

## Appendix B: Assessment of Vulnerability

### **A. Introduction**

The Wake County Composite Hazard Index (Table A-27 in Appendix A) outlines the six hazards rated “moderate” or “high” for potential threat to persons and property. Three of these hazards – droughts and heat waves, hurricanes and coastal storms, and winter storms and freezes – typically have a regional impact; however, the impact of droughts and heat waves on an urbanized area such as Wake County would be considered negligible as compared to rural, agrarian communities. Based on hazard event history, it is estimated that the county as a whole and Wake Forest, specifically, have a maximum 100% exposure to hurricanes and coastal storms and to winter storms and freezes. A 100% exposure means that all structures both public and private within the county and town could possibly be impacted by these types of hazard events.

The other three hazards – floods, severe storms and tornadoes, and wildfires – typically have a much more limited area of impact. Floods only impact flood hazard areas thus exposure is limited to development within these identified and mapped areas of the town. For severe storms and tornadoes and for wildfires, it is estimated that Wake Forest has a maximum 10% exposure, i.e., 10% or less of all structures within the town could be impacted by these types of hazard events. This information from Appendix A will be used in this section to estimate a dollar amount of exposure to these hazards.

### **B. Community Description** (see Wake Forest Flood Plain Map or Wake Forest Critical Facilities and Vulnerable Buildings and Populations Map – back pocket)

Wake Forest is located in northern Wake County which encompasses approximately 549,000 acres (860 square miles) and is located in a topographic transitional zone between the coastal plain and the rolling hills of the Piedmont section of the State. Centrally located, Wake County is the seat of State government with the largest municipality, the City of Raleigh, being the State’s capital city. The County is also home to the southern portion of the Research Triangle Park (RTP). Though the population of Wake County has and will continue to grow rapidly in the coming decades, remnants of rural landscapes still fringe outlying areas of the County. As of July 2002, Wake County’s population was 675,518. The Wake County population in July 2007 was estimated at 829,418. According to the 2000 Census the Town of Wake Forest had a population of 12,588 as of April 1, 2000. According to the State of North Carolina the Town of Wake Forest had an estimated population of 25,734 as of July 2007, representing a growth of over 104% in only seven years!

Accessibility to major roads and thoroughfares is a convenience to the citizens of Wake Forest. Major roads within Wake Forest include: US-1, US-1A, and NC-98. There is easy access to I-40, I-440, I-540, US-401, and NC 96.

Raleigh-Durham (RDU) International Airport provides air transportation into and out of the region. In 2001, there were 97,079 take offs and landings with 9.5 million passengers passing through RDU for an average daily passenger count of 26,258 persons. The airport also handled 121,000 tons of cargo with an average of 332 tons per day. The airport is served by 12 major airlines and 18 commuter airlines.

### **Demographics**

The educational achievement and the occupations of the citizens of Wake Forest reflect the fact that the town is the birthplace of Wake Forest University and the current home of the

Southeastern Baptist Theological Seminary. It is also easily accessible to Raleigh and the Research Triangle Park (partially in Durham County). In the 2000 Census, 46.8% of the population was employed in management or professional positions and 43% of the population had a college bachelor or higher degree (Table B-1). Median household income in 1999 was \$52,307 (133% of statewide median household income of \$39,184) and only 8.8% of the population lived below the poverty level.

**Table B-1: Selected Wake Forest Demographics**

<b>Economic</b>		
Median Household Income		\$52,307
Average Household Size		2.66
Percent of Population Below Poverty Level		8.8 %
<b>Occupation</b>	<b>People</b>	<b>Percent</b>
Management, professional, etc.	2,984	46.8 %
Service related	692	10.8 %
Sales and office	1,701	26.7 %
Farming, fishing, and forestry	7	0.1 %
Construction, extraction, and maintenance	476	7.5 %
Production, transportation, material moving	522	8.2 %
<b>Employment</b>	<b>People</b>	<b>Percent</b>
Employed	6,388	69.9 %
Unemployed	150	1.6 %
Not in labor force	2,605	28.5 %
<b>Social</b>		
<b>Level of Educational Attainment</b>	<b>People</b>	<b>Percent</b>
Less than 9 <sup>th</sup> grade	310	3.9 %
9 <sup>th</sup> – 12 <sup>th</sup> (no diploma)	538	6.8 %
High School Diploma (includes GED)	1,333	16.8 %
Some college, no degree	1,639	20.7 %
Associate degree	692	8.7 %
Bachelor's degree	2,562	32.3 %
Graduate or professional degree	848	10.7 %
<b>Housing</b>		
<b>Selected Characteristics</b>	<b>People</b>	<b>Percent</b>
Lacking complete plumbing facilities	14	0.3 %
Lacking complete kitchen facilities	9	0.2 %
Lacking phone service	49	1.1 %

Source: 2000 US Census.

### **Employment**

Wake Forest has two major public employers – the Wake County Public School System and the Town of Wake Forest (Table B-2). The Wake County Public School System employs 634 persons and the Town of Wake Forest employs an additional 158 persons. Major employers are shown in Table B-2. An updated table of major employers, appearing on the July 2009 website of the Wake Forest Chamber of Commerce are shown in Table B-2.1.

