

# Appendix A: Hazard Identification and Analysis



(Source of Photo: Natural Hazard Center, PSU.)

## A. Introduction

This section of the hazard mitigation plan provides details on the natural hazards that could affect Wilson County. The Federal Emergency Management Agency (FEMA) and the State of North Carolina require that the thirteen natural hazards listed below be considered in planning for local hazard mitigation. The threat of each hazard in Wilson County is unique in terms of probable level of impact, frequency of occurrence, likelihood of occurrence, and combined hazard index for potential harm to persons or property.

This section includes a description and history of natural hazard events that are known to have specifically affected Wilson County. Detailed data on hazard events within specific locations (including municipalities) were provided as available. Event histories are based on a search of two national databases - the National Climatic Data Center (NCDC - <http://www4.ncdc.noaa.gov/cgi-win/wwwcgi.dll?wwEvent~Storms>) and the Spatial Hazard Events and Losses Database for the United States (SHELDUS\* - [http://go2.cla.sc.edu/hazard/db\\_registration](http://go2.cla.sc.edu/hazard/db_registration)). All historical data searches were conducted for the period 1950 to 2008. Other specific data from the County and other municipalities were included as available.

\*Note: SHELDUS information concerning certain hazards causing fatalities and injuries are in decimal form. Casualties and damages are often listed without specific spatial reference, for instance severe thunderstorms affected Eastern NC. In order to assign the damage amount to a specific county, SHELDUS divides the total number of fatalities or injuries by the number of counties affected. For example, if a severe thunderstorm affected Pitt, Greene, Nash, and Edgecombe counties and resulted in 1 fatality, each county would receive a 0.25 rating.

As required by FEMA, all thirteen potential hazard classifications that could affect Wilson County are profiled in this section of the Plan. The Wilson County Composite Hazard Index Table (Table A-28) includes those hazards that were categorized as either "moderate" or "high" risk based on a review of all thirteen hazard histories.

### Natural Hazards

- Coastal and Riverine Erosion
- Dam and Levee Failures
- Droughts and Heat Waves
- Earthquakes
- Floods
- Hurricanes and Coastal Storms
- Expansive Soils and Land Subsidence
- Severe Storms/Hail/Tornados
- Tsunamis
- Volcanoes
- Avalanches
- Wildfires
- Winter Storms and Freezes

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## **B. Hazard Analysis - Evaluation Method**

Each natural hazard is evaluated for three characteristics:

1. Likelihood of Occurrence, i.e., expected frequency;
2. Likely Range of Impact, i.e., predictable size and location of impact; and
3. Probable Level of Impact, i.e., estimated strength and damage potential.

### **Likelihood of Occurrence**

The likelihood, or frequency, of occurrence of a particular hazard within a specific jurisdiction will be classified in one of four categories. These four categories are explained in Table A-1.

**Table A-1: Explanation of Hazard Likelihood of Occurrence**

<b>Likelihood</b>	<b>Frequency of Occurrence</b>
Highly Likely	Near 100% probability in the next year.
Likely	Between 10% and 100% probability in the next year or at least one chance within the next ten years.
Possible	Between 1% and 10% probability in the next year, or at least one chance in the next 100 years.
Unlikely	Less than 1% probability in the next year, or less than one chance in the next 100 years.

*Source: "Keeping Natural Hazards from Becoming Disasters", NC Division of Emergency Management, November 2001, p. 11.*

### **Likely Range of Impact**

The likely range of impact, or predictable size and location, of a particular hazard within a specific jurisdiction will be classified in one of three categories. These three categories are described in Table A-2.

**Table A-2: Description of Likely Range of Impact**

<b>Size of Area</b>	<b>Description</b>
Small	10 % or less of the total jurisdictional area
Medium	10 % to 40 % of the total jurisdictional area
Large	40 % to 100 % of the total jurisdictional area

*Source: "Keeping Natural Hazards from Becoming Disasters", NC Division of Emergency Management, November 2001, p. 11.*

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**Probable Level of Impact**

The probable level of impact, or estimated strength and damage potential, of a particular hazard within a specific jurisdiction is classified in one of four categories as described in Table A-3.

**Table A-3: Description of Hazard Probable Level of Impact**

Level	Area Affected	Impact <sup>1</sup>
Catastrophic	More than 50%	<ul style="list-style-type: none"> <li>• Multiple deaths.</li> <li>• Complete shutdown of facilities for 30 days or more.</li> <li>• More than 50% of property is severely damaged.</li> </ul>
Critical	25 to 50%	<ul style="list-style-type: none"> <li>• Multiple severe injuries.</li> <li>• Complete shutdown of critical facilities for at least 2 weeks.</li> <li>• More than 25% of property is severely damaged.</li> </ul>
Limited	10 to 25%	<ul style="list-style-type: none"> <li>• Some injuries.</li> <li>• Complete shutdown of critical facilities for more than 1 week.</li> <li>• More than 10% of property is severely damaged.</li> </ul>
Negligible	Less than 10%	<ul style="list-style-type: none"> <li>• Minor injuries.</li> <li>• Minimal quality of life impact.</li> <li>• Shutdown of critical facilities and services for 24 hours or less.</li> <li>• Less than 10% of property is severely damaged.</li> </ul>

Source: "Keeping Natural Hazards from Becoming Disasters", NC Division of Emergency Management, November 2001, p. 12.

<sup>1</sup>The impact of a natural hazard is a combination of the severity of the occurrence, the magnitude of the event, and the density of human activity in the affected area.

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**Composite Hazard Index**

These three sets of classification categories - likelihood of occurrence, likely range of impact, and probable level of impact – have been combined to create a composite hazard index for each natural hazard. The combined hazard index describes vulnerability in general terms of “low”, “moderate” or “high” hazard susceptibility. An individual hazard index is developed at the end of each of the thirteen hazard sections. Table A-28 at the end of Appendix A is a composite of the thirteen hazard index scores.

**Table A-4: Composite Hazard Index Rating**

Size of area	Small (1)	Medium (2)	Large (3)	Small (1)	Medium (2)	Large (3)	Small (1)	Medium (2)	Large (3)	Small (1)	Medium (2)	Large (3)
Likelihood of Occurrence / Impact	Catastrophic (4)			Critical (3)			Limited (2)			Negligible (1)		
Highly Likely (4)	9 High	10 High	11 High	8 Moderate	9 High	10 High	7 Moderate	8 Moderate	9 High	6 Moderate	7 Moderate	8 Moderate
Likely (3)	8 Moderate	9 High	10 High	7 Moderate	8 Moderate	9 High	6 Moderate	7 Moderate	8 Moderate	5 Low	6 Moderate	7 Moderate
Possible (2)	7 Moderate	8 Moderate	9 High	6 Moderate	7 Moderate	8 Moderate	5 Low	6 Moderate	7 Moderate	4 Low	5 Low	6 Moderate
Unlikely (1)	6 Moderate	7 Moderate	8 Moderate	5 Low	6 Moderate	7 Moderate	4 Low	5 Low	6 Moderate	3 Low	4 Low	5 Low

<sup>1</sup> Each variable was assigned a number from 1 (lowest) to 3/4 (highest) rating. A score from 9 to 11 is a “high hazard risk”; from 6 to 8 “moderate hazard risk”; and from 3 to 5 “low hazard risk”.

## **C. Natural Hazard Identification and Analysis**

### **1. Hazard Coastal and Riverine Erosion** *(Source: FEMA)*

The U.S. Congress through the National Flood Insurance Reform Act of 1994 required that FEMA conduct a study to evaluate erosion hazards along rivers and coast lines. The study was to assess the economic impact of erosion and erosion mapping on communities and on the National Flood Insurance Program (NFIP). The legislation defined "Erosion Hazard Area" as "an area where erosion or avulsion is likely to result in damage to or loss of buildings and infrastructure within a 60-year period."

The FEMA coastal erosion study was conducted by The Heinz Center for Science, Economics and the Environment and released in 2000. The study estimates that approximately 25 percent of homes and other structures within 500 feet of the U.S. coastline and the shorelines of the Great Lakes will fall victim to the effects of erosion within the next 60 years. Especially hard hit will be areas along the Atlantic and Gulf of Mexico coastlines, which are expected to account for 60 percent of nationwide losses. The report estimates that costs to U.S. homeowners will average more than a half billion dollars per year, and that additional development in high erosion areas will lead to higher losses.

The Atlantic and Gulf coasts account for 45 percent of the U.S. coastline and are home to 63% of the structures within 500 feet of the nation's shoreline. The nation's highest average erosion rates - up to six feet or more per year - occur along the Gulf of Mexico coastline. The average erosion rate on the Atlantic coast is about two to three feet per year; however, actual erosion rates can vary widely from one location to another and from one year to another. A hurricane or other major storm can cause the coast to erode 100 feet or more in a single day.

The Heinz study recommended FEMA be authorized to develop coastal erosion hazard area maps and include the cost of expected erosion losses when setting flood insurance rates for coastal areas. The independent report also presented possible federal policy options, most of them regarding the use of the federal flood insurance program to address the coastal erosion problem.

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(Source of Photo: Hurricane Fran erosion along NC coast, September 19, 1996. Source: North Carolina Division of Marine Fisheries. Photographer: Richard K. Davis.)

### **1.1 Coastal Erosion Hazard**

(Information source: FEMA)

Coastal erosion results from beach-ocean interaction coupled with human activity. The beach system is one that is considered to be in dynamic equilibrium. This means that sand is moved from one location to another but it does not leave the system. For example, winter storms may remove significant amounts of sand, creating steep, narrow beaches. In the summer, gentle waves return the sand widening beaches and creating gentle slopes. Because there are so many factors involved in coastal erosion, including human activity, sea level rise, seasonal fluctuations, and climate change, sand movement will not be consistent year after year in the same location.

Wind, waves, and long shore currents are the driving forces behind coastal erosion. This removal and deposition of sand permanently changes beach shape and structure. Sand may be transported to land-side dunes, deep ocean trenches, other beaches, and deep ocean bottoms. Coastal erosion poses many problems to coastal communities in that valuable property is frequently lost to this dynamic beach-ocean system. Additionally, human activity may intensify the process of coastal erosion through poor land use methods. Thus, issues of beach restoration and erosion control are at the forefront in coastal communities.

Poorly designed or sited development can lead to increased erosion, while measures to control erosion in one place may worsen erosion in others. Accretion (natural increase of sand) may also create problems, as when inlets fill in, interfering with navigation. Many experts predict that continued global warming will be accompanied by rising sea levels, resulting in increased coastal erosion worldwide.

#### **Wilson County Hazard Index for Coastal Erosion**

Since Wilson County is not a coastal county, coastal erosion is not included in the natural hazard index analysis.

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(Information source: Farm\*A\*System North Carolina/Photo: FEMA)

## **1.2 Riverine Erosion Hazard**

North Carolina's 37,000 miles of streams and rivers and the floodplains and upland areas adjacent to these waters have great economic, social, cultural, and environmental value. These corridors contain complex ecosystems that encompass the land, plants, animals, and stream networks. Rivers and streams perform a number of important functions, including carrying water and sediment, storing water in wetlands and floodplains, and providing habitat for aquatic and terrestrial plants and animals. For these and other reasons, protecting streams is important. Stable stream channels maintain their shape by slowly eroding the outside of a meander bend while depositing

sediment on the inside bends. Unaltered streams located in large, flat floodplains have more meanders than steep streams without floodplains. Whatever the channel form, most unaltered streams have alternating, regularly spaced, deep and shallow areas called pools and riffles.

Naturally stable floodplain stream channels are typically sinuous with varying channel depths and stream banks low enough to periodically allow large storm flows to overflow onto the floodplain in response to significant storm events. The natural meandering and varying channel depths dissipate the energy of the water and reduce stream bank erosion. Floodplains also dissipate water energy during high flows, spreading shallow water over a wide area.

Bank height and steepness are the most important indicators of stream bank stability. When stream banks are too high and steep, soil erodes from the bank. Bank height is related to factors such as bank slope, soil types, vegetation cover, and location along the channel. However, once a critical bank height is reached, erosion likely will occur regardless of the other factors.

Management practices that reduce stream bank erosion and sedimentation and protect riparian (on the bank of a river, stream, or other body of water) vegetation can help maintain critical stream channel features. Vegetation slows the flow of water and reduces erosion of the banks. Overall, streams with a mature, diverse riparian buffer are the most stable over time.

Many streams in North Carolina have been straightened and dredged for agriculture, development, and flood control. Straight streams have a steeper gradient than meandering streams which often results in channel incision. Incision is an erosion process that lowers the streambed elevation until it reaches bedrock or other resistant materials. Incision increases stream bank heights and disconnects the stream from the original floodplain. In channels with steeper slopes and higher banks, high volumes of water cause significant stream bank erosion.

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## **Hazard Analysis**

### **Likelihood of Occurrence of Riverine Erosion**

There is no recorded history of significant riverine erosion occurring in Wilson County, thus likelihood of occurrence is rated as “unlikely”.

### **Likely Range of Impact for Riverine Erosion**

The potential for riverine erosion is confined to limited areas of the County, thus the range of impact can be classified as “small”.

### **Probable Level of Impact for Riverine Erosion**

With limited occurrence and small exposure, the probable level of impact of riverine erosion in Wilson County can be categorized as “negligible”.

### **Wilson County Hazard Index for Riverine Erosion** (see Table A-28)

The hazard index for riverine erosion in Wilson County is categorized as “low” based on an “unlikely” occurrence, “small” range of impact, and “negligible” level of impact. This hazard index of “low” indicates that riverine erosion poses a relatively low threat and that local hazard mitigation efforts are more wisely directed to other hazards to which the County and its municipalities are more vulnerable. Localized riverine erosion can be confined to locations primarily along ditches and along streams in the event of heavy rains/flooding.

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*Flooding across the spill way at Buckhorn Dam on September 17, 1999*

## **2. Dam and Levee Failures**

Dam and levee failures can be a serious consequence of natural hazards. Dams are structures or appurtenances built to impound or divert water flow in streams or rivers. Levees are embankments built along rivers to contain flood waters.

### **2.1 Dams**

There are approximately 79,000 dams listed in the National Inventory of Dams. This number includes impoundment structures greater than or equal to 25' in height or impounding 50 acre-feet (an acre-foot equal's

water 1 foot deep across one acre of land) or more of water, or structures above 6 ft in height whose failure would potentially cause damage downstream. Nine thousand dams nationwide have been designated as high hazard dams.

The high hazard designation does not indicate the inherent stability or instability of a dam but instead measures the potential threat posed to downstream populations in the event of a dam failure.

#### **Background Information on Dams** *(Source: Association of State Dam Safety Officials)*

Dams provide a life-sustaining resource to people in all regions of the United States. Unlike most infrastructures, dam owners are solely responsible for the safety and the liability of the dam and for financing upkeep, upgrade and repair. While most infrastructure facilities (roads, bridges, sewer systems, etc.) are owned by public entities, the majority of dams in the United States are privately owned. Across the nation, about 58% of dams are privately owned, 16% are owned by local governments, 4% by states, and the rest by the federal government and public utilities.

Manmade dams are classified according to the type of construction material used, the methods used in construction, the slope or cross-section of the dam, the way the dam resists the forces of water pressure, the means used for controlling seepage and, occasionally, according to the purpose of the dam.

The materials used for construction of dams include earth, rock, tailings from mining or milling, concrete, masonry, steel, timber, miscellaneous materials (such as plastic or rubber) and any combination of these materials. Embankment dams, the most common type of dam, are usually constructed of natural soil or rock or waste materials obtained from mining or milling operations. An embankment dam is termed an "earth-fill" or "rock-fill" dam depending on whether it is comprised of compacted earth or mostly compacted rock. The ability of an embankment dam to resist water pressure is primarily a result of the mass, weight, type and strength of the materials from which the dam is made.

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Overtopping of an embankment dam is very undesirable since embankment materials may be eroded away. Water normally passes through the main spillway or outlet works; it should pass over an auxiliary spillway only during periods of high reservoir levels and high water inflow. All embankment and most concrete dams have some seepage; however, it is important to control the seepage to prevent internal erosion and instability. Proper dam construction, maintenance, and monitoring of seepage provide this control.

Intentional release of water is confined to water releases through outlet works and spillways. A dam typically has a principal or mechanical spillway and a drawdown facility. Additionally, some dams are equipped with auxiliary spillways to manage extreme floods. Spillways ensure that the reservoir does not overtop the dam. Outlet works may be provided so that water can be drawn continuously, or as needed, from the reservoir. Outlets also provide a way to draw down the reservoir for repair or safety concerns. Water withdrawn may be discharged into the river below the dam, run through generators to provide hydroelectric power, or used for irrigation. Dam outlets usually consist of pipes, box culverts or tunnels with intake inverts near minimum reservoir level. Such outlets are provided with gates or valves to regulate the flow rate.

**Dam Classifications**

Dams are classified in one of three categories:

**Table A-5: Dam Hazard Classification**

Hazard Classification	Description of Potential Damage	Quantitative Guidelines
Low	Interruption of road service, low volume roads	Less than 25 vehicles/day
	<b>Economic damage</b>	<b>&lt; \$30,000</b>
Intermediate	Damage to highways, interruption of service	25 to less than 250 vehicles/day
	<b>Economic damage</b>	<b>\$30,000 &lt; \$200,000</b>
High	Loss of human life*	Probable loss of 1 or more human lives
	<b>Economic damage</b>	<b>&gt;\$200,000</b>
	*Probable loss of human life due to breached roadway or bridge on or below the dam.	250 vehicles/day at 1000 feet visibility 100 vehicles/day at 500 feet visibility 25 vehicles/day at 200 feet visibility

Source: Dam Safety Program, NC Division of Land Resources.

