CHAPTER 4 – COASTAL STORM

Updates to the Wicomico County Chapter 4 - Coastal Storm included the following:

- Added New Nuisance Flooding Section
- Updated Historic Event Tables
- Updated Hurricane Storm Surge Inundation Areas Maps
- Reviewed and Updated Community Lifelines & Public Facilities At Risk to Hurricane Storm Surge Inundation Areas
- Added New At-Risk Community Lifelines and Public Facilities Mapping
- Added New Section – Facilities At Risk – Municipalities Of Wicomico County
- Added New At-Risk Municipal Owned Facilities Mapping
- Added New Hurricane Storm Surge Inundation Area Mapping for each Municipality
- Review and Updated Loss Estimations for Community Lifelines and Public Facilities as well as Municipal Owned Facilities
- Added Loss Estimations for New Construction
- Added New Limit of Moderate Wave Action Vulnerability Section
- Added New Section – Social Vulnerability
- Added New Section – Recent Mitigation Efforts
- Added New Conclusion Section

WICOMICO COUNTY HAZARD MITIGATION & RESILIENCE PLAN

CHAPTER 4 – COASTAL STORM

4.1 INTRODUCTION

The coastal storm hazard was ranked as a "medium-high" risk in both 2016 and 2021. Factors used to compute risk rankings in 2021 included eight (8) parameters: death, injury, annualized events, geographic extent, property damage, crop damage, future probability, and community perspective. For more detail information on hazard ranking, refer to *Appendix A: Hazard Identification and Risk Assessment*.

To adequately access the vulnerability of Wicomico County to the coastal storm risk, four (4) probable hazards were analyzed. These include:

1. Hurricane Wind;
2. Storm Surge;
3. Coastal Flood; and,
4. Nuisance Flooding.

Note: Coastal flooding occurs when intense offshore storm systems push ocean water inland above the normal tide level. The rise in water is the storm surge. A storm surge can occur in just a few minutes. Riverine and flash flooding are profiled within Chapter 8 Flood.

For each of the four (4) probable hazards associated with coastal storm, a section within this chapter has been developed. Each section includes, at a minimum, the following topics:

- Hazard Characterization;
- Hazard Risk & History;
- Vulnerability; and,
- Facilities At Risk.

The eye of Hurricane Isabel approaches North Carolina's Outer Banks in this true-color Moderate Resolution Imaging Spectroradiometer (MODIS) image captured by the Terra satellite on September 18, 2003, at 11:55 am US Eastern time.

4.2 HURRICANE WIND

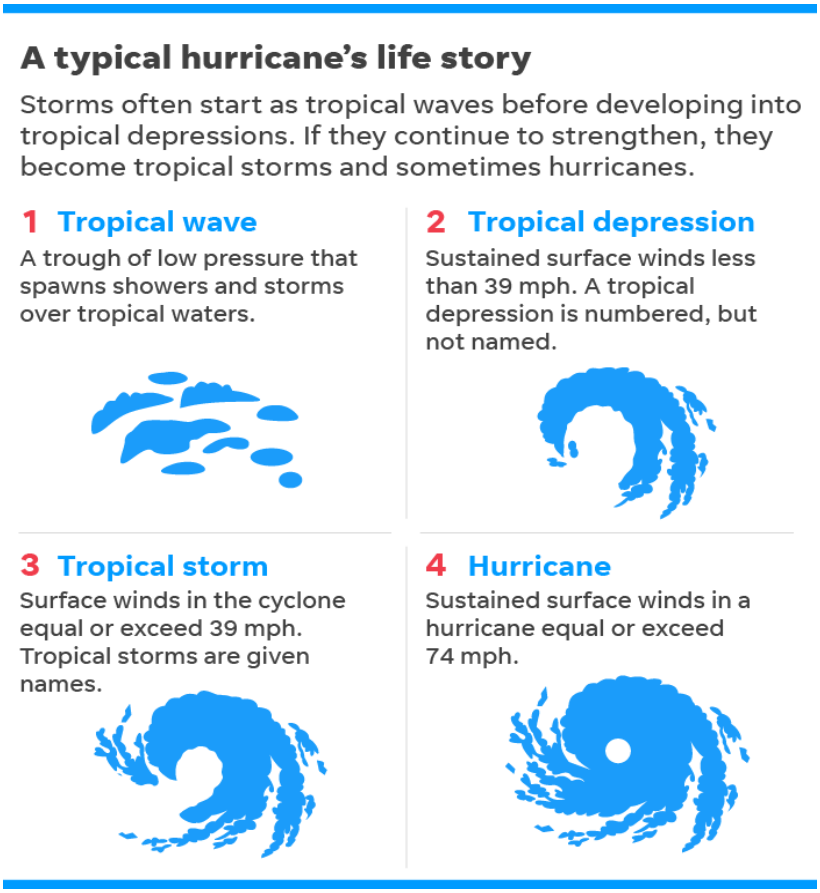
HAZARD CHARACTERIZATION

Tropical cyclones, a general term for tropical storms and hurricanes, are low pressure systems that usually form over the tropics, referred to as "cyclones" due to their rotation. Tropical cyclones are among the most powerful and destructive meteorological systems on earth. In terms of impact, high winds, heavy rain, lightning, tornados, hail, and storm surge are all associated with tropical cyclones. In addition, as tropical cyclones move inland, they can cause severe flooding, downed trees and power lines, and structural damage. Hurricanes, tropical storms, and tropical depressions are all examples of a tropical cyclone. The categories and associated wind speeds are as follows:

Tropical Depression: An organized system of clouds and thunderstorms with a define circulation and maximum sustained winds 38 mph (33 knots) or less.

Tropical Storm: An organized system of strong thunderstorms with a define circulation and maximum sustained surface wind speed from 39-73 mph (34-63 knots).

Hurricane: An intense weather system of clouds and thunderstorms with a define circulation and maximum sustained surface wind speed exceeds 73 mph



Source: Weather Jamaica, Twitter

Hurricane winds are rated for intensity by using the Saffir-Simpson Scale, which provides an estimate of the potential damage that a hurricane wind may cause. This scale is based upon both wind speed and surface pressure. Scale categories range from Category One to Five, with Category One having wind speeds from 74-95 mph and pressure greater than 980 mb, while a Category Five hurricane may have wind speeds in excess of 157 mph and pressure of less than 920 mb. Table 4.1 depicts the five categories of hurricane strength.

Table 4.1: Saffir-Simpson Hurricane Wind Scale

Saffir-Simpson Hurricane Wind Scale	
Category Wind Speed	**Effects**
Category 1 74-95 mph	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.
Category 2 96-110 mph	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.
Category 3-Major 111-129 mph	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 4-Major 130-156 mph	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 possible months. Most of the area will be uninhabitable for weeks or months.
Category 5-Major >157 mph	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

Some notable hurricanes that have affected Maryland include Hazel in 1954, Donna in 1960, Camille in 1969, David in 1979, Fran in 1996, Floyd in 1999, Isabel in 2003, Irene in 2011, Sandy in 2012, Hermine in 2016, and Isaias in 2020.

The most common coastal storms that impact Wicomico County are Category One Hurricanes and Tropical Storms. While at sea, notable hurricanes that had been classified as Category Four or Five storms, are typically downgraded to a Category One or Tropical Storm by the time they make landfall in Wicomico County. Heavy rain from Category One hurricanes and tropical storms have been known to cause 500-year floods (which have a 0.2% chance of occurring each year) and greater flooding in inland communities. In addition, coastal erosion can also be a major problem created from coastal storms. Coastal erosion may impact man-made structures and human activities such as shore protection structures and dredging.

Various factors point to the potential for increased danger from severe tropical cyclones in Maryland such as, population growth and continuing near-shore development, which is increasing the risk of human injury and property loss. Additionally, there is a widespread agreement among climatologists that gradual global warming is occurring. Potential effects include the melting of polar ice, expansion of the oceans, and an overall rise in sea levels. The slow sinking of land in the Chesapeake region (subsidence), due to the combined effects of ground water withdrawal and post-glacial rebound, effectively doubles the global rate of sea

level rise in Maryland's coastal areas. These factors increase the vulnerability to potential long storm hazards such as: sea level rise, erosion, and increased storm activity and severity.

HAZARD RISK & HISTORY

Wicomico County has been affected over the years by the passage of recent hurricanes, tropical storms and tropical cyclones as shown in Table 4.2. Older hurricanes that have occurred in the County include unnamed hurricanes of 1929, 1934, 1936 and Hurricane Connie in 1955. Hurricanes can affect Wicomico County from either the Gulf of Mexico or the Atlantic Ocean. Normally the greatest damage results from hurricanes that come ashore in the Tidewater area of Virginia and/or the Carolina Capes as was the case with Hurricane Isabel.

On August 17, 1955, Hurricane Diane induced tides 1.5 to 2.5 feet above normal. The full force of the hurricane missed the Delmarva Peninsula and Wicomico County (*The Banner*). Hurricane Donna struck on September 16, 1960, causing minor wind and water damage (*Star Democrat*). Tropical Storm Agnes brought winds up to 55 miles per hour during late June 1972 (*The Banner*). Some local flooding occurred but damage was primarily restricted to crops.

In 2018, remnants of Tropical Storm Michael caused major flooding in Wicomico County, specifically Salisbury. Residents of Canal Woods community were ordered to evacuate their homes due to flooding. More recently, Tropical Storm Isaias generated a tornado that touched down in Mardela Springs, moving a home 40 feet off its foundation. A second tornado reported touched down just north of Girdletree.

Table 4.2: Recent Hurricane Events

Storm Event	Date	Event Narrative	Property Damage	Crop Damage
Hurricane Bertha	July 13, 1996	The highest wind speed recorded was 23 mph at Salisbury. Numerous trees and power lines blown down resulted in scattered property damage and power outages. Rainfall amounts generally ranged from 3.0 to 5.0 inches and caused some street flooding.	$100,000	$15,000
Hurricane Fran	September 6, 1996	The highest sustained wind speed recorded was 22 mph at Salisbury with the highest gust at 35 mph. Many roads were flooded with some homes receiving water damage at the time of high tide. In some locations, nearly 10 feet of shore was lost due to surge effects.	$1 Million	Not Available
Tropical Storm Josephine	October 8, 1996	1.5 to 3.5 inches of rain resulting in flooding of several roads. Several trees and power lines were blown down resulting in some minor structural damage and scattered power outages.	$100,000	Not Available
Hurricane Floyd	September 15-September 16, 1999	The highest sustained wind speed recorded at Salisbury was 32 mph. The highest gusts recorded were 48 mph at Salisbury. Few trees and power lines were blown down across the Lower Maryland Eastern Shore resulting in scattered power outages. Rainfall amounts generally ranged from 3 to 6 inches across much of the Lower Maryland Eastern Shore and caused some crop damage and street flooding.	$278,000	$575,000

Storm Event	Date	Event Narrative	Property Damage	Crop Damage
Tropical Storm Isabel	September 18 - September 19, 2003	The highest sustained wind speed recorded was 37 mph at Salisbury. The wind uprooted many thousands of trees, downed many power lines, damaged hundreds of houses, and snapped thousands of telephone poles and cross arms. Hundreds of roads, including major highways, were blocked by fallen trees. Local power companies reported many thousands of customers were without power. Storm surge values near 4-to-5-foot surge values reported on the Wicomico and Nanticoke Rivers. Rainfall amounts ranged from 1 to 3 inches across the Lower Maryland Eastern Shore. There were more than 15 deaths indirectly attributed to the storm.	$2.5 Million	Not Available
Tropical Storm Hanna	September 6, 2008	Few trees were downed. Rainfall amount of 2.32 inches was recorded about three miles north of Vienna. Storm total rainfall ranged from around 1 to 3 inches. Coastal storm tides of 1 to 3 feet were common, with only minor beach erosion reported. Storm winds knocked down several trees and power lines, as well as caused minor structural damage. No fatalities or injuries were attributed to the winds.	$500,000	Not Available
Tropical Storm Irene	August 27-August 28, 2011	Tropical storm force winds knocked down several trees and power lines, as well as caused some substantial property damage. In addition, heavy rains contributed to significant crop damage. The highest sustained wind of 40 knots (46 mph) with a peak gust of 53 knots (61 mph) was recorded by SBY (Salisbury-Wicomico Airport). Storm total rainfall generally ranged from six to ten inches.	$100,000	$1,000,000
Tropical Cyclone Sandy	October 29-October 30, 2012	Tropical Cyclone Sandy moved northward well off the Mid Atlantic Coast then northwest producing very strong northeast winds which caused coastal flooding. Water levels reached 3-4 feet above normal. Salisbury experienced the worst flooding due to the combination of storm surge and excessive rainfall runoff. A number of privately owned docks and bulkhead were damaged or destroyed in the Nanticoke area.	$250,000	$0
2021 HMP Update				
Tropical Storm Hermine	September 2-5, 2016	Tropical Storm Hermine moving northeast along the Southeast Coast then off the Mid Atlantic Coast produced a few tropical storm force wind gusts, minor coastal flooding, and locally heavy rainfall across portions of the Lower Maryland Eastern Shore from Friday evening, September 2nd into early Monday morning, September 5th.	$0	$0
Tropical Storm Isaias	August 4, 2020	The center of Tropical Storm Isaias tracked north just inland of the Middle Atlantic Coast from late Monday night, August 3rd through Tuesday morning, August 4th. The tropical storm produced tropical storm force winds and associated wind damage across portions of the Lower Maryland Eastern Shore.	$250,000	$0

Source: NWS, NCDC (NOAA)

In terms of number of occurrences, as listed in Table 4.2, the National Weather Service - National Climatic Data Center listed a total of 10 hurricane and tropical storm events affecting Wicomico County from the years 1996-2020. Therefore, according to the data, Wicomico County experiences on average 0.4 hurricane and tropical storm events per year.

VULNERABILITY

An Enhanced HAZUS Analysis for hurricane wind was conducted. The storm track used in the hurricane wind analysis was modified to increase the impact to Wicomico County. Using the increased storm condition for the Enhanced HAZUS hurricane wind analysis accounts for the potentially increasing storm severity of future conditions.

The Hurricane Model allows practitioners to estimate the economic and social losses due to hurricane winds. The information provided by the model will assist state and local officials in evaluating, planning for, and mitigating the effects of hurricane winds. The Hurricane Model provides practitioners and policy makers with a tool to help reduce wind damage, reduce disaster payments, and make wise use of the nation's emergency management resources.

Although the software offers users the opportunity to prepare comprehensive loss estimates, it should be recognized that even with state-of-the-art techniques, uncertainties are inherent in any such estimation methodology. The next major hurricane to affect Wicomico County may be quite different than any "scenario hurricane" anticipated as part of a hurricane loss estimation study. Hence, the results of a scenario analysis should not be looked upon as a *prediction*, but rather as an indication of what the future may hold.

HAZUS provides different levels of analysis based on the level of effort and expertise employed by the user. Users can improve the accuracy of HAZUS loss estimates by furnishing more detailed data about their community, or engineering expertise on the building inventory. An Enhanced HAZUS analysis provides a more accurate loss estimates due to the inclusion of detailed information on local hazard conditions and/or by replacing the national default inventories with more accurate local inventories of buildings, essential facilities, and other infrastructure. The Enhanced HAZUS Analysis, conducted by Smith Planning and Design, utilized integrated user-supplied data in order to yield more accurate loss estimates and risk assessments.

County data including community lifelines used in Table 4.3 were reviewed and updated during this planning process. This table illustrates the discrepancy between the HAZUS default data, and the County data utilized in this Enhanced HAZUS Analysis. As shown, the accuracy of results are exponentially increased by utilizing County data and running the Enhanced HAZUS Analysis.

