CHAPTER 6: COASTAL FLOODING

INTRODUCTION

Hurricanes and Tropical Storms are often the most well documented causes of coastal flooding along the Eastern Shore of Virginia. Hurricane Sandy, in October 2012, grazed the Eastern Shore of Virginia causing significant damage and flooding although the storm had not yet reached its full strength and remained nearly 100 miles offshore. Sandy went on to be one of the largest Atlantic storms on record, and Eastern Shore residents were fortunate that Sandy did not follow a course up the Chesapeake Bay or stall off the coast as originally forecasted, which would have led to widespread damage and flooding across the Eastern Shore. If Sandy had tracked closer to the Eastern Shore, the results for the Chesapeake Bay, the local economy, and area residents could have been tragically different ("Ecological impacts of Hurricane Sandy on Chesapeake & Delmarva Coastal Bays," 2012). If the nine-foot storm surge caused by Sandy in the Northeast had occurred on the Eastern Shore, it would have been destructive to both the land and the Chesapeake Bay, since the flow of sediment from the land into the Chesapeake Bay would have impacted aquaculture and other water-based economic sectors (ibid).

Flooding poses a major risk to communities across the country and collectively accounts for more than 70 percent of federally declared disasters (FEMA, 2021). In the Eastern Shore of Virginia, coastal flooding is the most hazardous form of flooding. However, hurricanes and tropical storms are not the only source of coastal flooding. Different types of storms and storms paths, in addition to tide cycles and low-lying elevations, can all affect the extent of coastal flooding. Also, global and relative sea level rise combined with traditional causes of coastal flooding further complicates the risk of coastal flooding.

Chapter 1 provided a review of major storms in the Eastern Shore's history including all tropical cyclones and nor'easters, many of which have caused significant coastal flooding. However, other storms and events can cause coastal flooding, and the causes are not always as easily identifiable. Strong onshore winds, offshore low-pressure systems, changes to ocean currents, and high astronomical tides, or any combination of these, can also cause coastal floods that disrupt schools, local businesses, and transportation routes. For example, in October 2015 when Hurricane Joaquin's center was still near the Bahamas, a "cut-off low aloft" developed over the southern U.S. fed by a steady stream of moisture from Joaquin. Gales blowing in from New England, and the already occurring perigean spring tide (a period of extra-high tide) helped to contribute to local flooding (seen in Figure 1) as swell from Joaquin moved northward to the Eastern Shore. (Hurricane Joaquin, 28 September – 7 October, 2015) Recorded storm surge on Oct. 2 at Wachapreague was 3.9 feet; Kiptopeke recorded a storm surge of 3.2 feet.

This chapter examines in detail the natural forces and conditions that cause flooding, and the human systems used to gauge their impacts and protect against harm to lives and property. The quantitative assessment of risks posed by flooding will be found in the local chapters, beginning with Chapter 10.

Table 1 provides a recent history of coastal flooding events that were not included in the Chapter 1 list. The events were taken from the NOAA National Climatic Data Center storm events database. This data reinforces that while hurricanes and other tropical cyclones (tropical storms and depressions) are the predominant storm types causing coastal flooding, other conditions, such as coastal low-pressure systems, tide cycles, and rapidly moving cold fronts also can cause coastal flooding.

Figure 1: Flooding on Atlantic Ave. (above) and Drummondtown Rd. (right), Oct. 2, 2015. Photo Credit: A-NPDC staff

Table 1: Coastal Flooding Events Recorded in NOAA Storm Events Database, 2000-2021)

County	Date	Event Category	Property Damage *($, not adjusted for inflation)*	Crop Damage	Source	Narrative
Accomack Co.	12/21/12	Coastal Flood	150000	0	911 Call Center	A rapidly deepening low-pressure system drove a strong southeast wind with frequent gale force gusts over the Chesapeake Bay, which allowed water to flow up the Bay. Due to the very strong winds, moderate to severe coastal flooding was observed across portions of Accomack County.
Accomack Co.	3/6/13	Coastal Flood	10000	0	Park/Forest Service	A low-pressure system produced coastal flooding. Rising water levels resulted in moderate coastal flooding along the coastal side of Accomack County. The Chincoteague Causeway (Highway 175) was impassable due to two feet of water over the roadway.
Accomack Co./ Northampton Co.	10/2/15	Coastal Flood	0	0	River/Stream Gage	A combination of Hurricane Joaquin near the Bahamas and strong high pressure over New England produced strong onshore winds over the Mid-Atlantic. The strength and duration of the onshore winds produced a tidal departure of 3 to 4 feet resulting in moderate flooding.
Accomack Co./ Northampton Co.	1/23/16	Coastal Flood	0	0	C-MAN Station	A combination of low pressure moving from the southeast United States northeast and just off the Atlantic Coast, and high pressure over southeast Canada produced very strong onshore winds across the Mid-Atlantic. The strength and duration of the onshore winds produced moderate to major coastal flooding along the Atlantic Coast and Chesapeake Bay.
Accomack Co./ Northampton Co.	2/9/16	Coastal Flood	0	0	C-MAN Station & River/Stream Gauge	Strong winds behind a cold front caused minor to moderate coastal flooding along central and southern portions of the Chesapeake Bay region. Minor to low end moderate flooding occurred in bay side sections of the Eastern Shore.

County	Date	Event Category	Property Damage *($, not adjusted for inflation)*	Crop Damage	Source	Narrative
Northampton Co.	10/8/16	Coastal Flood	10000	0	Emergency Manager	Post Tropical Cyclone Matthew, tracking northeast just off the North Carolina and Virginia coasts, produced very strong northeast or north winds over and the Virginia Eastern Shore. These winds helped to cause moderate coastal flooding over portions of the area. Coastal storm tides of 2 to 3.5 feet above astronomical tide levels were common, with only minor beach erosion reported.
Northampton Co.	9/6/19	Coastal Flood	0	0	C-MAN Station & River/Stream Gauge	Hurricane Dorian tracking northeast along the North Carolina coast and just off the Virginia coast produced very strong northeast to north winds which caused moderate to major coastal flooding across portions of the southern Chesapeake Bay. It produced tidal anomalies between 2.5 and 3.0 feet causing major coastal flooding over portions of southern Northampton County.
Northampton Co.	10/10/19	Coastal Flood	0	0	Emergency Manager	The combination of low pressure sitting off the New Jersey coast and strong high pressure over southeast Canada resulted in persistent north or northeast winds over the Chesapeake Bay. These persistent north or northeast winds, along with high waves, allowed water levels to rise throughout the bay, producing tidal anomalies between 2.0 and 3.0 feet.
Northampton Co.	11/17/19	Coastal Flood	0	0	C-MAN Station	The combination of high pressure over northern New England and low pressure just off the Middle Atlantic Coast resulted in very strong northeast to north winds over the southern Chesapeake Bay, which caused minor to moderate coastal flooding.
Accomack Co.	8/4/20	Coastal Flood	0	0	River/Stream Gage	The center of Tropical Storm Isaias tracked north just inland off the Middle Atlantic Coast. Winds associated with the tropical storm caused moderate (tidal) coastal flooding across portions of the Virginia Eastern Shore adjacent to the Chesapeake Bay.

