III. Risk Assessment

A. Hazard Identification and Analysis

Orange County, including the Town of Carrboro and the Town of Hillsborough, is vulnerable to a number of natural hazards. Although each hazard cannot be predicted, they can be less disruptive to communities with hazard mitigation planning. Each hazard is unique to Orange County in terms of types, likelihood of occurrence, location, and impact. Each of these terms is explained below.

1. Types Of Hazards

Orange County has experienced or could experience many different types of natural hazards. Some are more likely than others to occur. Different hazards call for different hazard mitigation measures. The OCHM Team considered all of the hazards that threaten Orange County and focused on those that pose the greatest risk. The hazards considered for this plan were: Hurricanes, Floods, Tornadoes, Droughts and Heat Wave, Nor'easters, Thunderstorms, Severe Winter Storm, Wildfire, Chemical Spills, River Basins Dam Failure, Earthquake, Tsunamis, Volcano, Landslide, Plane Crash.

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Hurricanes

Because of Orange County's inland location, hurricanes have not historically been a significant threat. Hurricanes that have reached as far inland as Orange County have historically been greatly weakened as they neared and passed over the area. Hurricanes are cyclonic storms originating in tropical ocean waters and fueled by latent heat from the condensation of warm water. Heavy precipitation, high winds and tornadoes are all typically associated with hurricanes.

Hurricane intensity is measured using the Saffir-Simpson Scale, ranging from 1 (minimal) to 5 (catastrophic) based on wind speeds, surface pressure, and height of storm surge, as shown in the Table below. Major hurricanes are categorized as 3, 4, or 5 on the Saffir-Simpson Scale. While hurricanes within this range comprise only 20% of total tropical cyclone landfalls, they account for over 70% of the damage in the United States. Maximum sustained winds of category 3, 4 and 5 hurricanes range from 112 mph to over 156 mph. This wind intensity topples trees and causes severe damage to structures.

Saffir-Simpson Hurricane Scale (Simpson and Reihl, 1981)

Saffir-Simpson Category	Maximum Sustained Winds (mph)	Minimum Surface Pressure (mb)	Height of Storm Surge (in feet)
1	74-96	>980	3-5
2	97-111	979-965	6-8
3	112-131	964-945	9-12
4	132-155	944-920	13-18
5	156+	<920	19+

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

History of Hurricanes in North Carolina

"North Carolina has a long and notorious history of destruction by hurricanes. Ever since the first expeditions to Roanoke Island in 1586, hurricanes are recorded to have caused tremendous damage to the state. Reliable classification of the intensity of tropical cyclones began in 1886. Since that time, there have been 951 tropical cyclones recorded in the Atlantic Ocean and the Gulf of Mexico. Approximately 166 or 17.5% of those tropical cyclones passed within 300 miles of North Carolina. The coast of North Carolina can expect to receive a tropical storm or a hurricane once every four years, while a tropical cyclone affects the state every 1.3 years" ("Preventing Disasters through Hazard Mitigation", Ana K. Schwab, *Popular Government*, Spring 2000, p.4).

Since 1886, eighty-two hurricanes have passed through North Carolina. Of these, twenty-eight made direct landfall on the North Carolina coast. The worst hurricane to impact North Carolina was Hurricane Hazel, a Category 4, in 1954. In the past 50 years, two hurricanes have passed over Orange County; both of which sustained wind speeds of less than 50 miles per hour by the time they reached Orange County. Hurricane Fran (a 1996 Category 3 hurricane) did not pass directly over Orange County but structures in the county sustained some damage from the high winds (approximately 75 miles per hour) Hurricane Fran sustained in inland areas. Seven deaths and two injuries were reported in Orange County due to Hurricane Fran. The table below displays major hurricanes that have impacted the United States.

30 Costliest Mainland United States Tropical Cyclones 1900-2006				
Rank	**Name or Location**	**Year**	**Category**	**Damage* (Millions)**
1	Katrina	2005	3	$84,645
2	Andrew	1992	5	$48,058
3	Wilma	2005	3	$21,527
4	Charley	2004	4	$16,322
5	Ivan	2004	3	$15,451
6	Hugo	1989	4	$13,480
7	Agnes	1972	1	$12,424
8	Betsy	1965	3	$11,883
9	Rita	2005	3	$11,808
10	Camille	1969	5	$9,781
11	Frances	2004	2	$9,684
12	Diane	1955	1	$7,700
13	Jeanne	2004	3	$7,508
14	Frederic	1979	3	$6,922
15	New England	1938	3	$6,571
16	Allison	2001	TS	$6,414
17	Floyd	1999	2	$6,342
18	NE U.S.	1944	3	$5,927
19	Fran	1996	3	$4,979
20	Alicia	1983	3	$4,825
21	Opal	1995	3	$4,758

30 Costliest Mainland United States Tropical Cyclones 1900-2006				
Rank	**Name or Location**	**Year**	**Category**	**Damage* (Millions)**
22	Carol	1954	3	$4,345
23	Isabel	2003	2	$3,985
24	Juan	1985	1	$3,417
25	Donna	1960	4	$3,345
26	Celia	1970	3	$3,038
27	Bob	1991	2	$2,853
28	Elena	1985	3	$2,848
29	Carla	1961	4	$2,604
30	Dennis	2005	3	$2,330

