“Solutions-Oriented Learning” Storyline

3-Coastal Hazards: Flooding

Storyline introduction and overview:

The Washington State coastline is a culturally important place and valuable resource for communities of people, animals, and plants throughout Washington and the United States. As coastal flooding from storms and erosion threatens our coastal environments, communities are forced to make difficult decisions about how to protect themselves, their history, and their livelihoods. In this Storyline, students will learn what coastlines are and why they are important to humans and other types of natural communities. Given the specific weather hazard of coastal flooding, they will test materials and design structures that could be used to help reduce the impacts caused by this hazard.

Coastal Hazards NGSS Learning Progression: The 3rd grade storyline is part of a larger learning progression that includes students mastering standards pre-K to 12th grade. Look at how the 3rd grade performance expectations fit in a continuum of learning for your students.

Placemaking:

Coastal flooding is caused by other natural events, including storms, erosion, and tsunamis. It has major impacts on coastal communities. However, those who don’t live on the coast can also be affected by coastal flooding. The storms that cause coastal flooding can also cause flooding inland. If you like to visit the coast, flooding can damage your favorite areas. If you like seafood, flooding could threaten your favorite meals!

To spark students’ thinking about their connections to the coast, teachers may have students complete a Sit Spot, where students observe and record elements in their natural surroundings that connect to the coast (i.e., rivers, salmon). In an online setting, students could find items around their homes that connect to the coast (i.e., seafood, souvenirs from visits, photos).

Anchoring phenomenon:

Video of flooding in Westport and photos of flooding around Washington coast.

Use the video and photos to facilitate a conversation about coastal storms and flooding. Ask students to make connections about their own experiences on the coast and/or with storms and flooding. Elicit student thoughts about who might be impacted during coastal storms and flooding, prompting students to consider plants and animals in addition to humans and built property.

Environmental Justice:

Sea Level Rise Threatens Washington’s Coastal and Puget Sound Communities

As the Ocean Encroaches, this Washington State Tribe Is Building Its Next Chapter

Indigenous and other relevant cultural connections:

Since time immemorial Indigenous peoples have been connected to the ocean and the Salish Sea through harvesting food, managing marine land/resources, traveling/trade routes, and observations of

NGSS PEs (progress towards):

3-ESS3-1 Make a claim about the merit of a design solution that reduced the impacts of a weather-related hazard.

3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

ecosystem changes. The ocean and the Salish Sea have high cultural and sustenance value to Coastal and Puget Sound tribes.	

Estimated time required to implement this storyline: 2 to 3 weeks

NGSS PEs:

3-ESS3-1 Make a claim about the merit of a design solution that reduced the impacts of a weather-related hazard.

3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

Science & Engineering Practice (SEP)	Disciplinary Core Idea (DCI)	Cross Cutting Concept (CCC)
Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem. (3-ESS3-1) **Asking Questions and Defining Problems** in 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. (3-5-ETS1-1)	ESS3.B: Natural Hazards A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts. (3-ESS3-1) (Note: This Disciplinary Core Idea is also addressed by 4-ESS3-2.) ETS1.A: Defining and Delimiting Engineering Problems Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1)	Cause and Effect Cause and effect relationships are routinely identified, tested, and used to explain change. (3-ESS3-1) Connections to Engineering, Technology, and Applications of Science Influence of Engineering, Technology, and Science on Society and the Natural World Engineers improve existing technologies or develop new ones to increase their benefits (e.g., better artificial limbs), decrease known risks (e.g., seatbelts in cars), and meet societal demands (e.g., cell phones). (3-ESS3-1) Connections to Nature of Science is a Human Endeavor Science affects everyday life. (3-ESS3-1) Influence of Engineering, Technology, and Science on Society and the Natural World People’s needs and wants change over time, as do their demands for new and improved technologies. (3- 5-ETS1-1)

Materials:

Learning Session	Materials
1: Grounding Native Ways of Knowing	Computer(s) and internet to access two videos: Father Ocean and Run to High Ground
2: Phenomenon of coastal flooding	Computer(s) and internet to access Westport flooding video Science notebooks

