission, conduct online research for the city that you live in to find out about procedures for pet waste on the city or county website. If there is no clear information available, you may reach out to the city or county by writing an email or letter asking them to include this information online, along with the impact of pet waste on water quality.

If you don't have internet connection or access to a computer, you can also call your city or county directly and ask to speak to someone about their pet waste policy.

You might find it helpful to make a Cornell Notes Outline of things that you want to write to your city or county about before you write an email or letter, or before you give them a call. Use the outline provided on the following page to capture your main points and ideas!

Points to discuss with my city or county:

Problems with pet waste

Different methods of pet waste disposal

Possible solutions

Optional Activity

Stormwater Stewardship Challenge for Day 4

When faced with the large-scale issues that we've been learning about, it's easy to feel overwhelmed. Every person who learns about these situations has at least one moment where they ask themselves: "What can I really do?" After all, it can be really tough for one person to have a big impact on such large-scale events. While one person may not be able to change the course of climate change, stem the flow of pollution, or save the Puget Sound, there are many people out there who are working together to create positive change. Together as a community, we can accomplish far more than any individual can alone. There are many opportunities to get involved in these efforts!

Materials: Writing utensil

Today, **with adult permission**, visit your state, county, and city websites to look up some of the local organizations involved in managing stormwater and preventing pollution. In the space below, write some notes about the ones you find that might be interesting for you or others you know. Today's challenge is about spreading awareness of opportunities to get involved. Share your findings with at least three people around you! This can be done in person with people in your home, by written letter, or digitally through methods like email and social media.

To share your work, post your challenge to Facebook and/or Instagram (**with an adult**) so other people in your community can learn, too! Don't forget to tag @naturevisionorg in your post! Do you live in Auburn, Bothell, Lynnwood, or King County? Use the hashtags and tag the city or county group below. They want to see all the work you are doing to keep our water clean!

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- If you live in King County: Tag @KingCountyDNRP and @kingcountywtd

DAY 5

Stewardship

Stewardship is how we care for the natural world. It includes conservation of natural resources like water that all living things need to survive, thinking and acting carefully about how we interact with the world around us, and doing our best to make sure that we have a positive impact on the environment. Stewardship activities can be focused on what students and families can do help keep water clean for the rest of the environment.

The choices that we make in our homes and neighborhoods are extremely important. The products that we use in and around our homes, in addition to how we dispose of those products, have an impact on the Puget Sound. Even if we don't live right near the Sound, our actions have an **environmental impact** because pollutants can easily enter local bodies of water through the storm drains in our neighborhoods.

Best Management Practices (BMPs) are things we all can use to limit the amount of non-point source pollution from entering our waterways. Some BMPs include the following activities:

- Picking up after your pet (i.e. "Scoop the Poop!")
- Using the commercial car wash instead of washing cars on the driveway or street
- Using alternative transportation when possible (i.e. public transportation and riding a bike)
- Using compost instead of chemical fertilizers
- Disposing of hazardous waste properly
- Staying on the trail when exploring local waterways
- Sharing what you know about Best Management Practices with others

Vocabulary

Best Management Practices: Methods that have been determined to be the most effective and practical means of preventing or reducing non-point source pollution to help achieve water quality goals

Environmental impact: The effect, good or bad, that actions have on the environment

Stewardship: The act of caring for natural resources and the environment

Main Activity

Be a Water Warrior!

Below are actions that you can take to help make a difference in the health of Washington's waters. Check off any actions that you or your family are already doing. Underline four other actions that you can commit to start. Afterwards, write your answers into the pledge on the next page!

