CHAPTER 7: STORMWATER

INTRODUCTION

While the section does look at changes to portions of the Eastern Shore landscape over time, risk assessment is not found in in this chapter, but can be found in Chapter 3: Risk Assessment.

On September 3, 2003, a massive thunderstorm produced heavy rains, dropping 6 to 8 inches of rain in a very short period across northern Accomack County (NOAA Climate Data Center Severe Weather Events Database). In Bloxom, floodwaters reached a depth of at least 2 feet; in some areas the flooding was greater. Railroad tracks blocked drainage in some directions in town, contributing to extensive stormwater flooding that impacted several homes. An afternoon rainstorm that had saturated the soils earlier in the day, a common contributor to stormwater flooding on the Shore. The drainage ditches were inundated from high tides that accompanied the storm, and deferred maintenance leading up to the storm event meant the ditches could not accommodate the large amounts of water the storm produced.

Compounding the problem in Bloxom was that many acres of tomato fields in the area were covered in plastic, greatly increasing the amount of impervious surfaces and increasing stormwater runoff. This practice is still in use across the Shore, exacerbating runoff where it is employed.

Although there were no estimates of the probability of this storm event, the entire 12-hour period including the initial storms in the afternoon would put this at the 100-year storm event level, which on the Eastern Shore is 7 to 8 inches in 12 hours. Residents who remember the Bloxom storm recall that the larger storm's rainfall occurred over approximately 2 hours, making this storm above the 100-year storm event. The 2-hour 100-year storm on the Eastern Shore is between 4.5 and 5 inches of rain. Recurrence intervals of rainfall intensity are presented in Table 1 below.

Table 1: Recurrence Intervals of 24 hour Rainfall Totals

Recurrence Interval	Rainfall (inches)
1-year 24 hour	3.0 - 3.5*
2-year 24 hour	3.5 - 4.0
5-year 24 hour	4.5 - 5.0**
10-year 24 hour	5.0 - 6.0
25-year 24 hour	6.0 - 7.0
50-year 24 hour	7.0 - 8.0
100-year 24 hour	8.0 - 9.0

* All of the Eastern Shore has this recurrence interval except for the immediate environs around the Town of Saxis. Recurrence Interval: 2.5 – 3.0 ** All of the Eastern Shore has this recurrence interval except for the Southeast corner of Northampton County. Recurrence Interval: 5.0 – 5.5

Source: The National Weather Service established that the worst case scenario for the Eastern Shore would be 28 to 30 inches of rainfall during a 6-hour precipitation event for a 10 square mile area.

NATURAL FORCES AND CONDITIONS

STORMWATER AND UNDERLYING GEOLOGY

Surface features characteristic of the Coastal Plain of the Eastern Shore include terraces, stream channels, drowned valleys, Carolina bays, swamps and marshes, remnant dunes, and bar-like features formed during the Pleistocene time. The central portion of the Eastern Shore peninsula forms a broad, low ridge which trends northeast-southwest and stands at an elevation ranging from about +25 to +50 feet mean sea level. This central highland area is the principal fresh ground water recharge area for the peninsula and is referred to as the "recharge spine" of the Eastern Shore. The terrace has maintained the same strand line for almost the entire length of the Atlantic Coastal Plain and is divided into a lower and upper terrace which directs the drainage of the Eastern Shore.

The lower terrace, generally located west of Route 13, consists of broad flats broken by large meandering tidal creeks and bordered by tidal marshes. The topography of the upper terrace, typically thought of as more complex than the lower terrace, is characterized by shallow sand-rimmed depressions known as Carolina bays. Prior to the advent of LiDAR (Light Detection and Ranging, remote sensing method), there were fewer than 100 Carolina bays inventoried for the Eastern Shore. Now there have been 700 identified, not only along the spine, but also at lower elevations (Davias, 2016). These bays, predominantly oval in shape, exert an influence on the infiltration, retardation of runoff, and movement of surface and ground water, often due to the associated Nimmo series soil types. Between the mainland and the barrier islands are extensive tidal marshes flooded regularly by saltwater and drained by an extensive system of creeks (Hulme, 1955). These systems accept ground and surface water discharge.

