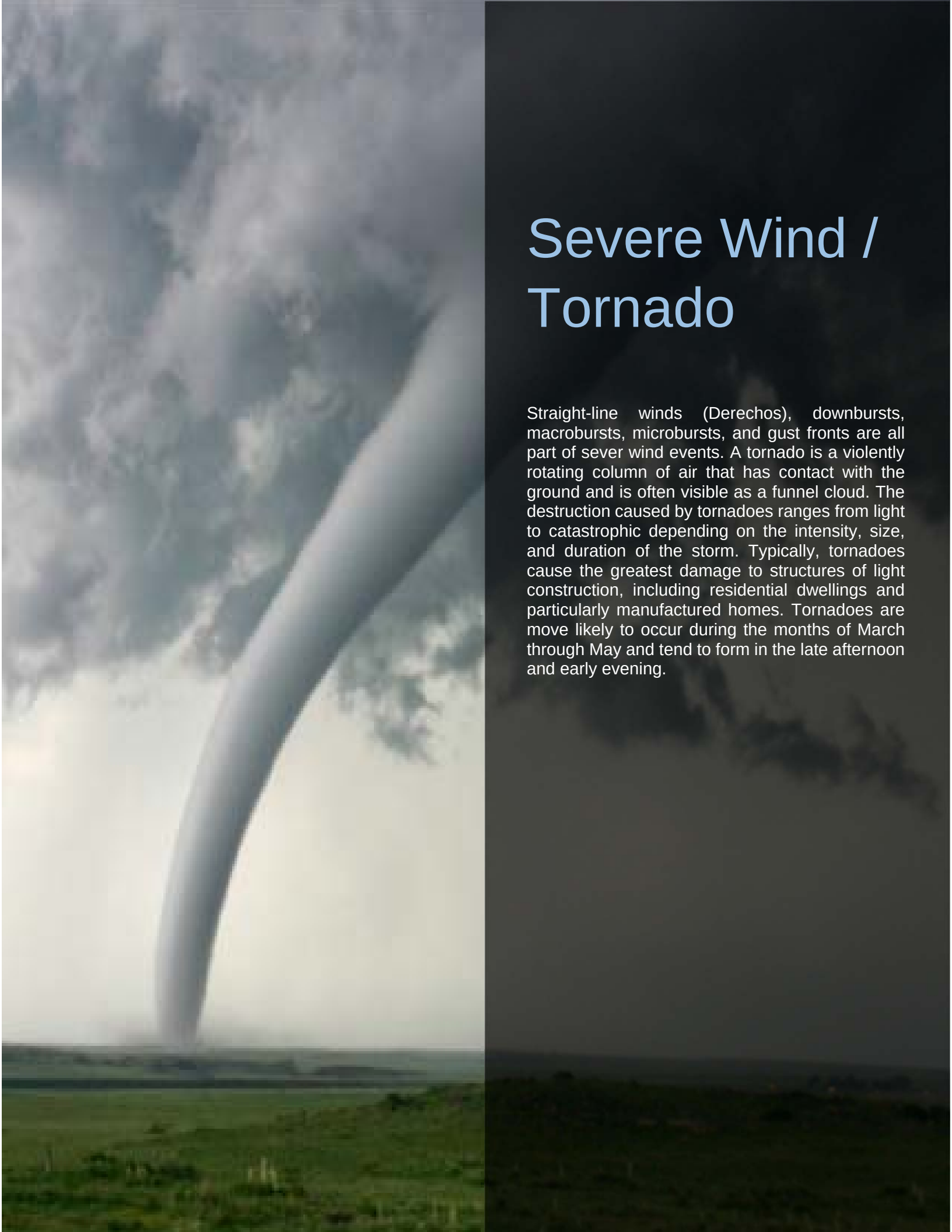


Severe Wind / Tornado

Straight-line winds (Derechos), downbursts, macrobursts, microbursts, and gust fronts are all part of sever wind events. A tornado is a violently rotating column of air that has contact with the ground and is often visible as a funnel cloud. The destruction caused by tornadoes ranges from light to catastrophic depending on the intensity, size, and duration of the storm. Typically, tornadoes cause the greatest damage to structures of light construction, including residential dwellings and particularly manufactured homes. Tornadoes are move likely to occur during the months of March through May and tend to form in the late afternoon and early evening.

