5 HAZARD ANALYSIS

INTRODUCTION

The *Hazard Analysis* section continues to focus on those hazards identified in the *Hazard Identification* section. The *Hazard Analysis* provides a summary of best available information on significant historical hazard events[1] that have occurred in Mecklenburg County, including the seven incorporated jurisdictions participating in this Plan, and also describes the future potential for a hazard event to occur. When possible, this includes an assessment of the location and spatial extent of potential hazards as well as best available data regarding notable historical damages[2] within the county. The outline for the *Hazard Analysis* is the same as that for the *Hazard Identification* section, and consists of the following hazards:

- FLOOD
- HURRICANES AND TROPICAL STORMS
- SEVERE THUNDERSTORMS
- TORNADOES
- WINTER STORMS
- EARTHQUAKES
- LANDSLIDES
- SINKHOLES
- DROUGHT
- WILDFIRE
- DAM/LEVEE FAILURE

To a large extent, historical records are used to identify the level of risk within the planning area—with the methodological assumption that the data sources cited are reliable and accurate. This section also provides a series of maps that illustrate the location and spatial extent for those hazards within Mecklenburg County that have a recognizable geographic boundary (i.e., hazards that are known to occur in particular areas of the county such as the 100-year floodplain). For those hazards with potential risk not confined to a particular geographic area (such as thunderstorms and tornadoes), historical event locations and/or general information on the applicable intensity of these events across the entire planning area is provided.

44 CFR Requirement

Part 201.6(c)(2)(i): The risk assessment shall include a description of the type, location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

This CFR requirement is met in the Hazard Identification *and* Hazard Analysis *sections of this risk assessment.*

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[1] Significant historical events are based on information made available through the National Oceanic and Atmospheric Administration (NOAA) unless otherwise cited. In most cases, NOAA information is obtained directly from NOAA's National Climatic Data Center (NCDC), the world's largest archive of weather data.

[2] Historical damage information is based on best available data and should only be considered approximate figures for general analysis and planning purposes. Dollar figures have not been adjusted for inflation in Section 5 but were adjusted in the calculation of annualized loss estimates for Section 6: *Vulnerability Assessment*.

It is important to note that for most hazards analyzed in this section, some level of property damage was possible during any or all of the hazard events cataloged. However, for events reaching deeper into Mecklenburg County's past, historical records in some instances may show no report of property damage. Therefore, totals of past property damages derived from historical records are considered to be estimates and should not be used as a stand-alone indicator of hazard risk.

The next section included in this Plan, the *Vulnerability Assessment*, further expands upon the foundation established in the *Hazard Identification* and *Hazard Analysis* sections.

SUMMARY OF PRESIDENTIAL DISASTER DECLARATIONS

Before beginning the hazard-by-hazard analysis, it is important to note and document past presidential disaster declarations that have included Mecklenburg County. A presidential disaster declaration is issued when a disaster event has been determined to be beyond the capabilities of state and local governments to respond. Since 1953—the first year presidential disaster declarations were issued in the United States—Mecklenburg County has been named in five such declarations (**Table 5.1**).

Table 5.1: Presidential Disaster Declarations Issued for Mecklenburg County

EVENT	DECLARATION DATE	DECLARATION NUMBER
Hurricane Hugo	09/25/1989	844
Blizzard of '96	02/02/1996	1087
Severe Winter Storm	01/31/2000	1312
Severe Ice Storm	12/13/2002	1448
Tropical Storm Frances	09/10/2004	1546

Source: Federal Emergency Management Agency

Under a presidential disaster declaration, the state and affected local governments are eligible to apply for federal funding to pay 75 percent of the approved costs for debris removal, emergency services related to the storm, and the repair or replacement of damaged public facilities.

The county has also experienced additional emergencies and disasters that were not severe enough to require federal disaster relief through a presidential declaration.

FLOOD

Mecklenburg County is estimated to have more than 3,000 miles of streams varying in size and depth within its boundaries, the western two-thirds of which drain to the Catawba River System while the eastern one-third drains to the Yadkin River System. Both of these river systems drain south into South Carolina and eventually flow into the Atlantic Ocean. When heavy or prolonged rainfall events occur, these rivers and streams are susceptible to some degree of riverine flooding. There have been a number of past riverine flood events, ranging widely in terms of location, magnitude and impact. The most frequent flood events have been localized in nature, resulting from heavy rains occurring in a short period of time over urbanized areas that are not able to adequately handle stormwater runoff. These events typically do not threaten lives or property and do not result in emergency or disaster declarations.[3]

Figure 5.1 shows the major water bodies in Mecklenburg County according its 33 unique watersheds. Watershed boundaries highlighted in yellow indicate those for which detailed studies and flood mitigation plans were completed in 2004. These studies and plans cover approximately 50 percent of the total land area of the county and 80 percent of Charlotte, and provide estimates of flood damages and recommend mitigation alternatives. These studies include the following and are essentially adopted by reference as detailed extensions to this Plan:

- Mecklenburg County Floodplain Management Guidance Document
- Determination of Financial Impacts from Flood Studies
- Watershed-specific Flood Hazard Mitigation Plans
    - Briar Creek
    - Four Mile Creek
    - Irwin Creek
    - Little Sugar Creek (Lower)
    - Little Sugar Creek (Upper)
    - Mallard Creek
    - McAlpine Creek
    - McDowell Creek
    - McMullen Creek
    - Sugar Creek

New floodplain maps for Mecklenburg County were made effective in March 2009. **Figure 5.2** shows the *existing* potential flood hazard areas throughout the county based on the best available GIS data for the FEMA-identified 100-year and 500-year floodplains. **Figure 5.3** shows a combination of the existing and *future* potential flood hazard areas throughout the county based on the FEMA and Community-identified 100-year floodplains. In 2000, Charlotte-Mecklenburg became the first community in the nation to show both current and future floodplains on its official maps. The "Community Floodplain" illustrates where flooding is likely to occur in the future based on expected development upstream, and extends the existing FEMA 100-year floodplain by approximately 4.18 square miles at the predicted future build-out conditions. While flood insurance is typically required for properties in a FEMA Floodplain, it is not required in the Community Floodplain but is strongly recommended. However, local development regulations apply to both the FEMA Floodplain and the Community Floodplain. Where available, more detailed flood hazard data for each participating jurisdiction within the county is provided in Section 6: *Vulnerability Assessment*.

[3] The vast majority of flood events in the United States do not meet the per capita damage thresholds required to trigger a presidential disaster declaration and the release of large sums of federal aid. This fact dramatizes the need for local governments to establish a comprehensive mitigation strategy that includes achievable actions that do not rely entirely on assistance from the state and federal government.

Figure 5.1: Major Water Bodies in Mecklenburg County, by Watershed

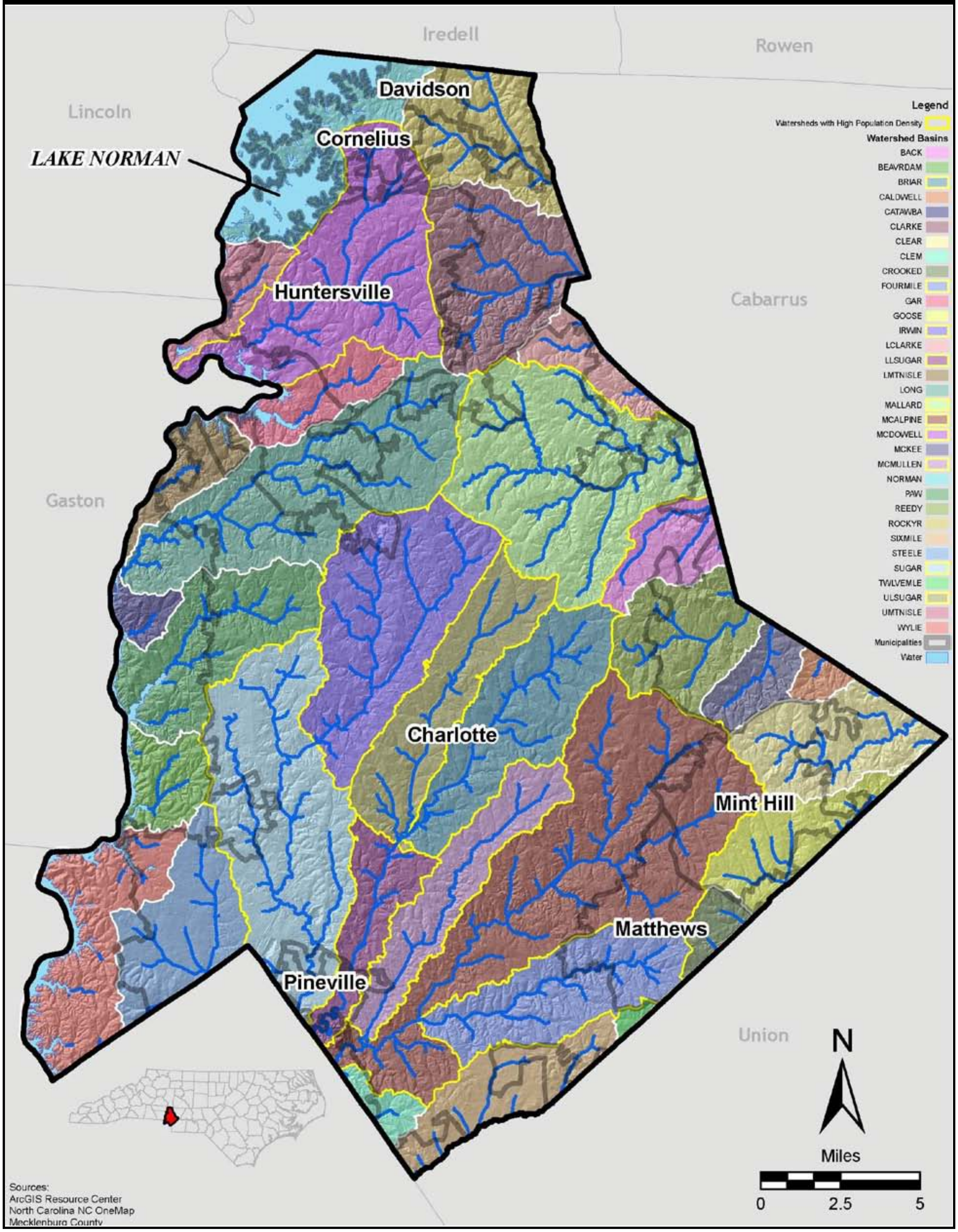


Figure 5.2: Existing Potential Flood Hazard Areas (FEMA Floodplains)

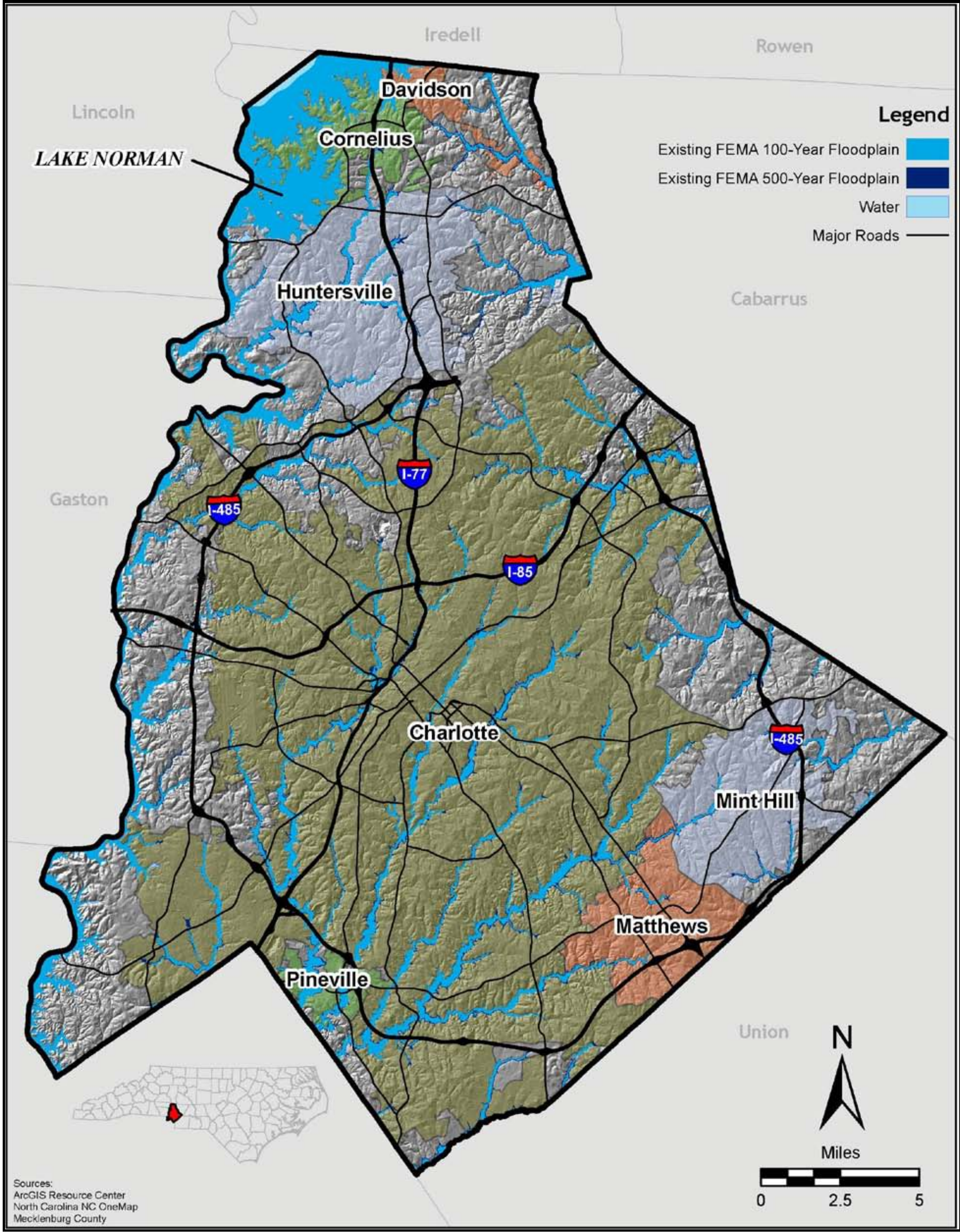
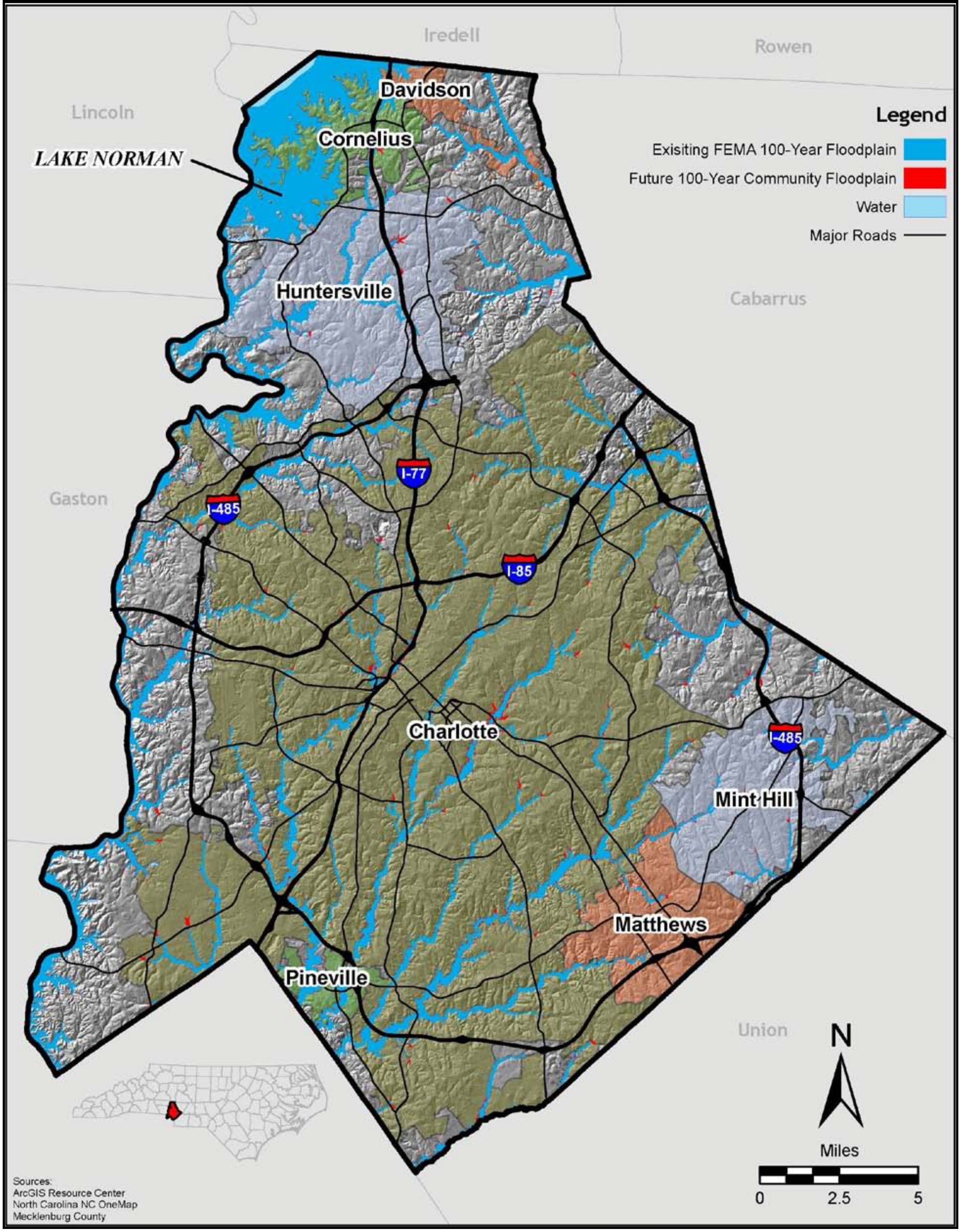


Figure 5.3: Future Potential Flood Hazard Areas (FEMA and Community Floodplains)



SIGNIFICANT HISTORICAL EVENTS

The most recent, significant flash flood event for Mecklenburg County occurred on **January 24-25, 2010** when heavy rains (three inches in four hours) combined with saturated soils caused flooding that forced evacuations and rescues across the Charlotte metro region along with several road closures. The area along the Briar Creek near the Plaza-Midwood community was especially hard-hit. Firefighters and police were kept busy for several hours overnight, rescuing trapped motorists and getting people out of homes that were flooded. Two Charlotte Area Transit System buses were used as temporary shelters during the night, but all residents were able to return to their homes before daybreak on the 25th and no injuries or fatalities were reported.

The most recent major and damaging flood event occurred in **August 2008** when the remnants of Tropical Storm Fay stalled just west of the Appalachian Mountains, resulting in a prolonged, moist south to southeasterly flow over western North Carolina. Storm total rainfall in this area averaged 8 to 10 inches, with locally higher amounts, resulting in significant urban and stream flooding – particularly along Briar Creek in east Charlotte. Numerous evacuations were required of homes and apartments along the creek as water entered dozens of structures, and numerous cars were submerged on Independence Boulevard, with some rescues required. Other affected roads included Dunlavin Way, Harbinger Court, Chantilly Lane, Cavalier Court, and Dolphin Lane. Uninsured losses included major damage to 147 homes and 1 business but would have been significantly higher if not for many of the County's ongoing flood hazard mitigation efforts including its highly successful Floodplain Buyout Program (further discussed in Section 7: *Capability Assessment*).