**Table B-2: Top Ten Largest Employers in Wake Forest (2004)**

<b>Company Name</b>	<b>Number of Employees</b>
Wake County Public School System	634
Wal-Mart Super Center	400
Southeastern Baptist Theological Seminary	350
The Body Shop	300
Target Stores	260
Town of Wake Forest	158
Carolina Sunrock	150
Chris Leith Automotive	144
Home Depot	135
Lowes Home Improvement	120

*Source: Wake Forest Chamber of Commerce.*

**Table B-2.1: Top Twelve Largest Employers in Wake Forest (Update)**

<b>Company Name</b>	<b>Number of Employees</b>
Wake County Public School System	734
Wal-Mart Super Center	425
Embarq	374
Southeastern Baptist Theological Seminary	360
The Body Shop	325
Target Stores	275
Town of Wake Forest	176
Hillside Nursing Center	167
Carolina Sunrock	150
Chris Leith Automotive	140
Lowes Home Improvement	120
Home Depot	118

*Source: Wake Forest Chamber of Commerce, Website July, 2009*

### **Housing and Growth** (see Wake Forest Zoning and Flood Plains Map – back pocket)

Residential land use is scattered throughout the town, with concentrations of residential development located within the older section of town and, more recently, as subdivisions and major developments, such as Heritage Wake Forest, are built. Residential property is predominantly single family housing with town homes and apartments growing more popular. There is very little manufactured housing.

As shown in Table B-3, the 2000 Census identified a total of 5,081 housing units within Wake Forest. Only 89 (1.7%) of these units were identified as mobile/manufactured homes, boats, recreational vehicles or vans. These types of housing structures are more susceptible than site-built homes to damages by natural hazards, especially high wind damages. As of 2000, over 43% of the housing units had been built since 1980 demonstrating the impact of recent population growth.

**Table B-3: 2000 Census of Housing Units – Wake Forest**

Types of Housing Units			Housing Units by Year Built		
Type of Unit	Number of Units	Percent of Total Units	Year Built	Number of Units	Percent of Total Units
Single-family	3,351	66.0%	1959 or earlier	727	14.3%
Multi-family	1,641	32.3%	1960 - 1979	763	15.0%
Mobile homes	87	1.7%	1980 - 1989	716	14.1%
Boat, RV, Van	2	-%	1990-March 2000	2,875	56.6%
<b>Total Units</b>	<b>5,081</b>	<b>100.0%</b>	<b>Total</b>	<b>5,081</b>	<b>100.0%</b>

Source: 2000 US Census.

The town has experienced significant population growth in recent years but expects the overall rate of population growth to slow somewhat in the next twenty years, along with a slower growth rate for the county as a whole. However, Wake Forest is expected to grow at a higher rate than the county as a whole. Housing units as of 2008 are shown in Table B-3.1.

**Table B-3.1: 2008 Housing Units – Wake Forest**

Type of Unit	Number of Units	Percent of Total Units
Single-family	7,977	72.1%
Duplexes	298	2.7%
Multi-family	2,660	24.1%
Mobile homes	118	1.1%
<b>Total Units</b>	<b>11,053</b>	<b>100.0%</b>

Source: Wake Forest Planning Department

Commercial growth has been the most rapid in recent years along the US-1 corridor.

As the currently undeveloped areas begin to be developed, it is imperative that the town continue to protect sensitive environmentally areas, particularly wetlands and flood hazard areas, from inappropriate development. Over time, floodplain protection regulations should ease the impact of stormwater runoff in areas susceptible to floods.

Table B-4 data indicates that tax value of all property, including vehicles and personal property, in the Town of Wake Forest was over \$1.4 billion (\$1,415,707,451). These, of course, represent tax value, including land. Market value or replaceable value may be different, which could represent greater potential losses if property is a total loss. Real estate improvements represent those property values most at risk, however, land characteristics (soils and vegetative cover) are also exposed to possible damage from future natural hazards.

**Table B-4: Property Value by Use in Wake Forest (2003-2004)**

Land Class Description	Total Number of Structures	Total Value
<b>Residential Uses</b>		
Residential Use Parcel Greater Than 10 acres	6	\$1,191,430
Apartments	84	\$39,056,979
Manufactured Homes	41	\$495,490
Condominiums	116	\$13,179,762
Residential Single Family	5,576	\$874,861,705
Historic Landmarks (50% tax deferred)	1	\$232,312
<b>Subtotal without Personal Property</b>		<b>\$929,017,678</b>
Autos	Not applicable	\$127,141,100
Personal Property	"	\$1,812,945
<b>Residential Subtotal</b>		<b>74.7%</b> <b>\$1,057,971,723</b>
<b>Commercial and Industrial Uses</b>		
Commercial	307	\$160,344,322
Industrial	17	\$17,788,118
Private Water Systems	Not applicable	\$233,060
<b>Subtotal without Personal Property</b>		<b>\$178,365,500</b>
Autos	Not applicable	\$4,178,956
Commercial Personal Property	"	\$58,689,263
<b>Commercial and Industrial Subtotal</b>		<b>17.0%</b>

		<b>\$241,233,719</b>
<b>Farm, Vacant, and Other Uses</b>		
Retirement	4	\$6,720,527
Leased	5	\$467,835
Golf Courses	Not applicable	\$10,842,979
Forest Parcel in Farm Use	"	\$1,183,156
Acreage with Improvements	"	\$880,844
Residential Vacant Land	"	\$55,387,001
Commercial or Industrial Vacant Land	"	\$41,487,502
		<b>8.3%</b>
<b>Farm, Vacant, and Other Subtotal</b>		<b>\$116,969,844</b>
<b>TOTAL</b>		<b>\$1,416,175,286</b>

Source: Wake County Revenue Department, August 2004, including personal property values for 2003-2004 and real property values as of 1/1/04.

**Building Permits**

Wake Forest building permit data (Table B-5) for 2002 – 2004 (January-July) illustrate how the town is growing. Each of the past three years for which data was available have resulted in increasing numbers of building permits issued. As of July 2004 there were already more permits issued than all of 2002.

**Table B-5: Building Permits – Wake Forest**

Year	Residential	%	Non-Residential	%	Demolition	%	Total Permits
2002	614	95.2	26	4.0	5	0.8	645
2003	762	94.4	38	4.7	7	0.9	807
2004	738	97.2	21	2.8	NA	-	759
2005	1,006	98.0	20	2.0	NA	-	1,026
2006	904	98.0	18	2.0	NA	-	922
2007	689	97.2	20	2.8	NA	-	709
2008	215	86.7	27	10.9	6	2.4	248
<b>Totals</b>	<b>4,928</b>	<b>96.3</b>	<b>170</b>	<b>3.3</b>	<b>18</b>	<b>0.4</b>	<b>5,116</b>

Source: Wake County and Wake Forest Planning Department.