2.0 RISK ASSESSMENT

2.2.10 Severe Wind & Tornado

Straight-line winds (Derechos), downbursts, macrobursts, microbursts, and gust fronts are all part of severe wind events. A tornado is a violently rotating column of air extending from a thunderstorm to the ground.				
Vulnerability HIGHEST HIGH MEDIUM LOW LOWEST	Period of Occurrence:	At any time, typically when warm and cold air masses are present together.	Hazard Index Ranking:	Medium
	Warning Time:	Less than 6 hours	State Risk Ranking:	4
	Probability:	Frequent (Will occur on an annual basis)	Severity:	Marginal (10-25% of land area affected)
	Type of Hazard:	Natural	Disaster Declarations:	DR-1227 DR-4077

Hazard Introduction and Overview

Severe winds includes non-tornadic, damaging winds from thunderstorms. There are six types of severe wind: straight-line wind, downbursts, macrobursts, microbursts, gust fronts, and Derechos.

- **Straight-line Wind:** Straight-line wind is a term used to define any thunderstorm wind not associated with rotation, used mainly to differentiate from tornadic winds.
- **Downburst:** Downburst is the general term for all localized strong wind events caused by a strong downdraft within a thunderstorm.
- **Macroburst:** An outward burst of strong winds at or near the surface with a diameter larger than 2.5 miles that occurs when a strong downdraft reaches the surface.
- **Microburst:** A small, concentrated downburst that produces an outward burst of strong winds near the surface. Microbursts are small and short-lived, with a diameter less than 2.5 miles and lasting only 5-10 minutes.
- **Gust Front:** The leading edge of rain-cooled air that clashes with warmer thunderstorm inflow. It is characterized by a wind shift, temperature drop, and gusty winds ahead of a thunderstorm.
- **Derecho:** A widespread, long-lived wind storm associated with a band of rapidly moving showers or thunderstorms. A typical derecho consists of numerous microbursts and downbursts. An event with wind speeds of at least 58 mph and a diameter of 240 miles is a derecho.

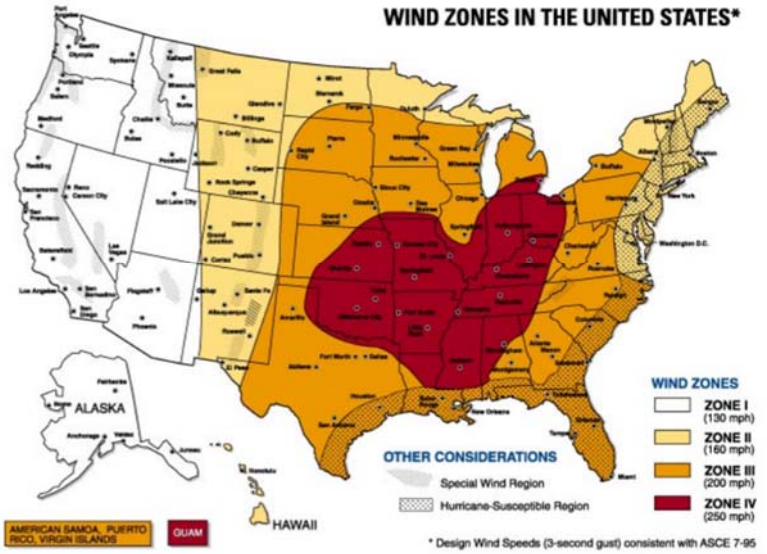
A tornado is a violently rotating column of air extending from a thunderstorm to the ground. Because wind is invisible, it is hard to see tornadoes unless they form a condensation funnel made of water droplets, dust, and debris. Tornadoes originate from rotating thunderstorms called "supercells" or from Quasi-Linear Convective Systems (QLCS). Normally, thunderstorms and associated tornadoes develop in warm, moist air in advance of strong eastward-moving cold fronts in late winter and early spring when warm, humid air collides with cold, dry air. Tornadoes can also occur along a "dryline" which separates very warm, moist air to the east from hot, dry air to the west.

The key atmospheric ingredient for tornado formation is instability, or warm moist air near the ground and cooler dry air higher in the atmosphere, and wind shear. An unstable air mass promotes the development of strong updrafts, and promotes the rotation from which tornadoes are spawn. Tornadoes can have wind speeds up to 250 miles per hour and a width of approximately 660 feet. They occur in the U.S. more than anywhere else in the world.