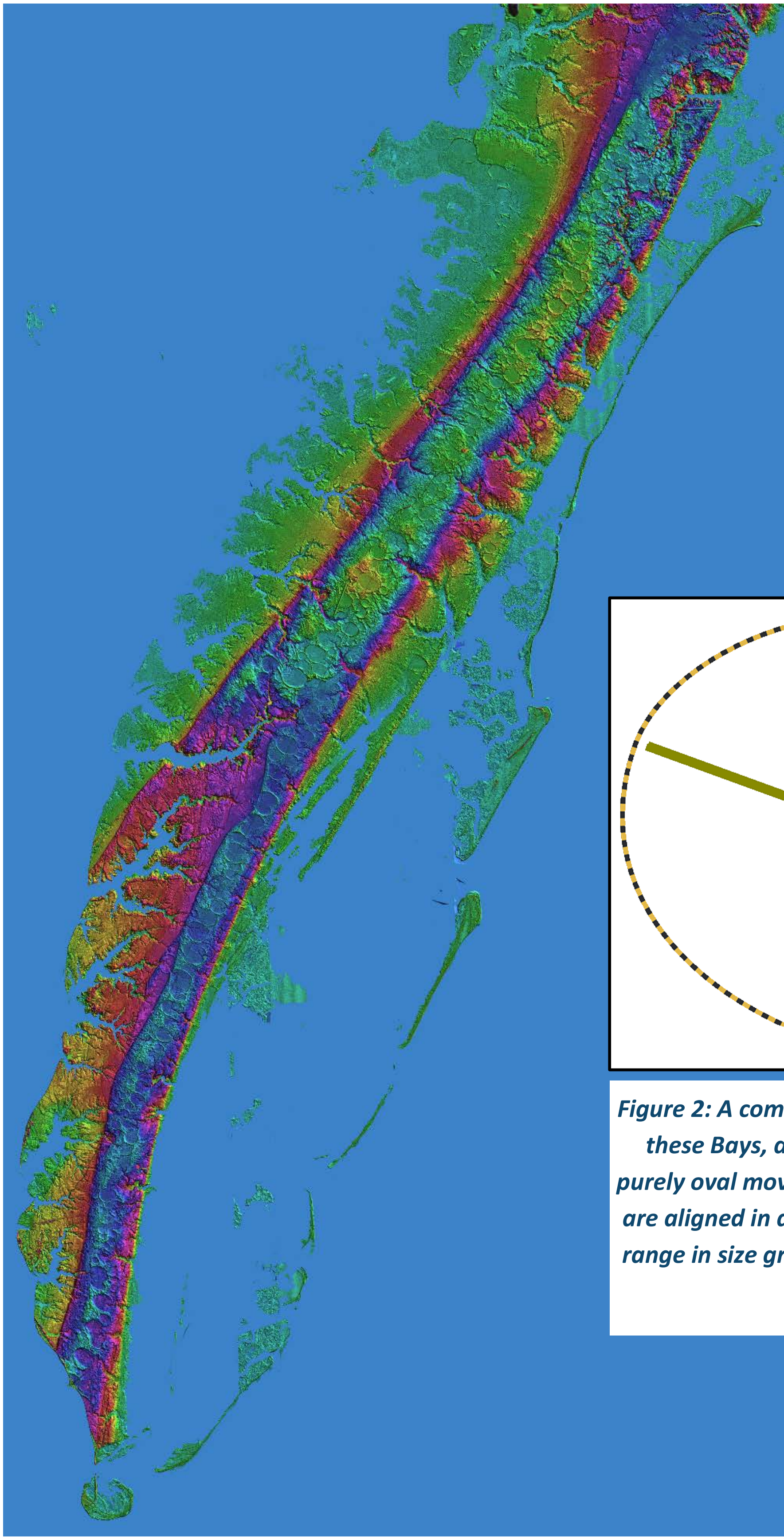


Figure 1: Created with LiDAR data, this "bayShore" overlay reveals the hundreds of ellipsoidal Carolina Bays. Prior to the advent of LiDAR, using aerial imagery only about 100 bays were identified, but now there are 700. Source: Michael Davias http://cintos.org/

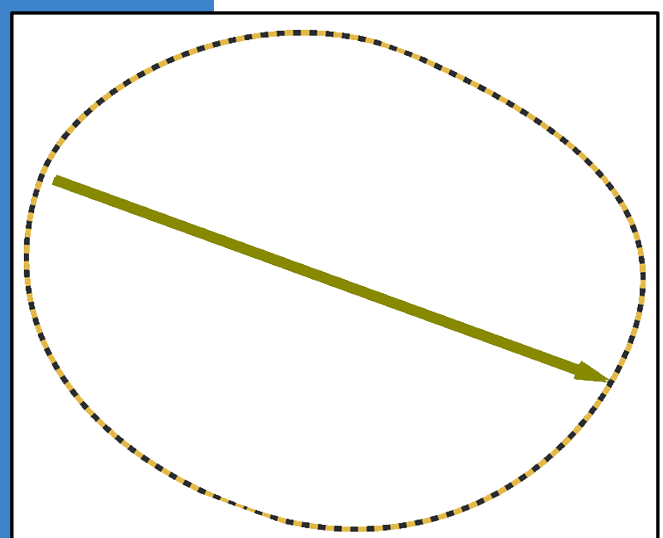


Figure 2: A common representation for the shape of these Bays, although the shape becomes more purely oval moving north from North Carolina. They are aligned in a northwest-southeast direction and range in size greatly, from one to several thousand acres.

Numerous drainage basins exist on the Shore ranging in size from approximately four to six square miles. These basins consist of several small creeks and interconnected ditches. Primary drainage basins of the Eastern Shore of Virginia are Gargathy Creek, Folly Creek, Finney Creek, Occohannock Creek, and Pungoteague Creek basins in Accomack County; and Mattawoman Creek and Nassawadox Creek basins in Northampton County. The Pocomoke River basin borders Worcester County, Maryland and Accomack County, Virginia and serves as a major drainage divide for this area.

STORMWATER AND SOIL COMPOSITION

The Eastern Shore exists entirely within the Atlantic Coastal Plain Physiographic Province, which consists of unconsolidated sediments deposited by marine and fluvial processes. The three most abundant soil types on the mainland of Accomack and Northampton Counties are the Bojac, Munden, and Nimmo series (Table 2, Figures 3 and 4). These soil types have distinct characteristics that affect the way that they either contribute towards or help alleviate stormwater impacts (ESVA Land Use & Ground Water Resources Report, 2010).

Table 2: Predominant Soil Types, Eastern Shore of Virginia

Soil Series	Description	Drainage	Suitability for Septic	Water Table
Bojac	Primarily loamy sands found on undulating surfaces and rims of Carolina bays	Moderately to excessively well drained	Considered most suited for septic drainage	Water table more than 4’ below surface
Munden	Sandy loam found in nearly level surfaces of coastal plain uplands and stream terraces	Not well drained	Not as well suited for septic drainage	Water table 18”-30” below surface
Nimmo	Sandy loam found in flats, depressions, and drainageways of coastal plain uplands and stream terraces	Poorly drained	Not suited for septic drainage	Water table 0-12” below surface

