Island STYLE

How Can You Save a Town from a Hurricane?

SUBJECT:

Social Studies

GRADE LEVEL:

6th

TIMEFRAME:

45 minutes

MATERIALS:

- Copies of *Galveston and the 1900 Storm: Catastrophe and Catalyst* by Bixel and Turner
- Other physical books showing Galveston before/after the Great Storm
- Reference images of Galveston before/after
- Job descriptions for "Expert Groups" - one copy per group
- Budget worksheet - one copy per group
- Model town
- Homes
- Sponges
- Play-Doh
- Clothes Pins

ACTIVITY SUMMARY:

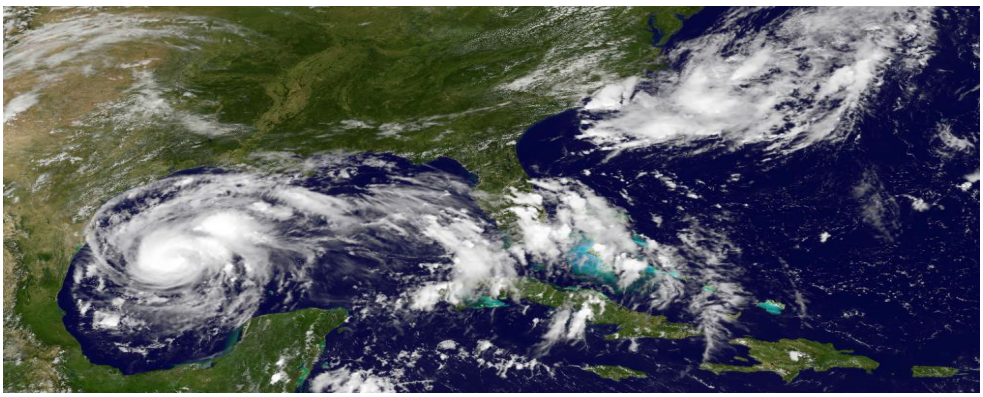
Students will learn about how Galvestonian's adapted the physical environment of the island after the Great Storm through raising of homes and building of the Seawall. Then they will identify and analyze ways to protect a fictious town using different engineering techniques.

LEARNING OBJECTIVES:

- The student will learn about how Galvestonian's adapted the physical environment of the island after the Great Storm and identify and analyze ways to protect a fictious town.

VOCABULARY

- **Evacuate** - Remove (someone) from a place of danger to a safer place
- **Hurricane** - A storm with violent wind, in particular a tropical cyclone in the Caribbean
- **Levee** - An embankment built to prevent the overflow of water



ALIGNMENT:

TEKS

Geography

(3) The student understands the factors that influence the locations and characteristics of locations of various contemporary societies on maps and/or globes. The student is expected to:

6.3 (A) - Identify and explain the geographic factors responsible for patterns of population in places and regions
6.3 (C) - Identify and locate major physical and human geographic features such as landforms, water bodies, and urban centers of various places and regions

(5) The student understands the impact of interactions between people and the physical environment on the development and conditions of places and regions. The student is expected to:

6.5 (A) - Describe ways people have been impacted by physical processes such as earthquakes and climate
6.5 (B) - Identify and analyze ways people have adapted to the physical environment in various places and regions
6.5 (C) - Identify and analyze ways people have modified the physical environment such as mining, irrigation, and transportation infrastructure

Social Studies

(18) The student understands the influences of science and technology on contemporary societies. The student is expected to:

6.18 (A) - Identify examples of scientific discoveries, technological innovations, and scientists and inventors that have shaped the world

(19) The student applies critical-thinking skills to organize and use information acquired through established research methodologies from a variety of valid sources, including technology. The student is expected to:

6.19 (A) - Differentiate between, locate, and use valid primary and secondary sources such as oral, print, and visual material and artifacts to acquire information about various world cultures

6.19 (B) - Analyze information by sequencing, categorizing, identifying cause-and-effect relationships, comparing, contrasting, finding the main idea, summarizing, making generalizations and predictions, and drawing inferences and conclusions
6.19 (D) - Identify different points of view about an issue or current topic

(20) The student uses geographic tools to collect, analyze, and interpret data. The student is expected to:

6.20 (A) answer geographic questions, including: Where is it located? Why is it there? What is significant about its location? How is its location related to the location of other people, places, and environments? Using latitude and longitude, where is it located?