**Land Susceptible to Flood Hazard** (Wake Forest Zoning and Flood Plains Map – back pocket)

Wake Forest has a total of 2,129 acres of soils susceptible to flood hazard in its jurisdiction and a total of 1,569 acres in its jurisdiction that are in the flood plain. The accompanying map, “Wake Forest Zoning and Flood Plains Map”, depicts the flood prone areas, including the land around the Wake Forest Reservoir and land along Richland Creek, Smith Creek, Horse Creek, Sanford Creek, Austin Creek, and Toms Creek.

**Table B-6: Acres Susceptible to Flood Hazard within Wake Forest**

Municipality	Flood Hazard Soils Within ETJ (in acres)	Flood Hazard Soils within City Limits (in acres)	FEMA Floodplain in ETJ/Planning Jurisdiction (in acres)	FEMA Floodplain in City Limits (in acres)
Wake Forest (2003)	1,181	948	952	617
Wake Forest (2009)	1,773	1,357	616	451

Source: Wake County (July 2003 and July 2009) and Wake Forest Planning Department (July 2009).

**C. Critical Public Facilities** (Wake Forest Critical Facilities and Vulnerable Buildings and Populations Map – back pocket)

Critical public facilities are those facilities that are essential to the health, safety, and viability of the community. Critical facilities include public buildings, public infrastructure (roads, highways, bridges, water and sewer facilities\*) and private utility services, e.g., electric, phone and cable, without which residents and businesses could not survive for extended periods of time. Certain facilities are critical to the response and recovery efforts in the wake of a disaster resulting from a natural or technological hazard. These include fire and rescue facilities, hospitals, major transportation facilities, communication facilities, and public water and sewer infrastructure. It is important to note that by the 2009 plan update the water and sewer facilities were owned and operated by the City of Raleigh.

The inventory of town-owned critical public facilities is shown in Table B-7 and the locations are shown on the Wake Forest Critical Facilities and Vulnerable Buildings and Populations Map in the back pocket of the Plan. The ability to protect these facilities from damage from a future natural hazard event is critical to the welfare of the citizens of Wake Forest. Other public, privately-owned, or semi-public critical facilities and essential and supportive public facilities are listed following Table B-7. For detailed information about municipal-owned facilities, please send for individual municipal plans.

**Rationale for Designating a Facility as Critical Tier 1 or Tier 2**

Facilities within Wake Forest have been divided into two categories of importance for hazard mitigation:

**Tier 1**

Town-Owned:

- Critical Facilities (Table B-7) – facilities that are absolutely necessary for response and recovery efforts during and after a disaster. This category includes all town-owned facilities that must either remain in operation without interruption or should be operational within 24 hours of an emergency.

Other-Owned:

- Critical - facilities necessary for response and recovery efforts that are not owned, operated or maintained by the town.
- Essential - facilities that are essential for normal community functions and that should be back in service within 72 hours following a disaster.
- Vulnerable Populations – facilities or properties housing concentrations of vulnerable populations, such as the elderly, children, and the sick.

**Tier 2**

- Supportive – facilities/services that are typically available to the public but which can be closed for a week or more following a disaster without undue harm to public health and safety.
- Community and Cultural Assets – buildings that have historic significance to Wake Forest

\*(Note: Major roads and highways within Wake Forest are owned and operated by the State of North Carolina and the Federal Highway System. Since the town is not responsible for the operation and maintenance of these facilities, they are not included in vulnerability calculations.)

**Table B-7: Town Owned Critical Public Facilities/Public Infrastructure (2004)**

Map #	Type of Facility	Location	Function	Size (sq. ft. or gal.)	Importance	Replacement Value <sup>1</sup>
<b>Town Offices and other Facilities</b>						
1	Town Hall	401 Elm Avenue	Town Offices	7,840 sq ft	Government Services	\$590,899
2	Planning & Inspections Department	221 South Brooks Ave.	Town Offices	7,670 sq ft	Planning & Inspection Services	\$492,493
3	Annex	401 Elm Avenue	Town Offices	2,613 sq ft	Engineering Services	\$145,981
4	Water Treatment Plant** Other Buildings & Fixtures	NC 98 East	Treatment Plant	Location Total: 2,704 sq ft	24/7 Operations	\$4,258,940 \$1,563,493
5	Water Tower**	South White Street	Water Storage	300,000 gal	Water Supply	\$744,580
6	Water Tower**	North Taylor Street	Water Storage	300,000 gal	Water Supply	\$744,580
7	Sewer Treatment Plant** Pumping Station Pump Station @ Bar Screen R A S Pump House Lab/Admin Building Thickener Pump Building Aerator Grit Chamber Electric Control Building Other Buildings & Fixtures	8505 Ligon Mill Road	Treatment Plant	Location Total: 4,082 sq ft	24/7 Operations	\$264,181 \$597,963 \$212,947 \$101,567 \$106,474 \$212,947 \$214,180 \$5,160,442
8	Community House	133 West Owen Ave.	Community Gathering Hall	8,300 sq ft	Public Meetings	\$686,991
9	Alston-Massenburg Recreation Ctr.	416 Taylor Street	Community Center	3,024 sq ft	Public Meetings	\$187,869
10	Flaherty Park Center	North White Street	Gym & Community Center	12,000 sq ft	Recreation	\$2,106,000
11	North Wake Senior Center	235 East Holding Ave.	Senior Center	8,464 sq ft	Senior Center	\$658,208
12	Public Works – Operations Center Warehouse Garage Parks & Recreation Storage	234 Friendship Chapel	Purchasing, Distribution, & Storage	4,478 sq ft 8,120 sq ft 6,240 sq ft 3,234 sq ft 7,380 sq ft	Town Supply Services	\$437,632 \$451,121 \$325,798 \$231,847 \$539,850
13	Electric Substation	West Cedar Avenue	Electric Substation	---	Electric Power	\$436,175
<b>Police Stations</b>						
14	Police Station	401 Elm Avenue	Police Station & Courtroom	7,028 sq ft	24/7 Operations	\$775,864
<b>Total Critical Public Facilities/Public Infrastructure</b>						<b>\$22,249,022</b>

Source: Town of Wake Forest.