“Solutions-Oriented Learning” Storyline

3-Coastal Hazards: Flooding

3: Pre-Assessment - Flood Barrier	Pre-assessment and rubric
4: What is the coast?	Computer(s) and internet OR printouts of coast photos (photo 1, photo 2, and photo 3) and Seabrook blog post Science notebooks U.S. map Flipchart/whiteboard space
5: What is a flood? What causes coastal flooding?	OWL chart Computer(s) and internet to access Flooding Explanation video Science notebooks
6: What are the effects of coastal flooding?	Science notebooks Flipchart/whiteboard space Copies of Card Sort: Flood Impacts (number depends on teacher choice of group size) Copies of Cause-Effect-Solution graphic organizer (number depends on teacher choice of group size)
7: What can people do to reduce the impacts of coastal flooding?	Science notebooks Computer(s) and internet to access Two Ways to Make a Dune Graphic organizers from previous lesson Flipchart/whiteboard space
8: What types of materials make the best flood barriers to reduce impacts of coastal flooding?	Copies of Barrier Materials Data Table (number depends on teacher choice of group size) Variety of materials to test (see details in lesson) Bin or container to conduct tests in Measuring cup Water and dirt/sand/soil Science notebooks
9: How can I design and build an effective flood barrier?	Completed data tables Science notebooks Selected materials for barrier Bin or container to conduct tests in Measuring cup Water
10 Post-Assessment - Flood barriers	Post-Assessment and rubric
11: Off-ramps - riverine flooding, Indigenous	Computer(s) and internet to access “Floating House” video Access to or printouts of the making of canoes; whales and salmon; and daily lives of the Pacific Northwest Native peoples

3-Coastal Hazards: Flooding

connections, careers	Access to or printouts of PEI Career Profile: Coastal Hazards Specialist

Learning Sessions

1.	**Grounding Native Ways of Knowing**	Estimated time: 25-30 minutes + optional readings or guest

To connect to native ways of knowing, consider exploring the following ideas in connection with your local tribal nation:

- Learn about current work and actions the Tribe is taking to mitigate, adapt to, and find solutions to a changing climate.
- Check with your school leaders for existing connections with the local tribes' leaders and storytellers. If appropriate, consider inviting someone to talk to students about how they traditionally dealt with flooding and how they deal with it now.
- Teachers may be interested in this web page hosted by the Quileute Nation that lists multiple reports on how some coastal tribes are addressing climate change and natural resource vulnerability: Natural Resources | Climate Change
- This short video, centered on a couple from the Quinault Tribe in Taholah, WA, documents the effects of sea level rise in the region: Quinault tribe Sea Level Rise

To access information on how to reach out and build relationships with local tribes, visit the OSPI Office of Native Education: Partnering with Tribes, and contact your district's tribal liaison/Title VI coordinator.

To learn more about respecting and building upon Indigenous Peoples' Rights visit the Learning in Places website, a project led by Dr. Megan Bang then read Practice Brief #10: Teaching STEM In Ways that Respect and Build Upon Indigenous Peoples' Rights and Practice Brief #11: Implementing Meaningful STEM Education with Indigenous Students & Families published on the University of Washington's STEM Teaching Tools website

Suggested activity for teachers and students: 3-2-1 research process

- Three new learnings about the Tribe most local to you
- Two questions that you still have about the Tribe most local to you
- One action you can commit to begin a partnership with the Tribe most local to you

Below are three stories about weather-related events (rainfall) and coastal hazards (earthquake and tsunami):

- Father Ocean, a story told by Roger Fernandes about why Western Washington gets more rain than the rest of the state. To access the story, click on "Native American Story Connections" and scroll down to the Father Ocean clip. After listening, have students share their observations of rainfall on both sides of the mountains or a personal story on a day of heavy rain.

	• Run to High Ground, a 13-minute video story told by Viola Riebe of the Hoh Tribe about how a young boy saved his tribe members' lives by warning them of a coming tsunami. After watching the video, have students share their own experiences of the coast or with preparedness for natural hazard impacts (earthquakes, tsunamis, storms).

2.	**Examine phenomenon: Coastal flooding caused by severe storms and erosion impacts coastal communities and communities throughout Washington.**	Estimated time: 20-25 minutes
	In this learning session, students will activate their knowledge of coastal storms and flooding. They will make observations about where and what the coast is, what coastal flooding is, and how it might impact their own lives and those of coastal communities. Video of flooding in Westport and photos of flooding around Washington coast. (Note that this video may be frightening for younger students; prepare students as appropriate.) Show students the video of waves crashing over the jetty in Westport. Facilitate a discussion about what students observe in the video. Some discussion prompts to consider: • What is happening in the video? • Where does the video take place? • What might be causing the waves? • What are some effects of the waves? After discussing the video, show a variety of additional images from the slideshow or elsewhere in the article. Prompt students to notice the different locations shown in the images. What do all the images have in common? What are some differences between the images? Students may record their observations about the images in a notebook. Additionally, have students list any questions they have about the images, coastal storms and flooding, or any other related topics.	