(21) The student communicates in written, oral, and visual forms. The student is expected to:
6.21 (A) - Use social studies terminology correctly
6.21 (C) - Express ideas orally based on research and experiences

(22) The student uses problem-solving and decision-making skills, working independently and with others. The student is expected to:

6.22 (A) - Use problem-solving and decision-making processes to identify a problem, gather information, list and consider options, consider advantages and disadvantages, choose and implement a solution, and evaluate the effectiveness of the solution.

Ocean Literacy Principles

1 Earth has one big ocean with many features
2 The ocean and life in the ocean shape the features of Earth
3 The ocean is a major influence on weather and climate
6 The ocean and humans are inextricably interconnected

Trinity Episcopal Church

120 years after the Great Storm of 1900

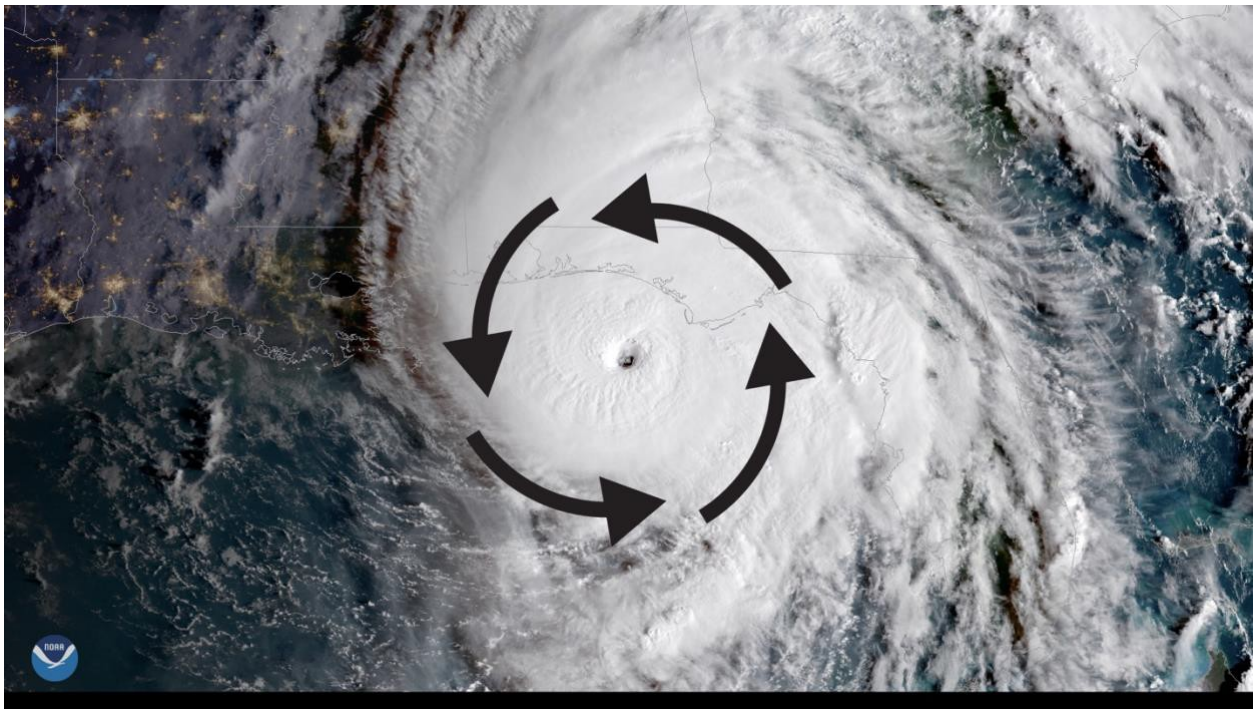
Notice the color difference of the bricks at the bottom of the building.
Compare the steps to the door in this picture with the historical photos.

BACKGROUND INFORMATION:

What is a hurricane?

Hurricanes, known generically as tropical cyclones, are low-pressure systems with organized thunderstorm activity that form over tropical or subtropical waters. They gain their energy from warm ocean waters.