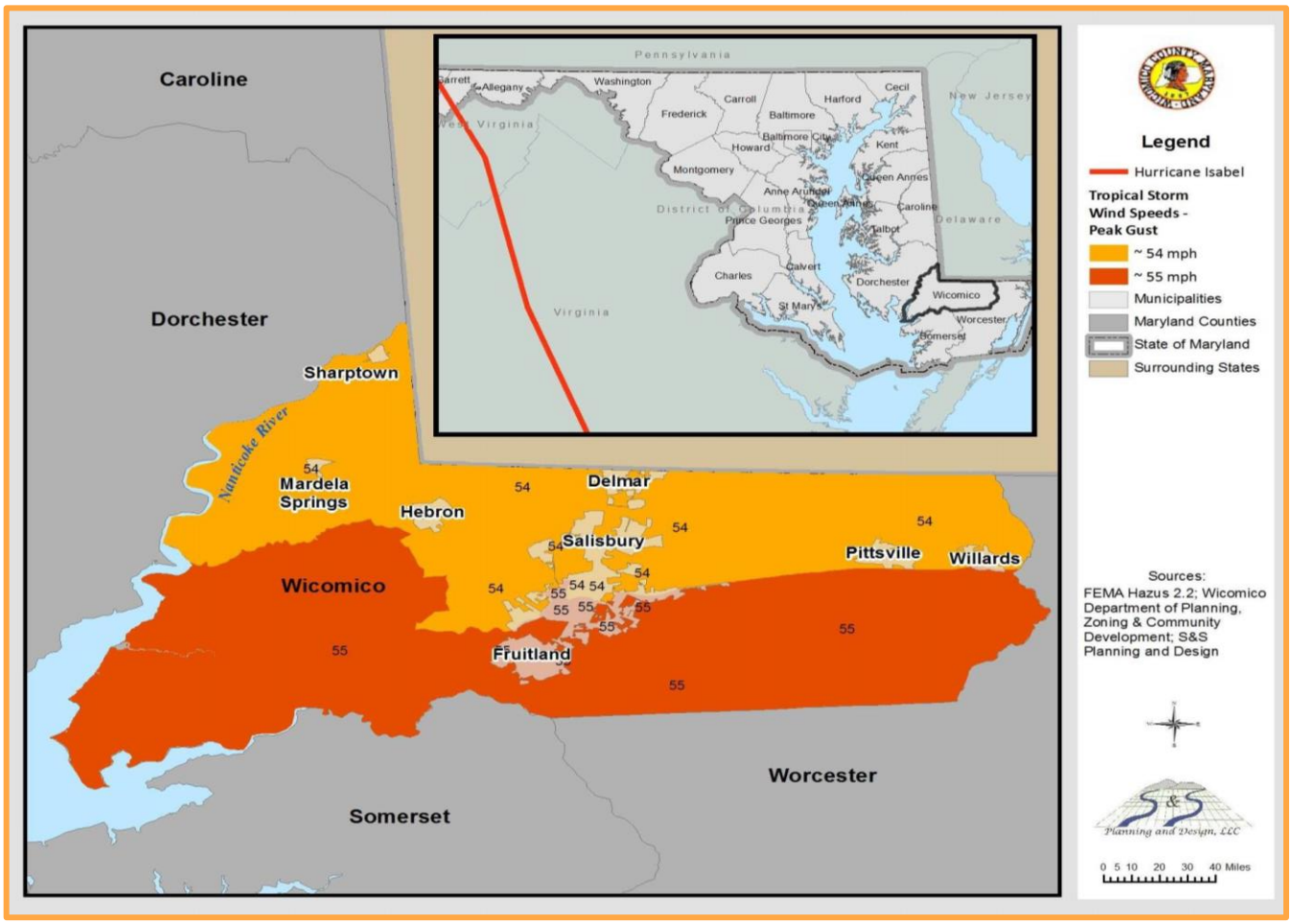
Table 4.3: HAZUS Default and County Data

Critical Facility Type	HAZUS Default Data	County Data Utilized for Enhanced HAZUS Analysis
Fire stations/EMS	9	13
Police Stations	4	7
Schools	42	45
EOC	0	1
Medical	3	27

Source: FEMA, Wicomico County and Smith Planning and Design

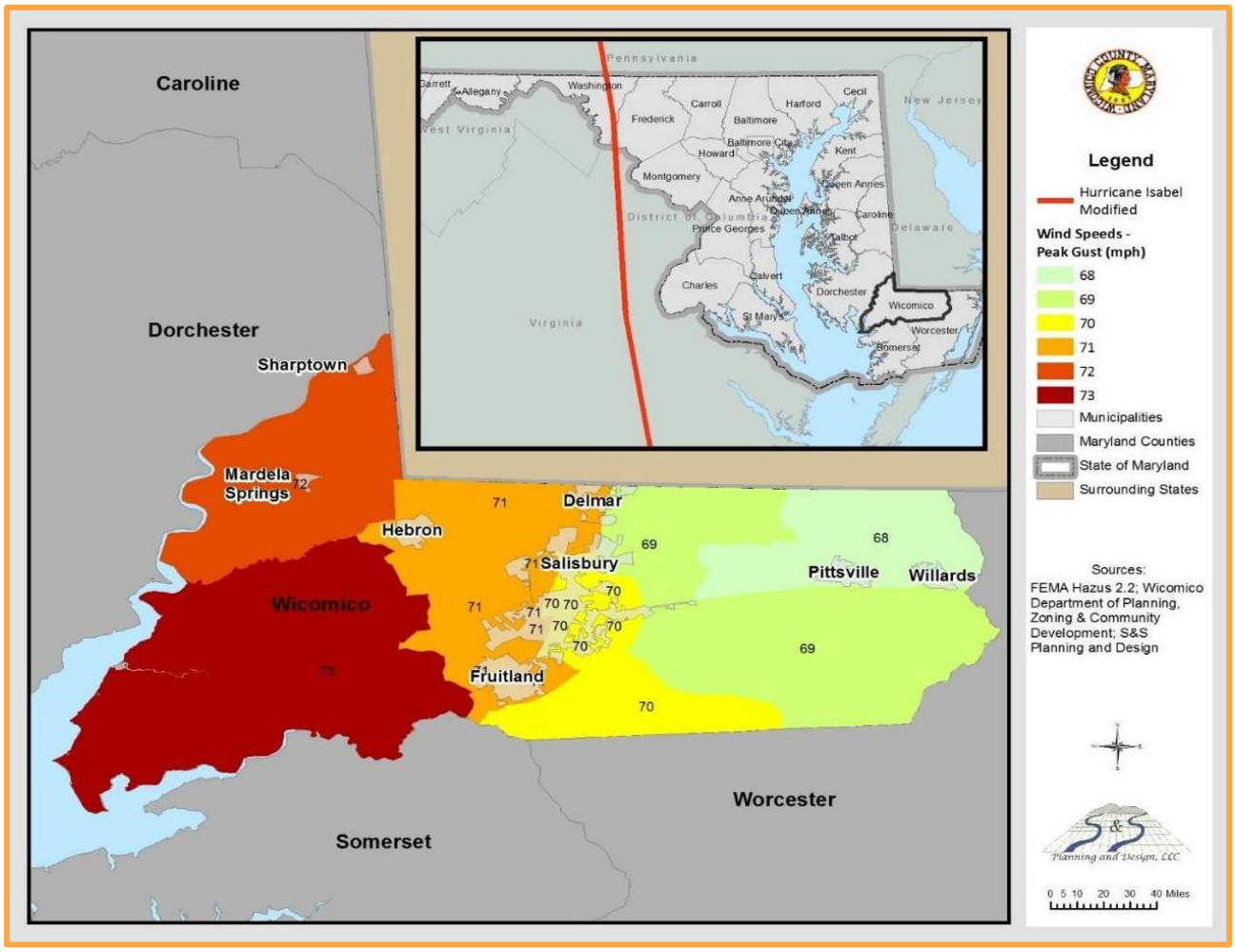
For the Hurricane Wind – Enhanced HAZUS Analysis, a historical storm analysis was initially modeled. In 2003, Hurricane Isabel impacted Maryland significantly and was Presidenitally Declared a disaster on September 19, 2003. Individual and public assisstance was provided in Wicomico County. Considering the severity of damage and impact Hurricane Isabel had on Wicomico County, this storm was utilized as the baseline storm for the Huricane Wind – Enhanced HAZUS Analysis. Map 4.1: Hurricane Isabel Wind Speeds – Peak Gust illustrates the wind speeds used in the baseline model.

Map 4.1: HAZUS Hurricane Analysis –Hurricane Isabel Wind Speeds - Peak Gusts



Modifications to the storm track were made to increase the impact to Wicomico County for further analysis. These modifications included alterations to the coordinates so the hurricane track was in closer proximity to Wicomico County, additionally, the severity of the storm was increased from a Tropical Storm to a Hurricane Category One. Peak wind gusts for tropical storms are 55 mph, while peak gusts for the Category One storm are 73 mph. Map 4.1 depicts the historic Hurricane Isabel model, while Map 4.2 illustrates the modified Hurricane Isabel used in the analysis.

Map 4.2: HAZUS Hurricane Analysis –Hurricane Isabel Modified Wind Speeds – Peak Gusts

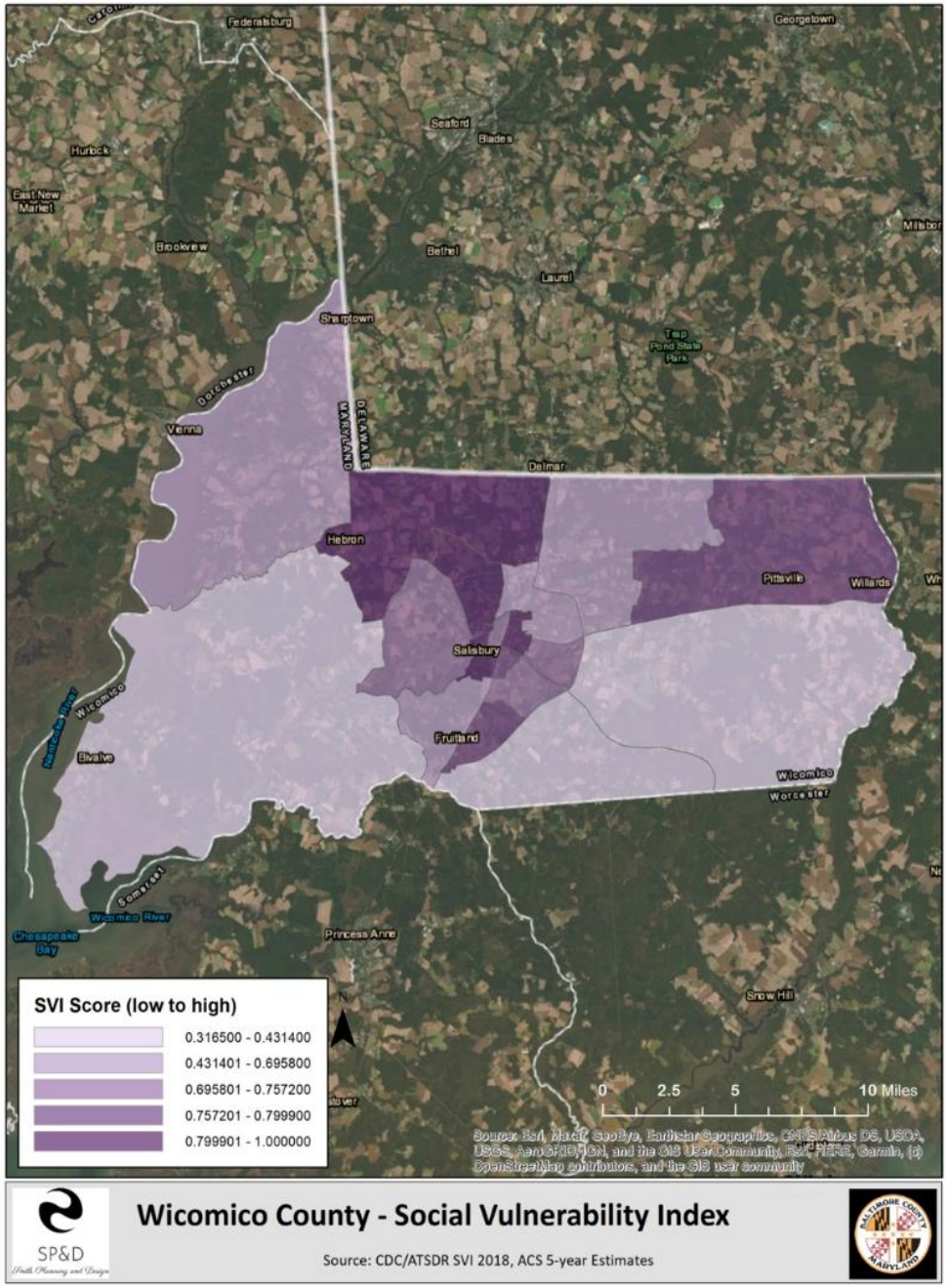


The western portion of Wicomico County, the area containing both the Wicomico and Nanticoke River, is the most vulnerable to hurricane wind. As shown on the map above, Hurricane Isabel Modified Wind Speeds – Peak Gusts could be up to 73 mph in this area. In addition to the unincorporated areas shown in darker shades of orange, the municipality of Mardela Springs is within the hurricane wind high-risk zone.

SOCIAL VULNERABILITY

The Centers for Disease Control and Prevention (CDC) Social Vulnerability Index (SVI) was developed to assist local officials identify communities within the county that may need additional support before, during, and/or after disasters. The SVI is discussed in further detail in Chapter 3 – Hazard Identification & Risk Assessment on page 3-6. The SVI has been conducted for Wicomico County at the census tract level and is depicted on map 4.3. The darker census tracts indicate areas of higher social vulnerability while the lightest tracts indicate relatively low social vulnerability.

Map 4.3: Wicomico County Social Vulnerability Index

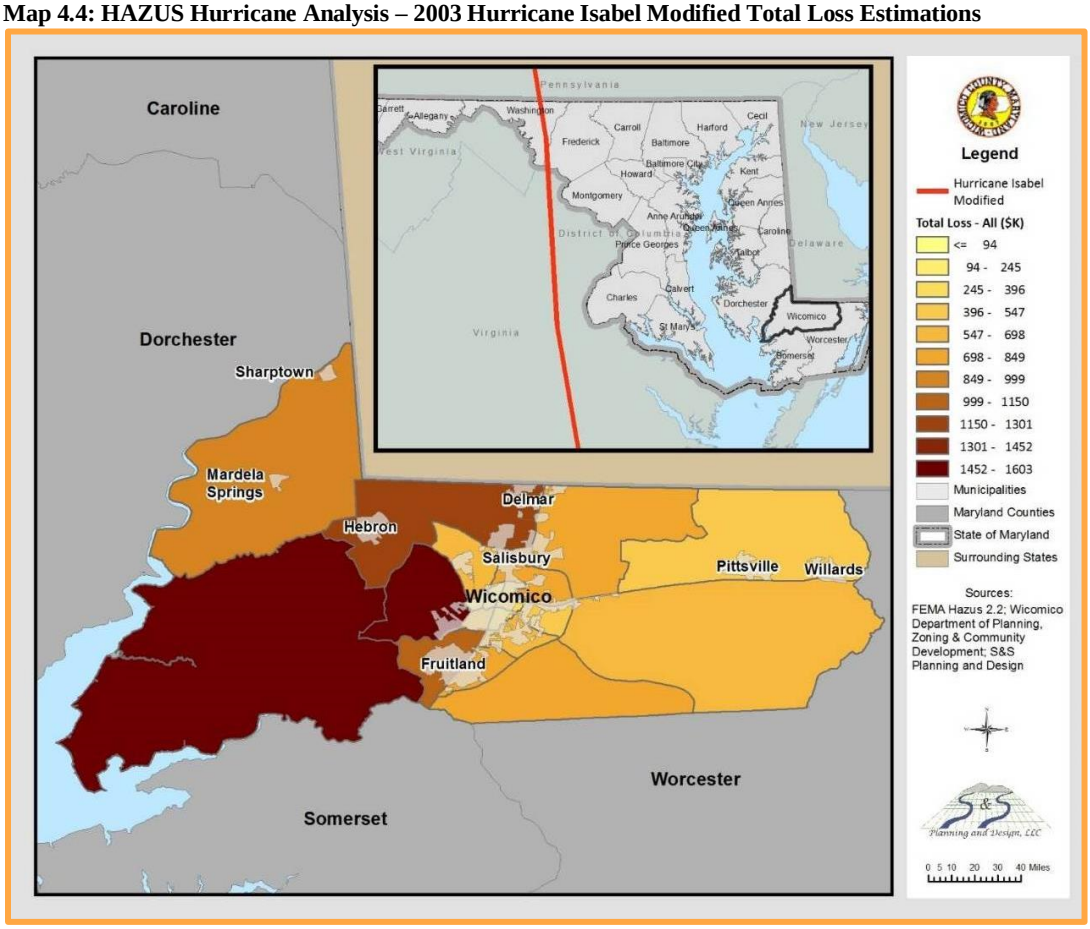


Using the information depicted on both Maps 4.2 and 4.3, the intersecting or overlapping areas of SVI score census blocks and Hurricane Isabel Modified Peak Gusts can be determined. Areas with higher social vulnerability index score as indicated on Map 4.3 by dark purple shading overlap with the orange shading indicating peak gusts of 73 mph as shown on Map 4.2. This area includes the Towns of Hebron and Delmar, the City of Fruitland, and portions of the City of Salisbury.

FACILITIES AT-RISK & LOSS ESTIMATIONS

Results of the Enhanced HAZUS Analysis determined residential structures would be affected by the hurricane more so than other occupancy types such as commercial or industrial facilities. Also, wood as a building material is more susceptible to damage than masonry, concrete or steel. There are over 35,000 buildings in the County with an estimated replacement value of approximately $11.2 million dollars. The economic loss for this event is approximately $13.7 million with 98% of this loss consisting of residential occupancy loss. Map 4.4 illustrates total loss estimations.

Map 4.4: HAZUS Hurricane Analysis – 2003 Hurricane Isabel Modified Total Loss Estimations



The HAZUS Hurricane Wind analysis estimates that approximately 4 residential structures will be moderately damaged due to wind during an event such as this. A total of 113 residential structures and 4 commercial structures are expected to experience minor building damage (Appendix I – HAZUS Hurricane Wind Report, page 6). Table 4.4 details the total estimated loss specific to Hurricane Wind for Wicomico County if a hurricane event of this magnitude occurred.