Flooding caused by the remnants of Tropical Storm Fay created the need for swift water rescues across the Charlotte area in August 2008 . (Photo courtesy of Mecklenburg County)

In total, downpours from the remnants of Tropical Storm Fay flooded more than 600 structures and required the evacuation of dozens of people, including 20 swift-water rescues made by the Charlotte Fire Department. Total estimated damages from the event are $8.5 million, and approximately 90% of the flooding was in the Briar Creek Watershed. Rainfall in a 24-hour period in northeastern Mecklenburg County exceeded 11 inches. Stream gauges measuring how deep the water is in local creeks set 19 new records, exceeding the 100-year flood level in some areas.

Other devastating flood events occurred in Mecklenburg County occurred in **August 1995** and **July 1997**. The flooding in 1995 was caused by excessive rainfall from the remnants of Tropical Storm Jerry, with rainfall ranging from 3.87 to 9.37 inches throughout the county. The highest rainfall amounts were concentrated in the southeastern part of the City of Charlotte between Providence Road and East Independence Boulevard, primarily in the Little Sugar Creek and McAlpine Creek drainage basins. The recurrence interval for a 24-hour storm exceeded 100 years in this part of the city. Due to the flooding, approximately $4 million in flood insurance claims were paid and $1 million in loans were issued for the repair of properties. Two years later in July 1997, the remnants of Hurricane Danny caused an estimated total of $8.5 million in property damage in Mecklenburg County and the loss of three lives in floodwaters, including a child in Charlotte who drowned when floodwater swept her into a creek. Rainfall amounts during the July 1997 storm were far greater than those of the August 1995 storm. The maximum total rainfall during the 1997 storm was 13.11 inches and the maximum rainfall amount measured in a continuous 24-hour period was 11.40 inches, which exceeds the 100-year storm total by 4.3 inches. The 24-hour rainfall recurrence interval exceeded 100 years for much of the central part of Mecklenburg County, including a large percentage of the Irwin Creek and Little Sugar Creek Basins (USGS, 1998). More than 100 flood-prone homes were bought and removed from the floodplain using Hazard Mitigation Grant Program (HMGP) and Flood Mitigation Assistance (FMA) program funds. Residents participating in these voluntary programs were relocated to higher ground out of harm's way.

A CSX derailment due to a bridge washout during the July 1997 flood event. (Photo courtesy of Mecklenburg County)

Table 5.2 lists the number of insured losses and total claims payments for historical flood damages in each jurisdiction as recorded under the National Flood Insurance Program (NFIP).[4]

Table 5.2: NFIP Statistics on Historical Losses and Claims Payments

JURISDICTION	NFIP ENTRY DATE	TOTAL LOSSES	TOTAL PAYMENTS
Mecklenburg County	06/01/1981	161	$2,202,649
Charlotte	08/15/1978	1,883	$33,340,976
Cornelius	09/30/1997	1	$0
Davidson	10/16/1997	21	$179,854
Huntersville	02/04/2004	0	$0
Matthews	02/04/2004	0	$0
Mint Hill	12/21/07	0	$0
Pineville	03/18/1987	2	$18,000
TOTAL		**2,068**	**$35,741,479**

Source: Federal Emergency Management Agency (as of 07/31/2009)

Table 5.3 provides more descriptive information on 72 significant flood events that are known to have occurred between 1900 and 2009 in Mecklenburg County. The flood events documented here resulted in a total within the county of 17 known deaths and four known injuries, and approximately $39.3 million in total reported property damages.[5] Based on historical and anecdotal evidence, it is clear that there is a relatively high frequency of flooding in the county.

[4] NFIP claims statistics provided by the Federal Emergency Management Agency (as of 7/31/2009).

[5] Property damage data reflects general estimates only, and include insured and uninsured losses. $27.2 million of this total is documented by Mecklenburg County and/or the National Climatic Data Center and covers a period from 1994 to 2009. Additional historical information was provided by Mecklenburg County for the period 1900 to 1994 and includes an estimated total of $12 million in recorded damages, though actual figures are likely much higher.

Table 5.3: Significant Flood Events (1900-2009)					
LOCATION	**DATE OF OCCURRENCE**	**TYPE OF EVENT**	**DEATHS/ INJURIES**	**PROPERTY DAMAGE**	**DETAILS**
Mecklenburg County	1916	Flood	13/0	NR[6]	"Great Flood" on the Catawba River. Two hurricanes converged over western North Carolina causing more than three days of downpours. West of Charlotte, the Catawba River crested at more than 47 feet. The flood water was nearly twice as deep as that of any previously recorded flood. At least 13 people died when a double-track railroad bridge over the river between Charlotte and Gastonia gave way. The crews had been trying to secure the bridge when it washed out. A few survivors were rescued from treetops the following morning.
Mecklenburg County	1928	Flood	0/0	NR	A 10-year flood caused minor property damage.
Mecklenburg County	1936	Flood	0/0	NR	A 20-year flood washed out two bridges on Stewart Creek; several streams were dredged throughout the city and county.
Mecklenburg County	1942	Flood	0/0	NR	A 10-year flood damaged several homes.
Mecklenburg County	1958	Flood	0/0	NR	A 5-year flood damaged several homes; families were evacuated in Myers Park and along Westfield Road.
Mecklenburg County	1962	Flood	0/0	NR	A 5-year flood caused minor flood damage.
Mecklenburg County	1973	Flood	0/0	NR	A 50-year flood along Little Sugar Creek damaged several homes and closed several roads.
Mecklenburg County	1975	Flood	0/0	**$12,000,000**	A series of three consecutive floods caused an estimated $12 million in damages.
Mecklenburg County	1976	Flood	0/0	NR	A 25-year flood on Irwin and Sugar Creeks severely damaged many homes in Pineville. It's the second time in two years that Irwin Creek had at least a 25-year flood.
Charlotte	1979	Flood	0/0	NR	25-year flood damaged some homes along McAlpine Creek near Sardis Road.
Charlotte	1982	Flood	0/0	NR	30-year flood in McMullen Creek and 25-year flood on Irwin Creek.
Mecklenburg County	1985	Flood	0/0	NR	Property damage was caused by 25-year floods on Little Sugar Creek and Little Hope Creek.
Charlotte	07/03/1995	Flash Flood	0/0	NR	Flooding on Sam Newell Road between East Independence and Highway 51.
Charlotte	08/27/1995	Flash Flood	0/0	**$5,000,000**	The remnants of Hurricane Jerry dropped 8 to 9 inches of rain producing serious flooding. Three hundred families were evacuated from their homes, some by boat. Many roads and bridges were flooded or washed away. Several roads were covered with 3 to 5 feet of water. Flooding in the Briar, McMullen and McAlpine watersheds resulted in $4 million in flood insurance claims and an additional $1 million in loans to repair property damage.
Charlotte	10/04/1995	Flash Flood	0/0	NR	Flash flooding was reported in several parts of Charlotte. The areas included Providence Road between Windover and Sharon Amity and Carmel Road between Fairview and Qual Hallow Road.
Charlotte	10/04/1995	Flash Flood	0/0	NR	Rainfall amounts of two to four inches produced widespread flooding of major roads in the county.
Charlotte	10/04/1995	Flash Flood	0/0	NR	Brier Creek came out of its banks at the intersection of Providence Road and Randolph Road.
Charlotte	08/02/1996	Flash Flood	0/0	NR	No details available.

[6] "NR" means "None Reported" indicating that no records exist of reported property damage figures. This does not exclude the possibility or probability that unreported damages did in fact occur.

Table 5.3: Significant Flood Events (1900-2009)					
LOCATION	**DATE OF OCCURRENCE**	**TYPE OF EVENT**	**DEATHS/ INJURIES**	**PROPERTY DAMAGE**	**DETAILS**
Southern Portion of Mecklenburg County	08/02/1996	Flash Flood	0/0	NR	Slow moving thunderstorms dumped heavy rain across southern Mecklenburg County causing several roads to flood.
Charlotte	08/05/1996	Flash Flood	0/0	NR	Slow moving thunderstorms caused severe urban flooding in northeast sections of Charlotte.
Charlotte	08/24/1996	Flash Flood	0/0	**$200,000**	No details available.
Charlotte	06/13/1997	Flash Flood	0/0	NR	Thunderstorms swept over areas of Charlotte causing some severe urban flooding. Roads were closed around the area because of flooding.
Countywide	07/23/1997	Flash Flood	**3**/0	**$8,500,000**	100-year flood in July from the remnants of Hurricane Danny caused $60 million in property damage. The maximum total rainfall recorded at USGS gauging stations was 13.11" inches over a 36-hour period. Flood stage record set for Little Sugar Creek at Archdale Drive at 15.06 feet. A railroad trestle collapsed, sending a CSX locomotive into Little Sugar Creek. Three people died in the floodwater: a man died in a car accident related to the storm, a woman drowned in her car on a flooded Charlotte street, and a child was swept away while playing near a flooded creek.
Charlotte	07/24/1997	Flash Flood	0/0	NR	The remnants of Hurricane Danny continued to move across the flood-ravaged Charlotte metro area during the early morning hours of the 24th. Additional rainfall of 2 to 3 inches aggravated the flooding problems mainly south and east of downtown Charlotte. This round of rain prompted the evacuation of some apartments near Pineville. Area roads were covered in 2 to 3 feet of water.
South Portion of Mecklenburg County	01/06/1998	Flood	0/0	NR	Heavy rain during the day caused area streams to rise out of their banks, flooding many roads. One road was washed out between Monroe and Wingate in neighboring Union County and other roads in the far southern part of Mecklenburg County, near the Union County line, were washed out as well.
Charlotte	04/09/1998	Flood	0/0	**$50,000**	Heavy rain and thunderstorms persisted over the Charlotte metro area during the early morning and resulted in several flooded roads. A park was flooded in Monroe and people were stranded in their van. Bridges were covered by the floodwaters in the southern portion of neighboring Cabarrus County with one vehicle stuck in the water. Apartments and cars in the Briar Creek area of south Charlotte were flooded and some evacuations took place.
Charlotte	06/10/1998	Flash Flood	0/0	NR	Heavy rain in a short period of time resulted in some urban flooding from the Belmont and Mount Holly areas, to the south side of Charlotte. Numerous roads were flooded and several motorists required rescue in different parts of the city.
Charlotte	07/20/1998	Flash Flood	0/**1**	NR	Flash flooding occurred in south Charlotte late in the evening and continued into the early morning hours. One injured woman had to be rescued from her auto on South Boulevard by a firefighter.

Table 5.3: Significant Flood Events (1900-2009)

LOCATION	DATE OF OCCURRENCE	TYPE OF EVENT	DEATHS/ INJURIES	PROPERTY DAMAGE	DETAILS
Southern Portion of Mecklenburg County	07/27/1998	Flash Flood	0/0	NR	Up to 4 inches of rain fell in just a few hours during the morning of the 27th, causing flash flooding across southern Mecklenburg County and much of neighboring Union County. McAlpine Creek, McMullen Creek and several other creeks flooded in these areas, flooding numerous streets and roads. A brick wall collapsed, 52 auto accidents occurred and six motorists required rescue in the southern part of Mecklenburg County.
Charlotte	08/09/1998	Urban Flood	0/0	NR	Flood-prone areas of south Charlotte were flooded during heavy rainfall in an afternoon thunderstorm. Four lanes of Archdale Road were also blocked. This area usually does not flood easily.
Charlotte	09/03/1998	Flood	0/0	NR	Duration rain from the remnants of Tropical Storm Earl caused some flooding problems. In the southern part of Charlotte, roads and streets were flooded in the typical areas. High water lingered until at least 9 a.m. the next morning.
Charlotte	01/23/1999	Flash Flood	**1**/0	NR	Thunderstorms in the Charlotte metro area dumped up to 1.5 inches of rain in a half hour during the afternoon. This caused severe urban flooding in low-lying paved areas. A man stepped into a storm drain, then was swept into a creek and drowned. A few roads were flooded and underwater, and a few small streams came out of their banks briefly.
Charlotte	6/10/1999	Urban / Small Stream Flood	0/0	NR	More than one inch of rain fell in a short period of time in Charlotte and caused some urban flooding in which a few cars were involved. However, no serious problems were reported
Charlotte	7/12/2000	Urban / Small Stream Flood	0/3	NR	Slow-moving thunderstorms produced heavy rain during the late afternoon and early evening. Three boys sustained minor injuries while playing in a swollen creek which swept them downstream. Typical urban flooding also occurred in the city.
Charlotte	08/04/2000	Flood	0/0	NR	Four to 6 inches of rain in a three-hour period resulted in several roads becoming impassable due to high water.
Charlotte	8/18/2000	Urban / Small Stream Flood	0/0	NR	Numerous streets were briefly blocked by high water.
Huntersville	09/04/2000	Flood	0/0	NR	Excessive rain from nighttime convection in the area resulted in flooded farm fields and overflowing ditches along Highway 73 about 4 miles west of Huntersville.
Charlotte	05/30/2002	Urban / Small Stream Flood	0/0	NR	Slow moving thunderstorms caused rainfall of 2 to 4 inches to accumulate in a short time across portions of the Charlotte metro area. Some small streams rose to bank full, and there was some flooding of streets and low lying areas around the city. Ponding of water on area roads caused some traffic accidents.
Pineville	07/01/2002	Flash Flood	0/0	NR	Cars were stalled in a shopping center parking lot by high water from severe urban flooding. Two people required rescuing from their cars.
Charlotte	07/14/2002	Urban / Small Stream Flood	0/0	NR	Two to three inches of rain fell in a short time, causing local creeks to rise quickly to near bank full. No creeks reportedly flooded, but usual flood-prone areas in the southern part of the metro area had minor flooding and standing water.
Charlotte	10/13/2002	Flood	0/0	NR	Flooding was reported at the intersection of Morgan Street and Blackman. Flooding was also reported along an I-85 service road where one car was stranded in water up to its fenders and doors.

Table 5.3: Significant Flood Events (1900-2009)					
LOCATION	**DATE OF OCCURRENCE**	**TYPE OF EVENT**	**DEATHS/ INJURIES**	**PROPERTY DAMAGE**	**DETAILS**
Countywide	03/20/2003	Flash Flood	0/0	NR	Heavy rainfall resulted in rapid rises and flooding along numerous creeks and small streams in and near the Charlotte metro area. Severe urban flooding was also reported.
Countywide	03/20/2003	Flood	0/0	**$2,000,000**	After flash flooding during the morning hours, moderating rainfall resulted in additional flooding along creeks and streams into the evening hours. Some of the flooding was described as the worst in the area in over five years. Flooding was especially severe along the Mecklenburg County/Union County line, where some people required rescue from vehicles and homes.
Charlotte	04/10/2003	Flood	0/0	NR	Flooding occurred along many creeks and streams in Charlotte and surrounding areas.
Charlotte	05/22/2003	Flood	0/0	NR	Heavy overnight rainfall resulted in mainly urban flooding in the Charlotte metro area during the morning and early afternoon hours, which resulted in a few road closures. However, by late afternoon area creeks and streams began to overflow their banks. By evening, several roads were closed due to flooded creeks and streams, including a portion of I-485, which were covered with water from Briar Creek. Sugar, Paw and McDowell Creeks also flooded.
Charlotte	06/07/2003	Flash Flood	0/0	**$1,000,000**	Slow-moving thunderstorms producing very heavy rainfall caused severe urban flooding to development in the Charlotte metro area during the evening of the 7th. Water levels on the Briar and Sugar Creek systems rose rapidly and overflowed their banks. Deep water covered portions of Independence Boulevard and several vehicles were submerged. The first floor of a hotel was flooded, causing severe damage that necessitated rebuilding of the hotel. Several large sinkholes also developed. People required rescue from two apartment complexes, as well as from submerged vehicles.
Charlotte	06/16/2003	Flash Flood	0/0	NR	Flooding of roads and a campground was reported in areas near the Charlotte Motor Speedway.
Matthews	06/16/2003	Flash Flood	0/0	**$50,000**	A vehicle traveling along Monroe Road was washed into Briar Creek. Four Mile Creek flooded several yards. Water also covered I-85 near the I-77 exchange.
Charlotte	06/18/2003	Flash Flood	0/0	NR	Several streets were closed on the east side of the city due to high water, including Independence, Randolph, Ballentyne Corporate Road and Sam Newell Road.
Charlotte	07/29/2003	Flash Flood	0/0	NR	Several creeks overflowed their banks and flooded adjacent roads. Sam Newell Road in Matthews was flooded. In southeast Charlotte, Four Mile Creek flooded Tank Town Road and Briar Creek flooded part of Sheffield Drive.
Charlotte	08/14/2003	Flash Flood	0/0	NR	Severe urban flooding developed during the early evening, with several roads flooded and closed, including Freedom, Ashley and Berry Hill Drives. Sam Newell Road in Matthews was covered with 5 feet of water.
Charlotte	7/17/2004	Flash Flood	0/0	**$25,000**	Severe urban flooding developed across the metro area, as a strong thunderstorm moved across the city, producing rainfall rates of 2 to 3 inches per hour. Several intersections and roads were closed, and numerous vehicles were stranded in high water. Several peopled had to be rescued from their vehicles. In addition, the roof of a business collapsed due to the weight of accumulated water.

Table 5.3: Significant Flood Events (1900-2009)

LOCATION	DATE OF OCCURRENCE	TYPE OF EVENT	DEATHS/ INJURIES	PROPERTY DAMAGE	DETAILS
Mecklenburg County	9/7/2004	Flood	0/0	**$1,500,000**	Remnants of Hurricane Frances dumped more than 20 inches of rain in the upper reaches of the Catawba River watershed in September. The resulting runoff caused significant flooding along the Catawba River below Mountain Island Lake dam. In Mecklenburg County, more than forty houses were flooded and eight were destroyed, with damages totaling approximately $1.5 million.
Charlotte	9/27/2004	Flash Flood	0/0	$0	Moderate to heavy rain fell through much of the early evening hours, but flooding developed rapidly around midnight, as an intense tropical rain band produced around 2 inches of rain across the area in a 2-to-3 hour span. Overflowing streams caused flooding of numerous roads in areas from Monroe northward to Charlotte and vicinity.
Charlotte	5/10/2005	Flash Flood	0/0	**$10,000**	Severe urban flooding developed, with 2 cars stranded in water on Sugar Creek Road. There was also water over North Tryon Street.
Charlotte	5/12/2005	Flash Flood	0/0	**$4,000**	Severe urban flooding developed, with water deep enough to float a car into the median on Independence Boulevard, and several inches of water covering Queens Road.
Charlotte	6/7/2005	Flash Flood	0/0	**$10,000**	A tributary of Little Sugar Creek flooded Bradbury and Montford drives in south Charlotte. Two vehicles were trapped in flood water, and their drivers had to be rescued. Several homes were threatened for a while, and at least 1 home had water up to the top of the front porch.
Charlotte	6/9/2005	Flash Flood	0/0	$0	A small creek overflowed its banks near Stateville Avenue, with water surrounding a home. At least one road was covered with water.
Charlotte	7/1/2005	Flash Flood	0/0	$0	Severe urban flooding developed in and around Charlotte, with water of 2 to 3 feet reported at some intersections on the southeast side of the city. This required several rescues.
Charlotte	7/22/2006	Flash Flood	0/0	**$100,000**	Significant flooding developed along Stewart Creek on the west side of Charlotte after strong to severe thunderstorms dumped 2 to 4 inches of rain over the city. Water entered several homes on Trade Street near its intersection with Seldon Avenue. Water also entered several units at 2 apartment complexes along the creek. Approximately 150 people were forced from their homes due to flood water, and about 5 apartment units were condemned. In addition to the stream flooding, poor drainage flooding developed in other areas of the city. 25 water rescues were performed, most of them due to motorists driving into deep standing water.