As storm systems strengthen into hurricanes, the surface winds move continuously in a circular motion. Meteorologists refer to this pattern as “closed circulation." The direction of circulation is different depending on where the storm is located: it is counter-clockwise in the Northern hemisphere and clockwise in the Southern hemisphere.



This satellite image of Hurricane Michael from October 10, 2018 has arrows superimposed on top to show the closed circulation wind pattern that is characteristic of a hurricane. (NOAA Satellites/NOAA Office of Education)

These rotating winds lead to the development of the characteristic “eye” of the hurricane, the calm, clear center of the storm. The eye is surrounded by the eyewall, where winds are strongest.

Tropical cyclones are classified by their maximum wind speed.

- Winds less than 39 mph: Tropical depressions
- Winds 39-73 mph: Tropical storms
- Winds 74 mph or greater: Hurricanes
- Major hurricanes have winds of at least 111 mph and can reach speeds of over 180 mph, with gusts of 200 mph.

How does the storm get its name?

Once a storm escalates to tropical storm-level winds, it is given a name. The names are chosen by an international committee of the World Meteorological Organization. Names are reused every six years, although the WMO may retire the name of a particularly deadly or costly storm.

How do tropical cyclones form?

Tropical storms form from an atmospheric disturbance like a tropical wave or group of thunderstorms. For these disturbances to grow into a tropical cyclone, the following environmental conditions must be in place:

- Warm ocean waters (at least 80°F/27°C).
- An unstable atmosphere driven by differences in temperature, where temperature decreases with height.
- Moist air near the mid-level of the atmosphere.
- Must be at least 200 miles (with rare exceptions) north or south of the equator for it to spin (due to the Coriolis effect).
- Little change in wind speed or direction with height (known as low vertical wind shear).

Hurricane safety

Hurricanes, tropical storms, and tropical depressions pose a variety of threats to people and property. Storm surge and inland flooding have historically been the number one and two causes of loss of life during hurricanes. Hurricanes can also bring strong winds, tornados, rough surf, and rip currents. The time to prepare for a hurricane is before hurricane season begins, June 1 in the Atlantic.

Hurricane categories only tell part of the story

Hurricanes are categorized using the Saffir-Simpson Hurricane Wind Scale, which addresses wind speed on a scale from one to five. However, a tropical storm or category one or two hurricane can cause as much overall damage as a major hurricane.

The Saffir-Simpson Hurricane Wind Scale

The scale was created by wind engineer Herb Saffir and meteorologist Bob Simpson to help explain damage that buildings will sustain under different wind speeds. Importantly, the Saffir-Simpson scale does not include hazards from rain, flooding, or storm surge.