Materials: Writing utensil

As a Water Warrior I can:

- ◇ Scoop my dog's poop, bag it, and trash it.
- ◇ Dispose of all trash in the appropriate trash or recycling receptacle. I won't litter!
- ◇ Remove any invasive species found in my yard.
- ◇ Plant native species.
- ◇ Talk with your family about using fertilizer and pesticides sparingly. Read the label. Follow the application instructions.
- ◇ Take my car to a commercial car wash, either self-serve or machine wash rather than washing my car on my driveway or street.
- ◇ Maintain my car. Check for oil leaks regularly and fix them promptly.
- ◇ Dispose of oil or other engine fluids properly, not on the ground or into the ditch.
- ◇ *(For homes with septic tanks)* Have my home septic tank inspected and pumped every 3-5 years or as suggested by my city, county, or health department.
- ◇ Hold the nozzle when refueling my car or boat to minimize spills.
- ◇ Plant a rain garden.
- ◇ Make a rain barrel for use in yard (check to make sure you can have one where you live).
- ◇ Pick up litter when I find it.
- ◇ Make sure any storm drains near my home are free of debris.
- ◇ Prioritize using compost in my garden over manure or fertilizer.

I Am a Water Warrior!

These are the actions that I commit to start:

1. _____
By taking this action I am helping Washington water by making the following difference:
(Fill in the way that this action impacts water quality below)

2. _____
By taking this action I am helping Washington water by making the following difference:
(Fill in the way that this action impacts water quality below)

3. _____
By taking this action I am helping Washington water by making the following difference:
(Fill in the way that this action impacts water quality below)

4. _____
By taking this action I am helping Washington water by making the following difference:
(Fill in the way that this action impacts water quality below)

Optional Activity

King County Protect and Restore

Over this past week, we learned about different pollutants that can make their way into our stormwater and eventually into our freshwater sources. The national conservation group Izaak Walton League of America, along with Scistarter, have launched a campaign with the goal of creating a map of potential stream-monitoring sites to be monitored in the future by citizen volunteers. They are asking for community volunteers of all ages to share photos of local neighborhood streams to help them add to their current mapping efforts. You can help and make a difference in our local water quality by recording the condition of a local stream in your neighborhood!

Materials: Phone or digital camera, internet access

With adult permission, visit the following website: <https://scistarter.org/form/stream-selfie>

With adult permission, visit a local stream in your neighborhood — or somewhere nearby to one — if it is safe to do so. On the website, you will enter some information about the stream that is helpful for mapping and monitoring the stream.

Some things to research:

- The name of the stream (if it has a name)
- Land ownership (e.g. public or private ownership)
- The amount of trash that you see

You will be asked to fill out these questions and a few others, to find the location of the stream on a map, and share a picture (if you took one).

*Note: the photo does NOT need to be a selfie! For privacy, you may choose to just take a picture of the stream and any trash that you find there. (PLEASE DISCUSS THIS WITH YOUR PARENT/CAREGIVER **BEFORE** POSTING)*

If you are unable to visit a local stream and help identify possible restoration projects, you can learn more about how King County is working to restore stream habitats in need of protection/restoration on the next page...

The Restore and Protect Project

Source: <https://kingcounty.gov/depts/dnrp/wlr/sections-programs/science-section/doing-science/restore-and-protect.aspx>

Stressor identification and recommended actions for restoring and protecting select Puget Lowland stream basins

The Restore and Protect Project focuses on improving freshwater quality and addresses Puget Sound Partnership recovery goals related to protecting and restoring streams throughout Puget Sound. This project is part of a phased effort, and this report reflects work done in the second of five phases. For more information about the first phase of the project, see [Strategies for Preserving and Restoring Small Puget Sound Drainages](#).

Streams are essential natural resources for humans and animals alike. Many of the animals that rely on healthy streams are especially sensitive to water quality and habitat conditions. This is true for well-known species like salmon, but it is also true for the many insects, worms, snails and other small critters that live on the bottoms of streams and often go unnoticed. These smaller animals, often collectively called “stream bugs,” are excellent [indicators of water quality and overall stream health](#). Collecting information about the number and types of stream bugs present at a site provides us with the big picture of how a stream is doing and what actions are needed to meet our water quality and habitat restoration and protection goals.



Stonefly in the genus *Pteronarcys*, a stream bug.

Goals

The goal of the second phase of the project is to identify human activities that are impacting a select group of streams and to recommend actions that restore and protect the stream basins, in order to advance the Puget Sound Partnership (PSP) overall goal of restoring, protecting, and sustaining Puget Sound.