\*\* By 2009 Owned and Operated by City of Raleigh.

<sup>1</sup> Not including contents.

**Table B-7.1: Town Owned Critical Public Facilities/Public Infrastructure (2010)**

Type of Facility	Location	Function	Importance	Replacement Value*
<b>Town Offices and Other Facilities</b>				
Town Hall (old)	401 Elm Avenue	Town Offices	Government Services	\$753,326
Town Hall (new)	301 South Brooks Street	Town Offices	Government Services	\$11,000,000
Planning & Inspection Department	221 South Brooks Street	Town Offices	Planning & Inspection Services	\$620,850
Town Hall Annex	401 Elm Avenue	Town Offices	Engineering Services & Human Resources	\$181,436
Community House	133 West Owen Avenue	Community Gathering Hall	Public Meetings	\$866,040
Holding Pool/Filter Building	133 West Owen Avenue	Swimming Pool	Recreation	\$75,035
Concession Stand/Restrooms	133 West Owen Avenue	User Services	Recreation	\$100,028
Alston-Massenburg Recreation Center	416 Taylor Street	Community Center	Public Meetings	\$236,833
Flaherty Park Center	North White Street	Gym & Community Center	Recreation & Public Meetings	\$2,654,882
Restrooms & Storage	North White Street	Restrooms & Storage	Recreation	\$112,833
Storage Building	1226 North White Street	Storage	Recreation	\$7,500
Northern Wake Senior Center	235 East Holding Avenue	Senior Center	Senior Center & Public Meetings	\$829,755
Public Works	234 Friendship Chapel Road	Purchasing, Distribution & Storage	Town Supply Services	
Operations Center				\$567,878
Warehouse				\$577,947

Garage				\$417,392
Parks & Recreation				\$297,027
Storage				\$691,620
Salt Shed				\$29,222
Wake Forest Power				
Electric Substation	West Cedar Avenue	Electric Substation	Electric Power	\$607,972
Electric Substation	NC-98 ByPass	Electric Substation	Electric Power	\$2,800,000
<b>Police Stations</b>				
Police Station	401 Elm Avenue	Police Station & Courtroom	24/7 Operations	\$989,136
Storage	401 Elm Avenue	Storage	Storage	\$16,352
<b>Total Critical Public Facilities/Public Infrastructure</b>				<b>\$24,433,064</b>

\*For insurance purposes.

Source: Town of Wake Forest

**Tier 1 Other-Owned Critical Facilities/Public Infrastructure**

**State/Federally-Owned Critical Facilities**

**Transportation Facilities**

- US-1
- US-1A
- NC-98

**Emergency Shelters (Wake County Public Schools)**

**Primary Shelters**

- None

**Secondary Shelters**

- Wake Forest-Rolesville Senior High School

**Other-Owned Critical Facilities**

**Emergency Medical**

- Wake Forest Urgent Care
- Wake County EMS
- Fast Med

**Utilities**

- Public Service Company of NC
- Century Link Phone Service (formerly Embarq)
- Progress Energy
- Wake Electric Membership Corporation

**Fire Stations**

- Station 1 – 420 East Elm Avenue
- Station 2 – 9925 Ligon Mill Road
- Station 3 – 1412 Forestville Road

**Police Sub-Stations**

- DuBois Center – 623 North Franklin Street
- 1988 South Main Street
- Massey Apartments – 153 N. Allen Road

<b><u>Privately-Owned Essential Services</u></b>	
<b><u>(used by town for fuel)</u></b>	
<ul style="list-style-type: none"> <li>• Holding Oil Company</li> <li>• Cruziers</li> </ul>	<p><b><u>Vulnerable Populations</u></b></p> <ul style="list-style-type: none"> <li>• Hillside Nursing Center</li> <li>• Wake Forest Care Center (nursing home)</li> <li>• <b>Carolina House of Wake Forest (assisted living)</b></li> <li>• The Lodge (elderly housing)</li> <li>• Turnberry Apartments (elderly housing)</li> <li>• Child Day Care Centers                             <ul style="list-style-type: none"> <li>Wake Forest Child Care</li> <li>Children’s Adventure</li> <li>Primrose School of Heritage Wake Forest</li> <li>Goddard School</li> <li>Wake Forest Kids-R-Kids</li> </ul> </li> </ul>

- Kids Educational Center
- Heritage Children's Academy
- Rising Star Christian Academy
- Wake Forest Baptist Church
- St. John's Episcopal Church
- Hope Lutheran Church
- Wake Forest Presbyterian Church
- St. Catherine of Siena Early Childhood Center
- Wake County Public Schools & Private Schools
  - Wake Forest Elementary School
  - Wake Forest-Rolesville Middle School
  - Wake Forest-Rolesville Senior High School
  - Wake Forest-Rolesville 9<sup>th</sup> Grade Center
  - Heritage Elementary School
  - Heritage Middle School
  - Heritage Senior High School
  - Jones Dairy Elementary School
  - Franklin Academy (elementary, middle, & high school)
  - Wakefield 9<sup>th</sup> Grade Center
  - St. Catherine's School
  - Thales Academy
  - Forest Pines Elementary School

