CHAPTER 9: TORNADO & HIGH WIND

2022 PLAN UPDATE

Chapter 9: visual and thematic updates were included throughout the chapter, including updates to fonts, colors, and the addition of a cover page.

Page 9-2: Section 9.3 Tornado History, Table 9-2, the NCEI Storm Events Database was reviewed for new tornado events: no new tornado events have been recorded since the last plan update.

Page 9-3: Section 9.4 High Wind History, Table 9-3 was updated to reflect the addition of two new high wind events occurring within the previous five year planning period (2017 to present).

Page 9-4: Section 9.5 County Perspective has been updated with both the tornado & high wind risk rankings from the 2021 State Hazard Mitigation Plan. The State ranks tornado as "Medium-Low" risk and high wind as "High" risk for Somerset County. Somerset County stakeholders rank tornado as "Low" risk and high wind as "Medium-High" risk.

Page 9-5: Map 9-1 Past Tornado Events has been visually updated.

Page 9-6: Section 9.7 Essential Facilities has been updated to reflect changes made to the County's Critical & Public Facilities Database within the last five years.

Page 9-6: Table 9-4 has been updated to include new improvement values per the most recent MdPropertyView.

Page 9-7: Added Section 9.9 Future Conditions. This section considers the impacts that climate change may have on the rate and severity of future tornadoes and high wind events in the County.

Chapter 9: Tornado and High Wind

9.1 Tornado Hazard Profile

A tornado is defined by Strahler in his *Physical Geography Text* as a violently rotating column of air extending from a thunderstorm to the ground. Normally thunderstorms and associated tornadoes develop in warm, moist air in advance of strong eastward moving cold fronts in late winter and early spring. Tornadoes can also occur along a "dryline" which separates very warm, moist air to the east from hot, dry air to the west. Both scenarios are common in the Central Plains. Under the right temperature and moisture conditions, intense thunderstorms can produce tornadoes in areas of differential heating such as occurs on the Eastern Shore.

Tornadoes can occur in every state, although the mid-west states have by far the greatest potential for this type of event. The most recent significant tornado in Maryland to cause substantial damage occurred in the Charles County-LaPlata vicinity in 2002. According to the National Centers for Environmental Information (NCEI) Storm Events Database, July is the peak month for tornado activity in Maryland. The NCEI Database has recorded four-hundred and two (402) tornado events in Maryland between 1950 and July 2022. Counties west of the Chesapeake Bay generally experience a higher frequency of tornadoes than those on the Eastern Shore.

Tornados were previously measured on the Fujita Scale (F-Scale), named for Dr. Tetsuya Theodore Fujita. The operational Fujita scale ranges from an F0 to an F5. The strongest tornadoes observed to date have been F5 (winds between 261-318 mph). A new Enhanced Fujita Scale (EF Scale) was developed and employed by the National Weather Service (NWS) in 2007. The EF Scale is a set of wind estimates (not measurements) based on damage. The new scale uses three-second gusts estimated at the point of damage based on 28 detailed damage indicators, which are available at www.spc.noaa.gov/efscale/ef-scale.html.

Table 9-1: Enhanced Fujita Scale

Fujita Scale			Enhanced Fujita Scale	
F Number	Fastest ¼ mile (mph)	3 Second Gust (mph)	EF Number	3 Second Gust (mph)
0	40-72	45-78	0	65-85
1	73-112	79-117	1	86-110
2	113-157	118-161	2	111-135
3	158-206	162-209	3	136-165
4	207-260	210-261	4	166-200
5	261-318	262-317	5	Over 200

Source: National Oceanic and Atmospheric Administration.

9.2 High Wind Hazard Profile

There are three basic types of damaging high wind events that affect Maryland: synoptic-scale winds, tropical storm winds, and thunderstorm winds. Synoptic-scale or large-scale winds are high winds that occur typically with cold frontal passages or Nor'easters and are uncommon in

Maryland. The National Weather Service considers a thunderstorm to be severe only if it produces wind gusts of 58 mph or higher.

"Downbursts" cause the high winds in a thunderstorm. Downburst winds result from the sudden descent of cool or cold air toward the ground. As the air hits the ground, it spreads outward, creating high winds. Unlike tornadoes, downburst winds move in a straight line, without rotation. The majority of wind events in Maryland occur in June and July. High winds generated from coastal storm events cause a significant amount of damage on Maryland's Eastern Shore.