NATURAL FORCES AND CONDITIONS

TROPICAL CYCLONES: HURRICANES, TROPICAL STORMS, AND TROPICAL DEPRESSIONS

Hurricanes and tropical storms occupy a memorable place in the memories of those whose lives and ancestry are tied to the Eastern Shore of Virginia. Accounts of the tempests date back to the mid-1600s, recording sinking ships, scattered cargo, demolished settlements, and re-carved landscapes. Shipwrecks themselves testify to some of these "dreadful" and "tremendous" storms, as they were colorfully named.

Hurricanes are simply one type of tropical cyclones, which are organized, rotating systems of clouds and thunderstorms originating in tropical or subtropical waters. They typically form during the months of June through November and feed off of the warm tropical waters present in the ocean during this period.

Categories of tropical cyclones are distinguished by wind speed.

- **Tropical depressions** have a maximum wind speed of 38 mph.
- **Tropical storms** have a wind speed between 39 – 74 mph.
- **Hurricanes** have a wind speed 75 mph or higher.

Hurricanes are further rated by the Saffir-Simpson Wind Scale from 1 to 5 based on the hurricane's sustained wind speed (Table 2). This tool helps to estimate potential property damage and threat to human life from winds.

Table 2: Saffir-Simpson Hurricane Wind Scale

Category	Sustained Winds	Types of Damage Due to Winds
1	74-95 mph 64-82 kt 119-153 km/hr	**Very dangerous winds will produce some damage**: Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap, and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110 mph 83-95 kt 154-177 km/hr	**Extremely dangerous winds will cause extensive damage:** Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3 (major)	111-129 mph 96-112 kt 178-208 km/hr	**Devastating damage will occur:** Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.

Category	Sustained Winds	Types of Damage Due to Winds
4 (major)	130-156 mph 113-136 kt 209-251 km/hr	**Catastrophic damage will occur:** Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted, and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5 (major)	157 mph or higher 137 kt or higher 252 km/hr or higher	**Catastrophic damage will occur:** A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Source: National Hurricane Center

The scale, however, is not an indicator of the extent of flood damage that can be expected, but winds do affect flooding in two ways. First, they drive wave action and push waters onshore. Secondly, with larger tropical storms, the storm's low pressure elevates the water and then pushes it ahead creating an elevated storm surge at the leading edge of the storm.

Figure 2 is a compilation of the tropical cyclones that have tracked within 75 miles of Painter, Virginia (generally the center point of the Eastern Shore) from 2000-2021 as catalogued by NOAA and identified by category.

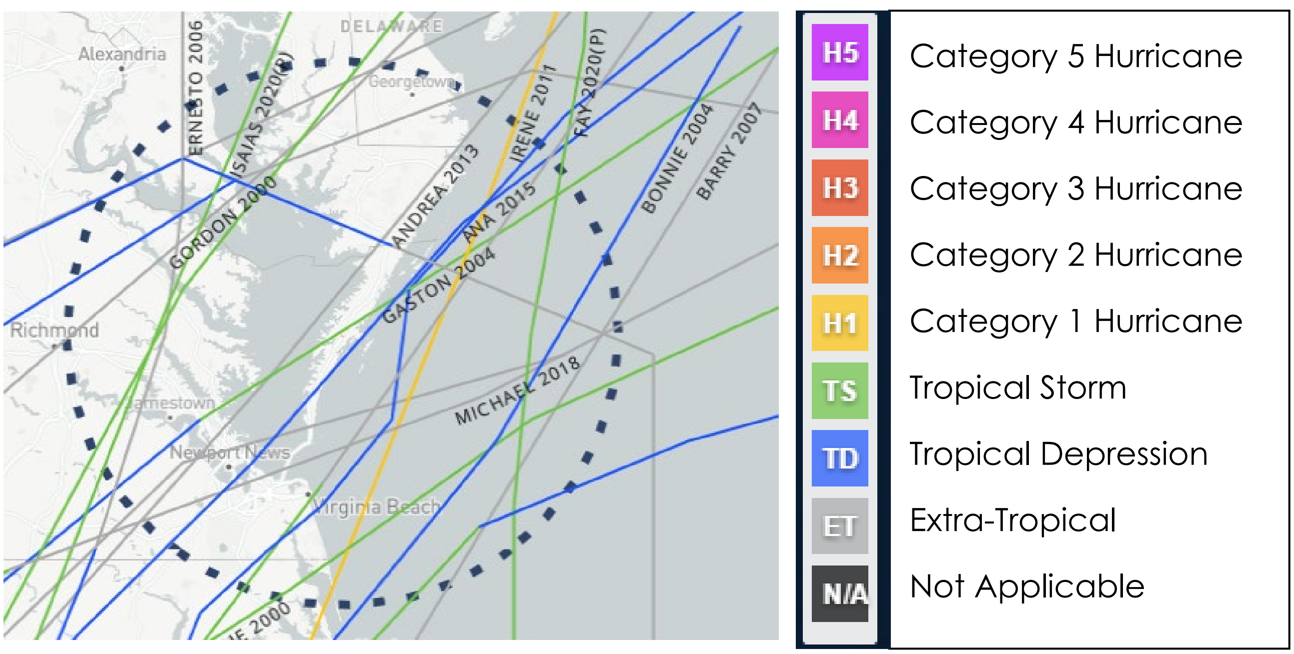

Figure 2: Paths of tropical and extra-tropical systems with 75 statute miles of Painter, Virginia, 2000-2021. Source: NOAA Digital Coast, Historical Hurricane Tracks

The proximity of storm centers to the Eastern Shore does not always demonstrate the storm threats from tropical cyclones with massive scales located farther offshore. One notable absence from Figure 2 is Hurricane Sandy; its storm-force winds extended over 1,000 miles in diameter, yet it did not register in Figure 2, as it only depicts tropical cyclones that passed within 75 miles of Painter. At its nearest point, the eye of Sandy was more than 100 miles away- and that was near Chincoteague after Sandy had begun to turn west and was no longer a hurricane.

Yet Sandy managed to cause more than $6 million in damage across the Eastern Shore, including significant damage in Cape Charles, Saxis, Sanford, Tangier, and other bayside locations, in addition to losses on Chincoteague. Although sustained winds did not reach a tropical storm strength on the Eastern Shore, the flow of the existing wind and impact on tides, similar to a severe nor'easter, is responsible for the damage from Sandy.

Likelihood of Recurrence: The timeframe of Figure 2 does not provide an accurate sense of the frequency of tropical cyclones over the short term. In its study of recurrent flooding in Tidewater Virginia, the Virginia Institute for Marine Science (VIMS), citing a NOAA report, asserts that a tropical storm, or its remnants can be expected to affect Virginia every year, with hurricanes every 2.3 years.

NOR'EASTERS

Nor'easters are cyclonic storms that form along the Atlantic Coast of North America when the polar jet stream reaches the Atlantic and meets warmer air pushed up from the Gulf of Mexico and southern Atlantic. They typically develop within 100 miles of the coastline between Georgia and New Jersey and are strongest and most frequent between September and April (NOAA).