## **Tier 2 Supportive Facilities and Community and Cultural Assets**

### **Privately-Owned Supportive Facilities**

- Southeastern Baptist Seminary
- DuBois Center
- Boys & Girls Club

### **Properties of Historic Significance**

- Wakefields

• Battle-Purnell House
• Glen Royall Apartments
• Calvin Jones House (Wake Forest Birthplace)
• DuBois Center
• I.O. Jones House
• Forestville Baptist Church
• Oak Forest
• Hartfield House
• Purefoy-Dunn House
• Crenshaw Hall
• Community House
• Purefoy-Chappell House
• Powell House

### **Publicly-Owned Supportive Facilities**

- US Post Office
- Wake Forest Library
- Flaherty Park Center
- Northern Wake Senior Center
- Alston-Massenburg Recreation Center

**D. Description of All-Hazards Exposure** (Wake Forest Zoning and Flood Plains Map – back pocket)

As detailed in Appendix A, the entire Wake Forest planning area is exposed to general hazards such as severe storms, hurricanes, droughts and heat waves, and winter storms and freezes. Tornadoes are another common threat but the exact location of a future tornado event can not be predicted. Only flood hazards have a known hazard location – the floodplains along major streams and creeks.

**Vulnerable Populations** (Critical Facilities and Vulnerable Buildings and Populations Map – back pocket)

Vulnerable populations were identified as child day care centers, nursing homes, assisted living facilities, elderly housing, and schools. The town identified eight child day care centers, two retirement homes (elderly housing), and three nursing or assisted living facilities located within the town planning jurisdiction. Wake County schools include Wake Forest Elementary, Heritage Elementary, Franklin Academy (elementary, middle, and high schools), Wake Forest-Rolesville Middle School, Heritage Middle School, Heritage High School, and Wake Forest-Rolesville High School. Locations are shown on the Wake Forest Critical Facilities and Vulnerable Buildings and Populations Map.

**Flood Hazard Areas** (Wake Forest Zoning and Flood Plains Map – back pocket)

Approximately 31,817 acres of the land area within the Wake County planning jurisdiction is located in identified FEMA floodplain areas. An additional 56,338 acres are identified as flood prone soils. Historically, the County's most significant flood damages have occurred along Middle Creek, Swift Creek, the Little River, the Neuse River and Moccasin Creek.

Within the corporate limits of the Town of Wake Forest there are 451 acres located in identified FEMA floodplain areas. There are 616 acres in Wake Forest's extraterritorial planning jurisdiction (ETJ) located in such floodplain areas.

Flash flooding is caused primarily by quick, heavy rainstorms that overwhelm stormwater drainage systems inundating yards and overtopping roads at stream crossings. More widespread general flooding is caused by longer rainstorm events such as those associated with coastal storms and hurricanes. General flooding will close off transportation routes and inundate structures located in low lying areas.

Increased storm water runoff from the built environment is the major cause of flooding in urban areas. Studies have shown that the volume of stormwater runoff from a 1" rainfall event is fifteen times greater off an acre of pavement than is off a 1-acre grassed area. The increased volume and velocity of runoff from impervious areas (paved road surfaces, rooftops, driveways, etc.) creates both erosion and flooding problems.

Flooding caused by rainwater rushing off impervious surfaces can be dangerous when street stormwater drainage systems are overwhelmed. Roadways may flood and in some cases paved surfaces will fail where stream culverts are undersized and unable to handle the volume of stormwater. Rain falling on denuded construction sites often causes severe erosion of soils that wash into and clog creeks and streams causing degradation of aquatic habitats and reducing the stormwater carrying capacity of drainage-ways.

**Hazardous Area Intersections with Community Features**

Other than some bridges and sewer pump stations there are no critical public facilities located within flood hazard areas. Those bridges and sewer pump stations are located on the Critical Facilities and Vulnerable Buildings and Populations Map.

**National Flood Insurance Program**

Wake Forest is an active participant in the National Flood Insurance Program (NFIP). Although the position of the Federal government is to discourage development within flood hazard areas, the NFIP was created to ensure that owners of flood susceptible properties could purchase flood insurance coverage to protect properties at risk. Data on current NFIP insurance policies and recent claims within Wake County are shown in Table B-8 and NFIP information Wake Forest is detailed in Table B-9.

**Table B-8: NFIP Statistics – Wake County**

Category	Number or Value
<b>Total Insured Value</b>	<b>\$365,061,000</b>
Number of Policies	1,841
<b>Total Premiums</b>	<b>\$904,372</b>
Average Premium	\$491.24
NFIP Claims Since 1978	840
NFIP Claim Amounts Paid Since 1978	\$11,786,338
Repetitive Loss Claims	0

Source: FEMA

**Table B-9: NFIP Statistics – Wake Forest (2004)<sup>1</sup>**

Category	Number or Value
<b>Total Insured Value</b>	<b>\$2,868,700</b>
Number of Policies	13
<b>Total Premiums</b>	<b>\$4,431</b>
Average Premium	\$340.85
NFIP Claims Since 1978	2
NFIP Claim Amounts Paid Since 1978	\$.00
Repetitive Loss Claims	0

<sup>1</sup> NFIP information includes only within the town limits.

Source: FEMA (2004)

**Table B-9.1: NFIP Statistics – Wake Forest (2009)**

Category	Number
Number of Policies	95
Policies Within AE Zones	33
Policies Within X Zone	62
Repetitive Loss Claims	0

Source: Wake Forest Planning Department, Wake County GIS, NC Floodplain Mapping Program (2009)

**Repetitive Loss Claims**

One of the main objectives of the hazard mitigation planning process is to determine how best to reduce repetitive loss claims. Through FEMA, the Federal government annually makes available grants to local governments for the purchase and/or elevation of flood prone properties in order to reduce the re-occurrence of flood damages. NFIP statistics on repetitive loss claims indicate that there are no repetitive loss claims in the Wake Forest.

### **High Wind Hazard Vulnerability**

Predicting where damage from high winds and tornadoes will occur is not possible. Mobile/manufactured homes, however, are more vulnerable to the damaging effects of high winds than are site-built structures.