Source: USDA Natural Resource Conservation Service Soil Survey, 1994

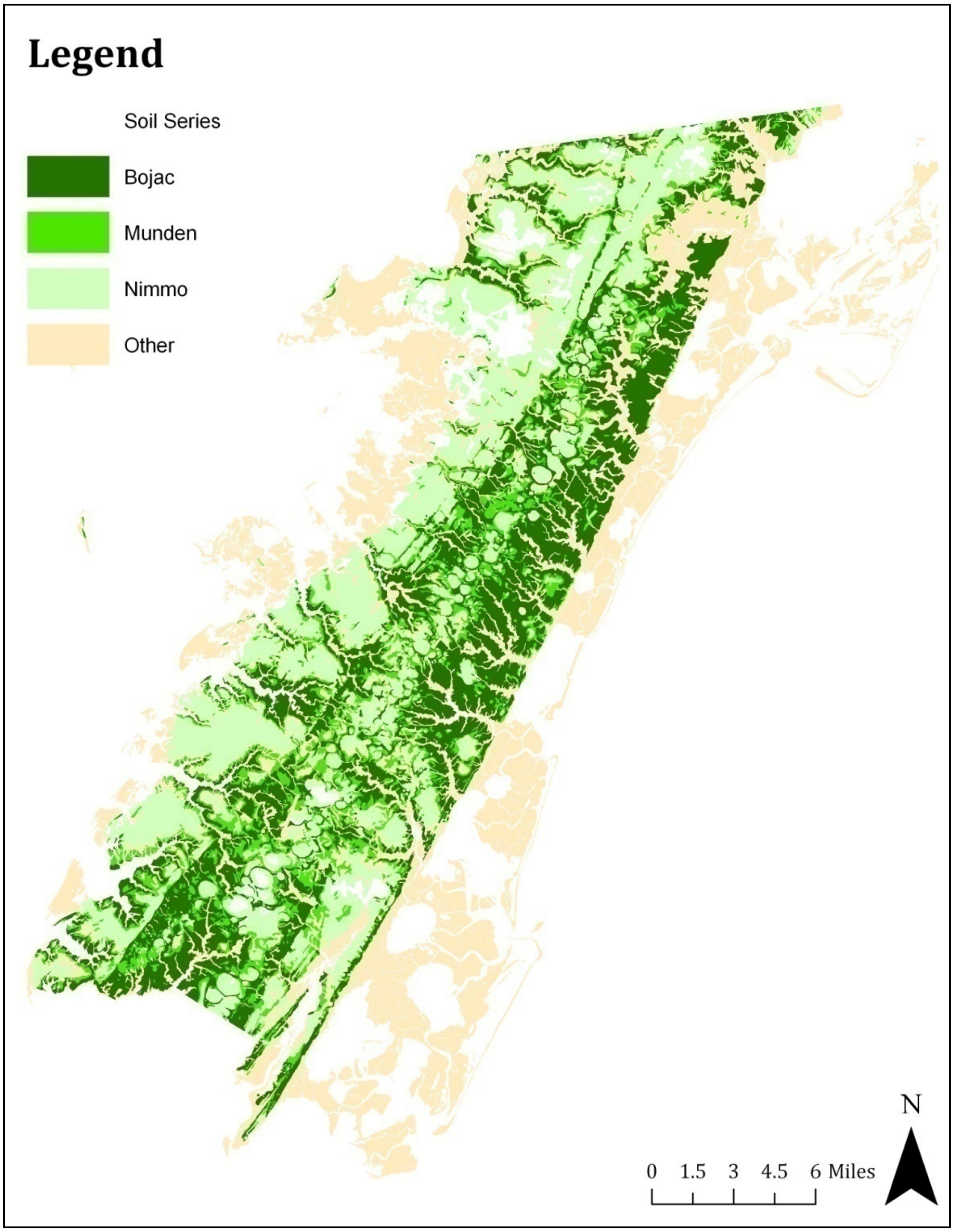


Figure 3: Accomack County Soils Map showing the distribution of the three predominant soil types in the county

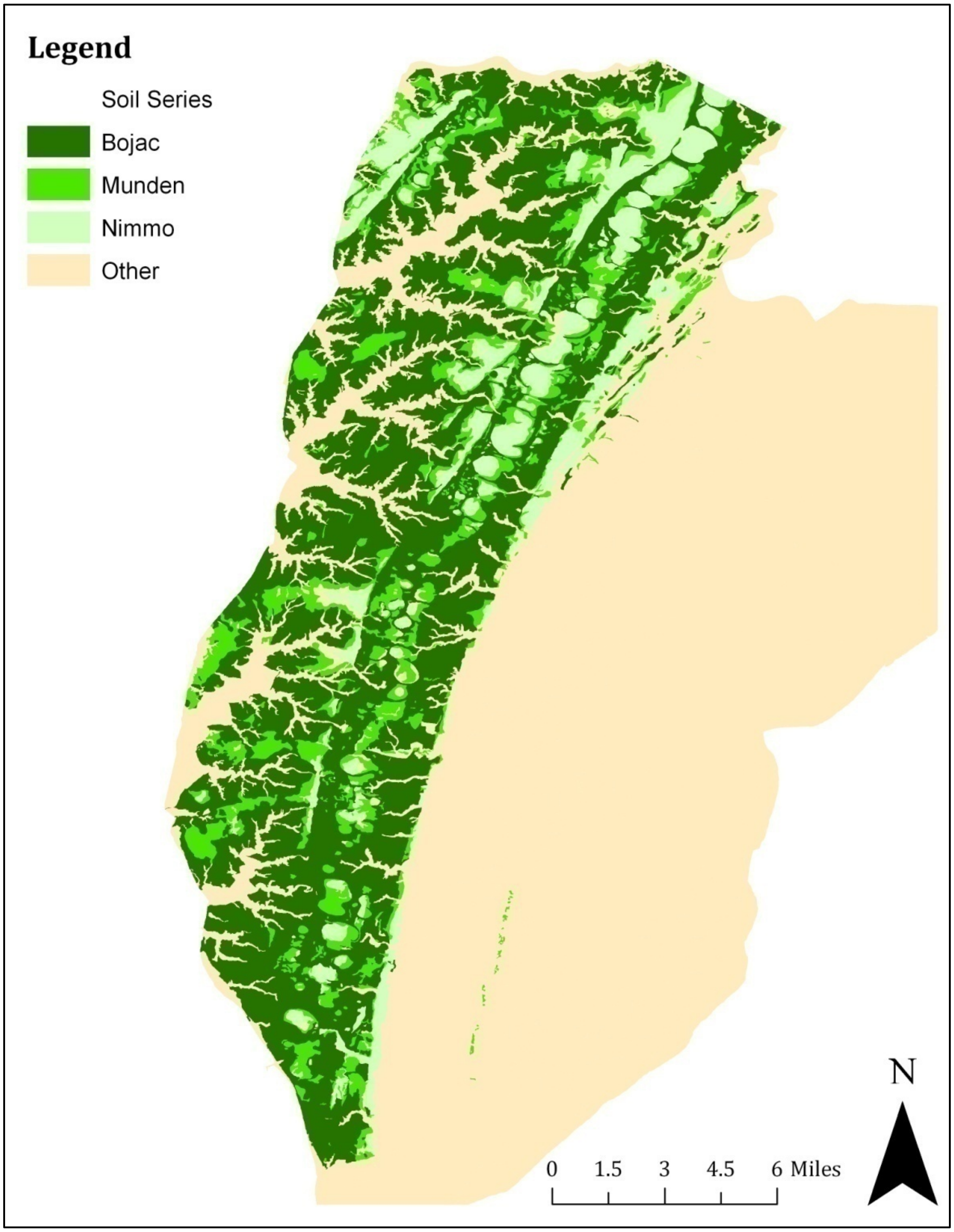


Figure 4: Northampton County Soils Map showing the distribution of the three predominant soil types in the county

CAUSES OF STORMWATER

Stormwater flooding is unlike coastal flooding in that it is caused by intense downbursts of rain or from rainwater accumulation in low-lying or poorly drained areas, or where debris blocks drainage paths. Once rainwater falls on the land surface, it drains into the soil and enters the ground water system, re-enters the atmosphere through evaporation, is taken up by vegetation via transpiration, or enters streams or creeks as surface runoff and eventually enters the tidal waters draining towards the Atlantic Ocean or Chesapeake Bay.