Some of the most damaging floods the Eastern Shore has experienced have been from nor'easters, which tend to move more slowly than hurricanes, lasting through multiple tide cycles. Additionally, these storms can further exacerbate flooding since they can sometimes occur in pairs, with one flood not fully receding before the next nor'easter flooding begins.

Some Eastern Shore residents remember nor'easters as much as or more so than hurricanes. Such storms like the devastating Ash Wednesday storm of 1962 and the nor'easters of November and December 2009. With the exception of "The Perfect Storm," nor'easters do not tend to receive the same public attention as hurricanes, but they can pack the same winds, catastrophic flooding, and severe coastal erosion. Other notorious nor'easters, including the so-called "Nor-Ida" nor'easter of November 2009, which formed from the remnants of Hurricane Ida, and during which tides exceeded levels experienced during Hurricane Isabel.

Likelihood of Recurrence: Nor'easters occur with sufficient frequency to provide a high level of confidence they will continue to be a significant coastal flooding threat.

ASTRONOMICAL TIDES

Note: Information in this section sourced from NOAA Ocean Service

Independently, astronomical tides rarely cause more than nuisance flooding, but high astronomical tides combined with storms can worsen coastal flooding. Astronomical tides result from the gravitational pull of the sun and the moon on the earth's oceans, causing the oceans to bulge. Because the moon is closer to the earth than the sun, its effect on tides is greater. As the moon makes its monthly orbit around the earth, and the earth makes its yearly orbit around the sun, the oceans are pulled back and forth as the bodies' positions relative to one another change, causing tides go in and out.

In the normal course of a day, the NOAA official tide stations record tidal differences between high and low tide of about three feet on the bayside and four and a half feet on the seaside (Table 3). During new and full moons, the earth, moon, and sun are nearly in full alignment, and the gravitational pull of the moon and sun are working together to cause the oceans to bulge more than usual. New and full moons cause high tides to be slightly higher and low tides to be slightly lower than average. These are known as spring tides.

Table 3: Tidal Ranges at Eastern Shore Tidal Stations

	Mean Tidal Range (feet)	Great Diurnal Change (feet)*
Seaside		
Wachapreague	3.99	4.47
Bayside		
Chesapeake Bay Bridge Tunnel	2.66	3.02
Kiptopeke	2.6	2.94
*Difference between highest and lowest tides of the day		
**Tidal gauges deployed by USGS in 2015		

Source: NOAA Tides and Currents

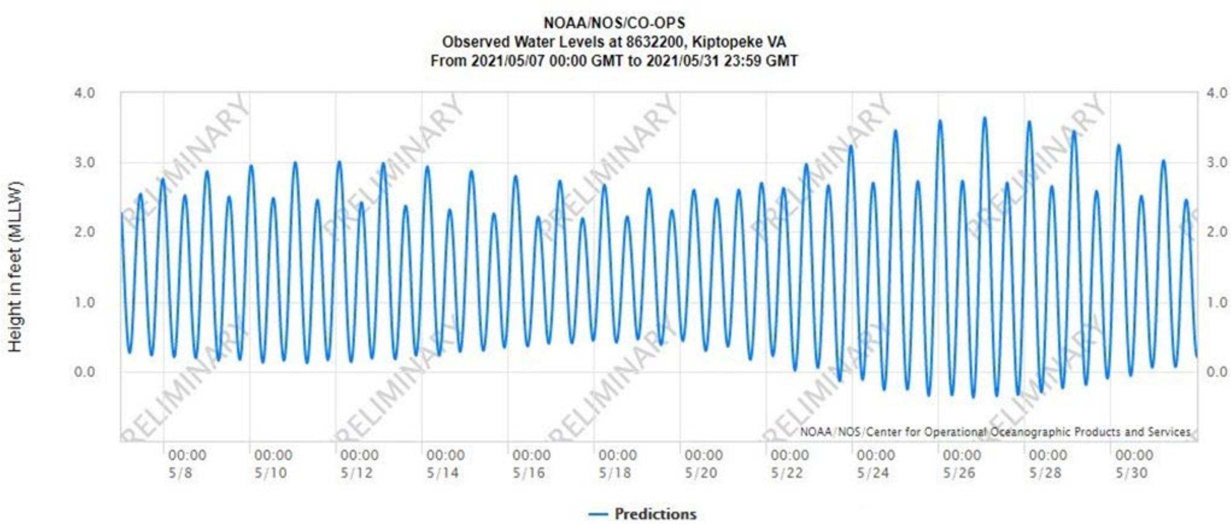

Figure 3: Perigean Spring Tide at Kiptopeke Tide Gauge. Source: NOAA Tides and Currents

Every 28 days, the moon reaches its closest point to the earth, known as a perigee, which also causes a larger tide. When perigee coincides with a spring tide, three or four times each year, it is referred to as a perigean spring tide and the effect is to expand the tidal range, as illustrated in Figure 3. Notice how the length of line representing the difference between low tide and high tide at the Kiptopeke tidal gauge is elongated approaching the perigean spring tide on February 18.

The converse of the perigee is the apogee – the point in the earth's elliptical orbit where the earth is farthest from the sun and the sun's gravitational pull on the earth is the weakest. Table 4 demonstrates some of these effects with the moon and tide phases on the landfall approach for some of the Eastern Shore's historic storms.

Table 4: Moon/Tide Phases Coinciding with Historic Eastern Shore Storms

Storm	Phase of the Moon	Perigee/Apogee
September 3, 1821 (The Great September Gust)	First Quarter (Neap Tide)	Apogee
August 23rd, 1933 (The Chesapeake-Potomac Hurricane)	Waxing Crescent – 3 Days from the New Moon (Spring Tide)	In between
October 15, 1954 (Hurricane Hazel)	Waning Gibbous – 3 Days from the Full Moon (Spring Tide)	2 Days after the Perigee
March 6th-8th, 1962 (The Ash Wednesday Storm)	New Moon (Spring Tide)	Perigee
September 15th-16th, 1999 (Hurricane Floyd)	Waxing Crescent – 6 Days from the New Moon and 2 Days to the First Quarter (Neap Tide)	Apogee
September 18th, 2003 (Hurricane Isabel)	Waning Gibbous – 8 Days from the Full Moon and 1 Day to the Third Quarter (Neap Tide)	Apogee
NOTE: The Ash Wednesday storm occurred during a perigean spring tide. Both the new moon and the perigee occurred on March 6th, 1962, the first day of the storm		

STORM SURGE

Note: information in this section is sourced from the National Hurricane Center.

The high tide generated by a storm that is above the predicted astronomical tide is known as storm surge. The surge is produced by the force of the cyclone winds pushing the water ahead, along with the lesser force of the low pressure. Figure 4 illustrates this effect.