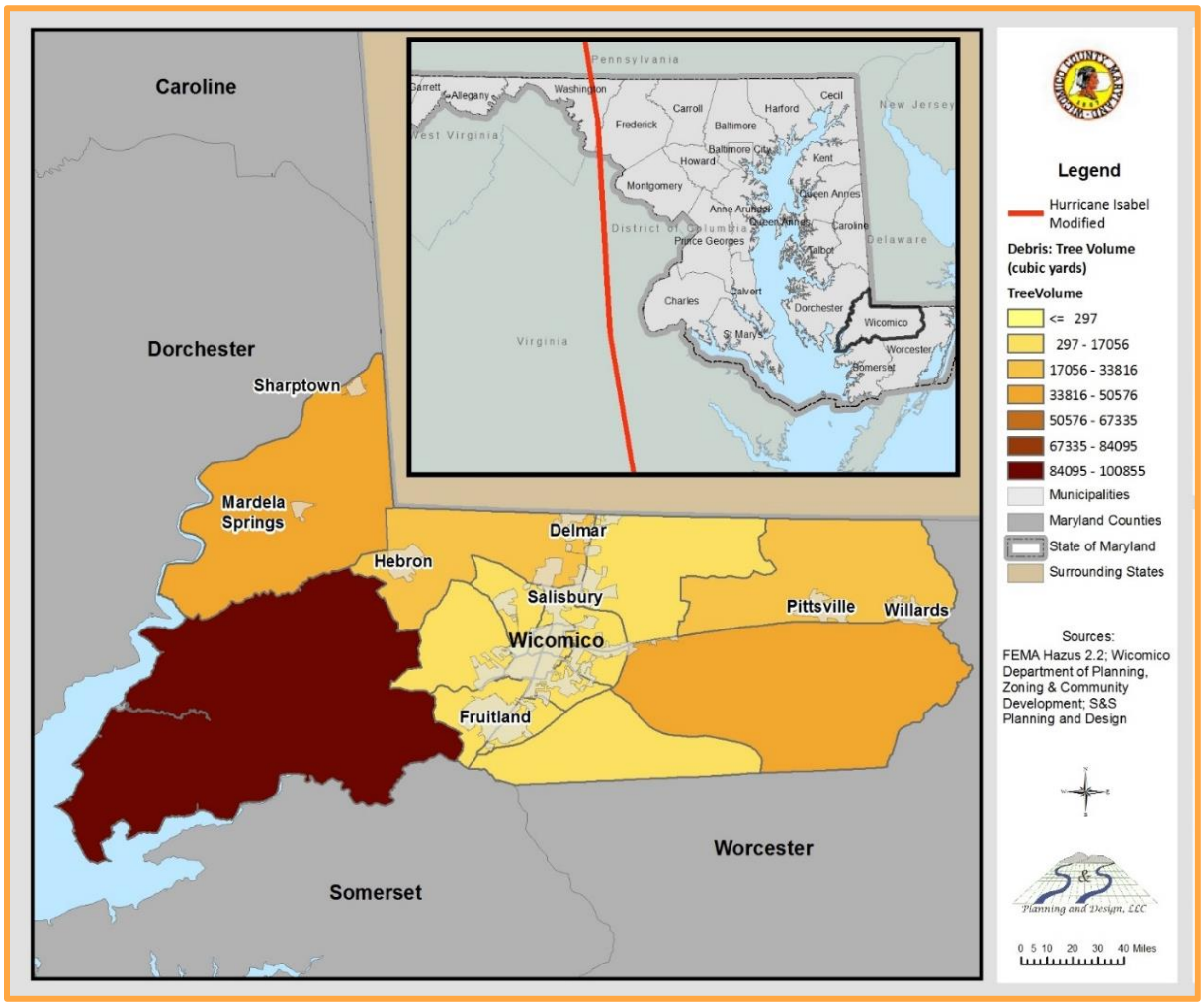
Table 4.4: HAZUS Hurricane Analysis – 2003 Hurricane Isabel Modified – Building-Related Loss Estimations

Building Type	Loss Estimations
Residential	$10,419,570.00
Commercial	$193,990.00
Industrial	$31,290.00
Other	$41,150.00
Total	**$10,686,000.00**

DEBRIS GENERATION

In terms of debris, the model estimates that a total of 27,837 ton of debris will be generated. If debris tonnage is converted to an estimated number of truckloads, it would require 28 truckloads (@25 tons/truck) to remove the debris generated by the hurricane. Additionally, 3,442 tons of debris is categorized as eligible tree debris, which could be chopped and/or chipped.

Map 4.5: HAZUS Hurricane Analysis – 2003 Hurricane Isabel Modified Debris

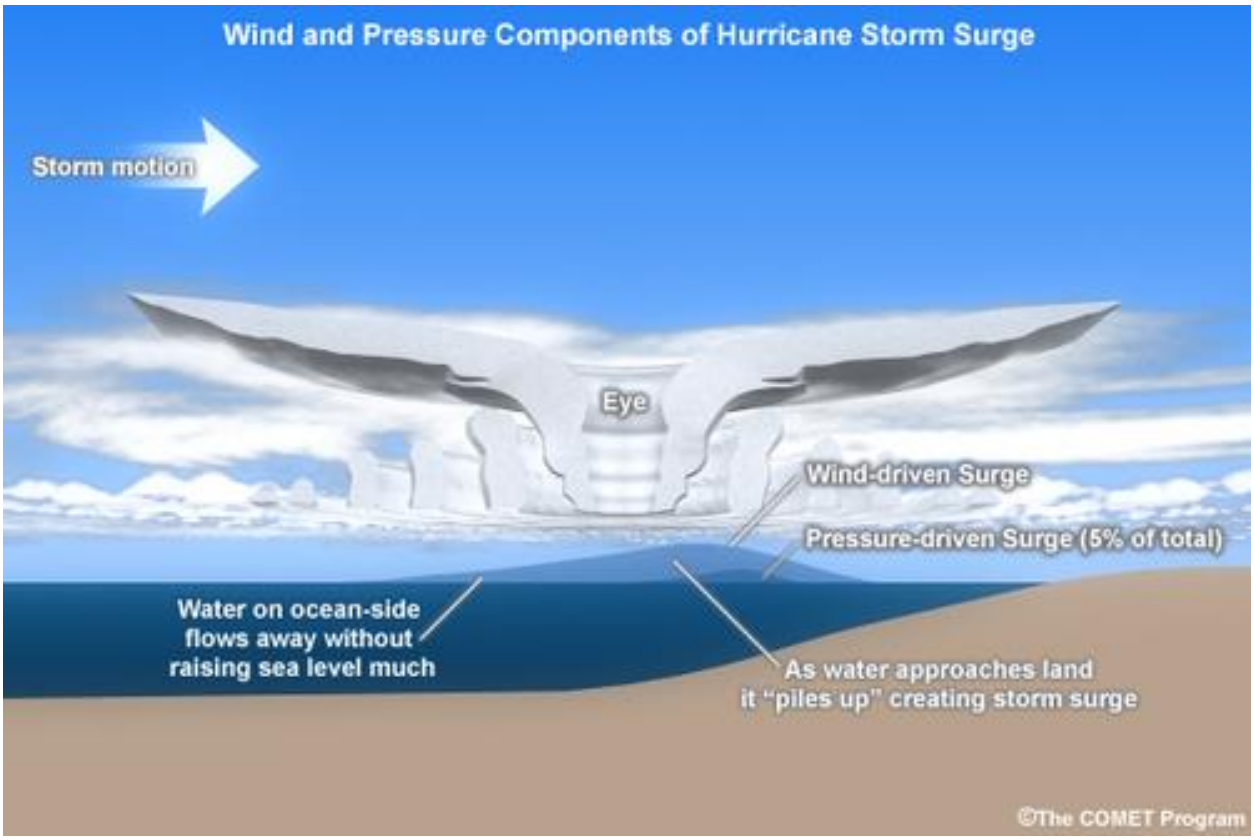


4.3 HURRICANE STORM SURGE

HAZARD CHARACTERIZATION

The National Weather Service (NWS) defines storm surge as "Storm surge is abnormal rise of water generated by a storm, over and above the predicted astronomical tide. It's the change in the water level that is due to the presence of the storm. Since storm surge is a difference between water levels, it does not have a reference level."

According to NOAA, storm surge is generated by water being pushed toward the shore by the force of the winds moving cyclonically around the storm. The impact on surge of the low pressure associated with intense storms is minimal in comparison to the water being forced toward the shore by the wind.



Wind and Pressure Components of Hurricane Storm Surge

HAZARD RISK & HISTORY

On Maryland's eastern shore, particularly on the Bay side, storm surge is also related to rising sea level and to shoreline subsidence. Counties fronting on the east side of the Bay are experiencing shoreline submergence that has been ongoing since the last glacial period when sea level was approximately 400 feet lower than today. While the process has been continuing for approximately 10,000 years, sea level is still rising at a rate of plus one foot or so every century. This rise in sea level will certainly affect the relative height of future storm surge events.

Hurricane Floyd caused widespread flooding in the northern portions of Maryland's Eastern Shore on September 16, 1999 (MDE). Remnants of Hurricane Isabel caused widespread tidal surge flooding on September 18-19, 2003 (MDE) causing the worst recorded flooding in the County's history. Hurricane Isabel produced four-to-five-foot storm surges on the Wicomico and Nanticoke Rivers and caused 15 deaths statewide. A large storm event in June 2006 dropped 3 to 6 inches of rain in most of Wicomico County between June 22 and June 30, 2006 (NWS), which caused widespread flooding. In 2012, Salisbury experienced the worst flooding with water levels reaching 3-4 feet above normal. This was due to the combination of storm surge and excessive rainfall runoff during Tropical Storm Sandy.

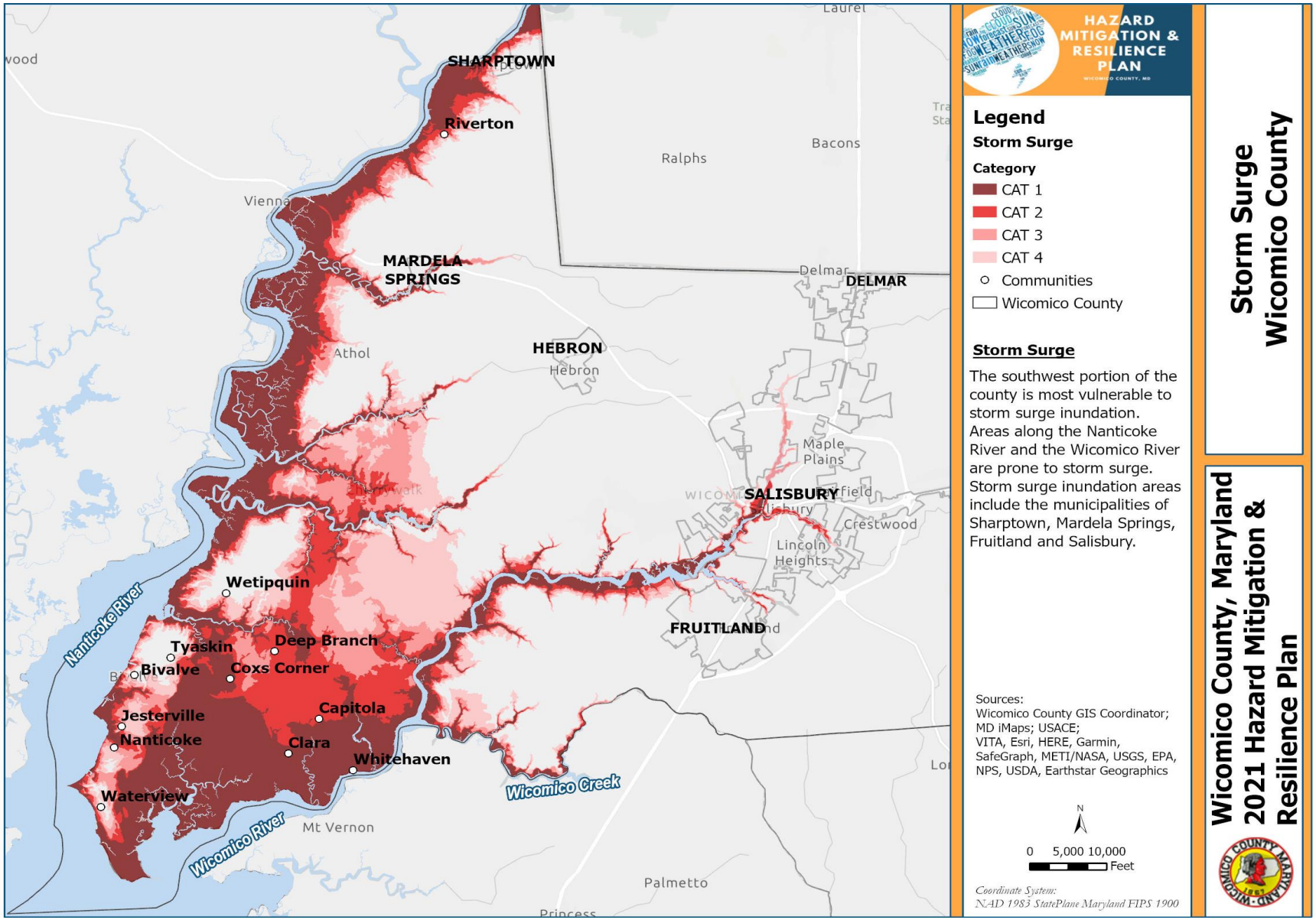
VULNERABILITY

Wicomico County is in southeastern Maryland and is bordered by Delaware. The southwest portion of the county is most vulnerable to storm surge inundation. Areas along the Nanticoke River and the Wicomico River are prone to storm surge. Storm surge inundation areas include the unincorporated areas of the county and the municipalities of Sharptown, Mardela Springs, Fruitland and Salisbury.

Several techniques are utilized to model storm surge including one technique involving the use of the National Weather Service's (NWS) Sea, Lake and Overland Surges from Hurricanes (SLOSH) model. This model is used to predict storm surge heights based on hurricane categories. The classification of the surge inundation area is based on the hurricane category causing the flooding. As the category of the storm increases, more land area will become inundated. Storm surge is a major component of nor'easter storms along the East Coast of the U.S. since winds are moving in a north and/or eastward direction. These winds move across the ocean towards the shore and generate large waves.

Storm surge data utilized for analysis reflects areas with a risk of storm tide flooding from hurricanes, based on potential storm tide heights calculated by the National Weather Service's SLOSH Model. The SLOSH Basin used for mapping was Chesapeake Bay (CP5); this data was prepared by the U.S. Army Corps of Engineers (USACE), Baltimore District, Planning Division. SLOSH storm tide elevations used for the mapping were based on the Maximum of Maximums (MOM) SLOSH output dataset. The MOM output elevations represent the highest calculated storm tide values based on thousands of SLOSH simulations using different combinations of approach direction, forward speed, landfall point, astronomical tide, and intensity (Category 1 through Category 4). Categories 1 through 4 refer to the Saffir-Simpson scale of hurricane intensity. Hurricane storm surge inundation areas are depicted in Map 4.6 below.

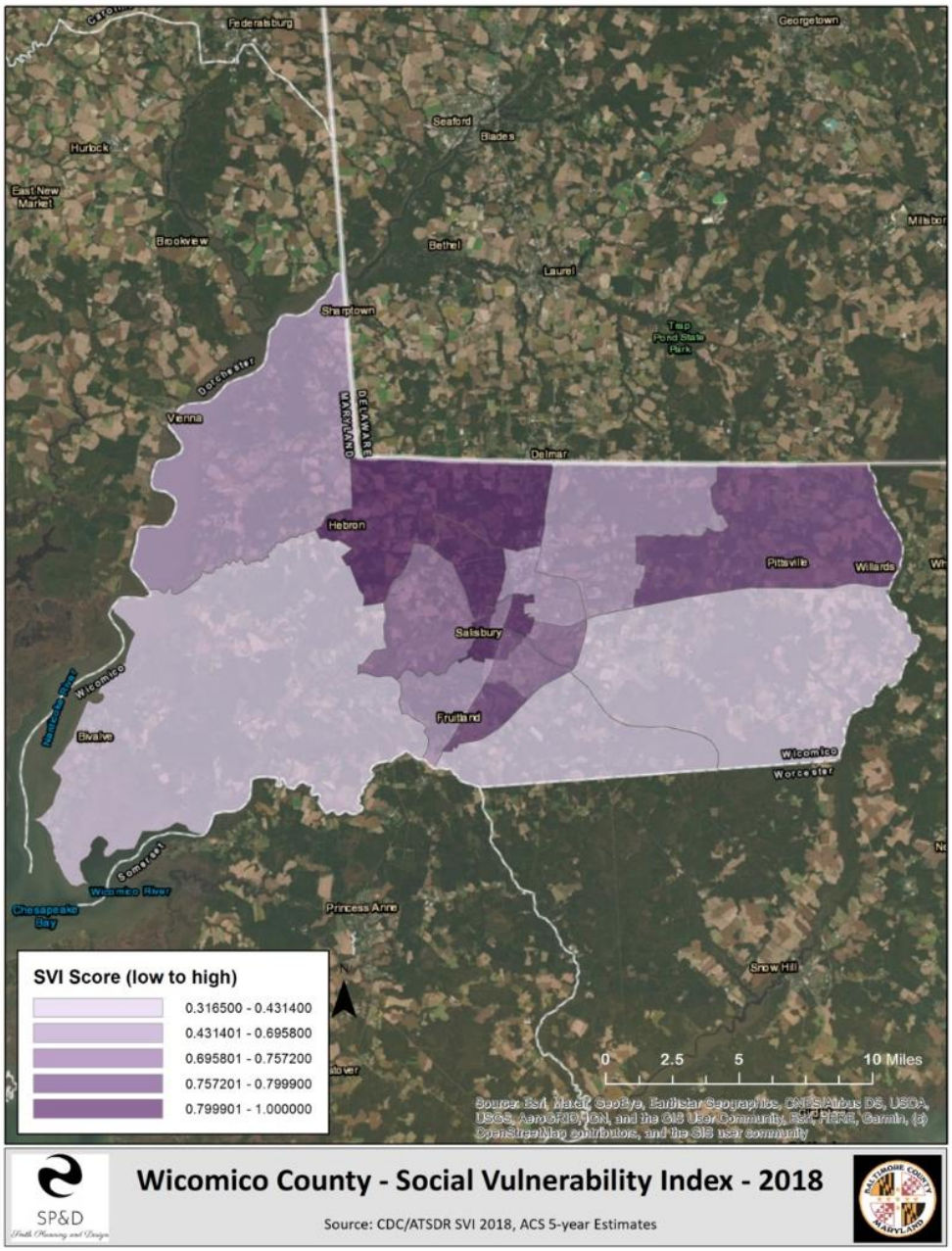
Map 4.6: Hurricane Storm Surge Inundation Area



SOCIAL VULNERABILITY

The Centers for Disease Control and Prevention (CDC) Social Vulnerability Index (SVI) uses fifteen (15) U.S. Census variables to calculate SVI scores that can help local officials identify communities within the county that may need additional support before, during, and/or after disasters. Map 4.3 was developed for the plan update and provides a visual depiction of the SVI scores, by shaded zones, for Wicomico County. Higher social vulnerability regions are indicated by dark purple shading.

Map 4.7: Wicomico County Social Vulnerability Index



Using the information depicted on both Maps 4.6 and 4.7, the intersecting or overlapping areas of SVI score census blocks and hurricane storm surge inundation areas can be determined. Areas with lower social vulnerability index score as indicated on Map 4.7 by light purple shading in the sourthern protion of the county overlap with the hurricane storm surge inundation areas as shown on Map 4.6. This area includes the Towns of Sharptown and Mardela Springs, and portions of the Cities of Fruitland and Salisbury.

