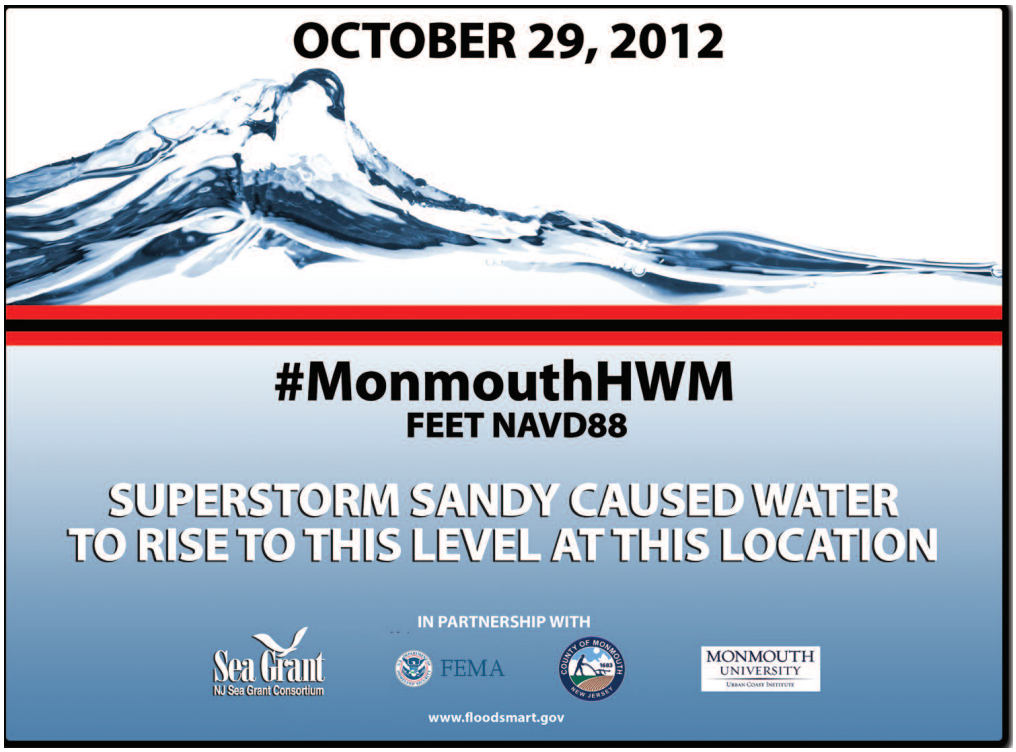
NEW JERSEY SEA GRANT CONSORTIUM'S

Teachers Guide to the Monmouth County High Water Mark Initiative

In an effort to make residents aware of flood risks and encourage them to take action to reduce risk, many of Monmouth County's coastal communities are participating in the Monmouth County High Water Mark Initiative. Through this initiative the County and its partners have recently placed nearly 100 high water mark signs throughout 14 towns and 2 federal sites.

The High Water Mark (HWM) Initiative is a component of the National Flood Insurance Program (NFIP) aimed to increase community awareness of flood risk and encourage risk mitigation actions. The HWM Initiative uses signs on public and private property to show the high water mark from past flooding events like Hurricane Irene in 2011 or Superstorm Sandy in 2012. For more information about Monmouth County's HWM Initiative go to: **www.njseagrant.org/hwm**



This guide is intended to help you and your students understand the importance of the High Water Mark Initiative and provide you with classroom tools you can use to teach your students what to do before, during, and after major storms, why storm surge and floods happen, and what can be done to prevent or lessen storm impacts in the future.

FLASH FLOODS are the #1 Weather Related Killer in the US!
Our hope is that this guide will increase your confidence in teaching about flood risk so students and their families will be well-informed before future events. The lessons and activities included in this guide could be integrated into your science lessons on weather, climate, or human impact on the earth, or during social studies lessons on geography or people and the environment. Connections to language arts and mathematics could be made as well.

Sea Grant
NJ Sea Grant Consortium

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GETTING STARTED WITH THE HIGH WATER MARK INITIATIVE

Introduce the High Water Mark Initiative

Introduce the High Water Mark (HWM) Initiative to your students. A picture of the sign is included on the cover of this guide and an online version is located at njseagrant.org/hwm. Please see FEMA'S website for information as well. www.fema.gov/high-water-mark-initiative.

Ask students to explain what the sign is telling them

Possible answers should include: The line on the sign tells us how high the flood water reached in elevation (given in feet), and what storm caused the water to rise. The sign tells us the date the water reached that level.

Ask students why they think the signs were installed

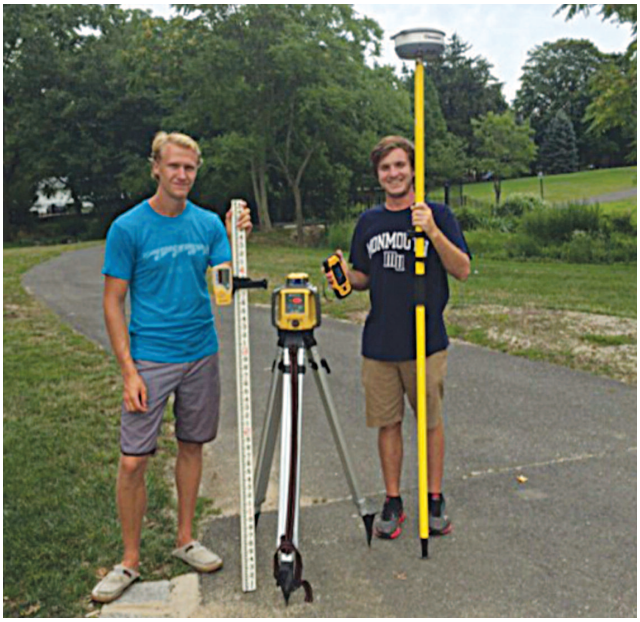
Possible answers include: The signs were installed to remind citizens and visitors that flood water reached that high and could happen again. The signs make people aware there is a flood risk in the area and anyone in the area should be prepared for possible future storms. The signs remind people that they should pay attention to any flood warnings that are given with a weather forecast.