Table 5.3: Significant Flood Events (1900-2009)

LOCATION	DATE OF OCCURRENCE	TYPE OF EVENT	DEATHS/ INJURIES	PROPERTY DAMAGE	DETAILS
Charlotte	8/15/2006	Flash Flood	0/0	**$100,000**	Severe urban flooding developed in the Charlotte metro area, when as much as 7.5 inches of rain fell in just a few hours. High water first developed at flood-prone intersections, such as John Belk Freeway and Independence Boulevard and I-85 and Billy Graham Parkway. Cars stalled out in deep water on East 9th Street and North Caldwell Avenue. In all, 12 motorists were rescued from high water across the city. Numerous other roads and highways were flooded with 2-4 feet of water, including portions of I-85. Although most of the flooding was due to drainage problems, Briar Creek and Little Sugar Creek both exceeded established flood stages and likely contributed to the problems. An apartment building on Dolphin Lane was evacuated when water entered one of the units. Another apartment building was evacuated on Monroe Road when a creek flooded the parking lot.
Charlotte	8/31/2006	Flash Flood	0/0	$0	Water from Steele Creek flooded a trailer park on John Price Road, forcing the evacuation of about 100 people. Steele Creek also flooded Choate Circle near the South Carolina border.
Charlotte	7/9/2007	Flash Flood	0/0	**$10,000**	Slow moving thunderstorms developed over the Charlotte metro area during the early evening hours, dropping several inches of rain in short period of time, causing significant urban and stream flooding. Several roads were closed north of Charlotte due to flooding streams, including Mallard Creek Road and Statesville Road near Lakeview Road. A motorist required rescue from his vehicle when it became submerged on Lakeview Road. A spotter reported 2-3 feet of water covering the intersection of Westfield Road and Queens Road West. Additional flooded roads were reported in the vicinity of the I-85 and I-77 exchange.
Charlotte	6/21/2008	Flash Flood	0/0	$0	Heavy rain resulted in an isolated area of flash flooding on the northeast side of Charlotte. A tributary of Little Sugar Creek flooded a business on Atando Road, inundating the building with several feet of water and trapping 5 employees inside. The employees had to be rescued via rafts.
North Charlotte	8/27/2008	Flash Flood	0/0	**$8,500,000**	The remnants of Tropical Storm Fay brought as much as 11 inches of rain to the area in less than 24 hours, flooding more than 600 structures and submerging vehicles on numerous roadways with some rescues required. Numerous evacuations were required of homes and apartments along the Briar Creek, as water entered dozens of structures. Stream gauges measuring how deep the water is in local creeks set 19 new records, exceeding the 100-year flood level in some areas.

Table 5.3: Significant Flood Events (1900-2009)					
LOCATION	**DATE OF OCCURRENCE**	**TYPE OF EVENT**	**DEATHS/ INJURIES**	**PROPERTY DAMAGE**	**DETAILS**
North Charlotte	9/10/2008	Flash Flood	0/0	**$100,000**	A cluster of slow moving thunderstorms produced several inches of rain over the northeast side of Charlotte, resulting in a flash flooding. Significant flash flooding developed along Little Sugar Creek in northeast Charlotte. Sugar Creek Road and Tryon Street were immersed by flood water, with at least one automobile submerged. Several water rescues were required in the area, with some people trapped in their homes. A homeless shelter was damaged by floodwater on North Tryon Street.
Charlotte	5/5/2009	Flash Flood	0/0	**$50,000**	Training thunderstorms caused localized flash flooding across parts of the Charlotte metropolitan area. Flash flooding developed across the southern and eastern sides of the city after thunderstorms dumped 3 to 5 inches of rain across the area in a couple of hours. Although much of the flooding was due to poor drainage, Briar Creek, Little Sugar Creek and other small streams flooded. Numerous motorists were trapped and required rescuing due to flood water, with the most serious situations occurring on Independence Boulevard near Wendover Road, Wellesley Avenue near Freedom Park, and on East Boulevard at Maryland Avenue. Some residents had to be evacuated from an apartment complex on Monroe Road due to flooding along Briar Creek. According to Mecklenburg County, floodwater entered the living space of about 10 homes and businesses. Another 85 buildings had water in crawl spaces or damage to air conditioners, and 80 unoccupied units of the Doral Apartments flooded. Damage was in the McMullen, Briar, and Little Sugar Creek Watersheds.
Charlotte	6/5/2009	Flash Flood	0/0	$0	A mesoscale convective vortex brought heavy rain to the Charlotte metro area, producing flash flooding on the northeast side of town. Later in the day, an area of thunderstorms developed to the southwest of Concord, producing more flooding. Rockland Drive was flooded and closed, as was Mary Alexander Road. Also, the stream gauge on Little Sugar Creek below 36th Street exceeded the established flood stage by more than 2 feet.
Charlotte	7/9/2009	Flash Flood	0/0	$0	A slow moving complex of thunderstorms produced flash flooding in metro Charlotte. Flooding of quite a few roads developed across the north side of the city, mainly due to poor drainage. Most of the flooding was concentrated along Freedom Boulevard, where several intersections were under 2-3 feet of water. Flooding extended northeast along portions of Statesville Road and North Tryon Street as well.

Table 5.3: Significant Flood Events (1900-2009)					
LOCATION	DATE OF OCCURRENCE	TYPE OF EVENT	DEATHS/ INJURIES	PROPERTY DAMAGE	DETAILS
Charlotte	7/28/2009	Flash Flood	0/0	$0	An old mesoscale convective vortex spawned numerous showers and thunderstorms over western North Carolina. Severe urban flooding developed during the evening hours on the south side of Charlotte. The road was closed at Rodman Street and Sam Drenan Road due to flood water and a sink hole. Also, Carmel Road was closed due to flooding. McMullen Creek overflowed its banks, flooding Addison Drive and Lincrest Place with 6-12 inches of water, and Little Sugar Creek exceeded its established flood stage at Hillside Avenue.
Charlotte	8/16/2009	Flash Flood	0/0	**$50,000**	Slow moving thunderstorms developed over the Charlotte metro area during the afternoon hours, resulting flooding of urban areas and small streams. Flash flooding developed across portions of the Charlotte metro area after as much as 4 inches of rain fell over the city in just a few hours. Most of the problems were within the Little Sugar Creek basin, especially in the Wakefield Drive area, where roads were flooded and some apartment units were evacuated. Water ended the crawl spaces of two homes in this area. The other main problem area was in the Parkwood Road area northeast of Charlotte, where roads were flooded. Flooding of numerous intersections was reported due to poor drainage, including at Tyvola Road and I-77, where two vehicles were reported floating through high water.
TOTAL			**17/4**	**$39,259,000**	

Sources: Mecklenburg County (1900 to 1993 data); Mecklenburg County and National Climatic Data Center (1993 to 2009 data)

PROBABILITY OF FUTURE OCCURRENCES

Flooding remains a highly likely occurrence throughout the identified flood hazard areas of Mecklenburg County. Smaller floods caused by heavy rains and inadequate drainage capacity will be more frequent, but not as costly as the large-scale floods which may occur at much less frequent intervals. While the potential for flood is always present, Mecklenburg County continues to reduce the likelihood of repetitive flood losses to existing development through its ongoing flood mitigation programs (including its *Floodplain Buyout Program*). Further, the County and each of its municipal jurisdictions do have effective flood damage prevention ordinances and other local regulatory policies for new development in place that should help lessen potential property damage due to future floods. These flood mitigation programs and policies are further discussed and demonstrated in Section 6: *Vulnerability Assessment* and Section 7: *Capability Assessment*.

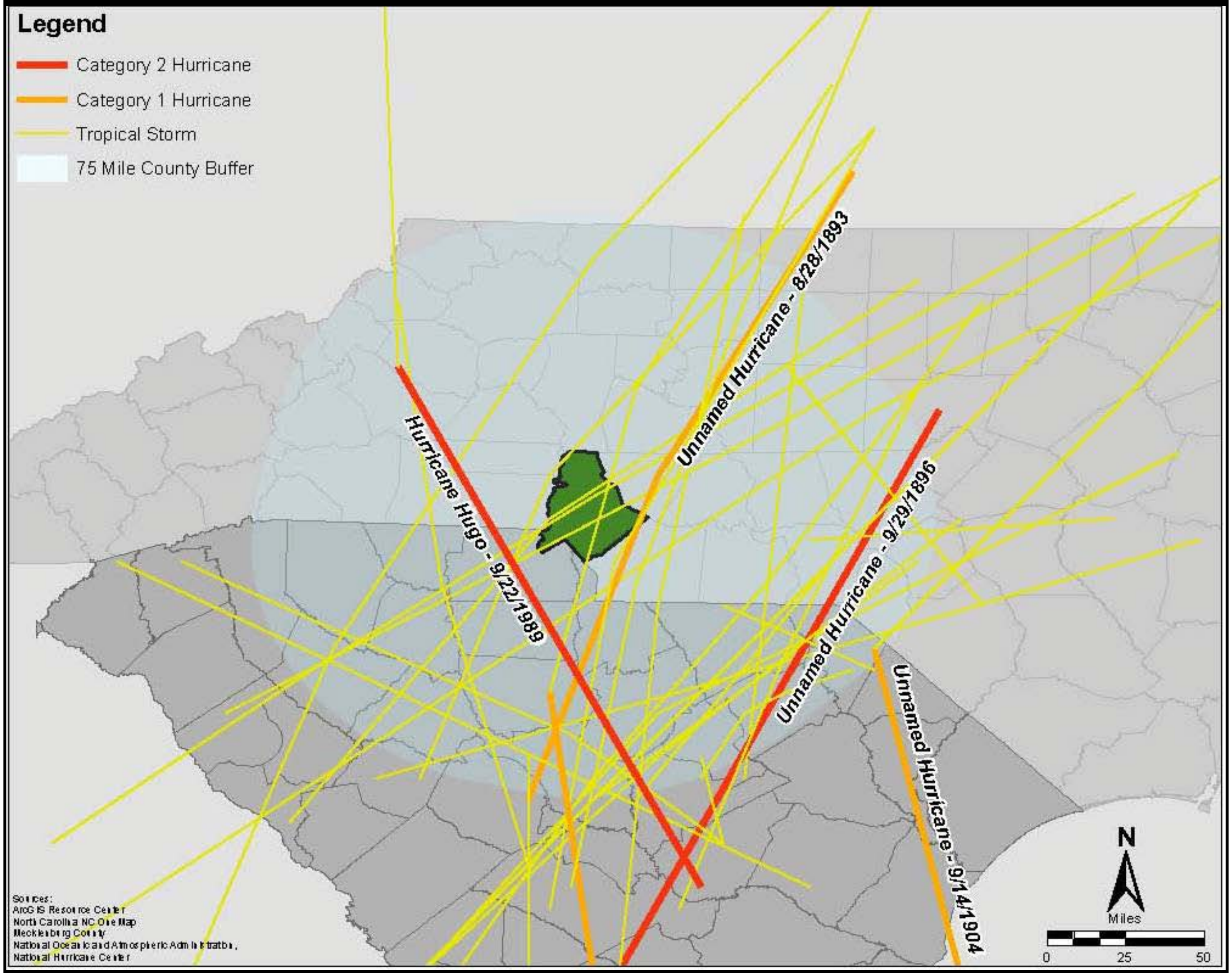
HURRICANES AND TROPICAL STORMS

On average, North Carolina experiences a hurricane approximately once every two years. Substantial hurricane damage is most likely to occur in the easternmost counties of the state; however, hurricane and tropical storm-force winds have significantly impacted areas far inland, including Mecklenburg County. In fact, 32 such storms have passed within 75 miles of Mecklenburg County since 1851 (**Figure 5.4**), seven of which crossed directly through the county. Two of the 32 storms were Category 2 hurricanes (Hurricane Hugo in 1989 and an unnamed hurricane in 1896), three were Category 1 hurricanes (Hurricane Able in 1952 and two unnamed hurricanes in 1893 and 1904), and 27 were tropical storms. Of the seven storms that passed through the county, Able was the most recent (1952).

After passing inland, Hurricane Hugo was not done wreaking havoc. Electric power was interrupted throughout Charlotte with some areas remaining without power for up to three weeks. (Photo courtesy of NOAA Photo Library, NOAA Central Library; OAR/ERL/ National Severe Storms Laboratory)

No nor'easters are known to have significantly impacted Mecklenburg County in recent history. If a nor'easter had impacted the county, the effects would have been perceived as severe winter weather and not as a coastal cyclone event.

Figure 5.4: Historical Storm Tracks Within 75 Miles of Mecklenburg County (Since 1851)



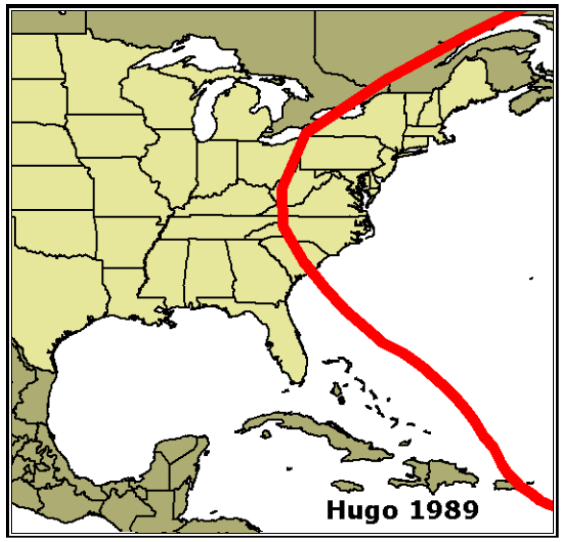
SIGNIFICANT HISTORICAL EVENTS

There is very little detailed information on the historical impacts of past hurricane and tropical storm events in Mecklenburg County. No official historical records or damage statistics specific to the area are available through Mecklenburg County, the North Carolina Division of Emergency Management or the Federal Emergency Management Agency. The county is known to have sustained a significant portion of the estimated statewide total of $1 billion in property damages caused by Hurricane Hugo in 1989, Mecklenburg County's most powerful storm event to date. Brief descriptions of significant known historical events, including Hurricane Hugo, are provided below.

Hurricane Hugo made landfall as a Category 4 storm on September 22, 1989 at Sullivan's Island, South Carolina and tracked northward across the Charlotte metro area (pictured right). As Hugo crossed western North Carolina, the storm dumped 3 to 7 inches of rain and caused wind damage as far north as Caldwell County. In North Carolina, Charlotte recorded the highest sustained wind of 69 miles per hour and wind gusts of 87 miles per hour, and a barometric pressure of 978 millibars. Mecklenburg County reported 3.16 inches of rain from the storm. Twenty-nine counties in North Carolina were presidentially declared disaster areas, with an estimated $1 billion in damages in North Carolina. In Mecklenburg County, the winds downed trees and power lines causing massive disruption for days. The following description of Hurricane Hugo was excerpted from *North Carolina's Hurricane History* by author Jay Barnes.

"As the center of the storm rolled past Charlotte, wind gusts of over 85 mph buffeted the region. Trees crashed into homes, cars, and power lines and utility poles snapped. Charlotte lost more than eighty thousand trees to the storm, many of which were more than seventy years old. Ninety-eight percent of the city's residents lost power, and for some, repairs were not made for more than two weeks. Power outages caused large amounts of raw sewage to bypass treatment plants and flow into streams throughout Mecklenburg County. North Carolina's largest metropolitan area was brought to its knees by the storm...

…The people of Mecklenburg County thought they were immune to hurricanes prior to this storm's arrival. Most had believed that tropical cyclones were strictly a coastal phenomenon, but Hugo proved to be an exception." (Jay Barnes 1998)



The track of Hurricane Hugo takes the powerful storm past Charlotte in 1989. (Photo courtesy of the National Hurricane Center)

An unnamed tropical storm caused winds up to 60 mph in the Charlotte area on July 14, 1916. An unnamed tropical storm impacted Mecklenburg County August 28, 1949 with heavy rains and minimal gale force winds. Hurricane Gracie crossed into North Carolina as a tropical storm and moved rapidly north out of the state, bringing heavy rain to Mecklenburg County on September 30, 1959. Although Hurricane Abby had dissipated by the time it reached North Carolina, remnants of the storm impacted Mecklenburg County on June 7 to June 13, 1968. Charlotte recorded 5.11 inches of rain, a wind gust of 46 mph, and one tornado that was spawned near Charlotte. Damages in the Charlotte area were estimated by the National Weather Service to be $30,000. Hurricane Ginger was a Category 1 storm when it made landfall near Atlantic Beach, North Carolina on September 30/October 1, 1971. The Charlotte area recorded a wind gust of 30 mph and 2.21 inches of rain as a result of this storm.

Table 5.4 shows the historical storm tracks within 75 miles of Mecklenburg County since 1851 that are the basis for Figure 5.4.

Table 5.4: Historical Storm Tracks Within 75 Miles of Mecklenburg County (Since 1851)

DATE OF OCCURRENCE	STORM NAME	WIND SPEED (MPH)	STORM CATEGORY
1854	Not Named	70	Tropical Storm
1859	Not Named	45	Tropical Storm
1877	Not Named	45	Tropical Storm
1878	Not Named	70	Tropical Storm
1882	Not Named	45	Tropical Storm
1885	Not Named	45	Tropical Storm
1886	Not Named	45	Tropical Storm
1888	Not Named	40	Tropical Storm
1889	Not Named	50	Tropical Storm
1893	Not Named	45	Tropical Storm
1893	Not Named	85	Category 1 Hurricane
1896	Not Named	100	Category 2 Hurricane
1901	Not Named	40	Tropical Storm

Table 5.4: Historical Storm Tracks Within 75 Miles of Mecklenburg County (Since 1851)

DATE OF OCCURRENCE	STORM NAME	WIND SPEED (MPH)	STORM CATEGORY
1902	Not Named	40	Tropical Storm
1904	Not Named	80	Category 1 Hurricane
1906	Not Named	70	Tropical Storm
1912	Not Named	40	Tropical Storm
1913	Not Named	40	Tropical Storm
1913	Not Named	40	Tropical Storm
1916	Not Named	65	Tropical Storm
1920	Not Named	65	Tropical Storm
1927	Not Named	45	Tropical Storm
1935	Not Named	65	Tropical Storm
1945	Not Named	45	Tropical Storm
1949	Not Named	45	Tropical Storm
1952	Able **(5)**	80	Tropical Storm
1959	Cindy	40	Tropical Storm
1959	Gracie	70	Tropical Storm
1979	David	65	Tropical Storm
1985	Bob	65	Tropical Storm
1988	Chris	40	Tropical Storm
1989	Hugo	100	Category 2 Hurricane

Source: National Hurricane Center

PROBABILITY OF FUTURE OCCURRENCES

Mecklenburg County will not likely experience the effects of a major (Category 3 or stronger) hurricane, however the county remains susceptible to the high wind effects from such storms making landfall along the Atlantic coast of the United States. The effects of tropical storms (sustained wind speeds of at least 39 miles per hour and torrential rains) will be more frequent, as storms making landfall along the Atlantic seaboard as well as the Gulf Coast could impact the county in any given year.

SEVERE THUNDERSTORMS

Thunderstorms are common throughout the state of North Carolina, and have been known to occur during all months of the year. In addition to the high winds associated with these events, thunderstorms can also bring dangerous lightning that can cause fires, property damage and may cause death or serious injury. Thunderstorms can also produce hail, which can cause varying degrees of property and crop damage. According to information provided by the National Lightning Safety Institute, the Piedmont Region, which includes Mecklenburg County, experiences an average of 70 thunderstorm days per year. According to the National Climatic Data Center, Mecklenburg County has experienced a recorded 244 *severe* thunderstorm events since 1950 resulting in four deaths, 13 injuries and approximately $2.2 million in property damage. In addition, and described separately herein, Mecklenburg County experienced 160 documented hail events since 1950 resulting in an estimated $1 million in reported property damages, and 32 lightning events resulting in 3 fatalities, seven injuries and an estimated $2.7 million in property damages.