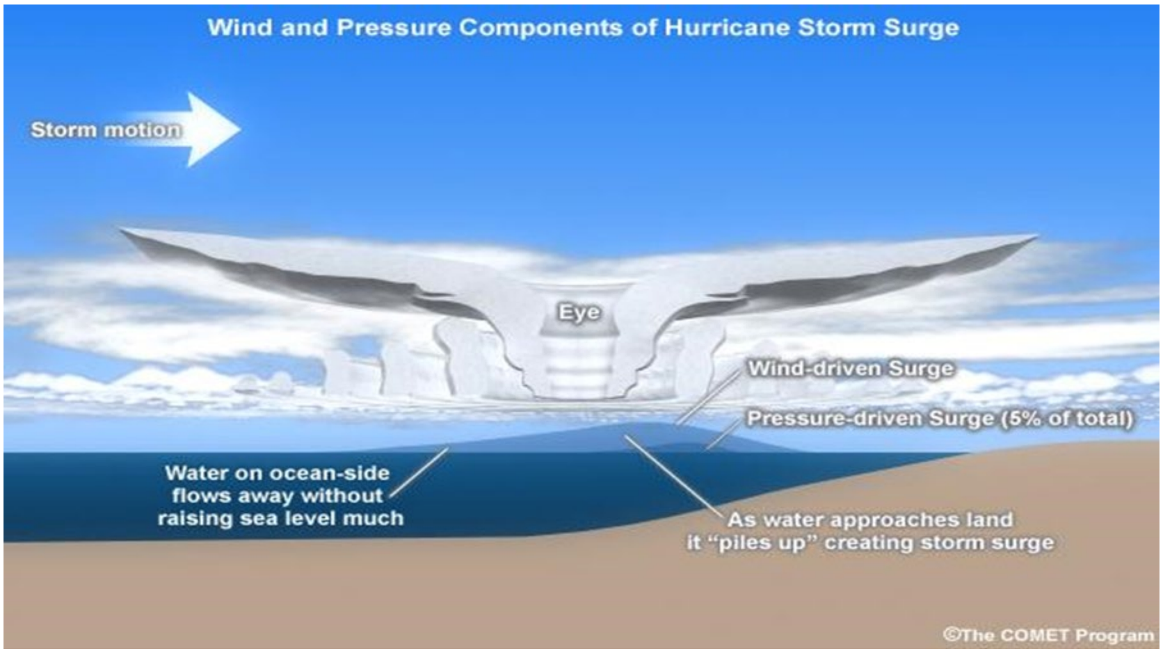

Figure 4: Wind and Pressure Components of Hurricane Storm Surge. Source: The Comet Program. ©1997-2021 University Corporation for Atmospheric Research. All Rights Reserved.

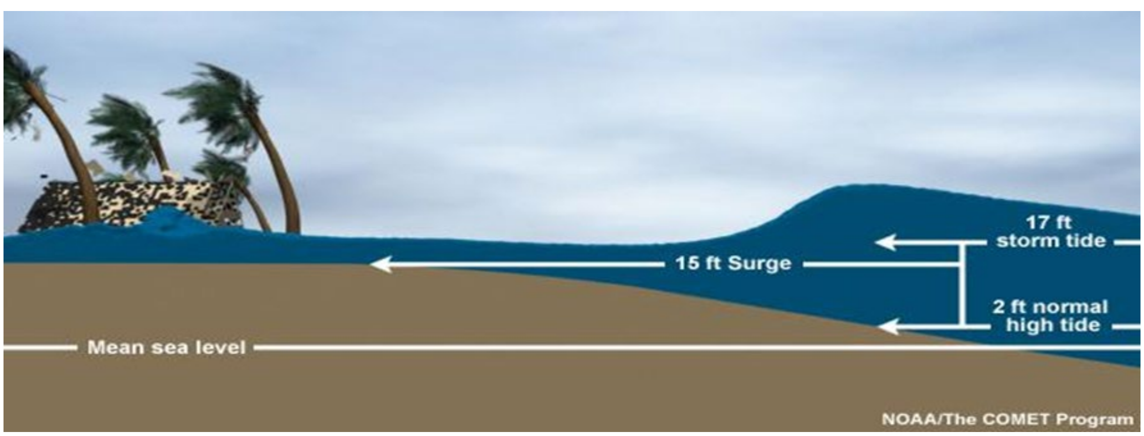

Figure 5: Storm Surge vs. Storm Tide. Source: NOAA/The COMET Program. ©1997-2015 University Corporation for Atmospheric Research. All Rights Reserved.

The bathymetry of the ocean and bay floors also greatly influence storm surge. Shallower gradients, such as those along the bayside and seaside of the Eastern Shore, allow for greater storm surge. For example, a Category 1 hurricane may cause four to five feet of surge. The shape of the Chesapeake Bay “pinches” the water and thereby makes the surge grow in height on the bayside. Storm surge is not the same as storm tide, however. Storm tide refers to the water level rise attributable to the astronomical tide plus the effects of the storm surge, as illustrated in Figure 5.

SEA LEVEL RISE AND COASTAL FLOODING

The Virginia Institute of Marine Science (VIMS) tracks sea level data and produces “report cards” highlighting sea level change at local levels. Using annual tide-gauge data, VIMS can also project sea-level height to the year 2050 (VIMS “U.S. Sea Level Report Cards. N.d.). Figure 6 below provides the sea-level report card for Norfolk, the nearest point to the Eastern Shore that VIMS tracks. This figure displays the Mean Sea Level (MSL) beginning in 1970 and projected through the year 2050. The quadratic trend line indicates the average projected rise in MSL, while “QHi95” and “QLo95” represent the 95% confidence interval. The “QHi95” indicates that MSL could be as high as 2.2 ft above current levels.

There is ample scientific evidence that sea level rise is occurring and is projected to continue quadratically into the future.