This project looks at one of PSP's Freshwater Quality indicators: the Puget Lowland [Benthic Index of Biotic Integrity](#) (B-IBI). This index is used to characterize stream health and is based on the variety of stream bugs present at a site. The B-IBI scoring system categorizes streams as “very poor” to “excellent,” on a scale of 0-100. This report focuses on four “fair” streams in need of restoration and 10 “excellent” streams in need of protection. These sites were selected from a long list of potential sites because of their history of B-IBI scores and their potential for improving or maintaining high scores. More information about the B-IBI scoring system and the criteria used to select sites can be found on the Puget Sound Stream Benthos website.

Selected basins

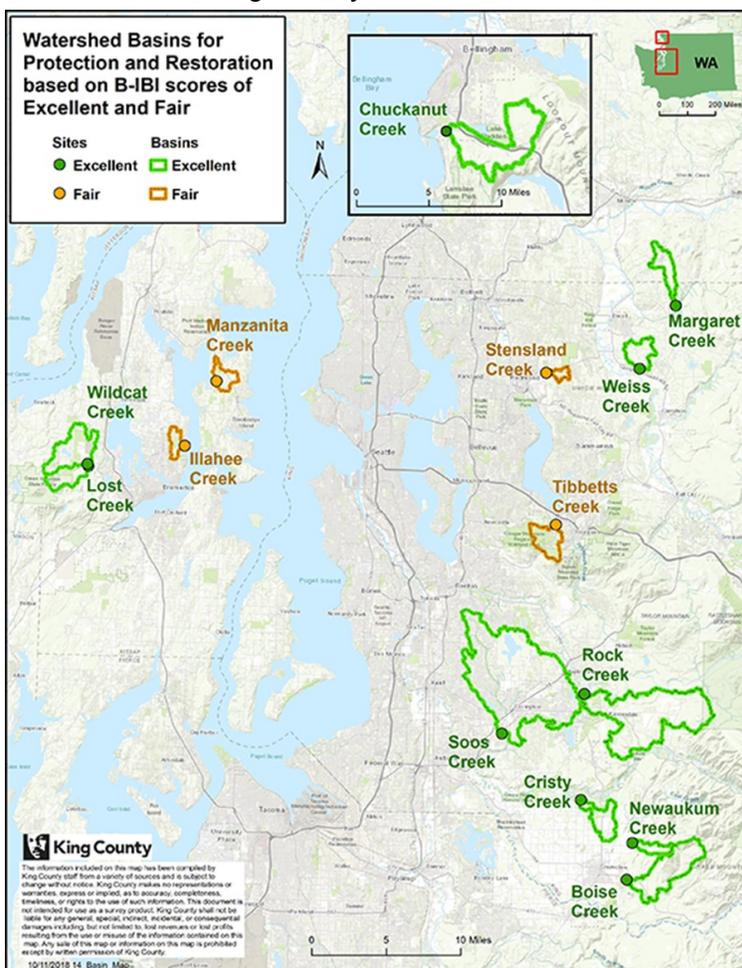
Regional stream bug data were used to identify 10 healthy basins needing protection and four degraded basins needing restoration.

“Fair” sites include:

- Illahee Creek, Kitsap County, Water Resource Inventory Area (WRIA) 15
- Manzanita Creek, City of Bainbridge Island, WRIA 15
- Stensland Creek, King County, WRIA 8
- Tibbetts Creek, City of Issaquah, WRIA 8

“Excellent” sites include:

- Lost Creek, Kitsap County, WRIA 15
- Wildcat Creek, Kitsap County, WRIA 15
- Chuckanut Creek, Whatcom County, WRIA 1
- Margaret Creek, King and Snohomish Counties, WRIA 7
- Big Soos Creek, King County, WRIA 9
- Weiss Creek, King County, WRIA 7
- Rock Creek, King County, WRIA 8
- Cristy Creek, King County, WRIA 9
- Newaukum Creek, King County, WRIA 9
- Boise Creek, King County, WRIA 10



Map of selected basins in the Restore and Protect Project

Identifying stressors

Identifying specific stressors affecting stream communities is challenging. Many stressors known to impact stream communities, such as excess fine sediment, loss of riparian trees and shrubs, and flashy flows, are associated with increased urbanization and thus co-occur in most basins.