FACILITIES AT-RISK – UNINCORPORATED AREAS OF WICOMICO COUNTY

Community Lifelines & Public Facilities

In an effort to minimize and/or eliminate storm surge hazard risk (mitigation) and continue the essential services and functions (resilience), community lifelines were assessed for storm surge hazard vulnerability.

According to the Federal Emergency Management Agency (FEMA), a Community Lifeline enables the continuous operation of critical government and business functions and is essential to human health and safety or economic security.

- Lifelines are the most fundamental services in the community that, when stabilized, enable all other aspects of society to function.
- FEMA has developed a construct for objectives-based response that prioritizes the rapid stabilization of Community Lifelines after a disaster.
- The integrated network of assets, services, and capabilities that provide lifeline services are used day-to-day to support the recurring needs of the community and enable all other aspects of society to function.
- When disrupted, decisive intervention (e.g., rapid re-establishment or employment of contingency response solutions) is required to stabilize the incident.

Public facilities can be any facility, including, but not limited to, buildings, property, recreation areas, and roads, which are owned, leased, or otherwise operated, or funded by a governmental body or public entity. In addition, infrastructure and transportation networks may be vulnerable to the flood hazard

Community Lifelines

Safety and Security - Law Enforcement/Security, Fire Service, Search and Rescue, Government Service, Community Safety

Food, Water, Shelter - Food, Water, Shelter, Agriculture

Health and Medical - Medical Care, Public Health, Patient Movement, Medical Supply Chain, Fatality Management

Energy - Power Grid, Fuel

Communications - Infrastructure, Responder Communications, Alerts Warnings and Messages, Finance, 911 and Dispatch

Transportation - Highway/Roadway/Motor Vehicle, Mass Transit, Railway, Aviation, Maritime

Hazardous Material - Facilities, HAZMAT, Pollutants, Contaminants

The U.S. Army Corps of Engineers, Baltimore District, Planning Division storm surge data layer was used to prepare Map 4.6: Hurricane Storm Surge Inundation Area. The 2021 Plan Update analyzed storm surge risk to community lifelines and public facilities. Facilities located within the storm surge areas were identified and differentiated by hurricane categories. Category One storm surge has the most likelihood of occurrence based on historical data. Table 4.5 lists the community lifelines and public facilities located within the each of the storm surge areas.

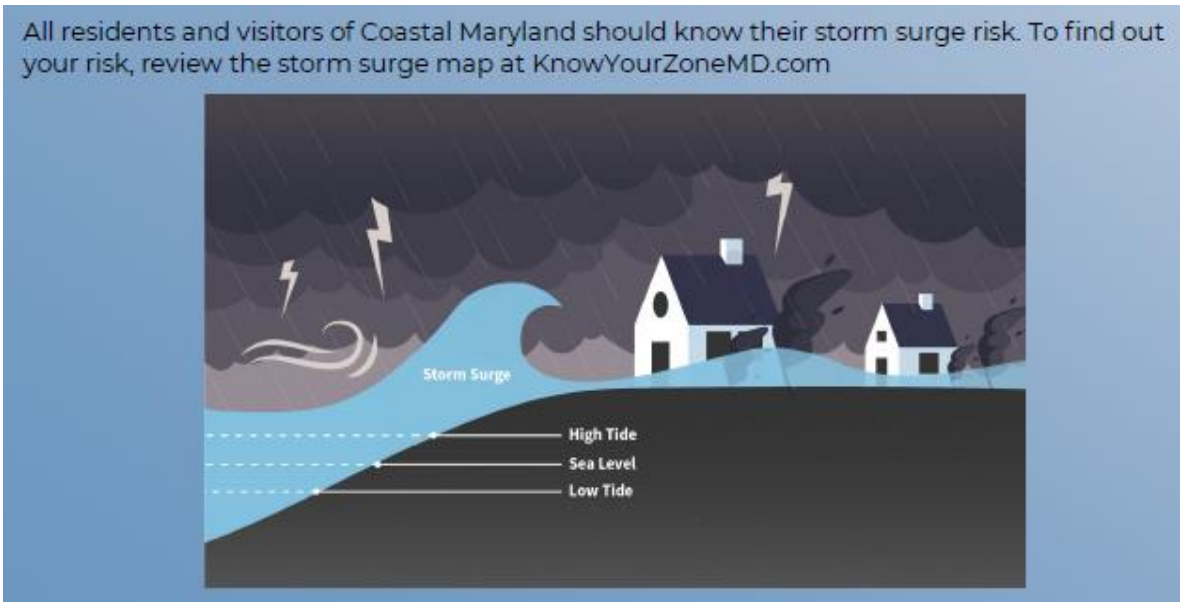
Table 4.5: Community Lifelines and Public Facilities in Storm Surge Areas

Facility Type	Number of Facilities	Facility Name	Address
Hurricane Category 1			
County Owned	8	Tyaskin Park	4778 Tyaskin Road
		Whitehaven Ferry	23865 River St
		Riverside Boat Ramp	Riverside Dr
		Bivalve Wharf	Bivalve Wharf Rd
		Nanticoke Harbor (2)	20411 Harbor Road
		Whitpquin Boat Launch	21664 Wetipquin Rd
		Upper Ferry	5420 N Upper Ferry Road
		Cedar Hill Marina & Park	20945 Harbor View Road
Tower	1	Wicomico County Tower	5635 Plantation Ln
Above Ground Storage Tanks	5	Perdue Inc (3 tanks)	521 Willow St
		Taylor Oil Co., Inc. (2 tanks)	333-335 Lake St
Underground Storage Tank	2	Valet Cleaners	223 Lake St.
		Walter Maycocks	600 West Main Street
Hurricane Category 2			
Please note, all facilities listed in Categories 1 Hurricane Storm Surge are included in Category 2.			
County Owned	3	Office of State's Attorney	309 E Main St
		Cope Bennett Park	100 Railway St
		Westside Solid Waste	20906 Nanticoke Road
Fire Department	1	Salisbury Fire Department - Station 16	325 Cypress St
Medical	1	William C Fritz Health Center	300 W Carroll St
Sanitary	2	Sharptown Sewer Plant	Little Water St
		Salisbury Pumping Station	611 Ridge Road
Tower	1	Tower	27410 Riverside Dr Ext
Hurricane Category 3			
Please note, all facilities listed in Categories 1 and 2 Hurricane Storm Surge are included in Category 3.			
County Owned	1	Library	122 S Division St
Underground Storage Tank	1	Mardela Goose Creek	24948 Ocean Gateway
Hurricane Category 4			
Please note, all facilities listed in Categories 1, 2, and 3 Hurricane Storm Surge are included in Category 4.			
County Owned	5	Housing Authority	613 Delaware Ave
		Housing Authority	611 Delaware Ave
		Housing Authority	609 Delaware Ave
		Cedar Hill Marina & Park	20945 Harbor View Road
		Youth & Civic Center/Rec, Park & Tourism Offices	500 Glen Ave
Fire Department	1	Sharptown Fire Department	317 Main St
Medical	1	Hurdle Health Center /Health Department	108 E Main St
Police	1	Salisbury Police Department	Police
Tower	4	Verizon	101 E. Main St.
		Verizon Wireless	25050 Nanticoke Rd
		Tower	24462 Nanticoke Rd
		Tower	4085 Disharoon Rd

Facility Type	Number of Facilities	Facility Name	Address
Above Ground Storage Tanks	1	Taylor Oil Company, Inc.-Bivalve Plant	3840 Texas Rd
Underground Storage Tank	4	Top Ten	825 West Isabella Street
		Wicomico Teen-Adult Center	Nanticoke St.
		Green Hill Yacht & Country Club	5471 White Haven Road
		Messick Funeral Home	20941 Nanticoke Rd

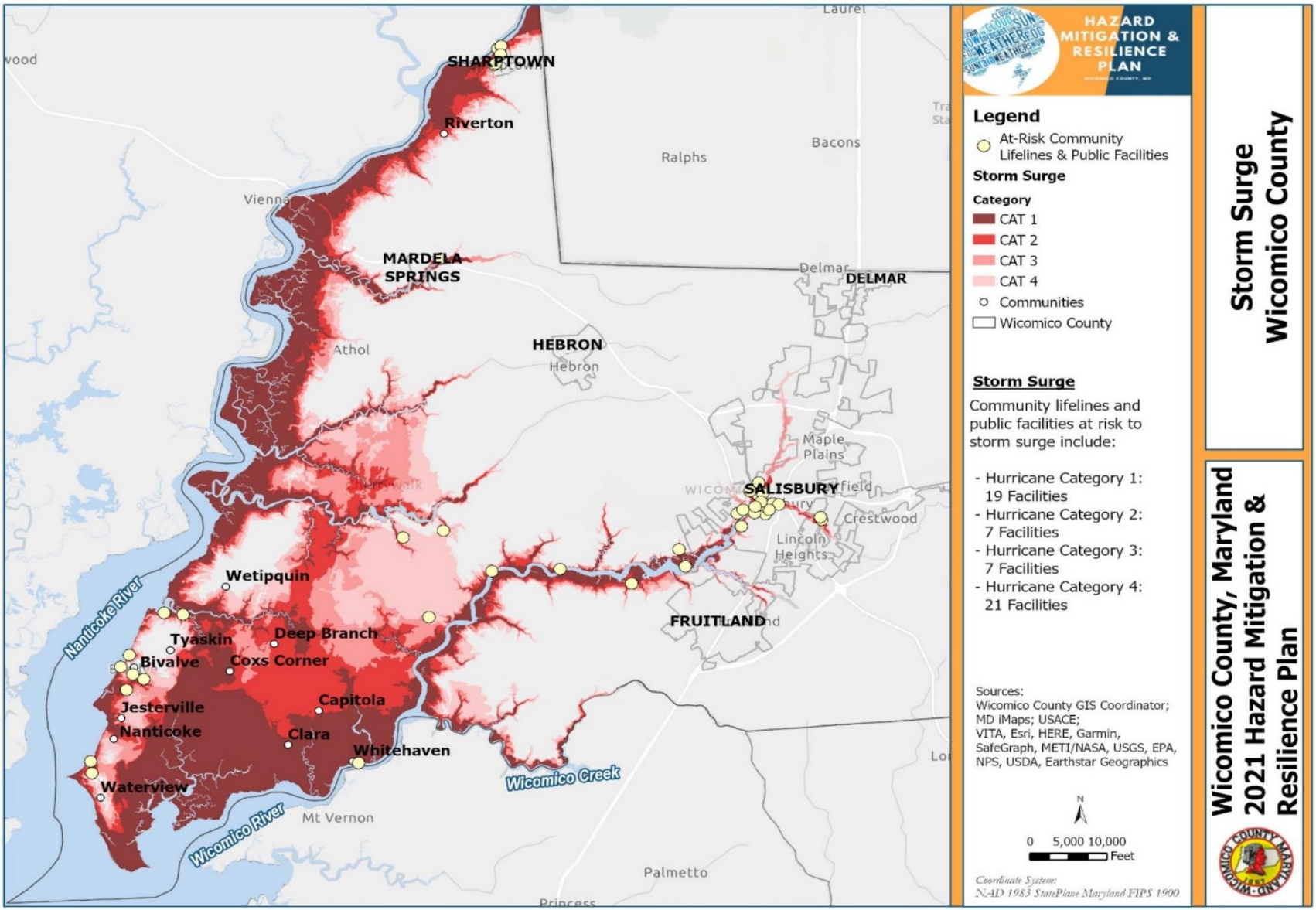
Map 4.8 illustrates the location of the community lifelines and public facilities within storm surge areas. The mapping does not reflect the expected storm surge flooding for every hurricane, or for any one hurricane. Instead, the data depicts an overall footprint of the area that has some risk of potential storm surge flooding due to hurricanes, based on the MOM output dataset.

A majority of the community lifelines and public facilities at risk are located around the Bivalve community and the City of Salisbury. Changing climate conditions resulting in increased storm activity and severity are projected to impact hurricane storm surge inundations areas. therefore, hurricane storm surge mitigation actions and recommendations should include projected future conditions.



Source: MDEM – Hurricane Evacuation Guide

Map 4.8: Storm Surge Relation to Community Lifelines & Public Facilities



FACILITIES AT RISK – MUNICIPALITIES OF WICOMICO COUNTY

Assessing hurricane storm surge vulnerability of municipal owned facilities (structures) was added as a new element during this plan update. Hurricane storm surge inundation areas and municipal facilities were mapped to determine which facilities were at risk to storm surge.

Municipal owned facilities listed on Table 4.6. A total of eight (8) facilities are vulnerable to hurricane storm surge. Municipal owned facilities at risk are located in the Town of Sharptown and the City of Salisbury. The remaining five (5) municipalities, Hebron, Delmar, Fruitland, Pittsville, and Willards did not own facilities within the hurricane storm surge inundation areas.

Table 4.6: Municipal Owned Facilities in Storm Surge Areas

Facility Type	Number of Facilities	Facility Name	Address
Hurricane Category 1 & 2			
Salisbury	3	Fire Training	317 & 325 Lake St
		Port of Salisbury Marina	506 W main Street
Hurricane Category 3			
Please note, all facilities listed in Categories 1 and 2 Hurricane Storm Surge are included in Category 3.			
Salisbury	2	Parking Garage	101 E Market St
		Salisbury Zoo	501 S Park Dr
Hurricane Category 4			
Please note, all facilities listed in Categories 1, 2, and 3 Hurricane Storm Surge are included in Category 4.			
Sharptown	1	Sharptown Town Hall	401 Main St
Salisbury	3	Fire Training Building	311 W Isabella St
		Housing Authority	621 Delaware Ave
		Housing Authority	610 Pearl St

Salisbury Zoo – October 2016 Flood Event
Source: MDEM – https://www.wboc.com/story/33310634/alpaca-dies-during-floods-cleanup-continues-at-salisbury-zoo
Photo Source: Salisbury Zoo

COMMERCIAL & RESIDENTIAL STRUCTURES AT RISK - MUNICIPAL

Commercial and residential structures located within the seven (7) municipalities of Wicomico County were assessed to determine storm surge vulnerability. This assessment including mapping products was added as a new element during the plan update. Assessment results indicate that commercial and residential structures within the Cities of Fruitland (Map 4.9) and Salisbury (Map 4.10) and the Towns Mardela Springs (Map 4.11), and Sharptown (Map 4.12) are located within the hurricane storm surge inundation areas.

Fruitland

The City of Fruitland is vulnerable to hurricane storm surge categories 3 and 4 along the eastern border. One (1) structure along Covered Bridge Lane is in Hurricane Storm Surge Category 3, while six (6) are within Category 4.

Salisbury

The hurricane storm surge inundation area surrounding Wicomico River, Coty Cox Branch, Johnson Pond, Peggy Branch, Schumaker Pond, Tony Tank Pond, Morris Prong. A total of 740 structures are vulnerable to the hurricane storm surge categories 1 to 4.

Mardela Springs

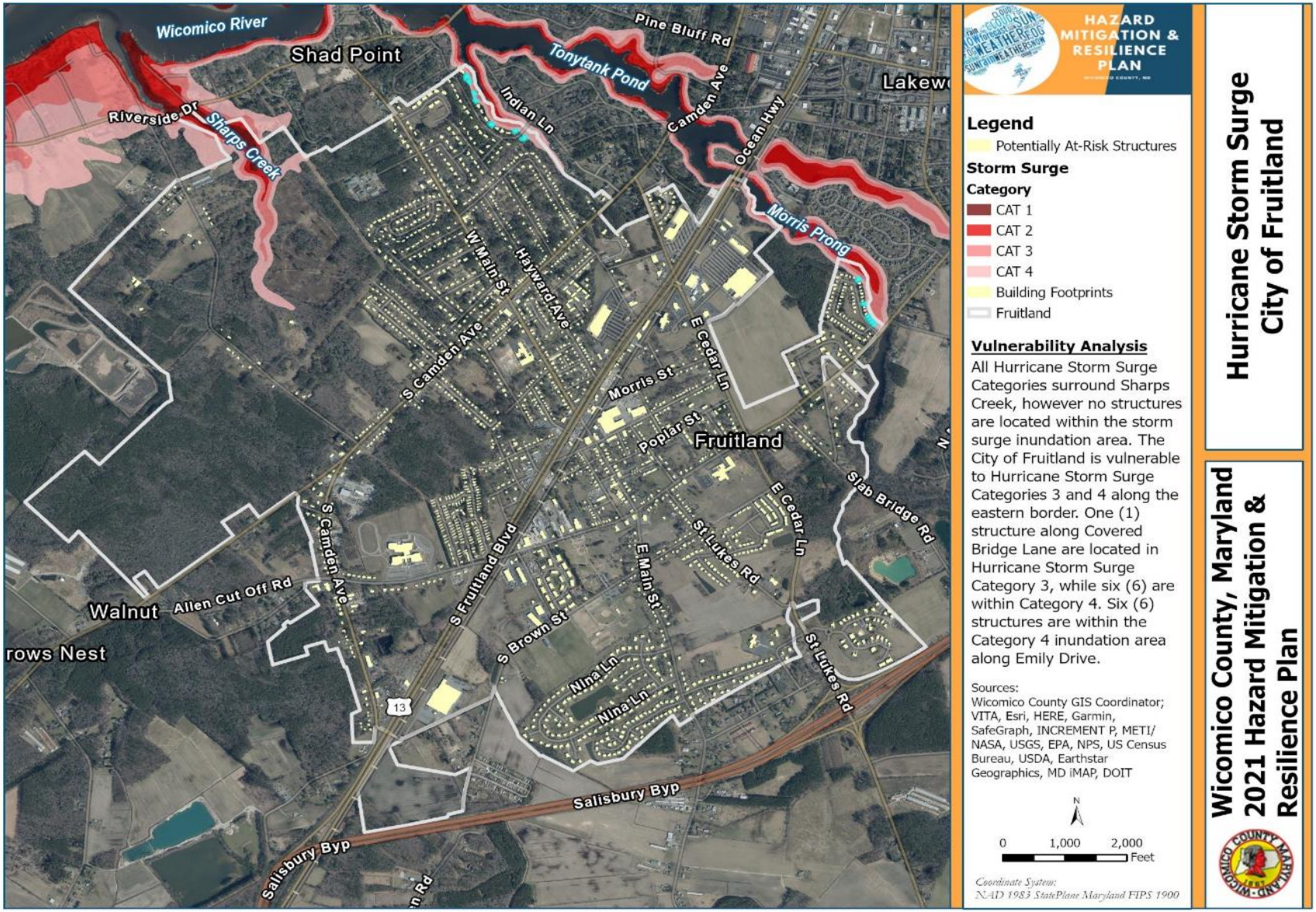
The hurricane storm surge inundation area surrounding Barren Creek. A total of 14 structures are vulnerable to the hurricane storm surge categories 1 to 4.