Location and Extent

Severe wind events are commonplace phenomenon across the globe. Wind events can impact several jurisdictions at the same time, with varying duration and severity. Western Washington County is more susceptible than the eastern portion of the county.

The United States experiences approximately 1,200 tornadoes each year, most of which occur east of the Rocky Mountains. Tornado season within the U.S. varies by location, with southern states experiencing peak tornado season from May to June, while the Midwest's peak is from June to July. Though these are typical times tornadoes are more likely to occur, any thunderstorm can potentially produce a tornado.



FEMA's wind zone map of the United States designates wind zones to ensure new construction can withstand winds appropriately. According to the wind zone map (shown below), Washington County is located predominately in Zone III, so

structures in this area should withstand 3-second gusts of up to 200 miles per hour. Ohio is positioned geographically on the eastern-most edge of what has come to be known as "tornado alley" and is no stranger to tornado sightings. The largest tornado to occur in Washington County was 100 yards wide, and longest track tornado remained on the ground for 13 miles.

The Beaufort Wind Scale measures wind. This scale characterizes wind using a 0-12 metric based on observation rather than exact measurements. The table below outlines the scale in detail.

BEAUFORT WIND SCALE					
Force	*Wind Speed*		*Description*	*Appearance of Wind Effects*	
	Knots	*MPH*		*On Water*	*On Land*
0	>1	>1	Calm	Sea surface smooth and mirror-like	Calm, smoke rises vertically
1	1-3	1-3	Light Air	Scaly ripples, no foam crests	Smoke drift indicates wind direction, still wind vanes
2	4-6	4-7	Light Breeze	Small wavelets, crests glassy, no breaking	Wind felt on face, leaves rustle, vanes begin to move
3	7-10	8-12	Gentle Breeze	Large wavelets, crests begin to break, scattered whitecaps	Leaves and small twigs constantly moving, light flags extended
4	11-16	13-18	Moderate Breeze	Small waves 1-4 ft. becoming longer, numerous whitecaps	Dust, leaves, and loose paper lifted, small tree branches move
5	17-21	19-24	Fresh Breeze	Moderate waves 4-8 ft. taking longer form, many whitecaps, some spray	Small trees in leaf begin to sway
6	22-27	25-31	Strong Breeze	Larger waves 8-13 ft., whitecaps common, more spray	Larger tree branches moving, whistling in wires
7	28-33	32-38	Near Gale	Sea heaps up, waves 13-19 ft., white foam streaks off breakers	Whole trees moving, resistance felt walking against wind
8	34-40	39-46	Gale	Moderately high (18-25 ft.) waves of greater length, edges of crests begin to break into spindrift, foam blown in streaks	Twigs breaking off trees, generally impedes progress
9	41-47	47-54	Strong Gale	High waves (23-32 ft.), sea begins to roll, dense streaks of foam, spray may reduce visibility	Slight structural damage occurs, slate blows off roofs
10	48-55	55-63	Storm	Very high waves (29-41 ft.) with overhanging crests, sea white with densely blown foam, heavy rolling, lowered visibility	Seldom experienced on land, trees broken or uprooted, "considerable structural damage"
11	56-63	64-72	Violent Storm	Exceptionally high (37-52 ft.) waves, foam patches cover sea, visibility more reduced	N/A
12	64+	72+	Hurricane	Air filled with foam, waves over 45 ft., sea completely white with driving spray, visibility greatly reduced	N/A

Officials also utilize the Enhanced Fujita (EF) Scale to classify tornadoes. This scale uses a rating system based on wind speeds and related damages. The EF scale was adapted from the original Fujita Scale designed by Dr. Theodore Fujita to better estimate wind and storm damage. The table below describes the EF Scale.

ENHANCED FUJITA (EF) SCALE		
EF Rating	*3-second Gust Speed (mph)*	*Possible Damage*
0	65-85	Light Damage. Some damage to chimneys; break branches off trees; push over shallow-rooted trees; damage to signboards.
1	86-110	Moderate Damage. Surface peeled off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off roads.
2	111-135	Considerable Damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
3	136-165	Severe Damage. Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; cars lifted off the ground and thrown.
4	166-200	Devastating Damage. Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
5	201+	Incredible Damage. Strong frame houses lifted off foundations and carried considerable distance to disintegrate; automobile sized missiles fly through the air more than 100-yards; trees debarked; incredible phenomena will occur.