Note: Cost of dam repair and loss of services should be included in economic loss estimate if the dam is a publicly owned utility, such as a municipal water supply dam.

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### **National Dam Safety Program**

The National Dam Safety Program Act, enacted in 1996 and reauthorized in 2006, was established to improve dam safety by:

1. providing assistance grants to state dam safety agencies to improve regulatory programs;
2. funding research to enhance technical expertise as dams are built and rehabilitated;
3. establishing training programs for dam safety inspectors; and
4. creating a National Inventory of Dams.

The Act also requires FEMA to provide education to the public, to dam owners and to others about the need for strong dam safety programs, nationally and locally, and to coordinate partnerships among all players within the dam safety community to enhance dam safety.

### **North Carolina Dam Safety Program**

The NC Dam Safety Program conducts the following:

1. Inspect high hazard dams at least every two years and intermediate and low hazards at least every five years.
2. Notify dam owners of deficiencies found in the dams and needed maintenance or engineering and repairs.
3. Enforcement action if needed.
4. Review plans for construction of new dams, and repairs, modifications and decommissioning of existing dams.
5. Inspect during construction activities as resources permit.
6. Inspect prior to impoundment once construction is completed.
7. Inspect during and after extreme events such as floods.
8. Maintain databases and records of dams under state jurisdiction.

The U.S. Army Corps of Engineers is responsible for dams under federal jurisdiction, e.g, Falls Lake Reservoir and Jordan Lake Reservoir, and for hydroelectric dams or cooling water dams for power plants.

### **Potential of Dam Failure**

Early in the 20<sup>th</sup> century, it was recognized that some form of regulation was needed after a number of dams failed due to lack of proper engineering and maintenance. Federal agencies, such as the Corps of Engineers and the Department of Interior, Bureau of Reclamation built many dams during the early part of the twentieth century and established safety standards during this time. It was not until a string of significant dam failures in the 1970s that awareness was raised to a new level among the states and the federal government.

Driving every other issue and all activities within the dam safety community is the risk of dam failure. Although the majority of dams in the U.S. have responsible owners and are properly maintained, still many dams fail every year. In the past several years, there have been hundreds of documented failures across the nation (this includes 250 after the Georgia Flood of 1994). Dam and downstream repair costs resulting from failures in 23 states reporting in one recent year totaled \$54.3 million.

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Dam failures are most likely to happen for one of the following reasons:

- Structural failure of materials used in dam construction
- Cracking caused by movements like the natural settling of a dam
- Piping—when seepage through a dam is not properly filtered and soil particles continue to progress and form sink holes in the dam.

Property owners downstream often know nothing about the potential that an upstream dam has to cause devastation should it fail. Even if citizens understand and are aware of dams, they still can be overly confident in the infallibility of these manmade structures. Living in dam-break flood-prone areas is a risk. Many dam owners do not realize their responsibility and liability toward the downstream public and environment. Adequate understanding of proper dam maintenance and upgrade techniques is a typical problem among many owners across the United States.

#### **History of Dam and Levee Failures in North Carolina**

The North Carolina Dam Safety Program has made use of National Dam Safety Program funds to create and implement the North Carolina Emergency Action Plan. The Plan was activated in 1999 during and after Hurricane Floyd and was instrumental in reducing response time in closing roads and evacuating persons from high-risk areas. Following Hurricane Floyd, no injuries were reported despite the failure of 36 dams (14 high hazard, 5 intermediate, and 12 low or unclassified dams). In the days and months following Hurricane Floyd, North Carolina dam safety personnel worked to ensure the safety of over fifty dams damaged by the hurricane. Dam owners, safety inspectors and local emergency management personnel monitored these dams asking owners to lower water levels and/or complete emergency repairs.

#### **Dams in Wilson County**

The North Carolina Department of Environment and Natural Resources, Division of Land Resources Dam Safety Program reports 19 dams located within Wilson County. Of those dams, two are classified as having a “high” hazard rating. Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause property damage or loss of human life. Listed below are the 2 high hazard dams and the associated drainage areas in square miles.

<b><u>Dam</u></b>	<b><u>River</u></b>	<b><u>Drainage Area (sq. miles)</u></b>
Lake Wilson (1960)	Toisnot Swamp	39.6
Bill Ellis Lagoon (1988)	March Swamp	0.01

Of the 17 remaining dams within Wilson County, 13 are classified as being “low hazard”. Low hazard dams are those where failure or misoperation would result in no probable loss of human life and low economic and/or environmental losses. Losses, if any, would be limited principally to the owner’s property. The remaining four dams are classified as being “significant” or intermediate. Significant hazard dams are those where failure or misoperation should result in no probable loss of human life but can cause economic loss, environmental damage, or disruption of lifeline facilities. Significant hazard dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

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### **History of Dam Failures in Wilson County**

No dam failures have been reported in Wilson County although the State did report a number of dam failures in eastern NC following Hurricanes Fran and Floyd. No injuries or property damages were reported with these failures and no specific failures were reported in Wilson County.

### **Hazard Analysis**

#### **Likelihood of Occurrence of Dam Failure**

There is no recorded history of significant dam failure occurring in Wilson County; however, failure of a high hazard dam due to high rain precipitation or other hazard events could result in significant damage to downstream properties and the possible loss of human life. The likelihood of a significant high hazard dam failure can be classified as “possible”.

#### **Likely Range of Impact for Dam Failure**

The potential for dam failure is confined to limited areas of the County, thus the range of impact can be classified as “small”.

#### **Probable Level of Impact for Dam Failure**

With limited possibility of occurrence and small exposure, the probable level of impact of dam failure in Wilson County can be categorized as “negligible”.

#### **Wilson County Hazard Index for Dam Failure** (see Table A-28)

The hazard index for dam failure in Wilson County is categorized as “low” based on a rating of “possible” occurrence, “small” range of impact, and “negligible” level of impact. This hazard index of “low” indicates that dam failure, especially given the regulation and inspection programs of the NC Dam Safety Program, poses a relatively low threat. Hazard mitigation efforts should continue to rely primarily on the State Dam Safety Program to discover and correct any potential failure problems.

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(Source of Photo: Flint River-Georgia Power Company levee failure, Albany, Georgia, September 14, 1994, Georgia Tech)

## 2.2 Levees

Many communities around the globe are nestled in the lush green valleys and fertile floodplains that surround the rushing waters of streams and rivers. These water systems are vital in moving rainwater from land to sea and also serve to transport and deposit sediments. It is estimated that streams and rivers move about 1.5 billion tons of sediment from land to oceans each year. By shifting such great masses of earth, streams become sculptors of the land.

Farming communities often settle along rivers on floodplains because the land is flat, the soil is deep and fertile, and there is abundant rainfall. People have long known the risk of settling in these areas but to them, the economic benefits of agricultural production there usually outweigh the flood risk.

People living in valleys or on flood plains next to earthen dams or levees are susceptible to sudden flooding. Dams and levees can both fail in the event of an earthquake, internal erosion, poor engineering and construction or avalanches. The most common cause of failure, however, is too much rainfall.

When a region experiences heavy rainfall, the water inside a levee builds up and flows over the top. Water flow washes away the upper portion of the barrier and carves out deep grooves. The levee will eventually weaken as the water destroys the structure, resulting in sudden release of tons of water.

Levees are broadly classified as either urban or agricultural. Urban levees provide protection from flooding in communities where industrial, commercial, and residential properties are at risk of flood damage. Agricultural levees protect agricultural lands. There are five main types of levees:

1. Main/Tributary Levees - parallel the main channel and/or its tributaries.
2. Ring Levees - encircle or "ring" an area from all directions.
3. Setback Levees - generally built as a backup to an existing levee that has become endangered due to such actions as river migration.
4. Sub-Levees - constructed for the purpose of under seepage control. Sub-levees encircle areas landward of the main levee, and capture seepage water during high-water stages.
5. Spur Levees - project from the main levee and provide protection to the main levee by directing erosive river currents riverward.

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Constructed levees cause water levels to rise upriver by forcing flood waters to pass through a narrow funnel-like opening between the levees. Waters impounded downstream by levees cause rapidly rising, higher than normal flood elevations such that properties upstream that have never been flooded are affected. The result is a chain reaction where people upstream build levees to protect their property – usually with taxpayer assistance. Overtime, the majority of the river will become contained within levees that isolate virtually the entire floodplain from the river.

### **Levee Failures**

When high levees break, a tremendous amount of energy is released as a “dam break flood wave” which creates huge scour holes adjacent to the channel. Sands from these holes are then scattered across the floodplain at varying depths creating natural levees and floodplains. During a flood, as sediment-laden water flows out of the completely submerged channel, the depth, velocity and turbulence of the water decrease abruptly at the channel margins, where the coarsest part of the suspended load is deposited to form a natural levee. Farther away, finer silt and clay settle out across the stream’s floodplain, a relatively flat region of valley floor that is periodically inundated by floodwater. The Midwest floods of 1993 caused \$14 - \$16 billion in property damages and recovery costs.

Since 1993, USGS scientists have decided that the best way to provide for flood control is to enclose the river’s entire meander belt within a system of setback levees. The meander belt is the area most susceptible to flooding, the area where old active river channels occur, and where most of the major levee breaks occurred during the 1993 flood. The meander belt is thus that portion of the floodplain least desirable for farming or other developmental uses.

### **Hazard Index for Levee Failures**

There are no known levees in Wilson County, thus levee failure is not included in the natural hazard index analysis.

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(Source of Photo: SE Regional Climate Center, Falls Lake 2005)

### **3. Droughts and Heat Waves**

#### **3.1 Droughts**

Droughts are not rare or random events but normal, recurrent features of climate. Droughts occur in virtually all climatic zones, but drought characteristics vary significantly from one region to another.

Drought is a temporary aberration and differs from aridity which is restricted to low rainfall regions and is a permanent feature of climate. Drought

originates from a deficiency of precipitation over an extended period of time, usually a season or more. This deficiency results in a water shortage for some activity, group, or environmental sector.

Drought should be considered relative to some long-term average condition of balance between precipitation and evapotranspiration (i.e., evaporation + transpiration) in a particular area, a condition often perceived as “normal”. It is also related to the timing (i.e., principal season of occurrence, delays in the start of the rainy season, occurrence of rains in relation to principal crop growth stages) and the effectiveness (i.e., rainfall intensity, number of rainfall events) of rain events. Other climatic factors such as high temperature, high wind, and low relative humidity are often associated with drought and can significantly aggravate drought severity.

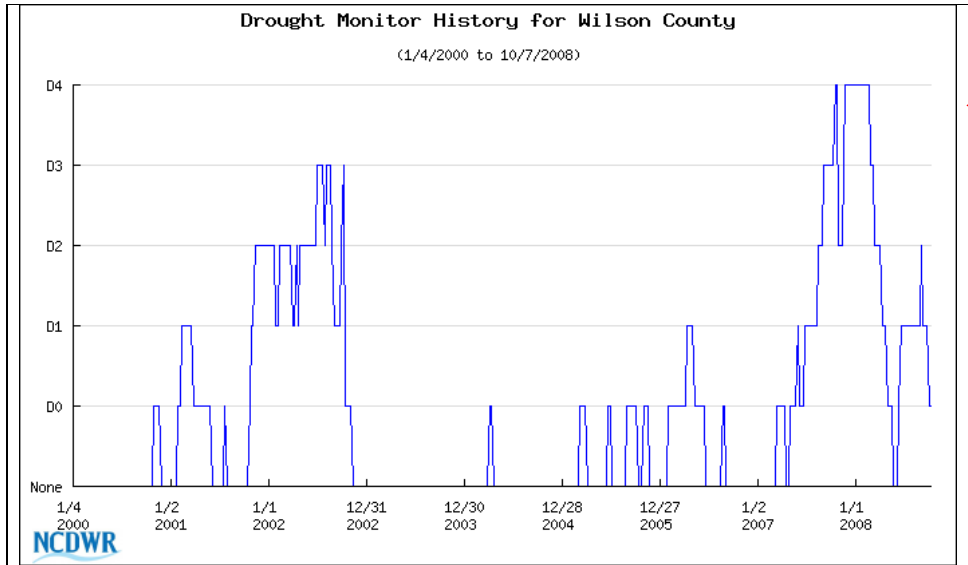
The more recent understanding that a deficit of precipitation has different impacts on groundwater, reservoir storage, soil moisture, snowpack, and streamflow led to the development of the Standardized Precipitation Index (SPI) in 1993. The SPI was designed to quantify the precipitation deficit for multiple time scales. These time scales reflect the impact of drought on the availability of the different water resources. Soil moisture conditions respond to precipitation irregularities on a relatively short scale. Groundwater, streamflow, and reservoir storage reflect longer-term precipitation inconsistencies.

#### **Sequence of Drought Impacts**

When drought begins, the agricultural sector is usually the first to be affected because of heavy dependence on stored soil water. Soil water can be rapidly depleted during extended dry periods. If precipitation deficiencies continue, then people dependent on other sources of water will begin to feel the effects of the shortage. Those who rely on surface water (reservoirs and lakes) and subsurface water (ground water), for example, are usually the last to be affected. A short-term drought that persists for 3 to 6 months may have little impact on these sectors, depending on the characteristics of the hydrologic system and water use requirements.

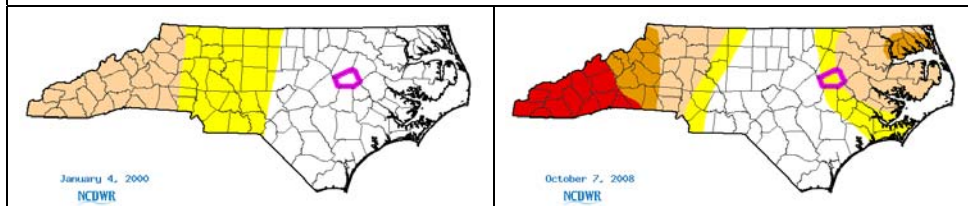
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When precipitation returns to normal and meteorological drought conditions have abated, the sequence is repeated for the recovery of surface and subsurface water supplies. Soil water reserves are replenished first, followed by streamflow, reservoirs and lakes, and ground water. Drought impacts may diminish rapidly in the agricultural sector because of its reliance on soil water, but linger for months or even years in other sectors dependent on stored surface or subsurface supplies. Ground water users, often the last to be affected by drought during its onset, may be the last to experience a return to normal water levels. The length of the recovery period is a function of the intensity of the drought, its duration, and the quantity of precipitation received as the episode terminates.



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No value = Normal, D0 (yellow) = Abnormally Dry, D1 (tan) = Moderate Drought, D2 (lt. brown) = Severe Drought, D3 (red) = Extreme Drought, and D4 (dk. brown) = Exceptional Drought  
Source: www.ncwater.org



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### **Severe Droughts in the United States**

The period of drought that has been the most well documented in both text and photographs occurred in the 1930s when drought covered virtually the entire Plains area of the U.S. for almost a decade. The direct effect of the drought is most often remembered as agricultural. Crops were damaged by deficient rainfall, high temperatures, and high winds, as well as insect infestations and dust storms that accompanied these conditions. The resulting agricultural depression contributed to the Great Depression with bank closures, business losses, increased unemployment, and other physical and emotional hardships. Although records focus on other problems, the lack of precipitation would also have affected wildlife and plant life, and would have created water shortages for domestic needs.

Effects of the Plains drought sent economic and social ripples throughout the country. Millions of people migrated from the drought areas, often heading west, in search of work. These newcomers were often in direct competition for jobs with longer-established residents, which created conflict between the groups. In addition, because of poverty and high unemployment, migrants added to local relief efforts, sometimes overburdening relief and health agencies.

To reduce the impact of future droughts, proactive measures were developed and implemented including an increase in conservation practices and irrigation, average farm size, and crop diversity. Federal crop insurance was established and the regional economy was diversified. Many other proactive measures taken after the 1930s drought also reduced rural and urban vulnerability to drought, including new or enlarged reservoirs, improved domestic water systems, and changes in farm policies, new insurance and aid programs, and removal of some of the most sensitive agricultural lands from production.

#### Historical drought conditions in North Carolina

Recently, North Carolina's shortage of rainfall resulted in major impacts on agriculture, city water supplies, tourism and recreation, energy (power) production, river navigation, and the environment. NC depends heavily on tropical systems to account for up to 25% of our rainfall. Historically, winter months are a period where water levels rebound because less is consumed. La Nina conditions are not favorable for rainfall because a ridge of high pressure blocks weather from reaching the Southeast, including NC. This can explain the flooding in the Midwest, while drought like conditions plagues the Southeast. In the 100 years of modern record keeping, the 2007 drought ranks as the most severe in recent history.