The greatest amount of flow in the creeks and streams lags after the peak rainfall. This is due to the various factors that cause the rain to slow down as it flows over the land including land cover, slope, extent of soil saturation, and capability of drainage in ditches and culverts.

STORM POTENTIAL

Extratropical storms including hurricanes and nor'easters represent the greatest threat of catastrophic stormwater flooding that can occur on the Eastern Shore. The 2009 storm known as Nor'Ida is one such example. When tropical storm Ida traveled northeast from Alabama, eventually moving into offshore Atlantic Ocean, it re-grouped into a major nor'easter, producing moderate to severe coastal flooding. Peak tide at Kiptopeke was 7.04 feet above MLLW, which was a higher reading than during Hurricane Isabel, which was a storm of record for much of the larger Chesapeake Bay region. Chincoteague recorded 13" of rain, and rainfall across the rest of the Eastern Shore averaged 4"-8". The National Weather Service recorded stormwater flooding in both counties on roadways and in poorly drained areas.

Figure 5: Common scene of flooded roadways following intense rainfall on the Eastern Shore. Photo by Jay Diem, Eastern Shore News.

The chapter of this report on Coastal Flooding details tropical storms and nor'easters, most of which were also stormwater events for the region. Downbursts of rain from thunderstorms also have the potential to create stormwater flooding. The worst downburst in Virginia's history was in Guinea across the Bay from Northampton County. On August 24, 1906, 9.25 inches fell in 40 minutes.

Table 3 below lists storm events that have caused stormwater flooding on the Eastern Shore, not including tropical cyclones and nor'easters, which were covered in Chapter 1.

Table 3: Storms that have generated intense rainfall on the Eastern Shore, 1996 - 2015

County	Date	Event Category	Property Damage (in 2015 $$)	Crop Damage (in 2015 $$)	Description	Source
ACCOMACK CO.	8/4/2000	STORM WATER FLOODING	$0	$0	Heavy rain caused flooding on Route 13 near Mappsville and Nelsonia	NOAA, National Climatic Data Center
NORTHAMPTON CO.	7/30/2003	STORM WATER FLOODING	$0	$0	Extensive flooding to secondary roads, as well as Route 13	NOAA, National Climatic Data Center
ACCOMACK CO.	9/3/2003	STORM WATER FLOODING	$0	$0	Several inches of water on Route 13 in the areas of Nelsonia and Mappsville. Many roads reported cloased under 6-8" of water.	NOAA, National Climatic Data Center
ACCOMACK CO.	7/28/2004	STORM WATER FLOODING	$0	$0	Thunderstorms produced 1' of water across Route 175 in town of Chincoteague; 6" of water to 1.5' of water across northbound and southbound lanes of Route 13. Southbound lanes of Route 13 were closed for a time. Standing water of 1.5'alongside northbound Route 13 was threatening houses along the road.	NOAA, National Climatic Data Center
NORTHAMPTON CO.	10/24/2007	STORM WATER FLOODING	$0	$0	Low pressure over the SE U.S. and a near-stationary front across the Mid-Atlantic Region helped to produce heavy rain across portions of Central and Eastern Virginia. The storm system brought an average of two to four inches of rainfall across the county	NOAA, National Climatic Data Center
ACCOMACK CO.	12/10/2008	STORM WATER FLOODING	$0	$0	2" -5" of rain fell across the county. Rainfall amount of 4.98 inches was measured at Wallops.	NOAA, National Climatic Data Center
ACCOMACK CO.	7/27/2009	STORM WATER FLOODING	$0	$0	Scattered thunderstorms in advance of a cold front produced heavy rain: 4.5" reported. Atlantic road was flooded near Wallops Island; Chincoteague and Fisher Rds. also reported flooded.	NOAA, National Climatic Data Center
ACCOMACK CO.	3/13/2010	STORM WATER FLOODING	$0	$0	Water was ponding on roads in Accomack county due to heavy rains. A portion of Route 13 north of Accomac was partially covered by water. Rainfall amount in the area was estimated to be 1.20 inches.	NOAA, National Climatic Data Center
ACCOMACK CO./ NORTHAMPTON CO.	3/28/2010	STORM WATER FLOODING	$0	$0	Showers and thunderstorms associated with low pressure and a cold front produced one to three inches of rain across portions of central and eastern Virginia from Sunday night, March 28th, through Monday afternoon March 29th. Eastville reported 3.28" rainfall	NOAA, National Climatic Data Center
ACCOMACK CO.	6/19/2011	STORM WATER FLOODING	$0	$0	Isolated thunderstorms associated with low pressure produced heavy rains which caused flash flooding across portions of the Virginia Eastern shore. High water was covering Routes 316 (Greenbush Rd) and 182.	NOAA, National Climatic Data Center

Source: NOAA, National Climatic Data Center, Storm Events Database: http://www.ncdc.noaa.gov/stormevents/

Table 4 (Cont.): Storms that have generated intense rainfall on the Eastern Shore, 1996 – 2015

County	Date	Event Category	Property Damage (in 2015 $$)	Crop Damage (in 2015 $$)	Description	Source
ACCOMACK CO.	7/14/2012	**STORM WATER FLOODING**	$0	$0	Isolated thunderstorm along a frontal boundary caused heavy rain which produced flash flooding across portions of the Virginia Eastern Shore. Bobtown Road was flooded. Pungoteague Elementary School was flooded. Portion of Hollies Church Road was washed out. 6.68" rain reported at Accomack Co. Airport	NOAA, National Climatic Data Center
ACCOMACK CO.	8/25/2012	**STORM WATER FLOODING**	$10,323	$0	Scattered thunderstorms associated with low pressure along the Mid Atlantic Coast produced heavy rain which caused flash flooding. Many roads were closed due to flooding. Cars were disabled and filing with water in the Keller-Painter area. Trailer home was damaged by straight line winds (57 MPH). One	NOAA, National Climatic Data Center
ACCOMACK CO.	6/7/2013	**STORM WATER FLOODING**	$0	$0	The combination of the remnants from Tropical Storm Andrea and a frontal boundary draped over the region caused heavy rain which produced flash flooding across portions of central and eastern Virginia. Heavy rainfall resulted in flash flooding over the southeast portions of the county. Several roads were impassable due to high water.	NOAA, National Climatic Data Center
NORTHAMPTON CO.	9/8/2013	**WATER FLOODING**	$0	$0	Showers associated with low pressure produced 3-7" rain	NOAA, National Climatic Data Center
NORTHAMPTON CO.	8/12/2014	**STORM WATER FLOODING**	$0	$0	Slow moving storms produced 3-5" of rain around Cape Charles. Flooding reported on many streets; some cars were flooded by 2-3 feet of water.	NOAA, National Climatic Data Center
ACCOMACK CO./ NORTHAMPTON CO.	11/9/2015	**STORM WATER FLOODING**	$0	$0	Low pressure moving up along the East Coast produced rainfall amounts between 1.5 inches and 3.5 inches across the area. New Church reported 2.93"; Onancock reported 2.50".	NOAA, National Climatic Data Center