SIGNIFICANT HISTORICAL EVENTS

Table 5.5 provides details of historical severe thunderstorm activity in Mecklenburg County for those events that resulted in casualties or property damage as recorded by the National Climatic Data Center.[7] The most notable thunderstorm damage occurred on July 20, 1998 when a storm moved into southern Mecklenburg County and blew down six trees on the southwest side of Charlotte striking 15 dwellings including apartments, condominiums and houses and causing an estimated $1 million in property damages. Also, flash flooding occurred in the city late in the evening of the 20th and continued into the early morning hours. One injured woman had to be rescued from her car during this storm event.

Table 5.5: Significant Severe Thunderstorm Events (1950-2009)

LOCATION	DATE OF OCCURRENCE	MAGNITUDE (KNOTS)	DEATHS/ INJURIES	PROPERTY DAMAGE	DETAILS
Mecklenburg	08/20/1990	58	0/**1**	NR	No details available.
Mecklenburg	06/21/1992	0	0/**1**	NR	No details available.
Charlotte	05/19/1993	N/A	0/0	**$5,000**	Thirty trees were blown down and a carport destroyed.
Mecklenburg	01/18/1996	N/A	0/0	**$3,125**	An extremely strong cold front, preceded by heavy rain all day, moved through the Piedmont during the night with the highest winds recorded in 20 years of record.
Charlotte	04/30/1996	0	0/0	**$25,000**	No details available.
Huntersville	05/27/1996	50	0/0	**$5,000**	No details available.
Huntersville	08/03/1996	65	0/0	**$50,000**	No details available.
Charlotte	02/21/1997	50	0/0	**$25,000**	No details available.
Cornelius	08/04/1997	70	0/0	**$25,000**	Two severe thunderstorms moved south-southeast causing significant damage. Around Lake Norman in northern Mecklenburg County several boats were capsized and hundreds of trees were blown down. There was also some damage to homes from both wind and fallen trees.
Mecklenburg	02/24/1998	50	0/0	**$1,250**	High gradient winds in the wake of an exiting strong storm system combined with saturated soil conditions to blow down some trees and power lines across the Piedmont.

[7] While the Severe Thunderstorm hazard is understood to include lightning and hail as hazardous elements, tables are provided with lightning and hail activity presented separately with the understanding that some duplication of deaths, injuries and property damage may occur when comparing all three tables.

Table 5.5: Significant Severe Thunderstorm Events (1950-2009)					
LOCATION	**DATE OF OCCURRENCE**	**MAGNITUDE (KNOTS)**	**DEATHS/ INJURIES**	**PROPERTY DAMAGE**	**DETAILS**
Charlotte	04/19/1998	50	0/0	**$70,000**	Fast low-topped thunderstorms moved rapidly north across the Charlotte metro area during the afternoon hours. A few of the storms became severe and produced a moderate amount of wind damage. A large tree was blown onto two cars, one house and broke a gas line on the south side of Charlotte. Trees and power lines were downed from Matthews to Mint Hill. North of Charlotte, a roof was blown off an old grocery store, a beauty shop was damaged, mobile home windows were blown out, and a car had a piece of wood hurled through its glass.
Charlotte	07/20/1998	50	0/0	**$1,000,000**	A strong thunderstorm struck 15 dwellings including apartments, condominiums and houses in the Charlotte area. Damage was estimated near $1 million.
Charlotte	08/08/1998	52	0/0	**$12,000**	A couple of severe thunderstorms developed late in the afternoon in the Piedmont. In east Charlotte trusses were blown off a house under construction and limbs were knocked down.
Mecklenburg	09/15/1999	45	0/**1**	NR	Near and east of Interstate 77, winds directly associated with Hurricane Floyd caused scattered damage. Winds gusting between 35 and 45 mph downed some trees and power lines.
Mecklenburg	03/28/2000	50	0/**1**	NR	High winds following a cold front caused a number of problems during the afternoon hours. Numerous trees and power lines were downed and some light structural damage occurred. Several thousand people were without power for a short time. Downed trees and power lines in Charlotte blocked streets.
Charlotte	08/18/2000	75	**1/2**	**$250,000**	A large swath of wind damage occurred from Ericsson Stadium to the east side of Charlotte. A trained spotter estimated the wind speed to be 90 mph at Dillworth Square. Other estimates were reported of between 75 and 100 mph. Numerous trees and power lines were downed and a canopy was blown off a gas station. Numerous streets were blocked and Interstate 85 was blocked in both directions. Nearly 90,000 people were left without power. The County 911 center said this event generated the most calls since Hurricane Hugo moved through Charlotte. Falling trees injured two people, and one person drowned when his boat was blown away from where he was swimming.
Mecklenburg	12/17/2000	55	0/0	**$25,000**	No details available.
Mecklenburg	03/20/2001	55	0/0	**$45,455**	No details available.
Mecklenburg	04/17/2001	50	**1**/0	NR	Gusty winds were strong enough to cause scattered damage. In Charlotte, a number of trees and limbs fell. One 60-foot section of a tree fell on a car, resulting in a fatality.
Cornelius	05/13/2002	55	0/0	**$3,000**	Numerous trees and power lines were blown down.
Charlotte	05/13/2002	60	0/0	**$50,000**	A roof was partially blown off of a business, a crane was blown over and numerous power lines were blown down.
Matthews	05/13/2002	52	0/0	**$50,000**	A tractor-trailer truck was toppled, and numerous trees and power lines were blown down.
Pineville	07/01/2002	50	0/0	**$1,000**	Power lines were blown down in Pineville. Trees were blown down along Highway 51 near Pineville.
Mecklenburg	07/02/2002	60	0/0	**$3,000**	Numerous trees and power lines were blown down.
Charlotte	07/03/2002	50	0/0	**$8,000**	A tree was blown onto a car. Several traffic lights and signs were damaged.
Charlotte	07/03/2002	50	0/0	**$20,000**	Trees were blown down onto an apartment complex, resulting in evacuation of some units.
Charlotte	07/03/2002	55	0/0	**$3,000**	Numerous trees and power lines were blown down.

Table 5.5: Significant Severe Thunderstorm Events (1950-2009)

LOCATION	DATE OF OCCURRENCE	MAGNITUDE (KNOTS)	DEATHS/ INJURIES	PROPERTY DAMAGE	DETAILS
Charlotte	08/16/2002	50	0/0	**$1,000**	Some power lines were blown down.
Cornelius	08/24/2002	55	0/0	**$3,000**	Numerous trees and power lines were blown down.
Charlotte	05/02/2003	65	0/**2**	**$100,000**	Tents, booths, and other property were blown down at an arts and food festival in uptown Charlotte. Some structures received damage. Flying debris injured two people. Trees and power lines were blown down in areas south of town.
Huntersville	05/02/2003	60	0/**3**	**$25,000**	Numerous trees and power lines were blown down. A tree fell through a mobile home, resulting in serious injuries to two people, and minor injuries to a third.
Charlotte	07/09/2003	50	0/0	**$1,000**	Trees were blown down.
Huntersville	07/11/2003	50	0/0	**$1,000**	Trees were blown down.
Huntersville	07/12/2003	50	0/0	**$5,000**	Trees were blown down.
Charlotte	08/05/2003	50	0/0	**$5,000**	No details available.
Charlotte	08/22/2003	54	0/0	**$1,000**	Wind equipment at the Charlotte/Douglass International Airport measured a wind gust of 62 mph. Trees and power lines were blown down in the same area.
Huntersville	11/19/2003	50	0/0	**$1,000**	Some power lines were blown down.
Charlotte	11/19/2003	50	0/0	**$1,000**	Large tree limbs and power lines were blown down in scattered locations across the city.
Mecklenburg Huntersville	03/07/2004	65	**1/2**	**$55,000**	Numerous trees and power lines were blown down, while roofs were torn off of some buildings. Some outbuildings and barns were damaged or destroyed. In Mecklenburg County, an 81-year-old man was killed in Huntersville, when a tree fell across the deck on which he was standing.
Charlotte	05/31/2004	50	0/0	**$1,000**	Several power lines were blown down.
Charlotte	01/14/2005	50	0/0	**$4,000**	County reports a tree blown onto a house.
Charlotte	01/14/2005	50	0/0	**$5,000**	A few trees down in the city. One fell on a house, causing damage.
Charlotte	03/08/2005	60	0/0	**$50,000**	Tree fell on a car on Mount Holly Road near NC 27. Several trees fell on homes along Beatties Ford Road near LaSalle Street. Some roofs were torn off buildings in this same area.
Pineville	03/08/2005	60	0/0	**$20,000**	Several 8-inch diameter pine trees blown down near the intersection of highways 51 and 521. A large road sign was blown down on I-485, and some scaffolding was blown down at a construction site. A portion of the roof was torn off Charlotte Catholic High (10 S. City Center) and several large trees were blown down on Windyrush Road near Rea Road. Numerous power outages were reported.
Davidson	07/28/2005	55	0/0	**$10,000**	Quite a few trees, power lines, and power poles down, with at least 2 trees on houses.
Charlotte	02/04/2006	50	0/0	**$10,000**	Two trees blown down on the east side of Charlotte and a privacy fence blown down. One large tree fell on a home, causing significant damage.
Charlotte	06/11/2006	60	0/0	**$100,000**	Numerous trees were blown down in various locations across the southern part of the city due to a series of microbursts. Several trees on homes in the Sardis Road area around Bently Oaks Road and Chevron Road. A private sector meteorologist estimated wind speeds at 65 to 75 mph based on the damage. Also, a spotter reported 3 trees snapped off on Patrick Springs Court. Trees were also blown down on Kings Drive and Hartford Avenue. Trees were also blown down in the Matthews area. There were at least 28,000 power outages in the area.

Table 5.5: Significant Severe Thunderstorm Events (1950-2009)					
LOCATION	**DATE OF OCCURRENCE**	**MAGNITUDE (KNOTS)**	**DEATHS/ INJURIES**	**PROPERTY DAMAGE**	**DETAILS**
Mecklenburg	04/16/2007	60	0/0	**$22,727**	Widespread damaging high wind event, with most damage reports coming from north of Charlotte and throughout the Piedmont. Thousands of trees fell across the region, resulting in widespread power outages. Numerous trees fell on roads, homes, and vehicles but no specific reports of damage in Mecklenburg County. The Blue Ridge mountains and the foothills received the brunt of the strongest winds.
Charlotte	08/26/2007	60	0/0	**$50,000**	Isolated severe storms affected the mountains and Piedmont of North Carolina during the afternoon and early evening hours. The roof of a business was damaged on Statesville Road. Part of the roof of a restaurant was damaged at the intersection of I-485 and Sunset. A canopy at a gas station was lifted and fell on several vehicles near the intersection of Sunset and Reames Road. Trees and power lines were blown down near the intersection of Beatties Ford Road and Trinity Road, and at I-485 and Brookshire.
Mecklenburg	03/09/2008	45	**1/0**	**$0**	Gusty winds toppled a large tree, which fell on a vehicle at the corner of East Boulevard and Asheville Place. The impact killed the 53-year-old woman driving the vehicle.
TOTAL			**4/13**	**$2,151,727**	

Source: National Climatic Data Center

North Carolina had 29 lightning-related deaths from 1990 to 2003 ranking North Carolina fifth in the United States in such deaths. Thirty-two lightning events not directly associated with a thunderstorm event are known to have impacted Mecklenburg County since 1995, resulting in three known deaths, seven known injuries and over $2.7 million in reported property damage, as shown in **Table 5.6.** The University of North Carolina at Charlotte conducted a study to evaluate whether there is geographic correlation of lightning damage with environmental and socio-economic variables in Mecklenburg County. The study found that the majority of lightning damage during a period from 1993 to 1995 occurred in the South Planning District among seven districts in which a significant suburban growth in Mecklenburg County has taken place since 1950. This planning area has been one of the primary locations for new residential developments containing predominantly single family residences over $100,000 (Cao, Xiang and Wilson, *GIS-Based Study of Lightning Damages*).

According to the National Lightning Safety Institute, damage estimates reported by government agencies (such as NCDC) do not accurately represent actual losses due to underestimation or underreporting of actual damages. Nationwide, realistic lightning costs and losses may reach $4 to $5 billion per year including losses associated with forest fires, insurance claims and damages to warehouses, aircraft, electrical infrastructure and nuclear power plants.

Table 5.6: Lightning Activity in Mecklenburg County (1950-2004)				
LOCATION	**DATE OF OCCURRENCE**	**DEATHS/ INJURIES**	**PROPERTY DAMAGE**	**DETAILS**
Unincorporated Mecklenburg County	07/16/1995	0/0	**$50,000**	Lightning and the ensuing fire damaged a home substantially.
Charlotte	07/23/1997	0/0	**$100,000**	Lightning struck a home in north Charlotte.

Table 5.6: Lightning Activity in Mecklenburg County (1950-2004)				
LOCATION	**DATE OF OCCURRENCE**	**DEATHS/ INJURIES**	**PROPERTY DAMAGE**	**DETAILS**
Charlotte	06/10/1998	0/0	**$200,000**	Lightning severely damaged a church in Millersville, but no damage estimate was available. Several homes were struck by lightning in the Charlotte area, causing extensive damage.
Countywide	07/20/1998	0/0	**$1,000,000**	Intense cloud to ground lightning struck 15 dwellings ranging from apartments to condominiums to houses in the Charlotte area. Damage was estimated near $1 million as many homes were destroyed.
Charlotte	07/31/1999	0/0	NR[8]	Lightning strikes across the region caused numerous structure fires.
Charlotte	06/14/2000	0/**1**	NR	A woman hanging clothes was shocked and injured by lightning that struck nearby her Charlotte home.
Charlotte	07/07/2000	0/0	**$100,000**	Lightning struck an apartment complex in Charlotte and caused a fire that destroyed the roof of one building. Fourteen people were left homeless.
Charlotte	07/03/2002	0/0	**$20,000**	Lightning struck a house and a condominium, resulting in damage to both.
Charlotte	07/03/2002	0/0	**$10,000**	Lightning ignited two house fires.
Charlotte	07/04/2002	0/0	**$260,000**	Lightning, some at apartments and houses ignited at least three major fires.
Huntersville	05/02/2003	0/**1**	NR	No details available.
Charlotte	06/16/2003	0/0	**$250,000**	Lightning struck the roof of a condominium, resulting in a fire that caused significant damage.
Charlotte	07/19/2003	0/0	**$30,000**	A house was struck by lightning.
Charlotte	07/21/2003	0/**1**	NR	A person was injured after being struck by lightning.
Matthews	07/29/2003	**3/1**	**$30,000**	Three people were killed and another injured when lightning struck a large oak tree, which then fell on and crushed the vehicle they were sitting in. The fallen tree damaged two other vehicles.
Charlotte	07/29/2003	0/**1**	NR	A person was injured when he was struck by lightning.
Charlotte	08/14/2003	0/0	NR	Lightning struck two homes.
Charlotte	05/23/2004	0/0	**$250,000**	Two houses and an apartment complex were damaged due to fires ignited by lightning.
Pineville	06/08/2004	0/0	**$5,000**	Intense lightning caused widespread power outages in Pineville and surrounding areas. Three houses were struck on Lancaster Highway alone.
Charlotte	07/05/2004	0/0	**$20,000**	Lightning ignited several fires at homes and outbuildings.
Charlotte	05/10/2005	0/0	**$50,000**	Report of 8 to 9 homes struck by lightning. A fire was started at one of the homes, resulting in considerable damage.
Charlotte	06/07/2005	0/0	**$25,000**	Lightning ignited fires at 2 homes.
Charlotte	07/1/2005	0/0	**$60,000**	Lightning was responsible for at least 6 house fires across the city.
Matthews	07/18/2005	0/0	**$0**	Lightning knocked out power to about 6,000 customers in the Matthews area.
Huntersville	07/28/2005	0/0	**$20,000**	Lightning struck a house, which ignited a fire that destroyed the porch and damaged the main part of the house.
Charlotte	04/03/2006	0/0	**$15,000**	Lightning ignited a house fire in northwest Charlotte.
Charlotte	06/23/2006	0/**1**	**$0**	A utility worker working on a water line was injured when lightning struck the ground nearby.

[8] "NR" means "None Reported" indicating that no records exist of reported property damage. This does not exclude the possibility or probability that unreported damages did in fact occur.

Table 5.6: Lightning Activity in Mecklenburg County (1950-2004)				
LOCATION	**DATE OF OCCURRENCE**	**DEATHS/ INJURIES**	**PROPERTY DAMAGE**	**DETAILS**
Charlotte	07/22/2006	0/0	**$150,000**	Lightning started a fire at the Barton Creek Apartment Complex near UNC-Charlotte.
Huntersville	06/24/2007	0/0	**$20,000**	Lightning struck a home, igniting a fire that damaged the roof.
Charlotte	07/07/2007	0/0	**$20,000**	Lightning struck a house, igniting a fire that damaged the roof and attic.
Charlotte	07/22/2008	0/0	**$50,000**	Lightning ignited a fire at a home on Morton Street, causing significant damage.
Charlotte	05/02/2009	0/**1**	**$0**	Lightning ignited a fire at a home on Nevin Road, causing extensive damage and causing minor injuries to a firefighter.
TOTAL		**3/7**	**$2,735,000**	

Source: National Climatic Data Center

Table 5.7 shows a summary of reported hail events for unincorporated areas of Mecklenburg County, Charlotte, Cornelius, Huntersville, Matthews and Mint Hill between 1950 and 2009. A total of 160 hail events are known to have impacted Mecklenburg County since 1950, resulting in a total of approximately $1 million in property damage. The size of the recorded hailstones ranged from 0.75 inches to 3 inches. No deaths, injuries or crop damages have ever been reported in Mecklenburg County as a result of hailstorm activity.[9]

Table 5.7: Hail Activity in Mecklenburg County (1950-2009)				
LOCATION	**TOTAL NUMBER OF EVENTS**	**MAXIMUM HAIL SIZE (INCHES)**	**MINIMUM HAIL SIZE (INCHES)**	**AVERAGE SIZE (INCHES)**
Mecklenburg	70	3.00	0.75	1.08
Charlotte	50	2.50	0.75	1.01
Cornelius	6	1.75	0.75	1.29
Davidson	2	1.00	0.75	0.88
Huntersville	7	1.00	0.75	0.80
Matthews	11	1.75	0.75	1.02
Mint Hill	8	2.00	0.75	1.24
Pineville	6	1.75	0.75	0.98
TOTAL	**160**	**3.00**	**0.75**	**1.04**

Source: National Climatic Data Center

PROBABILITY OF FUTURE OCCURRENCES

Severe thunderstorms will remain a highly likely occurrence for Mecklenburg County (100% annual probability). Lightning and hail may also be experienced in the area due to such storms.

[9] While no injuries or crop damages have been reported, this does not necessarily mean that they did not occur. It does, however, reflect the best readily available (reported) data.