9.3 Tornado History

The NCEI Storm Events Database classifies tornadoes as "A violently rotating column of air, extending to or from a cumuliform cloud or underneath a cumuliform cloud, to the ground, and often (but not always) visible as a condensation funnel. For a vortex to be classified as a tornado, it must be in contact with the ground and extend to/from the cloud base, and there should be some semblance of ground-based visual effects such as dust/dirt rotational markings/swirls, or structural or vegetative damage or disturbance."

Tornado events as reported by the NCEI Database for Somerset County are listed in Table 9-2, below.

Table 9-2: Tornado Events

Location	Date	Event Narrative	Magnitude	Width (Yards)	Property Damage
Crisfield	September 8, 1981	No report.	F1	60	$25,000
Deal Island	January 6, 2002	A small tornado tracked from Deal Island northeast to Chance in Somerset county. One mobile home was destroyed and another one was moved off its foundation. Also, several sailboats were knocked over and some pine trees were snapped in half.	F0	100	$20,000
Shelltown	May 12, 2002	Numerous trees down. Mobile home destroyed.	F1	100	$20,000
Crisfield	July 14, 2003	Waterspout that moved just onshore over a marsh, then dissipated. No damage occurred.	F0	50	$0
Marion	July 5, 2006	F0 tornado damaged trees and tossed around lawn furniture.	F0	25	$3,000
				Total:	**$68,000**

Source: NWS, NCEI Storm Events Database, 2010 to July 6, 2022.

In terms of number of occurrences, the NCEI Database listed a total of five (5) tornado events impacting Somerset County from 1981-2022. Therefore, Somerset County experiences approximately 0.12 tornado events annually. Total estimated property damage from these tornados is $68,000 with two (2) F1 and three (3) F0 tornados occurring in the last 40 years.

Recently, the National Weather Service confirmed the path of an EF1 tornadic waterspout occurring on Smith Island. According to the National Oceanic and Atmospheric Administration (NOAA), tornadic waterspouts are tornadoes that form over water or move from land to water. They have the same characteristics as a land tornado. On August 4, 2022, a waterspout touched down just southwest of the island at about 7:20 PM. The waterspout capsized several long boats before moving ashore where it reached an estimated 110 MPH near the intersection of Marsh and Smith Island roads. The waterspout damaged several buildings including a total of seventeen residences; three of these homes were severely damaged.

9.4 High Wind History

The NCEI Storm Events Database classifies high wind as "Sustained non-convective winds of 35 knots (40 mph) or greater lasting for 1 hour or longer, or gusts of 50 knots (58 mph) or greater for any duration (or otherwise locally/regionally defined)."

High wind events as reported by the NCEI for Somerset County are listed in Table 9-3, below.

Table 9-3: High Wind Events

Date	Event Narrative	Property Damage
September 1, 2006	The remnants of Ernesto along the Mid Atlantic coast combined with strong high pressure over New England produced very strong winds across the Lower Maryland Eastern Shore. Sustained winds in mph ranged from the lower 40s to near 50 with maximum gusts ranging from the mid-50s to as high as the mid-70s. Some higher sustained winds included 49 mph (43 knots) at Ocean City, and 45 mph (39 knots) at Salisbury. Some higher maximum gusts included 75 mph (65 knots) at Bishops Head, and 70 mph (61 knots) at Smith Island. The high winds caused numerous downed trees and power outages, along with significant structural damage.	$1 Million
May 11, 2008	Trees and powerlines were downed. In Wenona, Deal Island Road, the wind knocked down trees and caused a sailboat to break loose from its moorings. Some structural damage and power outages occurred. The high winds knocked out electrical service in parts of Crisfield, Princess Anne and Fairmount.	$10,000
October 29, 2012	The very strong winds downed trees, produced minor structural damage, and caused scattered power outages.	$10,000
March 2, 2018	The very strong winds downed trees, produced minor structural damage, and caused power outages.	$25,000
October 11, 2018	Several trees were downed and there was minor structural damage.	$5,000
	Total:	**$1.05 Million**

Source: NWS, NCEI Storm Events Database, 2010 to July 6, 2022.

In terms of number of occurrences, the NCEI Database listed a total of five (5) high wind events impacting Somerset County from 2006-2022. Therefore, Somerset County experiences approximately 0.29 high wind events annually. Total estimated property damage from these high wind events is $1.05 million.