In March 2007, drought conditions were reported in western NC. By May, Governor Easley has asked 12 western counties to stop non-essential water usage. In August, all 100 counties are experiencing various levels of drought, 27 of those are severe to extreme. By late August, North Carolinas are asked to cut water consumption by 20%, while 80 public water systems are under consumption restrictions and federal disaster aid is declared for 85 drought stricken counties. September 2007, 6.7 of the 8.5 million residents are under voluntary, if not mandatory water restrictions. By October, 55 counties are experiencing exceptional drought conditions, statewide outdoor burning is banned and water consumption is urged to be cut by 50%. (Source: [www.ncdrought.org](http://www.ncdrought.org) and [www.wral.com/news/local/story/1916680/](http://www.wral.com/news/local/story/1916680/))

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**Table A-6: History of Drought in North Carolina and the U.S.**

Year	Drought Description
1980	The drought/heat wave summer of 1980 caused over \$20 billion in damages to agriculture and related industries and an estimated 10,000 heat stress-related deaths in the United States.
1983	In August, severe heat/drought temperatures over 100 degrees contributed to 0.07 fatalities in Wilson County
1985	In April, drought/wildfires/wind contributed to estimated property damages in Wilson County of \$500 and crop damages in excess of \$50,000.
1986	\$1 - \$1.5 billion in damages and an estimated 100 deaths.
1987	In July, excessive heat contributed to property damage totaling \$5,000 in Wilson County.
1988	Over \$40 billion in damages and 5,000 to 10,000 deaths across central and eastern United States.
1993	During June-July 1993 most of the Southeast received less than 50% of normal rainfall along with temperatures 3 – 6 degrees above normal. Eighty-nine of the one hundred counties in NC were declared disaster areas. Crop losses for NC were estimated at \$165 million. During this period, North Carolina also recorded the second driest summer (June-August) on record (since 1895) with a statewide average precipitation of only 9.43 inches. The Raleigh-Durham area recorded the driest June on record with 0.33 inches of rain. Estimated damages for the United States exceeded \$1 billion in damages to agriculture and at least 16 deaths.
1998	Severe drought/heat wave from Texas/Oklahoma eastward to the Carolinas resulted in \$6 - \$9 billion in damages to agriculture and at least 200 deaths. Central and eastern NC counties were plagued during 6/22-23, where temperatures reached the 98 to 103 degree range combined with dew points in the 78 to 80 degree range with little wind to give heat index values of around 110 degrees for several hours each afternoon. To make matters worse, the minimum temperatures did not fall below 80 at several locations and those that did achieved that feat for only an hour or two. Strong thunderstorms ended the 2 day excessive heat ordeal on the evening of the 23 <sup>rd</sup> when rain cooled the environment enough to send temperatures into the lower 70s at most locations.
1999	Summer drought/heat wave of 1999 resulted in extensive agricultural losses estimated at over \$1.0 billion in damages and an estimated 502 deaths in the United States. The east coast was hardest hit by the drought, with record and near-record short-term precipitation deficits occurring on a local and regional scale resulting in agricultural losses and drought emergencies being declared in several states. Drought was especially severe in the mid-Atlantic states, where local water restrictions were in effect and drought emergencies were declared by several governors. February-August 1999 ranked as the fifth driest such period in the 105-year record.
2000	Severe drought and persistent heat over south-central and southeastern states caused significant losses to agriculture and related industries estimated at over \$4.0 billion in damages and 140 deaths.
2002	According to the National Climatic Data Center, moderate to extreme drought affected more than 45% of the United States June through August of 2002. Nationwide, the summer of 2002 was the third hottest on record after the summers of 1934 and 1936. The 12 months that ended with August 2002 were the driest on record for North Carolina. Local water restrictions were in effect throughout central and western North Carolina.
2004	In April 2004, Wilson County experienced abnormally dry weather patterns.
2005	During the months of March, June, August, September, October, and November, abnormally dry conditions were reported in Wilson County.
2006	During the months of January, February, March, April, May, June, and August Wilson County reported abnormally dry conditions. Conditions in April escalated to moderate drought levels.

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Year	Drought Description
2007	<p>During the months of March, April, May, June abnormally dry conditions were present. Also, during May, June, July and August, conditions of moderate drought existed. Conditions escalated during August, October and November to severe. October, November and December experienced exceptional drought conditions.</p> <p>March 19: Moderate drought conditions reported in western North Carolina by U.S. Drought Monitor. June 29: Gov. Easley announces drought expands to all 100 counties, urges water conservation by residents and local governments statewide. Aug. 2: Twenty-seven counties in extreme and severe drought; 39 public water systems impose mandatory or voluntarily restrictions. Aug. 22: Gov. Easley seeks federal disaster aid for drought-stricken farmers. Sept. 13: 98 counties now classified as experiencing exceptional, extreme or severe drought. Oct. 15: Statewide outdoor burning ban issued to lessen potential for wildfires. Oct. 21: Gov. Easley calls on N.C. residents to cut water consumption by 50 percent by end of October.</p>
2008	Wilson County, during the months of January and February were subject to exceptional drought conditions, where as March and April were listed as severe. June though October, conditions pivoted between moderate to abnormally dry conditions.

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Source: National Climatic Data Center, <http://www4.ncdc.noaa.gov/cgi-win/wwcqi.dll?wwEvent-Storms>, SHELUS (Spatial Hazard Events and Losses Database for the United States, [http://go2.cla.sc.edu/hazard/db\\_registration](http://go2.cla.sc.edu/hazard/db_registration), and NC Water, [www.ncwater.org](http://www.ncwater.org) )

### North Carolina Drought Management Legislation (HB 2499)

House Bill 2499 addresses drought management planning, emergency powers of the Governor, registration of water withdrawals, reporting of water conservation measures, and water reuse and efficiency measures. NC Department of Environment and Natural Resources (NC DENR) have the approval authority over the Local Water Supply Plans and the authority to require water systems to move to a more stringent level of conservation measures if they can demonstrate that water supply conditions are not improving with the imposition of the current restrictions.

The legislation transferred emergency powers during a water shortage emergency from the Environmental Management Commission to the Governor. A “water shortage emergency” means a water shortage resulting from prolonged drought, contamination of the water supply, and damage to water infrastructure, or other unforeseen causes that presents an imminent threat to public health, safety, and welfare or to the environment.” This may require water systems with water in excess of that required to meet the essential water uses of its customers to provide water to the system(s) experiencing the water shortage emergency.

North Carolina is traditionally a riparian rights state; all land owners adjacent to waters of the state may make reasonable withdrawals without seeking a permit from the state. Municipal water systems in NC traditionally have been required to get a permit for water withdrawals and to report all withdrawals or transfers of over 100,000 gallons per day (gpd). Other non-agricultural water users are also required to report water usage over 100,000 gpd, while agricultural water use only required reporting when it reached 1,000,000 gpd. This legislation reduced the threshold for agriculture to 10,000 gpd.

The legislation included provisions to increase water efficiency (through metering) and to encourage broader use of reclaimed water (treated wastewater). The legislation also addressed the use of gray water, the wastewater from household wash basins, bathtubs and showers. To alleviate the confusion over allowed uses of gray water, the legislation clearly states that untreated gray water may be used during periods of drought to hand water trees, shrubs, and inedible plants on a single-family residential property. (Source: [www.ncdm.org](http://www.ncdm.org) and [www.ncga.state.nc.us](http://www.ncga.state.nc.us) )

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(Source of Photo: National Oceanic and Atmospheric Administration (NOAA))

### **3.2 Heat Waves**

Heat kills by taxing the human body beyond its abilities. In a normal year, about 175 Americans succumb to the demands of summer heat. Among large natural hazards, only the cold of winter -- not lightning, hurricanes, tornadoes, floods, or earthquakes -- takes a greater toll. In the 40-year from 1936 through 1975, nearly 20,000 people in the United States were killed by the effects of heat and solar radiation. In the disastrous heat wave of 1980, more than 1,250 people died as a direct result of the heat wave. People at higher risk, e.g., with aging or diseased hearts,

are especially susceptible to excessive heat. In recent years, the National Weather Service (NWS) has stepped up efforts to more effectively alert the general public and appropriate authorities to the hazards of heat waves and prolonged excessive heat/humidity episodes.

#### **How Heat Affects the Body**

Human bodies dissipate heat by varying the rate and depth of blood circulation, by losing water through the skin and sweat glands, and - as the last extremity is reached - by panting, when blood is heated above 98.6 degrees. As heat rises, the heart begins to pump more blood, blood vessels dilate to accommodate the increased flow, and the bundles of tiny capillaries threading through the upper layers of skin are put into operation. Blood is circulated closer to the skin's surface, and excess heat drains off into the cooler atmosphere. At the same time, water diffuses through the skin as perspiration. The skin handles about 90 percent of the body's heat dissipating function. Sweating, by itself, does nothing to cool the body, unless the water is removed by evaporation -- and high relative humidity retards evaporation.

Heat disorders generally have to do with a reduction or collapse of the ability of the body to shed heat by circulatory changes and sweating, or a chemical (salt) imbalance caused by too much sweating. When heat gain exceeds the level the body can remove, or when the body cannot compensate for fluids and salt lost through perspiration, the temperature of the body's inner core begins to rise and heat-related illness may develop.

Ranging in severity, heat disorders share one common feature: the individual has overexposed or over exercised for his/her age and physical condition in the existing thermal environment. Sunburn, with its ultraviolet radiation burns, can significantly retard the skin's ability to shed excess heat. Studies indicate that, other things being equal, the severity of heat disorders tend to increase with age -- heat cramps in a 17-year-old may be heat exhaustion in someone 40 and heat stroke in a person over 60.

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**Heat Index**

The heat index, given in degrees Fahrenheit, is an accurate measure of how hot it really feels when the relative humidity is added to the actual air temperature (see Table A-7 Heat Index Chart). If the air temperature is 95°F (found on the left side of Table A-7), and the relative humidity is 50% (found at the top of Table A-7), the heat index - or how hot it really feels - is 106.7°F. This is at the intersection of the 95° row and the 50% column. Since heat index values were devised for shady, light wind conditions, exposure to full sunshine can increase HI values by up to 15°F. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous. In Table A-7, the shaded zone above 105°F corresponds to a heat index level that may cause increasingly severe heat disorders with continued exposure and/or physical activity.

**Table A-7: Heat Index Chart**

Temperature (F) versus Relative Humidity (%)									
°F	90%	80%	70%	60%	50%	40%	30%	20%	10%
65	65.6	64.7	63.8	62.8	61.9	60.9	60.0	59.1	58.1
70	71.6	70.7	69.8	68.8	67.9	66.9	66.0	65.1	64.1
75	79.7	76.7	75.8	74.8	73.9	72.9	72.0	71.1	70.1
80	88.2	85.9	84.2	82.8	81.6	80.4	79.0	77.4	76.1
85	101.4	97.0	93.3	90.3	87.7	85.5	83.5	81.6	79.6
90	119.3	112.0	105.8	100.5	96.1	92.3	89.2	86.5	84.2
95	141.8	131.1	121.7	113.6	106.7	100.9	96.1	92.2	89.2
100	168.7	154.0	140.9	129.5	119.6	111.2	104.2	98.7	94.4
105	200.0	180.7	163.4	148.1	134.7	123.2	113.6	105.8	100.0
110	235.0	211.2	189.1	169.4	151.9	136.8	124.1	113.7	105.8
115	275.3	245.4	218.0	193.3	171.3	152.1	135.8	122.3	111.9
120	319.1	283.1	250.0	219.9	192.9	169.1	148.7	131.6	118.2

Source: National Weather Service Heat Index Program, NOAA.

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**Heat Index/Heat Disorders**

The Heat Index/Heat Disorders (Table A-8) relates ranges of heat index with specific disorders, particularly for people in higher risk groups. Heat disorder symptoms are described in Table A-9.

**Table A-8 Heat Index/Heat Disorders**

Prolonged Exposure or Physical Activity	HI	Possible Heat Disorder
Caution	80°F - 90°F	Fatigue possible with prolonged exposure and physical activity.
Extreme Caution	90°F - 105°F	Sunstroke, heat cramps and heat exhaustion possible.
Danger	105°F – 130°F	Sunstroke, heat cramps, and heat exhaustion likely, and heat stroke possible.
Extreme Danger	130°F or greater	Heat stroke highly likely with continued exposure.

Source: National Weather Service Heat Index Program, NOAA.

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**Table A-9: Heat Disorder Symptoms**

Heat Disorder	Symptoms	First Aid
Sunburn	Redness and pain. In severe cases, swelling of skin, blisters, fever, headaches.	Ointment for mild cases if blisters appear. If breaking occurs, apply dry sterile dressing. Serious cases should be seen by a physician.
Heat Cramps	Painful spasms usually in muscles of legs and abdomen possible. Heavy sweating.	Firm pressure on cramping muscles, or gentle massage to relieve spasm. Give sips of water. If nausea occurs, discontinue use.
Heat Exhaustion	Heavy sweating, weakness, skin cold, pale and clammy. Pulse thready. Normal temperature possible. Fainting and vomiting.	Get victim out of sun. Lie down and loosen clothing. Apply cool wet cloths. Fan or move victim to air conditioned room. Sips of water. If nausea occurs, discontinue use. If vomiting continues, seek immediate medical attention.
Heat Stroke/Sunstroke	High body temperature (106°F, or higher). Hot dry skin. Rapid and strong pulse. Possible unconsciousness.	Heat stroke is a severe medical emergency. Summon medical assistance or get the victim to a hospital immediately. Delay can be fatal. Move the victim to a cooler environment. Reduce body temperature with cold bath or sponging. Use extreme caution. Remove clothing, use fans and air conditioners. If temperature rises again, repeat process. Do not give fluids.

Source: National Weather Service Heat Index Program, NOAA.

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**Cities Pose Special Hazards**

The stagnant atmospheric conditions a heat wave trap pollutants in urban areas and add the stresses of severe pollution to the already dangerous stresses of hot weather, creating a health problem of greater dimensions. A map of heat-related deaths in St. Louis during 1966, for example, showed a heavier concentration in the crowded alleys and towers of the inner city, where air quality would also be poor during a heat wave.

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The high inner-city death rates also can be read as poor access to air-conditioned rooms. While air-conditioning may be a luxury in normal times, it can be a lifesaver during heat wave conditions. The cost of cool air moves steadily higher, adding what appears to be a cruel economic side to heat wave fatalities. Indications from the 1978 Texas heat wave suggest that some elderly people on fixed incomes, many of them in buildings that could not be ventilated without air conditioning, found the cost too high, turned off their units, and ultimately succumbed to the stresses of heat.

#### **History of Droughts and Heat Waves in Wilson County**

There have been 7 recorded instances of droughts occurring on 7/12/1983, 8/1/1983, 4/1/1985, 5/1/1986, 7/1/1986, 7/1/1987 and 6/1/1993. Information available on past droughts and heat waves specific to Wilson County indicate excessive temperatures that resulted in wildfires. One day of excessive heat was reported on 7/22/98. This event caused temperatures to increase to over 110 degrees for several hours during the afternoon. It should be noted that the previously documented drought conditions experienced in 2006-2008, although not indicated by a specific occurrence, drastically impacted Wilson County. These occurrences are likely to be included as databases are updated.

#### **Hazard Analysis**

\*Note: Droughts and heat waves have regional impact thus historical data on the impact of droughts and heat waves in North Carolina (Table A-7) were assumed to have affected all of Wilson County.

#### **Likelihood of Occurrence of Droughts and Heat Waves**

Since 1980 there have been several periods of significant drought affecting the southeastern portion of the United States. Although there is no recorded information from the National Climatic Data Center on heat waves in North Carolina, these hazard events can be considered “likely” in Wilson County.

#### **Likely Range of Impact for Droughts and Heat Waves**

When droughts and heat waves do occur, they impact several states or an entire region of the United States, therefore, the range of impact can be classified as “large”.

#### **Probable Level of Impact for Droughts and Heat Waves**

Extended droughts can have a significant impact on local resources and local economies as evidenced by data on drought impacts since 1980. Heat waves have a much more limited impact, but considered together these two related natural hazards can have a huge impact on a community; therefore, the probable level of impact can be classified as “limited”.

#### **Wilson County Hazard Index for Droughts and Heat Waves** (see Table A-28)

The hazard index for droughts and heat waves in Wilson County is categorized as “moderate” based on a “likely” occurrence, “large” range of impact, and “limited” level of impact. This hazard index of “moderate” indicates that droughts and heat waves pose a relatively large threat in Wilson County and that major hazard mitigation efforts are advised. However, mitigating the impact of a drought or heat wave is generally considered a State or regional issue and planned for at those levels. Local initiatives could include public education/conservation and limits on water usage.

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(Source of Photo: FEMA)

#### **4. Earthquakes**

The Federal Emergency Management Agency (FEMA) defines an earthquake as “a sudden, rapid shaking of the earth caused by the breaking and shifting of rock beneath the earth’s surface”. Earthquakes result when stress forces build up along fractures or fault lines in the earth’s crust over extended periods of time. At the point where these stresses exceed the strength of the rocks on either side of the fault there is a sudden rupture or snapping that releases energy in the form of seismic waves.

The 1931 Modified Mercalli Scale (Table A-10) is used in the United States to measure the intensity of an earthquake. The scale assigns a Roman numeral from Category I to Category XII to describe the qualitative effects of an earthquake. The methodology used involves:

1. Assigning an intensity numeral at each location to describe the earthquake effect.
2. Creating a contour map of the zones of similar effect.
3. The earthquake assumed to occur near the region of maximum intensity.
4. The earthquake is characterized by the largest Roman numeral assigned.

The scale is a qualitative assessment that measures different phenomena. The lower intensity values measure human response to ground motions, the intermediate values characterize the response of simple structures, and the upper values describe ground failure processes. A problem with the scale is that incomplete spatial coverage may lead to missing the location of the earthquake or an underassessment of its size. This can be a problem when measuring offshore earthquakes or where sparsely populated, less developed areas result in inadequate measurements.

#### **History of Earthquakes Impacting North Carolina**

North Carolina’s vulnerability to earthquakes decreases from west to east. Epicenters that affect North Carolina are generally concentrated in the Eastern Tennessee Seismic Zone (ETSZ), which is second in activity in the eastern United States only to the New York Madrid Fault. The eastern portion of the State faces minimal effects from seismic activity (North Carolina Natural Hazards Mitigation (Section 409) Plan, North Carolina Department of Environment and Natural Resources, 1998, p. 14.).

