A House to Come Home to

Grades
9-12

Overview:

In this lesson, students explore the various loads a structure can experience in a tsunami and possible design solutions to decrease the likelihood of structural failure.

Targeted Alaska Grade Level Expectations:

Science

[9] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating.

[10-11] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring , classifying, making generalizations, analyzing data, developing models, inferring, and communicating.

[9] SE2.1 The student demonstrates an understanding that solving problems involves different ways of thinking by questioning, researching, modeling, simulating, and testing multiple solutions to a problem.

[10-11] SE2.1 The student demonstrates an understanding that solving problems involves different ways of thinking by questioning, researching, modeling, simulating, and testing multiple solutions to a problem.

[10-11] SE3.1 The student demonstrates an understanding of how scientific discoveries and technological innovations affect our lives and society by researching a current problem, identifying possible solutions, and evaluating the impact of each solution.

Objectives:

The student will:

- determine recommended design elevations based on historic runups;
- identify forces that create loads on a structure in a tsunami; and
- identify design solutions to strengthen structures in tsunamis.

Materials:

- Computers with Internet access
- VIDEO FILE: “A House to Come Home to”
- STUDENT WORKSHEET: “A House to Come Home to”

Whole Picture:

Although it is not safe to stay in a house during a tsunami in an inundation area, structural design solutions can be incorporated to increase the likelihood that a family will have a house to come home to after a tsunami event. In this lesson, students examine seven tsunami load effects and their design solutions. Houses in tsunami prone areas are also likely to be subject to earthquake loads and possibly wind loads.

Vocabulary associated with this lesson includes:

Hydrodynamic forces: Pushing forces caused by the wave on the building and the drag caused by flow around the building and overturning forces that result.

Mitigation: The act of making a hazard, like tsunamis, less severe.

Scour: This is erosion around manufactured structures.

Hydrostatic forces: This force is a result of pressure on a structure caused by an imbalance of pressure from different water depths on opposite sides of a structure.

Buoyancy forces: This force causes flotation or uplift.

Impulsive forces: Forces caused by the leading edge of a surge of water impacting a structure.

Load: A force that acts on a structure. If a structure cannot handle this, the structure will fail.

Drag: A force that slows an object's movement through a fluid such as air or water.

Period: The time it takes for one wavelength (one crest + one trough) to pass a given point. This is 5-60 minutes for a tsunami.

Activity Procedure:

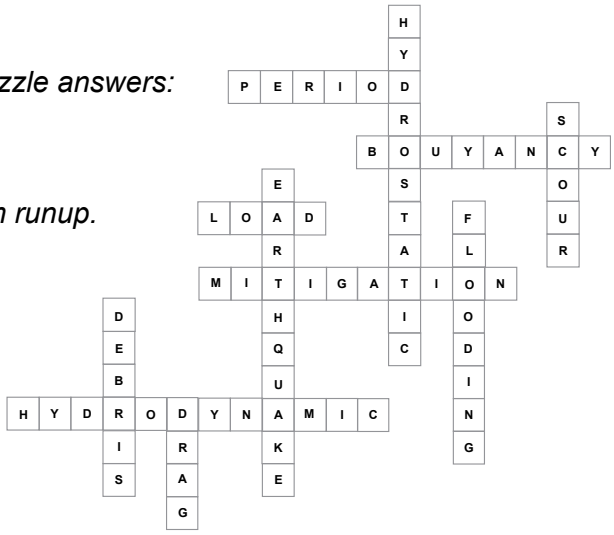
1. Ask students, "What should you do if you hear or see a tsunami warning?" *Go uphill and/or inland.* Ask them if they have ever thought about what could be done to make sure that there is a house for them to come home to after the evacuation is over? Explain in this lesson, students will examine the different forces that can act on a house in a tsunami and the design solutions that can be used to make the house more sturdy.
2. Distribute STUDENT WORKSHEET: "A House to Come Home To" and briefly review the introductory information and the tasks assigned on the worksheet.

Extension Idea:

Challenge students to demonstrate tsunami design solutions using a three-dimensional structural model.