Hazard Impacts

Severe wind events can cause a variety of secondary and tertiary hazard events. In addition to damaging roofs and other home finishing's, wind can cause damage to trees that may interrupt power service or block roadways. Such damages could be widespread and severe, potentially overwhelming the capacity of local responders to address the situation.

While tornadoes are typically short-lived, they are intensely focused and destructive. Tornadoes are the most violent of all atmospheric storms. Damage from tornadoes comes from the strong winds they contain. Wind speed in tornadoes can reach 300 miles per hour; winds of that speed can destroy homes, uproot trees, cause automobiles to become airborne, and turn glass and debris into high-velocity projectiles. Secondary and tertiary impacts from tornadoes include damage to roofs and other home finishing's. Additionally, fallen trees can interrupt power service or block transportation access.

Historical Occurrences

The National Centers for Environmental Information's Storm Events Database maintains records of tornadoes since 1950, as well as historical occurrences of severs wind events. Most tornadoes are classified as weak tornadoes, which are those that last for just a few minutes and have wind speeds of less than 100 miles per hour. This has historically held true in Washington County. There have been seven tornado events in Washington County over the past 70 years. These tornadoes ranged from EF-0 to F2, and did not result in any fatalities and five injuries. All seven tornadoes did result in property damage, totaling $1.4 million.

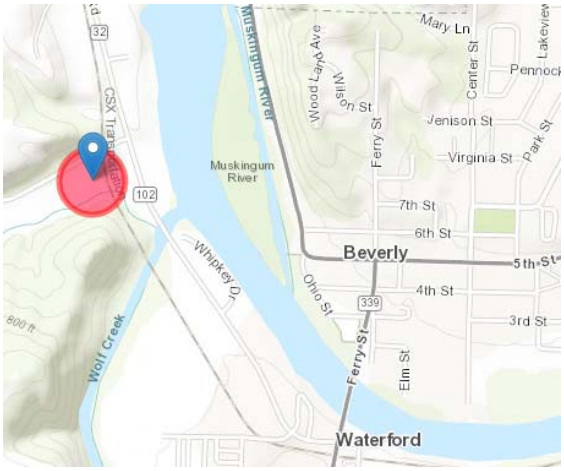
Washington County has experienced numerous severe wind events. There have been 125 severe wind events classified as either high winds, strong winds, or thunderstorm winds since 1974. The vast majority were classified as thunderstorm winds, accounting for 109 of the 125 events. These severe wind events have resulted in four injuries, $6.0 million in property damage and $50,000 in crop damage.

HISTORICAL SEVERE WIND & TORNADO OCCURRENCES – WASHINGTON COUNTY							
Location	*Date*	*Event Type*	*Magnitude*	*Deaths*	*Injuries*	*Property Damage*	*Crop Damage*
Washington County	7/24/1971	Tornado	F2	0	0	$250,000	$0
Washington County	7/10/1973	Tornado	F1	0	0	$250,000	$0
Washington County	7/28/1981	Tornado	F2	0	5	$250,000	$0
Washington County	7/22/1990	Tornado	F0	0	0	$250,000	$0
Washington County	9/16/1990	Tornado	F0	0	0	$250,000	$0
Waterford	5/23/2000	Tornado	F1	0	0	$150,000	$0
Bartlett	6/20/2015	Tornado	EF0	0	0	$15,000	$0
			TORNADO TOTAL:	0	5	$1,415,000	$0
Washington County	4/16/1999	Strong Wind	N/A	0	0	$0	$0
Washington County	11/24/2014	Strong Wind	39 kts.	0	0	$10,000	$0
Washington County	3/1/2016	Strong Wind	39 kts.	0	0	$10,000	$0
Washington County	4/2/2016	Strong Wind	43 kts.	0	0	$50,000	$0
Washington County	2/24/2019	Strong Wind	45 kts.	0	0	$25,000	$0
Washington County	1/10/2000	High Wind	N/A	0	0	$0	$0
Washington County	1/11/2000	High Wind	N/A	0	0	$0	$0
Washington County	11/9/2000	High Wind	N/A	0	0	$0	$0
Washington County	12/11/2000	High Wind	N/A	0	0	$75,000	$0
Washington County	2/9/2001	High Wind	N/A	0	0	$0	$0
Washington County	2/25/2001	High Wind	N/A	0	0	$0	$0
Washington County	3/13/2001	High Wind	N/A	0	0	$0	$0
Washington County	10/24/2001	High Wind	N/A	0	3	$15,000	$0
Washington County	12/14/2001	High Wind	N/A	0	0	$0	$0
Washington County	3/9/2002	High Wind	N/A	0	0	$10,000	$0
Washington County	12/1/2006	High Wind	50 kts.	0	0	$0	$0
Washington County	1974 - 2020	Thunderstorm Wind	N/A	0	1	$5,800,000	$50,000
			SEVERE WIND TOTAL:	0	4	$6,000,000	$50,000