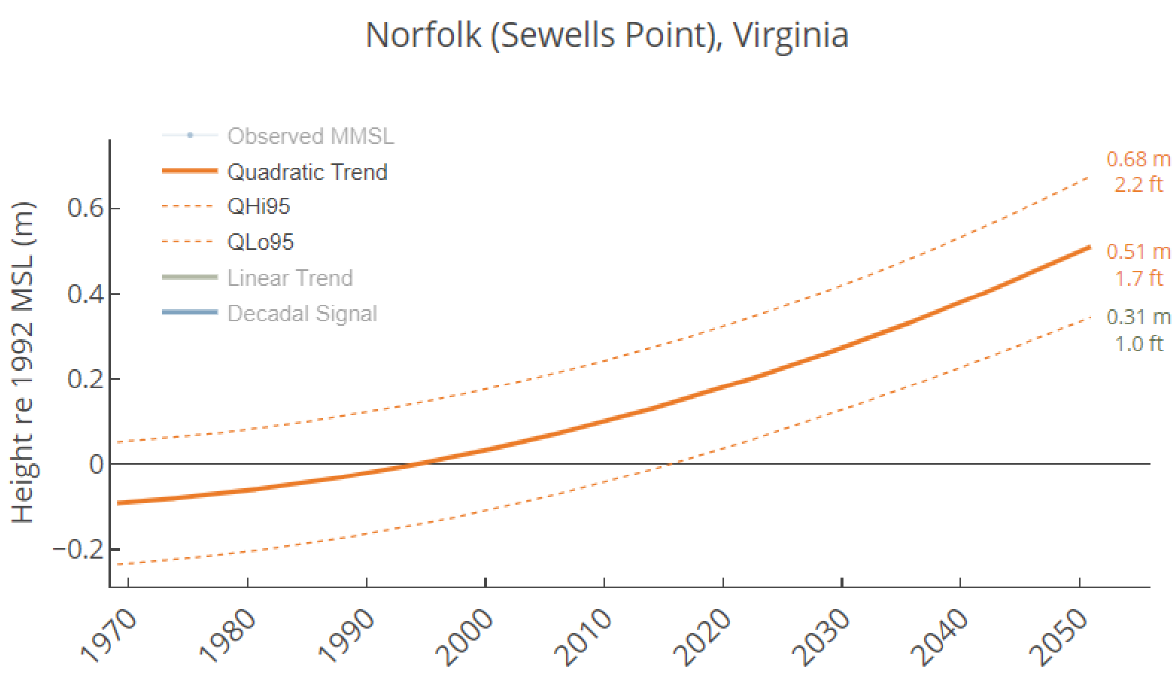

Figure 6: Sea Level Rise Scenarios. Source: VIMS Sea-Level Report Cards

RELATIVE SEA LEVEL RISE

Relative sea level is the perceived water level as it relates to the level of land. The discussion of relative sea level rise in the lower Chesapeake region begins approximately 35.5 million years ago when a bolide, or object from space, two to three miles in diameter, struck near the area that is now Cape Charles, creating an impact crater roughly twice the size of Rhode Island (Figure 7). The crater, now underlying all of Northampton County and portions of southern Accomack County, and the sediments that have buried it, have continuously settled over time, creating increased subsidence of landforms in the region (USGS Fact Sheet 049-98).

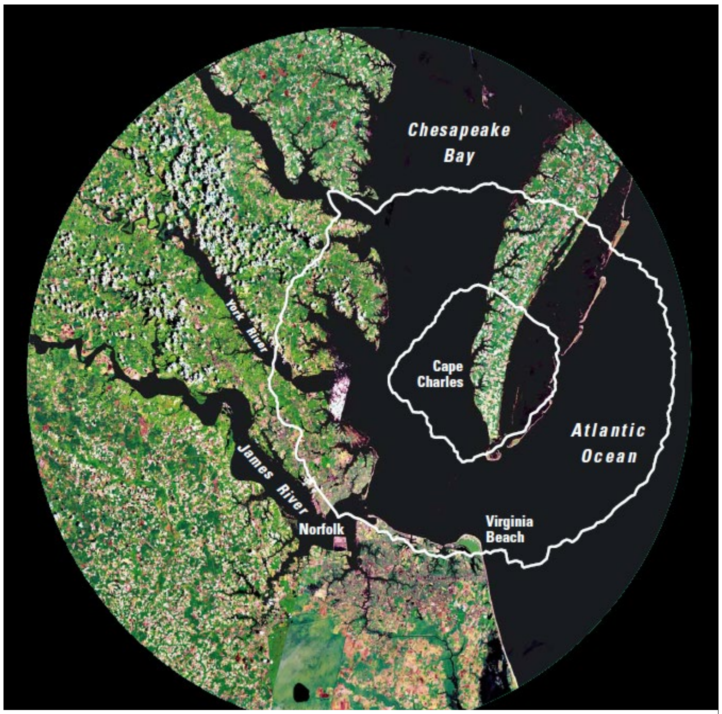

Figure 7: A Bolide Bulls-Eye. Source: USGS

A second cause of subsidence is rebound of the earth's crust from glaciers. Even though the Laurentide ice sheet did not reach the lower Delmarva Peninsula, the weight of the ice as it pressed down caused the earth's crust to bulge in adjacent areas. As the ice retreated, and the pressure it exerted was relieved, the earth's crust began to rebound, the bulging areas began gradually sinking, and in fact are still trying to achieve a state of equilibrium (USGS Circular 1392).

Two other factors that affect relative sea level rise to a lesser degree on the Eastern Shore are groundwater withdrawal and tectonic changes. Subsidence from all sources range from 1.2 millimeters of subsidence per year at Kiptopeke to 2 millimeters per year at southern Assateague (Holdahl and Morrison, 1974).

GLOBAL SEA LEVEL RISE

The increasing volume of water in the ocean is a global cause of sea level rise. As water trapped in glaciers and ice sheets melts into the earth's oceans, and water already in the ocean expands as the temperature increases, the volume of water in the ocean increases, causing sea level to rise (VIMS).

Scientists posit that another contributor to sea level rise could be changes to the Gulf Stream brought on by warmer polar regions. A smaller difference in temperature between the Atlantic coast and the polar region slows the cycle in which waters sink and move south as they are cooled, which in turn slows the rate at which they are replaced by warmer waters drawn north (VIMS). The result of the sluggish cycle is higher tides in the mid-Atlantic, as illustrated in Figure 8.

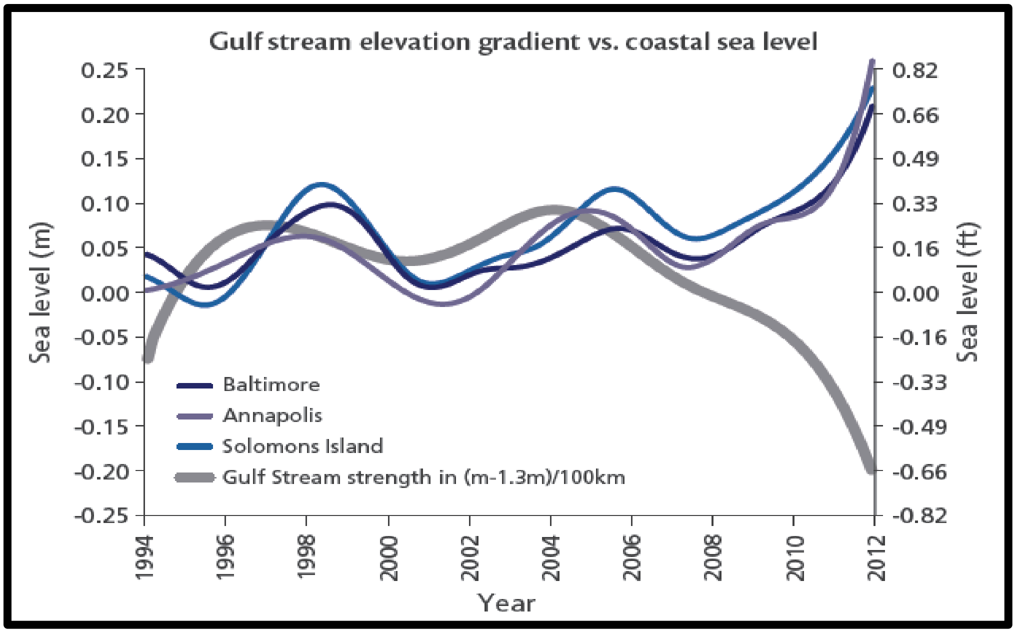

Figure 8: Sea level at elevation vs. Gulf Stream strength. Source: Ezer et al., 2013

The result of sea level rise ultimately raises the base flood elevation. The same VIMS study estimates 208 square miles of land in Accomack County is vulnerable to sea level rise over the next century, and another 186 square miles is vulnerable in Northampton County, along with increased threats from erosion and infrastructure flooding. A study conducted by the A-NPDC during 2015 examined the implications of future sea level rise upon roads within the region and the communities they serve. The study found that just one foot of inundation – a threshold that could be reached in the next 10 years – could put the majority of Tangier's roads completely under water, disrupt access to eight more communities, and limit access to two more. More about the study results can be found in local chapters, beginning with Chapter 10.