Mobile/manufactured homes built before 1993 when more stringent Department of Housing and Urban Development (HUD) wind resistance standards became effective are especially susceptible to wind damage (Table B-10). County tax and building permit records do not indicate the age of individual manufactured home units, however, in the 2000 Census, only 89 (1.7%) of all residential units located within Wake Forest were mobile/manufactured home units or boats, recreational vehicles, or vans (Table B-3). These types of dwelling units, regardless of age, are generally more susceptible to wind damage than are site-built dwelling units.

**Table B-10: HUD Wind Resistance Standards for Mobile/Manufactured Homes**

<b>Year</b>	<b>Wind Resistance<sup>1</sup></b>	<b>Weight</b>	<b>Anchor Requirements<sup>2</sup></b>
Pre-1993	75 mph	16,000	5-6 anchors/side
Post 1993	100 mph	40,000	11-14 anchors/side

Source: *Manufactured Housing Institute, www.mfghousing.org*

<sup>1</sup> Wind resistance standards for coastal placement are more rigorous.

<sup>2</sup> An anchor is a weighted disc buried in the ground and attached to the manufactured unit with steel cable.

### **E. Future Hazard Vulnerability**

Future vulnerability can be defined as the extent to which people are expected to experience harm and the likelihood of property damage by a hazard event if projected development were to occur. If development is allowed to occur within identified floodplains, then vulnerability will increase accordingly.

According to the 2000 Census the population of the Wake Forest grew 45.8% from 1990 to 2000. The town has projected future population growth for 2010 and 2020 as shown below in Table B-11. Using the 2000 Census average persons per household of 2.66 and the projected population growth, an estimated 14,171 persons will move into Wake Forest between 2000 and 2020. To accommodate this growth, an estimated 5,823 new housing units will be built in Wake Forest during the twenty year study period.

The actual estimated population, according to the State of North Carolina figures, was 25,734 in 2007, the latest estimates available, and the Wake Forest planning department reported 10,845 housing units in 2007. (In 2008, 11,053 units were reported but not used in Table B-11 below in order to be consistent in the years used.) In the calculations used for Table B-11 it was assumed that after the economic downturn the town will return to the originally projected growth rate of 45.8%. There is no way to know whether this has any relationship to reality. Therefore, the projected population for 2020 is likely very poor. To obtain the figures for additional housing units needed in 2020 over 2007 it was assumed that the town will retain the 2.37 persons per household as in 2007, based upon the state population estimate and the town figures for total housing units.

**Table B-11: Projected Population Figures for Wake Forest<sup>1</sup>**

Year	Ten-Year Growth Rate <sup>2</sup>	Total Population	Projected Number of New Housing Units Needed to Accommodate Population <sup>3</sup>
2000	45.8%	12,588	---
2010	45.8%	18,353	2,369
2020	45.8%	26,759	3,454
2007	104.4% <sup>4</sup>	25,734 <sup>5</sup>	10,845 <sup>6</sup> Total Units Available
2020	45.8% <sup>7</sup>	37,520 <sup>7</sup>	4,986 <sup>8</sup> Additional Units Needed Over 2007

Source: Wake Forest Planning Department.

<sup>1</sup> Population Projections for populations as small as Wake Forest are almost guaranteed to be extremely inaccurate. Any small change in development patterns, the national or local economy, migration, employment opportunities, etc. can result in major unforeseen changes in projected population.

<sup>2</sup> Wake Forest is in one of the most rapidly growing areas of Wake County. Therefore, the same rapid growth of the 1990s was used for the following two decades.

<sup>3</sup> Based on the 2000 Census average household size of 2.66 persons per household and 2000 Census vacancy rate of 9.3%.

<sup>4</sup> Growth during 7 years from 2000.

<sup>5</sup> Estimated 2007 population according to North Carolina Department of Administration.

<sup>6</sup> Housing units as of 2007 according to Town of Wake Forest planning department.

<sup>7</sup> For lack of better figures it was assumed that after the economic downturn we will return to the same growth rate as the originally projected 10-year growth rate and that rate was applied to the 13 years between 2007 and 2020. Therefore, these figures are likely very poor.

<sup>8</sup> Assuming 2.37 persons per household as in 2008, including vacant housing.

Future growth and development must be concentrated in known areas of low vulnerability that are not within identified floodplains. Strict enforcement of mitigation measures, such as hurricane building codes and enhancement and enforcement of local land use ordinances, in particular regulations dealing with flood damage prevention and stormwater runoff, will further efforts to decrease community vulnerability to hazards.

**Redevelopment**

Planning for redevelopment in the wake of a natural disaster also serves to reduce future vulnerability. Redevelopment should be encouraged in a manner which will result in lower vulnerability by restricting rebuilding within high-risk areas and requiring, where building does occur, incorporating the use of mitigation measures such as higher finished floor elevations and flood proofing.

**Urbanization**

Spreading urban development and increased impervious surface coverages can be expected to contribute to a rise in the height of general flooding within Wake Forest in coming years. Urban-intensity development in basins that already have significant flooding problems will contribute to more frequent flash flood events and to higher levels of general flooding unless efforts are made to correct existing problems and to reduce runoff volumes and velocities from new sites.

Flash flood levels can be expected to increase if mitigation measures such as on-site storm water retention are not required for sites with high impervious surface coverage. Another long term problem will be a reduction in the amount of time between a rainfall event and actual flooding. Without mitigation, urbanization increases the likelihood of flash floods, increases the land susceptible to flooding, and reduces warning time for evacuation of susceptible populations.