The ETSZ is part of a crescent of moderate seismic activity risk extending from Charleston, South Carolina northwestward into eastern Tennessee and then curving northeastward into central Virginia. There have not been any earthquakes in the ETSZ with MMI intensity greater than IV since 1928, but the potential to produce an earthquake of significant intensity still exists.

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**Table A-10: Modified Mercalli Scale of Earthquake Intensity**

Scale	Intensity	Description of Effects	Maximum Acceleration (mm/sec)	Richter Scale
I	Instrumental	Detected only on seismographs.	<10	<2.9
II	Feeble	Some people feel it.	<25	>3 – 3.5
III	Slight	Felt by people resting.	<50	>3.5 - <4.2
IV	Moderate	Felt by people walking.	<100	4.2 - <4.8
V	Slightly Strong	Sleepers awake; church bells ring.	<250	<4.8
VI	Strong	Trees sway; suspended objects swing, objects fall off shelves.	<500	<5.4
VII	Very Strong	Mild alarm; walls crack; plaster falls.	<1000	<6.1
VIII	Destructive	Moving cars uncontrollable; masonry fractures, poorly constructed buildings damaged.	<2500	6.1 - <6.9
IX	Ruinous	Some houses collapse; ground cracks; pipes break open.	<5000	<6.9
X	Disastrous	Ground cracks profusely; many buildings destroyed; liquefaction and landslides widespread.	<7500	<7.3
XI	Very Disastrous	Most buildings/bridges collapse; roads/railways/pipes/cables destroyed; other hazards triggered.	<9800	<8.1
XII	Catastrophic	Total destruction; trees fall; ground rises and falls in waves.	>9800	>8.1

Source: *Local Hazard Mitigation Planning Manual*, NC Division of Emergency Management, 1998.

Earthquakes are relatively infrequent but not uncommon in North Carolina. From 1568 to 1992, 157 earthquakes occurred in North Carolina (*Local Hazard Mitigation Planning Manual*, NC Division of Emergency Management, 1998, p. 77.). The strongest earthquake on record in the State occurred March 8, 1735 near Bath. During the great earthquake of 1811 (MMI VI), centered in the Mississippi Valley, tremors were felt throughout North Carolina.

The most earthquake property damages recorded in North Carolina are attributed to an earthquake that occurred August 31, 1886 in Charleston, SC. This quake left 65 people dead in Charleston and caused chimney collapses, fallen plaster and cracked walls as far away as Charlotte, Elizabethtown, Henderson, Hillsborough, Raleigh, Waynesville, and Whiteville, North Carolina. On February 21, 1916, the Asheville area was the center for a large MMI VI earthquake that was felt in several states. Subsequent minor earthquakes have caused damages in North Carolina in 1926, 1928, 1957, 1959, 1971, 1973, and 1976.

**History of Earthquake Damage in Wilson County**

There is no history of earthquake damage in Wilson County.

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## **Hazard Analysis**

### **Likelihood of Occurrence of an Earthquake**

The probability of a notable earthquake occurring in Wilson County can be classified as “unlikely”.

### **Likely Range of Impact of an Earthquake**

Earthquakes are not localized events within a small land area and therefore are not easily mapped. Any diminishment of the destructive force of an earthquake from one side of Wilson County to the other would probably be negligible. The impact of an earthquake within the area would be fairly uniform among structures which were built using comparable construction methods and materials. If an earthquake were to occur, the range of impact would be classified as “small”.

### **Probable Level of Impact of an Earthquake**

Earthquakes can cause buildings and bridges to collapse, damage utility service lines, trigger landslides and avalanches, and cause flash floods and fires. Regarding earthquakes, FEMA reports that “buildings with foundations resting on unconsolidated landfill, old waterways, or other unstable soil are most at risk. Buildings or trailers and manufactured homes not tied to a reinforced foundation anchored to the ground are also at risk since they can be shaken off their mountings during an earthquake”.

There are no records of the Wilson County area experiencing an earthquake. Past history indicates that only minor property damage is likely from an earthquake that affects this area. The probable level of impact of an earthquake in the greater Wilson County area can be classified as “negligible”.

### **Wilson County Hazard Index for Earthquakes** (see Table A-28)

Earthquakes have been assigned a hazard index of “low” for the Wilson County area based on the likelihood of occurrence “unlikely”, a “small” likely range of impact, and a “negligible” probability of damage. The combined hazard index of “low” for earthquakes indicates that this particular hazard poses a relatively low threat and that hazard mitigation efforts would be more wisely directed to other hazards to which the area is more vulnerable.

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## 5. Floods (Map A-1 Multi-Hazards)

Areas susceptible to flood damage caused by heavy rainfall have been determined through the Federal Emergency Management Agency (FEMA) floodplain mapping program. The economic and human impact a hurricane or other heavy rainfall event has on a community depends greatly on how development has occurred within that community. Development in areas of high risk or vulnerability greatly increases the potential for property damage and loss of life.



Flooding is normally the result of a larger event such as a hurricane, nor'easter or thunderstorm, but flooding can be as frequent as the occurrence of a spring rain or a summer thunderstorm. Flooding is caused by excessive precipitation and can be generally considered in two categories: flash floods and general floods.



(Photo Source: City of Wilson)

Flash floods are the product of localized, high-intensity precipitation over a small drainage basin in a short time period. Flash floods, which typically occur more frequently than general floods, occur along small streams and creeks. The undermining or washing out of roads is typically associated with flash floods. General floods are caused by precipitation over a longer time period and over a given river basin. These larger storm events occur along the East Coast of the United States most often in the late summer and fall.

A combination of river basin physiography, local thunderstorm movements, past soil moisture conditions, the degree of vegetative clearing and the amount of impervious surface coverage buildings.

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### History of Floods in Wilson County

Since 1966, thirty flood events have been reported in Wilson County (Table A-11).

**Table A-11: Flood Event Data for Wilson County – 1966 – 2008**

Location	Date	Time	Type	Deaths	Injuries
Wilson County	2/13/1966	N/A	Flooding	0.01	0
Wilson County	2/28/1966	N/A	Flooding	0	0
Wilson County	3/4/1966	N/A	Flooding	0	0
Wilson County	9/21/1979	N/A	Flooding	0.12	0
Wilson County	3/17/1983	N/A	Flash Flood	0	0
Wilson County	10/10/1990	N/A	Flash Flood	0.02	0
Wilson County	10/22/1990	N/A	Flash Flood	0	0
Wilson County	8/16/1992	N/A	Flash Flood	0	0
Wilson	7/1/1994	10:45 PM	Flash Flood	0	0
Wilson County	7/24/1997	8:30 AM	Flash Flood	0	0
Lucama	1/27/1998	1:00 PM	Flash Flood	0	0
Eastern Portion	1/27/1998	1:00 PM	Flash Flood	0	0
Wilson	2/3/1998	12:00 PM	Heavy Rain	0	0
Wilson	2/16/1998	12:00 PM	Heavy Rain	0	0
Wilson County	9/15/1999	10:00 PM	Flash Flood	0	0
Wilson County	9/21/1999	11:45 AM	Flash Flood	0	0
Wilson County	9/27/1999	6:00 PM	Flash Flood	0	0
Wilson County	9/28/1999	4:30 PM	Flash Flood	0	0
Wilson County	9/28/1999	11:00 AM	Flash Flood	0	0
Wilson County	9/28/1999	7:30 AM	Flash Flood	0	0
Wilson County	10/17/1999	6:00 PM	Flash Flood	0	0
Wilson County	6/16/2001	8:04 PM	Flash Flood	0	0
Wilson	7/5/2002	7:30 PM	Flooding	0	0
Wilson	8/26/2002	6:50 AM	Flooding	0	0
Wilson	8/31/2002	6:30 AM	Flooding	0	0
Wilson	5/22/2004	7:55 PM	Flash Flood	0	0
Northwest Portion	6/14/2006	12:00 PM	Flash Flood	0	0
Wilson	7/25/2006	6:21 PM	Flash Flood	0	0
Evansdale	8/26/2007	5:45 PM	Flash Flood	0	0
<b>Totals</b>				<b>0.15</b>	<b>0</b>

Source: National Climatic Data Center, <http://www4.ncdc.noaa.gov/cgi-win/wwwcgi.dll?wwEvent-Storms> and SHELUDS (Spatial Hazard Events and Losses Database for the United States, [http://go2.cla.sc.edu/hazard/db\\_registration](http://go2.cla.sc.edu/hazard/db_registration)).

The total economic and loss of life impact in a community depends greatly on the amount of development within flood prone areas. In September 1999, Tropical Storm/Hurricane Dennis I and II and Hurricane Floyd together dealt eastern North Carolina a severe two-punch blow. Rains from Dennis saturated the ground and overfilled creeks, rivers, and reservoirs before Floyd made landfall three weeks later. Once Floyd passed through the State, severe flash flooding and general flooding occurred with floodwaters overflowing stream and riverbanks for up to two weeks following the storm.

Both flash flooding and longer-term general flooding from Hurricane Floyd caused property damage to structures located in floodplains. A number of individuals and families in Wilson County were left homeless and a number of businesses were either closed for several weeks or destroyed by the flooding.

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Hurricane Floyd's unprecedented flooding levels resulted in private property and public infrastructure damage totaling \$3 billion throughout eastern North Carolina. Crop damage was estimated at \$500 million. Damages within Wilson County, as reported by the Wilson County Tax Department and the North Carolina Cooperative Extension Service, are outlined in Tables A-12.

**Table A-12: Hurricane Floyd Damage Assessment for Wilson County**

Category	Damages
Agricultural Equipment and Structure Loss	\$3,800,000

Source: Wilson County Tax Department; NCSU Cooperative Extension Service.

**Hazard Analysis**

**Likelihood of Occurrence of Floods**

Localized flooding can occur several times a year in Wilson County. In recent years there have also been a number of more widespread flooding events caused by hurricanes and tropical storms. The likelihood of localized flooding can be categorized as "highly likely" and area wide flooding as "likely".

**Likely Range of Impact for Floods**

Flooding is normally confined to specific, known flood hazard areas where development can be controlled or limited. The likely range of flood impact can be classified as "medium".

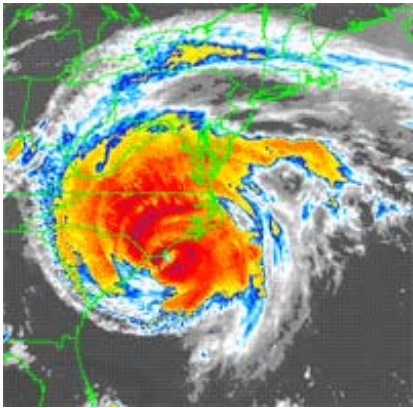
**Probable Level of Impact for Floods**

Localized flooding typically has a "negligible" level of impact, whereas area wide flooding can have a "limited" level of impact in Wilson County.

**Wilson County Hazard Index for Floods** (see Table A-28)

The hazard index for floods in Wilson County is categorized as "moderate" based on a "likely to highly likely" level of occurrence, "medium" range of impact, and "limited" level of impact. This hazard index indicates that floods should be a major focus of local hazard mitigation efforts. Wilson County is particularly vulnerable to flooding because of the extensive drainage patterns in the area. There are three major drainage basins that extend throughout the area, including Contentnea Creek, Harmony Swamp and Toisnot Swamp drainage basins. Toisnot Swamp consists of 62 square miles of drainage area; Harmony Swamp 12 square miles of drainage area, and Contentnea Creek 261 square miles of drainage area.

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(Hurricane Fran, Source of Photo: NC Office of Archives and History)

## **6. Hurricanes and Coastal Storms**

Hurricanes are cyclonic low-pressure system storms originating in tropical ocean waters and fueled by latent heat from the condensation of warm water. Hurricanes and tropical storms that affect North Carolina normally form in the Atlantic Ocean off the coast of western Africa between the months of June and November with the peak season occurring in early September. (State Climate Office of North Carolina)

Hurricanes are born over tropical oceans when the water is warmer than about 80 degrees. These storms start as areas of disturbed weather where a combination of clouds and falling pressure combined with the rotation of the earth result in increasing winds. Once these winds mature into hurricanes, they can remain constant for days or they may peak and quickly die. Hurricanes lose power when taken away from a warm water source - which is what happens when a storm moves over land.

Hurricanes and other cyclones that form in the tropics during summer months are different from the extratropical storms (nor'easters) that form during winter months. Both types of storms produce strong winds and may cause flooding. The main differences between hurricanes and nor'easters are:

- Hurricanes and tropical systems have no fronts.
- Hurricane winds weaken with height.
- The centers of hurricanes are warmer than the surroundings.
- Hurricanes and tropical systems form under weak high-altitude winds.
- Air sinks at the center of a hurricane.
- Latent heat of condensation is the major energy source for hurricanes.
- Hurricanes weaken rapidly when over land.

### **Tropical Storm Categories**

Tropical systems/hurricanes are classified into four categories according to degree of organization and maximum sustained wind speed:

1. Tropical Disturbance/Tropical Wave - unorganized mass of thunderstorms, very little, if any, organized wind circulation.
2. Tropical Depression - evidence of closed wind circulation around a center with sustained winds from 20-34 knots (23-39 mph).
3. Tropical Storm - maximum sustained winds are from 35-64 knots (40-74 mph). A storm is named once it reaches tropical storm strength.
4. Hurricane - maximum sustained winds exceed 64 knots (74 mph).

With favorable atmospheric and oceanic conditions, a storm will intensify from a tropical depression to a tropical storm and then to a hurricane. Heavy precipitation, high winds and tornadoes are all typically associated with hurricanes. Hurricanes have long threatened the North Carolina coast and, as evidenced in recent years, can strongly affect inland areas as well.

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The Saffir-Simpson Scale measures hurricane intensity ranging from one (minimal) to five (catastrophic). The scale ratings are based on wind speeds, surface pressure and height of storm surge (Table A-13). To improve storm-rating accuracy, scientists are currently considering revising the Saffir-Simpson Scale to include rainfall potential as a fourth rating variable.

**Hurricane Categories**

Major hurricanes are categorized as 3, 4 or 5 on the Saffir-Simpson Scale. While hurricanes within this range comprise only 20% of total tropical cyclone landfalls, they account for over 70% of the damage in the United States. Maximum sustained winds of category 3, 4 and 5 hurricanes range from 112 mph to over 156 mph. The higher wind intensities topple trees and cause severe damage to structures.

**Table A-13: Saffir-Simpson Hurricane Scale**

Category	Barometric Pressure (mb)	Wind Speed (miles per hr)	Height of Storm Surge (feet)	Damage Potential
1 Weak	>980.2	75 – 95	4 – 5	Minimal damage to vegetation
2 Moderate	979.68 – 965.12	96 – 110	6 – 8	Moderate damage to houses
3 Strong	945.14 – 964.78	111 – 130	8 – 12	Extensive damage to small buildings
4 Very Strong	920.08 – 944.80	131 – 155	13 – 18	Extreme structural damage
5 Devastating	<920.08	> 155	> 18	Catastrophic building failures possible

Source: State Climate Office of North Carolina, NC State University.

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The National Hurricane Center, describes damages associated with hurricanes categories as:

**Category 1**

Damage primarily to unanchored mobile homes, shrubbery and trees. Some damage to poorly constructed signs. Also, some coastal road flooding and minor pier damage.

**Category 2**

Some building roofing material, door and window damage. Considerable damage to shrubbery and trees with some trees blown down. Considerable damage to mobile homes, poorly constructed signs and piers. Coastal and low-lying escape routes flood 2-4 hours before arrival of the hurricane center. Small craft in unprotected anchorages break moorings.

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**Category 3**

Some structural damage to small residences and utility buildings with a minor amount of curtain wall failures. (Curtain walls are typically associated with non-residential buildings where non-structural window and/or wall panels are attached to the structural framework to form the exterior skin of the building.) Damage to shrubbery and trees with foliage blown off trees and large trees blown down. Mobile homes and poorly constructed signs are destroyed. Low-lying escape routes are cut by rising water 3-5 hours before arrival of the hurricane center. Flooding near the coast destroys smaller structures with larger structures damaged by battering of floating debris. Terrain continuously lower than 5 feet above mean sea level may be flooded inland 8 miles or more. Evacuation of low-lying residences within several blocks of the shoreline may be required.

**Category 4**

More extensive curtain wall failures with some complete roof structure failures on small residences. Shrubs, trees, and all signs are blown down. Complete destruction of mobile homes. Extensive damage to doors and windows. Low-lying escape routes may be cut by rising water 3-5 hours before arrival of the hurricane center. Major damage to lower floors of structures near the shore. Terrain lower than 10 feet above sea level may be flooded requiring massive evacuation of residential areas as far inland as 6 miles.

**Category 5**

Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. All shrubs, trees, and signs blown down. Complete destruction of mobile homes. Severe and extensive window and door damage. Low-lying escape routes are cut by rising water 3-5 hours before arrival of the hurricane center. Major damage to lower floors of all structures located less than 15 feet above sea level and within 500 yards of the shoreline. Massive evacuation of residential areas on low ground within 5-10 miles of the shoreline may be required.

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**Historic Impact of Hurricanes and Coastal Storms in Wilson County**



(Source of Photo: FEMA)

During the time period from 1993 - 2003, five hurricanes or tropical storms impacted Wilson County - Hurricanes Bertha (July 1996), Bonnie (August 1998), and Fran (September 1996), Tropical Storm/Hurricane Dennis (August 1999), Floyd (September 1999) and Isabel (September 2003). These storms caused significant damage within the State. (Table A-14). (Note: For more detail on hurricane damages, also see section on Floods.)