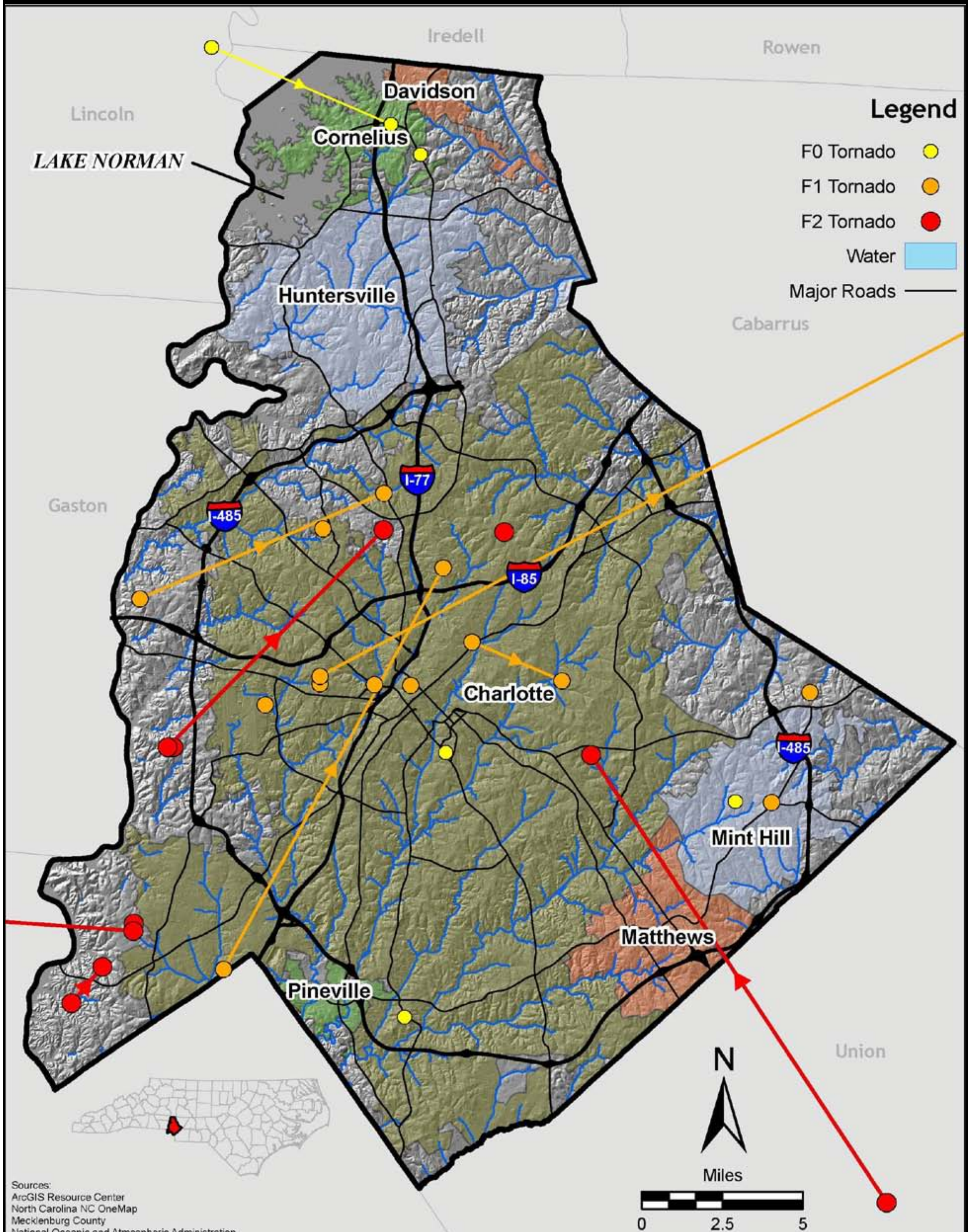
TORNADOES

When compared with other states, North Carolina ranks 22nd in number of tornado events, 20th in tornado deaths, 17th in tornado injuries and 21st in damages. These rankings are based upon data collected for all states and territories for tornado events between 1950 and 2003. According to the State Climate Office of North Carolina, most (43 percent) of tornado occurrences in North Carolina are minimal (F0) in intensity, followed F1 (37 percent).[10]

Figure 5.5 illustrates the approximate location where confirmed tornadoes have touched down in Mecklenburg County (and for those with end locations, the approximate tracks) according to historical tornado data collected from the National Oceanic and Atmospheric Administration through 2009, and according to their intensity classification on the Fujita scale.

[10] For more information on classifying tornado intensity according to the Enhanced Fujita Scale, please see Section 5: *Hazard Analysis*.

Figure 5.5: Tornado Occurrences in Mecklenburg County



SIGNIFICANT HISTORICAL EVENTS

According to National Climatic Data Center records, Mecklenburg County experienced 20 tornado events from 1950 through August of 2009, causing no deaths, 19 injuries and approximately $3.9 million in property damage (**Table 5.8**). The majority (50%) of these events were classified as F1 tornadoes, with the remaining 50% split evenly between F0 and F2. The most significant recorded event occurred on March 10, 1992 when an F2 tornado touched down in the late evening hours, was on the ground for 3.4 miles with a reported width of 180 yards, and caused 18 injuries and $2.5 million in damages. No additional information on this event (outside of NCDC records) was found.

Table 5.8: Tornado Events in Mecklenburg County (1950-2009)

LOCATION	DATE OF OCCURRENCE	MAGNITUDE	DEATHS/ INJURIES	PROPERTY DAMAGE	DETAILS
Mecklenburg	02/18/1960	F1	0/0	**$3,000**	No details available.
Mecklenburg	04/12/1961	F1	0/0	**$25,000**	No details available.
Mecklenburg	08/10/1964	F1	0/0	NR[11]	No details available.
Mecklenburg	09/12/1965	F2	0/0	**$25,000**	No details available.
Mecklenburg	06/07/1968	F2	0/0	**$25,000**	No details available.
Mecklenburg	05/28/1973	F2	0/0	**$250,000**	No details available.
Mecklenburg	05/28/1973	F1	0/**1**	**$250,000**	No details available.
Mecklenburg	10/08/1975	F1	0/0	**$25,000**	No details available.
Mecklenburg	09/16/1977	F1	0/0	**$25,000**	No details available.
Mecklenburg	08/14/1978	F0	0/0	**$3,000**	No details available.
Mecklenburg	05/03/1984	F1	0/0	**$250,000**	No details available.
Mecklenburg	06/06/1985	F0	0/0	**$250,000**	No details available.
Mecklenburg	11/28/1990	F1	0/0	**$25,000**	No details available.
Mecklenburg	03/10/1992	F2	0/**18**	**$2,500,000**	No details available.
Mint Hill	03/20/1998	F0	0/0	NR	A weak, short-lived tornado was observed by a woman in Mint Hill to briefly touchdown in front of her stopped car. Tornado damage was confined to trees and power lines.
Cornelius	05/07/1998	F0	0/0	**$50,000**	A waterspout/tornado crossed Lake Norman from neighboring Lincoln County and moved through Cornelius. The roof of a grocery store was damaged and debris from the store damaged cars and other buildings across the street at a dealership.
Pineville	08/01/1999	F0	0/0	NR	A citizen near Pineville reported twin gustnadoes separated by 30 seconds, which spun up along the gust front of one of the severe thunderstorms. The wind from the gustnadoes pinned the man against the outside wall of his home, chewed up tree limbs and downed a few trees, and threw a 40 foot section of a tree over his house. A neighbor measured the wind associated with the first gustnado at 70 mph with a hand held anemometer.
14 Miles Southwest of Charlotte	09/07/2004	F2	0/0	**$150,000**	This tornado produced widespread damage to trees and power lines along its two-mile path across the southwest corner of Mecklenburg County. The roof of a well-constructed home was blown off, and several other homes incurred shingle damage. There was additional damage to automobiles and homes due to fallen trees.

[11] "NR" means "None Reported" indicating that no records exist of reported property damage. This does not exclude the possibility or probability that unreported damages did in fact occur.

Table 5.8: Tornado Events in Mecklenburg County (1950-2009)					
LOCATION	**DATE OF OCCURRENCE**	**MAGNITUDE**	**DEATHS/ INJURIES**	**PROPERTY DAMAGE**	**DETAILS**
Charlotte	03/08/2005	F1	0/0	**$50,000**	A weak tornado developed within a squall line as it moved over the Charlotte metropolitan area. The tornado developed near the intersection of 36th and North Tryon streets, where the roof of a building was torn off. In the same general area, the roofs of two trailers were partially torn off. Intermittent tree damage occurred along most of the remaining three miles of the track, with some trees falling on vehicles. At the end of the track, the roof was damaged and some windows blown out when a large oak tree fell on Cochrane Middle School. The roof cover was torn off of a business and some large pine trees and limbs were blown down just south of the school.
Mecklenburg	05/09/2008	F1	0/0	NR	A mini-supercell thunderstorm produced a tornado with a nearly 20-mile path through the Gastonia and Charlotte metro areas during the early morning hours. It produced damage to several structures in extreme eastern Gaston County before moving into Mecklenburg County, where the track became more intermittent. The public reporting several large trees blown down in the area around Woodlyn Drive in Northwest Charlotte. The path ended in the Beatties Ford Road area north of Charlotte, where an outbuilding was lifted and blown 20 to 30 feet and two large dumpsters were overturned.
TOTAL			**0/19**	**$3,906,000**	

Source: National Climatic Data Center

PROBABILITY OF FUTURE OCCURRENCES

It is likely that Mecklenburg County will continue to experience weak to moderately intense tornadoes. Based on historical data, the annual probability for tornado events (F0 to F2 intensity) across the county is estimated to be 41 percent. It is unlikely that very strong tornadoes (F3, F4 or F5) will strike the area, though it does remain possible.

WINTER STORMS

Mecklenburg County has been impacted by varying degrees of snow storms and ice storms over the last century; however, the occurrence of severe winter storms in the county is intermittent. In terms of receiving measurable snowfall, the National Climatic Data Center estimates that there is statistically an 84.9 percent probability that Mecklenburg County (Charlotte Douglas International Airport weather station) will receive measurable snowfall in any given year; an 87 percent probability in winter; and a 29.1 percent probability in spring. The month of January has the highest single probability at 54.5 percent, with February a close second (49.1 percent). December has a 23.6 percent probability of receiving measurable snowfall. Measurable snowfall has typically occurred between December and March. The snowiest winter on record was in 1960, when a cumulative total of approximately 22.9 inches of snow fell (November through April).

The primary concern with severe winter storms in Mecklenburg County is the impacts of widespread power outages (including business interruption and potential life/safety threats associated with the loss of power – most notably home heating during cold weather), as well as the negative impacts to transportation infrastructure that can cause disruptions to mobility and an increased potential for traffic accidents, a leading cause of fatalities reported for winter storm events.

SIGNIFICANT HISTORICAL EVENTS

According to the National Climatic Data Center, Mecklenburg County has experienced 38 significant winter storm events including snow and ice storms, extreme cold, and freezing rain since January 1994 (**Table 5.9**). These events account for a recorded estimate of $112 million in property damages for the affected areas, which includes multiple counties including Mecklenburg County in most instances. Mecklenburg County received presidential disaster declarations from major winter storms in 1996, 2000 and 2002. It is also important to consider that recorded property damages understate the true impact and cost to local governments wrought by severe winter storms as these figures do not include the expenses of snow removal, debris clean-up and the loss of electrical power which are often very significant.

The “1996 Blizzard” from January 6 to January 8, 1996 affected much of the eastern seaboard. In North Carolina, the winter storm claimed five deaths and left up to 30 inches of snow in portions of the state. In Mecklenburg County, rain gradually changed to freezing rain and then to snow and sleet. The layer of ice under the 3 to 4 inches of snow caused serious traffic problems. The ice accumulation caused widespread power outages around the Charlotte metro area and numerous traffic accidents were reported.

Five winter storms hit North Carolina from January 18 to January 29, 2000. More than 25 inches of snow and icy conditions were reported across central portions of the state, prompting the governor to declare a state of emergency. One state meteorologist considered the storm to be a 100-year event. Heavy snow and freezing rain were heavy enough across the southern Piedmont, including the Charlotte area, to result in a 1/4 to 1/2-inch glaze and downed trees and power lines. Nearly 127,000 people in North Carolina were without power early January 19th, with more cold weather in the forecast. Shelters were opened in Charlotte where about 40,000 people were without power and heat. Dozens of cars were stranded on a 15-mile stretch of Interstate 85. At the height of the storm, more than 399,000 North Carolina customers were without power and schools were closed across affected areas. A total of 31 counties in North Carolina including Mecklenburg County received $12 million in federal assistance for snow removal and public infrastructure recovery.

The 2002 December Ice Storm paralyzed central parts of North Carolina with ice, snow and freezing rain, leaving 1.3 million customers without power and blocking streets with snapped tree limbs. Total cleanup and response costs have been estimated at $97 million. Forty-three counties in North Carolina, including

Mecklenburg County, were declared for federal assistance. According to Duke Energy, the number of outages exceeded the power loss experienced after Hurricane Hugo hit Mecklenburg County in 1989. Of the 1.3 million customers affected, 285,000 lived in the Charlotte area with some being without power for 10 days or more. Twenty-seven patients were treated and released for carbon monoxide poisoning in the Charlotte area after bringing grills inside for use as heaters. The American Red Cross opened several public shelters, including public schools, the Charlotte Coliseum, and the Convention Center to accommodate more than 600 people in the Charlotte area. More than 100 roads, mostly residential and secondary roads, were closed or blocked because of downed power lines or debris in the roadway.

Table 5.9: Winter Storm Activity in Mecklenburg County (1998-2004)

LOCATION	DATE OF OCCURRENCE	TYPE OF EVENT	PROPERTY DAMAGE	DETAILS
Statewide including Mecklenburg County	02/10/1994	Ice Storm	NR[12]	A strong cold front brought a surge of arctic air into North Carolina on the 10th and plunged temperatures 40 to 50 degrees from readings the previous day to below freezing. Low pressure developed along the front causing widespread sleet and freezing rain across northern portions of the state. The greatest ice accumulation of 1 to 2 inches and associated damages to trees and power lines occurred in the northern Piedmont. Elsewhere in northern interior portions of the state, ice accumulations ranged from 1/4 inch to 1 inch. Numerous motor vehicle accidents were also reported.
4 Counties including Mecklenburg County	01/06/1996	Winter Storm	NR	Rain gradually changed to freezing rain and then snow and sleet across the southern Piedmont. The precipitation continued well into the next day. The layer of ice under the 1 to 2 inches of snow (3 to 4 inches in neighboring Gaston County) caused serious traffic problems. The ice accumulation was enough to cause widespread power outages around the Charlotte metro area. Across central North Carolina, numerous traffic accidents were reported. There were numerous indirect injuries and a few fatalities associated with the storm. Most injuries and deaths were traffic related.
25 Counties including Mecklenburg County	01/11/1996	Winter Storm	NR	In the Piedmont, there was more of a mixture of ice with minimal ice storm conditions reported in and around the Charlotte area. There were some power outages and numerous traffic accidents.
8 Counties including Mecklenburg County	02/02/1996	Ice Storm	**$1,250,000**	Frozen rain fell in most of the Piedmont. Bridges and overpasses quickly became icy with numerous problems reported on highways and streets. Rain was falling so heavily that not much was accumulating as ice. However, by about noon ice storm conditions began to develop quickly with numerous power outages reported. Areas west and north of Charlotte were hardest hit. Damage estimates for this major ice storm are a broad estimate and are not reliable. Road repair/cleanup costs in North Carolina exceeded $20 million. Numerous traffic accidents caused many injuries and some indirect fatalities.
14 Counties including Mecklenburg County	02/03/1996	Snow	NR	Light snow accumulated to 1 to 3 inches on top of the ice. Travel problems worsened in some places.
Mecklenburg County	02/04/1996	Extreme Cold	NR	A homeless man on the streets of Charlotte died from exposure/ hypothermia.
14 Counties including Mecklenburg County	02/16/1996	Snow	NR	Snow fell and accumulated to several inches.

[12] "NR" means "None Reported" indicating that no records exist of reported property damage. This does not exclude the possibility or probability that unreported damages did in fact occur.

Table 5.9: Winter Storm Activity in Mecklenburg County (1998-2004)

LOCATION	DATE OF OCCURRENCE	TYPE OF EVENT	PROPERTY DAMAGE	DETAILS
11 Counties including Mecklenburg County	02/13/1997	Ice Storm	NR	A winter storm brought a variety of weather woes to central North Carolina. Several inches of snow fell in parts of the Piedmont with up to 3 1/2 inches around Cherryville. In the Piedmont, the snow changed to a sleet storm during the afternoon with several inches of accumulation. Around Charlotte freezing rain during the evening caused scattered power outages.
29 Counties including Mecklenburg County	04/01/1997	Cold	NR	Several cold snaps following the relatively warm late winter caused temperatures to dip well into the 20s at times yielding substantial damage to the apple crop and perhaps to other crops.
7 Counties including Mecklenburg County	12/29/1997	Snow	NR	Snow moved north across the Piedmont during the morning and became heavy north and west of the Charlotte area before ending in the middle of the afternoon. Snowfall ranged between 1 and 4 inches across the southern Piedmont, to 4 to 8 inches across the northwest Piedmont. There were hundreds of traffic accidents.
4 Counties including Mecklenburg County	01/19/1998	Snow	NR	A wet snow fell at a steady rate early in the morning across the southern Piedmont, including the Charlotte metro area. Despite temperatures hovering just above freezing, the snow accumulated to between 1 and 3 inches.
21 Counties including Mecklenburg County	12/23/1998	Freezing Rain/ sleet	NR	Freezing rain and some sleet developed early Wednesday morning and persisted through the morning of Christmas Eve. Some areas later received enough glaze to cause damage.
2 Counties including Mecklenburg County	12/24/1998	Ice Storm	NR	Freezing rain built a glaze to damaging levels by sunrise and many power outages continued to occur until late morning. Power was not restored to some places until the next morning.
16 Counties including Mecklenburg County	02/19/1999	Snow	NR	A surface low moving across central Georgia and South Carolina combined with a strong upper level system to produce light snow across much of North Carolina during the afternoon. Most accumulations were between 1 and 2 inches.
9 Counties including Mecklenburg County	01/18/2000	Snow	NR	Low pressure moved east across Tennessee and weakened as it ran into a surface high pressure ridge along the East Coast. Enough moisture was available to cause heavy snow to fall across the northwest Piedmont. Precipitation began as light rain in the mid-evening hours on the 17th, but quickly turned to snow as the atmosphere cooled to below freezing. Snowfall ranged between 3 and 6 inches across the area by noon on the 18th, with a narrow band of 1 to 3 inches of accumulation of snow and sleet to the immediate south.
28 Counties including Mecklenburg County	01/22/2000	Heavy Snow	NR	Snow became heavy by evening across the Piedmont. Generally, 4 to 6 inches of snow fell across the Piedmont, with a local maximum of 7 inches in neighboring Lincoln County. Freezing rain and sleet mixed with the snow for a short time before the precipitation ended, and for the most part, caused little additional problems.
6 Counties including Mecklenburg County	01/24/2000	Heavy Snow	NR	Low pressure rapidly deepened near the North Carolina coast, wrapping abundant moisture back across the Piedmont. Snow fell all day and into the night, heavy at times south and east of Interstate 85. By the time snow ended, accumulations ranged from a trace to 4 inches to the immediate north and west of Interstate 85, to 4 to 8 inches in Charlotte, and 10 to 14 inches across southeastern Mecklenburg County. This storm followed no more than 36 hours after the area received several inches of snow and ice from a previous storm over the weekend.