## **F. Summary Conclusions**

### **Current Vulnerability**

Wake Forest, as determined in Appendix A, is most vulnerable to droughts and heat waves; hurricanes and coastal storms; winter storms and freezes; floods; severe storms and tornadoes; and wildfires. Since droughts and heat waves have minimal impact on urbanized areas such as Wake Forest, other than the issues involved in water usage and the shortage of city water for the rapid growth of development in the Raleigh area, this hazard is not included in vulnerability assessment tables at the end of this section. (Other than address the use of water for the non-necessary uses of irrigation of lawns and landscaping, which Wake Forest is doing, exceeding the requirements of the City of Raleigh, owner and operator of the town water and sewer systems; there is not much that the Town of Wake Forest can do.)

Based on hazard event history, it is estimated that Wake Forest has a maximum 100% exposure to hurricanes/coastal storms and winter storms/freezes. A 100% exposure means that all structures both public and private within the town could possibly be impacted by these types of hazard events.

Floods only impact flood hazard areas thus exposure is limited to development within these identified and mapped areas of the town. For severe storms and tornadoes and wildfires, it is estimated that Wake Forest has a maximum 10% exposure, i.e., 10% or less of all structures within the town could be impacted by these types of hazard events. This is based on the estimates used in Appendix B of the Wake County Hazard Mitigation Plan.

**Table B-12: Potential Hazard Exposure**

<b>Hazard</b>	<b>Hazard Ranking</b>	<b>Estimated Level of Exposure</b>
Droughts and Heat Waves	Moderate	Minimal
Hurricanes and Coastal Storms	Moderate	100% Exposure
Winter Storms and Freezes	High	100% Exposure
Floods	Moderate	Limited to Flood Hazard Areas
Severe Storms and Tornadoes	Moderate	10% Exposure
Wildfires	Moderate	10% Exposure

Source: Appendix A Table A-27.

### **Methodology for Calculating Current Hazard Exposure**

Current (Year 2000) hazard exposure has been estimated using the 2000 Census housing and population count and Year 2000 property tax values in Wake County. The left side of Table B-13 summarizes the total vulnerability of persons and property values in the Year 2000. This information is presented in two categories - Private Development and Public Critical Facilities. (Note: Due to the limited amount of data that was available on specific monetary damages from past hazard events; it is difficult to predict exactly what monetary level of damages can be expected with future hazard events.

### **Current Vulnerability to Hurricanes/Coastal Storms and Winter Storms/Freezes**

It is estimated that Wake Forest has a maximum 100% exposure to hurricanes/coastal storms and winter storms/freezes. A 100% exposure means that all existing development - both public and private - within the town could possibly be impacted by this type of hazard event. A dollar estimate of current exposure to these hazards is detailed on the left side of Table B-13 Current Conditions (Year 2000). Current Flooding Vulnerability

### **Current Vulnerability to Flooding**

Wake Forest currently has limited exposure to flood hazards and the town enforces development regulations in flood plains and in the required Neuse River buffer. These regulations help protect flood hazard areas from inappropriate development, so exposure is limited to pre-existing homes and businesses that were in flood hazard areas as well as preexisting lots created prior to the restrictions. In the National Flood Insurance Program Biennial Report for Calendar Year 2001 and 2002 the town identified 135 1-4 family structures with an estimated population of 352 within FEMA Flood Hazard areas, as determined by lot location, not structure location. Only one building permit was issued during the two year reporting period of 2001 and 2002. All the other residential structures in the flood hazard areas were preexisting.

### **Current Vulnerability to Severe Storms/Tornadoes and Wildfires**

For severe storms and tornadoes and wildfires, it is estimated that Wake Forest has a maximum 10% exposure, i.e., 10% or less of all structures within the town could be impacted by these types of hazard events. A dollar estimate of current exposure to these hazards is detailed on the left side of Table B-14 Current Conditions (Year 2000).

### **Methodology for Calculating Potential Future Vulnerability**

Wake Forest expects to continue to grow substantially in the next two decades. Using town population growth figures from 1990 to 2000 (Table B-11) the town estimates that total townwide population will increase to 26,759 persons by year 2020. However, to estimate the population in 2003-2004 the number of housing units identified by Wake County Department of Revenue were multiplied by the Census average household size of 2.66. To obtain 2020 (right side of Tables B-13 and B-14), figures the 2003-2004 were multiplied by 1.966, using the estimated growth rate of 45.8% for ten years. The number of commercial/industrial and other structures were then estimated to increase a comparable amount. Year 2020 values were predicted using the same procedure (constant 2003-2004 dollars).

The town has already instituted a number of measures to help reduce flood hazard exposure as the population grows over the next two decades. It is also considering other measures (see Mitigation Action Plan) that will further limit development in sensitive environmental areas as well as reduce stormwater runoff.

### **Future Vulnerability to Hurricanes/Coastal Storms and Winter Storms/Freezes**

Future exposure to hurricanes/coastal storms and winter storms/freezes (right side of Table B-13 – Potential Future Conditions (Year 2020)) was estimated using the methodology described above. A 100% exposure of all development - both public and private - was assumed for these two types of hazards.

### **Future Vulnerability to Flooding**

Future flooding vulnerability should be reduced over time through the purchase and/or elevation of existing flood threatened properties. The town should pursue voluntary acquisition of flood exposed structures through State and Federal funding, but actual realization of flood hazard reduction will be dependent on the number of property owners who choose to participate in that program. The town will continue to enforce and enhance land use regulations that limit construction in flood hazard areas (see Mitigation Action Plan). Year 2020 vulnerability should not exceed the current vulnerability.

### **Future Vulnerability to Severe Storms/Tornadoes and Wildfires**

Future exposure to severe storms/tornadoes and wildfires (right side of Table B-14 – Potential Future Conditions (Year 2020)) was estimated using the methodology described above. A 10% exposure of all development – both public and private – was assumed for these two hazards.