Source: NCEI Storm Event Database

Waterford F2 Tornado 7/24/1971

On July 24, 1971, an F2 tornado approximately 33 yards wide passed through the community of Waterford. The tornado remained on the ground for approximately one mile before lifting. Tin roofing from a few barns and homes flew through the air for nearly a mile, and windows exploded outward on a home. This tornado resulted in approximately $250,000 in property damages.



Marietta Area FO Tornado 7/22/1990

On July 22, 1990, six small tornadoes touched down in northeastern and southeastern Ohio. They only lasted a few minutes, the tornado that crossed Washington County was the strongest of the outbreak, it was 50 yards wide and remained on the ground for 13 miles. Damages were minor, confined mostly to trees and minor structural damage to a few outbuilding. Approximately $250,000 in property damages were sustained as a result of this tornado.

Waterford F1 Tornado 5/23/2000

On May 23, 2000, an F1 tornado approximately 100 yards wide, touched down on County Route 32 near the old power plant in Waterford. On its one mile trek, the tornado destroyed a barn, threw a piece of wood from the barn through the wall of a house, and shifted several trailers and outbuildings off their foundations. The tornado deposited roofing debris on the other side of the Muskingum River, in the Town of Beverly. The tornado resulted in approximately $150,000 in property damages.

Countywide High Winds 10/24/2001

Wind gusts estimated around 40 mph caused scattered property damage, mainly from branches falling onto homes. The southern end of the county, from Barlow to Belpre and Little Hocking bore the brunt of the wind. An interstate construction sign blew into an approaching vehicle near Marietta, causing minor injuries.

Marietta Thunderstorm Winds 6/27/1998

Wind gusts of approximately 70 mph were associated with a bow echo configuration thunderstorm. Numerous large trees were blown down, several homes and businesses were hit by fallen trees. Residents described the aftermath in the hardest hit portions of downtown Marietta as looking like a war zone.

Countywide Derecho 6/29/2012 (DR-4077-OH)

The second day of a developing heat wave brought afternoon temperatures reaching the upper 90s to above 100 degrees across most of southeast Ohio. An area of multi-cellular convection moved into southeast Ohio, it had already formed into a large arch of storms, or bow, with a developing cool pool in its wake. The temperature contrast between the air ahead of the developing derecho, compared to that in its wake was reaching 30 to 35 degrees. The derecho reached southeast Ohio near the hottest time of the day, after 4 pm. The outflow or gust front began to outrace the rain as it moved into southeast Ohio. As the system matured, the strong wind gusts were longer in duration, in some cases around 10 minutes. Widespread wind gusts of 60 to 85 mph were associated with the leading gust front across southeast Ohio. The winds caused trees and large branches to fall in scattered locations throughout nine counties in southeast Ohio. The lack of electricity in the midst of the heave wave, disrupted the daily routines of most citizens for several days, water and ice were in high demand. An emergency declaration allowed federal supplies to be quickly delivered. With limited gas stations available to pump gas, long lines developed for a few days in the wake of the storm. Due to the public damage, a federal major disaster was eventually declared for this episode. The derecho resulted in approximately $3.6 million in property damage in Washington County.

The map on the following page illustrates the location of tornado touchdowns and, where appropriate and available their paths.