Sharptown

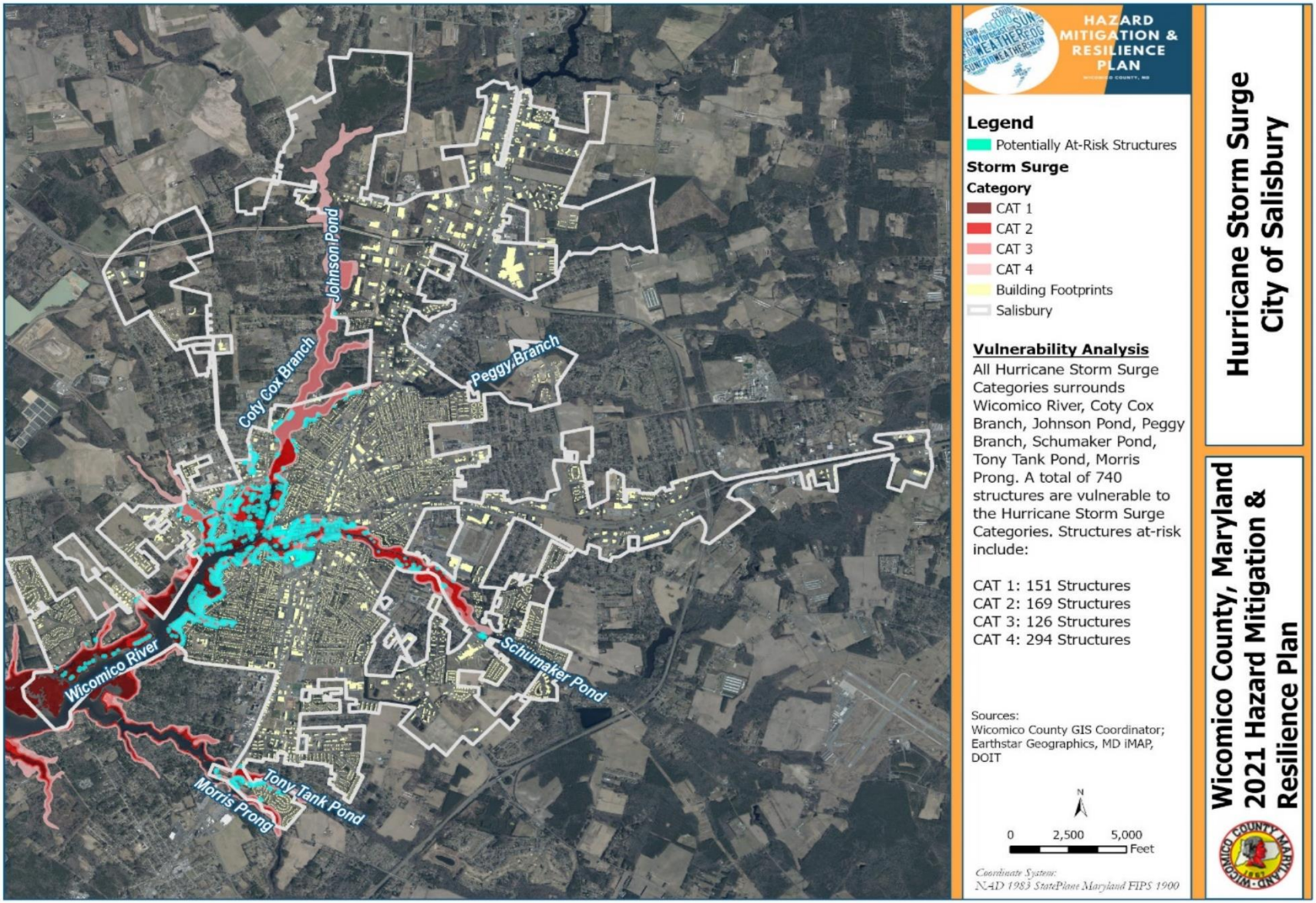
The hurricane storm surge inundation area along the Nanticoke River affects the Town of Sharptown. A total of 175 structures are at-risk to the hurricane storm surge categories 1 to 4. The Sharptown Fire Department is located in Categories 3 and 4.

Note: Flood vulnerability assessment results were shared with and reviewed by municipal representatives.

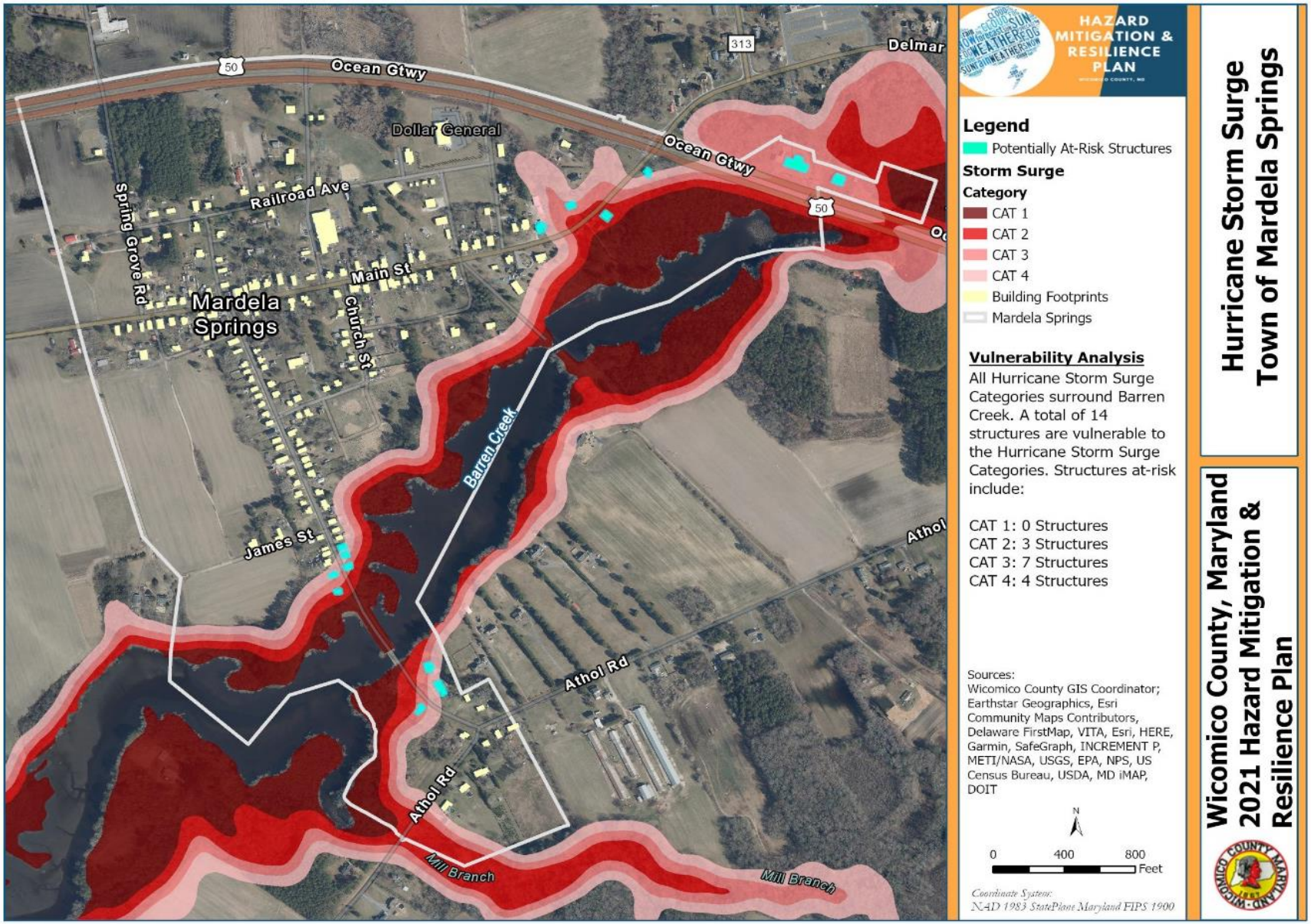
Map 4.9: At-Risk Municipal Facilities – City of Fruitland



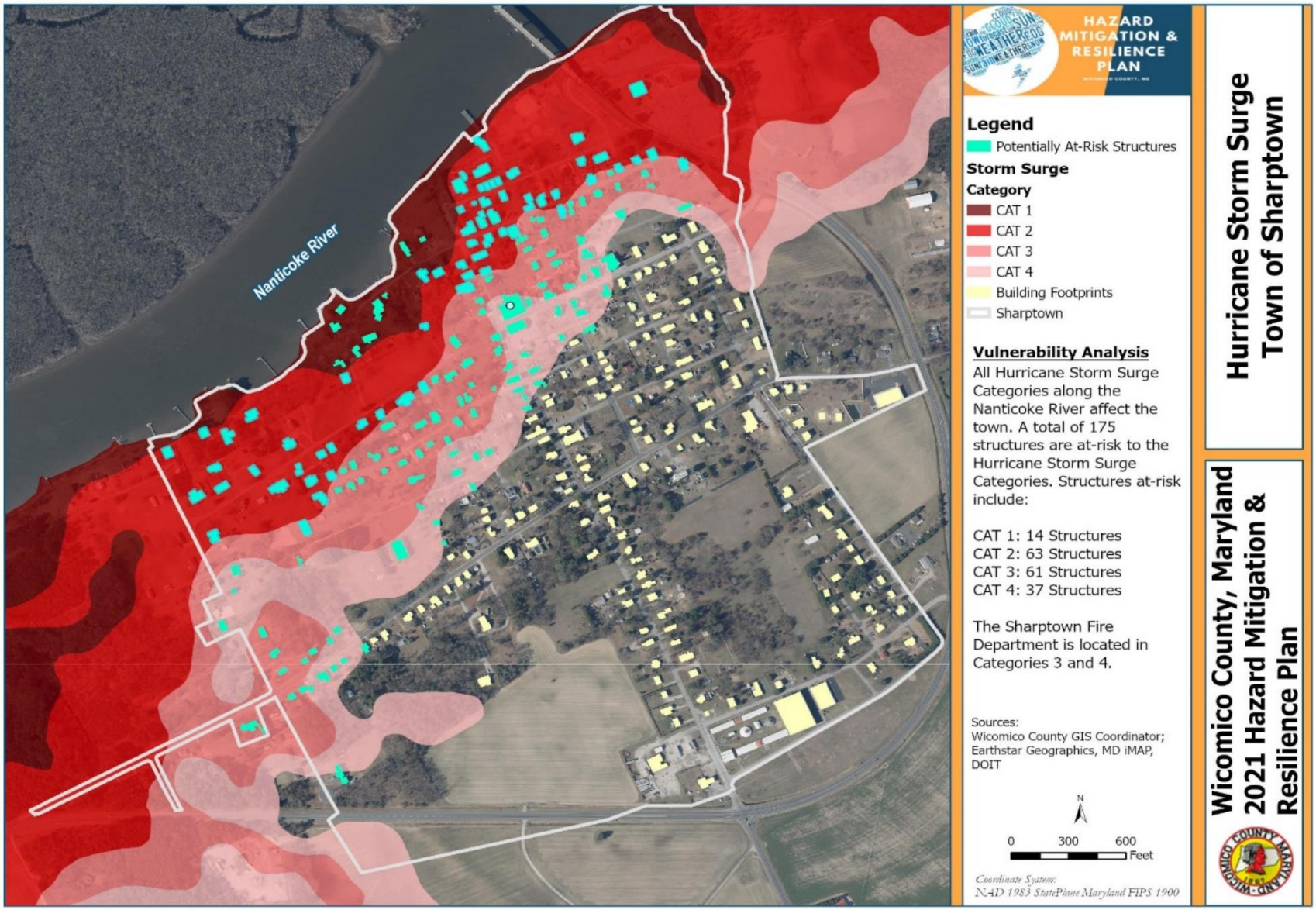
Map 4.10: At-Risk Municipal Facilities – City of Salisbury



Map 4.11: At-Risk Municipal Facilities – Town of Mardela Springs



Map 4:12: At-Risk Municipal Facilities – Town of Sharptown



LOSS ESTIMATIONS - UNINCORPORATED COMMUNITY LIFELINES & PUBLIC FACILITIES

Loss estimates for community lifelines and public facilities located in the hurricane storm surge inundation areas were assessed. Structure improvement values using the most recent Maryland Tax Assessment values are included in Table 4.7.

Table 4.7: Loss Estimates for Community Lifelines and Public Facilities

Facility Type	Facility Name	Loss Estimate (Structure Improvement Values)	Total
Hurricane Category 1			
County Owned	Tyaskin Park	$5,800	$417,000
	Whitehaven Ferry	$1,300	
	Riverside Boat Ramp	$56,700	
	Bivalve Wharf	$1,700	
	Nanticoke Harbor (2)	$160,400	
	Wetipquin Boat Launch	$9,900	
	Upper Ferry Harbor	$1,500	
	Cedar Hill Marina & Park	$179,700	
Tower	Wicomico County Tower	*$175,000	$175,000
Above Ground Storage Tanks	Perdue Inc (3 tanks)	**$1,500	$3,000
	Taylor Oil Co., Inc. (2 tanks)	**$1,500	
Underground Storage Tank	Valet Cleaners	**$1,500	$3,000
	Walter Maycocks	**$1,500	
Hurricane Category 2			
Please note, all facilities listed in Categories 1 Hurricane Storm Surge are included in Category 2.			
County Owned	Office of State's Attorney	$3,091,300	$3,115,000
	Cope Bennett Park	$21,000	
	Westside Solid Waste	$2,700	
Fire Department	Salisbury Fire Department – Station 16	$7,618,600	$7,618,600
Medical	William C Fritz Health Center	$1,199,700	$1,199,700
Sanitary	Salisbury Sewage Pumping Plant	$98,900	$150,500
	Salisbury Pump Station M Park	$51,600	
Tower	Tower	*$175,000	$175,000
Hurricane Category 3			
Please note, all facilities listed in Categories 1 and 2 Hurricane Storm Surge are included in Category 3.			
County Owned	Library	$3,918,500	$3,918,500
Underground Storage Tank	Mardela Goose Creek	**$1,500	$1,500
Hurricane Category 4			
Please note, all facilities listed in Categories 1, 2, and 3 Hurricane Storm Surge are included in Category 4.			
County Owned	Housing Authority	$45,700	$26,428,700
	Housing Authority	$45,700	
	Housing Authority	$45,700	
	Cedar Hill Marina & Park	$179,700	
	Youth & Civic Center/Rec, Park & Tourism Offices	$26,111,900	
Fire Department	Sharptown Fire Department	$349,200	$349,200
Medical	Hurdle Health Center /Health Department	$4,249,900	$4,249,900
Police	Salisbury Police Department	$8,124,800	$8,124,800

Facility Type	Facility Name	Loss Estimate (Structure Improvement Values)	Total
Tower	Verizon	*$175,000	$700,000
	Verizon Wireless	*$175,000	
	Tower	*$175,000	
	Tower	*$175,000	
Above Ground Storage Tanks	Taylor Oil Company, Inc.- Bivalve Plant	**$1,500	$1,500

Source: Smith Planning and Design, Maryland Property View- Parcel Dataset June 2020
**Average cost for a cell tower.*
***Average cost for above and underground storage tanks*

LOSS ESTIMATIONS - MUNICIPAL OWNED

Loss estimates for municipal owned facilities located in the hurricane storm surge inundation areas were assessed. Current assessment values within the City of Salisbury's parcel database were used, while structure improvement values from the most recent Maryland Tax Assessment value were used for the Town of Sharptown.

Table 4.8: Municipal Owned Facilities in Storm Surge Areas

Facility Type	Facility Name	Loss Estimate (Structure Improvement Values)	Total
Hurricane Category 1 & 2			
Salisbury	Fire Training	$88,433	$88,433
	Port of Salisbury Marina	$125,500	$125,500
Hurricane Category 3			
Please note, all facilities listed in Categories 1 and 2 Hurricane Storm Surge are included in Category 3.			
Salisbury	Parking Garage	$2,224,100	$2,224,100
	Salisbury Zoo	$2,556,000	$2,556,000
Hurricane Category 4			
Please note, all facilities listed in Categories 1, 2, and 3 Hurricane Storm Surge are included in Category 4.			
Sharptown	Sharptown Town Hall	$202,100	$202,100
Salisbury	Fire Training Building	$159,100	$201,700
	Housing Authority	$16,800	
	Housing Authority	$25,800	

LOSS ESTIMATION BY LAND USE – COUNTYWIDE

Loss estimates for the previous planning process were calculated in dollars for all facilities, including community lifelines and public facilities by land use using Maryland Tax Assessment values listed in Table 4.9. This information was reviewed, and new information was included for this plan update in Table 4.10.