Ask students if they have any questions about the signs

The most common questions that may be asked are answered below. If students do not ask these questions ask them if they can answer the two questions below.

How did the county know how high the water went?

HWM elevations were derived from water marks within a town left behind after a storm, such as a water mark left on a wall or a tree. Flood elevations were also gathered from temporary water level sensors installed by the US Geological Survey just before Sandy hit . The water level on each sign is reported in feet above the known land elevation determined by NAVD88. It is not reported above mean sea level because sea level can be different at different locations although in some locations it may be approximate.



Students from Monmouth University surveyed elevations for placing Monmouth County's High Water Mark signs. Two students are shown here with equipment used to complete the surveys.

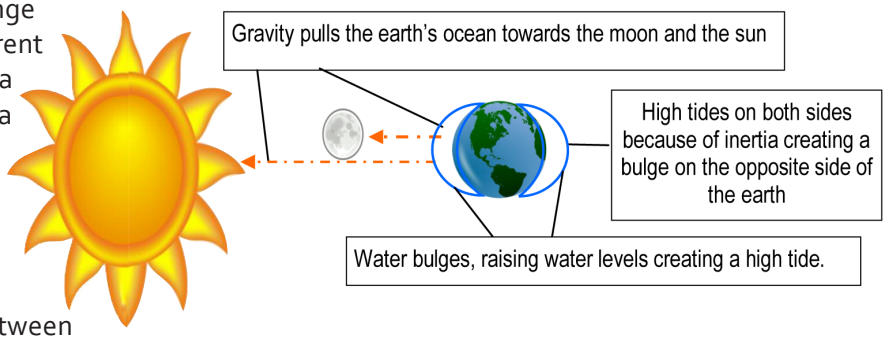
WHAT IS NAVD88?

The North American Vertical Datum of 1988 (NAVD88) is a common standard data set used by surveyors to measure the actual vertical elevations of land or water. All vertical elevation measurements referenced to NAVD88 (such as on the HWM signs) is based on a single location or origin point. This is known as a datum, and has an elevation equal to zero. The datum for NAVD88 is located off the coast of Quebec, Canada. There are thousands of NAVD88 fixed locations that are networked together across North America. These are known as benchmarks, and have a known height difference above or below the NAVD88 datum. Since there are many ways to measure elevation, surveyors try to use just one method so measurements are consistent. NAVD88 is considered the most accurate and up-to-date. To determine the height displayed on Monmouth County's HWM signs, surveyors found the height difference from a local NAVD88 benchmark to the water mark at a sign's location, and were then able to determine the height of the high water mark in feet the above NAVD88. Today, making elevation measurements like these is made easy through the use of sophisticated surveying tools such as laser levels and GPS (Global Positioning Systems) which use satellites to give more accurate dimensions of the earth, such as longitude and latitude. Although not the same as NAVD88, GPS tools can measure elevation which can be easily converted into feet above or below NAVD88.

Activity for Grades 4-12: What are the Water Levels?

With help from the background informatiom provided, explain to students what tides are, how tides change water depths daily, and the meanings of the different types of tide levels. Many people confuse tide data with NAVD88, or do not understand why tide data is not used to measure the height of flood water. To help clarify, explain what NAVD88 is, why it is used to determine land elevations, and how it is different than tide levels. After explaining the meanings of the different types of tide levels and NAVD88, students should know the difference between tide levels, NAVD88, and be able to answer the questions asked in Figure 2 - Sandy Hook Water Levels.

Figure 1 - Tides



Background Information
Tides are the rise and fall of water levels in the ocean.

There are differences in tidal levels because the gravity of the moon and the sun pull the ocean towards them changing the height of the ocean's water levels.

As the earth rotates, the closer an area of the ocean is to the sun and/or moon, water levels rise, the higher the tide. The further away an area of the ocean is to the sun and/or moon, water levels drop, the lower the tide. In the Northeast U.S. there 4 alternating tides, 2 high and 2 low tides per day.

MSL - Mean Sea Level– the average of the tide height measured over a period of time at a particular tide gauge.

MLLW - Mean Low Low Water– the average of the lower low tides each day.

MHHW - Mean High High Water-the average of the highest high tides each day.