Washington County Hazard Mitigation Plan

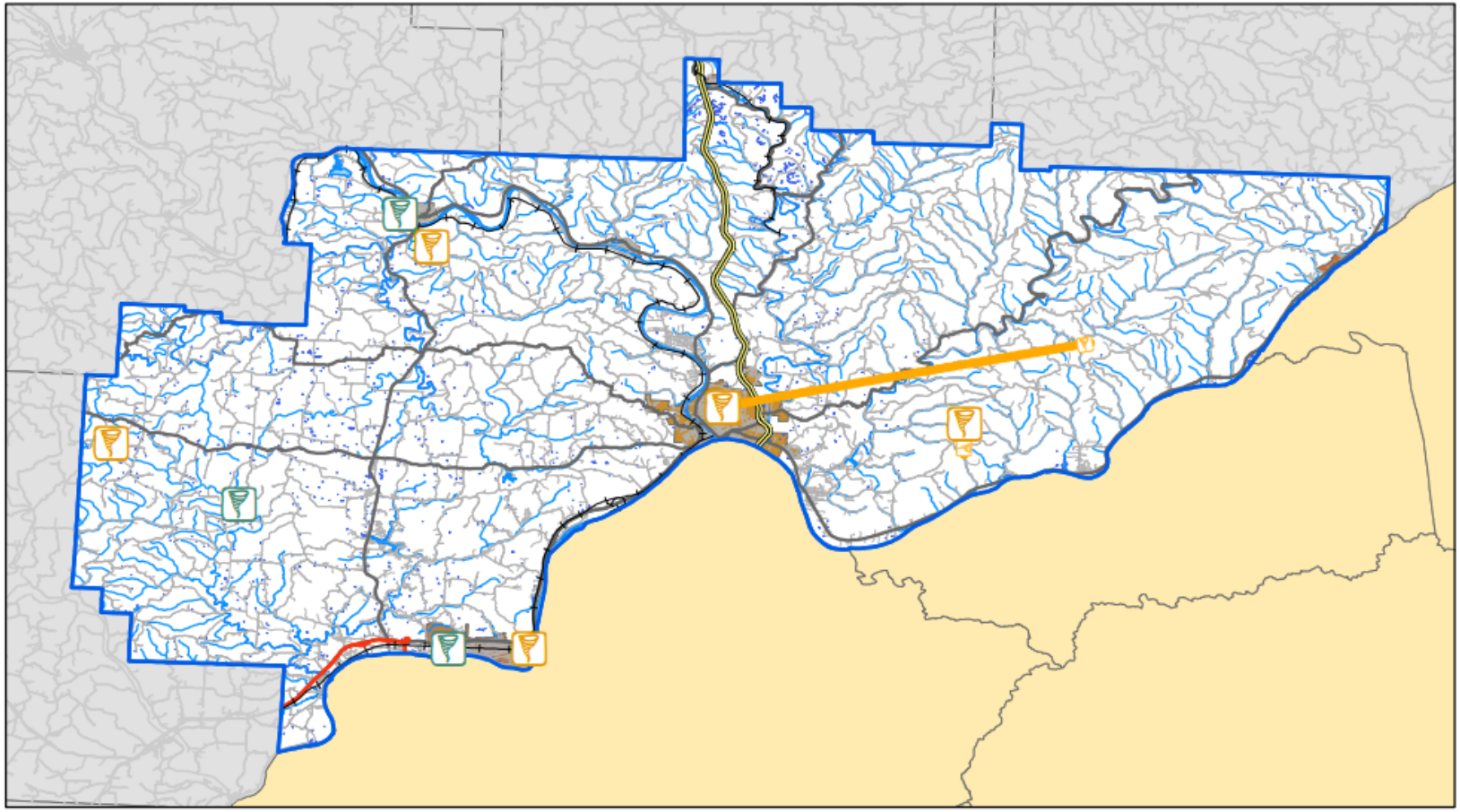
Historical Tornado Occurrences

Data Source(s):
NOAA NCEI

DISCLAIMER: Data is meant for use as reference only. Some sources may be intended to be used at national or regional scales and are thus used beyond their original intent for demonstrative purposes.