**Table A-14: Hurricanes and Tropical Storms Affecting Wilson County**

Date	Storm Name	Deaths and Injuries in NC		Damages in NC	
		Deaths	Injuries	Property	Crop
10/16/1964	Isbell	0	0	\$500	\$500
9/4/1979	David	0.01	0	\$50,000	\$500
8/19/1981	Dennis	0	0	\$0	\$156,000
9/11/1984	Diana	0.09	0.09	\$1,429,000	\$143,000
7/24/1985	Gloria	0	0	\$8,000	\$0
7/12/1996	Bertha	0	0	\$0	\$45,450,000
9/05/1996	Fran	7	2	N/A	N/A
8/27/1998	Bonnie	0	0	N/A	\$50,000,000
9/04/1999	Dennis	N/A	N/A	N/A	\$3,000,000
9/15/1999	Floyd	N/A	N/A	\$3,000,000,000	\$500,000,000
9/18/2003	Isabel	N/A	N/A	\$7,3000,000	N/A

Source: National Climatic Data Center, <http://www4.ncdc.noaa.gov/cgi-win/wwwcgi.dll?wwEvent-Storms> and SHELUDS (Spatial Hazard Events and Losses Database for the United States, [http://go2.cla.sc.edu/hazard/db\\_registration](http://go2.cla.sc.edu/hazard/db_registration)).

**Hazard Analysis**

**Likelihood of Occurrence of Hurricanes and Coastal Storms**

According to the Local Hazard Mitigation Planning Manual, "by virtue of its position along the Atlantic Ocean adjacent to and protruding to the edge of the Gulf Stream, North Carolina is frequently impacted by hurricanes (and tropical storms). In fact, North Carolina has experienced the fourth greatest number of hurricane landfalls of any state in the twentieth century (after Florida, Texas and Louisiana)." Many of these storms track inland and pass over Wilson County, although they usually have weakened below hurricane force by the time that they reach the area. There are other storms that do not even make landfall and instead just skirt the North Carolina coastline, but they can still cause high winds and torrential rains in the area, because of the tremendous size of these storms.

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There have been a number of hurricanes (and tropical storms) whose impacts have been felt in Wilson County. Hurricanes that have struck North Carolina in the last 50 years include Hazel in 1954, Connie, Diane and Lone all in 1955, Donna in 1960, Hugo in 1989, Emily in 1993, Opal in 1995, Bertha and Fran in 1996, Bonnie in 1998, and Dennis Floyd in 1999 and Isabel in 2003. Because of the size of these storms (up to 400 miles wide), the Wilson County area felt some impact (including torrential rains and high winds) from these storms. The probability of the Wilson County area experiencing the affects of a hurricane, or tropical storm, can be classified as “likely”.

**Likely Range of Impact of Hurricanes and Coastal Storms**

Hurricanes and tropical storms are not localized events. The diminishment of the destructive force of a hurricane or tropical storm from one side of Wilson County to the other would probably be negligible. The impact of the wind element of a hurricane or a tropical storm within the County would be fairly uniform among structures which were built using comparable construction methods and materials. The impact of the associated rainfall from a hurricane or tropical storm would primarily affect structures and infrastructure in proximity to regulatory floodplains and secondary tributaries and creeks. The accumulation of wind blown debris in public or private storm drainage inlets and drainage swales has the potential to cause minor flooding problems throughout the area. If a hurricane or tropical storm were to occur, the entire Wilson County area would be subject to the effects of the storm, therefore the range of impact can be classified as “large”.

**Probable Level of Impact of Hurricanes and Coastal Storms**

The Local Hazard Mitigation Planning Manual indicates that “hurricanes have the greatest potential to inflict damage as they cross the coastline from the ocean, which is called landfall. Because hurricanes derive their strength from warm ocean waters, they are generally subject to deterioration once they make landfall. The forward momentum of a hurricane can vary from just a few miles per hour to up to 40 mph. This forward motion, combined with a counterclockwise surface flow makes the right front quadrant of the hurricane the location of the most potentially damaging winds.”

Property damage can result when the high winds of a hurricane or a tropical storm combine with saturated soils from extended heavy rains which may cause trees to be uprooted and fall onto nearby structures, or when wind blown debris damages structures. Additionally, hurricanes and tropical storms generally include bands of severe thunderstorms, which may produce hail and spawn tornadoes. The probable level of impact of a hurricane or tropical storm in Wilson County can be classified as “limited”. Although most hurricanes cause only limited damage within the area, occurrences within the last decade have tracked inland causing critical damage throughout the County and region.

**Wilson County Hazard Index for Hurricanes and Coastal Storms** (see Table A-31)

The hazard index for hurricane impacts in Wilson County is “moderate” based on the probability of occurrence being “likely”, the “large” area that would be impacted, and the probable “limited” damage impact. This hazard index of “moderate” for hurricanes indicates that this particular hazard poses a relatively large, but infrequent threat. Since hurricanes and coastal storms are also significant contributors to flooding, there are opportunities for local hazard mitigation efforts to have a significant impact on exposure to future events.

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(Road failure caused by a landslide. Source of Photo: NOAA.)

## **7. Expansive Soils and Land Subsidence, including Landslides and Sinkholes**

### **7.1 Expansive Soils**

Expansive soil is a fine-grained clay which occurs naturally and is generally found in areas that historically were a flood plain or lake area, but can occur in hillside areas also. Expansive soil is subject to swelling and shrinkage of the soil, varying in proportion to the amount of moisture present in the soil. As water is initially introduced into the soil (by rainfall or watering), an expansion takes place. If dried out, the soil will contract,

often leaving small fissures or cracks. Excessive drying and wetting of the soil will progressively deteriorate structures over the years. This excessive wetting and drying causes damage due to differential settlement within buildings and other improvements. Soils containing expansive clays become very sticky when wet and usually are characterized by surface cracks or a "popcorn" texture when dry. Therefore, the presence of surface cracks is usually an indication of an expansive soil. (Source: West Covina Engineering Department and [www.surevoid.com](http://www.surevoid.com))

Mitigative techniques used to reduce the impact of expansive soils include: removing large trees and bushes that grow within about ten feet of a structure; not planting large plants tend to dry out the soil unless a drip irrigation system is installed, utilizing drip irrigation systems to water vegetation; (drip irrigation minimizes the amount of water used and maintains a more even soil moisture content), ensuring that downspouts and roof gutters do not deposit water close to the foundation; if possible, directing roof water into closed pipes that empty onto the street or other suitable location, and sloping the soil or concrete away from the foundation (such construction aids runoff and helps prevent water from puddling or seeping into the ground). Keeping water away from the foundation is the single most important step that can be taken to help minimize an expansive soil problem. (Source: JCP Geologists Inc.)

#### **7.1.1 Landslides**

According to the United States Geological Survey (USGS), landslides are a major geologic hazard that occur in all 50 states and cause on average \$1-2 billion in damages and more than 25 fatalities each year. (USGS, 1997) Landslides often occur in conjunction with other natural hazards such as earthquakes and floods.<sup>1-6</sup>

Clay-rich soil landslides are common throughout the mountainous Appalachian region of the United States. The USGS classifies landslide incidence/susceptibility for the eastern United States as low, medium, or high based on geographic features and geologic formations.

USGS further defines susceptibility to landslides as the probable degree of response of geologic formations to natural or artificial cutting, loading of slopes, or unusually high precipitation. Generally, unusually high precipitation or changes in existing conditions can initiate landslide movement in areas where rocks and soils have experienced landslides in the past.

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Historic records suggest that destructive landslides and debris flows in the Appalachian Mountains occur when unusually heavy rain from hurricanes and intense rain storms soaks the ground, reducing the ability of steep slopes to resist the downward pull of gravity. Scientists have documented fifty-one debris-flow events in North Carolina between 1844 and 1985. All of these occurred in the Appalachian Mountains and most were in the Blue Ridge area. (Gori and Burton, 1996)

**Table A-15: USGS Landslide Susceptibility/Incidence**

Category	Incidence	Susceptibility
1	Low	Low
2	Low	Moderate
3	Low	High
4	Moderate	Moderate
5	Moderate	High
6	High	High

Source: *Local Hazard Mitigation Planning Manual*, North Carolina Division of Emergency Management, 1998.

**Wilson County Qualifies as a Category 1**

Wilson County is categorized as having a landslide vulnerability of “1” on a scale of “1” to “6” where “1” is the lowest level of risk. This categorization generally corresponds to the likelihood of earthquake activity and is based upon a combination of landslide susceptibility and incidence. This information is derived from the USGS National Landslide Overview Map. The potential of sinkholes in Wilson County has not been analyzed by the State. The likelihood of occurrence for landslides and sinkholes can be categorized as “unlikely”.

An area with a “low” incidence ranking means that less than 1.5% of the area has experienced a landslide in the past. An area with a “medium” incidence ranking means that between 1.5% and 15% of the area has experienced a landslide in the past. An area with a “high” incidence ranking means that greater than 15% of the area has experienced a landslide in the past. The susceptibility rankings of “low”, “medium” and “high” follow the same percentage classifications for landslide susceptibility for a specific area. The overall likelihood of occurrence of a landslide in Wilson County can be classified as “unlikely”.

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(Source of Photo: Land subsidence, Mojave Desert, California. Source: USGS.)

## 7.2 Land Subsidence

Land subsidence occurs when large amounts of ground water have been withdrawn from certain types of rocks, such as fine-grained sediments. The rock compacts because the water is partly responsible for holding the ground up. When the water is withdrawn, the rocks fall in on itself. You may not notice land subsidence too much because it can occur over large areas rather than in a small spot, like a sinkhole. Land subsidence is a gradual settling or sudden sinking of the Earth's surface owing to subsurface movement of earth materials.

Subsidence is a global problem and, in the United States, more than 17,000 square miles in 45 States, an area roughly the size of New Hampshire and Vermont combined, have been directly affected by subsidence. More than 80 percent of the identified subsidence in the Nation has occurred because of exploitation of underground water, and the increasing development of land and water resources threatens to exacerbate existing land-subsidence problems and initiate new ones. In many areas of the arid Southwest, and in more humid areas underlain by soluble rocks such as limestone, gypsum, or salt, land subsidence is an often-overlooked environmental consequence of our land- and water-use practices. Land subsidence is most often caused by human activities, mainly from the removal of subsurface water. Compaction of soils in some aquifer systems can accompany excessive ground-water pumping and it is by far the single largest cause of subsidence. Excessive pumping of such aquifer systems has resulted in permanent subsidence and related ground failures. In some systems, when large amounts of water are pumped, the subsoil compacts, thus reducing in size and number the open pore spaces in the soil the previously held water. This can result in a permanent reduction in the total storage capacity of the aquifer system. (Source: USGS)

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**7.2.2 Sinkholes** (Source: Virginia Department of Conservation and Recreation publication "Living with Sinkholes")

Sinkholes are basin-like, funnel-shaped, or vertical sided depressions in the land surface. In general, sinkholes form by the subsidence of unconsolidated materials or soils into voids created by the dissolution of the underlying soluble bedrock.



(Source of Photo: Sinkhole in Georgia. Source: USGS.)

There are three general types of sinkholes – collapse, subsidence, and solution. These different types of sinkholes generally correspond to the thickness of the sediments overlying limestone. The sediments and water contained in the unsaturated zone, surficial aquifer system, and the confining layer are collectively referred to as overburden. Collapse sinkholes are most common in areas where the overburden is thick, but the confining layer is breached or absent. Subsidence sinkholes form where the overburden is thin and only a veneer of sediments is present overlying the limestone. Solution sinkholes form where the overburden is absent and the limestone is exposed at land surface.

The rock exposed in a collapsed sinkhole is usually weathered and rounded, but some sinkholes contain freshly broken rock along steep sides of the hole. Freshly broken rock may indicate that the sinkhole has formed by the collapse of a cave (naturally occurring) or a mine (manmade). Where sinkholes and caves have formed by the dissolution of soluble rock, such as limestone, dolomite, and gypsum, surface water is uncommon and streams may sink into the ground. This type of topography formed by dissolution is referred to as karst terrain. In karst terrain, sinkholes are input points where surface water enters the groundwater system. The most important current and future environmental issue with respect to karst is the sensitivity of karst aquifers to groundwater contamination.

Karstic groundwater problems are accelerated with the advent of (1) expanding urbanization, (2) misuse and improper disposal of environmentally hazardous chemicals, (3) shortage of suitable repositories for toxic waste (both household and industrial), and (4) ineffective public education on waste disposal and the sensitivity of the karstic groundwater system.

Because sinkholes are natural holes in the ground surface, they have been inviting sites for dumping of trash. The number of active and inactive sinkhole dumps in karst regions is staggering. It is conceivable that each county with karst has hundreds of sinkhole dumps. The profusion of these dumps is the result of (1) the absence of a refuse-removal service in rural areas and the expense and inconvenience of trash haulage, (2) the convenient proximity of sinkholes, and (3) a lack of appreciation of the role of sinkholes in the karstic groundwater system.

Sinkholes are natural funnels that conveyed toxic substances directly into the karstic plumbing system. In many cases, chemicals may be transmitted directly to domestic

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wells in a matter of the few hours. Thoughtless disposal of game or farm animal carcasses into sinkholes (a common practice) can contaminate the well water of the landowner and even his neighbors.

Sinkhole dumping is only one way of contaminating a karstic groundwater supply. Fertilizers, herbicides, and pesticides applied to fields overlying carbonate rock can enter the aquifer through diffuse infiltration and contaminate springs and wells. Improper siting of municipal landfills on or near karst allows leakage or runoff from these landfills to easily contaminate karst waters. Chemicals introduced in this fashion may include many of the most hazardous, including hydrocarbons, heavy metals, PCBs, and others. Additionally, leaky septic systems or sewage lines and effluent from feed lots or faulty sewage treatment facilities introduced coliform bacteria and other disease causing organisms into the karst system.

A good conservation practice would be to establish natural buffer zones around sinkholes in order to maintain the quantity and quality of recharge entering the aquifer. Conditions, such as fractures in the bedrock, size of drainage area, and proximity to sources of contamination, should be considered when establishing the level protection that is needed.

### **Hazard Analysis**

#### **Likelihood of Occurrence of Expansive Soils and Land Subsidence, including Landslides and Sinkholes**

The Local Hazard Mitigation Planning Manual indicates that landslides are common throughout the mountainous Appalachian region of the eastern United States and New England and that these events primarily involve the sliding of clay-rich soils. This source also states that “the USGS identifies landslide incidence/susceptibility for the eastern United States by (1) classifying geographic areas by high, medium, or low landslide incidence and (2) evaluating geologic formations in these areas by high, medium, or low susceptibility to sliding. Susceptibility to landslides is defined by the USGS as the probable degree of response of geologic formations to natural or artificial cutting, loading of slopes, or to unusually high precipitation.” The likelihood of occurrence of expansive soils and land subsidence, including landslides and sinkholes in Wilson County is “unlikely”.

#### **Likely Range of Impact of Expansive Soils and Land Subsidence, including Landslides and Sinkholes**

Any landslide or sinkhole events that may occur within Wilson County will probably be in the form of very isolated and small-scale slumps of steep slope areas that are heavily saturated and/or under a load condition from a nearby structure such as a house or road. The range of impact from expansive soils and land subsidence, including landslide and sinkhole events in Wilson County can be classified as “small”.

#### **Probable Level of Impact of Expansive Soils and Land Subsidence, including Landslides and Sinkholes**

Landslides in other portions of the country, even in other portions of North Carolina (i.e.—the Blue Ridge Mountains) have the potential of being large-scale, fast moving events that may pose a serious risk to life and property that may be in their path. However, the mostly gently sloping terrain in Wilson County can be coupled with no record of notable landslide events and a low risk of earthquake activity to yield an

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impact classification of “negligible” for a landslide event. Likewise, the sinkholes, if they were to occur, could be expected to have only “negligible” impact in Wilson County. The same level of impact, negligible, can also be assumed for expansive soils and land subsidence.

**Wilson County Hazard Index for Expansive Soils and Land Subsidence, including Landslides and Sinkholes** (see Table A-28)

The Hazard Index for expansive soils and land subsidence, including landslides and sinkholes in Wilson County can be categorized as “low” based on the “unlikely” probability of occurrence, the “small” area that would be impacted by soil related hazard event, and the probable “negligible” damages that could be expected from such events. The hazard index of “low” for expansive soils and land subsidence, including landslides and sinkholes in Wilson County indicates that these natural hazards pose a very low threat, and that hazard mitigation efforts would be more wisely directed to other hazards to which Wilson County is vulnerable. Due to Wilson County’s topography, expansive soils could potentially be a plausible threat due to the high water table and varying levels of moisture more often associated with soil shifting along structural foundations.

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*(Source of Photo: National Oceanic and Atmospheric Administration, NOAA)*

## **8. Severe Storms and Tornadoes**

### **8.1 Thunderstorms (Hail and Lightning)**

Severe thunderstorms can occur alone or in clusters, but affect relatively small areas compared to those affected by hurricanes or nor'easters. In eastern North Carolina, thunderstorms most frequently occur in the late afternoon or during the evening or night hours during the summer months. Summer thunderstorms involve lightning, strong winds, heavy rains and hail that can result in wildfires, localized wind damage and flash flooding.

According to the North Carolina State Climate Office, thunderstorms typically are 15 miles or less in diameter and last an average of 20 to 30 minutes. Downbursts and straight-line winds associated with thunderstorms can produce winds of 100-150 miles per hour - enough to flip large trucks and endanger airplane landings and takeoffs. The potential impact of thunderstorms, however, can be rated low due to the localized nature of the storms.

The National Weather Service considers a thunderstorm severe if it produces hail at least three-quarters of an inch in diameter, has winds of 58 miles per hour or greater or produces a tornado. Of the estimated 100,000 thunderstorms in the United States each year, only about 10% are classified as severe.