Source: "The Deadliest, Costliest, and Most Intense United States Tropical Cyclones from 1851 to 2006 (and Other Frequently Requested Hurricane Facts)"by Eric S. Blake, Edward N. Rappaport,and Christopher W. Landsea, National Weather Service – National Hurricane Center, Miami FL, 2007
**Using 2006 Deflator: 2006 $ based on U.S. DOC Implicit Price Deflator for Construction*

Floods

Flooding is normally the result of a larger event such as a hurricane, nor'easter or thunderstorm. Flooding is caused by excessive precipitation and can be generally considered in two categories: flash floods and general floods. Flash floods are the product of localized, high-intensity precipitation over a short time period in small drainage basins. General floods are caused by precipitation over a longer time period and over a given river basin.

A combination of river basin physiography, local thunderstorm movements, past soil moisture conditions, and the degree of vegetative clearing determine the severity of a flooding event. Flooding is typically most severe in areas of the floodplain immediately adjacent to major streams and rivers.

Flooding can be as frequent as the occurrence of a spring rain or summer thunderstorm. The amount of precipitation produced by storm events determines the type of flooding. Flash floods, which typically occur more frequently than general floods, occur along small streams and creeks.

The undermining or washing out of roads is typically associated with flash floods. General flooding occurs less frequently and as the result of much larger storm events such as hurricanes. These larger storm events occur along the East Coast of the United States most often in the late summer and fall.

Orange County is located at the headwaters of three major river basins (the Roanoke, Neuse, and Cape Fear Rivers). Because of this, floodplains in the county tend to be much narrower than floodplains found further downstream. The total economic and loss of life impact due to flooding depends greatly on the amount of development within the area. Orange County prohibits new construction in floodplain areas and the Town of Carrboro has significant restrictions on new development in floodplain areas. The Town of Hillsborough allows construction within floodplains provided the finished building elevation is high enough to sufficiently prevent flooding.

Flooding is normally associated with other types of events such as hurricanes and thunderstorms. Past occurrences of flooding in Orange County is documented in the appropriate hazard section with which the flooding occurred.

Tornados

Many times severe storms, such as thunderstorms and hurricanes, can produce smaller, more localized storms. Tornados, typically the by-product of a larger storm, are violently rotating columns of air that come in contact with the ground. Tornados have a more localized impact than a hurricane or nor'easter. Tornados generally produce a narrow path of concentrated destruction from 0.01 mile wide to greater than 1 mile wide. Tornados may also produce paths of destruction from less than 1 mile in length to greater than 100 miles in length.

The destruction caused by tornados may range from light to severe depending on the path of travel. Typically, structures of light construction, such as residential homes, suffer the greatest damage from tornados. Tornados are generally rated according to the Fujita-Pearson Scale as shown in the table below.

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

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

Because tornados are typically a by-product of thunderstorms, they have a higher likelihood of occurrence. In North Carolina, tornados and thunderstorms are most likely to occur during the spring months (March through June). Tornados during these months have also been strongest, resulting in the greatest amount of harm or damage. Tornados can occur at any time of day but are mostly likely to form between the hours of 3 p.m. and 9 p.m.

Historic Impact of Tornados in Orange County

North Carolina ranks 20th out of the 50 states for frequency of tornados, 19th for number of tornado related deaths, 17th for injuries and 20th for cost of damages (source: Top 20

States for Number of Tornadoes, Fatalities, and Damages, 1950 to 2007; NOAA). Tornados in North Carolina are typically less severe than in other parts of the country, and the North Carolina Division of Emergency Management has rated Orange County as a "moderate" risk for tornados.

According to available records, six tornados impacted Orange County between 1956 and 2008. The most violent was an F3 tornado that occurred on November 23, 1992, which caused two (2) deaths, ten (10) injuries, and $500,000 in property damage.

Droughts and Heat Waves

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

Drought is a temporary aberration and differs from aridity, which is restricted to low rainfall regions, and is a permanent feature of climate. Drought originates from a deficiency of precipitation over an extended period of time, usually a season or more. This deficiency results in a water shortage for some activity, group, or environmental sector.