These high wind events are just part of the wind events that can be obtained from the NCEI. Wind data is also available in *Chapter 5: Hurricane* and *Chapter 8: Thunderstorm* of this Plan.

9.5 County Perspective

9.5.1 Tornado

The *2021 State Hazard Mitigation Plan* ranked Somerset County's risk for tornado as "Medium-Low." As part of this plan update, a Hazard Identification and Risk Assessment (HIRA) was conducted for the tornado hazard.

A composite scoring method was utilized to rank natural hazards, which included five (5) key components: historical impacts (in terms of human lives and property), geographic extent, historical occurrences, future probability, and community perspective.

Based on this method, tornado was assigned a ranking of "Low" during the 2022 plan update. This represents a slight decrease compared to tornado's ranking of "Medium-Low" in the 2017 Plan. The future probability of a tornado event is considered "unlikely", as determined by the HIRA.

Note: Full results of the HIRA, including method, are included within *Appendix A: Hazard Identification and Risk Assessment* of this plan.

Between 1981 and 2022 there were five (5) reported tornado touchdowns in Somerset County as shown on Map 9-1 on the following page. Local National Weather Service (NWS) offices are responsible for issuing tornado warnings. Tornado warnings indicate that a tornado has been spotted or that Doppler radar detects a thunderstorm circulation capable of spawning a tornado. Nationally, tornado season is from March through August. July is the peak month for activity in Maryland.

9.5.2 High Wind

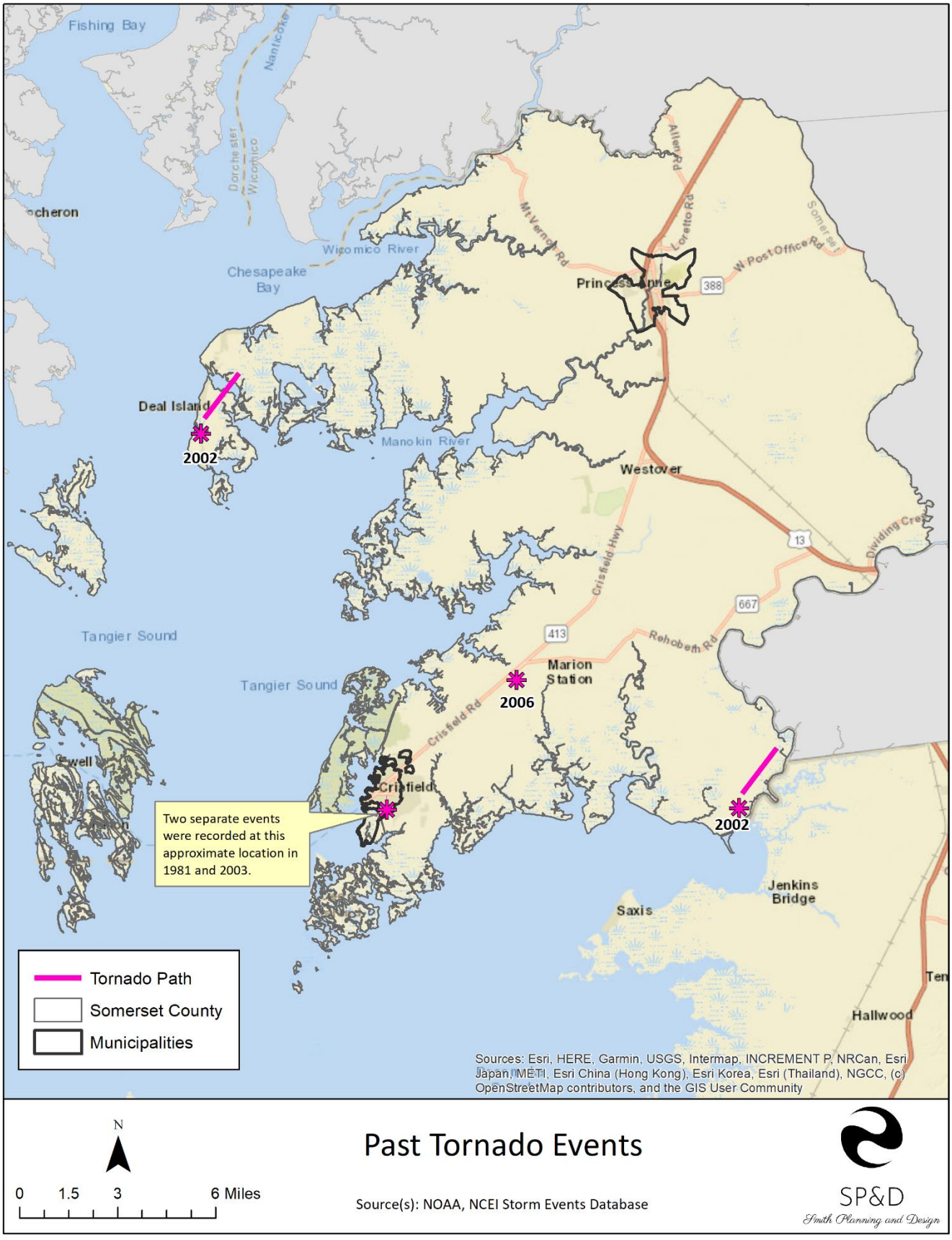
The *2021 State Hazard Mitigation Plan* ranked Somerset County's risk for high wind as "High." As part of this plan update, a Hazard Identification and Risk Assessment (HIRA) was conducted for the high wind hazard.