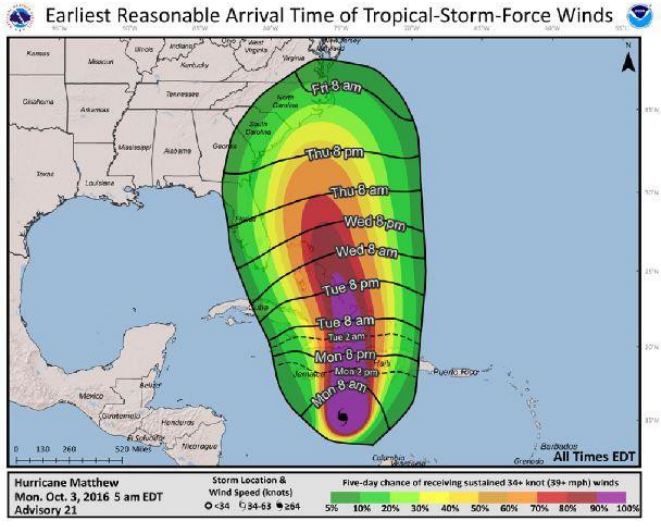
Every storm is different

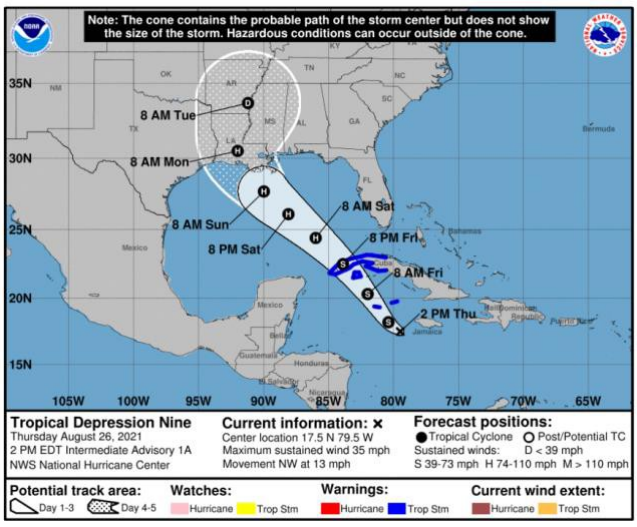
Each tropical system can bring a variety of unique, life-threatening hazards to a given location. It's critical to know your risk, especially if you live in a storm surge evacuation zone or in an area where flooding could occur. Even if you've previously survived a storm in your area, future hurricanes may bring different hazards.

Local officials may issue evacuation orders before storm or storm surge watches or warnings are issued for your area. Evacuation orders are released to ensure residents have enough time to leave vulnerable areas before the first hazards from the storm arrive.

Hurricanes bring extreme rainfall

Warm air can hold more moisture than cool air. In tropical cyclones, the air is particularly warm and can hold a tremendous amount of moisture. The moisture cools as it rises and condenses into heavy rain, often much more than a typical low-pressure system. These rains can occur not only at the coast, but many miles inland, causing flooding that can continue for days or even weeks after a storm.





The state of hurricane forecasting

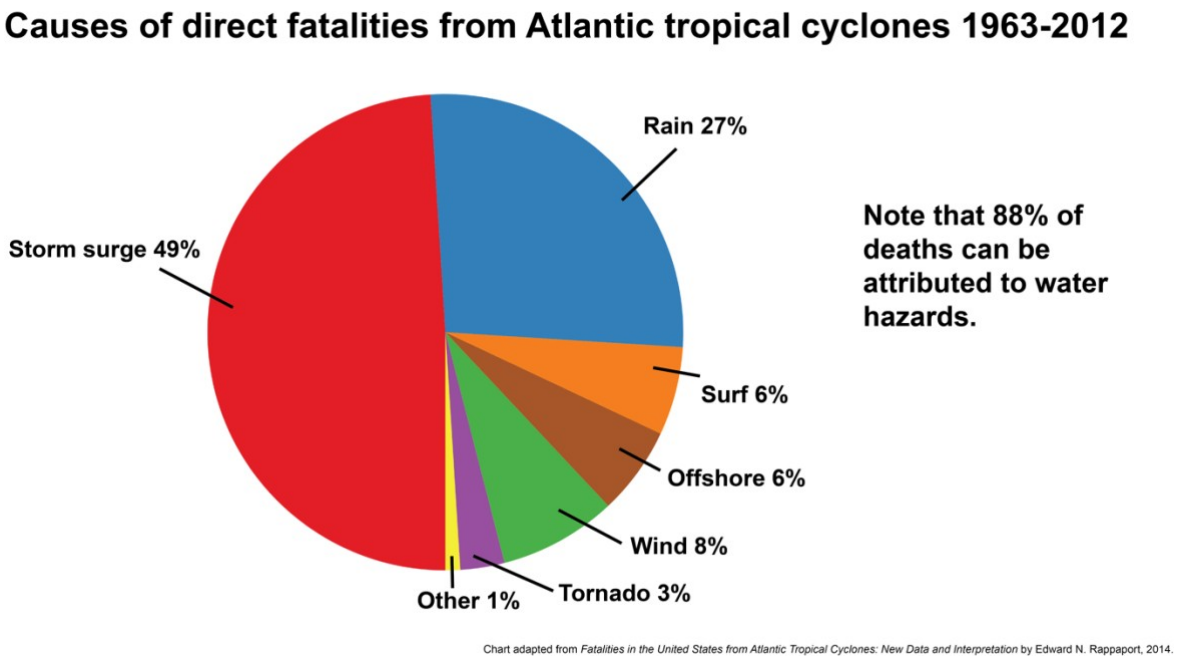
The National Hurricane Center has a long history of issuing tropical cyclone advisories, with the first known recorded forecast being in 1954, when 24-hour predictions of a storm's track were made. Since then, forecasts have been expanded out in time and added predictions of intensity, size, and associated hazards, such as wind, storm surge, and rainfall.