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

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

Sequence of Drought Impacts

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

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

Severe Droughts in the United States

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

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

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

History of Drought in North Carolina and the U.S.	
Year	**Description**
1980	The drought/heat wave summer of 1980 caused over $20 billion in damages to agriculture and related industries and an estimated 10,000 heat stress-related deaths in the United States.
1986	$1 - $1.5 billion in damages and an estimated 100 deaths nationwide.
1988	Over $40 billion in damages and 5,000 to 10,000 deaths across central and eastern United States.
1993	During June-July 1993 most of the Southeast received less than 50% of normal rainfall along with temperatures 3 – 6 degrees above normal. Eighty-nine of the one hundred counties in NC were declared disaster areas. Crop losses for NC were estimated at $165 million. During this period, North Carolina also recorded the second driest summer (June-August) on record (since 1895) with a statewide average precipitation of only 9.43 inches. The Raleigh-Durham area recorded the driest June on record with 0.33 inches of rain. Estimated damages for the United States exceeded $1 billion in damages to agriculture and at least 16 deaths.
1998	Severe drought/heat wave from Texas/Oklahoma eastward to the Carolinas resulted in $6 - $9 billion in damages to agriculture and at least 200 deaths. 1999 Summer drought/heat wave of 1999 resulted in extensive agricultural losses estimated at over $1.0 billion in damages and an estimated 502 deaths in the United States. The east coast was hardest hit by the drought, with record and near-record short-term precipitation deficits occurring on a local and regional scale resulting in agricultural losses and drought emergencies being declared in several states. Drought was especially severe in the mid-Atlantic states, where local water restrictions were in effect and drought emergencies were declared by several governors. February-August 1999 ranked as the fifth driest such period in the 105-year record.
2000	Severe drought and persistent heat over south-central and southeastern states caused significant losses to agriculture and related industries estimated at over $4.0 billion in damages and 140 deaths.
2002	According to the National Climatic Data Center, moderate to extreme drought affected more than 45% of the United States June through August of 2002. Nationwide, the summer of 2002 was the third hottest on record after the summers of 1934 and 1936. The 12 months that ended with August 2002 were the driest on record for North Carolina. Local water restrictions were in effect throughout central and western North Carolina.
2003 - 2004	A period of dry weather that began in Aug. 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.

Sources: National Climatic Data Center; State Hazard Mitigation Plan, Final 2007.

North Carolina experienced dry weather again in 2007 and 2008, resulting in a statewide drought. Lake and reservoir levels were below normal and communities across the state instituted water restrictions.

Heat Waves

Heat kills by taxing the human body beyond its abilities. In a normal year, about 175 Americans succumb to the demands of summer heat. Among large natural hazards, only the cold of winter – not lightning, hurricanes, tornadoes, floods, or earthquakes – takes a greater toll. In the 40-year period from 1936 through 1975, nearly 20,000 people in the United States were killed by the effects of heat and solar radiation. In the disastrous heat wave of 1980, more than 1,250 people died as a direct result of the heat wave. People at higher risk, e.g., with aging or diseased hearts, are especially susceptible to excessive heat. In recent years, the National Weather Service (NWS) has stepped up efforts to more effectively alert the general public and appropriate authorities to the hazards of heat waves and prolonged excessive heat/humidity episodes. *(Source: National Oceanic and Atmospheric Administration (NOAA))*

How Heat Affects the Body

Human bodies dissipate heat by varying the rate and depth of blood circulation, by losing water through the skin and sweat glands, and -- as the last extremity is reached -- by panting, when blood is heated above 98.6 degrees. As heat rises, the heart begins to pump more blood, blood vessels dilate to accommodate the increased flow, and the bundles of tiny capillaries threading through the upper layers of skin are put into operation. Blood is circulated closer to the skin's surface, and excess heat drains off into the cooler atmosphere. At the same time, water diffuses through the skin as perspiration. The skin handles about 90 percent of the body's heat dissipating function. Sweating, by itself, does nothing to cool the body, unless the water is removed by evaporation -- and high relative humidity retards evaporation. Heat disorders generally have to do with a reduction or collapse of the ability of the body to shed heat by circulatory changes and sweating, or a chemical (salt) imbalance caused by too much sweating. When heat gain exceeds the level the body can remove, or when the body cannot compensate for fluids and salt lost through perspiration, the temperature of the body's inner core begins to rise and heat related illness may develop.

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

Heat Index

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

Heat Index Chart						
Temperature (F) versus Relative Humidity (%)						
°F	**90%**	**80%**	**70%**	**60%**	**50%**	**40%**
80	85	84	82	81	80	79
85	101	96	92	90	86	84
90	121	113	105	99	94	90
95	>130	133	122	113	105	98
100			142	129	118	109
105				148	133	121
110						135

Heat Index	Possible Heat Disorder
80°F - 90°F	Fatigue possible with prolonged exposure and physical activity.
90°F - 105°F	Sunstroke, heat cramps and heat exhaustion possible.
105°F - 130°F	Sunstroke, heat cramps, and heat exhaustion likely, and heat stroke possible.
130°F or greater	**Heat stroke highly likely with continued exposure.**

Source: National Weather Service Heat Index Program, NOAA.

Nor'easters

Nor'easters (or northeasters) are wind or gale storms with winds predominantly from the northeast. Nor'easters typically impact the eastern United States and are similar to hurricanes in respect to their effects. Unlike hurricanes, however, nor'easters are extra-tropical storms, deriving their strength from horizontal gradients in temperature - they form as a result of a drop in temperature.

Nor'easters affect the state in a similar fashion as hurricanes in that they produce heavy surf and high winds. A nor'easter occurring during winter months may also produce ice hazards and effects similar to those of a severe winter storm.

Orange County, including the Town of Carrboro and Town of Hillsborough, would typically suffer the same effects from a nor'easter as from a hurricane. Because of Orange County's inland location, the impact of a nor'easter would not be expected to be exceptionally severe. The occurrence of a nor'easter often produces substantial amounts of precipitation and strong winds. Nor'easters occurring in the winter may result in accumulation of snow and/or ice.