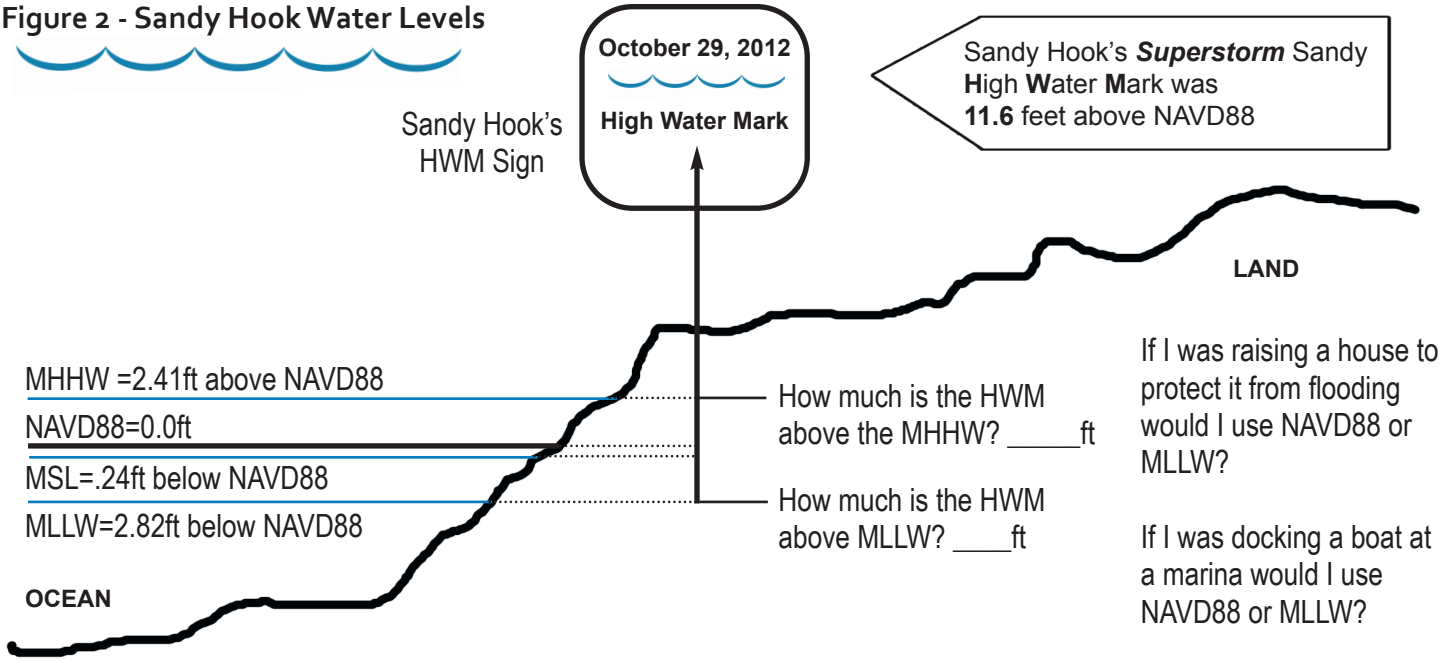
Tide data help others understand where the water levels are in reference to the land, measured by a tidal gauge. They are based off the average measured water levels at a tide gauge over time. In Figure 2 the tide data is based off NOAA's tide gauge located in Sandy Hook Bay, NJ and from the time period of 1983-2001 (also known at the National Tidal Epoch). This data informs boat or ship captains about the depth of the water and is used in nautical charts. Tide data is not often used in measuring the height of land because tide differences can vary at different tidal gauge locations and tide levels can change over time.

NAVD88 – North American Vertical Data of 1988 is a vertical geodetic datum, which means it is the measurement of the vertical height on land above or below a fixed starting point that is considered 0.0 ft. The starting point for NAVD88 is the mean sea level off the coast of Quebec, Canada. This is where all land elevation measurements across North America start from. When all measurements are referenced as either below or above this location that is considered most accurate to zero (0) ft, this avoids confusion between different surveyors and different land elevation readings. NAVD88 is most often used on topographic maps and for building structures on land to be sure they are safe from flooding. NAVD88 was used to place the High Water Mark signs because of its accuracy.

As you can see in Figure 2, NAVD88 and MSL are very close to being at the same level at Sandy Hook, NJ. However mean sea level at one location may be higher or lower than mean sea level elsewhere, so if surveying the land or flood elevations the measurements will not be starting at the same level at different locations.

Tidal gauge - the white pipe contains tide level detection equipment.

Figure 2 - Sandy Hook Water Levels



Activity for Grades 3-8: What Causes Floods? How High Water is Measured After a Storm

For a more detailed lesson plan on Storm Surge go to www.seagrant.org/teacherreasources/stormsurge

Many towns in Monmouth County, NJ are located along the Atlantic Ocean or are directly connected to the ocean by their location on or near an estuary. Many other neighborhoods are connected to the ocean by nearby rivers, creeks, and streams that flow through town and eventually drain to an estuary. Harsh storms such as tropical storms, nor'easters, or hurricanes, can bring powerful winds that push ocean water up along the shore and into the mouths of bays or onto land. This pushing of water results in storm surge. During these storms tremendous amounts of rain often fall, sometimes for extended periods. This fills and overflows local rivers and streams creating flash floods.

For this activity students will create a model of a coastal community, and by following the procedure described, attain a better understanding of how storm surge and flash floods are created and how they impact a coastal community. Students will observe how harsh storms bring in flood waters fast and furiously, how flood water inundates a landscape, and how it affects the shape of the land.

Materials needed:
Plastic shoe box or other rectangular shaped reusable container; Sand/Dirt mixture or modeling clay; Water; Food coloring (optional); Small paddle (such as large popsicle stick or small ruler); Popsicle sticks; Two rulers; Markers; String; A bottle or watering can filled with water.

Procedures:

1. See Figure 3 for a photograph that shows how to set up the container for this activity. Have students work in small teams to create a land area using clay and/or sand or dirt in their container. The "land" should be a few inches high, and slope down to create a beach-like area. Sand along the shoreline creates a great visualization as to what happens to sandy beaches during storms. Leave about 1/3 of the container empty. This will be the "ocean."
2. In this land mass students may also carve out a meandering river or stream that is wider at the end to simulate a small estuary.
3. Fill the "ocean" with water. Water can be dyed blue to make it easier to see. Water should just cover the bottom of the river basin.
4. Place Monopoly or Lego "houses" and/or popsicle sticks at various locations all around the land area. Place at least a few near the ocean, the river, and on land areas. The "houses" represent homes and businesses in a flood zone, and the popsicle sticks represent the sensors set out to take water height measurements. Try to have at least 10 "houses" and/or 10 popsicle sticks set out along the ocean, river, and at various locations on the land.
5. Now create a storm! Using a flat paddle, students