Table 4.9: Storm Surge - Loss Estimates for All Facilities by Land Use

Land Use	Loss Estimates by Storm Surge Category			
Hurricane Category	**CAT 1**	**CAT 2**	**CAT 3**	**CAT 4**
Agricultural	6,536,830	8,790,320	17,003,510	29,867,320
Apartments	0	0	192,600	4,867,900
Commercial	0	878,500	2,359,000	21,247,700
Commercial Condominium	0	0	0	954,700
Commercial Residential	0	0	334,000	334,000
Exempt	0	139,000	139,000	1,598,070
Exempt Commercial	473,000	603,100	1,855,000	15,171,200
Industrial	592,500	1,158,300	1,344,200	3,174,300
Marsh Land	35,790	35,790	35,790	35,790
Residential	29,225,480	40,208,990	75,287,690	200,806,740
Residential Condominium	608,400	608,400	1,622,240	8,304,930
Town House	0	0	0	254,910

Source: Maryland Property View and Smith Planning and Design

In determining loss estimations for the 2021 Plan update, structures constructed between 2017 and April 2021 were derived from permit data provided by Wicomico County Permit and Inspections Division. Loss estimates were included for these new structures using Maryland Tax Assessment improvement values. Table 4.10 lists the total number of new structures that have been constructed within the hurricane storm surge inundation areas.

Table 4.10: 2021 Loss Estimates for New Construction by Land Use

Land Use	Loss Estimates			
Hurricane Category	**CAT1**	**CAT 2**	**CAT 3**	**CAT 4**
Agricultural	$0	$0	$0	$0
Commercial	1 structure $145,900	$0	$0	$0
Residential	11 structures $2,767,800	7 structures* $1,332,400	3 structures* $491,000	4 structures $859,600

Source: Wicomico County Permit and Inspections Division and Smith Planning and Design
** One new construction is a replacement mobile home.*
Please note, all facilities listed in Categories 1, 2, and 3 Hurricane Storm Surge are included in Category 4.

4.4 COASTAL FLOOD RISK

HAZARD CHARACTERIZATION

A coastal flood, or the inundation of land areas along the coast, is caused by higher-than-average high tide and worsened by heavy rainfall and onshore winds (i.e., wind blowing landward from the ocean); while a flood is a general and temporary inundation of normally dry land areas. When a coastal process such as waves, tides, and/or storm surge produces that flood condition, it is referred to as a coastal flood.

Chapter 8 Flooding included flood zones associated with riverine and flash flooding, whereas, FEMA coastal flood zones are included in this section.

Coastal Zones

COASTAL SPECIAL FLOOD HAZARD AREA (COASTAL SFHA)

The portion of the SFHA where the base flood is from a coastal flooding source. On the FIRM, the coastal SFHA is designated by Zones VE (which are unique to coastal areas), AE, and AO. SFHAs typically have multiple BFEs that vary along the coast and change as you move inland.

COASTAL HIGH HAZARD AREA (CHHA)

A Coastal High Hazard Area (CHHA) is identified as Zone V or Zone VE on FEMA flood maps. These parts of the coastal SFHA are called "V zones" and they show areas where waves and fast-moving water can cause extensive damage during the base flood event. In V zones, wave heights are larger than 3 feet. "Zone VE" means that a detailed study has been done for the area, and BFEs have been calculated. The label "Zone V" means that a detailed study has not been done for the area. BFE data is not available, but wave hazards are still expected.

Structures in areas mapped as Zone V and Zone VE are subject to stricter building requirements because of the higher risk of damage from strong waves.

ZONE AE

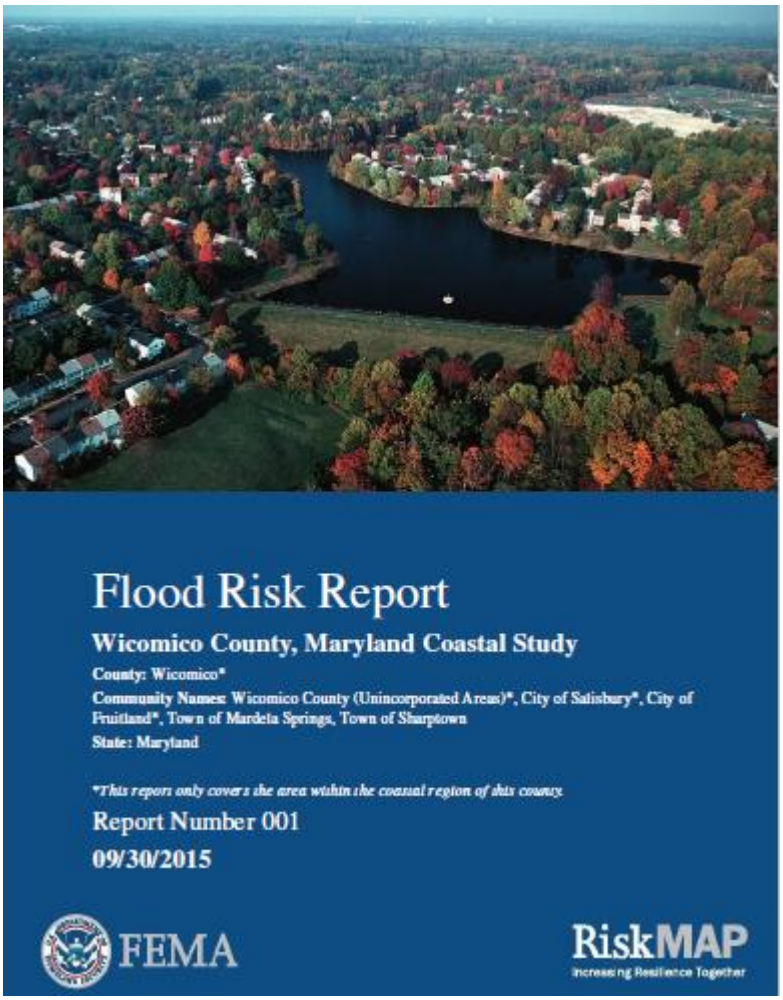
Zone AE is used to label parts of the SFHA on flood maps in coastal and non-coastal areas. In coastal areas, AE zones indicate areas that have at least a 1-percent-annual-chance of being flooded and wave heights are less than 3 feet. For Zone AE, detailed analyses have been performed and BFEs have been calculated.

Source: https://www.fema.gov/sites/default/files/documents/fema_coastal-glossary.pdf

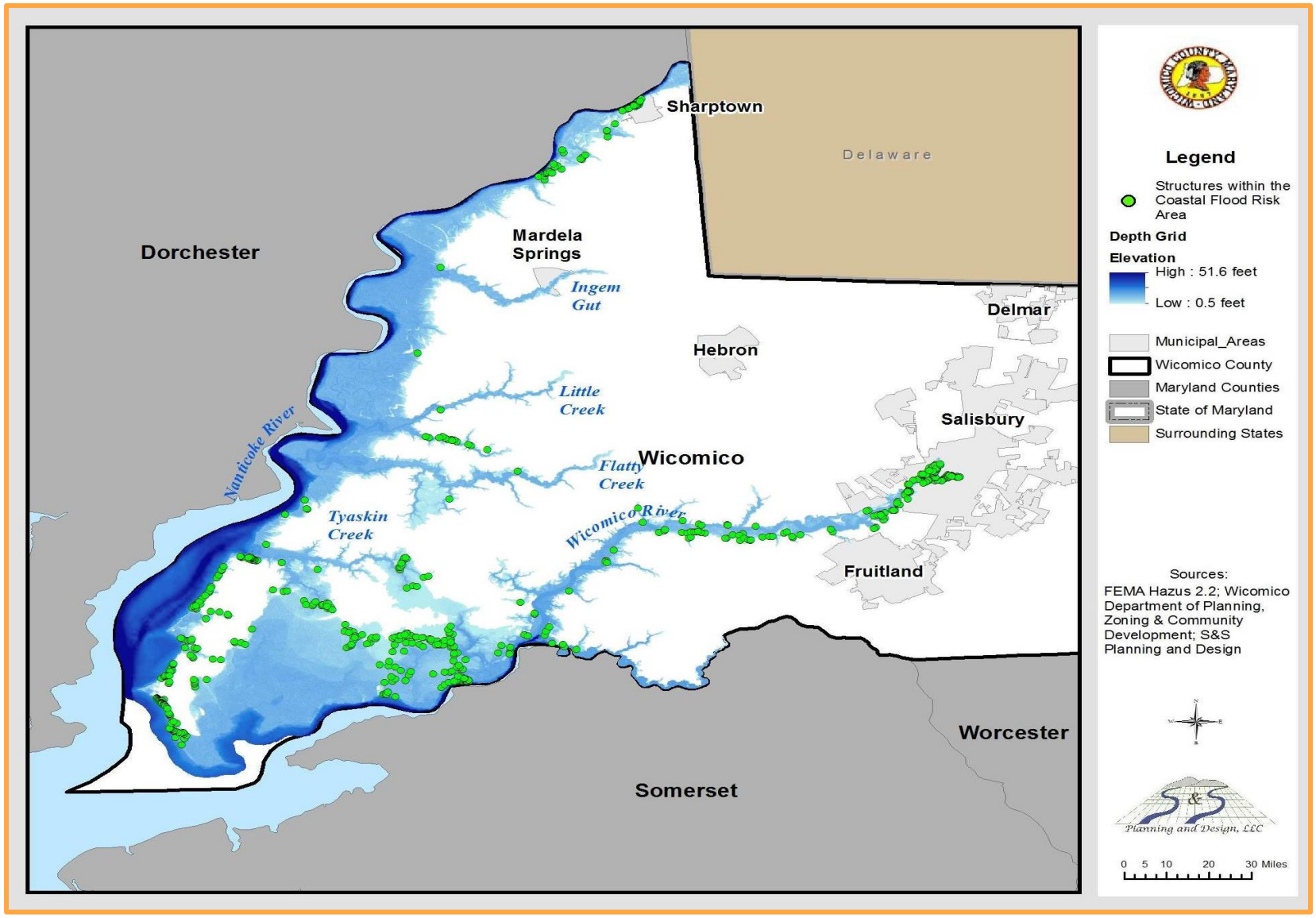
HAZARD RISK & HISTORY

The Maryland Department of Environment (MDE) and Maryland Department of Emergency Management (MDEM) are developing Non-Regulatory Coastal Flood Risk Product for jurisdictions located within the coastal area of the Chesapeake Bay. This planning initiative is intended to assist local communities with increasing their resiliency to flooding and to better protect their citizens. Results are provided in a Flood Risk Report (FRR), which is not intended to be regulatory or the final authoritative source of all flood risk data in the project area. The report is intended to be used in conjunction with other data sources to provide a comprehensive picture of flood risk within the project area.

FEMA's HAZUS program was utilized to determine coastal flood losses for the 1-percent-annual-chance flood event. In order to accurately calculate loss estimates, user defined data was imported into HAZUS for the coastal flood risk product. First, depth grids were developed using the high-resolution digital elevation model (DEM) and FIRM Zones AE and VE with a static base flood elevation (BFE) for the approved Digital Flood Insurance Rate Maps (DFIRM). Flood depths were obtained by subtracting the water surface from the ground elevation; hence depth grids. Next, the user defined facility inventory was developed. User defined inventory includes residential, commercial and other (industrial, agriculture, religion, government and educational). Building footprints were utilized to determine which structures were located within the flood zone. The lowest adjacent grade was determined for each structure within the flood risk area to depict where the flood will be the highest on each structure affected. Additionally, information from the 2012 Maryland Property View Database was incorporated to ensure all necessary attributes were captured in order to obtain more accurate loss estimates. By inputting user defined data and inventory into the HAZUS program, site-to-site results versus an aggregated table of damages and losses is provided. Map 4.3 below depicts the depth grid and user defined structures located within the coastal 100-year floodplain.



Map 4.13: Non-Regulatory Coastal Flood Risk – HAZUS Coastal Analysis



VULNERABILITY

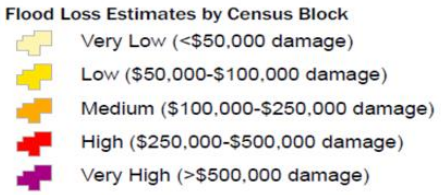
To help coastal communities understand and reduce their risks, FEMA has initiated coastal flood hazard studies. According to the Flood Risk Report developed for Wicomico County in 2015, the coastal flood risk is highest in areas of the county that lie close to the Chesapeake Bay and the Nanticoke and Wicomico Rivers. These areas include the Towns of Mardela Springs and Sharptown, which have the highest percentage of coastal land area, followed by the City of Fruitland. Forty-nine percent of the unincorporated portion of the county's land area is coastal.

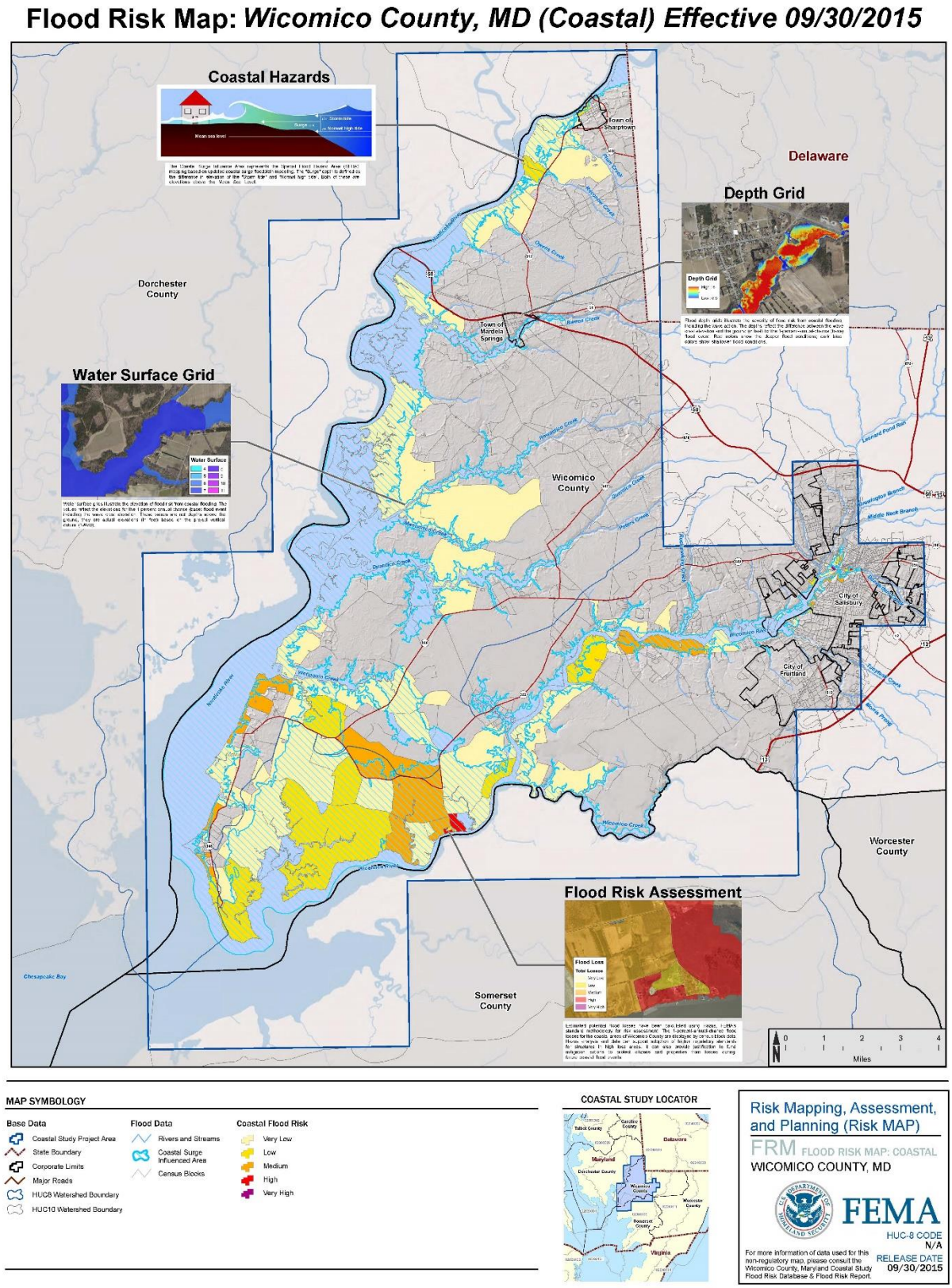
Community Name	CID	Total Community Population[1]	Percent of Population in County (Coastal)	Total Community Land Area (sq mi)	Percent of Land Area in County (Coastal)	NFIP	CRS Rating
City of Salisbury	240080	30,343	72	13.4	53	Y	10
City of Fruitland	240139	4,866	81	3.8	81	Y	10
Town of Mardela Springs	240079	347	100	0.4	100	Y	10
Town of Sharptown	240081	651	100	0.4	100	Y	10
Wicomico County (Unincorporated Areas)	240078	56,064	51	350.3	49	Y	10

[1]Population according to 2010 U.S. Census

Source: 2015 Wicomico County Flood Risk Report

The Flood Risk Report (FRR) also included a Flood Risk Map. According to the FRR, the Flood Risk Map includes a countywide map of estimated flood losses by census block and summary tables for the entire project area, and a series of maps for High-Risk Areas (places in the county that have a large amount of flood damage in a concentrated area). High-Risk Areas are created by grouping together adjacent Census Blocks with high flood loss estimations. As shown below on the Flood Risk Map for Wicomico County, the area around the community of Whitehaven was denoted in red as the High-Risk Area.



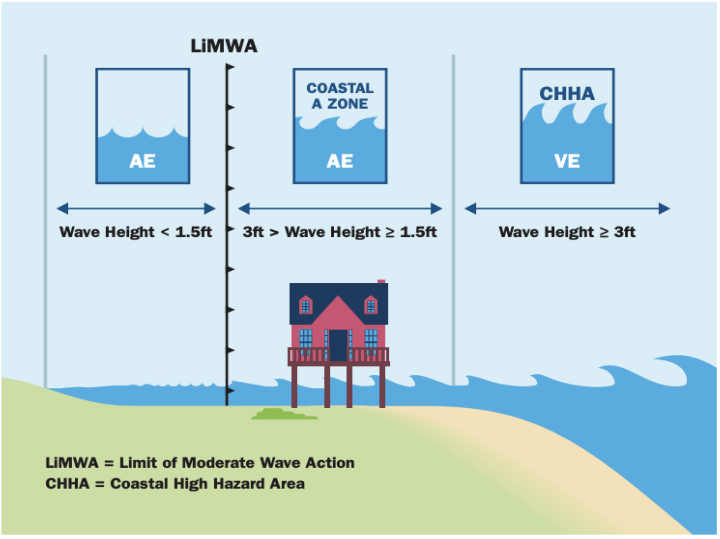


Source: 2015 Wicomico County Flood Risk Report

In addition to coastal flood, Wicomico County also has Limit of Moderate Wave Action (LiMWA). This information line is located along the coastal area and marks the inland limit of the Coastal A Zone. FEMA's LiMWA Fact Sheet states that due to the higher risk of wave damage to structures in the Coastal A Zone, FEMA encourages communities to apply VE Zone floodplain managements standards in this area.