According to an analysis of nor'easter frequency, fewer nor'easters occurred during the 1980's. However, the frequency of major nor'easters (Class 4 or 5) has increased in recent years. From 1987 to 1993 at least one class 4 or 5 storm occurred each year along the

Atlantic seaboard of the United States, a situation duplicated only once in the last 50 years. Nor'easters are rated by the Dolan-Davis Intensity Scale. The scale is not included in this document because it is based upon beach and dune erosion and overwash, none of which are relevant to Orange County, the Town of Carrboro or the Town of Hillsborough.

Thunderstorms

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

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

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

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

Historic Impact of Thunderstorms in Orange County (including Carrboro & Hillsborough)

As the Hazard History table at the end of this section shows, a number of thunderstorm/high wind storm events and thunderstorm related events (hail and lightning) have been reported in Orange County.

Severe Winter Storm

Severe winter weather is typically associated with much colder climates; however, winter storms involving extremely cold temperatures, ice storms, and/or heavy snow have occurred in Orange County. The impact of a winter storm in Orange County can be significant. Although equipment such as snow plows is available in the region, winter storms can produce an accumulation of snow and ice on trees and utility lines resulting in loss of electricity and blocked transportation routes. Frequently, loss of electric power means loss of heat for residential customers, which poses an immediate threat to human life.

As the Hazard History table at the end of this section indicates, ice storms, heavy snow, and extreme cold has impacted Orange County, including Carrboro and Hillsborough, several times from 1956 to 2008.

Wildfire

Wildfires occur in North Carolina during the dry spring and summer months of the year. The potential for wildfires depends upon recent climate conditions, surface fuel characteristics, and fire behavior. Wildfires can destroy precious natural resources and forestry essential to the survival of wildlife.

Increased development in Orange County, including the Town of Carrboro and Town of Hillsborough, in recent years has increased the potential impact of wildfires as structures that locate near vulnerable woodlands become vulnerable themselves. Because wind fuels wildfires, structures in close proximity to potential wildfire fuels are at risk of damage as wind direction and velocity change.

The frequency and extent of wildfires in Orange County has historically been quite low.

Chemical Spills

A chemical spill or HAZMAT (Hazardous material) spill is an accidental and unwanted release of a hazardous chemical from its container. Chemical spills can occur at chemical storage sites or while chemicals are in transit via roadways or railways. Approximately 6,774 HAZMAT events occur each year nationwide. On average, there will be 991 events. Trucks are responsible for most of the remainder of events. The average distance for trip lengths for gasoline transport is 28 miles; 260 miles is the average trip length for chemical trucks. Even though trucks account for most accidents, it is railway transport that has the greatest potential for concern in many areas. Collisions and derailments can cause very large spills as it is rare that a single car will be damaged. Extremely hazardous substances, as defined by the EPA, can pose a serious threat, whether by rail or other ground transportation.

HAZMAT spills occur at fixed sites each year. Natural disasters, such as floods and earthquakes can cause HAZMAT releases or disturb old HAZMAT release sites (Superfund sites). These same disasters can make it difficult to contain these events once they occur. Also, natural disasters can limit access to the spill, waterlines for fire suppression may be broken, and response personnel and resources may be limited. Flooding and high winds can quickly spread the contaminant, threatening agriculture, water supply and air.

HAZMAT releases pose short and long term threats to people, wildlife, vegetation, and the environment. HAZMAT materials can be absorbed through inhalation, ingestion, or direct contact with the skin.

Orange County Emergency Services maintains an inventory of chemical storage sites within the county and has developed plans to rapidly notify the public of situations involving those sites and have personnel and equipment to effectively respond to incidents involving those sites. Orange County Emergency Services, and the fire departments that serve those sites maintain contact with the site owners and exchange information as necessary to provide for the safety of the public and those that may have to respond to an incident at those locations.

River Basins Dam Failure

There are approximately 80,000 dams listed in the National Inventory of Dams. This number includes impoundment structures greater than or equal to 25 feet in height or impounding 50 acre-feet (an acre-foot equals water 1 foot deep across one acre of land) or more of water, or structures above 6 feet in height whose failure would potentially cause damage downstream. Nine thousand dams nationwide have been designated as high hazard dams. For purposes of this report, dams meeting these criteria, shall be termed regulated dams.

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

Background Information on Dams

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

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

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

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

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

Dam Classifications

Dams are classified in one of three categories:

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

Source: Dam Safety Program, NC Division of Land Resources.
Note: Cost of dam repair and loss of services should be included in economic loss estimate if the dam is a publicly owned utility, such as a municipal water supply dam.

National Dam Safety Program

The National Dam Safety Program Act, enacted in 1996, was established to improve dam safety by:
1. providing assistance grants to state dam safety agencies to improve regulatory programs;
2. funding research to enhance technical expertise as dams are built and rehabilitated;
3. establishing training programs for dam safety inspectors; and
4. creating a National Inventory of Dams.