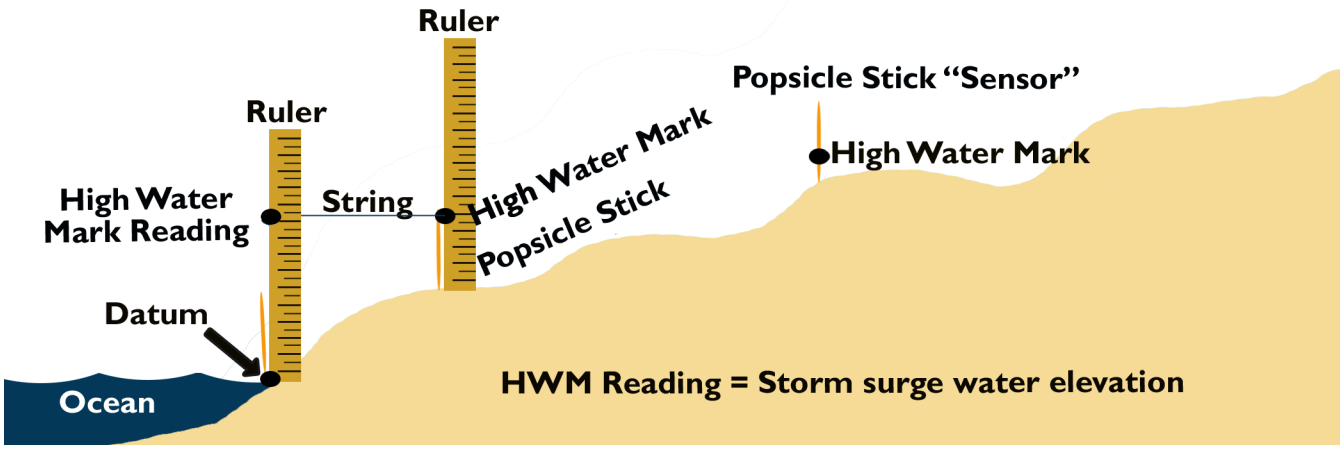
should PUSH water up onto land. They should not splash the water onto the land. Storms cause sea levels to rise due to a low pressure weather system. Unrelenting winds cause storm surge which pushes the rising waters onto land.

6. Simultaneously, at the other end of the box, pour water either through a bottle or watering can to represent heavy rainfall during the storm that enters the rivers and streams. Create a heavy storm for at least 20-30 seconds or more over the land to represent the heavy and prolonged rainfall that causes rivers to overflow and cause flooding.
7. After they are done, students should observe and possibly mark how high the water reached on popsicle sticks.
8. **Extension – Measuring the High Water Mark.** Before creating a storm and to help students understand how NAVD88 elevation readings are made, have students pick one location on land in the model to represent a "datum." Students should choose a spot where the land and ocean meet along the beach and place a popsicle stick in that area securely to represent the datum. This datum, the level where the land and water meet, equals a measurement of zero (0) inches in elevation. This datum is the base to where all measurements of high water marks will be made. After creating a storm in the container, use a black marker to mark the high water marks left behind on the popsicle sticks. Using two rulers, hold one ruler at the datum upright and level, and then hold the second ruler at the high water mark on the popsicle stick (also upright and level). Hold a piece of string, (representing a level) horizontally that reaches from the datum ruler to the high water mark ruler. Make the string as level as possible between the two rulers. Students may tape the string to the ruler to make measuring easier. Students will make a reading in inches or centimeters where the level string connects to the datum ruler. This reading is the high water mark (see figure below). Students will discover the high water mark is not the same or as simple as measuring from the ground up to the high water mark on the popsicle stick "sensor."

Figure 3 - Coastal Community Model

9. Students may work in groups to report how the flood impacted their coastal town, give the flood height water elevations found at each of their popsicle stick "sensors," and discuss how the ocean and rain worked together to flood their town.
10. Have students brainstorm ideas on how to slow or stop flooding in the model town, or how to protect houses and businesses. See another extension to this activity, on page 11.

Figure 4 - Side View of Model



Activity for Grades 3-12: Be Prepared for High Water

Explain to students that flooding events, such as storm surge, become a crisis when people are not aware of and/or not prepared for rising water. Sometimes people do not realize they live in areas that could be at risk for flooding, and when a flooding event does happen many people are surprised how fast and high the water rises.

To follow are a few of the top actions that students can take to make themselves and their family aware and prepared for floods and surge—or any emergency for that matter! Review these important safety tips with students and be sure they share this information with their family. For older students see the two web-based activities. Both are computer mapping programs that will help students visualize flooding impacts from storms and help students find out if they live in area at risk for flooding. Have students brainstorm ideas of how they and their community can be prepared.

Visit FEMA's Ready.gov/kids for more information.

TOP ACTIONS TO BE PREPARED!

- Talk to your family to create an emergency plan! To help get started see this *www.ready.gov/sites/default/files/documents/files/Family_Emergency_Plan.pdf*. Where will you go? What will you need?

- Be aware of posible storm and/or flooding events. Find out about weather alerts at www.weather.gov/alerts.

- Often during a predicted storm, areas predicted to experience a large storm surge or flash flood are given evacuation orders. Make sure to follow orders! Do you know your evacuation zone? If you live in Monmouth County see *www.mcsonj.org/knowyourzone.*

- Have an emergency kit ready. You will not have time during an emergency to gather supplies. To learn how to make one go to https://www.ready.gov/kids/build-a-kit.

- **KNOW YOUR RISK!** Before a storm ever arrives you can know if you live in a zone that could be flooded. Students may check out the following online mapping tools to find out if they live in an area at risk and where it might be safe to go and share these websites with friends and family that they feel might be at risk. NJFloodmapper.org and region2coastal.com are both great websites to find out if you are at risk.