3.	**Pre-Assessment: Flood Barrier**	Estimated time: 30-45 minutes
	Pre-Assessment Rubric	

4.	**Guiding question: What is the coast?**	Estimated time: 25-30 minutes
	In this learning session, students will access their background and personal knowledge about what the coast is, who and what can be found on the coast, and why the coast is so important.	

	Begin by showing these pictures of coastlines from various places: Photo 1 Photo 2 Photo 3 Ask students to share their observations of the photos. Question prompts to consider: ● Where were these photos taken? ● What do the locations of these photos all have in common? ● What are some differences between the photos? As needed, prompt students to notice both land and water in each of the photos. Generate a working definition for coast or coastline that incorporates the meeting or joining of land and the ocean. Once you have a definition, show students on a map where the U.S. coasts are and point out the Washington coast. Students should record the definition in their science notebooks and sketch a picture of the coast. Other vocabulary to include in this discussion: *beach, coastline, shore, shoreline* After defining and locating the Washington coast, scroll to the "beaches" section of this Seabrook blog post and discuss observations of the photos of the Washington coast and beaches. How are these sections of the coast the same as and different from the previous photos? Once students have a strong understanding of what the coast is, facilitate a discussion and generate a list of who and what can be found on the coast and what happens on the coast. Prompt students to draw from any personal experiences of living on or visiting the coast, watching movies or reading books that took place on the coast, eating food from the coast, or details from photos shown earlier in this lesson. Ensure that the list includes plants and animals in addition to humans and record students' ideas. Ask students to add details to the sketch they made in their science notebooks. Check for plants, animals, humans, and appropriate coastal activities on students' sketches.

5.	**Guiding question: What is a flood? What causes coastal flooding?**	Estimated time: 20-45 minutes, depending on pacing/repeat views of video
	In this learning session, students will use an OWL (Observe, Wonder, Learn) chart to activate their background knowledge and questions about flooding. Students will watch a video and revisit science notebooks to record a definition of flooding and causes of coastal flooding specifically.	

3-Coastal Hazards: Flooding

	Start with a read aloud Tiny Tides: Storm Boy ● Note: This book was not written by an Indigenous author. Distribute (in person or virtually) or have students create a "Observations, Wonderings, Learned" (OWL) chart titled "Coastal Floods." Give students a few minutes to complete the O and W sections of their charts. Discuss and record students' knowledge and questions. Introduce the video below to students. Explain that flooding can happen anywhere, and the video will discuss all types of flooding, but as a class you will focus on coastal flooding. Before beginning the video, ask students where they think coastal flooding might occur, prompting them to use vocabulary from Lesson 4. Ask students to play close attention to the video, listening especially for details about floods on the coast. Flooding Explanation video: There is a lot of content in this video, so teachers may want to have students watch the video more than once, listening for specific things each time, or pause frequently throughout to draw attention and ensure students are catching important details. (This is an animated video, but it still may be frightening or unsettling for students to watch. Consider preparing your students as appropriate. Additionally, at minute 3:15, the video transitions into safety tips for dealing with floods. Teachers may choose to stop the video at this point, as individual safety tips are not a focus of this unit.) Discuss the vocabulary and concepts explained in the video. Some content to note: ● Flood: when a normally dry area is underwater ● Causes of floods: rain, overflowing rivers, breaking of dams, strong winds, melting snow ● Types of floods: flash flood, rapid onset flood, slow onset flood, storm surge flood After reviewing key terms and concepts from the video, ask students which types of floods they think are most common or likely to happen on the coast. Prompt students to remember details from the video, guiding them to note that storm surge floods, which bring rain and wind, cause coastal floods. Remind students of the "Run to High Ground" video from Lesson 1, prompting them to note that a tsunami could also cause a coastal flood. Additionally, guide students to recall their previous knowledge of erosion, which can cause flooding on beaches as coastline disappears. Direct students back to the OWL chart they created at the beginning of the lesson. Give students a few minutes to add to the L section of the chart and discuss and record student learnings. Discuss any remaining or new questions students have about coastal flooding.

6.	**Guiding question: What are the effects of coastal flooding?**	Estimated time: 25-30 minutes
	In this learning session, students will use their knowledge of coastal floods and coastal ecosystems to consider various impacts of coastal flooding.	