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

North Carolina Dam Safety Program

The NC Dam Safety Program conducts the following:

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

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

Potential of Dam Failure

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

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

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

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

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

History of Dam and Levee Failures in North Carolina

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

Dams in Orange County

There are 38 regulated dams in Orange County. Three (3) of these are within the town limits of Chapel Hill, which is not included in this plan. Seven (7) of the dams are rated “high hazard” (3 of these are within Chapel Hill),meaning that if a failure were to occur there is a probable loss of one or more human lives and property damage exceeding $200,000. A list of the dams is found in the table below.

Orange County Dams
(including Town of Carrboro and Town of Hillsborough)

Orange County Dams		
Dam Name	**Hazard Potential**	**River or Stream**
Caldmont Lake Dam	Low	Buffalo Creek
Hogan Farms Dam	High	Bolin Creek
Lake Michael Dam	Intermediate	Back Creek-Tr
Arrowhead Lake Dam	Low	East Fork Eno River-Tr
Lake Orange Dam	Intermediate	East Fork Eno River
Johnson Lake Dam	Low	Eno River-Tr
Orange-Alamance Lake Dam	Low	Eno River
Blackburn Lake Dam	Intermediate	Eno River-Tr
Smith Lake Dam	Low	Crabtree Creek-Tr
Fellowship Lake Dam	Low	Seven Mile Creek-Tr
Cane Creek Reservoir Dam	High	Cane Creek
Blackwood Lake Dam	Low	Morgan Creek
Eastwood Lake Dam	High	Booker Creek
University Lake Dam	High	Morgan Creek
Ashley Lake Dam	Low	North Fork Little River-Tr
Piedmont Minerals Lake Dam	Low	Eno River
New Hope Dam	Low	Off New Hope Creek
Clearwater Lake Dam	Low	Big Branch
Hogan Dam	Low	Rocky Run-Tr
Lake Ellen Dam	High	Booker Creek
Rush Dam	Low	Prichard Mill Creek
Wilsondel Pond Dam	Low	Haw Creek-Tr
Spring Valley Lake Dam	Low	Eno River-Tr
Fox Lake Dam	Low	Little Creek-Tr
Pleasant Green Road Dam	Low	Eno River
Carrboro Park Dam	Intermediate	Morgan Creek-Tr
Rogers Dam	Low	Back Creek-Tr
C. S. Burton Dam	Low	Rocky Run-Tr
Lloyd Heron Pond Dam	Low	Buffalo Creek-Tr
Spring Valley Dam	High	Bolin Creek-Tr
Gordon Dam	Low	Eno River-Tr
Hines Pond Dam	Low	Eno River-Tr
Rogers Pond	Low	Frank Creek-Tr
P.W. Scott Lagoon	Low	Toms Creek-Os
Meadowlands	Intermediate	Eno River-Tr
Strayhorn Farm Dam	Intermediate	Stony Creek-Tr
Strayhorn Dam #2	Intermediate	Stony Creek-Tr
Colony Lake	High	Little Creek-Tr

Source: Dam Safety Program, NC Division of Land Resources

Note: Shaded lines indicate dams within the town limits of Chapel Hill (not included in this Plan)

History of Dam Failures in Orange County

There is no recorded history of significant dam failures occurring in Orange County, including the Town of Carrboro and Town of Hillsborough. However, several years ago, a dam breach in Chatham County, which is located directly south of Orange County, caused some flooding problems within the southern limits of the Town of Carrboro.

Earthquake

Earthquakes are geological events that involve movement or shaking of the crust of the earth. Earthquakes are measured in terms of their magnitude and intensity as shown in the table below. Earthquakes can cause devastating destruction to the manmade environment.

Earthquakes are relatively infrequent but not uncommon in North Carolina. From 1568 to 1992, 157 earthquakes have occurred in North Carolina. There is no existing data to indicate that any earthquakes have occurred in Orange County.

North Carolina's vulnerability to earthquakes decreases from west to east in relation to the Eastern Tennessee Seismic Zone. Epicenters are generally concentrated in this active seismic zone, which is second in activity in the eastern United States only to the New York Madrid Fault.

Modified Mercalli Scale of Earthquake Intensity

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

Source: Local Hazard Mitigation Planning Manual, North Carolina Division of Emergency Management, 1998, p. 75.

Since there is no recorded history of earthquakes impacting Orange County and its' municipalities, and it is highly unlikely that a earthquake would impact Orange County, this natural hazard was not analyzed for potential impact on Orange County, including the Town of Carrboro and Town of Hillsborough.

Tsunamis

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

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

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

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

History of Tsunamis in Orange County

Since there is no recorded history of tsunamis impacting North Carolina, and it is highly unlikely that a tsunami would impact Orange County, this natural hazard was not analyzed for potential impact on Orange County.

Volcanoes

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

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

Volcano Hazard Areas Around the Globe

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

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

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

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

Historic Volcanic Eruptions in the United States

Records of volcanic eruptions within the United States are centered in the states of Alaska, Washington, Oregon, California, and Hawaii. Since there are no recorded instances of volcanic eruptions in North Carolina, this natural hazard was not analyzed for potential impact.

Landslides

According to the United States Geological Survey (USGS), landslides are a major geologic hazard that occur in all 50 states, cause $3.5billion in damages per year and cause between 25 and 50 fatalities each year (USGS, 2005). Landslides often occur with other natural hazards such as earthquakes and floods.