Vulnerability of Virginia's Eastern Shore to Sea Level Rise

"Several communities in Accomack are considered vulnerable to sea level rise. The natural resource-based agriculture and seafood industries of the region are being impacted as farmlands are experiencing increased inundation and salt contamination and local seafood industries are experiencing problems created by stormwater runoff and changing coastal dynamics. Accomack has three developed islands, Tangier, Saxis, and Chincoteague. In Tangier, approximately 90% of structures are in the 100-year flood plain, the entire island is below the 5-ft contour, and severe shoreline erosion threatens the island. Saxis Island also has severe erosion problems, and the northern portion of the island is very low-lying land. The evacuation route, a causeway through the marsh, is at risk from both potential compaction of the roadbed and erosion of the surrounding marshes as well as recurrent flooding and sea level rise. Chincoteague is somewhat less vulnerable to erosion, because it is located in the wave attenuated Chincoteague Bay but is vulnerable to recurrent flooding and sea level rise.

"Overall, the risk to communities in Northampton County is lower than those in Accomack County. This is due in a large part to topography; even the lowest lying town (Town of Cape Charles) is mostly above the 5-ft elevation. However, it is still vulnerable to storm surges and stormwater flooding as drainage ditches become tidal, reducing their capacity to handle stormwater. The lowest lying lands (the barrier islands) are largely undeveloped. The primary impact from sea level rise is expected to be increased shoreline erosion."

"Recurrent Flooding Study for Tidewater Virginia," Virginia Institute of Marine Science, 2013.

ELEVATION

The elevation of land in relation to water levels must also be considered as a contributing factor in flooding. Northampton and Accomack Counties are low-lying areas with the highest elevation in the town of Melfa at 60 feet above mean sea level.

In 2011, LiDAR (Light Detection and Ranging) elevation data was acquired for all of the Eastern Shore. LiDAR data is collected by flying aircraft using light pulses to measure distance to earth. The data is the most accurate comprehensive elevation data collected for the Eastern Shore of Virginia, accurate to within about six inches. In 2015, a second set of LiDAR elevation data was collected and further enhanced the region's planning capacity.

The 2013 VIMS study considered anything under 4.5 feet to be potential recurrent flood zones (Figure 9).

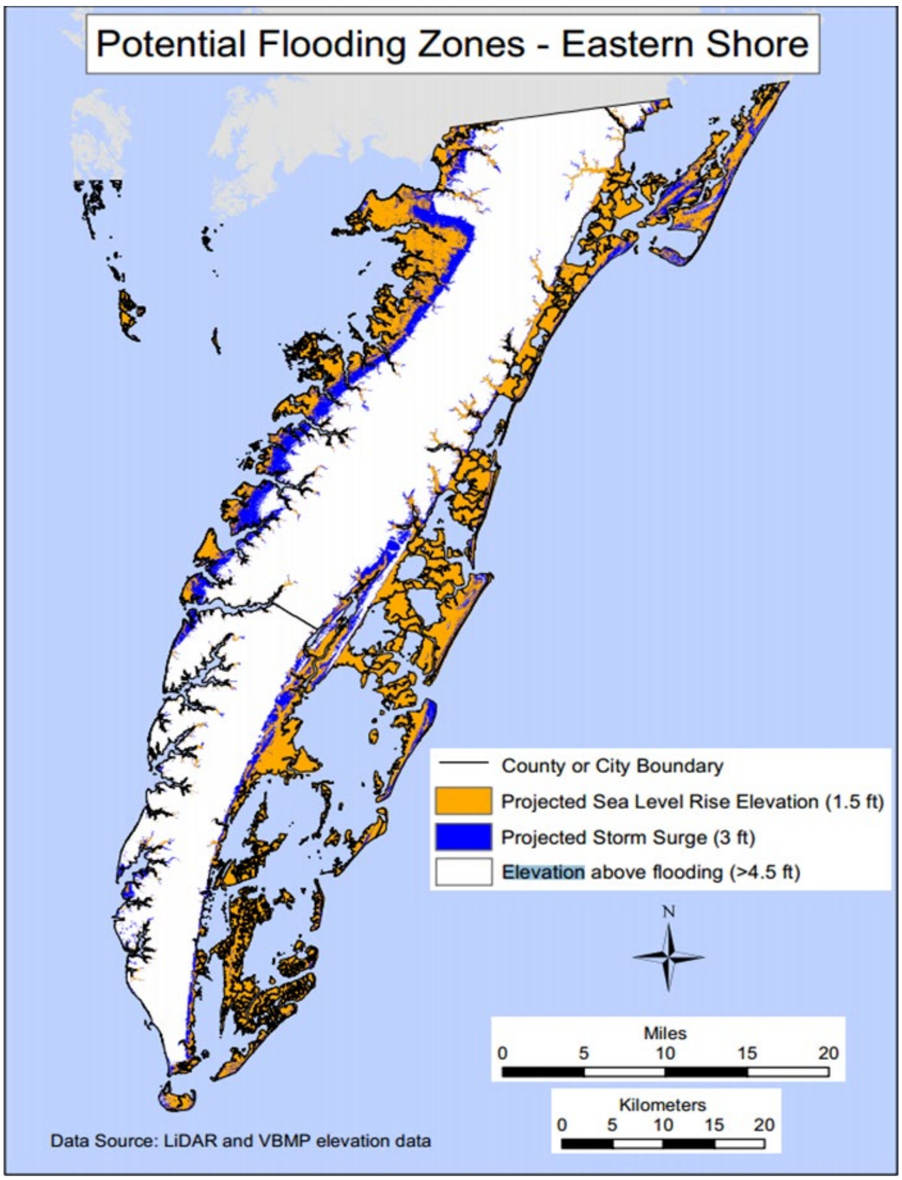

Figure 9: Potential Recurrent Flood Zones

TYPE, LOCATION, AND EXTENT

FLOOD ZONES

A flood is a general and temporary condition where two or more acres of normally dry land or two or more properties are inundated by water or mudflow. To identify a community's risk, FEMA conducts a flood insurance study, which is then used as the basis for maps that identify flood risk areas, called Special Flood Hazard Areas (SFHA). The maps are known as Flood Insurance Rate Maps or FIRMs.

It should be pointed out that FIRMs and flood zones are regulatory tools used to set construction standards and flood insurance rates and are based on a flood that has a one percent chance of occurring in any given year. Although storm surge is a factor in determining the extent of the flood zones depicted on FIRMs, a storm surge map issued for a given storm is not the same, and a FIRM should not be counted on to determine potential storm surge from a storm event.

V ZONES

V zones are the portion of the Special Flood Hazard Area (SFHA) that extends from offshore to the inland limit of a primary frontal dune along an open coast, and any other area subject to high-velocity wave action. Within these zones, damage from coastal flooding is from hydrodynamic force called velocity flow. This type of flow is known to scour around buildings and to destroy structures in its path. In addition, velocity flow picks up debris and smashes that debris into anything in its way. FEMA has identified areas where velocity flow from the 100-year flood event would occur as V zones. These flows commonly damage or destroy any wall that is struck by this moving water.