**Table B-13: Wake Forest Vulnerability Assessment for Hurricanes/Coastal Storms and Winter Storms/Freezes**

Private Development						
Current Conditions (Year 2003-2004) <sup>1</sup>				Potential Future Conditions (Year 2020) <sup>2</sup>		
Type of Development	Number of Existing Private Buildings	Current Value (Year 2003-2004)	Current Number of People <sup>3</sup>	Projected Number of Private Buildings	Projected Value (Yr 2003-2004 \$s)	Projected Number of People <sup>4</sup>
Single-Family Residential	5,582	\$876,053,135	13,468	10,974	\$1,722,320,463	26,478
Multi-Family Residential <sup>5</sup>	200	\$52,236,741	1,036 <sup>6</sup>	393	\$102,697,433	2,037 <sup>7</sup>
Mobile Homes	41	\$495,490	98	81	\$974,133	193
<b>Subtotal Residential</b>	<b>5,823</b>	<b>\$928,785,366</b>	<b>14,602</b>	<b>11,448</b>	<b>\$1,825,992,029</b>	<b>28,708</b>
Commercial/Industrial	324	\$178,132,440	0	637	\$350,208,377	0
Other	9	\$7,188,362	0	18	\$14,132,320	0
<b>Subtotal Non-Residential</b>	<b>333</b>	<b>\$185,320,802</b>	<b>0</b>	<b>655</b>	<b>\$364,340,697</b>	<b>0</b>
<b>Total Private Development</b>	<b>6,156</b>	<b>\$1,114,106,168</b>	<b>14,602</b>	<b>12,103</b>	<b>\$2,190,332,726</b>	<b>28,708</b>

Publicly-Owned Critical Facilities						
Current Conditions (Year 2004)				Potential Future Conditions (Year 2020) <sup>8</sup>		
Type of Development	Number of Existing Buildings and Critical Facilities	Current Replacement Value	Current Number of People	Projected Number of Public Buildings and Critical Facilities	Projected Replacement Value (Year 2004 \$s)	Projected Number of People
Town Office Facilities	12	\$6,854,689	0	24	\$13,476,319	0
Town 24/7 Operational Facilities	6 <sup>9</sup>	\$15,394,333	0	12	\$30,265,259	0
<b>Total Public Facilities</b>	<b>18<sup>9</sup></b>	<b>\$22,249,022</b>	<b>0</b>	<b>36</b>	<b>\$43,741,578</b>	<b>0</b>
<b>Community Total</b>	<b>6,174</b>	<b>\$1,136,355,190</b>	<b>14,602</b>	<b>12,139</b>	<b>\$2,234,074,304</b>	<b>28,708</b>

<sup>1</sup> 2003-2004 Data received from Wake County Department of Revenue.

<sup>2</sup> 2020 Projections based on population projections and estimated number of new dwelling units with comparable increase in commercial/industrial properties, assuming the same rate of growth in each housing type.

<sup>3</sup> Estimated at 2000 Census average household size, allowing for a 9.3% vacancy rate.

<sup>4</sup> Based on estimated growth of 96.6% from 2003-2004 to 2020. This gives a significantly higher estimated total population than the town projects for 2020 (See table B-11).

<sup>5</sup> These figures are buildings, not dwelling units, therefore estimates on a per unit basis are not possible.

<sup>6</sup> Based on projected growth rate for 3 ½ years over Census, less those estimated in single family homes and mobile homes.

<sup>7</sup> Same proportion estimated in 2003-2004.

<sup>8</sup> Projected at the same rate of growth as private development.

<sup>9</sup> Plus various additional buildings and other facilities.

**Table B-14: Wake Forest Vulnerability Assessment for Severe Storms/Tornadoes and Wildfires<sup>1</sup>**

Private Development						
Current Conditions (Year 2003-2004)				Potential Future Conditions (Year 2020)		
Type of Development	Number of Existing Private Buildings	Current Value (Year 2003-2004)	Current Number of People	Projected Number of Private Buildings	Projected Value (Yr 2003-2004 \$s)	Projected Number of People
Single-Family Residential	558	\$87,605,314	1,347	1,097	\$172,232,046	2,648
Multi-Family Residential	20	\$5,223,674	104	39	\$10,269,743	204
Mobile Homes	4	\$49,549	10	8	\$97,413	19
<b>Subtotal Residential</b>	<b>582</b>	<b>\$92,878,537</b>	<b>1,461</b>	<b>1,144</b>	<b>\$182,599,202</b>	<b>2,871</b>
Commercial/Industrial	32	\$17,813,244	0	64	\$35,020,838	0
Other	1	\$718,836	0	2	\$1,413,232	0
<b>Subtotal Non-Residential</b>	<b>33</b>	<b>\$18,532,080</b>	<b>0</b>	<b>66</b>	<b>\$36,434,070</b>	<b>0</b>
<b>Total Private Development</b>	<b>615</b>	<b>\$111,410,617</b>	<b>1,461</b>	<b>1,210</b>	<b>\$219,033,272</b>	<b>2,871</b>

Publicly-Owned Critical Facilities						
Current Conditions (Year 2004)				Potential Future Conditions (Year 2020)		
Type of Development	Number of Existing Buildings and Critical Facilities	Current Replacement Value	Current Number of People	Projected Number of Public Buildings and Critical Facilities	Projected Replacement Value (Year 2004 \$s)	Projected Number of People
Town Office Facilities	1.2	\$685,469	0	2.4	\$1,347,632	0
Town 24/7 Operational Facilities	0.6 <sup>2</sup>	\$1,539,433	0	1.2	\$3,026,526	0
<b>Total Public Facilities</b>	<b>1.8<sup>2</sup></b>	<b>\$2,224,902</b>	<b>0</b>	<b>3.6</b>	<b>\$4,374,158</b>	<b>0</b>
<b>Community Total</b>	<b>616.8</b>	<b>\$113,635,519</b>	<b>1,461</b>	<b>1,213.6</b>	<b>\$223,407,430</b>	<b>2,871</b>

<sup>1</sup> 10% Table B-13

<sup>2</sup> Plus various additional buildings and other facilities.