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

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

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

USGS Landslide Susceptibility/Incidence		
Category	**Incidence**	**Susceptibility**
1	Low	Low
2	Low	Moderate
3	Low	High
4	Moderate	Moderate
5	Moderate	High
6	High	High

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

An area with a "low" incidence ranking means that less than 1.5% of the area has experienced a landslide in the past. An area with a "moderate" incidence ranking means that between 1.5% and 15% of the area has experienced a landslide in the past. An area with a "high" incidence ranking means that greater than 15% of the area has experienced a landslide in the past. The susceptibility rankings of "low", "moderate" and "high" follow the same percentage classifications for landslide susceptibility for a specific area. The overall likelihood of occurrence of a landslide in Orange County, including the Town of Carrboro and Town of Hillsborough, can be classified as "moderate," especially the southeastern quadrant of the county, which includes the Town of Carrboro, due to the soil types and slopes found in the county.

History of Landslides in Orange County

There are no records of landslides occurring in Orange County although the hazard is classified as "moderate" due to soil types and topography, especially in the southeastern portion of the county.

Plane Crash

Orange County is located approximately 20 miles west of RDU (Raleigh-Durham) Airport. In addition, Horace Williams Airport, a non-commercial airport, is located in Chapel Hill. Some approach and take-off zones for Horace Williams Airport are over the town limits of Carrboro. The vulnerability of the county and its municipalities to a plane crash is minimal but does exist.

RDU Airport, which is centrally located between the city limits of Raleigh and Durham, is a major commercial airport that is also open to the public for general aviation use. The airport has an air traffic control tower and three (3) runways. The main runway, which is concrete/wired/combed construction, is 10,000 feet long and 150 feet wide. A second runway, with an asphalt/grooved surface, is 7,500 feet long and 150 feet wide. The third runway, which is asphalt surfaced, is 3,570 feet long and 100 feet wide. There are an average of 662 airport operations per day with the following categorization by type: 38% air taxi, 33% commercial, 26% transient general aviation, 2% military, and <1% local general aviation.

Horace Williams Airport, located in Chapel Hill, is operated by the University of North Carolina at Chapel Hill (UNC-CH) and is open to the public for general aviation use. The small airport does not have an air traffic control tower. It is equipped with one (1) asphalt-surfaced runway which is 4,005 feet long by 75 feet wide. Aircraft are limited in weight to no more than 12,500 pounds. There are an average of 30 airport operations per day with the following categorization by type: 76% local general aviation, 19% transient general aviation, 5% air taxi, and 1% military operations.

The following table is a history of aviation incidents in Orange County, including the Town of Carrboro and Town of Hillsborough, from January 1, 1964 through December 31, 2008:

History of Aviation Incidents in Orange County 1964 - 2008						
Date	**Nature of Incident**	**Location**	**Injuries**			**Commercial Flight?**
			Fatal	Major	Minor/ None	
4/22/2008	Collision with ground in heavy winds	Chapel Hill			4	No
4/19/2001	Collision with trees	Chapel Hill			2	No
5/25/2000	Collision with ground	Chapel Hill			2	No
6/5/1999	Collision with trees	Chapel Hill		1		No
8/29/1998	Forced landing in wooded area	Chapel Hill			1	No
2/25/1998	Collision with ground	Chapel Hill		3		No
7/5/1996	Forced landing in open pasture	Hillsborough			2	No
4/20/1996	Forced landing	Mebane		1		No
7/10/1994	Collision with drainage ditch	Chapel Hill			2	No
5/25/1994	Departed Runway surface	Chapel Hill			4	No
12/11/1993	Collision with wooded area	Chapel Hill	3			No
1/17/1993	Emergency landing in open area	Mebane		4		No
10/1/1989	Collision with trees	Hurdle Mills	2			No
8/11/1989	Collision with ground	Chapel Hill	1			No
7/21/1986	Collision with ground	Chapel Hill			5	EMS (Emergency Medical Service)
10/1/1985	Collision with tree, power transmission line, and ground	Chapel Hill	2			No
10/30/1981	Collision with ground	Chapel Hill		1		No
6/5/1981	Collision with ground	Chapel Hill	1	3		No
2/7/1981	Collision with trees	Chapel Hill	7			No
9/13/1980	Collision with ground	Chapel Hill			3	No
8/14/1980	Collision with ground	Mebane			1	No
6/13/1977	Gear Collapsed	Chapel Hill			4	No
11/3/1975	Collided with wires/poles	Carrboro			2	No
9/3/1975	Gear Collapsed	Chapel Hill			2	No
11/14/1974	Collision with ground	Chapel Hill			3	No
1/9/1972	Emergency landing off airport	Hillsborough			2	Yes

History of Aviation Incidents in Orange County 1964 - 2008						
Date	**Nature of Incident**	**Location**	**Injuries**			**Commercial Flight?**
			Fatal	Major	Minor/ None	
3/27/1969	Collision with ditch	Hillsborough			1	No
1/19/1969	Collision with trees	Carrboro			2	No
4/24/1968	Collision with ground	Hillsborough	1			No
7/20/1967	Collision with trees	Chapel Hill			2	No
5/10/1967	Collision with ground	Chapel Hill		2		No
12/8/1966	Gear Collapsed	Chapel Hill			1	No
11/21/1964	Collision with trees	Chapel Hill			3	No
3/30/1964	Collision with trees	Chapel Hill			4	No

Source of data: NTSB – Accident Database & Synopses, 2009

2. Hazard Likelihood of Occurrence

The OCHM Team estimated the likelihood of each type of hazard occurring in Orange County. This estimate is based on the local history of the events.