	Direct students to revisit their science notebook drawings of the coastal environment. After reviewing definitions and causes of coastal floods, facilitate a Think-Pair-Share (one to two minutes to think, two to three minutes to discuss with a partner, and a few minutes for a class discussion) for students to consider what the effects of coastal floods might be. Prompt students to look at their drawings to think about all the different things (humans, plants, animals, coastal features) that could be impacted by floods. Record students' answers for the class to see. In an online setting, a Think-Share may be more appropriate. Cut and distribute Card Sort: Flood Impacts. Without giving students categories, have them work in pairs or groups to sort the cards into categories. Record results, discussing categories students created and how they justified their organization. For a second sort, have students sort the cards into three categories: humans, plants, and animals. Record results, discussing categories and justifications. Note that most pictures could go in multiple categories, so student explanations are important for checking understanding. Ask students if they can think of any other flooding impacts not depicted in the photos or categories not captured in the three, they've used for this activity. If applicable, give students a few minutes to add any new coastal features to their coastline sketches. Distribute (in person or virtually) this Cause-Effect-Solution graphic organizer. Explain that the last box for solutions will be completed in a future lesson. Additionally, while the effects box says, "human impacts," you will include impacts to plants and animals as well. Using the causes students recorded in their notebooks during Lesson 5 and the affects you have discussed in this lesson, model completing the graphic organizer. As an example, you might write "heavy rains" in the causes box and "flooded homes" in the effects box.

7.	**Guiding question: What can people do to reduce the impacts of coastal flooding?**	Estimated time: 25-30 minutes
	With a baseline understanding of coastal flooding, its causes, and its effects, students will spend the next three lessons exploring potential solutions to reduce the impacts of coastal flooding. Now that the students have watched multiple videos and seen photos of coastal flooding and its impacts, facilitate a discussion about some of the solutions they have seen or that they personally know about. Discuss a wide variety of solutions, including elevating structures, using specific materials that are flood-resistant, and relocating altogether. Discuss pros and cons of each. Throughout the discussion, ensure that students understand that they are not trying to prevent flooding itself; rather, they are trying to determine how to reduce the impacts of flooding on people, plants, and animals on the coast. Introduce "barrier" as a new vocabulary word. As you have just discussed, there are many ways people try to protect themselves and the environment from the effects of coastal flooding. One solution is a flood barrier. If barrier solutions came up in the previous discussion, make a	

	note of those. A barrier is something that stops or gets in the way of something else. So, a flood barrier is something that stops or gets in the way of flood waters. Barriers can be made from many different materials. Ask students to recall some of the materials they have seen used in previously shown videos and images. Have students record the definition of flood barrier in their notebooks. Explain that some barriers are natural (exist naturally and are made of materials found in that environment), and some are created. One example of a barrier that can be both natural and created is a sand dune. To explore this distinction further, have students watch Two Ways to Make a Dune. After watching the video, discuss the processes that create natural dunes and how those are different from man-made dunes. Note that both options use mostly natural materials, but they have different time requirements and costs (criteria and limitations). Ask students to share their thoughts on why sand can make an effective flood barrier. Direct students to revisit their sketches of the coastal environment. With their drawings in mind, have students share ideas for what materials they might use to protect the coast from flooding and where they might want to put flood barriers. Talk through students' thinking, making notes of places where barriers would and would not make sense (in front of a building vs. in front of a tree, for example). Direct students to return to their Cause-Effect-Solution graphic organizer. Ask students what types of solutions they've learned about today. Have students record 2-3 solutions in the appropriate box.

8.	**Guiding question: What types of materials make the best barriers to reduce the impacts of coastal flooding?**	Estimated time: 90 minutes (could be split across multiple sessions)
	Based on an understanding that some materials make better flood barriers than others, students will use this learning session to test the effectiveness of several materials. Additionally, they will identify what desired features (criteria) make a material an effective flood barrier and consider limits (constraints) that might present a challenge to using that material. Distribute the Barrier Materials Data Table document. Students will use the instructions and table in this document to conduct their tests and record results. **Materials** 1. Barrier Materials Data Table 2. Variety of materials for testing (see categories below) 3. Measuring cup (one cup)	

4. Water
5. One tablespoon of soil or sand
6. Tub or bin to conduct tests in
7. Object to act as house (optional)

Procedure & Data Collection

Step 1. Collect materials from at least three of the following categories: *

- Solid minerals such as sand, rocks of various sizes and smoothness, brick, or concrete.
- Wood such as twigs or sticks of various sizes, toothpicks, or popsicle sticks.
- Fibrous plant materials like paper of any type, bark from trees, vines, etc.
- Metal such as nails, steel wool, tin foil, or wires.
- "Other" materials such as recyclables, spongy, or absorbent materials

*In an in-person setting, students can collect materials from around the schoolyard or teacher can collect and prepare materials in advance. In an online setting, students can collect materials from around and outside their homes or students can observe as teacher demonstrates and conducts tests.