Source: NOAA, National Climatic Data Center, Storm Events Database: http://www.ncdc.noaa.gov/stormevents/

SEA-LEVEL RISE AND STORMWATER

Since 1933, the relative sea-level rise measured at Sewell's Point has risen by 14.5 inches, and the rate of rise is shown to be steadily increasing. Because of the Chesapeake Bay impact crater, the Eastern Shore is also subsiding. The combination of the sinking and the sea-level rise is considered the relative sea-level rise and is an even greater threat.

With issues associated with climate change, recurrent flooding, and or increased storm frequency, the frequency of heavy precipitation events (or proportion of total rainfall from heavy storms) is expected to increase in the Eastern United States. Although the average total annual precipitation isn't predicted to change significantly in our region, the timing and intensity of storm events is expected to change (ICPP, 2007), with increased precipitation extremes leading to increases in stormwater flooding.

Changes to vegetation can also occur, and depending on the ecosystems' ability to migrate and their ability to retain flood waters, the impacts on stormwater flooding will vary greatly. Overall, it is predicted that there will be a decrease in dry land (developed and undeveloped), irregularly flooded salt marsh, and other nontidal wetlands, but an increase in the expanse of regularly flooded and transitional salt marshes. Figure 5 reveals these changes, as shown by the Future Habitat application of the Coastal Resilience mapping tool. Vegetation serves as a stabilizing force for shorelines and a water retention resource on the shoreline and inland, and thus a loss of vegetation increases inland areas' susceptibility to flooding.

Figure 6: One of the ecosystem services of fresh water wetlands is flood mitigation. Shifting habitats can alter the ability of an area to help absorb flood waters. Photo By: Shannon Alexander

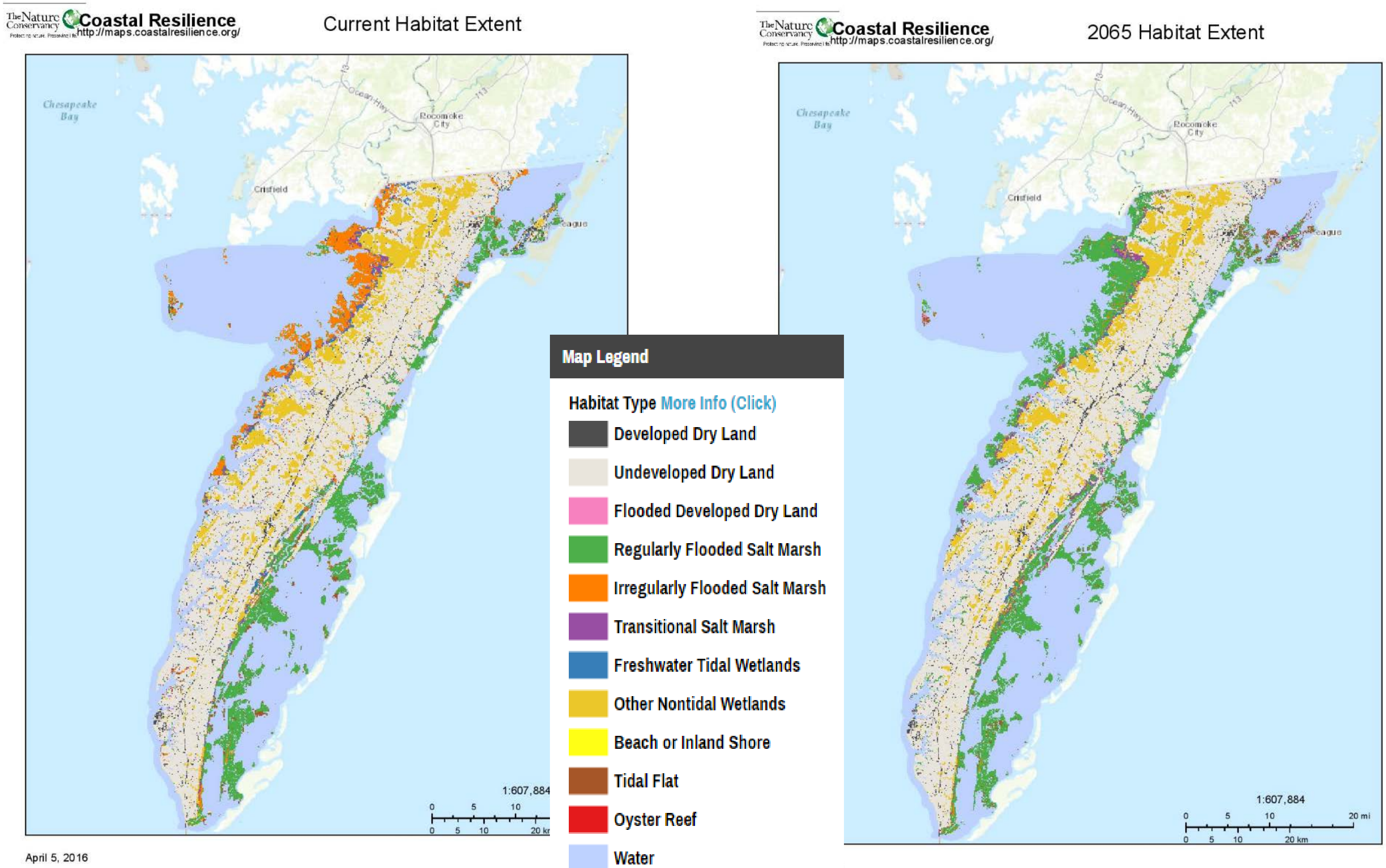
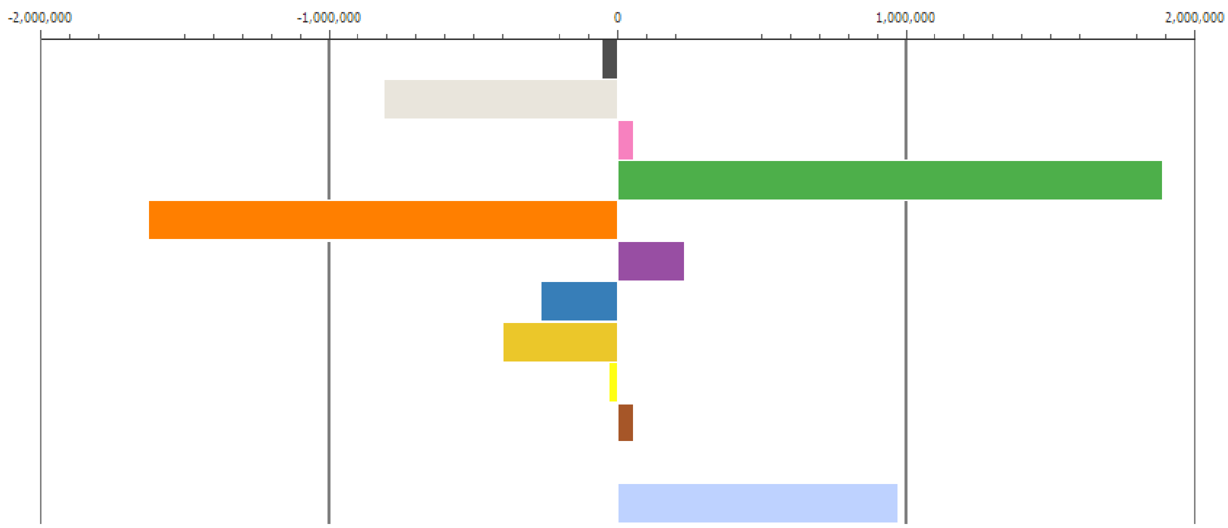