Lightning, a major threat during a thunderstorm, is responsible for more deaths each year in the United States than are tornadoes. Since lightning strikes are very unpredictable, the risk to individuals and property can be significant.

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### History of Thunderstorms in Wilson County

A number of thunderstorm/high wind storm events and thunderstorm related events (hail and lightning) have been reported in Wilson County (Tables A-16 - A-18).

**Table A-16: Thunderstorm and High Wind Data for Wilson County 1961-2008**

Location	Date	Time	Magnitude (in knots)	Damages in NC	
				Property	Crop
Countywide	2/25/1961	N/A	N/A	\$500	\$0
Countywide	6/29/1962	N/A	N/A	\$3,125	\$312,500
Countywide	11/9/1962	N/A	N/A	\$649	\$0
Countywide	11/23/1963	N/A	N/A	\$500	\$0
Countywide	1/20/1964	N/A	N/A	\$6,579	\$0
Countywide	8/29/1964	N/A	N/A	\$500	\$500
Countywide	9/29/1964	N/A	N/A	\$50,000	\$50,000
Countywide	6/12/1965	N/A	N/A	\$588	\$588
Countywide	7/1/1965	N/A	N/A	\$0	\$5,882
Countywide	3/12/1968	N/A	N/A	\$500	\$0
Wilson	8/9/1968	1:00 PM	N/A	\$0	\$0
Countywide	11/9/1968	N/A	N/A	\$5,000	\$500
Countywide	12/28/1968	N/A	N/A	\$500	\$0
Countywide	4/2/1970	N/A	N/A	\$5,000	\$0
Wilson	6/21/1970	11:45 PM	N/A	\$0	\$0
Wilson	6/25/1970	5:30 PM	N/A	\$0	\$0
Countywide	10/30/1970	N/A	N/A	\$500	\$50
Countywide	1/26/1971	N/A	N/A	\$500	\$0
Countywide	3/1/1971	N/A	N/A	\$500	\$50
Countywide	5/12/1971	N/A	N/A	\$1,220	\$1,220
Wilson	7/21/1971	2:30 AM	N/A	\$0	\$0
Countywide	10/1/1971	N/A	N/A	\$1,316	\$131,579
Countywide	2/2/1973	N/A	N/A	\$5,000	\$500
Countywide	3/4/1975	N/A	N/A	\$5,747	\$0
Countywide	4/3/1975	N/A	N/A	\$500	\$0
Countywide	12/31/1975	N/A	N/A	\$694	\$0
Wilson	7/9/1977	5:40 PM	N/A	\$0	\$0
Wilson	7/21/1977	7:00 PM	N/A	\$0	\$0
Countywide	1/25/1978	N/A	N/A	\$50,000	\$0
Countywide	8/11/1981	N/A	N/A	\$1,220	\$122
Countywide	2/27/1984	N/A	N/A	\$5,000	\$0
Wilson	11/28/1984	3:25 PM	N/A	\$0	\$0
Countywide	2/12/1985	N/A	N/A	\$694	\$0
Wilson	6/28/1986	9:00 AM	N/A	\$0	\$0
Wilson	7/10/1986	5:30 PM	N/A	\$50,000	\$0
Wilson	7/11/1986	5:45 PM	N/A	\$0	\$0
Wilson	7/12/1986	1:30 PM	N/A	\$0	\$0
Wilson	5/2/1987	7:45 PM	N/A	\$0	\$0
Wilson	5/2/1987	7:30 PM	N/A	\$0	\$0
Countywide	1/7/1988	N/A	N/A	\$63,291	\$0
Wilson	5/17/1988	2:40 PM	N/A	\$0	\$0
Wilson	5/19/1988	7:10 PM	N/A	\$0	\$0
Wilson	2/21/1989	11:17 AM	N/A	\$0	\$0
Wilson	3/18/1989	5:20 PM	N/A	\$0	\$0

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Location	Date	Time	Magnitude (in knots)	Damages in NC	
				Property	Crop
Wilson	5/23/1989	6:20 PM	N/A	\$0	\$0
Wilson	6/15/1989	4:25 PM	N/A	\$0	\$0
Countywide	2/25/1990	N/A	N/A	\$5,000	\$0
Wilson	5/1/1990	7:15 PM	N/A	\$0	\$0
Wilson	6/23/1990	3:30 PM	N/A	\$0	\$0
Wilson	7/1/1990	7:00 PM	N/A	\$0	\$0
Wilson	7/1/1990	7:50 PM	N/A	\$0	\$0
Wilson	8/29/1990	3:21 PM	N/A	\$0	\$0
Wilson	8/29/1990	3:40 PM	N/A	\$0	\$0
Wilson	8/29/1990	6:37 PM	N/A	\$0	\$0
Countywide	10/25/1990	N/A	N/A	\$5,000	\$0
Wilson	1/24/1993	4:37 PM	N/A	\$5,000	\$0
Wilson	7/1/1994	6:25 PM	N/A	\$5,000	\$0
Eastern Half	7/1/1994	10:15 PM	N/A	\$0	\$0
Elm City	7/1/1994	10:15 PM	N/A	\$0	\$0
Wilson	7/27/1994	5:40 PM	N/A	\$0	\$0
Wilson	5/10/1995	5:30 AM	N/A	\$0	\$0
Wilson	7/11/1995	7:45 AM	N/A	\$0	\$0
Wilson	11/11/1995	7:30 PM	N/A	\$0	\$0
Lucama	4/20/1996	6:45 PM	N/A	\$10,000	\$0
Wilson	4/23/1996	8:25 PM	N/A	\$0	\$0
Western Half	7/2/1996	5:10 PM	N/A	\$0	\$0
Wilson	7/15/1996	6:15 PM	N/A	\$0	\$0
Elm City	3/5/1997	9:00 PM	50	\$0	\$0
Wilson	4/29/1997	12:30 AM	50	\$0	\$0
Wilson	5/3/1997	9:23 AM	70	\$50,000	\$0
Elm City	7/4/1997	11:45 PM	50	\$0	\$0
Elm City	7/18/1997	6:07 PM	50	\$0	\$0
Eastern NC	7/24/1997	6:20 PM	50	\$0	\$0
Eastern NC	2/16/1998	10:00 PM	52	\$0	\$0
Wilson	3/3/1999	4:00 PM	50	\$0	\$0
Countywide	3/3/1999	4:40 PM	50	\$0	\$0
Wilson	8/26/1999	2:25 PM	N/A	\$5,000	\$0
Wilson	4/8/2000	4:50 PM	50	\$0	\$0
Wilson	8/18/2000	5:30 PM	50	\$0	\$0
Sims	12/17/2000	5:35 AM	50	\$0	\$0
Wilson	5/13/2002	7:25 PM	50	\$0	\$0
Wilson	5/13/2002	7:35 PM	50	\$0	\$0
Buckhorn Crossroads	6/1/2002	5:15 PM	50	\$0	\$0
Sims	6/6/2002	7:55 PM	50	\$0	\$0
Saratoga	10/14/2003	10:48 PM	50	\$0	\$0
N/A	10/14/2003	N/A	N/A	\$0	\$0
Wilson	3/7/2004	9:10 PM	60	\$0	\$0
N/A	3/7/2004	N/A	N/A	\$5,000	\$0
Countywide	3/7/2004	7:20 PM	65	\$136,000	\$0
Wilson	5/2/2004	1:40 PM	50	\$0	\$0
Elm City	10/13/2004	8:35 PM	50	\$0	\$0
Wilson	3/8/2005	10:30 AM	60	\$0	\$0
Wilson	7/27/2005	9:30 PM	N/A	\$20,000	\$0
N/A	7/27/2005	N/A	N/A	\$20,000	\$0
Wilson	4/25/2006	10:22 PM	50	\$0	\$0

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Location	Date	Time	Magnitude (in knots)	Damages in NC	
				Property	Crop
Wilson	4/25/2006	10:22 PM	50	\$0	\$0
Wilson	4/25/2006	10:22 PM	50	\$0	\$0
Black Creek	6/21/2006	12:50 PM	50	\$0	\$0
Saratoga	7/28/2006	8:05 PM	50	\$0	\$0
Stantonsburg	7/28/2006	8:05 PM	50	\$0	\$0
Stantonsburg	7/29/2006	6:30 PM	50	\$0	\$0
Countywide	4/16/2007	10:37 AM	41	\$0	\$5,000
N/A	4/16/2007	N/A	N/A	\$0	\$300
Wilson	7/10/2007	2:30 PM	50	\$0	\$0
Wilson	8/9/2007	5:08 PM	50	\$0	\$0
Sims	8/21/2007	6:15 PM	50	\$0	\$0
Wilson	8/21/2007	6:15 PM	50	\$0	\$0
Countywide	2/10/2008	12:00 PM	43	\$0	\$0
Lucama	3/5/2008	12:00 AM	52	\$0	\$0
Lucama	6/1/2008	7:25 PM	50	\$0	\$0
<b>Totals</b>				<b>\$555,623</b>	<b>\$508,791</b>

Source: National Climatic Data Center, <http://www4.ncdc.noaa.gov/cgi-win/wwcqi.dll?wwEvent-Storms> and SHELUDS (Spatial Hazard Events and Losses Database for the United States, [http://go2.cla.sc.edu/hazard/db\\_registration](http://go2.cla.sc.edu/hazard/db_registration)).

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**Table A-17: Hail Storm Data for Wilson County 1960- 2008**

Location	Date	Time	Magnitude (in inches)
Wilson County	5/26/1960	N/A	N/A
Countywide	5/30/1960	N/A	N/A
Countywide	4/12/1961	N/A	N/A
Countywide	6/8/1961	N/A	N/A
Countywide	5/21/1963	N/A	N/A
Countywide	7/16/1963	N/A	N/A
Countywide	7/28/1963	N/A	N/A
Countywide	8/7/1963	N/A	N/A
Countywide	5/20/1964	N/A	N/A
Countywide	4/27/1965	N/A	N/A
Countywide	5/27/1965	N/A	N/A
Countywide	7/4/1965	N/A	N/A
Countywide	7/10/1965	N/A	N/A
Countywide	7/4/1966	N/A	N/A
Countywide	7/5/1966	N/A	N/A
Countywide	3/15/1967	N/A	N/A
Countywide	5/29/1967	N/A	N/A
Countywide	6/17/1967	N/A	N/A
Countywide	7/20/1967	N/A	N/A
Countywide	6/3/1968	N/A	N/A
Countywide	6/17/1968	N/A	N/A
Countywide	7/3/1968	N/A	N/A
Countywide	8/9/1968	N/A	N/A
Countywide	8/11/1968	N/A	N/A
Countywide	5/31/1969	N/A	N/A
Countywide	7/12/1969	N/A	N/A
Countywide	4/13/1970	N/A	N/A
Countywide	6/21/1970	N/A	N/A
Countywide	7/4/1970	N/A	N/A
Countywide	7/20/1970	N/A	N/A
Countywide	8/18/1970	N/A	N/A
Countywide	12/1/1970	N/A	N/A
Countywide	6/29/1971	N/A	N/A
Countywide	7/9/1971	N/A	N/A
Countywide	7/11/1971	N/A	N/A
Countywide	7/21/1971	N/A	N/A
Countywide	9/11/1971	N/A	N/A
Wilson County	1/13/1972	N/A	N/A
Wilson County	5/15/1972	N/A	N/A
Wilson	4/27/1980	6:20 PM	1.00 in
Wilson County	8/1/1980	N/A	N/A
Wilson	5/8/1984	4:20 PM	0.75 in.
Wilson County	5/21/1986	5:10 PM	1.75 in.
Wilson	5/21/1986	N/A	N/A
Wilson County	7/1/1987	N/A	N/A
Wilson	3/26/1988	9:15 PM	0.75 in.
Wilson	5/4/1988	12:04 PM	1.00 in.

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Location	Date	Time	Magnitude (in inches)
Wilson	5/4/1988	5:37 PM	1.00 in.
Wilson	5/5/1988	2:05 PM	1.00 in.
Wilson	5/19/1988	3:35 PM	0.75 in.
Wilson	4/27/1989	5:30 PM	1.00 in.
Wilson	7/12/1990	6:45 PM	1.25 in.
Wilson	5/19/1993	12:07 AM	1.75 in.
Lucama	5/29/1996	7:10 PM	1.00 in.
Countywide	7/2/1996	5:10 PM	1.75 in.
Black Creek	5/1/1997	6:15 PM	0.75 in.
Stantonsburg	5/1/1997	6:40 PM	0.75 in.
Wilson	5/4/1998	3:45 PM	0.75 in.
Lucama	5/8/1998	2:30 PM	1.50 in.
Black Creek	5/8/1998	2:45 PM	1.75 in.
Elm City	6/3/1998	6:49 PM	1.00 in.
Sims	5/7/1999	7:00 PM	0.75 in.
Sims	4/1/2001	1:50 PM	0.88 in.
Wilson	7/5/2002	5:37 PM	0.75 in.
Elm City	5/9/2003	7:05 PM	1.00 in.
Wilson	5/22/2004	7:35 PM	1.00 in.
Wilson	5/22/2004	8:48 PM	0.75 in.
Lucama	7/12/2005	1:45 PM	0.75 in.
Wilson	7/27/2005	10:50 PM	0.75 in.
Stantonsburg	4/25/2006	10:25 PM	0.88 in.
Lucama	5/20/2006	8:05 PM	0.75 in.
Wilson	5/20/2006	8:07 PM	1.25 in.
Wilbanks	7/3/2006	3:35 PM	0.75 in.
Stantonsburg	7/28/2006	8:00 PM	0.88 in.
Lucama	6/12/2007	4:45 PM	0.88 in.
Rock Ridge	6/11/2008	2:55 PM	1.00 in.

Source: National Climatic Data Center, <http://www4.ncdc.noaa.gov/cgi-win/wwcqi.dll?wwEvent-Storms> and SHELUDUS (Spatial Hazard Events and Losses Database for the United States, [http://go2.cla.sc.edu/hazard/db\\_registration](http://go2.cla.sc.edu/hazard/db_registration)).

**Table A-18: Lightning Data for Wilson County 1960 - 2005**

Location	Date	Time	Deaths	Injuries	Damages in NC	
					Property	Crop
Countywide	5/26/1960	N/A	0	0.22	\$555	\$5,555
Countywide	4/8/1962	N/A	0.01	4.41	\$735	\$0
Countywide	4/12/1961	N/A	0	0	\$500	\$0
Countywide	3/21/1962	N/A	0	0	\$384	\$0
Countywide	8/17/1962	N/A	0	0	\$16,666	\$0
Countywide	5/21/1963	N/A	0	0	\$657	\$657
Countywide	7/16/1963	N/A	0	0	\$833	\$8,333
Countywide	7/28/1963	N/A	0.04	0	\$17,857	\$17,857
Countywide	7/16/1963	N/A	0	0	\$833	\$8,333
Countywide	7/28/1963	N/A	0.04	0	\$17,857	\$17,857
Countywide	8/7/1963	N/A	0	0	\$5,000	\$5,000
Countywide	5/20/1964	N/A	0	0	\$3,125	\$3,125
Countywide	1/30/1965	N/A	0.05	0	\$500	\$0
Countywide	4/27/1965	N/A	0	0	\$4,545	\$454
Countywide	5/27/1965	N/A	0	0	\$312	\$3,125

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Location	Date	Time	Deaths	Injuries	Damages in NC	
					Property	Crop
Countywide	7/4/1965	N/A	0	0	\$1,190	\$1,190
Countywide	7/10/1965	N/A	0	0	\$1,190	\$1,190
Countywide	7/18/1965	N/A	0	0	\$89	\$892
Countywide	7/27/1965	N/A	0	0	\$121	\$0
Countywide	7/4/1966	N/A	0.01	0	\$568	\$568
Countywide	7/5/1966	N/A	0	0	\$555	\$5,555
Countywide	7/6/1966	N/A	0	0	\$25,000	\$0
Countywide	7/29/1966	N/A	0.22	0	\$555	\$555
Countywide	3/15/1967	N/A	0	0	\$5,000	\$0
Countywide	7/16/1967	N/A	0	0	\$3,751	\$3,571
Countywide	6/3/1968	N/A	0	0	\$1,666	\$16,667
Countywide	6/17/1968	N/A	0.02	0	\$1,190	\$1,190
Countywide	7/3/1968	N/A	0	0	\$4,166	\$41,666
Countywide	8/9/1968	N/A	0	0	\$5,555	\$5,555
Countywide	12/7/1968	N/A	0	0	\$1,388	\$0
Countywide	5/24/1969	N/A	0	0	\$714	\$71
Countywide	5/31/1969	N/A	0	0	\$81	\$819
Countywide	7/12/1969	N/A	0	0	\$1,250	\$12,500
Countywide	7/28/1969	N/A	0	0	\$657	\$657
Countywide	4/13/1970	N/A	0.02	0	\$1,000	\$1,000
Countywide	6/21/1970	N/A	0	0	\$500	\$500
Countywide	7/4/1970	N/A	0.01	0	\$500	\$500
Countywide	7/20/1970	N/A	0	0	\$65	\$657
Countywide	8/18/1970	N/A	0.01	0	\$500	\$50
Countywide	6/29/1971	N/A	0	0	\$3,846	\$3,846
Countywide	7/9/1971	N/A	0.02	0	\$1,219	\$1,219
Countywide	7/11/1971	N/A	0.12	0	\$12,195	\$1,219
Countywide	8/4/1971	N/A	0	0	\$1,219	\$0
Countywide	9/11/1971	N/A	0	0	\$500	\$50
Countywide	1/13/1972	N/A	0	0	\$500	\$0
Countywide	5/15/1972	N/A	0	0	\$4,545	\$4,545
Countywide	7/11/1995	6:30 AM	0	0	\$15,000	\$0
Countywide	7/27/2005	9:30 PM	0	0	\$20,000	\$0
<b>Totals</b>			<b>0.57</b>	<b>4.63</b>	<b>\$186,650</b>	<b>\$176,541</b>

Source: National Climatic Data Center, <http://www4.ncdc.noaa.gov/cqi-win/wccqi.dll?wwEvent~Storms> and SHELUDS (Spatial Hazard Events and Losses Database for the United States, [http://go2.cla.sc.edu/hazard/db\\_registration](http://go2.cla.sc.edu/hazard/db_registration)).