Answers:

Crossword puzzle answers:



1. *Answers will vary.*
2. *Answers will vary.*
3. *Student responses should be 1.3 times the maximum runup.*
4. *Elevate building*
5. *E, A and C*
6. *A. Breakaway walls*
7. *A. Hydrostatic forces*
   B. Hydrodynamic forces
   C. Buoyancy

Lesson Information Sources:

Applied Technology Council. (2008). *Guidelines for design of structures for vertical evacuation from tsunamis.* [FEMA P646]. Retrieved from http://www.fema.gov/library

National Tsunami Hazard Mitigation Program (2001). *Designing for tsunamis: seven principles for planning and designing for tsunami hazards.* Retrieved from http://purl.access.gpo.gov/GPO/LPS69015

Pickett, J.P.,et al.(2005). *The American heritage children's science dictionary.* Boston: Houghton Mifflin Company.

Name:_____

A House to Come Home to

Student Worksheet (page 1 of 3)

Tsunami mitigation means taking steps beforehand to lessen the severity of a tsunami. Tsunami risk is most effectively mitigated when development is avoided in tsunami runup areas. When development cannot be avoided, steps can be taken to mitigate the risk on buildings and increase the likelihood that you will have a house to come home to after evacuation.

The first step in planning for tsunami hazards is to understand the community's risk. One way to explore risk is to examine the tsunami history of the community.

STEP 1. Access the NOAA/WDC Historical Tsunami Database at the National Geophysical Data Center at the following URL (http://www.ngdc.noaa.gov/hazard/tsu_db.shtml).

STEP 2. Select "Tsunami Runup Search."

STEP 3. Enter the name of a coastal Alaskan community in "Runup Location Name."

STEP 4. Complete the table below and repeat the steps for another community.

1. Complete the table below:

Name of Community	Number of Tsunamis	Highest Maximum Water Height

2. Compare the two communities listed above. Does one of the communities experience a higher risk based on history? Explain.

_____

_____

_____

_____

_____

3. The Federal Emergency Management Agency (FEMA) recommends that the design runup elevation of buildings in tsunami inundation zones be 1.3 times the predicted maximum runup elevation. For the two communities listed above, what is the recommended design elevation?

Name of Community	Design Elevation

Name:_____

A House to Come Home to

Student Worksheet (page 2 of 3)

Access the VIDEO FILE: “A House to Come Home to” to explore how the forces inflicted by tsunamis can be overcome with design solutions. Complete the following ques-tions:

4. What is the most common design solution?_____

5. Which of the following design solutions strengthen a home’s capability to withstand hydrodynamic forces?
   A. lateral bracing
   B. a horizontal beam added to the foundation that is parallel to the incoming tsunami wave
   C. a horizontal beam added to the foundation that is perpendicular to the incoming tsunami wave
   D. A and B
   E. A and C

6. Which of the following design solutions combats hydrostatic forces by providing adequate openings to allow water to reach equal heights inside and outside of the building.
   A. Deep piles
   B. Anchoring buildings to foundations
   C. Breakaway walls
   D. A horizontal beam added to the foundation
   E. Tsunami forest