Figure 7: Coastal Resilience Tool Habitat Mapping Application. Source: http://maps.coastalresilience.org/virginia/

Habitat Change from Current Condition (Acres)



Code	Name	Total (Acres)	Change (Acres)	Change (%)
1	Developed Dry Land	782,370	-57,509	-6
2	Undeveloped Dry Land	15,189,164	-811,377	-5
3	Flooded Developed Dry Land	57,508	57,508	NaN
4	Regularly Flooded Salt Marsh	5,795,452	1,889,253	48
5	Irregularly Flooded Salt Marsh	235,928	-1,629,778	-87
6	Transitional Salt Marsh	619,368	232,417	60
7	Freshwater Tidal Wetlands	184,504	-266,523	-59
8	Other Nontidal Wetlands	3,636,670	-400,878	-9
9	Beach or Inland Shore	29,391	-33,096	-52
10	Tidal Flat	497,880	55,801	12
11	Oyster Reef	649	-8,538	-92
12	Water	20,804,538	972,720	4
	Totals	47,833,422	6,415,398	13

Figure 8: Histogram and table showing the change in acreage data associated with Figure 7. Source: http://maps.coastalresilience.org/virginia/

TYPE, LOCATION, AND EXTENT

DAMAGES

Flash flooding from stormwater can be quite hazardous to humans. Since conditions develop rapidly, people can become trapped before even realizing they are in danger. During the Great Bloxom Flood of 2003, two people had to be rescued. There were several inches of water even on Routh 13 in the areas of Nelsonia and Mappsville, several parts impassable. Many secondary roads were closed as they were under 6 to 8 or more inches of water. Floodwater commonly blocks roads in the area. This is quite a dangerous problem since motorists commonly believe that they can ford these areas without knowing whether the water has damaged the road below.

Figure 9: Stormwater flooding in Bloxom, VA in 2003. Photo Credit: Franklin Kreisl

Buildings are in danger from hydrostatic loads, which occur when flood waters come into contact with a building, its foundation, or a building element. The hydrostatic load can be lateral or vertical. In order for lateral forces to cause displacement of a building or element, there must be a substantial difference in water elevation on opposite sides of the wall. The purpose of flood vents is to allow water to flow freely through a crawl space area to equalize hydrostatic pressure on either side of the foundation wall (Coastal Construction Manual, 2011).

Inadequately elevated buildings on shallow foundations are those most in danger from vertical hydrostatic forces (buoyancy or flotation). Such buildings are vulnerable to uplift from flood and wind forces because the weight of a foundation or building element is much less when submerged than when not submerged. (Coastal Construction Manual, 2011).

Stormwater floods that move faster than 10 feet per second are generating hydrodynamic loads in addition to the hydrostatic loads (Figure 10). Hydrodynamic loads are a function of flow velocity and structural geometry, including frontal impact on the upstream face, drag along the sides, and suction on the downstream side. These loads can destroy walls, push structures off of foundations, and carry sediment and debris (*FEMA Coastal Construction Manual*, 2011).

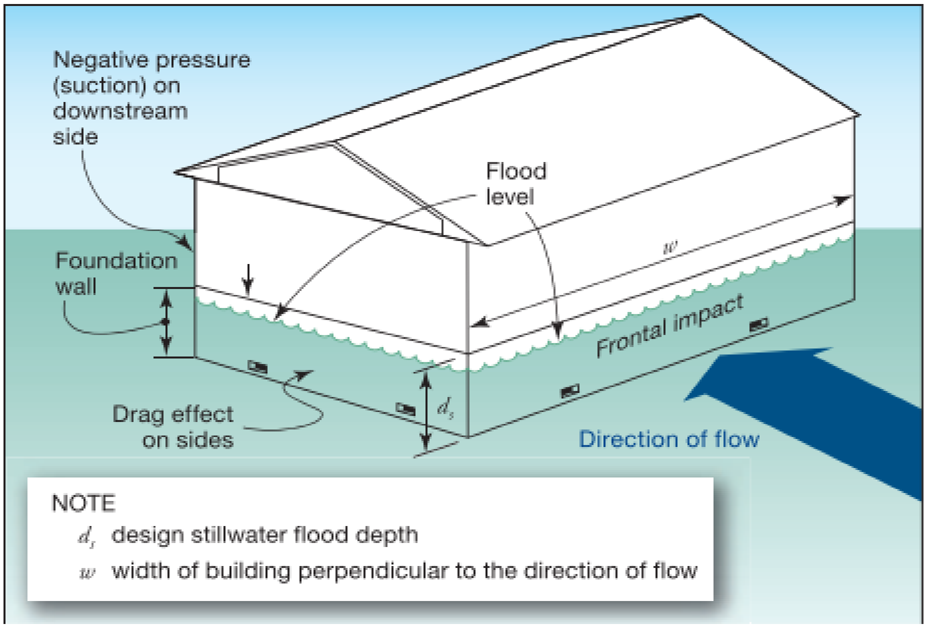


Figure 10: Hydrodynamic building loads

Source: FEMA Coastal Construction Manual, 2011

Table 5: Locations identified as flooded following rain events. Source: See local Chapter personal communication reference.