Below are two different computer mapping programs suggested to use to help students visualize and understand flood risk in coastal communities, such as in Monmouth County, NJ. NJfloodmapper is a visualization mapping tool used to observe what areas could be inundated during storm surge. Region2coastal.com is a mapping tool to be used by property owners to find out if they live in flood zone, and how much flood risk they have according to FEMA and it's National Flood Insurance Program (NFIP). Directions are provided to guide students through the use of each website along with questions to help students in their understanding of the website, it's usefulness, includ ing finding areas in Monmouth Country that are at risk, including a students own home.

View Flood Inundation- NJFloodmapper.org (grades 4-12)

NJFloodmapper is an easy to use, interactive mapping website for students from upper elementary grades to high school. This tool lets anyone view coastal flooding hazards and evaluate the risk of storm surge heights and inundation. To view the surge of a storm in New Jersey, start the *Viewer*, click on *Flooding* (in the top left box), then *Storm Surge*. Next zoom into a town or neighborhood, then click on each layer to view storm surge models of SLOSH category 1 through 4 hurricane. Each layer shows the maximum storm surge heights scientists think are possible during each SLOSH category. Be sure students understand that weather forecasts will let them know if there is an actual threat of a storm surge. This tool will help people know what to expect.

Have students investigate njfloodmapper.org then answer a few questions.

1. **Have students read the overview and answer the following -**
   A. Does this show the least or maximum storm surge heights? Why do you suppose they show these heights?
   B. This model is based on the SLOSH model - what does SLOSH stand for? (Sea Lake Overland Surges from Hurricanes). Name a few factors that the model takes into account to model storm surge height and inundation.
2. **Discuss with students why this information is important to state and local officials.** Have students understand that local officials make decisions about what areas need to be evacuated during a storm. This model could tell them what areas could be inundated during a storm. Have students also think about public facilities such as schools and emergency service locations (fire, police, EMT) and why those locations need to be aware of flood risks in the area.
3. **Discuss with students how a citizen could use this information.** Have students realize that property owners and residents will want to know if they are in a flood zone because they will have the most to do to protect their property and themselves during a storm.

4. **Utilizing Street View have students find areas in their community that will remain dry through a SLOSH Category 1-4.** Ask students why this is important information to know as well.

Exploring Flood Risks -

www.region2coastal.com (Grades 9-12) This is a more complex website however teachers may have students view the different flood zones and explain that this map was created to make property owners and insurance companies aware of flood risks, and determine how much flood insurance people who live in flood zone areas will need. There is also a brief explanation on the definition of insurance and the meanings of BFE (base flood elevations) while investigating where the flood zones are located in each community. This website could easily be integrated into a high school social studies class with a focus on economics and/or civics lesson.

To Explore the Map - On the home page click on the tab "View Flood Hazard Info" and choose drop box "What is My BFE Address Look Up Tool." An address or just a zip code can be entered. The tool allows you to zoom in and out of the map, and by double clicking on different areas of the map you can view different flood hazard data. The two most important pieces of information students should want to know from the data table below the map are:.

1. "What is my property's Base Flood Elevation (BFE)?"
2. "What is my property's flood zone?"

Information may or may not be given in the FEMA Flood Hazard Table but should be in the Effective Flood Insurance Table.

What is a BFE (Base Flood Elevation)?
This is most likely the highest elevation that water has a 1% or greater chance of reaching every year, or 26% chance of reaching every 30 years. A 1% chance storm might not seem high but it COULD STILL HAPPEN! Hurricane Sandy was considered a .5% storm and the HWM signs remind us what happened and could happen again. IT PAYS TO BE PREPARED!

What are the meanings of a property's flood zones A, AO, AE, VE and X?
Have students investigate the meanings which are found on the website. Have students find important areas (such as their home) or schools and businesses in their community that are in A, AO, AE, VE and/or X flood zones.

Find Solutions!
Students can explore the problem of flooding and building resilience in their community and what actions they could take to fix this problem. The site provides a lot of references, especially at the bottom of the address look-up tool page with "What should I do with information in this report?" Here students can find actions that can be taken to make property owners and the community more resilient to future flooding. www.toolkit.climate.gov/#steps is also a good resource for more action.

Activity for Grades 5-7: High Water Mark Math Homework!

The National Flood Insurance Program (NFIP) offers flood insurance in communities that take the required actions to reduce flooding and its risks. Communities who want to go beyond what is required by NFIP may join a program called the Community Rating System (CRS). CRS has many voluntary actions communities can take that reduce the risk of flooding, and reduce the cost of the flood insurance for property owners. Installing HWM signs is one of those actions that can be taken. Using the chart with figures from a community in the CRS program in Monmouth County students can perform some simple calculations to see how the CRS program benefits communities, and might even benefit their own family and friends.

CRS Rate Class	Savings in SFHA	Savings Non-SFHA
9	$62	0
8	$123	0
7	$185	0
6		

Premium cost of NFIP of those in Special Flood Hazard Area (SFHA) - $1231
Premium cost of NFIP of those in a Non-SFHA** - $868

Total # of property owners with NFIP in SFHA – 565
Total # of property owners with NFIP in Non-SFHA area – 180

A community chose to join the CRS program and installs HWM signs. They are given a CRS rate class of 9.
How much does the flood insurance policy now cost for those in a SFHA? ____
What is the % discount received? ____
Based on the # property owners in a SFHA, what is the savings for the entire community? ____

What is the % discount received for CRS Rate class 8 and 7 for property owners in a SFHA? ___
Based on the % savings in the other categories, if a community volunteers to complete many more activities outlined by the CRS to give a Rate Class of 6, what will be the % discount received for those in the SFHA? ____
What would be the total savings for a property owners in a SFHA? (fill in the blank in table above) What does the flood insurance policy now cost? ____