Limit of Moderate Wave Action (LiMWA)

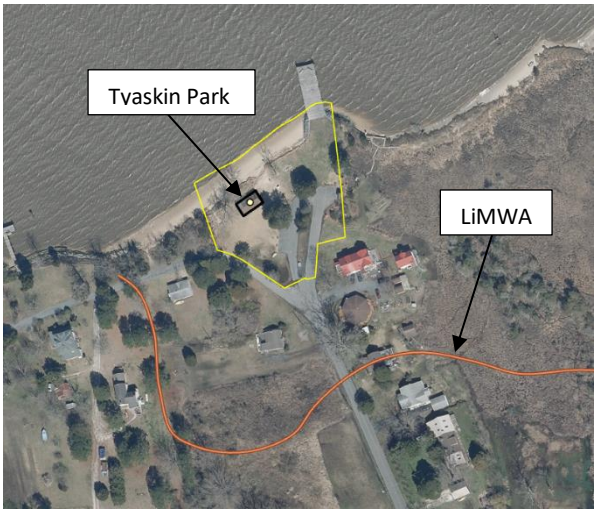
Flood maps in coastal areas may include a line called the Limit of Moderate Wave Action (LiMWA). The LiMWA marks the inland limit of the "Coastal A Zone," a term referenced by building codes and standards. The Coastal A Zone is the part of the coastal SFHA where wave heights can be between 1.5 and 3 feet during the base flood event. Because of the higher risk of damage to homes and other structures from waves in the Coastal A Zone, FEMA encourages the practice of building to Zone V standards within this area. Many local building codes require that buildings in the Coastal A Zone be built to Zone V standards. However, the LiMWA does not impose any additional National Flood Insurance Program (NFIP) regulations.



The Limit of Moderate Wave Action (LiMWA) is depicted below. Several communities are in close proximity to the LiMWA including Bivalve, Jesterville, Nanticoke, Waterview, Clara, and Whitehaven. The community of Whitehaven was also determined to be in the High-Risk Area in the Flood Risk Report.

Several public facilities (county owned) are located within or next to the LiMWA. These facilities are parks and include accommodations for boats. Only two (2) county owned facilities contain structures located between the shoreline and the LiMWA and included:

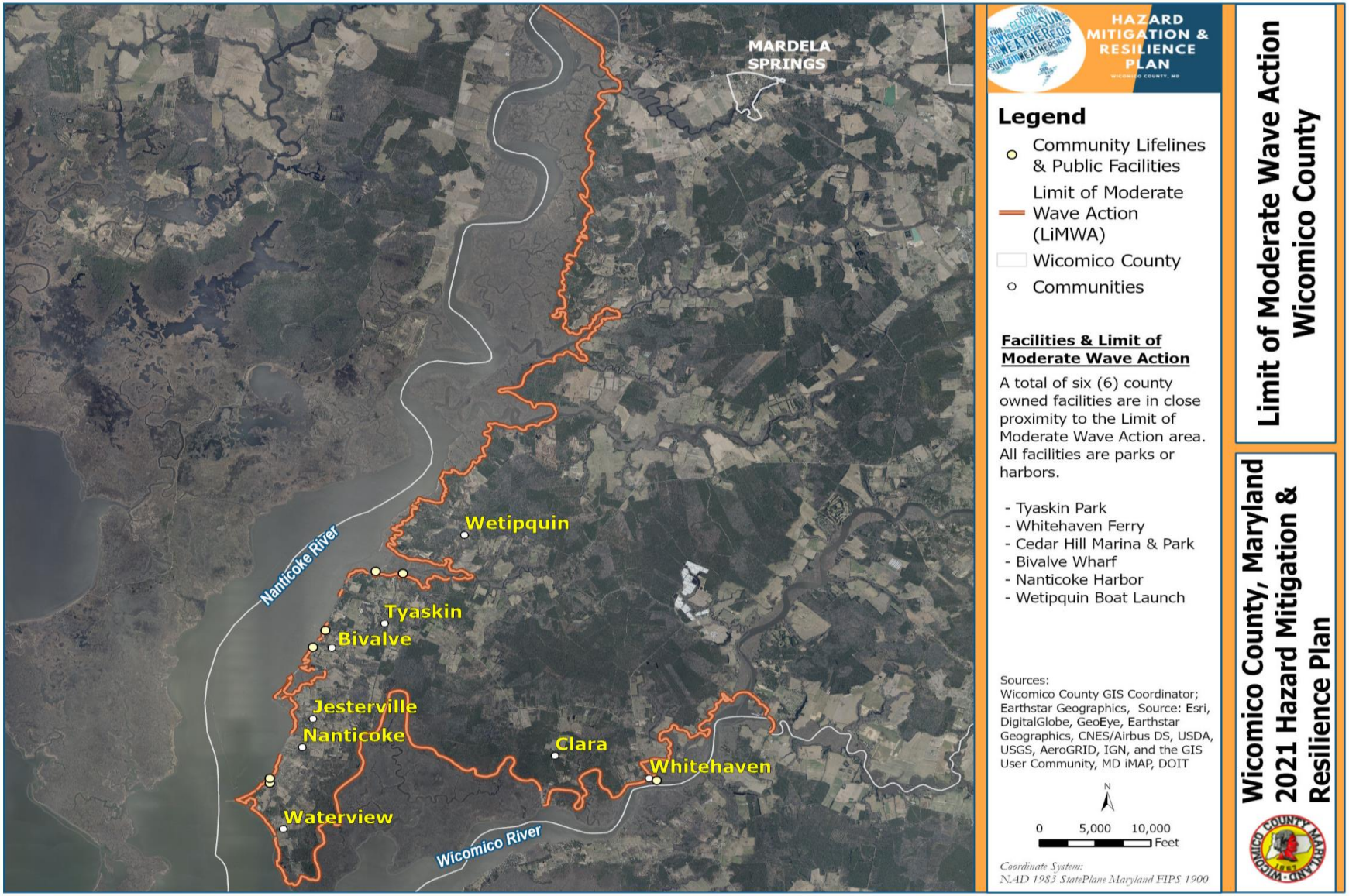
- Tyaskin Park (1 structure - pavilion); and,
- Whitehaven Ferry (1 structure and pier).



The following public facilities are within or in close proximity to the LiMWA, however do not have structures within the LiMWA.

- Cedar Hill Marina & Park (structure just outside of LiMWA);
- Bivalve Wharf (pier);
- Nanticoke Harbor (two boat ramps, loading ramp, and 68 boat slips); and,
- Wetipquin Boat Launch (boat ramp).

Map 4.14: Limit of Moderate Wave Action

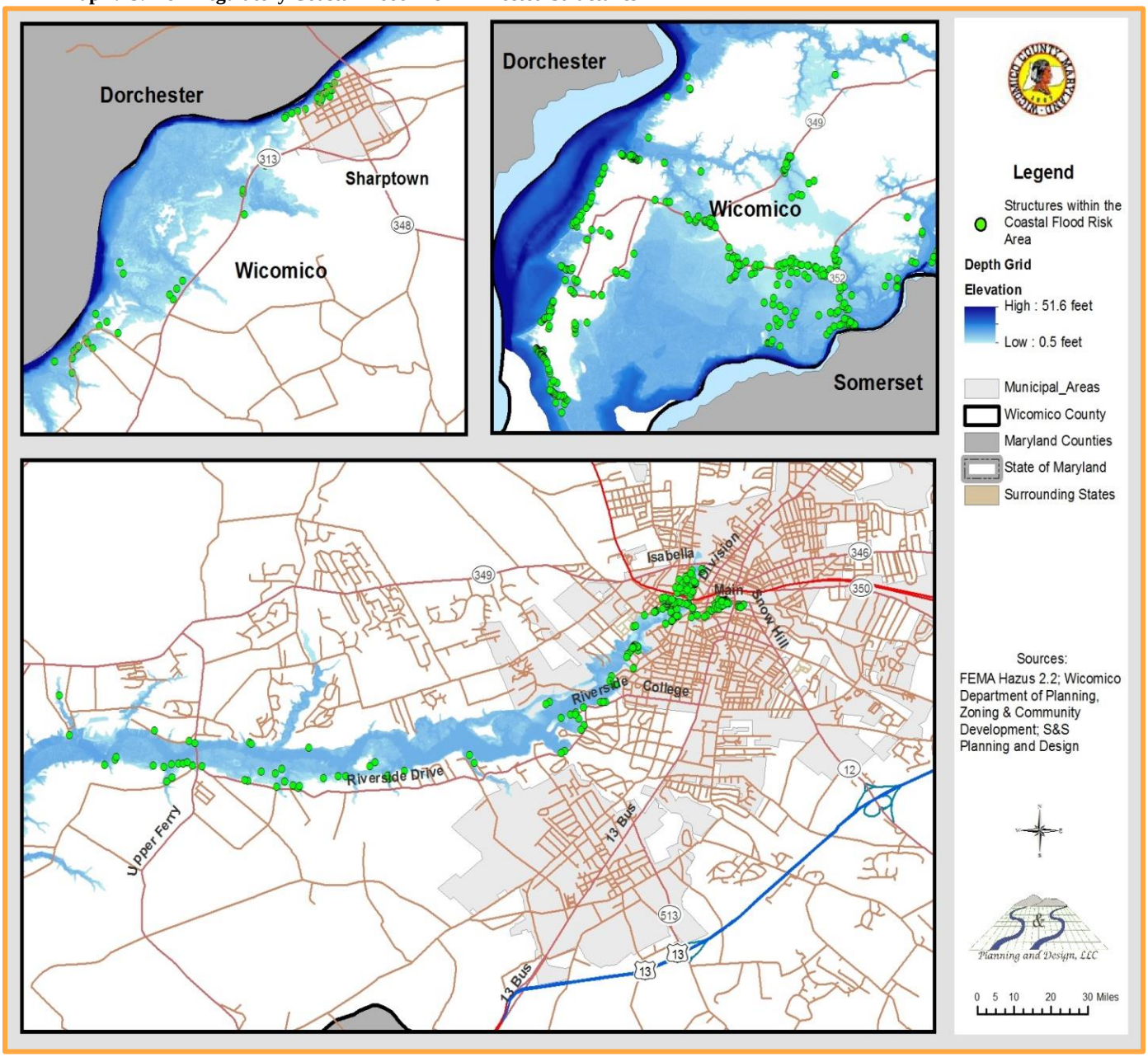


FACILITIES AT-RISK

1. Non-Regulatory Coastal Flood Risk Product

A total of 619 structures are located within the coastal flood zone. As depicted in Map 4.15, affected structures are concentrated in three locations: Town of Sharptown, City of Salisbury and the unincorporated southwestern portion of the County. The Town of Sharptown comprises 3% of structures located within the coastal floodplain, while the City of Salisbury contains 25% and the remaining 72% are within the unincorporated areas of the County. A total of 516 structures affected by coastal flooding are residential. The remaining structures are comprised of structures such as commercial, industrial, etc.

Map 4.15: Non-Regulatory Coastal Flood Risk – Affected Structures



LOSS ESTIMATIONS

The Non-Regulatory coastal flood risk analysis incorporates results from a HAZUS Coastal Flood analysis which accounts for newly modeled areas in the Coastal Flood Risk Project and newly modeled depths for the 1-percent-annual-chance flood event. Potential losses were compared with state-level tax data and locally provided building footprints to estimate loss estimations for the 1-percent-annual-chance flood scenario. The following tables provide the overall cost of structures within the flood prone areas and their associated loss estimates.

Table 4.11: Non-Regulatory Coastal Flood Risk – User Defined Facilities within Affected Area

Political Area	Total Cost	Total Residential Cost	Total Commercial Cost	Total Other Cost
Wicomico County Unincorporated Areas	$95,771,000.00	$92,601,200.00	$2,308,000.00	$861,800.00
Town Of Delmar	$0.00	$0.00	$0.00	$0.00
Town Of Fruitland	$0.00	$0.00	$0.00	$0.00
Town Of Hebron	$0.00	$0.00	$0.00	$0.00
Town Of Mardela Springs	$0.00	$0.00	$0.00	$0.00
City Of Salisbury	$62,149,200.00	$15,604,200.00	$4,505,800.00	$21,978,200.00
Town Of Sharptown	$2,620,400.00	$2,582,200.00	$38,200.00	$0.00
Town Of Pittsville	$0.00	$0.00	$0.00	$0.00
Town Of Willards	$0.00	$0.00	$0.00	$0.00
Wicomico County, Maryland Coastal Study	**$160,540,600.00**	**$110,787,600.00**	**$6,852,000.00**	**$22,840,000.00**

Source: FEMA HAZUS

Note: Municipalities containing $0.00 value losses did not contain structures within the coastal risk area according to the HAZUS model. Both Fruitland and Mardela Springs contain areas of risk, however these risk areas are 3.8 and 0.4 square miles, respectively. Refer to Appendix J – Non-Regulatory Coastal Flood Risk Product, page 25.

Table 4.12: Non-Regulatory Coastal Flood Risk – Loss Estimations

Political Area	Total Cost	Total Residential Cost	Total Commercial Cost	Total Other Cost
Wicomico County Unincorporated Areas	$7,068,228.00	$6,109,036.00	$518,629.00	$115,173.00
Town Of Delmar	$0.00	$0.00	$0.00	$0.00
Town Of Fruitland	$0.00	$0.00	$0.00	$0.00
Town Of Hebron	$0.00	$0.00	$0.00	$0.00
Town Of Mardela Springs	$0.00	$0.00	$0.00	$0.00
City Of Salisbury	$3,320,396.00	$695,004.00	$2,056,446.00	$568,946.00
Town Of Sharptown	$188,280.00	$177,818.00	$10,462.00	$0.00
Town Of Pittsville	$0.00	$0.00	$0.00	$0.00
Town Of Willards	$0.00	$0.00	$0.00	$0.00
Wicomico County, Maryland Coastal Study	**$10,576,904.00**	**$6,981,858.00**	**$2,585,537.00**	**$684,119.00**

Source: FEMA HAZUS

4.5 NUISANCE FLOODING

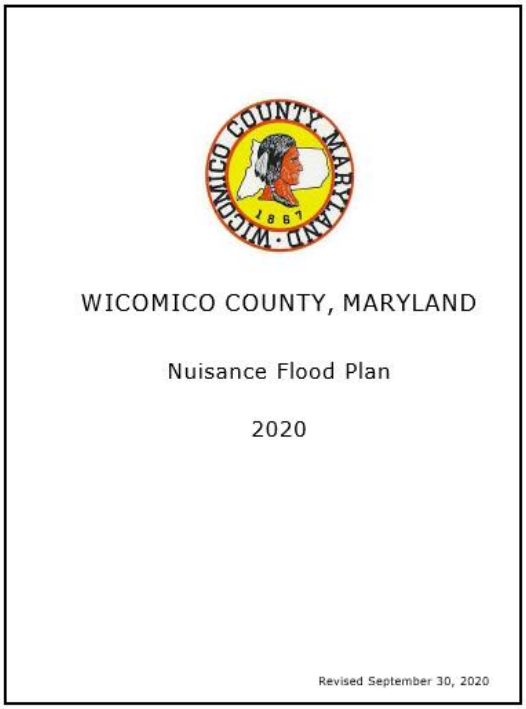
HAZARD CHARACTERIZATION

Nuisance flooding is defined in **§3-1001 of the Natural Resource Article of the Maryland Annotated Code** as "high-tide flooding that causes public inconvenience."

Nuisance flooding is associated with high tides that flow back through the stormwater system, increasing/raising the level of groundwater, and overtopping the banks and edges of waterways. Nuisance flooding is an indicator of rising water levels in the Chesapeake Bay and its tributaries. Areas that were previously dry now flood during high tides because the water elevation is high enough to lap over the banks of waterways and to enter stormwater systems through outfalls that were previously high enough to prevent backflow, while allowing outflow.

HAZARD RISK & HISTORY

Maryland Senate Bill (SB) 1407 states that "on or before October of 2020, a local jurisdiction that experiences nuisance flooding shall develop a plan to address nuisance flooding." The legislation further specifies that the plan must be submitted to the Maryland Department of Planning, published on the local jurisdiction's website, and updated at least every five years. Wicomico County's Nuisance Flood Plan was revised in September 2020 and was approved by the State. In addition, the City of Salisbury Nuisance Flooding Plan was published July 1, 2019.


WICOMICO COUNTY, MARYLAND

Nuisance Flood Plan

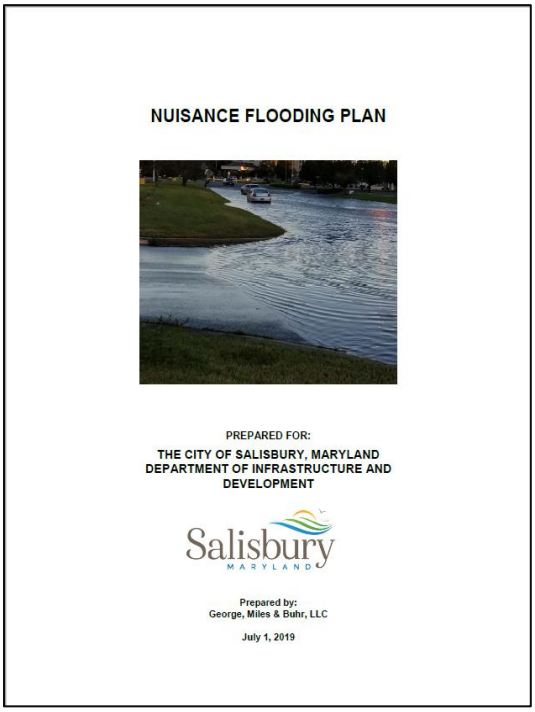
2020

Revised September 30, 2020

Wicomico County is a coastal community located in southeastern Maryland on the Delmarva Peninsula. The City of Salisbury is the only municipality that experiences tidal nuisance flooding, and as such a separate Nuisance Flood Plan was developed. Both nuisance flood plans were reviewed and integrated for this plan update.