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## **Hazard Analysis**

### **Likelihood of Occurrence of Thunderstorms**

There is an extensive history of thunderstorms, hail and lightning storms in Wilson County. Thus, the likelihood of occurrence can be rated as “highly likely”.

### **Likely Range of Impact for Thunderstorms**

Thunderstorms typically have a more localized effect but over a fairly large area of land, thus the range of impact can be classified as “small”.

### **Probable Level of Impact for Thunderstorms**

Although occurring frequently, severe thunderstorms typically have only a minor impact on the areas affected. The probable level of impact of severe thunderstorms, hail and lightning in Wilson County can be categorized as “negligible”.

### **Wilson County Hazard Index for Thunderstorms** (see Table A-28)

The hazard index for severe thunderstorms in Wilson County is categorized as “moderate” based on a “highly likely” occurrence, “small” range of impact, but “negligible” level of impact. This hazard index of “moderate” indicates that although thunderstorms definitely pose a regular threat in Wilson County, the impacts are not at the level that requires a concentration of local hazard mitigation efforts.

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(Source of Photo: National Oceanic and Atmospheric Administration, NOAA)

### 8.2 Tornadoes (Map A-1 Multi-Hazards)

Many times severe storms, such as thunderstorms and hurricanes, can produce concentrated windstorms called tornadoes. Tornadoes are violently rotating columns of air created where warm, moist air intersects with cold, dry air. Tornadoes have a much more localized impact than a hurricane or nor'easter and have been known to destroy one building while leaving a nearby building virtually unharmed. Tornadoes can produce a path of destruction from 0.01 mile wide to greater than 1 mile wide but generally tornadoes are less

than 0.6 mile in width. In terms of length, paths of destruction vary from a few hundred feet to several miles in length. The duration of a tornado is typically less than 30 minutes.

The destruction caused by tornadoes may range from light to severe depending on the intensity of the storm and the travel path. Typically, tornadoes cause the greatest damages to structures of light construction, such as residential homes. The Fujita-Pearson Scale for tornado strength is shown in Table A-19.

**Table A-19: Fujita-Pearson Tornado Scale**

F-Scale	Damage	Winds (mph)	Path Length (miles)	Mean Width (miles)
F0	Light	40-72	<1.0	<0.01
F1	Moderate	73-112	1.0-3.1	0.01-0.03
F2	Considerable	113-157	3.2-9.9	0.04-0.09
F3	Severe	158-206	10-31	0.1-0.3
F4	Devastating	207-260	32-99	0.32-0.99
F5	Incredible	261-318	100+	1.0+

Source: *Local Hazard Mitigation Planning Manual*, North Carolina Division of Emergency Management, 1998.

Tornadoes are most likely to occur during the spring and early summer months of March through June. Tornadoes during these months tend to be the strongest, resulting in the greatest amount of physical harm and property damage. Tornadoes can occur at any time of day but are mostly likely to form between the hours of 3 p.m. and 9 p.m.

#### **History of Tornadoes in Wilson County**

North Carolina ranks 22nd out of the 50 states for frequency of tornadoes, 18th for number of tornado related deaths, 17th for injuries, and 21st for cost of damages. Although tornadoes in North Carolina are typically less severe than in other parts of the country, the North Carolina Division of Emergency Management has rated Wilson County as a "possible" risk for tornadoes.

The strongest recorded tornadoes in Wilson County (F3's) occurred in 1953, 1957, and 1992. Seven tornadoes hit Wilson County between 1953 and 2002. (Table A-20) No tornado has reported any casualties; however 10 people had been seriously injured by the storm. The three largest single tornado events occurred in the evening hours of

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March 15, 1953, during the early evening hours on November 8, 1957 and in the early afternoon hours of November 23, 1992. These tornadoes each caused more than \$1,000,000 in property damages.

**Table A-20: Tornado Data for Wilson County – 1953-2002**

Date	Time	Scale	North Carolina		
			Fatalities	Injuries	Damages
3/15/1953	8:25 PM	F3	0	1	\$250,000
9/20/1954	1:00 PM	F2	0	4	\$250,000
11/8/1957	5:30 PM	F3	0	5	\$500,000
11/23/1992	3:53 AM	F3	0	0	\$250,000
7/12/1996	12:30 PM	F0	0	0	\$0
5/1/1997	5:00 PM	F0	0	0	\$7,000
10/11/2002	1:10 AM	F1	0	0	\$0
<b>Totals</b>			<b>0</b>	<b>10</b>	<b>\$1,257,000</b>

Source: National Climatic Data Center, <http://www4.ncdc.noaa.gov/cgi-win/wwcqi.dll?wwEvent-Storms> and SHEL DUS (Spatial Hazard Events and Losses Database for the United States, [http://qo2.cla.sc.edu/hazard/db\\_registration](http://qo2.cla.sc.edu/hazard/db_registration)).

**Hazard Analysis**

**Likelihood of Occurrence of Tornadoes**

Since 1953, tornadoes have impacted Wilson County almost once seven years on average. This translates to a “possible” level of occurrence.

**Likely Range of Impact for Tornadoes**

Tornadoes in Wilson County typically have a very localized effect over a “small” area.

**Probable Level of Impact for Tornadoes**

Although tornadoes occur on a fairly regular basis in Wilson County, there has never been a level F4 tornado in the last fifty years. 29 percent of tornadoes have been at the F0 level, 14% F1, 14% F2, 43% F3 and 0% F4. The probable level of impact of tornadoes in Wilson County can be categorized as “negligible” due to the relatively small extent of the areas affected. Nevertheless, tornadoes have been the cause of a number of deaths, injuries and cause, on average, almost a quarter of a million dollars a year, over the course of the past 50 years.

**Wilson County Hazard Index for Tornadoes** (see Table A-28)

The hazard index for tornadoes in Wilson County is categorized as “low” based on a “possible” occurrence, “small” range of impact, and “negligible” level of impact. This hazard index of “low” indicates that although tornadoes pose a threat, tornado impacts can be expected to be minor on the population and property as a whole. Thus, local hazard mitigation efforts should not concentrate on this natural hazard.

Note: For purposes of the composite hazard index rating, it is assumed that Tornadoes are closely associated with the occurrence of severe thunderstorms and should be generally classified within the same hazard index rating; although, the frequency of tornadoes is less than that of severe thunderstorm potential.

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(Source of Photo: NOAA)

**9. Tsunamis** (Information Source: University of Washington Geophysics Program)

Tsunami (pronounced tsoo-nah-mee) is a wave train, or series of waves, generated in a body of water by a disturbance that vertically displaces the water column. Earthquakes, landslides, volcanic eruptions, explosions, and even the impact of cosmic bodies, such as meteorites, can generate tsunamis. Tsunamis can savagely attack coastlines, causing devastating property damage and loss of life.

Tsunamis are unlike hurricane or wind generated waves in that they are characterized as shallow-water waves, with long periods and wave lengths. A wind-generated swell that rhythmically rolls in, one wave after another, might have a period of about 10 seconds and a wave length of 150 meters. A tsunami, on the other hand, can have a wavelength in excess of 100 kilometers and last on the order of one hour.

The character of a tsunami transforms as it leaves the deep water of the open ocean and travels into the shallower water near the coast. A tsunami travels at a speed that is related to the water depth - hence, as the water depth decreases, the tsunami slows. But the energy flux of a tsunami, which is dependent on both wave speed and wave height, remains nearly constant. Consequently, as the speed of the tsunami diminishes as it travels into shallower water, the height of the tsunami grows. A tsunami may be imperceptible at sea but grow to be several meters or more in height near the coast. When the tsunami finally reaches the coast it may appear as a rapidly rising or falling tide or a series of breaking waves.

Just like other water waves, tsunamis begin to lose energy as they rush onshore - part of the wave energy is reflected offshore, while the shoreward-propagating wave energy is dissipated through bottom friction and turbulence. Despite these losses, tsunamis still reach the coast with tremendous amounts of energy that strips beaches of sand and undermines trees and other coastal vegetation. Capable of inundating or flooding hundreds of meters inland past the typical high-water level, a tsunami can crush homes and other coastal structures. Tsunamis may reach a maximum vertical "runup" height onshore above sea level of 10, 20, and even 30 meters.

**History of Tsunamis in Wilson County**

Since there is no recorded history of tsunamis impacting North Carolina, this natural hazard was not analyzed for potential impact on Wilson County.

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(Source: USGS Volcano Hazards Program, Photo: Mount St. Helens, USGS)

## **10. Volcanoes**

Volcanic eruptions are one of the most dramatic and violent agents of environmental change. Not only can powerful explosive eruptions drastically alter land and water for tens of kilometers around a volcano, but tiny liquid droplets of sulfuric acid erupted into the stratosphere can temporarily change the climate of the planet. Eruptions often force people living near volcanoes to abandon land and homes, sometimes forever. Those living farther away are likely to avoid complete destruction, but cities and towns, crops,

industrial plants, transportation systems, and electrical grids can still be damaged by tephra, lahars, and flooding caused by volcanic eruptions.

Worldwide volcanic activity since 1700 A.D. has killed more than 260,000 people, destroyed entire cities and forests, and severely disrupted local economies for months or years. Even with the improved ability to identify hazardous areas and warn of impending eruptions, increasing numbers of people face certain danger. Scientists have estimated that the total population at risk from volcanoes in 2000 is at least 500 million, which is comparable to the entire population of the world at the beginning of the seventeenth century.

### **Volcano Hazard Areas Around the Globe**

Active volcanoes are not randomly distributed over the earth surface. Instead, they tend to be located in linear volcanic mountain chains thousands of kilometers long on the edges of continents, in the middle of oceans, or as island chains. The locations of these volcanic chains are closely related to the way in which the earth crust is divided into more than a dozen enormous sections or "plates" and how the plates move relative to one another.

According to the theory of plate tectonics, rigid plates averaging 80 kilometers in thickness, move in slow motion on top of the hot, pliable interior of the earth. Most active volcanoes are located along the boundaries where these massive plates spread apart or collide. But some of the most active volcanoes, like Kilauea Volcano on the Island of Hawaii, are found in the middle of these massive plates above hot spots in the interior of the earth. More than fifty volcanoes in the United States have erupted one or more times in the past few hundred years.

The United States Geological Survey (USGS) is charged with the responsibility to issue warnings of hazardous volcanic activity in the United States. The USGS has identified volcano-hazard zones around active and potentially active volcanoes. Volcano-hazard assessments are based on the assumption that the same general area around a volcano is likely to be affected by future volcanic activity of the same type and at about the same average frequency as in the past. Through detailed geologic mapping of the type and size of past eruptions, the USGS has estimated the area most likely to be affected by similar events in the future.

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Volcanoes generate a wide range of activity that can affect the surrounding land, river valleys, and communities in different ways. Depending on the type, size, and duration of the eruptive activity, hazardous areas might exist within a few kilometers of a volcano or extend to areas hundreds of kilometers from an active vent. By studying the natural history of a volcano, it is possible to identify those hazard areas most likely to be affected in the future by volcano hazards.

**History of Volcanic Eruption in Wilson County**

Since there is no recorded history of volcanic eruptions in North Carolina, this natural hazard was not analyzed for potential impact on Wilson County.

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## 11. Avalanches

An avalanche is an abrupt and rapid flow of snow, often mixed with air and water, down a mountainside. Avalanches are among the biggest dangers in the mountains for both life and property. Contributing factors of all avalanches are caused by an over-burden of material, typically [snowpack](#), that is too massive and unstable for the slope that supports it. Determining the critical load, the amount of over-burden which is likely to cause an avalanche, is a complex task involving the evaluation of a number of factors.

Avalanches may also comprise of rocks and boulders.

Several types of snow avalanche may occur. Loose snow avalanches occur when the weight of the snowpack exceeds the shear strength within it, and are most common on steeper terrain. In fresh, loose snow the release is usually at a point and the avalanche then gradually widens down the slope as more snow is entrained, usually forming a teardrop appearance. This is in contrast to a slab avalanche. Slab avalanches account for around 90% of avalanche-related fatalities, and occur when there is a strong, stiff layer of snow known as a slab. These are usually formed when snow is deposited by the wind on a lee slope. When the slab fails, the fracture, in a weak layer, very rapidly propagates so that a large area, that can be hundreds of meters in extent and several meters thick, starts moving almost instantaneously. The third starting type is an isothermal avalanche which occurs when the snowpack becomes saturated by water. These tend to also start and spread out from a point.

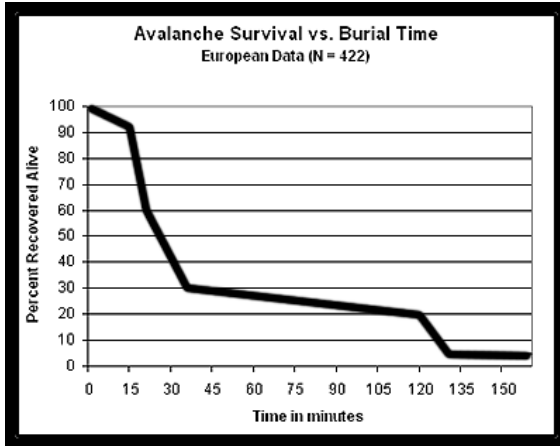


(Source: Photo: National Snow and Ice Data Center (NSIDC))

Slopes flatter than 25 degrees or steeper than 60 degrees typically have a low risk of avalanche. Snow does not accumulate significantly on steep slopes; also, snow does not flow easily on flat slopes. Human triggered avalanches have the greatest incidence when the snow's [angle of repose](#) is between 35 and 45 degrees; the critical angle, the angle at which the human incidence of avalanches is greatest, is 38 degrees.

The four variables that influence [snowpack](#) evolution and composition are temperature, precipitation, solar radiation, and wind. In the mid-latitudes of the [Northern Hemisphere](#), more avalanches occur on shady slopes with northern and north-eastern exposures. However, when the human triggered incidences of avalanches are normalized to mid-latitude rates of recreational use, no significant difference in hazard for a given exposure direction can be found. The snowpack on slopes with southern exposures are strongly influenced by [sunshine](#); daily cycles of surface thawing and refreezing create a crust that may tend to stabilize an otherwise unstable snowpack, but the crust, once it has been fractured, may detach itself from the underlying layers of snow, slide, and promote the generation of an avalanche. Slopes in the lee of a ridge or other wind obstacle accumulate more snow and are more likely to include pockets of abnormally deep snow, windslabs, and [cornices](#), all of which, when disturbed, may trigger an avalanche. (Sources of data and chart include: <http://nsidc.org>, [www.alavanche.org](http://www.alavanche.org), [www.wikipedia.com](http://www.wikipedia.com), and <http://avalanche.state.co.us>)

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**Historic Avalanches in the United States**

Records of avalanche activity within the United States are predominately located in higher elevations with steeper slopes. Since there are no recorded instances of avalanche activity in North Carolina, this natural hazard was not analyzed for potential impact.

Note: It should be noted that not all avalanches involve snow and instances of rockslides could more accurately portray potential instances in North Carolina.

**History of Avalanches in Wilson County**

There is no recorded information about the occurrence of avalanches in Wilson County, thus, avalanches are not included in the hazard index for Wilson County. There are no known instances of avalanche activity in Wilson County, thus avalanches are not included in the natural hazard index analysis.

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Trees damaged by Hurricane Fran, 1996, Source: NC Division of Forestry.

## 12. Wildfires

Wildfires occur in North Carolina during the dry spring and summer months. The potential for wildfires depends upon recent climate conditions, surface fuel characteristics, and fire behavior. Wildfires can destroy precious natural resources and forestry essential to the survival of wildlife. There are four types of wildfires as described in Table A-21. Causes of wildfires in Wilson County are detailed in Table A-22, along with specific wildfire information regarding Wilson County in Table A-23.

**Table A-21: Types of Wildfires**

Type	Description	Control
Ground	Burns in natural litter, duff (decayed organic matter), roots, or high organic soils.	Once started, difficult to control. Fire may rekindle.
Surface	Burns in grasses, low shrubs, and lower branches of trees.	May move rapidly. Ease of control depends upon fuel involved.
Crown	Burns in tops of trees.	Difficult to control; wind plays important role.
Spotting	Produced by crown fires; wind/topography conditions. Large burning embers thrown ahead of main fire.	Makes fire very difficult to control.

Source: National Weather Service, [www.seawfo.noaa.gov/fire/olm/firetype.htm](http://www.seawfo.noaa.gov/fire/olm/firetype.htm)

In recent years, increased residential development has been occurring along the urban/rural interface where homes built in or near forests become susceptible to wildfire damage. These buildings are at great risk since wildfires often begin unnoticed and spread rapidly igniting brush, trees and buildings.

State forestry personnel have estimated that Hurricanes Fran and Floyd together multiplied the amount of forest fire fuel (pine needles, cones, twigs and damaged trees on the ground) by more than three times – increasing potential wildfire fuel from five tons to sixteen tons per acre in central and eastern North Carolina. In areas where downed or damaged trees were not removed, excess wildfire fuel has greatly increased the likelihood of uncontrollable wildfires due to increased fire intensity and blocked fire roads.