Step 2. Using this sentence frame, write a prediction in your science notebook about each of the materials you will test:

The _____ will be an effective/ineffective barrier because _____.

Example: The popsicle sticks will be an effective barrier because they can be stacked in a pile that will keep out water.

Step 3. Using the instructions and data table on the Barrier Materials Data Table sheet, test each of your materials. In an online setting, teachers may request photos or videos of tests as appropriate.

Analysis and Conclusion

Facilitate a discussion about students' test results. Some question prompts to consider:

- Based on your data, which materials would make effective flood barriers?
- What features (criteria) make that material effective?
- Which materials would make ineffective flood barriers?
- What limitations (constraints) should we consider?

In their science notebooks, have students record their conclusions. For example, they might write:

Cotton balls would be ineffective flood barriers because they cannot be stacked, and they float away. The constraints we considered were that cotton balls cost money and you would need

	way too many of them.

9.	**Guiding question: How can I design and build an effective flood barrier?**	Estimated time: 90 minutes (could be split across multiple sessions)

In this final learning session, students will use everything they have learned about effective flood barriers to design, build, and test a flood barrier themselves. Teachers may be interested in viewing Elementary kid's STEM projects focus on solutions to flood damage of students conducting a similar activity.

In an in-person setting, students can work in groups to complete this activity. In an online setting, students with adequate internet access may also work in groups, with one or more students conducting the building and tests. Alternatively, students can complete the activity independently, submitting pictures, videos, and/or written descriptions of results.

Materials

1. Completed Barrier Materials Data Table
2. Chosen barrier materials
3. Measuring cup
4. Water
5. Tub or bin to conduct tests in
6. Object to act as house (ideally from a material that will show water damage, such as paper, cardboard, etc.)

.

Procedure & Data Collection

Step 1. Using the results from the materials tests conducted in Lesson 8, students should choose a set of materials to use for their flood barrier. Students should also choose materials to hold the barrier together (tape, clay, etc.).

Step 2. Sketch out your barrier design in your science notebook, including labels for all materials and features.

Step 3. Build your house and set it up in the test bin. If possible, use a material that will show water damage.

Step 4. Build your flood barrier around or in front of your house.

Step 5. Test your barrier! Begin by pouring one cup of water in the bin and wait at least one minute. If your barrier doesn't move or break and the house does not appear to be damaged,

	add another cup of water and wait one minute again. Continue adding water until your barrier breaks, your house is damaged, or you've added five cups - whichever comes first. If you reach five cups, be sure to lift the house out of the bin to check the bottom for any damage you may not have seen. *Step 6*. Use this sentence frame to record your results in your science notebook: My flood barrier was effective/ineffective. My house was/was not damaged after I added ___ cups of water. I think my flood barrier was effective/ineffective because _____. Example: My flood barrier was effective. My house was damaged after I added 3 cups of water. I think my flood barrier was effective because it was tall enough to stop water and water did not get through until I added 3 cups. **Analysis & Conclusions** Facilitate a discussion about students' results. Some question prompts to consider: ● Which materials did and did not make effective barriers? ● Which materials failed right away, which kept some water out, and which kept all water out? ● Were the results consistent with their materials tests from Lesson 8? ● What do the results tell us about real-world flood barriers? ● Based on your tests, how would you change the design, placement, materials, etc., of your flood barrier?

10	**Post -Assessment:**	Estimated time: 30-45 minutes
	Post-Assessment Rubric	

11	**Possible next steps/off-ramps/career connections:**	
	● "Floating House" video ● Additionally, teacher and students can read the making of canoes; whales and salmon; and daily lives of the Pacific Northwest Native peoples ● PEI Career Profile: Coastal Hazards Specialist ● Career Connections ○ Park Ranger ○ Geologist ○ Ocean Engineer	

	○ Statistician ○ Landscape Architect

3-Coastal Hazards: Flooding OER Tracker

Pacific Education Institute would like to acknowledge and thank the writing team for their work. The team included Tressa Arbow, Wendy Boles, Tina Niels, Lourdes Flores and Shelley Stromholt. In you have comments or questions please contact info@pacificeducationinstitute.org