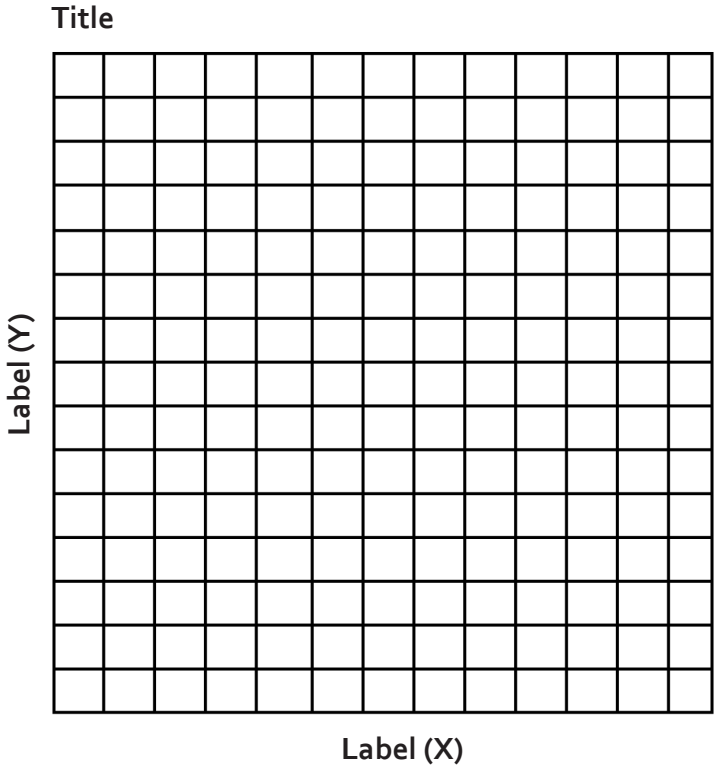
With a Category 6 CRS rating those with flood insurance in a Non-SFHA will also receive a discount of 10 %. How much savings will they receive? (fill in blank on table above.) Based on the total # of residents in the SFHA and non-SFHA, how much savings will the entire community receive as a CRS Rate Class of 6?_____

*The dollar costs reported here are based on a true estimated cost of a flood insurance policy in a community in Monmouth County, but are being used for educational purposes only. National Flood Insurance policy rates differ for every property owner in every community. Please see floodsmart.gov to find your local insurance agents. **This does not include those with Preferred Risk Policies..

Activity for Grades 3-7: Chart the High Water

Based on the HWM data from each town listed have students create a bar chart. They should create a title, label the X (horizontal) and Y (vertical) axis. Students will decide on a scale, start at zero, and use the least and greatest number in the data to help create the bars and label each one.

Town	HWM # feet in elevation above NAVD88
Aberdeen	14.5
Atlantic Highlands	11.7
Belmar	12
Hazlet	11
Keansburg	9.0
Manasquan	10.1
Monmouth Beach	10.0
Neptune	11.4
Oceanport	9.5
Sea Bright	10.6
Sandy Hook	11.5

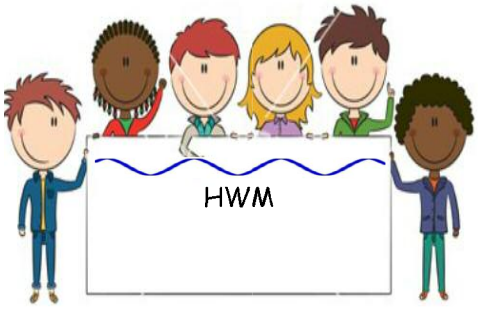


1. What is the title of your bar chart? _____
2. In this graph x (horizontal) axis represents _____
3. In this graph y (vertical) axis represents_____
4. In this graph each bar will represent_____
5. From this data what is the highest HWM?_____
6. From this data what is the lowest HWM? _____
7. How many signs are above 9 feet NAVD88? _____
8. What is the average height of the HWM in Monmouth County? _____
9. What town could have the highest threat of severe flooding during a harsh storm?_____
10. How did you use your bar graph to answer this question? _____
11. How much higher did the water go in Atlantic Highlands compared to Sea Bright? _____

Activity for Grade 3-5: How High was the High Water Compared To You?

Using the attached map and data table on page 10 have students find the High Water Mark sign closest to their school. Next have them find the height of the water in feet. Using a large piece of fabric, like a tablecloth or sheet, or even just a large sheet of paper, cut a piece that measures from the floor to the height of the high water mark on the sign. Your fabric or paper can be as wide or narrow as you like, however if it is wide enough for a few students to hold up, it may give students a better visualization. Have students hold up the fabric or paper so the bottom edge is touching the ground and the top edge is in front of their bodies. Now they can see how the high water mark compares to their own height. It could be chest high or even over their heads! Make sure other students can see the student(s) holding the fabric or paper so they can also visualize how high the water was in their town.

Have students think about what it would have been like to be caught in water that deep especially when the water was flowing. Storm surge and flash floods are not like water in a swimming pool or puddle. It is moving water and can move at high speeds! Storm surge is a lot like a tsunami crashing on shore, except it is caused by wind and not an underwater earthquake. The surge may also have crashing waves on top. Even if waves have subsided there are still obstacles under the water, and the water will not be clear like a pool. To help students understand what it may be like to have to move around in flood water, have the students imagine trying to swim or walk in the classroom after a flood.



Have students think of what dangers could lurk in flood waters and make a list to display in your classroom.

* It is important for students to understand to NEVER ENTER FLOOD WATER!

FLASH FLOODS ARE
#1 WEATHER RELATED KILLER!