In this study, we identified potential stressors affecting each basin using data from field surveys and a variety of geospatial data. With this information, we characterized conditions at the local, riparian and basin scales and compared those to conditions we find in other stream basins.

To provide context for the site conditions, we used two approaches to generate a list of conditions that characterize typical “excellent” B-IBI sites and identify thresholds at which stream bug communities change in response to degraded conditions.

First, we examined the relationships between environmental conditions and B-IBI scores from additional sites within the Puget Sound basin. We also examined how sensitive stream bug species (independent of B-IBI scores) respond to degraded conditions. Second, we evaluated conditions at the local, riparian, and basin scale for each study site, and compared those to conditions observed in typical “excellent” sites.

What did we find?

We found what others have observed in studies evaluating the relationship between B-IBI scores and environmental conditions: multiple, related factors associated with urbanization and loss of forest are likely responsible for degraded stream health and negative impacts on B-IBI scores.

Changes in the stream bug community composition are best explained by large scale stressors (e.g., extent of urbanization in the basin and the associated stressors) rather than a single stressor.

At all “fair” sites, we found multiple conditions were degraded. Generally, conditions were most impacted at the basin and riparian scale, and in some cases, less at the local scale. These results corroborate other studies that indicate B-IBI scores are better correlated with basin-scale conditions than with site-scale conditions.

As we expected, environmental conditions at “excellent” sites were much better than conditions at the “fair” sites. However, we were surprised to find evidence of multiple degraded conditions at most “excellent” sites. This suggests stream bug communities either have some resilience to degraded conditions, or the impact of the degraded conditions may be time-lagged. If so, their “excellent” status may be tenuous.



Cristy Creek survey

Recommended restoration and protection actions

Improving stormwater management and forest health will have a positive impact on the streams categorized as “fair.” This can be done by protecting intact forestland; establishing more forest cover; increasing the density of vegetation in, and the width of, riparian buffers; and controlling and treating stormwater as much as possible.

To improve local conditions at “fair” sites, stressors affecting conditions at the basin and riparian scale need to be addressed first. Restoration actions targeting site conditions, like reducing excess fine sediment, often require dealing with the source of the problem up in the basin or in the riparian buffer. Once the source of the problem is resolved, local conditions can be restored.

Recommendations for protecting “excellent” basins were highly variable and dependent on basin-specific conditions. Some basins were quintessential “excellent” basins that exhibited almost no degraded conditions and consistent “excellent” B-IBI scores. In these basins, we recommend protecting forests and limiting development to prevent future degradation. Other “excellent” basins had high B-IBI scores despite the presence of multiple degraded conditions. In these basins, we recommend improving stormwater controls, protecting and enhancing riparian buffers, and increasing forest cover throughout the basin.

Optional Activity

Stormwater Stewardship Challenge for Day 5

There are so many ways to protect and care for our water. At the end of every daily lesson, we will be giving a stormwater challenge to help you show off what you've learned.

Materials: (Optional) writing utensil, colored pencils/markers, computer/phone/tablet, internet connection

Using what you've learned this week regarding stormwater pollution, it's time to be creative! Create a challenge you can pose to those in your household, to your friends, to your community, or to a broader audience on the internet through social media. Think about each topic the packet covered this week and list one aspect you can take from each lesson to incorporate into a new stormwater challenge for today:

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To share your work, post your challenge to Facebook and/or Instagram (**with an adult**) so other people in your community can learn, too! Don't forget to tag @naturevisionorg in your post! Do you live in Auburn, Bothell, Lynnwood, or King County? Use the hashtags and tag the city or county group below. They want to see all the work you are doing to keep our water clean!

- If you live in City of Auburn: Tag @auburnwa and include the hashtag #auburnwa
- If you live in City of Bothell: Tag @BothellWaUSA and include the hashtag #PugetSoundStartsHere
- If you live in City of Lynnwood: Tag @LynnwoodWA and include the hashtag #Lynnwood
- If you live in King County: Tag @KingCountyDNRP and @kingcountywtd