Tornado Touchdowns

Tornado (w/ Paths)



Loss and Damages

Since 1971, a total of seven tornadoes have resulted in five injuries, and $1,415,000 in property damages, for an average of $202,143 per event or $28,878 per year. The 125 severe wind events that have occurred since 1974 have resulted in four injuries, and approximately $6.0 million in property damage and $50,000 in crop damage. The historical worst-case scenario loss was $3,565,000, which was the derecho that occurred in late June of 2012, which was a rare event (with no other event coming close to that amount). A more realistic worst-case scenario would be $250,000 losses experienced with five of the seven tornadoes that have occurred. Planners utilized the more realistic scenario as the representative historical occurrence for completion of the following table.

SEVERE WIND & TORNADO LOSS ESTIMATE – MIP DATA ENTRY		
Structure Type	*Number*	*Loss Estimate*
Residential	1	$143,521.53
Non-Residential	1	$48,514.32
Critical Facilities	1	$10,107.15
TOTALS	3	$202,143

Source: Ohio EMA HAZUS-MH Loss Estimate Workbook Calculation

The table below was compiled using historic data obtained from NWS, NOAA's National Centers for Environmental Information Storm Event Database. Statistical information on tornadoes occurring in Washington County was entered in a spreadsheet using a time period of January 1, 1950, through December 31, 2020. Calculations were performed to obtain the following information: average damage amounts per tornado, annual probability, and estimated future annual losses. Damage calculations include all reported property and crop damage. The following are definitions of the terms used in the table.

- Total Damages – Cumulative sum of all reported damages associated with all tornadoes occurring in the 70 year period from January 1, 1950 to December 31, 2020 (reported damages obtained from the Strom Events Database).
- Average Damage per Tornado – Total damages divided by the number of tornadoes.
- Estimated Annual Tornadoes – Number of tornadoes divided by the number of reporting years (70).
- Estimated Future Annual Losses – Average Damage per Tornado x Estimated Annual Tornadoes

TORNADO LOSS ESTIMATIONS – WASHINGTON COUNTY				
Total # of Tornadoes	*Total Damages*	*Avg. Damage per Event*	*Estimated Annual Tornadoes*	*Estimated Future Annual Losses*
7	$4,958,252	$708,322	0.10	$70,832

Source: NWS, NOAA and OEMA

Vulnerability Assessment

This section summarizes the vulnerability of Washington County to severe wind and tornadoes. Washington County conducted an online survey for the public to share its thoughts on hazard vulnerabilities. The following table presents the results of that survey regarding severe wind and tornadoes.

PUBLIC SENTIMENT, SEVERE WIND & TORNADOES – WASHINGTON COUNTY					
	Level of Concern				
Hazard	*Not at All*	*Somewhat*	*Concerned*	*Very*	*Total Responses*
Severe Wind & Tornadoes	7 (19.44%)	18 (50.00%)	7 (19.44%)	4 (11.11%)	36
In the past ten years, do you remember this hazard occurring in your community?				6 (16.67%)	36
Have you noticed an increase in the occurrences or intensity of this hazard?				4 (11.11%)	36
Have you noticed a decrease in the occurrences or intensity of this hazard?				2 (5.56%)	36

Source: Online Public Survey Results

The following table assigns point totals based on the research presented in this profile for each category that appears in Ohio EMA's Mitigation Information Portal (MIP) tool.

SEVERE WIND & TORNADO VULNERABILITY SUMMARY			
Category	*Points*	*Description*	*Notes*
Frequency	5	Excessive	NOAA has listed 125 wind events and seven tornadoes since 1971, thus 2.69 wind events occur per year.
Response	3	One week	Regular county operations would likely resume within a week.
Onset	4	Less than 6 hours	While officials can predict strong wind events relatively accurately in advance, tornadoes are sporadic and cannot be predicted as effectively.
Magnitude	2	Limited (10-25% of land area affected)	Less than 10% of land area affected. Though destructive, a tornado would not affect a significant portion of the county. Planners utilized the tornado scenario for this category because it typically results in the most damage.
Business	2	One week	Typical business activity should resume within the week for those affected by high wind and tornadoes.
Human	2	Low (some injuries)	In all cases of high wind and tornadoes, there have been nine injuries sustained. Few events lead to multiple injuries.
Property	1	Less than 10% of property affected	Tornadoes are localized events, and a single event would not affect more than 10% of property in the county.
Total	19	Medium