Current floodplain management ordinances require that in V zones any new structure be built with its lowest horizontal structural element to be elevated above the Base Flood Elevation. Further, no living space is to be put below the Base Flood Elevation and any enclosures must have breakaway walls.

The debris carried by velocity flow can destroy a structure that is built to flood regulations. This debris commonly includes parts of houses, decks, vehicles, propane or oil tanks, and any other objects that the floodwater picks up. During Hurricane Isabel in 2003, six-ton riprap was swept-up from beaches and came to rest in front of houses. Smaller riprap actually was swept through broken walls and came to rest inside of structures. If flood-borne debris strikes or gets caught against the foundation of a post-FIRM structure, that structure could sustain severe damage or destruction despite it being built to floodplain regulations.

Waves are another source of damage to structures in velocity flow areas. When waves break against a structure the tremendous force can damage the walls. Waves commonly destroy decks as waves advance up a vertical wall further than they would on a sloped surface.

(Source for this section: FEMA Coastal Construction Manual, 2011; local oral accounts from Hurricane Isabel)

A ZONES

A zones are areas where the one-percent-annual-chance flood would inundate, but waves would not exceed three feet. A-zone construction must have the lowest floor positioned at or above the base flood elevation, and foundation walls must be equipped with openings that allow floodwaters to enter and exit to equalize hydrostatic pressure (Figure 10).

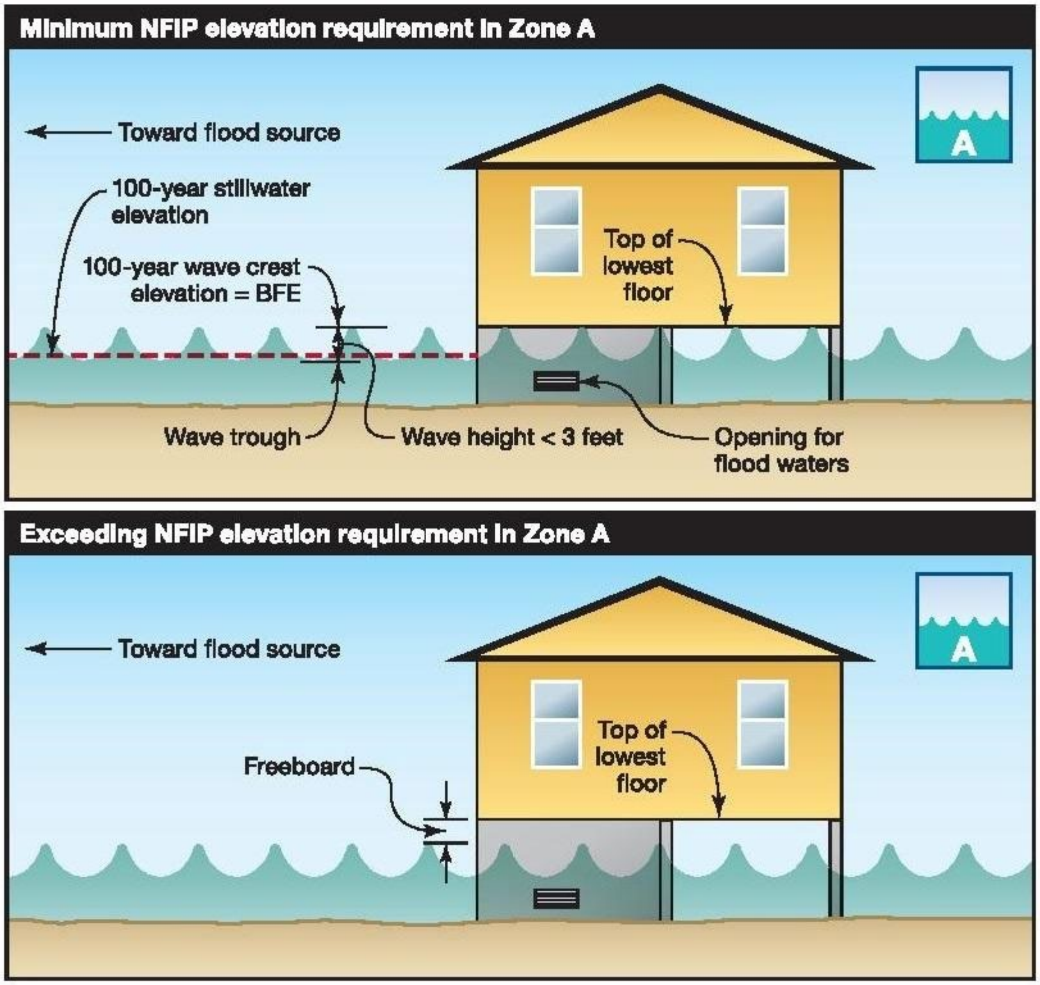

Figure 10: Recommended Elevation for Buildings in Zone A Compared to Minimum Requirements Source: FEMA Coastal Construction Manual, 2011

FEMA post-storm inspections have shown that coastal A zones are areas of increased damages. The A zone regulation does not take into account the hazards of waves, hydrodynamic flow, and erosion. Yet coastal A zones can be subject to all of these hazards during a 100-year flood event.

Some of the coastal A zones may not experience these types of hazards but will suffer from damage from standing water. Common types of direct damage include waterlogged and corroded building elements, waterlogged furniture, damaged electronic appliances and equipment, damaged tanks from buoyancy forces, and contaminated exteriors and interiors from black water. In addition, building materials may wick up floodwater to higher areas not directly inundated (FEMA Coastal Construction Manual, 2011). All new construction must address these issues and meet the Virginia Uniform Statewide Building Code.

Damages from flooding increase rapidly with water depth. The National Flood Insurance Program provides an online interactive flood damage estimation tool at floodsmart.gov. Based on estimates from this tool, just 1 inch of water in a 1,000-square-foot home built on a slab with average furnishings would cause an estimated $10,600 of damage – most of it in finished floors and carpet. At 6 inches of water, the damage estimates roughly doubles.

Former flood zone maps used still water to establish base flood elevations, not taking into account wave height associated with storm surge. FIRM maps effective in early 2015 incorporated this information, along with the line of moderate wave action (LIMWA) – a line that delineates the approximate edge of 1.5-foot wave height, which although not in a velocity zone, can still pose a significant hazard to properties constructed to A-zone standards (Accomack County Flood Insurance Study, 2015).

SECONDARY FLOOD HAZARDS

Secondary hazards associated with coastal flooding include water that contaminates wells. Floodwater commonly becomes contaminated with pollutants. When this water level is above the elevation of a well's air vent, the contaminated water can flow into the well and render it unusable until the water is treated and in agreement with state and federal health standards. Wells for public use are required to be tested regularly per state and federal health regulations, but private wells are not held to the same standards. Therefore, private well owners are responsible for tracking the water quality of their wells. In economically-disadvantaged communities, private well owners may not be able to afford the sampling needed to ensure adequate water quality.