Water, not wind, is the biggest threat

Though hurricanes are well known for strong and destructive winds, hurricane storm surge is the greatest threat. Storm surge is water that is pushed toward the shore by winds swirling around the storm. This rise in water level can cause severe flooding in coastal areas. With much of the United States' densely populated Atlantic and Gulf Coast coastlines less than 10 feet above mean sea level, the danger from storm surges is tremendous. Historically, about half of direct fatalities from hurricanes that make landfall in the U.S. are from storm surge.

Run from the water, hide from the wind

When you're at risk from flooding, it's important to get to high ground away from bodies of water and any flood-prone areas. When there are high winds, but no danger of flooding (rare in hurricanes, but also important during any storm), it's important to shelter in place in a sturdy structure, away from doors and windows. This is why most evacuation orders are given for water, not wind.



PREPARATION:

Divide students into groups of 4 people

INTRODUCTION:

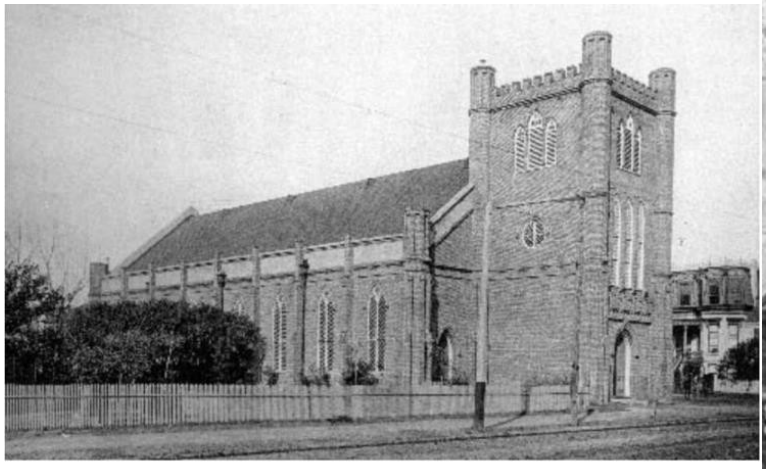
Have students talk to their elbow partner about their experience with hurricane preparedness.

Have you been a part of a hurricane evacuation? What did your family do to prepare before the storm hit? Did you help others prepare? How? How did you feel during the preparation? Did you actually evacuate? What was it like when you returned?

Show pictures of Galveston Island from before and after the 1900 Storm. Point out as many locations as can be identified that students would know today. Compare the Trinity Episcopal Church before, during, and after the storm using the photos below.

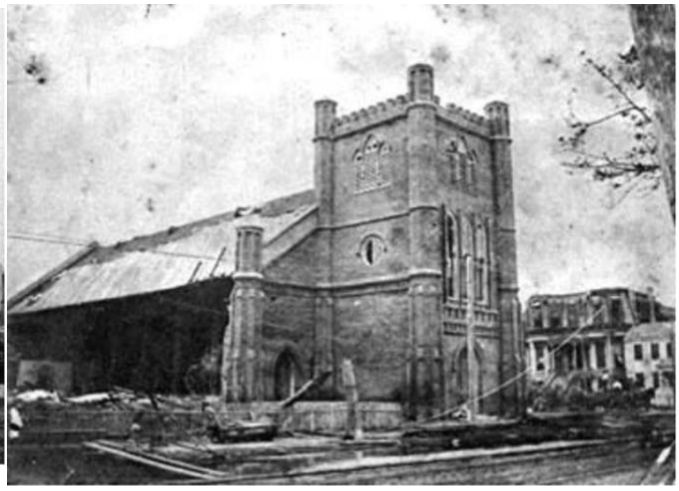
Trinity Episcopal Church

Before the 1900 Storm



- **Accession Number:** AW-50(b)
- **Date:** 1894
- **Description:** "Trinity Episcopal Church." Art Work of Galveston, 50 (bottom view).
- **Format:** Sepia print; 10.9 x 17.8 cm