If they come to an area that is covered with water, they will not know the depth of the water or the condition of the ground under the water. Teach them to play it smart and play it safe. Whether driving or walking, any time you come to a flooded road, *Turn Around-Don't Drown!*

FEMA has a great website with handouts for kids with information about flooding and storms that you can review and share with your students. Go to www.ready.gov/kids/know-the-facts/floods

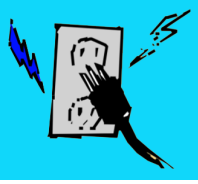
How to Stay Safe During a Flooding Event

BE PREPARED! Listen to local TV or radio weather reports. Weather.com, Weather Underground and NOAA also have reliable weather forecasts that will alert users to watches and warnings in their area. You can check these online, on smart phone apps and on tablets. Today many smart phones and tablets have a WEA (Weather Emergency Alert). This will automatically display on your device (no sign-up needed). Also know these terms:

Flash Flood WATCH – means a flood is possible.

Flash Flood WARNING – means flooding is happening or will happen soon. You may have to evacuate!

Turn off Utilities



Do Not Walk or Drive Through Water

Head to Higher Ground

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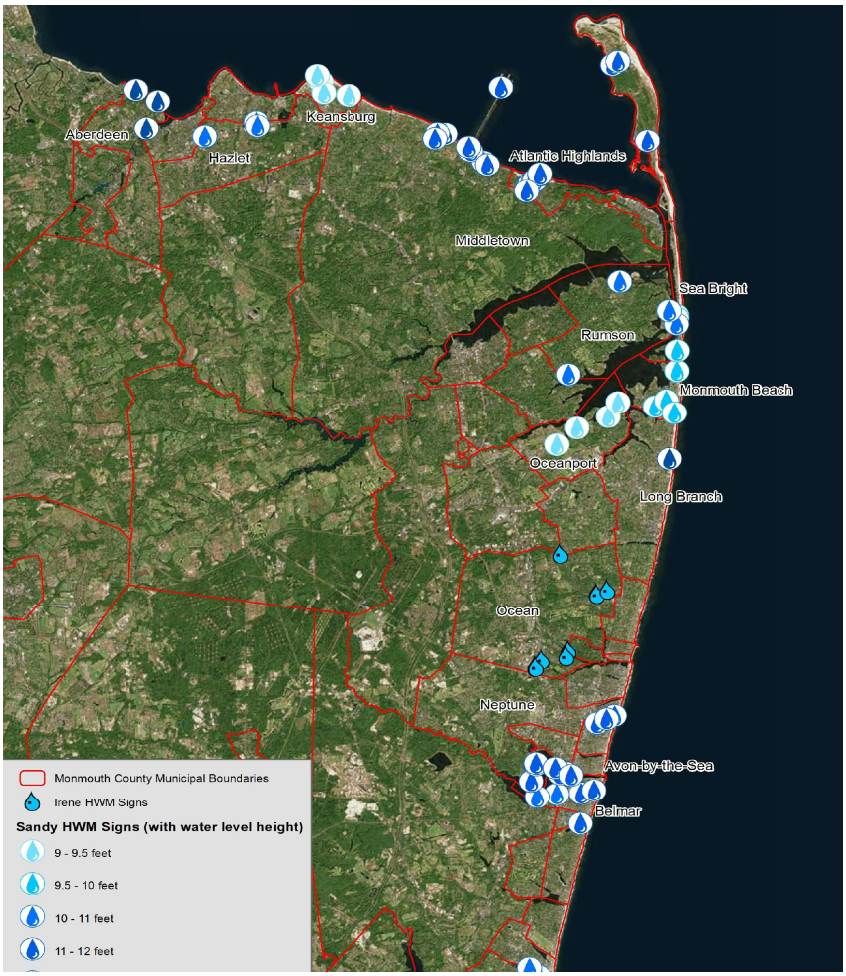
High Water Mark Map of Monmouth County



Data Table with Height of the High Water Marks

TOWN	Storm with Height of HWM in ft.
Aberdeen	Irene - 7.5 Sandy - 11.5
Atlantic Highlands	Sandy - 11.7
Avon-by-the-Sea	Sandy - 11.9
Belmar	Sandy - 11.5
Hazlet	Sandy - 11.0
Keansburg	Sandy - 9.0
Manasquan	Sandy - 10.1
Middletown-Belford	Sandy - 11.5
Middletown-Leonardo	Sandy - 14.0
Middletown-Port Monmouth	Sandy - 11.5
Monmouth Beach	Sandy - 10.0
Neptune	Sandy - 11.4
Oceanport	Sandy - 9.5
Sea Bright	Sandy - 10.0
Rumson	Sandy - 10.5
Sandy Hook	Sandy - 11.5

Future Ready Communities

Not only do coastal communities, such as those located in Monmouth County, need people to be safe and prepared for a possible flooding event in the next few years, communities also need to think about what future storms and floods might be like in 100 years, and what actions can be taken to reduce future flood risk. As an extension to the previous activity *What Causes Floods* and using the *NJfloodmapper.org* website, students can investigate how climate change could impact flood zones.

As humans burn fossil fuels, such as coal, oil and gas, this creates a heat trapping blanket around the earth. The excess heat is causing polar ice on land to melt. This water from melted ice runs off into the oceans and causes sea levels to rise. Plus, water expands as it warms, which is also raising sea levels. In addition, in New Jersey, we have land subsidence or the sinking of land. This is causing sea levels to go even higher along our coasts than in other parts of the country. Sea levels along the coast of New Jersey have risen about 16 inches in the past century and are predicted to rise by 1.5-2.5 feet by 2050 *(geology.rutgers.edu/images/stories/faculty/miller_kenneth_gSealevelfact-sheet7112014update.pdf).* To learn more about climate change see www.nationalgeographic.org/media/changing-climate/

Rising seas will change how flooding events impact communities. Using the model *created in the Activity – What Causes a Flood,* students can make ocean water levels higher by 1cm, 2cm or more, then follow the directions for creating a storm to see how sea level rise will change flood levels and how water flows through the rivers and/or streams at higher levels.