Based on this method, high wind was assigned a ranking of "Medium-High" during the 2022 plan update. This ranking is consistent with the 2017 Plan. The future probability of a tornado event is considered "likely", as determined by the HIRA.

According to the U.S. Department of Energy (DOE) and the Maryland Energy Administration (MEA) the average annual wind speed in Maryland ranges from 4.0 to 5.5 meters per second, or roughly 9 to 12 MPH.

The inland portions of Somerset County are similar in average annual wind speed to the State; however, the coastal regions of the County have higher average annual wind speeds – 5.5 to 6.0 meters per second, or roughly 12 to 13.5 MPH. Wind Maps and Other Technical Resources are available at the MEA's website.

Map 9-1: Past Tornado Locations



9.6 Municipal Perspective

As is the case with most weather events, all areas of the County share similar concerns. However, the municipality of Crisfield has been affected by two recorded tornadoes and a wind gust event of 79 knots (90 mph). Smith Island and Deal Island also have a slightly higher chance, comparatively, of being impacted by high winds due to the limited amount of neighboring land masses and surrounding vegetation. Due to their protruding positions in the Chesapeake Bay, Crisfield, Deal Island, Frenchtown, Rumbley, and Smith Island could potentially take the initial impact of storm systems traveling up the east coast, such is the case with many hurricanes and tropical storms.

9.7 Essential Facilities

Essential facilities constructed prior to the current building codes are at-risk to tornado or high wind events. Essential facilities are those facilities that must continue to operate for a community to effectively respond to, and recover from, a hazard incident. Essential facilities include: Emergency Operation Center(s), Fire and Rescue Stations, Police, Schools, and Medical facilities. As shown by the table below, four (4) essential facilities located within the unincorporated areas of the County were constructed in 1967 or prior. Three (3) essential facilities located in Crisfield are at-risk to high wind impacts, while six (6) essential facilities are within the Town of Princess Anne. Improvement value of all essential facilities that could be impacted by tornado or high wind events is $91,749,900. It is important to keep in mind, high wind events in this chapter do not include high wind from hurricane or thunderstorm events.

Table 9-4: Essential Facilities Constructed 1967 & Prior

Location	Facility Type	Facility Name	Year Built	Improvement Value
County	Fire	Marion Fire Dept.	1948	$301,700
County	Medical	Somerset County Health Dept.	1950	$2,189,600
County	Fire	Deal Island/Chance Fire Dept.	1954	$149,600
County	Fire	Ewell Fire Dept.	1957	$350,600
Crisfield	Police	Crisfield Police	1900	$125,200
Crisfield	School	Crisfield H.S.	1960	$3,992,500
Crisfield	Fire	Crisfield Fire Dept.	1961	$262,100
Princess Anne	Police	Princess Anne Police	1857	$239,100
Princess Anne	School	U. of MD Eastern Shore	1886	$80,000,000
Princess Anne	Fire	Mt. Vernon Fire Dept.	1920	$202,900
Princess Anne	EOC	EOC	1950	$888,900
Princess Anne	School	Princess Anne E.S.	1958	$1,905,300
Princess Anne	School	Greenwood E.S.	1961	$1,142,400
			Total Value:	**$91,749,900**

Source: Somerset County 2022 Critical & Public Facilities Database and Improvement Values From 2017 Maryland Property View (last updated July 2020).