After the 1900 Storm



- **Accession Number:** G-1771FF3.3-1
- **Date:** Sep 1900
- **Description:** Trinity Episcopal Church
- **Format:** Print from newspaper photograph; 13.5 x 17.5 cm

- **Accession Number:** G-1771FF3.3-2
- **Date:** Sep 1900
- **Description:** "Trinity Church"
- **Format:** Sepia photograph, mounted; 8.5 x 9.0 cm

After the 1900 Storm

Notice the pilings under the church and the height of the people

GUIDED PRACTICE:

People have been changing their environment throughout history to make where they live and work better for them. They dug ditches to bring water to their fields and homes. They dredged harbors to allow bigger ships in. They even built up the land to protect themselves from flooding.

Let's look at the model town (allow for students to gather around the model town or show it under a projector).

- **Where should the city go and why?** (Near the river outflow into the ocean for best connection to a harbor and transportation. *Place the buildings where the students decide).*

- **What if it rains upstream from the town?**
  - *(Pour water into the river to show the flow)* The rain will fill up the lakes, rivers, and canals throughout the city. Many canals have barriers around them, called levees, which are walls made of concrete and soil. A levee keeps water in the waterway and out of the city. Sometimes there is so much water that it starts flowing over the top of the levees. A boat or other large marine debris washed from upstream could actually smash into a levee during a storm, creating a hole where water could rush out. Water would then spill into the city. You know that water flows from high places to low places. Places that are low elevation get more flooding because water naturally flows downhill and collects there. Just like puddles forming in a low spot. **What could our townsfolks do to stop that flooding?** (allow students time to think and answer)

- **What if a hurricane came ashore in our town?**
  - Hurricanes form over the ocean in late summer when the water is warm. Warm water evaporates more easily than cold water does to form rain clouds. So as a hurricane moves over the warm ocean, its rain clouds get bigger and bigger as more and more ocean water evaporates. As a hurricane hits the coast, all the water that had evaporated from the ocean falls as rain onto the land. But the rain from a hurricane isn't the only problem. There's something else about a hurricane that causes flooding: ocean waves. Remember, hurricanes aren't just rainclouds. They're also super strong windstorms. The winds of a hurricane push on the surface of the ocean, creating waves that can come all the way up onto the shore. That causes flooding. When this happens, it's called a storm surge. Storm surge waves can be incredibly destructive. Some people who live near the ocean have to build their houses up on stilts to protect them from getting flooded in a storm surge. The stronger the winds in a hurricane, the higher the storm surge. Together, the storm surge and the rain both add water to the city.

- **What could our townsfolks do to deal with the ocean waves and flooding from the storm?**
  - After the Great Storm in Galveston in 1900, engineers had to come up with ideas for how to make sure the city wouldn't flood in the future if another hurricane hit. The first thing engineers had to figure out was how to protect the city from a storm surge. They figured out that one way to do that would be to build a seawall, a giant cement wall along the ocean shore to block the storm surge waves. Now suppose you were an engineer.

- **What would you do if you were in charge of protecting a town from flooding during a hurricane?**
  - You'll get a chance to figure that out in today's activity!

INDEPENDENT / GROUP PRACTICE:

Prompt:

In today's activity, you're going to protect Modeltown from flooding during a hurricane. The town is located along the Gulf of Mexico and has great beaches and many historic buildings. Tourists come from all over to relax on the beaches and visit the town's old buildings. Unfortunately, Modeltown is in the path of hurricanes. When the last hurricane swept through Modeltown, it caused a lot of problems. The storm surge sent ocean water into many buildings near the shore, flooding them. Water from the heavy rains made the river overflow, flooding buildings nearby. It took months to clean out the water and rebuild all those historic buildings. Before another hurricane comes along, the town council wants to add some kind of flood protection to the town. Your job is to find a solution to Modeltown's flooding problem.

Roles:

Split your class into teams of 4 four engineers and assign a type of engineer to each person in the group. Using Jigsaw, split into Expert groups so each engineer type can learn what they can do to help save our town.

Each expert group of engineers should read through their information and ask any questions they have. They should look at the town model or their drawing and discuss where their type of construction could best work to help save the town.