Students may also use njfloodmapper.org as a tool to see how scientists are using models to predict how sea level rise will impact New Jersey. Have them zoom into your community to see where the water will go with 1-6ft of sea level rise.

TAKING ACTION! A community resilient to coastal storms can also be resilient to sea level rise.
Action needs to be taken to safeguard and shield coastal towns from future storms and flooding events. We must protect communities from not only possible flooding that could happen tomorrow, but also for future generations that will experience serious consequences from sea level rise if nothing is done. Luckily a community safe from a Category 4 or 5 hurricane is also safe from future sea level rise. Have students research ways to help protect against flooding and sea level rise. Students may research natural and green engineering solutions by looking at how dunes and wetlands can protect a coastal community and compare and contrast this to hard or "grey" engineered solutions such as levees, walls, dams, and other barriers. Using the Activity – *What Causes Floods*, students can explore "green" engineering by using materials such as sponges along the shoreline to represent wetlands, pipe cleaners and toothpicks and extra sand to represent vegetated dunes, and/or plastic aquarium plants to represent other types of vegetation. Compare and contrast to the model without vegetation to see if green engineering solutions might be helpful in reducing the impact of flooding and the effect of sea level rise.

Have students take action by doing an actual presentation for another class, the school, or at a community fair or festival. It could be in the form of a power point presentation, a video, a song, a poster or brochure that could handed out. Or students could participate in an action such as community gardening, dune planting, or by creating a plan for the school to reduce its carbon footprint to help slow climate change.

For inquiry based lesson plans on sea level rise go to njseagrant.org/we-content/uploads/2014/02/Shrinking-Shorelines-PDF-1.pdf

PREPARE FOR THE FUTURE!

Preserve wetlands and floodplains that protect coastlines from flooding and damage.

Protect barrier beaches and reduce erosion.

Incorporate green design and infrastructure.

Improve drainage systems.

Elevate existing structures or build protective barriers in certain places.

Build houses further from the shoreline and other areas that could flood easily.

This lesson and its correlation to the NJ Science and Social Studies standards can be accessed online at http://njseagrant.org/education/resources-for-educators/lesson-plans/

For a complete list of lesson plans and other educational materials produced by the NJSGC on related marine and coastal topics please go to http://njseagrant.org/education/resources-for-educators

Visit the NJSGC at njseagrant.org

Project Partners

FEMA

MONMOUTH UNIVERSITY

Sea Grant NJ Sea Grant Consortium

Introduction and Correlation to Standards

After the devastating floods of Hurricane Irene and Sandy, the Monmouth County Office of Emergency Management (OEM), with help from Federal Emergency Management Agency (FEMA) decided to create a community level outreach program designed to inform citizens about the potential risks of severe flooding for the communities in Monmouth County. The High Water Mark Sign (HWM), was created and has been installed in 13 Communities in Monmouth County. HWM signs raise flood risk awareness in local communities by displaying flood heights from past severe storm events on public buildings, utility poles, or other structures. In an effort to spread information about the signs and flood risk, Monmouth County OEM and scientists from Monmouth University's Urban Coast Institute joined with the educators at the NJ Sea Grant Consortium to create a Teacher's Guide to the High Water Mark Initiative.

This guide is designed for teachers to communicate flood risk and awareness in their school's hometown. Much like the importance of fire safety, and the benefits of recycling, this guide hopes to help create informed citizens who understand flood risks, how floods happen, how these risks have been determined, and how not only individuals, but communities can be prepared and resilient to the next storm. We also hope as students develop an understanding and awareness, they are able to pass the information on to others in their community of what could happen, and should be done to protect people and properties from potential future floods.

With increased risk of harm from an increase in frequency of storms in Monmouth County, especially in coastal communities, we ask you please find time to integrate the High Water Mark into your current lessons. We understand this adds to the many tasks teachers must take on, so to help, we correlated many of the activities with NGSS standards, and many activities could also be easily built into social studies and math lessons.
Each lesson is labeled according the appropriate grade levels and may need to be modified according to your specific grade and lesson. To start off your lesson, the first page of this guide explains the High Water Mark Signs installed in many different locations, in many communities in Monmouth County. After an introduction, any activity can stand alone, or teachers may incorporate other lessons as warranted.

Through math and science students will learn the cause of flood waters, especially in coastal areas, and explore either through inquiry based lesson, or guided computer models how flood can affect their community. Students will learn about flood hazards, flood risk, flood safety. There are also activities that will make students aware of what communities can do to shield themselves, and to make citizens more aware, and even save money!

Upper grades learn about the different flood zones and will be able to evaluate the risk, and in their or other local communities, and find possible solutions. They may also view and model how sea level rise will impact a community's flood risk in the future.

Please have students pass this information on! After Hurricane's Irene and Sandy, Monmouth County knows the devastation a harsh storm can bring, and realizes a prepared and resilient community will be a community that will not just survive but thrive!

Next Generation Science Standards:
PE's- 2-ESS1-1 , 2-ESS2-1, 3-ESS3-1, 4-ESS2-1, 4-ESS2-2, 4-ESS2-3, 5-ESS2-1, 5-ESS3-1, MS-ESS3-2, HS-ESS2-2, HS-ESS3-5, HS-ESS3-1, HS-ESS3-4.

DCI's- ESS2.A, B, ESS3.B, ESS3.C, ESS3.D, ESS2.C, D