On the Eastern Shore, several types of older wells are in use. The rarest type is the hand dug well. This well is usually 10 to 12 feet deep and would have initially been used with a bucket. There are also shallow wells, less than 100 feet deep, that have a static water level near the top of the well and a non-submersible pump that pulls water into a tank.

Deeper wells, greater than 100 feet, that were drilled prior to the 1970s, were designed in much the same way but instead of just a pump located in the top of the well there is a second pipe running down to the static water level capped by a packer with a venturi. The packers were most useful with metal pipes but in the 1970s most well pipes were replaced with PVC and the packers could not easily maintain a seal against this material. These wells also have low pumping rates and are hard to prime if power is lost (Written communication, Jon Richardson, Eastern Shore Health District, May 10, 2016).

In most cases, since the 1970s, submersible pumps have been used. The well with this setup needs an air vent. During a flood, water can enter the well through the air vent. Elevating this air vent above the Base Flood Elevation is one of the best ways to avoid contaminated floodwater entering the well. (Written communication, Jon Richardson, Accomack and Northampton Health Department, May 10, 2016). An NFIP flood policy will not cover wells damaged by floods (NFIP Standard Flood Policy).

Septic tanks and septic systems are also not covered under an NFIP flood policy. When a flood is in the area of a septic tank, the water will backflow from the drain field into the tank causing the cushion of air at the top of the tank to disappear. This means the tank can no longer handle flow from the structure and drainage will fail inside. After the floodwater recedes, a small cushion of air will redevelop, and it is during this time that sewage can escape the septic tank through the drain field. This small cushion of air will allow the tank to accept wastewater from the structure, but at the level of drainage inside the tank the water is poorer than it usually is. This poor-quality water containing sewage can escape into the drain field (Written communication, Jon Richardson, Eastern Shore Health District, May 10, 2016).

Alternative sewage systems are much more susceptible to flood waters than conventional septic tank and drain field (STE) systems because they, in most instances, rely on an above grade mound to dispose of wastewater. All of the mound, or portions, could erode away during a flood event. Alternative systems also produce a higher quality (cleaner) effluent than STE systems. In addition, they include electrical components to operate pumps and pre-treatment tanks which can malfunction if exposed to flood waters. A pump malfunction would render the system incapable of receiving wastewater from the home once that tank filled with wastewater. A failure of the pre-treatment tank operation would result in wastewater of lesser quality to be dispersed to the mound which would foul the distribution piping in the mound and could lead to premature mound failure. Pre-treatment tanks are also susceptible to flooding (Written communication, Jon Richardson, Eastern Shore Health District, May 10, 2016).

HUMAN SYSTEMS

NATIONAL FLOOD INSURANCE PROGRAM (NFIP)

While NFIP flood insurance covers some losses associated with flood events, several types of property have no available coverage under this program.

Although NFIP flood insurance has many exclusions and types of property not covered, some of the more important ones to remember are wells, septic systems, land, seawalls, bulkheads, piers, wharves, containers, decks, driveways, and walks. In addition to these, FEMA's 38 General Property Form, Standard Flood Policy lists several other types of property that will not be covered. Finally, NFIP flood insurance only covers flood damage, not coastal erosion, rain damage, wind damage, or water spray. Past disasters have shown that many policyholders, while carrying flood insurance for the structure, do not purchase flood contents insurance. In Hurricane Floyd, several homes were not structurally damaged to a great degree, yet the contents were completely destroyed (local oral accounts).

The federal government requires that all improved property in a SFHA with a federally backed mortgage be covered with flood insurance. Content coverage is not required unless it is part of the security of the mortgage. Many buyers who are confronted with this requirement will obtain flood insurance for the structure but will opt not to buy contents insurance to reduce the cost of closing on the property. After an event occurs, these policyholders learn the costly consequences of this decision.

Although the 100-year base flood is a 1% chance in each year that it will occur, over 30 years (the standard mortgage) a structure in an A or V zone will have a 26% chance of experiencing a 100-year flood. If that same house lasts 70 years, the useful life of most buildings, it has a 51% chance of experiencing a 100-year base flood. The 50-year flood event has a 45% probability of occurring within its floodplain over the course of a 30-year mortgage and a 76% chance of occurring in 70 years. It is important to understand that a smaller flood such as the 50-year event could damage a structure, especially those built below the Base Flood Elevation. The 50-year still water elevation for V zones ranges from 7.5 – 8.5' on the seaside and 3.8 – 7.4' on the bayside. In addition, the 50-year still water depth in Chincoteague Bay ranges from 4.8 – 6.0'.

Over time, buildings become more susceptible to hazards, so it is important to maintain coastal structures. The predominant hazards in coastal areas are corrosion from salty air and wind driven salt spray, termites, moisture, and sun-caused weathering. Regular maintenance lowers the risk of flood damage during a storm event. The 2011 FEMA Coastal Construction Manual recommends an annual inspection of foundation, exterior walls, porches, walls, floors, windows and doors, roof, and attic using a checklist provided in the manual.

COMMUNITY RATING SYSTEM

Localities volunteering to participate in the NFIP Community Rating System (CRS) have chosen to recognize and encourage floodplain management activities that exceed the minimum NFIP requirements. The CRS is a voluntary incentive program that rewards residents with reduced flood insurance premium rates as a result of the participating community's actions pertaining to the three goals of the CRS: reducing flood losses, facilitating accurate insurance rating, and promoting the awareness of flood insurance. Flood insurance premium rates are discounted in increments of 5% for the ten different class ratings.

Accomack County, plus the towns of Cape Charles, Chincoteague, and Wachapreague participate in the Community Ratings System. Information about savings through their participation in the program can be found in Table 5.

Communities participating in CRS are rated A, B, or C based on the number of repetitive losses. Each category carries specific steps that must be taken, with C requiring a plan or repetitive loss analysis. Accomack County is the only community currently participating in CRS that must take this step. As a Category A, Cape Charles is required only to submit information as needed to update the repetitive loss list. Chincoteague and Wachapreague are both Category B communities, and must take steps to identify the repetitive loss areas and properties, but not in the level of detail required for Category C communities. Several other localities in the region have expressed interest in joining the program but have not done so to date due to staff limitations.

Table 5: Regional Participation in the Community Rating System

CRS Jurisdiction	CRS Class	Number of Policies	Total NFIP Premium	CRS Discount SFHA	CRS Discount Non-SFHA
Accomack County	6	1,230	$872,839	20%	10%
Town of Cape Charles	8	170	$92,992	10%	5%
Town of Chincoteague	8	1,710	$1,299,222	10%	5%
Town of Wachapreague	8	72	$56,723	10%	5%

Source: FEMA Community Status Book Report, 2021

REPETITIVE LOSS PROPERTIES

An insured property with two or more NFIP losses (occurring more than 10 days apart) of at least $1,000 each during any 10-year period since 1978 is known as a repetitive loss property. A 2004 report of the U.S. Government Accountability Office found 38 percent of NFIP claim costs were the result of repetitive loss properties. Between the two counties, 103 repetitive loss properties have seen 304 losses with payments from the NFIP totaling nearly $5.5 million for both structures and contents (FEMA NFIP Data Report, 2022). More information on RL/SRL properties can be found in Chapter 9: The Region.