Return to the home group with the new found expertise. Have each engineer explain their expertise, what buildings their flood solutions can protect and how they could help the town.

These home groups should then work together to solve Modeltown's flooding problems. This could be done with a paper drawing or around the actual model.

Once you have completed the final plan, prepare to explain your plan to the other groups and discussing why they made the decisions that they did. There's more than one solution to Modeltown's problem!

ASSESSMENT OF LEARNING:

Discussion -

- Were the people of Galveston Prepared for the Great Storm to hit the island?
  - No they were not prepared!
- What did they do to change the island to help them prepare for the next hurricane?
  - Build the Seawall to keep back waves and raise the height of the island to help drain the water off if waves did come onshore.
- How are different parts of Galveston Island protected from hurricanes?
  - The sections of Galveston that are directly behind the seawall art protected due to the tall wall preventing waves from coming up high enough to flood the city
  - Roads such as 9-Mile and 11-Mile Road allow for a direct pathway back into the salt marsh ecosystem where the water is absorbed back into the watertable through the grasses and soil like a sponge
- Did other teams have ideas you didn't think of?
- Did any plan save all the historic buildings and come in under budget?
- What was the most convincing reason for why a team's plan was best?
- Are there things to consider other than cost?

CLOSING:

As you teach lessons linked to the Galveston Bay Watershed and the Gulf of Mexico, you can use the "I Wonder" Board as a closure assignment. You might ask what else the students want to learn about hurricane recovery and safety. Students may ask about specific named storms, the IKE Dike/ Coastal Spine, seawall expansion related questions, or even how the people of Galveston Island lived through the raising. All of their questions (even the ones asked multiple times) will go on the "I Wonder" Board. If a question was answered in the lesson, it can still be placed on the board.

Students may even have follow-up questions after these lessons that could be added to the board The goal is to have a place for all questions about the Galveston Bay and the Gulf of Mexico in one place.

EXTENSION:

Tell your students that the people of Modeltown had a meeting to discuss the proposals your class came up with. Ask your students how they would answer their questions or address their issues.

Remember: There are no right answers and it may be difficult to make everyone happy.

- Mrs. Green doesn't like the plans that include wetlands because she thinks wetlands have lots of mosquitoes. What would you say to convince Mrs. Green that wetlands are a good idea?
- Mr. Crawford's great-great-grandfather owned a historic general store near the River and the Ocean front. He says that stilts are not historically accurate and does not want them on his building. Can you protect that building without using stilts?
- Mr. Hunter is a bird watcher. He thinks you should make a paved nature trail and parking lot through the wetlands for bird watchers. Would these structures affect the wetlands ability to act like a sponge?

NOTES:

Job Descriptions for Expert Groups

Environmental Engineers can solve the flooding problem by planting wetlands. A wetland is a swampy area between the ocean and dry land with plants that slow down the storm surge and land that acts like a sponge to absorb the extra water. They only protect the areas directly behind them however. Wetlands protect against storm surge but they don't protect against river flooding.

- As an expert group, figure out which parts of town your solution would be best for and which historic buildings you can protect.
- Add your sponge wetlands to the city model where they would protect the city the best

Seawall Engineers can solve the flooding problem by building seawalls. A seawall is a strong concrete wall built to stand between the ocean and the town. A seawall can stop storm surge from approaching the city from the beach side, but it won't protect from river flooding.

- As an expert group, figure out which parts of town your solution would be best for and which historic buildings you can protect.
- Add your seawall pieces to the city model where they would protect the city the best

Levee Engineers can solve the flooding problem by building levees. A levee is a wall of earth or stone built between the river and the town to prevent rainwater from overflowing into the city. Levees protect against a flooding river, but don't protect against storm surge from the ocean. Figure out which historic buildings you can protect by putting in levees.

- As an expert group, figure out which parts of town your solution would be best for and which historic buildings you can protect.
- Add your levee pieces to the city model where they would protect the city the best

Structural Engineers can solve the flooding problem by putting buildings on stilts. Each set of stilts lifts a building above flood waters so the flood waters will go under the buildings instead of through them. Stilts protect from both river flooding and storm surge.

- As an expert group, figure out which parts of town your solution would be best for and which historic buildings you can protect.
- Add your stilts to the city model where they would protect the city the best