Table 5.9: Winter Storm Activity in Mecklenburg County (1998-2004)

LOCATION	DATE OF OCCURRENCE	TYPE OF EVENT	PROPERTY DAMAGE	DETAILS
14 Counties including Mecklenburg County	01/29/2000	Ice Storm	NR	Weakening low pressure in the Ohio River Valley, developing low pressure along the Gulf Coast and cold, arctic air in place across the Carolinas resulted in a wintry mess across parts of North Carolina. This was the last in a series of five winter storms that wreaked havoc on North Carolina in an 11-day span. Across the Piedmont, precipitation that briefly began as some light sleet and snow turned quickly to freezing rain. The freezing rain was heavy enough across the southern Piedmont, including the Charlotte area, to result in a 1/4 to 1/2 inch glaze. Scattered power outages resulted. The entire Duke Power system reported 77,000 people without power.
29 Counties including Mecklenburg County	11/19/2000	Snow	NR	Light to moderate snow started in the mountains and spread southeast, lasting through the day. Generally 1 to 3 inches of snow fell.
29 Counties including Mecklenburg County	12/01/2000	Extreme Cold	NR	December 2000 will long be remembered for the brutal hold that cold weather had on the region. Temperatures ran 6 to 8 degrees below normal for the entire month. At Charlotte, it was the coldest month in 83 years.
2 Counties including Mecklenburg County	01/02/2002	Heavy Snow	NR	Heavy snow started falling early in the evening and reached heavy snowfall accumulation status between 8 p.m. and midnight in this part of the Piedmont.
7 Counties including Mecklenburg County	12/04/2002	Ice Storm	**$14,142,857**	Freezing rain began over the extreme southern mountains of North Carolina during the early afternoon on the 4th, and spread into the southwest Piedmont by mid-afternoon. Resultant damage due to ice accumulation began during the mid-to-late afternoon. The intensity of the freezing rain increased after midnight, and by sunrise on the 5th, devastating ice accumulations of 1/2 to 1 1/2 inches were observed. The hardest hit area was the Charlotte metro area. Hundreds of thousands lost power, and the outages lasted for as long as 2 weeks in some areas.
12 Counties including Mecklenburg County	01/16/2003	Winter Weather/mix	NR	Light snow fell during the evening across portions of the Piedmont of North Carolina and accumulated to 1 to 2 inches. Numerous traffic accidents were reported.
4 Counties including Mecklenburg County	01/23/2003	Heavy Snow	NR	Light snow began around midnight in the southwest Piedmont of North Carolina. A burst of heavy snow during the pre-dawn hours resulted in total accumulations of 3 to 8 inches by mid-morning.
18 Counties including Mecklenburg County	02/27/2003	Winter Weather/mix	NR	A light freezing rain developed during the overnight hours in areas from the Blue Ridge Mountains eastward to the I-77 corridor. Light ice accumulations were mainly confined to trees, bushes and automobiles. However, some slick spots did develop on bridges and overpasses, especially in the Piedmont.
12 Counties including Mecklenburg County	12/04/2003	Winter Weather/mix	NR	Light freezing rain and sleet fell for much of the day, resulting in ice accretion on trees and power lines of generally 1/8 inch or less. Some icy spots developed on bridges and overpasses.
7 Counties including Mecklenburg County	01/27/2004	Winter Weather/mix	NR	Light freezing rain developed during the early morning hours of the 27th across the southwest Piedmont. This added an additional layer of glaze to the mixture of sleet and ice that was already present. The layer of ice was as thick as 2 inches in some areas. Hundreds of traffic accidents occurred overnight and into the morning rush hour. Many of the accidents involved injuries and some fatalities. The ice was slow to melt, and traffic accidents continued for another two days.

Table 5.9: Winter Storm Activity in Mecklenburg County (1998-2004)

LOCATION	DATE OF OCCURRENCE	TYPE OF EVENT	PROPERTY DAMAGE	DETAILS
16 Counties including Mecklenburg County	02/26/2004	Heavy Snow	**$193,750**	Heavy snow began to fall across the Piedmont of North Carolina during the late morning. Although snowfall intensity decreased dramatically during the early-to-middle portion of the afternoon, heavy snow redeveloped during the late afternoon and continued into the evening and overnight hours. Scattered thunderstorms contributed to intense snowfall rates of 2 to 3 inches per hour from time to time, especially in the Piedmont, where total snowfall of 12 to 22 inches occurred. The heaviest amounts occurred in the southwest Piedmont, particularly in southern portions of the Charlotte metro area. Thousands of people were stranded on I-77 during the early afternoon, and some required rescue. The weight of the snowfall caused damage to numerous roofs, while some roofs completely collapsed.
4 Counties including Mecklenburg County	1/29/2005	Winter Storm	NR	Up to an inch of snow fell across the area during the morning, but sleet and ice made the greatest impact. Most locations received between 1/2 to 1 inch of sleet. In addition, freezing rain deposited a glaze of ice over the sleet during the afternoon and evening, creating extremely dangerous driving conditions, and numerous accidents.
7 Counties including Mecklenburg County	12/15/2005	Ice Storm	$300,000	Ice accretion began to cause damage in the northwest piedmont of North Carolina by late morning. Quite a few trees fell and power outages numbered in the tens of thousands. Several trees and large limbs fell on and damaged homes and vehicles. A 58 year-old male was killed when a tree fell through the roof of his home south of Kannapolis. Total ice accumulation ranged from a half inch or more near and west of Interstate 77 to around an eighth of an inch further east toward the Triad. Fortunately, traffic problems were few, as the temperature hovered right around freezing through the event, causing only a few slick spots.
19 Counties including Mecklenburg County	1/18/2007	Winter Weather	NR	Widespread light precipitation, mainly in the form of freezing rain, produced light ice accretion, mainly across the foothills and piedmont during the morning hours. Accretion was mainly confined to elevated surfaces, although some slick spots developed on bridges and overpasses. Quite a few traffic accidents occurred, especially in the Charlotte metro area and in the northern North Carolina foothills. A few sporadic power outages were reported.
8 Counties including Mecklenburg County	1/16/2008	Winter Weather	NR	Light snow developed across the Piedmont during mid-evening, and continued through much of the overnight hours. By mid-morning on the 17th, total accumulations ranged from around an inch south of I-85, to 3 inches or so along the I-40 corridor. Sleet and freezing rain mixed in with the snow before the event ended.
5 Counties including Mecklenburg County	1/22/2008	Winter Weather	NR	Freezing drizzle and light freezing rain developed across the western Piedmont around sunrise. Roads became very slick and hazardous, and there were numerous traffic accidents during the morning commute.
12 Counties including Mecklenburg County	1/20/2009	Winter Weather	NR	Snow developed across the foothills and western Piedmont of North Carolina. The snow continued through the overnight hours before tapering off during the morning. Total snowfall accumulations ranged from trace amounts across the North Carolina foothills, to 3 inches in the Charlotte metro area and surrounding locations.
5 Counties including Mecklenburg County	2/3/2009	Winter Weather	NR	A small area of snow developed across the piedmont during the evening, with some areas picking up a quick 2 inches before the snow tapered off.

Table 5.9: Winter Storm Activity in Mecklenburg County (1998-2004)				
LOCATION	DATE OF OCCURRENCE	TYPE OF EVENT	PROPERTY DAMAGE	DETAILS
11 Counties including Mecklenburg County	3/1/2009	Heavy Snow	NR	Rain changed to snow during the early evening across portions of the foothills and the western Piedmont of North Carolina. Snow became heavy at times throughout the evening, and up to 4 inches had accumulated across the area by 10 pm. Snow, heavy at times and accompanied by occasional lightning, continued into the late evening and early overnight hours. By the time the snow tapered off, accumulations of 3-6 inches were common across the area. However, localized amounts of up to 9 inches were reported, especially along a corridor extending from Shelby to Hickory. The heavy wet snow caused quite a few trees and power lines to fall, resulting in numerous power outages. Some structures received minor to moderate roof damage due to the weight of the snow. Some customers were without power for several days. Numerous traffic accidents also occurred.
TOTAL			**$15,629,464**[13]	

Source: National Climatic Data Center

PROBABILITY OF FUTURE OCCURRENCES

Winter storms will remain a likely occurrence for Mecklenburg County. While most storms will be more likely to produce small amounts of snow, sleet or freezing rain with minimal impacts in terms of property damage, larger storms, though less frequent in occurrence, may also occur with more significant impacts to the area.

[13] Damages are for Mecklenburg County only based on the methodological assumption that damages were equally distributed among impacted counties. While this may not produce an exact estimate of property damage within the county, it is deemed sufficient for planning purposes within this context.

EARTHQUAKES

While there are no active fault zones in North Carolina, Mecklenburg County is affected by the New Madrid (Missouri), Eastern Tennessee, Giles County, Virginia and Charleston, South Carolina Seismic Zones. During the last 200 years, major faults in both the New Madrid and Charleston seismic zones have generated earthquakes measuring greater than 8 on the Richter Scale and causing ground shaking events in Mecklenburg County.[14] **Figure 5.6** shows the location of ancient (and inactive) fault lines and the location of historical earthquake epicenters in North Carolina between 1698 and 1997. The state has had its share of earthquakes, but large, damaging seismic events are infrequent – most are relatively small, random and scattered events. Approximately two-thirds of North Carolina is subject to earthquakes, with the western and southeast regions the most vulnerable to a very damaging earthquake.

Figure 5.6: Earthquake Epicenters in North Carolina (1698-1997)

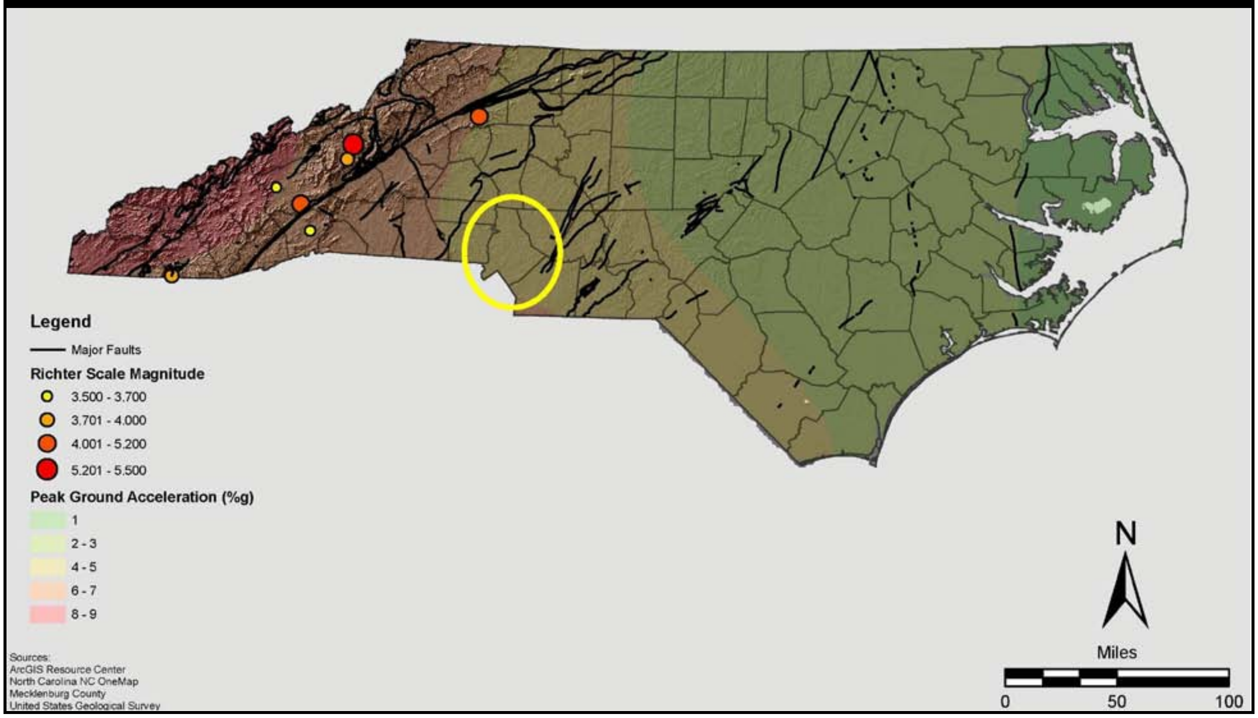
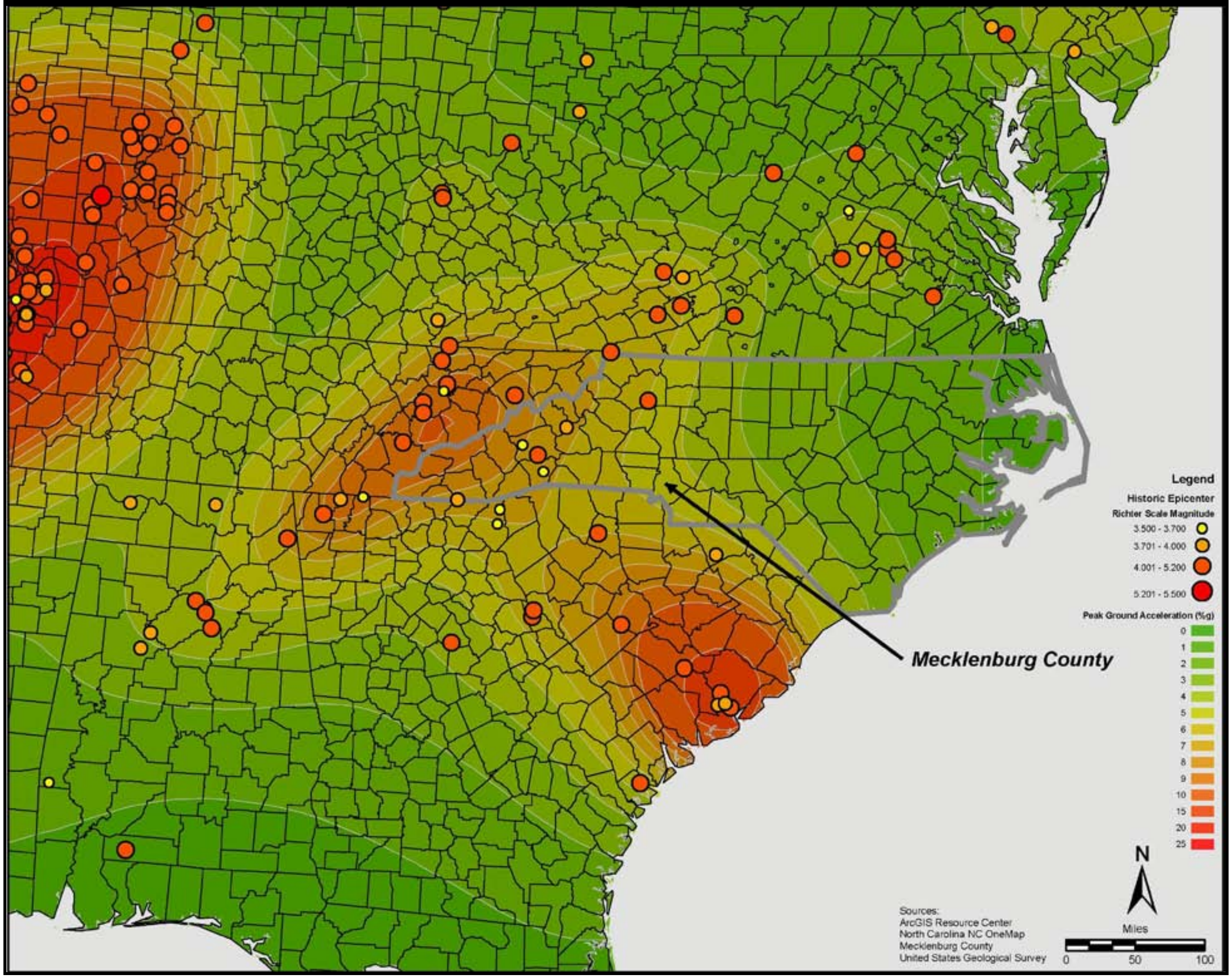


Figure 5.7 shows the earthquake intensity level associated with Mecklenburg County relative to regional hazard susceptibility, based on the national U.S. Geological Survey map of peak acceleration with 10 percent probability of exceedance in 50 years.[15] According to this data, Mecklenburg County is in a moderate risk zone, with a peak ground acceleration value (%g) of 5.

[14] Refer to the *Hazard Identification* in the preceding section for details regarding the Richter Scale and the potential damages associated with varying degrees of seismic events.

[15] This national USGS base map is presented and discussed in the *Hazard Identification* section of this Plan. The zones indicated on the Mecklenburg County map are based on and consistent with the national map.

Figure 5.7: Peak Acceleration with 10 Percent Probability of Exceedance in 50 Years



SIGNIFICANT HISTORICAL EVENTS

Table 5.10 lists the 16 significant earthquake events that have impacted Mecklenburg County as compiled from National Geophysical Data Center records for the period 1638 to 1985 according to database queries for all participating jurisdictions using "city name". This includes data on the intensity of each event as felt locally in Mecklenburg County. Of particular note, on December 13, 1879, a minor earthquake awakened residents in Charlotte, Pineville and surrounding communities, but no property damage or injuries were reported. The most severe property damage in North Carolina ever attributed to an earthquake was caused by the 1886 Charleston earthquake. Severe property damage occurred within a 160-kilometer radius of Charleston including the southeast portion of North Carolina. Several communities, including Charlotte, reportedly had chimneys thrown down, fallen plaster and cracked walls.

While not listed in the table, the great earthquakes of 1811-1812 centered on the Mississippi Valley near New Madrid, Missouri were felt throughout North Carolina. The North Carolina Geological Survey reports that MMI VI effects were observed in the western part of the state. The relatively small amount of damage in North Carolina associated with the event is attributed to the low population density of the area at that time.

Table 5.10: Significant Seismic Events in Mecklenburg County			
LOCATION	DATE OF OCCURRENCE	MMI[16]	DISTANCE FROM EPICENTER (MILES)
Charlotte	12/13/1879	5	4
Pineville	12/13/1879	5	14
Charlotte	09/01/1886	8	270
Pineville	09/01/1886	4	256
Charlotte	11/25/1898	4	N/A
Charlotte	02/21/1916	5	153
Charlotte	10/20/1924	2	162
Charlotte	11/3/1928	4	180
Charlotte	12/23/1928	3	N/A
Charlotte	07/26/1945	4	101
Charlotte	11/20/1969	5	241
Cornelius	11/20/1969	3	213
Matthews	11/20/1969	3	254
Pineville	11/20/1969	3	257
Davidson	11/22/1974	4	296
Charlotte	09/13/1976	2	152

Source: National Geophysical Data Center

PROBABILITY OF FUTURE OCCURRENCES

Earthquakes of significant magnitude are unlikely occurrences for Mecklenburg County, though the proximity of the area to major faults in several active seismic zones could increase the possibility of feeling some impact of a large, regional earthquake if it were to occur within those zones. The potential for ground shaking caused by events in these zones is well documented, and modern building codes do take them into account for today's design and construction standards. Those buildings, infrastructure and assets built long ago and not constructed to these codes are most susceptible to damage during future earthquake events.

[16] Refer to the *Hazard Identification* in the preceding section for details regarding the Modified Mercalli Intensity (MMI) scale for earthquakes.

LANDSLIDES

Figure 5.8 shows general indication of areas that may be susceptible to landslides according to the United States Geological Survey, though these geographic delineations are based on nationally mapping and not recommended for local planning or analysis purposes. More refined and detailed landslide hazard maps are produced for North Carolina communities through the North Carolina Geological Survey (NCGS), however to date Mecklenburg County has not been studied.[17] While better local spatial data on landslide hazards is not currently available for Mecklenburg County, it is assumed that minor landslide events are possible in localized, steep-sloped areas during extremely wet conditions.

According to NCGS, landslides are most common in the mountain region of North Carolina because of steep slopes. The Piedmont and Coastal Plain regions also have landslides that are commonly related to human activity such as making a road cut too steep. Large rainstorms, hurricanes, freeze-thaw processes and human activities all can trigger landslides.