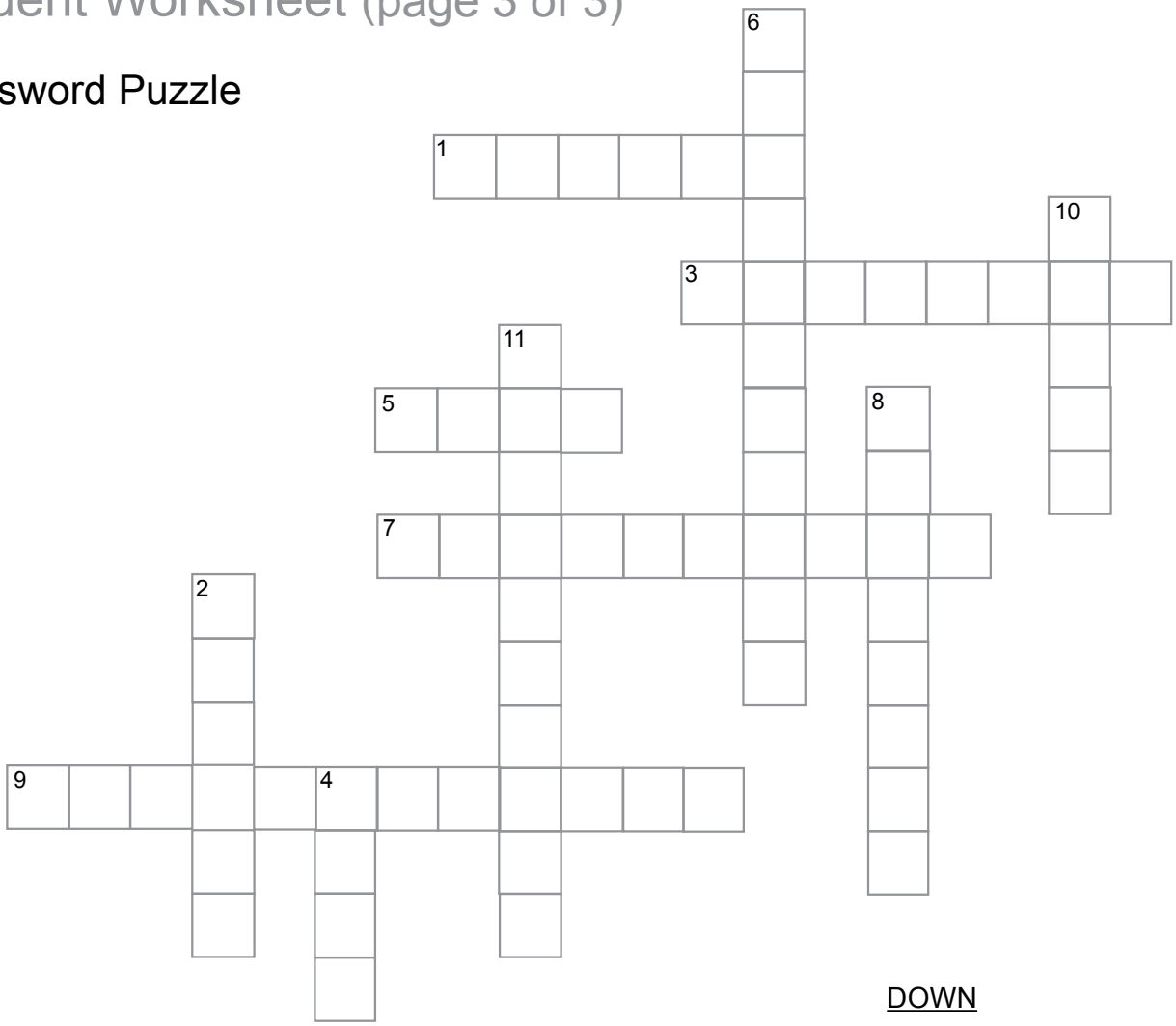
7. Breakaway walls limit which four forces from tsunamis?
   A. _____
   B. _____
   C. _____
   D. _____

Name:_____

A House to Come Home to

Student Worksheet (page 3 of 3)

Crossword Puzzle



ACROSS

1. The time it takes for one wavelength (one crest + one trough) to pass a given point. This is 5-60 minutes for a tsunami.
3. This force causes flotation or uplift.
5. A force that acts on a structure. If a structure cannot handle this, the structure will fail.
7. The act of making a hazard, like tsunamis, less severe.
9. Pushing forces caused by the wave on the building and the drag caused by flow around the building and overturning forces that result.

DOWN

2. Some examples of this impacting force includes logs, shipping containers, boats, and vehicles.
4. A force that acts on an object in a direction opposite that the object is moving through a fluid.
6. This force is a result of pressure on a structure caused by an imbalance of pressure from different water depths on opposite sides of a structure.
8. As water inundates the land, this effect is common. In the past, some tsunamis have been described as this from the sea.
10. This is erosion around manufactured structures.
11. Structures that are likely to endure tsunamis are also likely to be subjected to this load as well.