- Highly Likely: Near 100% probability in the next year.
- Likely: Between 10% - 100% probability in the next year, or at least one chance in the next ten years.
- Possible: Between 1% - 10% probability in the next year or at least one chance in the next 100 years.
- Unlikely: Less than 1% probability in the next year, or less than one chance in the next 100 years.

3. Hazard Prone Areas

Certain areas, such as floodplains and steep slopes, are more prone to hazards than others. Many of these are readily identifiable on maps. The OCHM Team identified those areas that are most vulnerable to each natural hazard and determined whether they cover a small, medium, or large proportion of Orange County and Towns.

All but two of the types of natural hazards most likely to affect Orange County (Severe Winter Storms, Thunderstorms and Tornadoes, Drought and Heat Waves, Flooding, and Landslides) have equal potential to occur anywhere within the county and its municipalities (i.e.: one area of the county is not more likely to be affected than another). Landslides are more likely to occur in the southeastern portion of the county, which includes the Town of Carrboro, due to the types of soils and topography prevalent in that geographic area. Flooding, while it can conceivably occur anywhere in the county, is more likely in floodplain areas, which are located throughout unincorporated Orange County, the Town of Carrboro, and the Town of Hillsborough.

4. Hazard Impact

Some natural hazards have greater impacts than others, but occur infrequently (severe earthquakes) and others hazards occur annually or several time a year but cause less damage (thunderstorms). The impact is a combination of the magnitude of the event, how large an area within the community is affected and the amount of human activity in that area. The following table explains how the impact is measured.

Measurement of Types of Hazard Impacts		
Type	**Magnitude (percent of property in county damaged)**	**Severity**
Catastrophic	More than 50%	Multiple deaths, complete shutdown of facilities for 30 days or more. 50% of property damaged.
Critical	25% to 50%	Multiple severe injuries, complete shutdown of critical facilities for 2 weeks, more than 25% of property damaged.
Limited	10% to 25%	Some injuries, complete shutdown of critical facilities for more than a week. More than 10% of property damaged.
Negligible	Less than 10%	Minor injuries, minimal quality of life impact, shutdown of critical facilities for 24-hours or less. Less than 10% of property is severely damaged.

Orange County Hazard Identification and Analysis				
Hazard	**Likelihood of Occurrence**	**Area Small/Medium/ Large**	**Impacts Catastrophic/ Critical/Limited/ Negligible**	**Hazard Index**
Hurricanes	Possible	Large	Critical	Low
Floods	Possible	Large	Negligible	High
Tornadoes	Possible	Medium	Limited	Moderate
Drought and Heat Wave	Possible	Large	Limited	Moderate
Nor'easter	Unlikely	Medium	Limited/ Negligible	Low
Thunderstorms	Highly Likely	Large	Negligible	Low
Severe Winter Storm	Likely	Large	Negligible	Moderate
Wildfire	Possible/Unlikely	Medium	Negligible	Low
Chemical Spills	Likely	Small	Limited	Moderate
River Basins Dam Failure	Possible	Large	Limited	Low
Earthquake	Unlikely	Large	Critical	Low
Tsunamis	Unlikely	Medium	Limited	Low
Volcano	Unlikely	Medium	Critical	Low
Landslide	Possible	Small	Negligible	Moderate
Plane Crash	Possible	Small	Limited	Low

Data Sources: North Carolina Emergency Management, Orange County Emergency Management, "Keeping Natural Hazards From Becoming Disasters"

5. Hazard Historical Summary

Hurricanes have affected Orange County, including the Town of Carrboro and Town of Hillsborough, with the most recent being Floyd (1999) with property damage exceeding $1,000,000, though Fran in 1996 was the most severe. In addition, Floyd inflicted over $10,000 in direct recovery costs on Orange County. Furthermore, it caused major damage to property, businesses and infrastructure that impacted the economy.

Flooding, which historically has caused the largest damage in terms of dollar amounts in Orange County, is caused when drainage basins are not capable of withstanding large amounts of rain in a short period of time (thunderstorms).

Tornados have struck with little or no warning to alert citizens to protect themselves. A tornado occurred in May 2000, which damaged 55 mobile homes, 80 site-built homes and caused several tons of debris.

Severe winter storms can quickly impact and immobilize the county and its' municipalities. With roads blocked, power outages and possible loss of critical services, it can pose an immediate threat to loss of life. The last severe winter storm to impact the county was January 2000, when 20 inches of snow and ice fell. Direct recovery costs for Orange County due to the storm event totaled approximately $45,500.