County	Town	Intersection / Road	Intensity/Effect
Accomack	Bloxom	Between Bull St & Bayside Dr	No homes, recreational area for the Town
Northampton	Cape Charles	Historic district; Intersection of Plum St & Madison Ave	Residential and commercial; primarily road flooding, hindering travel
Northampton	Cheriton	Mill St, Cherrystone Rd; Drainage an issue Town-wide	Residential, saturated soils, higher risk of wind damage to trees
Northampton	Eastville	Courthouse Rd, Willow Oak Rd east of Rt 13, northwestern side of the Rt 13 & Willow Oak Rd intersection. Willow Oak Rd receives water from the Holland Court area.	Residential, commercial, and access to County seat buildings and jail

Northampton	Exmore	Town-wide except along the railroad tracks and New Road's housing area (west of Rt 13 & south of Occohannock Neck Rd)	Damage to buildings and other personal property, affects mobility of non-automobile travelers, erosion cutting away parking lots, can impact public water/sewer
Accomack	Hallwood	Town-wide; particularly adjacent to the railroad past Bethel Church Rd, Main St	Hinders travel, saturated soils, damage to personal property
Accomack	Keller	Central & northern part of Town, intersection of Center Ave w/ West St & Lee St, northern end of West St	Town Office & PO susceptible
Accomack	Melfa	Woodland Ave – entire street (culvert pipe needed)	Residential and Shore Engineering
Northampton	Nassawadox	Woodstock residential area, Hospital Ave (even next to Rayfield 's Pharmacy)	Hinders travel, residential, commercial, medical
Accomack	Onancock	Lilliston Ave, North St area including the Police Station/Town Office	Residential, Town facilities
Accomack	Onley	Town-wide, particularly east of Rt 13 (hydric soils)	Primarily commercial
Accomack	Parksley	Intersection of Dunn Ave & Adelaide St, in front of Jaxon's, perennial ditch on south side	Some residential, but primarily the downtown business district

Bloxom and Melfa had some success mitigating stormwater flooding through aggressive ditch maintenance programs.

EXPOSURE AND POTENTIAL LOSS

In some interior areas of the Shore, the Base Flood Elevation (BFE) is 4 feet. However, the AE Zones identified are associated with creeks, the ocean or a bay. For example, there is no identified Special Flood Hazard Area in Bloxom. Flood Insurance Rate Maps (FIRMs) were updated in 2015, but some still miss many areas with recurring stormwater flooding.

There are two main hazards to residential construction associated with falling rain itself. One is the penetration of the building envelope during high-wind events and the other is the vertical weight load due to rainfall ponding on a roof (*FEMA Coastal Construction Manual*, 2011).

To look at potential losses it is necessary to observe what a flood would do to a structure. The average 2,000 ft^2 home, built on a slab, and with typical household items would suffer from $52,220 in total losses with a foot flood and $74,580 in total losses under a four-foot flood (NFIP The Cost of Flooding App).

Since so many areas of stormwater flooding are unstudied and unmapped, probabilities of the occurrence of certain flood elevations are not really known. High resolution LiDAR elevation data has been produced for the entire Eastern Shore making the region one of the few regions in the state to have access to such excellent data. There are current efforts to recapture the LiDAR data to create an even more accurate data set. This will provide the resolution needed to map and analyze stormwater flooding issues on the Eastern Shore. The data have already been used in the Eastern Shore of Virginia Transportation Infrastructure Inundation Vulnerability Assessment and subsequently in the Coastal Resilience 2016 mapping portal for the Eastern Shore.

Just because a rain event is within a certain probability also does not necessarily correspond to the same flood probability. Since floods are dependent on both rain and other conditions, such as soil moisture, a small isolated low probability rain event might not cause a low probability flood.

In 2011, there were 246 and 173 non-Special Flood Hazard Area (SFHA) NFIP flood insurance policies in the unincorporated portions of Accomack County and Northampton County, respectively. These numbers represent the percent of all policies in Accomack County and 11.9 percent in Northampton County. There was an increase in the total number of policies, both SFHA and non-SFHA policies, and in the percentage of non-SFHA policies in both Counties from 2003 to 2011, but then a decline from 2011 to 2016, although the number of policies remains higher than in 2003 (FEMA NFIP Insurance Reports, July 2003, May 2011, and January 2016). Table 5 summarizes these trends. This is an indication that there are areas in both Counties where property owners feel the need to buy flood insurance although their structure is not in an identified flood zone, but that perhaps the new FEMA flood zone maps has prompted some home owners to discontinue their policies.

Table 6: Summary of flood insurance policies for the unincorporated areas of Accomack and Northampton Counties.

Flood Insurance Policy Summary – Unincorporated Areas of Accomack and Northampton Counties				
	Year	SFHA Policies (% of Total)	Non-SFHA Policies (% of Total)	Total Policies
Accomack County	2016	2060 (88.1%)	246 (11.9%)	2306
	2011	2724 (93.7%)	184 (6.3%)	2908
	2003	2457 (95.8%)	107 (4.2%)	2564
Northampton County	2016	161 (48.2%)	173 (51.8%)	334
	2011	252 (59.9%)	169 (40.1%)	421
	2003	213 (73.2%)	78 (26.8%)	291

***Sources: FEMA NFIP Insurance Reports, May 2011, July 2003, and January 2016**

Take these Steps to Minimize Damage from Major Storms

Harrison Jackson, Column, DelmarvaNow, Feb. 27, 2016

As we have seen with Hurricane Joaquin and Winter Storm Jonas, one of the biggest problems major storms pose to our coastal bays watershed is flooding. Due to a variety of factors – including tides, a high water table and porous soils – we often experience flooding during major rainstorm events, which can cause serious damage to houses, businesses and other infrastructure.