9.8 Mitigation Efforts

While mitigating tornado and high wind damage is difficult, Somerset County does have a state mandated Building Code which includes wind loading requirements and tie-down requirements for mobile homes.

Essential Facilities that were built prior to 1967 may be more susceptible to wind damage. These facilities should be evaluated for wind load and vulnerability and retrofitted accordingly to mitigate wind damage. The thirteen (13) essential facilities identified in Table 9-4 should be assessed and retrofitted as necessary to meet the design wind speeds of 120 mph within the Somerset County Building Code.

Additionally, high wind speeds may impact infrastructure, specifically communications and utilities. Mass power outages due to tornado or high wind events also affect facilities and utilities. Downed trees and power lines on roadways negatively impact the communities' ability to quickly return to normal operations following a high wind event. Therefore, maintenance such as tree trimming should be prioritized in order to avoid disruption to essential facilities and other utilities.

The County's local electric providers (Delmarva Power, Choptank Electric and Old Dominion) have made major safety improvements to their transmission lines and substations which has drastically reduced the risk of power outages.

Finally, visitors to the County's campgrounds and hunting lodges who are utilizing recreational vehicles (i.e., motorhomes, camper vans, trailers) face a higher risk and are more vulnerable to high wind events. A study conducted by Kent State University found that while stationary RVs are less likely to move around or flip due to winds when compared to moving vehicles, their narrow widths and high profiles put them at risk of flipping in high wind conditions. The study found that perpendicular wind speeds of 53 mph could overturn a stationary 18-foot travel trailer. It took 65 mph winds to upset a 20-foot motorhome. Residents and tourists utilizing campgrounds within the County should be aware of this risk prior to recreating in areas that are subject to frequent high winds.[i]

9.9 Future Conditions

9.9.1 Tornadoes

National Geographic states that predicting whether climate change will have an effect on the frequency and power of tornadoes is challenging.

Tornadoes are small compared to other extreme weather events, such as hurricanes, which can span hundreds of miles. The largest tornado on record measured "only" 2.6 miles wide. Tornadoes are also very short lived, lasting from a few seconds to a few hours as opposed to days or weeks at a time. These two factors make them very difficult to model in the climate simulations that are used to project the effects of climate change.[ii]

Instead, scientists must attempt to predict how climate change may impact the individual weather components that support the development of supercell thunderstorms (the type that produce tornadoes). These weather components include:

- warm, moist air;
- an unstable atmosphere; and
- wind shear.

As global temperatures rise, the warmer atmosphere is able to hold more moisture. This increases atmospheric instability, a vital supercell component. However, as the planet warms, wind shear is likely to decrease. These two forces work against each other, so it is difficult to anticipate which might have a greater impact on tornado formation.

The fourth National Climate Assessment summarizes the complicated relationship between tornadoes and climate change: "Some types of extreme weather (e.g., Rainfall and extreme heat) can be directly attributed global warming. Other types of extreme weather, such as Tornadoes, are also exhibiting changes which may be linked to climate change, but scientific understanding isn't detailed enough to project direction and magnitude of future change."

One thing known for certain is that we live in a warmer and wetter world due to climate change, and this is likely to have an effect on extreme weather events, including tornadoes. Unfortunately, in the case of tornadoes we cannot yet predict what that effect might be.[iii]

9.9.2 High Wind

High winds accompany tropical cyclones, thunderstorms, and tornadoes. It is known that climate change will increase the intensity and frequency of tropical cyclones and thus the high wind associated with these events. However, as is the case with tornadoes, it is not well known how climate change might impact the strength and frequency of thunderstorm wind.

Somerset County should prepare for potentially more severe and frequent non-convective (i.e., thunderstorm) high wind events due to climate change. The mitigation actions recommended in *Section 9.9* provide a solid base-level of protection against the impacts of future high wind events, regardless of their level of severity or frequency.

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[i] Wind speeds required to upset vehicles. Thomas W. Schmidlin, Kent State University, Kent, OH; and B. O. Hammer, P. S. King, and L. S. Miller.

[ii] Tornadoes and climate change. National Geographic Society. (2022, May 20). Retrieved July 7, 2022, from https://education.nationalgeographic.org/resource/tornadoes-and-climate-change

[iii] Ibid.