VULNERABILITY

Areas of nuisance tidal flooding vulnerability were identified in both the 2020 Wicomico County Nuisance Flood Plan (WCNFP) and the 2019 City of Salisbury Nuisance Flooding Plan. According to the WCNFP, only unincorporated areas of the county and the City of Salisbury experience tidal nuisance flooding.


NUISANCE FLOODING PLAN

PREPARED FOR:
THE CITY OF SALISBURY, MARYLAND
DEPARTMENT OF INFRASTRUCTURE AND DEVELOPMENT

Salisbury
MARYLAND

Prepared by:
George, Miles & Buhr, LLC

July 1, 2019

Sources of Flooding

According to the 2020 WCNFP, Wicomico County is bordered on three sides by waterways – to the west by the Nanticoke River, to the south by the Wicomico River and Wicomico Creek, and to the east by the Pocomoke River. The latter water source is so close to its headwaters that it is not tidally influenced. However, the Nanticoke and Wicomico Rivers are occasional sources of nuisance tidal flooding. Nuisance tidal flooding impacts are associated with repetitive roadway flooding. Wicomico County has identified roadways subject to nuisance flooding, most of which are located in rural areas, as discussed in the Wicomico County Nuisance Flood Plan and Comprehensive Plan.

The plan states that Wicomico County has mostly minor flooding from extreme high tides, with some moderate flooding during lunar events. Major flooding can occur during any weather event that pushes water up the Chesapeake Bay, such as a circulating "nor'easter" storm or a strong south-southwest wind. When water levels rise within the Chesapeake Bay, a similar effect is experienced within the Wicomico and Nanticoke Rivers and their tributaries. A positive aspect of tidal flooding is that it recedes within hours of the peak high tide.

March 7, 2018- Salisbury's Field Operations placed hazard signs and barricades along flooded roads across the city.

Photo Credit: Jennifer Isacoff
Source: https://wicoclimate.weebly.com/flooding--infrastructure.html#floodinginfrastructure

According to City of Salisbury Nuisance Flooding Plan, the area subject to nuisance flooding is the floodplain near the confluence of both the North and South Prongs of the Wicomico River. This area was separated into three (3) areas of interest due to the geographical nature of the overall area being discussed.

The plan states that these areas all have a direct connection to the Wicomico River with very little topographic relief. Tidal fluctuations and the resulting tailwater conditions have a direct impact on the storm drain capacity throughout the entire area of interest.

Furthermore, some high tide events can cause flooding in some areas, even without any associated rainfall.

Levels of Nuisance Flooding

During the development of the WCNFP, staff from various departments met to identify and review nuisance tidal flooding issues. As part of the development of the WCNFP, different levels of nuisance flooding were identified and defined, as follows:

- Minor Flooding – Less than 6” of water in the roadway that recedes within 6 to 12 hours
- Moderate Flooding – 6” to 2’ of water in the roadway that recedes within 6 to 12 hours
- Major Flooding – greater than 2’ of water in the roadway that recedes within 6 to 12 hours

Levels of nuisance flooding were not identified in the City of Salisbury Nuisance Flooding Plan.

FACILITIES AT RISK

Following the identification of areas vulnerable to nuisance tidal flooding, facilities at risk for both Wicomico County and the City of Salisbury were assessed. Facilities at risk due to nuisance tidal flooding including transportation routes and are considered a community lifeline. These transportation routes are listed in both plans and those listings have been integrated into this plan section.

Wicomico County

During the nuisance flood plan development, several roads were identified as experiencing nuisance tidal flooding based on staff experience and other available tools, including:

- Tide charts for Roaring Point (Nanticoke) and Whitehaven available from the Maryland Department of Natural Resources.
- Readings from the NOAA/NOS/CO-OPS observed water levels at flood gauge number 8571421 located in Bishops Head, Maryland.

Bishops Head, MD - Station ID: 8571421

Source: NOAA Tides & Currents *https://tidesandcurrents.noaa.gov/stationhome.html?id=8571421*

Wicomico County has identified the following flood depths for each level of flooding.

- **Minor Flooding**
  approximately 1.5’ to 2.0’ high tide
- **Moderate Flooding**
  approximately 2.0’ to 2.8’ high tide
- **Major Flooding**
  approximately greater than a 2.8’ high tide

Wicomico County will monitor tidal flooding events that occur over the next five years and refine tide depths and levels of flooding, as appropriate.

In addition, the Department of Public Works will monitor road conditions and, when appropriate, place high water signs and re-route traffic if flooding reaches hazardous levels. The Department of Emergency Services will alert the public to impending nuisance tidal flooding issues via social media, emergency alerts and other means outlined in the Wicomico County Emergency Operations Plan.

A total of sixteen (16) roadways, community lifeline – transportation, were identified in Nuisance Flood Plan as experiencing nuisance tidal flooding and are shown in the following table.

Table 4.13: Roads Identified as Experiencing Nuisance Tidal Flooding

Road Name/Flood Source	Location Of Flooding	Comments
Clara Road, Tyaskin Wicomico River and tidal ditches	Worse flooding occurs south of Mezick Road; however, occasional minor tidal flooding can occur along the length of Clara Road due to tidal ditches.	Minor collector road. Mitigation efforts are planned. See additional comments in the Mitigation Efforts section of the Nuisance Flood Plan.
Cove Road, Tyaskin Nanticoke River	Final approximately 1,000 feet of the road as it reaches the Nanticoke River.	Minor collector road. Moderate tomajor flooding can occur during extreme tidal events.
Deep Branch Road, Quantico Tyaskin Creek	At the bridge	Minor collector road. Moderate flooding can occur during extreme tidal events. The road would have to be raised significantly in order to mitigate the flooding.
Harbor Road, Nanticoke Nanticoke River	Parking lot and road near boat ramp	Local road. Minor flooding occurs in this area from an unprotected beach area and a boat ramp.
Muddy Hole Road, Tyaskin Broad Creek, Muddy Hole Creek, and various tidal tributaries of the Wicomico River	Entire length	Minor collector. This is primarily an unimproved road running through tidal marshlands. A new bridge was built over Broad Creek several years ago, and continued maintenance has only kept the road passable in some areas. No significant improvements are planned due to the lack of residences along this unimproved road.
Nanticoke Drive, Nanticoke Nanticoke River and tidal ditches	Near community park and at the end of the cul-de-sac	Local road. Mitigation efforts have occurred with more planned. See additional comments in the Mitigation Efforts section of the Nuisance Flood Plan.
Nanticoke Road, Waterview Nanticoke River, tidal ditches and marshes	Several locations near Waterview	This is a State Road, and it is unlikely that mitigation efforts will occur since this road serves only a small number of residences in this section.
Riverside Drive, Salisbury Stock Creek	Where tidal creek crosses Riverside Drive	Major collector. Only minor occasional nuisance flooding.
Riverton Road, Riverton Nanticoke River and tidal ditches	Near Old School House Road	Minor collector. This area has minor flooding on high and lunar tides and can experience moderate to major flooding during extreme tidal events. There is no bulkhead or rip rap along the Nanticoke River in the area; there is a tidal ditch which runs along theroad; and ground elevations are only approximately two to four feet.
Town of Whitehaven – Church Street, River Street and Whitehaven Road Wicomico River and tidal ditches and marshes	All three roads in the town flood repeatedly on high and lunar tides,with the worst flooding occurring on River Street and Whitehaven Road.	Whitehaven Rd. is major collector.Other roads are local roads. Mitigation efforts have occurred with more planned. See additional comments in the Mitigation Efforts section of the Nuisance Flood Plan.

Road Name/Flood Source	Location Of Flooding	Comments
Trinity Church Road, Tyaskin Muddy Hole Creek and tidal ditches	Various places along the road	Minor collector. Raising the road may help. This is a rural road serving only a couple residences.
Tyaskin Road, Tyaskin Nanticoke River	Park and Parking Lot at the end of the road	Minor road. Nuisance flooding occurs occasionally in the park area.
Upper Ferry Road, Eden Wicomico River and tidal ditches	Near the ferry and for about 200 feet	Major collector. The elevation of the road is only about 1.5' to 2.5' above sea level and there is a tidal ditch running along the road. With the ferry, elevating the road would be difficult.
Wetipquin Road, Tyaskin Wetipquin Creek	At the bridge	Minor collector. There is minor to moderate flooding occurring on both sides of the bridge from high and lunar tides. The road would have to be raised.

According to the WCNFP, two of the roads noted above – Upper Ferry Road and Whitehaven Road – lead to vehicular ferries providing transportation across the Wicomico River. These routes are used daily by commuters from the west side of Wicomico County who work in Somerset County – especially those working at Eastern Correctional Institution or working or attending the University of Maryland Eastern Shore (UMES). They are also popular routes for tourists and bicyclists.

The ferries are vulnerable to high tides and often have to cease operation during peak hours of a higher-than-normal tide. During a 2012 study, it was determined that the two ferries were closed 21 times during a 60-day period due to high tides. The closings are often only for an hour and a half to two hours, but these closings can cause serious headaches for residents depending upon the ferries for travel to work and school. Detours around the ferries are time-consuming.

City of Salisbury

Area 1 is below the confluence along the main section of the river down to where Mitchell Pond enters the Wicomico River. It includes Fitzwater Street and West Main Street on the north bank and a portion of Riverside Drive on the south bank. The Fitzwater Street area has been subject to chronic flooding events. The Germania Circle neighborhood has also seen persistent flooding.

Area 1: Fitzwater Street
Source: Google StreetView

Area 2 is located along the South Prong and is bound to the east by a dam just beyond Snow Hill Road and includes a fair portion of downtown Salisbury. East Main Street, West Market Street, East Market Street, Baptist Street, and Poplar Hill Road are all within this area.

Area 3 is located along the North Prong of the Wicomico River and is bound to the north by Johnson Dam. Portions of Lake Street and Mill Street are included within the outlined area.

Area 2: West Main Street
Source: https://www.wmdt.com/2019/10/roads-flooded-closed-in-downtown-salisbury/

4.6 RECENT MITIGATION EFFORTS

WICOMICO COUNTY

The 2020 Wicomico County Nuisance Flood Plan provided recent mitigation efforts. The following mitigation efforts are excerpts from the plan.

1. **Clara Road**
   The road serves residences and one seasonal business. That portion of the road south of Mezick Road is the sole evacuation route for the approximately 10 residences and one seasonal business located in that section. The Department of Public Works is planning to clean out the ditches and culverts for the last 2,000 feet of road before it meets the Wicomico River to assist the tidal waters in receding faster. That project is expected to begin in the Fall of 2020. Raising the road may also assist with nuisance tidal flooding. The County will continue to monitor tidal flooding events along this road following the ditch and culvert clean-out project to determine if further mitigation efforts are feasible.

2. **Nanticoke Drive**
   This local road runs along the Nanticoke River in the community of "Nanticoke Acres". There are primarily two areas along the road experiencing minor flooding during high and lunar high tides, with moderate to major flooding occurring during extreme high tides and high wind events. The tidal ditch at the park has filled in with silt. Bushes and trees have grown, reducing the ditch's capacity to allow flood waters to recede back to the Nanticoke River. The Department of Public Works has contacted the Homeowners Association and requested the clean out of the ditch along the community park, the County will ditch along Nanticoke Drive and replace failed driveway culverts so tidal waters can flow out to the Nanticoke River quicker. There are two repetitive loss properties which are affected by this tidal ditch, so mitigation is a priority.

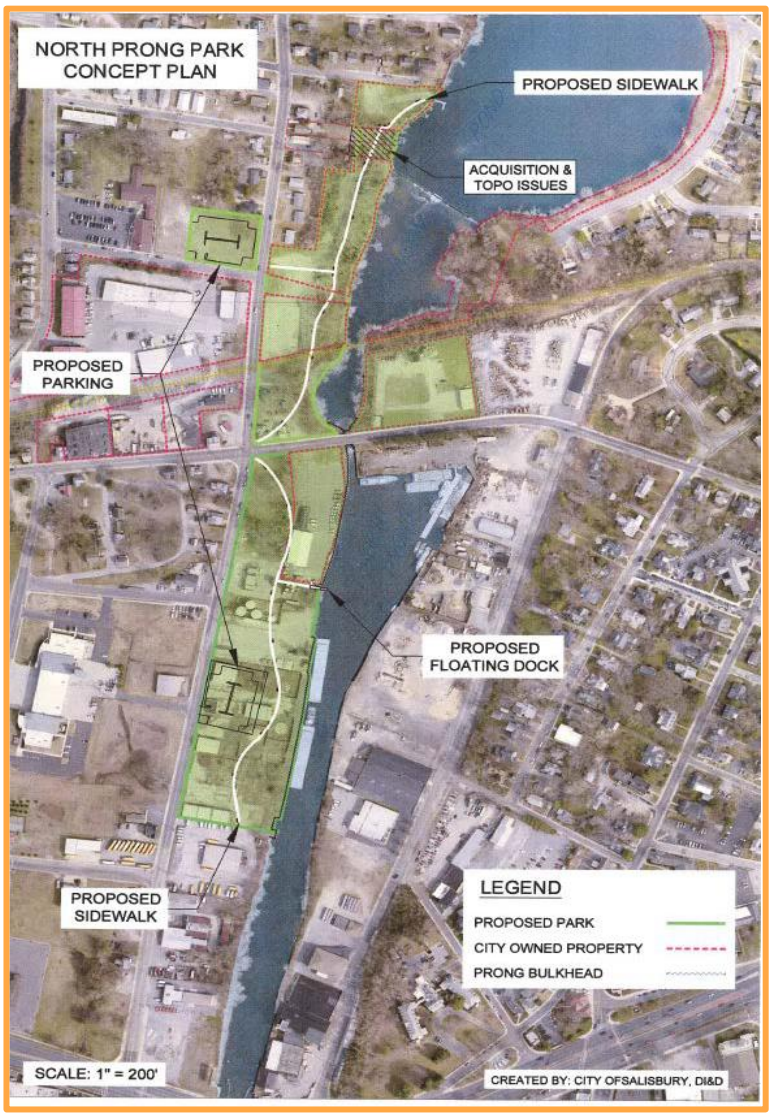
3. **Town of Whitehaven – Church Street, River Street and Whitehaven Road**
   The entire historic town of Whitehaven is vulnerable to tidal flooding from the Wicomico River, tidal ditches to the east and west, as well as the tidal marsh to the east. There is a significant tidal ditch running along Whitehaven Road which has been responsible for minor flooding of that road during high tides, moderate flooding during lunar tides, and major flooding during extreme and storm events. Along River Street there are two drainage outlets which backwash with water during high tides, creating minor to moderate flooding. Further down River Street, there is no bulkhead at the intersection with Church Street and the River is able to wash over the narrow land, adding to the backwash from the outlet located nearby. Due to the complexity of the flooding issues, the County contacted the Army Corp of Engineers for assistance. A planning study was completed, and a final report was received in September 2020. Once the report has been reviewed by County officials, a meeting with the town's residents will be held to discuss possible courses of action to reduce flooding within Whitehaven. Mitigation efforts are necessary in order to protect this historic town and ferry from rising sea levels and increased tidal events. There are repetitive loss properties within Whitehaven, so mitigation is a priority.

CITY OF SALISBURY

Current mitigation efforts for the North Prong Park and the City-wide I/I Study are detailed in the Nuisance Flood Plan. The city is also evaluating the tide gates and is participating in a pilot program, which will address the concern of the tide gates function in low head situations. The City is also partnering with Sharp Energy's property owner to provide temporary stormwater storage within the watershed where the tide gates are located.

The North Prong Park was included in the Downtown Salisbury Master Plan. The Park project would remove vulnerable properties from the floodplain, provide open space, and provide some mitigation benefit by allowing the area to be inundated during flood events.

A City-wide Infiltration/Inflow (I/I) Study began in 2016 for approximately 155 miles of sewer mains and 3,200 manholes in their system. The study continued through 2020 with remedial construction slated through 2022. According to the Nuisance Flooding Plan, the inflow portion of this work will yield direct benefits to the city in protecting both their mains and the treatment plant from nuisance flooding.



Concept Design of the North Prong Park
Source: 2019 City of Salisbury Nuisance Flooding Plan

4.7 CONCLUSION

Review of the various vulnerability assessments conducted and presented within this chapter indicates that the jurisdictions that are most vulnerable to coastal storm hazards include the City of Salisbury, Town of Sharptown, and the unincorporated southwestern portion of the county. One particularly notable community lifeline at risk to coastal storm hazards is the Salisbury Fire Station No. 16. This facility was identified in both the Category 2 Storm Surge and Coastal Flood risk vulnerability assessments. Finally, there are several marinas/docks and underground storage tanks located within both storm surge and coastal flood risk areas. Many of these facilities are located within or near the City of Salisbury.

Whitehaven was determined to be the High-Risk Area in the Flood Risk Report. This area is also located between the shoreline and the mapped Limit of Moderate Wave Action (LiMWA). The Nuisance Flood Plan noted this community as a high-risk for flooding.

According to the permit data provided by Wicomico County Permit and Inspections Division, several mobile homes within the floodplain and storm surge areas have been removed, however both were replaced.

Finally, both the County and City of Salisbury have completed Nuisance Flood Plans. These documents have identified areas of tidally influenced nuisance flooding. Information from these plans are included in Chapter 14 Mitigation Strategies.