SIGNIFICANT HISTORICAL EVENTS

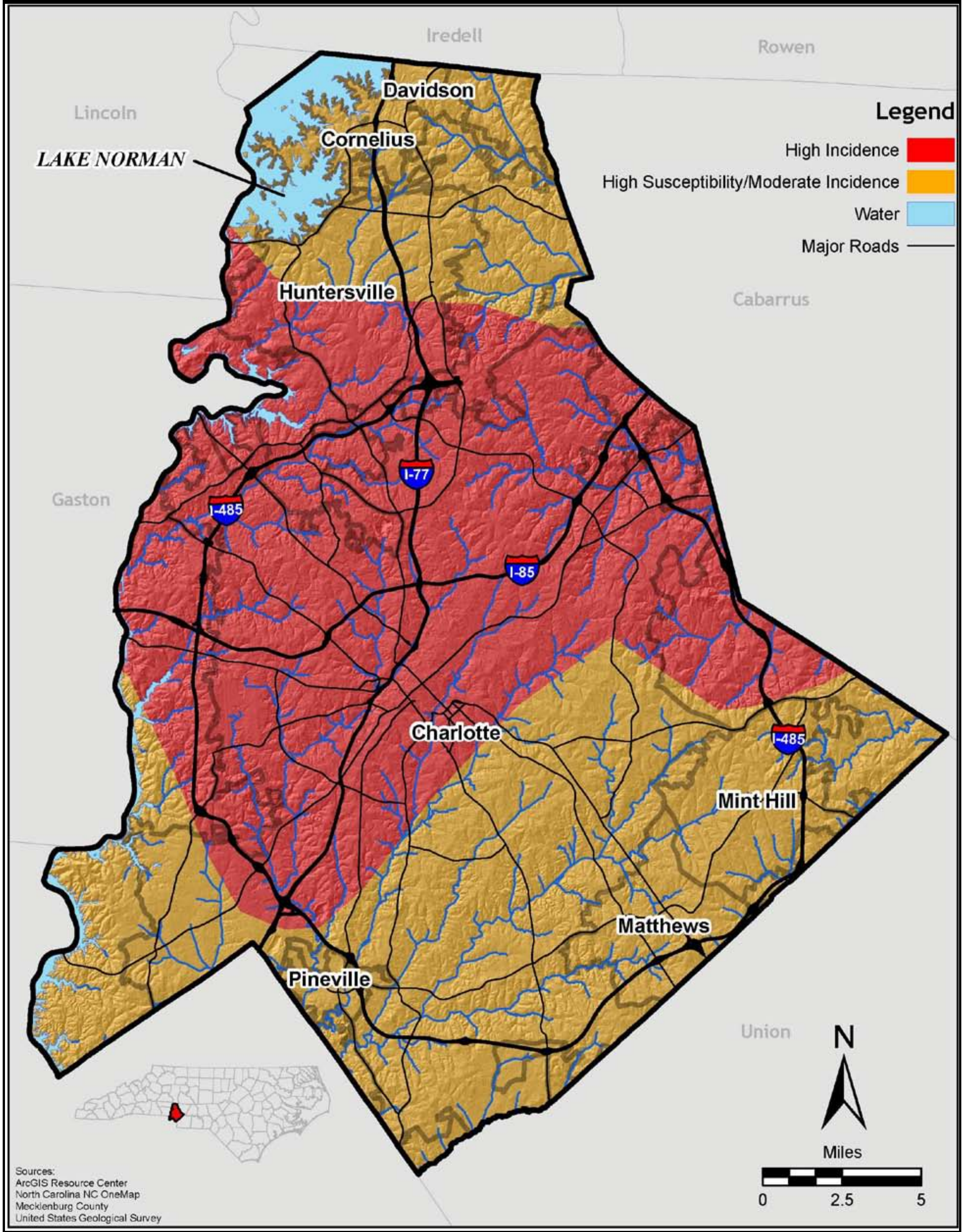
There is no history of significant landslide events in Mecklenburg County.

PROBABILITY OF FUTURE OCCURRENCES

Landslides remain a possible occurrence in localized areas of Mecklenburg County, but impacts from such events would likely cause minimal localized damage.

[17] NCGS has focused their landslide hazard mapping efforts on counties with a more significant risk and history of landslide occurrence including Buncombe, Macon and Watauga.

Figure 5.8: Landslide Incidence and Susceptibility



SINKHOLES

Existing soil types in Mecklenburg County are not conducive to the formation of natural sinkholes. There is a higher potential for soil piping and/or erosion caused by leakage from drainage pipes, collapsed water mains or sewer lines, failed culverts and the effects of other human infrastructure activity.

SIGNIFICANT HISTORICAL EVENTS

Mecklenburg County has experienced minor sinkhole activity in the past; however, these events are very uncommon occurrences and very few have caused any reported property damages. The most recent significant incident was reported in June 2003 when heavy rain formed a 150-foot wide sinkhole in the parking lot of a hotel located on Independence Boulevard. A giant steel pipe could not hold all the rainwater from heavy rain and the pipe gave way and the parking lot collapsed. It caused damages to a passenger car and resulted in approximately $500,000 in repair costs. According to the county engineer, sinkholes of that magnitude are very uncommon. However, many pipes underneath the ground could form cracks due to age and over time leaks could erode the dirt and soil around it.

PROBABILITY OF FUTURE OCCURRENCES

Sinkholes remain a possible occurrence in localized areas of Mecklenburg County, though primarily as caused by human activity versus a naturally occurring event. This is particularly the case in areas of the county with older water and sewer lines that are prone to possible leakage or collapse, though Charlotte-Mecklenburg Utility crews continuously examine underground pipes for problems and spend approximately $15 million each year to maintain and repair water and sewer lines. Impacts from such events would likely cause minimal localized damage, though potentially significant service interruptions caused by infrastructure damage and road closures.

DROUGHT

According to the Palmer Drought Severity Index (PDSI) illustrated in Section 4: *Hazard Identification* (Figure 4.4), Mecklenburg County is located in a region that experienced severe drought conditions less than 10 percent of the 100-year period during 1895 to 1995, meaning that severe long-term drought conditions are a relatively low probability event for Mecklenburg County. However, based on historical event data, shorter term droughts of less severity are more common and may occur several times in a decade.

While Mecklenburg County doesn't have nearly the amount of agriculture-based businesses as other counties in North Carolina, the regional impacts of long-term drought conditions are felt locally. In addition to the negative effects on agriculture, lower lake levels, reduced streamflows and decreases in groundwater supply can result in the drying up of wells and often necessitate mandatory water restrictions for all areas of the county, including those urbanized communities.

SIGNIFICANT HISTORICAL EVENTS

In recent years, all of western North Carolina has experienced severe to extreme drought conditions. Since 1998, the National Climatic Data Center has recorded 34 instances of drought in Mecklenburg County (**Table 5.11**).[18] Though instances are recorded on a monthly basis by the National Climatic Data Center, events are usually part of ongoing drought conditions that last several months or years. This was certainly the case for Mecklenburg County which endured what can be classified as multiple drought periods in 1998-2002 (severe to extreme), Spring 2004 (moderate), and 2007-2008 (severe to extreme). None of these events resulted in any deaths or injuries, and no damages to property or crops were recorded for Mecklenburg County.[19] However, according to some NCDC reports, agricultural and other losses attributed to the long-term drought in western North Carolina are estimated to be in the hundreds of millions of dollars. In addition, these droughts resulted in near record lows for stream flows, reservoirs and groundwater levels and the implementation of mandatory water restrictions across the area.

Of particular note, Mecklenburg County received a USDA agricultural disaster declaration in July 2002 along with 72 other counties in North Carolina due to long-term drought conditions. According to the North Carolina Department of Agriculture (NCAGR), agricultural losses exceeded a total of $170 million for the state. The NCAGR estimated that crop losses in some of the affected counties were as high as 75 to 80 percent. This agricultural disaster declaration makes farmers eligible for USDA low interest emergency farm loans. Lastly, according to the National Climatic Data Center, there have been no occurrences of prolonged extreme heat events in Mecklenburg County that are sometimes a hazardous element of drought conditions.

[18] Drought occurrences recorded by the National Climatic Data Center are not necessarily unique events, as many instances of drought persist through multiple reporting periods. This is reflected in the details provided for some long-enduring occurrences in Table 5.11.
[19] While no injuries or crop damages have been reported to the NCDC, this does not necessarily mean that they did not occur. For example, the USDA disaster declaration data that follows provides another means to measure the impact of drought-related damages.

Table 5.11: Occurrences of Drought in Mecklenburg County (1998-2004)		
LOCATION	DATE OF OCCURRENCE	DETAILS
Countywide	07/01/1998	Dry weather continued through much of the month of July, affecting crops during the critical part of the growing season. Corn and other vegetables sustained the most damage, but a dollar amount was not available at the time of this writing.
Countywide	10/01/1998	The drought that began during the summer continued through October. The only significant rainfall during the month occurred on the 7th and 8th. Cities and counties began to restrict water usage and stream flows for several mountain locations were reduced to the lowest seen in 50 years.
Countywide	11/01/1998	Dry weather persisted into the late fall with rainfall deficits between 5 and 10 inches. This affected late season crops and caused water shortages. Water usage restrictions were initiated in many communities.
Countywide	07/01/1999	A long-term dry spell became a drought in July. Without any widespread rain events, the only relief came in the form of rare, widely scattered afternoon and evening thunderstorms. The lack of rainfall lowered water tables significantly and significant damage to crops began to occur. The northwest Piedmont was affected first, followed by the southern Piedmont.
Countywide	08/01/1999	The drought worsened during the month of August as high evaporation rates and little rainfall occurred. The most severe conditions by the end of the month had developed in the Piedmont. Water restrictions began in several communities, and for some, the first time in memory. Hay and late crops dried up in many counties. Ponds and wells began to dry up as well, affecting homeowners, farmers and businesses such as nurseries. In addition, boaters were running aground on recreational lakes due to low water levels.
Countywide	09/01/1999	Rainfall continued to be scarce across portions of North Carolina through the month of September, prolonging the drought conditions that existed all summer. However, some areas in the Piedmont picked up some rain from the remnants of Hurricane Dennis early in the month and from Hurricane Floyd itself two weeks later. Although this rain brought some relief, more wells ran dry and many more areas began mandatory water restrictions.
Countywide	10/01/1999	The return of some rainfall as well as lower evaporation rates due to the change of seasons resulted in the drought easing somewhat. Drought classifications were lowered in some cases, and some jurisdictions lifted water restrictions. However, the drought had not ended by the end of the month.
Countywide	08/01/2000	The two-year drought was reaching a critical stage by late summer. Many 80 to 100-foot wells were going dry. Area lakes were at record low levels causing property damage to docks, boats, etc.
Countywide	09/01/2000	Overall, drought conditions continued across portions of North Carolina despite some locations receiving near their month's average rainfall. Low stream flow and municipal water supply remained the largest issues with many cities and towns enacting water restrictions. Citizens were quoted as saying this is the driest they had ever seen it. Despite the drought conditions, impact on crops seemed to be minimal.
Countywide	10/01/2000	Effects of the drought intensified, as many areas received absolutely no rain during the month setting records for the longest stretch without measurable rainfall in several locations. Wells and some streams continued to dry up and lake levels continued to drop. Many communities were forced to start more stringent water conservation measures.
Countywide	11/01/2000	The long-term drought continued to affect the region. Rainfall during the month was near or slightly above normal, but this had little effect on the ground water levels. Numerous wells dried up during the fall, and well borers and drillers could not keep up with the demand. Large lakes reported record low levels and some communities continued or initiated water control measures.
Countywide	02/01/2001	The long-term drought's impact became more severe, even during the winter, as water levels in lakes dropped and stream flow on rivers reached the lowest in memory. More and more communities began water restrictions and started preparing for a busy fire weather season.
Countywide	03/01/2001	Despite beneficial rain during March, the drought continued to grip most of the area. Severe water restrictions were implemented in parts of the Piedmont, where reservoirs had dropped to all-time low levels.
Countywide	04/01/2001	Some relief to the long-term drought occurred at mid-month, but for the most part, the rainfall deficit for the three-year period actually grew larger by the end of April. Mandatory water restrictions continued at some locations, with voluntary water restrictions urged at many others. Numerous wells went dry during April.

Table 5.11: Occurrences of Drought in Mecklenburg County (1998-2004)		
LOCATION	**DATE OF OCCURRENCE**	**DETAILS**
Countywide	05/01/2001	Unprecedented drought conditions continued. Some rivers and lakes reached record-low levels. Well-drilling companies in the Piedmont were recording twice as much business as usual.
Countywide	08/01/2001	The effects of the long-term drought became more severe, especially in the Piedmont. Critical water conditions were beginning to concern officials and residents of Charlotte.
Countywide	11/01/2001	Drought was again the major concern during November. An extended short-term dry spell exacerbated the 3.5-year drought, beginning in mid October and persisting through late November. During that stretch of weeks, many areas received no measurable rainfall. Toward the end of the month, wildfires became common, burning many acres especially in the higher terrain. Extremely low lake levels affected boating and water supplies. The Piedmont had received about half the normal rainfall for the calendar year by the end of November. Many additional wells and ponds dried up, tree farms closed and many communities began or expanded water restrictions. Streams were observed with record low flow levels.
Countywide	12/01/2001	Very little active weather during December signaled that the drought was still present—and becoming critically important to more and more people. The Charlotte area recorded an all-time record dry calendar year with just 26.23 inches of rainfall during 2001. Records have been kept in the area since 1878. Many communities initiated either mandatory or voluntary water restrictions.
Countywide	08/01/2002	The water supply situation reached crisis levels in some communities, as the effects of the long-term drought continued to plague North Carolina. Particularly hard hit were several Piedmont communities along the Interstate 77 corridor. Water levels on area lakes were as much as 10 feet below full pond. Most of the larger cities and towns along the I-77 corridor had imposed mandatory water restrictions by the end of the month, including the Charlotte metro area.
Countywide	5/1/2004	A period of dry weather that began in August of 2003 resulted in moderate drought conditions across portions of western North Carolina by late spring of 2004. Streamflow and lake levels began to run below normal, and a few communities instituted water restrictions.
Countywide	5/1/2007	The effects of an extended period of dry weather were exacerbated by an abnormally dry May, with many locations reporting one of the driest Mays in recorded history. By the end of May, many climatological stations were reporting yearly rainfall deficits as high as 10 inches. The result was severe to extreme drought conditions across much of western North Carolina by the end of the month. Water restrictions were implemented in some counties across extreme western North Carolina. The very dry conditions added to agriculture hardships caused by a hard freeze and widespread damaging winds in April.
Countywide	6/1/2007	Despite an increase in thunderstorm activity, drought conditions persisted across much of western North Carolina. The persistent drought continued to cause hardships to agricultural interests that were still recuperating from the April freeze.
Countywide	7/1/2007	Drought conditions persisted across much of western North Carolina during July. By the end of July, voluntary water restrictions were instituted in almost all North Carolina counties along and west of I-77. Agricultural interests continued to be especially hard hit. The absence of rain negatively affected the hay crop, creating concern for the loss of livestock.
Countywide	8/1/2007	Severe to extreme drought conditions persisted across much of western North Carolina during August. Stream flows and groundwater levels approached record low levels. Water levels on some reservoirs decreased by as much as 1 foot every 10 days. Agricultural interests continued to be especially hard hit, and the North Carolina governor requested federal disaster aid by the end of the month.
Countywide	9/1/2007	Extreme drought conditions persisted across western North Carolina through September, as the region experienced another month of well-below normal precipitation. By the end of the month, most locations were running a yearly rainfall deficit of 11-17 inches. Stream flows and groundwater levels were near record low levels, with many streams running at 5 percent or less of normal flow. Water levels on area reservoirs were some of the lowest in recorded history. Agricultural interests continued to be especially hard hit. Farmers continued to struggle to feed livestock due to a lack of hay and poor pasture conditions, forcing many cattle to be sold or slaughtered. Agricultural and other losses attributed to the drought are estimated to be in the hundreds of millions of dollars.

Table 5.11: Occurrences of Drought in Mecklenburg County (1998-2004)

LOCATION	DATE OF OCCURRENCE	DETAILS
Countywide	10/1/2007	Unusually dry weather continued across western North Carolina through October. Although a soaking rain near the end of the month resulted in near-normal monthly precipitation for the mountains, the piedmont saw another month of well-below normal rainfall. Most areas were on pace to break yearly rainfall deficit records. By the end of the month, exceptional drought conditions were reported across the majority of the area. Water flow on area streams continued at 3 to 6 percent of normal, while lake levels remained at near-record lows. Although most cities and towns were requesting voluntary water restrictions be observed, mandatory restrictions were ordered in quite a few communities. Also, private wells were beginning to dry up in many areas. Agriculture continued to be severely impacted by the drought.
Countywide	11/1/2007	November provided no relief from the effects of the long term drought. Many locations remained on pace to set annual records for rainfall deficit. By the end of the month, the vast majority of the region was experiencing exceptional drought conditions. Streamflow on area rivers remained extremely low, generally less than 10 percent of normal. Meanwhile, lakes continued to gradually fall toward record low levels.
Countywide	12/1/2007	The latter half of December saw a transition to a wetter pattern across the southeast. Most observing stations in western North Carolina reported above normal monthly rainfall for the first time since January 2007. However, this was not enough to put much of a dent in the long-term drought as extreme to exceptional drought conditions persisted into the New Year. Although the increase in rainfall did allow for some recharge of area streams, many were still running at less than 25 percent of normal flow at the end of the month.
Countywide	1/1/2008	January saw a return to dry weather across western North Carolina. Most observing stations across the region reported a rainfall deficit of 1 to 2 inches during the month, resulting in another month of exceptional drought conditions across most of the area. Water levels on area lakes remained within a foot or two of record low stages. However, rivers and streams remained somewhat recharged from the December rains, with streamflow on most waterways running 25 to 75 percent of normal.
Countywide	6/1/2008	Although near normal rainfall was observed across much of the area during the late winter and early spring, another period of abnormally dry weather in May and June exacerbated severe to extreme drought conditions over the western Carolinas and northeast Georgia. Much of the area saw less than 2 inches of rain during this period of time. By the end of the month, much of the mountains and foothills of western North Carolina were running 10 inches below normal annual rainfall. Total rainfall deficits since the beginning of 2007 were around 20 inches or more in the hardest hit areas. By the end of the month, flow on almost all major streams was running less than 10 percent of normal. Many area crops suffered.
Countywide	7/1/2008	Unusually dry weather continued through the month of July, with severe to extreme drought conditions persisting across the area. Afternoon and evening thunderstorms provided some degree of relief across portions of the North Carolina piedmont, but locations across Upstate South Carolina and extreme western North Carolina reported annual rainfall deficits of nearly 11 inches by the end of the month. Mandatory water restrictions were instituted across much of the North Carolina foothills. Water well levels began to descend below record low levels, most of which were recorded during the 1999-2002 drought. The vast majority of major streams across the area continued to run 1-10 percent of normal flow. Agriculture continued to be hard hit, with some areas reporting a 100 percent loss of the corn crop.

Table 5.11: Occurrences of Drought in Mecklenburg County (1998-2004)		
LOCATION	DATE OF OCCURRENCE	DETAILS
Countywide	8/1/2008	Dry weather persisted across much of the area for most of August, although portions of the North Carolina Piedmont began to see relief from the dry conditions early in the month, due to an increase in daily thunderstorm activity. Elsewhere, exceptional drought conditions persisted and even expanded slightly westward to cover more of far western North Carolina and northeast Georgia. During the early part of the month, flows on most of the major streams across the area were running at record low levels, with the French Broad River setting a minimum flow record that had stood for almost 100 years. Only a handful of streams were running at more than 1 to 7 percent of normal. Groundwater levels were 2-5 feet below normal. Significant agricultural impacts persisted, with losses to summer crops, including hay, estimated at 30%. The dry weather also affected the livestock industry, due to shortages of pasture crops necessary for feeding. By the end of the month, Tropical Storm Fay had dropped up to 11 inches of rainfall across the area, providing some relief from the drought conditions, especially across the North Carolina Piedmont.
Countywide	9/1/2008	The heavy rain brought by Tropical Storm Fay in late August provided some relief to the drought conditions across the area. This was particularly true across the North Carolina piedmont, where improving conditions were aided by normal September rainfall. However, another dry month resulted in a persistence of extreme to exceptional drought conditions across the North Carolina mountains and foothills. Voluntary water restrictions remained widespread during the month. A few communities held onto mandatory restrictions early in the month, but many of these were lifted by the end of the month. Well water remained near record low levels in many areas, while lake levels persisted well below normal stages. Rainfall from Fay resulted in some improvement in streamflows, although most rivers and major streams remained at less than 25 percent of normal, with many still running at less than 10 percent of normal. By the end of the month, government officials had requested a federal disaster declaration for most of the counties in the area due to crop damages.