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Evans Road Fire, Pocosin Lakes National Wildlife Refuge  
 Source: US Fish and Wildlife Service & NC Division of Forestry, 2008

North Carolina has recently experienced the affects of wildfire along the Pocosin Lakes National Wildlife Refuge located along the Inner Banks of the Albermarle-Pamlico Peninsula in Hyde, Tyrrell and Washington Counties. This wildfire is believed to have started due to lighting on June 1, 2008. It is estimated that close to 41,000 acres were burned as a result of this wildfire; 25,000 directly affecting the refuge. The US Fish and Wildlife Service indicate that smoke from the Evans Road Fire impacted areas more than 100 miles away.

**Table A-22: Causes of Wildfires in Wilson County**

Causes	Year 2007	5 Year Average
Lightning	1	1
Campfire	1	0
Smoking	6	5
Debris	35	19
Incendiary	5	19
Machine Use	2	1
Railroad	0	1
Children	11	4
Miscellaneous	7	4
<b>Total</b>	<b>68</b>	<b>37</b>

Source: NC Division of Forestry (<http://test.dfr.state.nc.us/contacts/Wilson.htm>)

**Table A-23: Wilson County Forestry Facts**

Areas of timberland by Ownership Class:	Acres
Federal Government	0
State Government	0
County and Municipal Government	0
Forest Industry	0
Private	111,600
<b>All ownership</b>	<b>111,600</b>
Total forest land in Wilson County	111,600
Total acres in Wilson County	237,500

Source: NC Division of Forestry (<http://test.dfr.state.nc.us/contacts/Wilson.htm>)

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### **History of Wildfires in Wilson County**

Increased development in Wilson County in recent years has increased the potential impact of wildfires as structures located near vulnerable woodlands become vulnerable themselves. Because wind fuels wildfires, structures in close proximity to potential wildfire fuels are at risk of damage as wind direction and velocity change. According to data provided by the State Forest Service, the frequency of wildfires in Wilson County is relatively moderate.

### **Hazard Analysis**

#### **Likelihood of Occurrence of Wildfires in Wilson County**

There were 68 recorded wildfire events for Wilson County in 2007, thus they are considered “highly likely.”

#### **Likely Range of Impact for Wildfires in Wilson County**

When wildfires do occur they typically impact a relatively small area of land, typically under private ownership. As evident by the Evans Road wildfire, large undeveloped areas pose a greater wildfire risk. Wilson County’s range of impact can be classified as “small”.

#### **Probable Level of Impact for Wildfires in Wilson County**

Wildfires have a very limited impact on the community so the level of impact of wildfires can be classified as “negligible” for Wilson County.

#### **Wilson County Hazard Index for Wildfires** (see Table A-28)

The hazard index for wildfires in Wilson County is categorized as “moderate” based on a “highly likely” level of occurrence, “small” range of impact, and “negligible” level of impact. This hazard index of “moderate” indicates that the wildfire potential exists and is a threat that should be addressed with local hazard mitigation initiatives where possible and in conjunction with state prevention efforts. Public awareness regarding outdoor burning bans and drought conditions should be encouraged to limit the wildfire potential.

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(Source of Photo: US Army Corp of Engineers)

### **13. Winter Storms and Freezes**

#### **13.1 Nor'easters**

Nor'easters are similar to hurricanes in respect to their effects. However, nor'easters, unlike hurricanes, are extra-tropical storms that derive their strength from horizontal gradients in temperature - they form as a result of a drop in temperature. Nor'easters affect the coast in a similar fashion to hurricanes as they produce high winds and heavy surf.

Nor'easters are usually more diffuse and less intense than hurricanes resulting in less significant damage. Nor'easters occur more frequently, cover larger land areas and those storms occurring during winter months may also produce ice hazards and effects similar to those of a severe winter storm.

The frequency of major nor'easters (Class 4 or 5) has increased in recent years. From 1987 to 1993, at least one class 4 or 5 storm occurred each year along the Atlantic seaboard of the United States. This high frequency is a situation duplicated only once in the last 50 years (State Climate Office of North Carolina, North Carolina State University.) Nor'easters are rated by the Dolan-Davis Intensity Scale shown in Table A-24.

**Table A-24: Dolan-Davis Nor'easter Intensity Scale (1993)**

<b>Storm Class</b>	<b>Beach Erosion</b>	<b>Dune Erosion</b>	<b>Overwash</b>	<b>Property Damage</b>
1 (Weak)	Minor changes	None	No	No
2 (Moderate)	Modest; mostly to lower beach	Minor	No	Modest
3 (Significant)	Erosion extends across beach	Can be significant	No	Loss of many structures at local level
4 (Severe)	Severe beach erosion and recession	Severe dune erosion or destruction	On low beaches	Loss of structures at community-scale
5 (Extreme)	Extreme beach erosion	Dunes destroyed over extensive areas	Massive in sheets and channels	Extensive losses on a regional-scale

Source: *Local Hazard Mitigation Planning Manual*, NC Division of Emergency Management, 1998.

#### **Historic Impact of Nor'easters in Wilson**

Nor'easters have certainly affected Wilson County however; the National Climatic Data Center does not list a history of those events. The North Carolina Division of Emergency Management has rated Wilson County as a "moderate" risk for nor'easters (*Local Hazard Mitigation Planning Manual*, p. 86).

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**13.2 Severe Winter Storms**

Severe winter weather is typically associated with much colder climates; however, in some instances winter storms do occur in the warmer climate of North Carolina. On occasion, Wilson County has had moderate winter weather as a result of a nor'easter originating in the Gulf Stream and producing frozen precipitation.

Winter storms can paralyze a community by shutting down normal day-to-day operations. Winter storms produce an accumulation of snow and ice on trees and utility lines resulting in loss of electricity and blocked transportation routes. Frequently, especially in rural areas, loss of electric power means loss of heat for residential customers, which poses an immediate threat to human life. Because of the rare occurrence of these events, central and eastern North Carolina communities are often not prepared because they can not afford to purchase expensive road and debris clearing equipment for these relatively rare events.

**History of Severe Winter Storms in Wilson County**

The North Carolina Division of Emergency Management has rated Wilson County as a "moderate" risk for severe winter storms (Local Hazard Mitigation Planning Manual, p. 86).

**Table A-25: Snow and Ice Storm Data for Wilson County 1960 - 2007**

Location	Date	Time	Type
Countywide	3/2/1960	N/A	Winter Weather
Countywide	3/9/1960	N/A	Winter Weather
Countywide	1/21/1961	N/A	Winter Weather
Countywide	1/26/1961	N/A	Winter Weather
Countywide	12/12/1962	N/A	Winter Weather
Countywide	1/26/1963	N/A	Winter Weather
Countywide	2/26/1963	N/A	Winter Weather
Countywide	5/2/1963	N/A	Winter Weather
Countywide	1/13/1964	N/A	Winter Weather
Countywide	3/30/1964	N/A	Winter Weather
Countywide	1/25/1966	N/A	Winter Weather
Countywide	1/29/1966	N/A	Winter Weather
Countywide	5/9/1966	N/A	Winter Weather
Countywide	2/17/1967	N/A	Winter Weather
Countywide	3/18/1967	N/A	Winter Weather
Countywide	1/9/1968	N/A	Winter Weather
Countywide	1/24/1968	N/A	Winter Weather
Countywide	2/15/1969	N/A	Winter Weather
Countywide	12/25/1969	N/A	Winter Weather
Countywide	1/7/1970	N/A	Winter Weather
Countywide	1/20/1970	N/A	Winter Weather
Countywide	12/1/1970	N/A	Winter Weather/Wind
Countywide	1/8/1971	N/A	Winter Weather

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Location	Date	Time	Type
Countywide	2/3/1971	N/A	Winter Weather/Fog
Countywide	2/13/1971	N/A	Winter Weather
Countywide	3/25/1971	N/A	Winter Weather
Countywide	12/3/1971	N/A	Winter Weather
Countywide	1/16/1972	N/A	Winter Weather
Countywide	3/25/1972	N/A	Winter Weather
Countywide	1/7/1973	N/A	Winter Weather
Countywide	2/4/1975	N/A	Winter Weather
Countywide	1/7/1976	N/A	Winter Weather
Countywide	3/14/1976	N/A	Winter Weather
Countywide	1/12/1978	N/A	Winter Weather
Countywide	1/19/1978	N/A	Winter Weather
Countywide	2/17/1979	N/A	Winter Weather
Countywide	4/18/1983	N/A	Winter Weather
Countywide	1/20/1985	N/A	Winter Weather
Countywide	4/9/1985	N/A	Winter Weather
Countywide	3/12/1993	N/A	Winter Weather
Countywide	1/3/1994	6:00 PM	Heavy Snow
Countywide	1/15/1994	N/A	Winter Weather
Statewide	1/15/1994	N/A	Extreme Cold
Statewide	1/19/1994	N/A	Extreme Cold
Countywide	2/10/1994	8:00 PM	Ice Storm
Countywide	1/6/1996	1:00 PM	Ice Storm
Countywide	1/11/1996	10:00 PM	Ice Storm
Countywide	2/2/1996	2:00 AM	Ice Storm
Countywide	2/3/1996	10:00 PM	Extreme Cold
Countywide	2/16/1996	6:00 AM	Heavy Snow
Countywide	1/19/1998	6:00 AM	Heavy Snow
Countywide	12/23/1998	2:00 PM	Ice Storm
Countywide	1/18/2000	2:00 AM	Winter Storm
Countywide	1/20/2000	12:00 AM	Winter Storm
Countywide	1/22/2000	6:00 PM	Winter Storm
Countywide	1/24/2000	5:00 AM	Winter Storm
Countywide	1/28/2000	10:00 AM	Winter Storm
Countywide	11/19/2000	11:00 AM	Heavy Snow
Countywide	12/3/2000	12:00 PM	Winter Storm
Countywide	1/3/2002	12:00 AM	Winter Storm
Countywide	12/4/2002	3:00 PM	Winter Storm
Countywide	2/16/2003	12:00 PM	Winter Storm
Countywide	1/26/2004	4:30 AM	Winter Storm
Countywide	2/26/2004	9:00 AM	Winter Storm
Countywide	12/26/2004	1:00 AM	Winter Storm

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Location	Date	Time	Type
Countywide	2/1/2007	9:00 AM	Winter Storm
Countywide	2/1/2007	9:00 AM	Winter Weather
Countywide	12/7/2007	5:00 AM	Winter Weather
Countywide	12/7/2007	n/a	Winter Weather

Source: National Climatic Data Center, <http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent-Storms> and SHELUDS (Spatial Hazard Events and Losses Database for the United States, [http://go2.cla.sc.edu/hazard/db\\_registration](http://go2.cla.sc.edu/hazard/db_registration)).

## **Hazard Analysis**

### **Likelihood of Occurrence of Winter Storms and Freezes in Wilson County**

North Carolina averages more than one severe winter storm per year in the Piedmont area of the State. The likelihood of occurrence of a severe winter storm can be classified as “likely”.

### **Likely Range of Impact for Severe Winter Storms in Wilson County**

When severe winter storms do occur they typically impact a relatively large area or region of the State, thus the range of impact can be classified as “large”.

### **Probable Level of Impact for Severe Winter Storms in Wilson County**

Severe winter storms can have a tremendous impact on communities within the State, but they do not typically result in more than “limited” impact.

### **Wilson County Hazard Index for Severe Winter Storms** (see Table A-28)

The hazard index for severe winter storms in Wilson County is categorized as “moderate” based on a “likely” occurrence, but “large” range of impact, and “limited” level of impact. This hazard index of “moderate” indicates that the severe winter storms are a serious threat that should be addressed with local hazard mitigation initiatives where possible. Because of the regional impact of severe winter storms, however, many initiatives are more appropriately addressed and coordinated at the State level.

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**D. NC Emergency Management Hazard Analysis for Wilson County**

North Carolina experiences different types of hazards with some more likely than others to affect various regions of the State. The North Carolina Division of Emergency Management has assessed each county within the State for vulnerability to natural hazards. Table A-26 shows the State's summary assessment for Wilson County for the nine natural hazards identified in the Local Hazard Mitigation Planning Manual as affecting North Carolina.

**Table A-26: Natural Hazard Summary Assessment for Wilson County**

Natural Hazard <sup>a</sup>	Vulnerability of Wilson County <sup>b</sup>
Hurricane	Moderate
Flood	Moderate
Tornado	Moderate
Nor'easter	Moderate
Thunderstorm <sup>c</sup>	Moderate
Severe Winter Storm	Low
Wildfire	Low
Earthquake	Low
Landslide	Low

Source: Local Hazard Mitigation Planning Manual, NCEM, 1998, p. 84-5.

<sup>a</sup> The "Local Hazard Mitigation Planning Manual" does not rate the following hazards for Wilson County - coastal erosion, levee failures, coastal storms, tsunamis, and volcanoes.

<sup>b</sup> The North Carolina Division of Emergency Management Methodology: Each of the one hundred counties in North Carolina was categorized into one of three levels of natural hazard likelihood – "Low", "Moderate", or "High" for eight natural hazards. Some assignments were made, in part, using the Climate Division (formulated by the National Climatic Data Center - Guttman and Quayle, 1995) to which each county was assigned. The Climate Division number for Wilson County is 8. For additional information on how ratings were developed, see Local Hazard Mitigation Planning Manual, North Carolina Division of Emergency Management, November 1998.

<sup>c</sup> Thunderstorms were not rated in the Local Hazard Mitigation Planning Manual. For the purposes of this report, thunderstorms were rated moderate.

The State of North Carolina has estimated the probable level of impact of various natural hazards for Wilson County as shown in Table A-27.

**Table A-27: Natural Hazards–Probable Level of Impact Data for Wilson County**

Natural Hazard	Range	Wilson County
Earthquake Vulnerability	Low =1 to High = 6	1
Landslide Vulnerability	Low =1 to High = 6	1
Frequency of All Hurricanes, 1900-96	Saffir-Simpson Class 1-5	0
Frequency of Minor Hurricanes, 1900-96	Saffir-Simpson Class 1-2	0
Frequency of Major Hurricanes, 1900-96	Saffir-Simpson Class 3-5	0
Nor'easter Vulnerability	1 = some direct vulnerability	0
Frequency of Tornadoes, 1953-1995	Number of tornadoes	7
Extreme 1-day snowfall	In inches	15
Cold Air Damming Vulnerability	1 = some vulnerability	0
Wildfires, 1950-1993	Low = 1, Mod. = 2, High = 3	1
Number of Acres Burned	Low = 1, Mod. = 2, High = 3	1

Source: Local Hazard Mitigation Planning Manual, NCEM, 1998, pp. 88-91.

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**E. Wilson County Composite Hazard Index**

Certain parts of the County, such as floodplains and steep slopes, are more prone to hazards. In addition, certain types of hazards are likely to produce only localized effects while others have wide spread effects. Some natural hazards have extraordinary impacts but occur infrequently. Other hazards occur annually or several times a decade, but cause little damage. (Note: Information in the manual was presented only on the county level.)

The total potential impact of each type of hazard has been projected using a combination of likely strength of the event, the size of the area(s) affected, and the density of human activity within the likely path of the hazard. Table A-28 gives natural hazards a “composite hazard index” rating based on the combination of three factors – likelihood of occurrence, likely range of impact, and probable level of impact. (Note: An explanation of the terms and the ranking system are included in Tables A-1 through A-4 at the beginning of Appendix A.)

**Table A-28: Composite Hazard Index for Wilson County**

Hazard Type	Likelihood of Occurrence	Likely Range of Impact	Probable Level of Impacts	Hazard Index (combined ranking)
Droughts and Heat Waves	(3) Likely	(3) Large	(2) Limited	(8) <b>Moderate</b>
Floods	(4) Highly Likely	(2) Medium	(2) Limited	(8) <b>Moderate</b>
Hurricanes and Coastal Storms	(3) Likely	(3) Large	(2) Limited	(8) <b>Moderate</b>
Severe Storms and Tornadoes	(4) Highly Likely	(1) Small	(1) Negligible	(6) <b>Moderate</b>
Wildfires	(4) Highly Likely	(1) Small	(1) Negligible	(6) <b>Moderate</b>
Winter Storms and Freezes	(3) Likely	(3) Large	(2) Limited	(8) <b>Moderate</b>

Source: Individual hazard evaluations were combined to produce the summary table.

The Wilson County Composite Hazard Index (Table A-28) addresses only the six hazards that received a “moderate” rating (no hazard received a “high” rating) as these hazards pose the greatest potential risk to persons and property. Three of these hazards – droughts and heat waves, hurricanes and coastal storms, and winter storms and freezes – typically have a regional impact; however, the impact of droughts and heat waves on agrarian communities, such as Wilson County, have a more economic impact, typically limited to agricultural crops. Based on hazard event history, it is estimated that Wilson County has a maximum 100% exposure to hurricanes and coastal storms and to winter storms and freezes. A 100% exposure means that all structures both public and private within the County could possibly be impacted by these two types of hazard events. (See Appendix B Vulnerability Assessment for more detail.)

The other three hazards – floods, severe storms and tornadoes, and wildfires – typically have a much more limited area of impact. Floods only impact flood hazard areas thus exposure is limited to development within these identified and mapped areas of the County. For severe storms and tornadoes and wildfires, it is estimated that Wilson County has a maximum 10% exposure, i.e., 10% or less of all structures within the County could be impacted by these types of hazard events. (See Appendix B Vulnerability Assessment for more detailed information.)

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**Insert Map A-1 Multi-Hazards**

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