While it may seem daunting, there are simple solutions most homeowners or families can do to help reduce local flooding in their area and improve water quality:

- Rain Barrels
- Rain Gardens
- Lawn Tips
  - Let it grow a bit
  - Use little fertilizer & pesticides
- Storm Drains
  - Keep clear of trash
- Pet Waste
  - Pick it up
  - Avoid human and environmental health impacts

"Homeowners can help keep the coastal bays watershed clean and reduce flood damage, too."

SECONDARY HAZARDS

There are secondary hazards from stormwater flow. Generally, intense rainfalls will not only affect the immediate area but will affect other places downstream. On the Eastern Shore, this is less of a problem than other areas in Virginia that have much larger watersheds. Unlike most places in Virginia and the nation, Accomack and Northampton are not coping with stormwater coming from other jurisdictions.

Intense rainfalls increase the amount of contaminants in the water. When the water flows over agricultural land, residential yards, roads and commercial parking lots, contaminates are picked up and carried into the streams. Larger overland flows also erode streams and if this erosion is severe, property damage can ensue. The excess nutrients that are introduced into our coastal creeks and bays following heavy rain events can cause algal blooms followed by eutrophication, depleting the dissolved oxygen levels to a level that kills aquatic animals. Additional steps need to be made to ensure that areas storing materials with high levels of nutrients are not built in the flood plain or too near tidal tributaries.

Often the saturated soils and standing water cause septic system and drain field failures. In some flooding instances alternative system tanks have become dislodged and actually floated out of the ground (see Chapter 14: Town of Chincoteague, page 22). When this occurs, additionally contaminants that pose immediate risk to human health, are introduced into the flood waters. Without proper education about these dangers, residents often wade through and children often play in the remaining waters once the storm system has passed.

HUMAN SYSTEMS

FRESH WATER IMPOUNDMENTS

An important source of water for agricultural and other irrigation supply is from dug farm ponds and, to a much lesser extent impounded creeks and streams. Most of the impounded creeks and streams are historical, many created before 1980 and most of the dug ponds post-date 1980. These impoundments often serve as a sort of holding tank for stormwater, however, the source of water is a combination of both stormwater and groundwater recharge from the Columbia aquifer. (Eastern Shore Ground Water Management Plan, 2013)

STORMWATER FLOODING PREVENTION LAWS AND PROGRAMS

The lead agency for developing and implementing statewide Stormwater management and nonpoint source pollution control programs in the Commonwealth is the Virginia Department of Environmental Quality (DEQ). As a result of precipitation events, stormwater runoff from streets, lawns, parking lots, construction sites, industrial facilities and other impervious surfaces occurs. Stormwater can cause erosion and flooding and carry excess nutrients, sediment and other contaminants into our creeks, particularly when not managed appropriately. When managed well, stormwater can recharge groundwater and protect land and streams from erosion, flooding, and pollutants.

A new EPA study released in December of 2015 supports long-term benefits of green infrastructure and low impact development. This modeling study used the FEMA Hazus model and national-scale datasets to estimates the flood loss avoidance benefits from application of small storm retention practices for new development and redevelopment nationwide. According to the study, the use of green stormwater infrastructure can save hundreds of millions of dollars in flood losses when applied to new development and redevelopment, and if retrofitting were to occur, the avoided losses would be even more significant (Atkins, 2015).

The Clean Water Act (CWA), properly titled the Federal Water Pollution Act, was essentially established in 1972, and is managed by the U.S. Environmental Protection Agency (EPA). This is the origin of Virginia’s Total Maximum Daily Loads (TMDLs). These are important values developed by DEQ to assess state waters and causes of impairment. The development process of the TMDL and the Implementation Plan (IP), often result in a need to reduce the amount of runoff. On the Eastern Shore this is frequently due to nutrients associated with the runoff, and the resulting eutrophication, elevated bacteria levels, and reduced dissolved oxygen (DO).

At this point in time, there are three Commonwealth of Virginia laws that apply to land disturbance activity in Virginia, however, the Stormwater Stakeholder Advisory Group (SAG) is currently brainstorming ways to streamline these programs. These laws include the Stormwater Management Act (§ 62.1-44.15:24 et seq.), Erosion and Sediment Control Law (§ 62.1-44.15:51 et seq.), and Chesapeake Bay Preservation Act (§ 62.1-44.15:67 et seq.), all three of which were incorporated into the State Water Control Law (§62.1-44.2 ET SEQ.) in 2013. For counties and towns, these laws are important in the creation of zoning and subdivision ordinances, in setting out the way in which these laws are followed. From the restricting of where new development can occur, to the frequency of septic pump-outs, these regulations affect the local municipalities and residents, with the intent to improve water quality.

In rural areas, the volume of water that is discharged following a storm event has an increased flow rate due to the combined effects of subdivisions, roads, and buildings. Historically the aim of stormwater management was to quickly drain water away, in our case to the seaside and bayside creeks and bays. Not only can this lead to erosion and nutrient loading, but it is also eliminating the opportunity for that rainwater to recharge aquifers or be retained for irrigation and agricultural use.

Virginia's Erosion and Sediment Control Law requires soil-disturbing projects to be designed to reduce soil erosion and to decrease inputs of chemical nutrients and sediments to the Chesapeake Bay, its tributaries and other rivers and waters of the Commonwealth. This program is administered by DEQ (Virginia Code §62.1-44.15:51 *et seq.*).

Coastal Lands Management is a state-local cooperative program administered by the Department of Environmental Quality (DEQ) Water Division and 84 localities that regulates activities in the Chesapeake Bay Resource Management Areas and Resource Protection Areas in Tidewater, Virginia. It was established pursuant to the Chesapeake Bay Preservation Act (Virginia Code §§62.1-44.15:67 through 62.1-44.15:79) and the Chesapeake Bay Preservation Area Designation and Management Regulations (Virginia Code 9 VAC 25-830-10 *et seq.*).

The Department of Conservation and Recreation (DCR) has 47 Soil and Water Conservation Districts (SWCDs), who work closely with districts, land owners, and other land managers to control and decrease harmful runoff. The Eastern Shore Soil and Water Conservation District offers technical assistance in shoreline erosion control, soil surveys, and animal waste management and more information can be found on their web site at http://esswcd.org/.

The United States Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS) also provides technical and financial assistance to farmers, private landowners, conservation districts, tribes, and other types of organizations through the Farm Bill.