Source: National Climatic Data Center

PROBABILITY OF FUTURE OCCURRENCES

Based on current and seasonal outlook drought maps available through the National Weather Service's Climate Prediction Center and the National Drought Mitigation Center[20], there is no concern for imminent or forecasted drought occurrences. However, based on past events, it certainly remains likely over the long-term that Mecklenburg County will experience recurring drought conditions when precipitation falls below normal for extended periods of time. Based on climate data, Mecklenburg County will likely continue to experience occasional periods of extreme heat, but not nearly as severe as other regions of the country. It is estimated that the annual probability of severe to extreme drought conditions for the area is less than 10 percent.

[20] Current and seasonal drought outlook maps are made available by the National Drought Mitigation Center at www.drought.unl.edu/dm/index.html.

WILDFIRE

According to the North Carolina Division of Forest Resources (NCDFR), Mecklenburg County contains 337,773 acres of land, of which 85,800 acres are classified as forest. This is a notable decrease in forestland from the nearly 133,000 acres reported in 2004. Approximately 78 percent of the total timberland is privately owned with the remaining 22 percent being owned by Mecklenburg County or its incorporated municipalities.

In an effort to map potential wildfire hazard areas in Mecklenburg County, a GIS-based data layer called the "Wildland Fire Susceptibility Index" (WFSI) was obtained from NCDFR. The WFSI is a component layer derived from the Southern Wildfire Risk Assessment (SWRA), a multi-year project to assess and quantify wildfire risk for the 13 Southern states. The Wildland Fire Susceptibility Index (WFSI) is a value between 0 and 1. It was developed consistent with the mathematical calculation process for determining the probability of an acre burning. The WFSI integrates the probability of an acre igniting and the expected final fire size based on the rate of spread in four weather percentile categories into a single measure of wildland fire susceptibility. Due to some necessary assumptions, mainly fuel homogeneity, it is not the true probability. But since all areas of the Mecklenburg County have this value determined consistently, it allows for comparison and ordination of areas of the county as to the likelihood of an acre burning. **Figure 5.10** illustrates the level of wildfire potential for Mecklenburg County based on the WFSI data provided by NCDFR.

SIGNIFICANT HISTORICAL EVENTS

According to the most recent wildfire statistics made available through NCDFR, Mecklenburg County experiences an average of 37 wildfire events per year, the majority of which are caused by "miscellaneous" or undetermined reasons. The leading cause of wildfires in North Carolina is debris burning, but much less so in Mecklenburg County due to strong local ordinances which severely restrict outdoor burning. Minor property damages generally amounting to less than $10,000 per year have been recorded as resulting from wildfire events, though occasionally, and especially during periods of severe to extreme drought, more severe damages result as was the case in 2008 with an estimated $1.6 million in property damages. **Table 5.12** shows the causes of historical occurrences of wildfire events in Mecklenburg County and a five-year average as updated by NCDFR in 2008. **Table 5.13** provides wildfire statistics for Mecklenburg County for the past ten years as reported by NCDFR, including the number of fires, acreage burned and total property damages. No additional information on these events was made available through NCDFR.

Table 5.12: Causes of Wildfire Occurrences in Mecklenburg County

CAUSE OF FIRE	NUMBER OF OCCURRENCES IN 2008	FIVE-YEAR AVERAGE
Lightning	3	1
Campfire	2	2
Smoking	9	5
Debris Burning	2	2
Incendiary	11	5
Machine Use	8	5
Railroad	3	1
Children	9	5
Miscellaneous	25	11
TOTAL	**72**	**37**

Source: North Carolina Division of Forest Resources, 2008

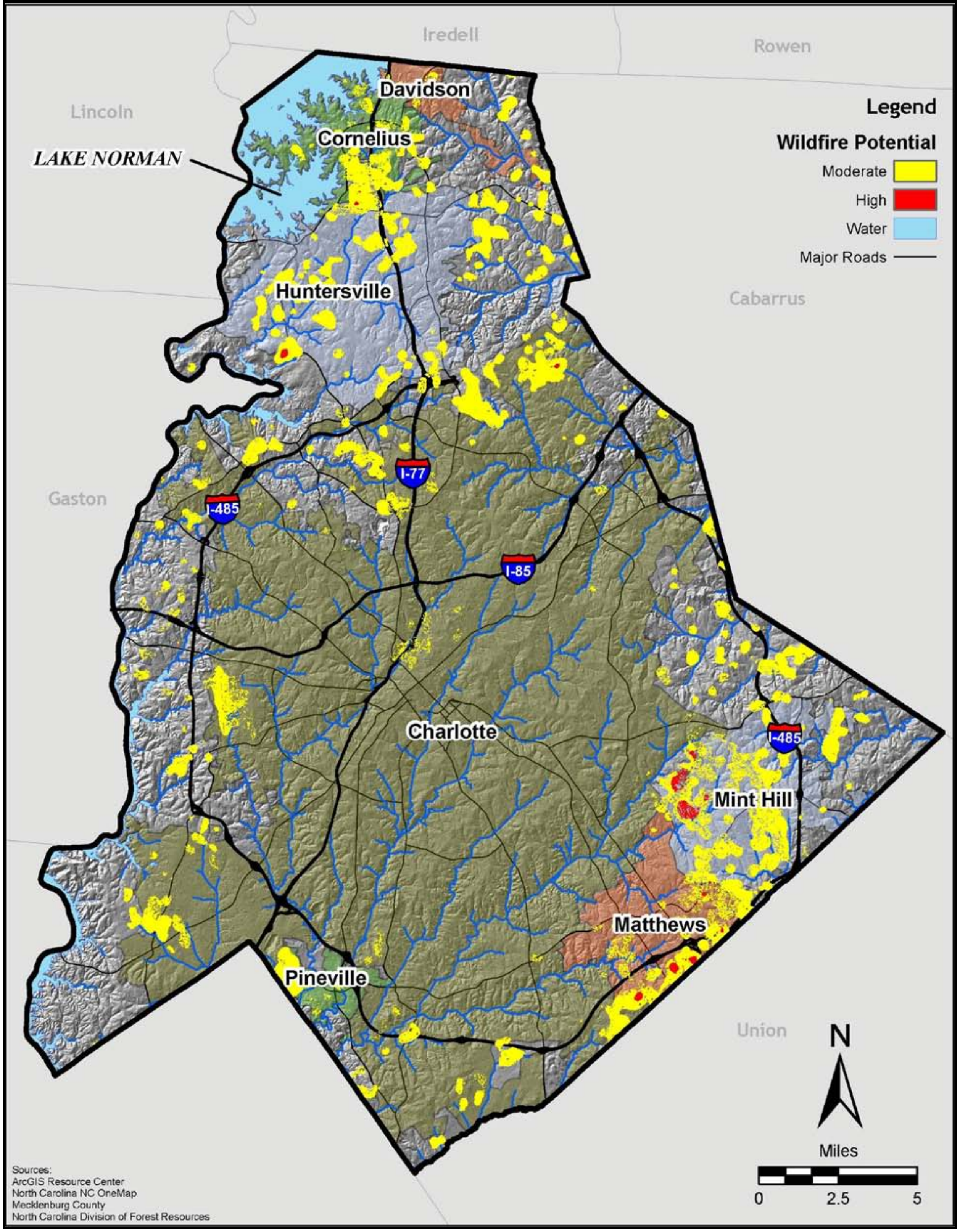
Table 5.13: Wildfire Statistics for Mecklenburg County (2000-2009)			
YEAR OF EVENT	NUMBER OF FIRES	ACREAGE BURNED	PROPERTY DAMAGE
2000	45	40.6	$6,100
2001	47	94.4	$18,600
2002	43	40.6	$2,350
2003	17	6.9	$0
2004	17	11.7	$0
2005	16	8.7	$11,000
2006	25	14.8	$5,500
2007	59	61.5	$11,000
2008	72	51.8	$1,600,000
2009	49	17	$22,025
TOTAL	**390**	**348**	**$1,676,575**

Source: North Carolina Division of Forest Resources, 2009

PROBABILITY OF FUTURE OCCURRENCES

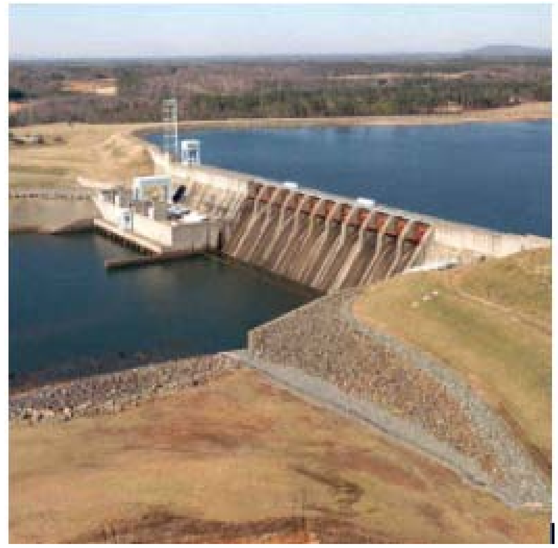
Wildfires remain a highly likely occurrence for Mecklenburg County (100% annual probability), though most will likely continue to occur in less urbanized areas and be small in size before being contained and suppressed.

Figure 5.10: Areas of High and Moderate Wildfire Potential



DAM/LEVEE FAILURE

According to the National Inventory of Dams maintained by the U.S. Army Corps of Engineers[21], there are five major dams located in Mecklenburg County (**Table 5.14**). Major dams are defined as dams being 50 feet or more in height, or with a normal storage capacity of 5,000 acre-feet or more, or with a maximum storage capacity of 25,000 acre-feet or more. Of the five major dams located in the county, four are classified as "high" hazards where failure or mis-operation of the dam will probably cause loss of human life. It is important to note that these hazard classifications are not related to the physical condition or structural integrity of the dam (nor the probability of its failure) but strictly to the potential for adverse downstream effects if the dam were to fail.



The Cowans Ford Dam created the largest manmade body of fresh water in North Carolina when it dammed the Catawba River in 1963. (Photo courtesy of Duke Energy)

The state regulatory agency for dams is the North Carolina Department of Environment and Natural Resources, Division of Land Resources. In addition to the five major dams listed in the National Inventory of Dams, this agency tracks and regulates a number of other smaller dams (such as farm pond impoundments, etc.) that present less severe hazard threats. According to their database there are 195 state-regulated dams[22] located in Mecklenburg County, of which 69 have been classified as "high" hazard dams where in the event of a dam failure there is a probability of at least one death and more than $200,000 in economic damages. According to the Charlotte-Mecklenburg Emergency Management Office and a review of the National Inventory of Dam Performance (NPDP) database, there is no record of failure for any of these state-regulated dams.

Table 5.14: Major Dams in Mecklenburg County

NAME OF DAM	HAZARD CLASSIFICATION	YEAR BUILT	NORMAL STORAGE (ACRE FEET)
Cowans Ford	HIGH	1963	1,028,307
Mountain Island	HIGH	1923	45,970
250 MG Raw Water Reservoir	HIGH	1990	0
Hicks Crossroad Dike	HIGH	1963	1,028,307
McGuire Standby Nuclear Service Water	LOW	1981	578

Source: National Inventory of Dams

[21] The National Inventor of Dams was developed by the U.S. Army Corps of Engineers in cooperation with FEMA's National Dam Safety Program. The full inventory contains over 75,000 dams, of which 7,700 are classified as major, and is used to track information on the country's water control infrastructure.

[22] State-regulated dams include any dam structure greater than 15 feet in height or that has an impoundment capacity of greater than 10 acre-feet, along with any dam in which failure could result in loss of human life or significant damage below the dam. Exempt dams include those constructed by the United States government or licensed by the Federal Energy Regulatory Commission, as well as those in connection with electric generating facilities under the jurisdiction of the North Carolina Utilities Commission.

Figure 5.11 shows the location of all major and state-regulated dams in Mecklenburg County, and notes which of those are classified as high, intermediate and low hazard. The Charlotte-Mecklenburg Emergency Management Office also maintains inundation maps that were prepared based on computer-simulated dam failure scenarios by Duke Energy, the owner and operator for the major hydroelectric dams in Mecklenburg County (Cowans Ford and Mountain Island). These inundation maps are currently not yet digitally referenced and are therefore not included in the GIS-based risk assessment for Mecklenburg County, but it is expected that they may be in future Plan updates – particularly if dam/levee failure is determined to be a high or moderate risk hazard through future updates to this assessment.

The Mountain Island Dam. (Photo courtesy of Duke Energy)

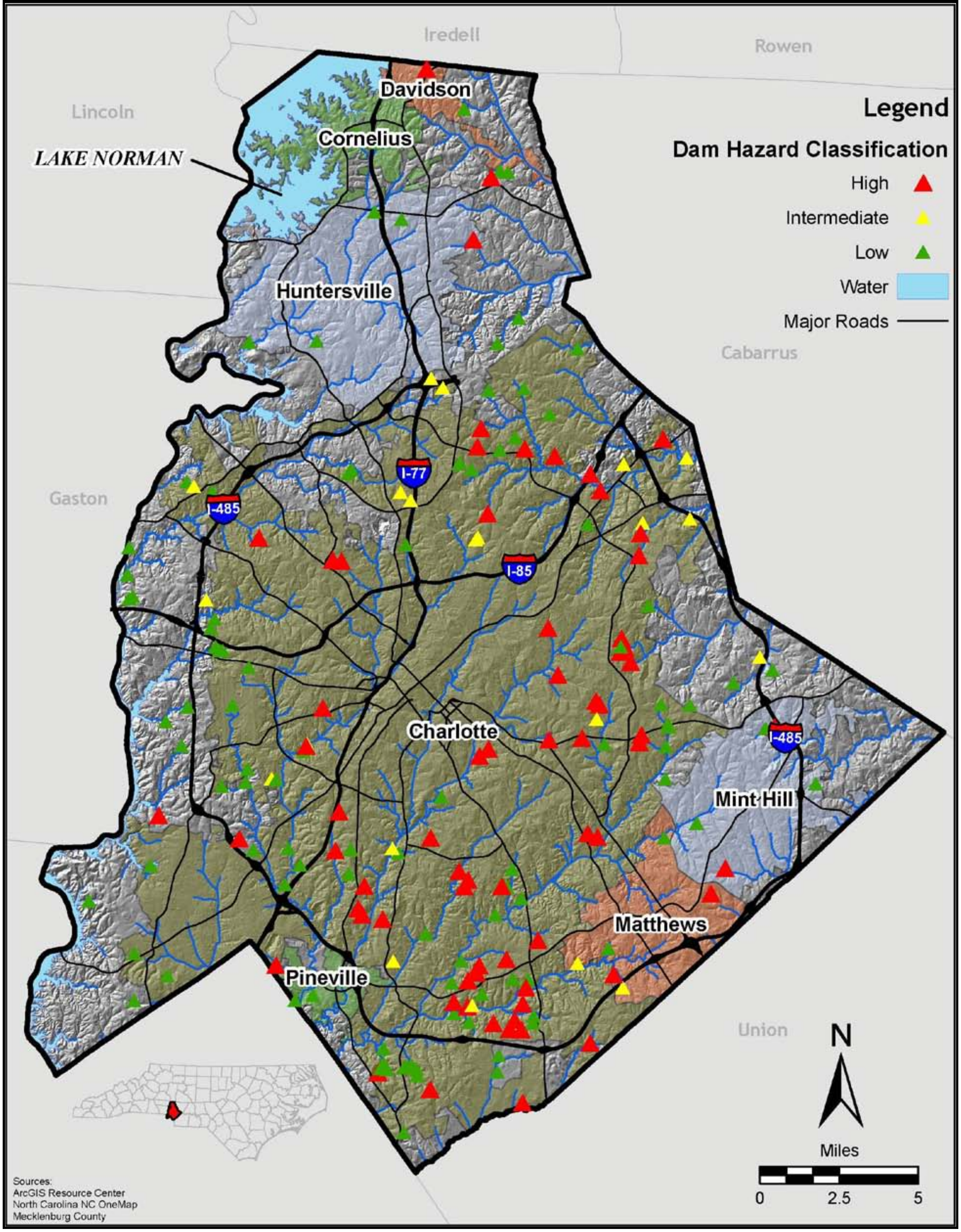
SIGNIFICANT HISTORICAL EVENTS

There is no record of any damages, deaths or injuries associated with dam failure in Mecklenburg County. However, in September of 2004 the torrential rains from the combined remnant effects of hurricanes Ivan and Frances forced Duke Energy to release flows through the Cowans Ford dam, resulting in the overtopping of the Mountain Island dam further downstream (there is no controlled spillway for the Mountain Island dam). This overtopping caused moderate flooding of areas immediately below the dam, including an approximately one-mile stretch of residential properties (an estimated 50-70 homes were affected in the vicinity of Riverside and Lake Drives). More recent heavy rain and localized flood events in the area have created the need for Duke Energy and Charlotte-Mecklenburg Emergency Management to update their plans and procedures for issuing notifications and evacuation orders for these same areas, including the use of Charlotte-Mecklenburg's Reverse 911® system.

PROBABILITY OF FUTURE OCCURRENCES

Dam failure remains an unlikely occurrence for all major and state-regulated dams in Mecklenburg County. The North Carolina Department of Environment and Natural Resources, Division of Land Resources is tasked with monitoring the routine inspection and maintenance of those dams that present the greatest risk or are in need of structural repair. Further, Duke Energy routinely monitors and inspects the major hydroelectric dams located in the county, and maintains the capabilities to control lake levels and the flows running through its dams on a routine basis. These activities are done so in coordination with Charlotte-Mecklenburg County Emergency Management Office.

Figure 5.11: Location of Dams in Mecklenburg County



DATA SOURCES

The following primary data sources were among those used to collect the information presented in this section.

- *American Society of Civil Engineers (ASCE), "Facts About Windstorms"*
  (www.windhazards.org/facts.cfm)
- *Bureau of Reclamation, U.S. Department of the Interior*
  (www.usbr.gov/)
- *Charlotte-Mecklenburg, Emergency Management/Homeland Security*
  (www.charmeck.nc.us)
- *Federal Emergency Management Agency (FEMA)*
  (www.fema.gov)
- *Jay Barnes, North Carolina's Hurricane History, 1998*
- *Lin Cao, Wei-Ning Xiang, and Joseph C. Wilson, Department of Geography and Earth Sciences University of North Carolina at Charlotte*
  (www.lightningsafety.com/nlsi_lhm/GIS_study.html)
- *National Climatic Data Center (NCDC), U.S. Department of Commerce, National Oceanic and Atmospheric Administration*
  (http://lwf.ncdc.noaa.gov/oa/ncdc.html)
- *National Drought Mitigation Center, University of Nebraska-Lincoln*
  (www.drought.unl.edu/index.htm)
- *National Geophysical Data Center*
  (www.ngdc.noaa.gov)
- *National Hurricane Center, National Oceanic & Atmospheric Administration (NOAA)*
  (www.nhc.noaa.gov)
- *National Lightning Safety Institute*
  (www.lightningsafety.com)
- *National Severe Storms Laboratory (NSSL), U.S. Department of Commerce, National Oceanic and Atmospheric Administration*
  (www.nssl.noaa.gov)
- *National Weather Service (NWS), U.S. Department of Commerce, National Oceanic and Atmospheric Administration*
  (www.nws.noaa.gov)
- North Carolina Geological Survey
  (www.geology.enr.state.nc.us)
- *Storm Prediction Center (SPC), U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service*
  (www.spc.noaa.gov)
- *The Tornado Project, St. Johnsbury, Vermont*
  (www.tornadoproject.com)
- *United States Geological Survey (USGS), U.S. Department of the Interior*
  (www.usgs.gov)
- *WCNC.com, Belo Interactive, Inc.*
  (www.wcnc.com)
- *WRAL News, Capitol Broadcasting Company*
  (www.wral.com)