With increased home development in vulnerable wooded areas, a wildfire can cause heavy losses to homes and forestry. Structures in close proximity of wooded areas are at a greater risk to wildfires than homes in urban areas.

Technological hazards can impact the county in many ways including road closures, power outages, evacuations, and water use restrictions.

The following table depicts natural hazards, for which there is a record, that have affected Orange County, including the Town of Carrboro and Town of Hillsborough, from 1956 through 2008.

Orange County Hazard History
1956-2008

Date	Type of Event	Magnitude*	Deaths**	Injuries**	Property & Crop Damage ($)**
7/22/1998	Excessive Heat	N/A			
1/15/1994	Extreme Cold	N/A	3		500,000
1/19/1994	Extreme Cold	N/A	6		
2/3/1996	Extreme Cold	N/A			
3/23/1993	Flash Flood	N/A			
8/27/1995	Flash Flood	N/A			300,000
8/27/1995	Flash Flood	N/A			750,000

Orange County Hazard History 1956-2008					
Date	Type of Event	Magnitude*	Deaths**	Injuries**	Property & Crop Damage ($)**
9/6/1996	Flash Flood	N/A			5,000
3/19/1998	Flash Flood	N/A			
9/05/1999	Flash Flood	N/A			
9/28/1999	Flash Flood	N/A			
7/23/2000	Flash Flood	N/A			6,400,000
3/20/2003	Flash Flood	N/A			150,000
7/13/2003	Flash Flood	N/A			
8/09/2003	Flash Flood	N/A			
8/17/2004	Flash Flood	N/A			
6/14/2006	Flash Flood	N/A			
6/24/2006	Flash Flood	N/A			
7/25/2006	Flash Flood	N/A			
9/06/2008	Flash Flood	N/A			150,000
3/18/1956	Hail	0.75			
6/26/1961	Hail	1.5			
5/14/1967	Hail	2.75			
6/20/1974	Hail	0.75			
4/2/1983	Hail	1			
5/26/1983	Hail	1			
5/6/1984	Hail	1			
3/24/1985	Hail	0.75			
5/22/1985	Hail	1			
5/22/1985	Hail	1.75			
5/23/1985	Hail	0.88			
6/4/1985	Hail	1.75			
8/27/1985	Hail	1			
4/26/1986	Hail	1.75			
6/2/1988	Hail	1			
9/24/1988	Hail	1.75			
3/15/1989	Hail	0.75			
5/5/1989	Hail	1			
4/2/1990	Hail	0.75			
8/4/1991	Hail	0.75			
6/19/1992	Hail	.75			
6/24/1992	Hail	.75			
3/27/1993	Hail	0.75			
8/3/1993	Hail	1.75			
7/25/1994	Hail	0.75			
6/8/1995	Hail	0.88			
10/27/1995	Hail	1			
10/27/1995	Hail	0.75			

Orange County Hazard History 1956-2008					
Date	Type of Event	Magnitude*	Deaths**	Injuries**	Property & Crop Damage ($)**
7/18/1996	Hail	0.75			
3/5/1997	Hail	0.75			
4/21/1997	Hail	0.75			
3/20/1998	Hail	0.75			
3/20/1998	Hail	0.75			
3/20/1998	Hail	1.75			
4/9/1998	Hail	0.75			
6/2/1998	Hail	0.75			
6/3/1998	Hail	1.75			500,000
6/3/1998	Hail	1.75			
5/17/2000	Hail	1.50			
4/01/2001	Hail	.75			
4/30/2003	Hail	.75			
3/08/2005	Hail	1.75			
5/19/2005	Hail	.75			
4/08/2006	Hail	1.75			
5/14/2006	Hail	1.0			
5/14/2006	Hail	.88			
5/25/2006	Hail	1.0			
6/06/2006	Hail	.75			
7/03/2006	Hail	.88			
6/04/2007	Hail	1.75			
5/09/2008	Hail	.75			
5/09/2008	Hail	1.0			
5/09/2008	Hail	.75			
5/09/2008	Hail	1.75			
5/20/2008	Hail	.88			
5/20/2008	Hail	.75			
6/01/2008	Hail	.75			
6/22/2008	Hail	1.0			
6/22/2008	Hail	.88			
6/22/2008	Hail	.88			
7/23/2008	Hail	.75			
2/3/1998	Heavy Rain	N/A			
2/16/1998	Heavy Rain	N/A			
1/3/1994	Heavy Snow	N/A			
1/6/1996	Heavy Snow	N/A			
2/16/1996	Heavy Snow	N/A			
11/19/2000	Heavy Snow	N/A			
2/3/1998	High Wind	35			
2/16/1998	High Wind	52			

Orange County Hazard History 1956-2008					
Date	**Type of Event**	**Magnitude***	**Deaths****	**Injuries****	**Property & Crop Damage ($)****
3/07/2004	High Wind	65			136,000
11/22/2006	High Wind	35			1,000
4/16/2007	High Wind	46			5,000
2/10/2008	High Wind	43			
9/06/2008	High Wind	50			100,000
9/06/2008	High Wind	39			50,000
7/12/1996	Hurricane	N/A			
9/5/1996	Hurricane	N/A	7	2	
9/04/1999	Hurricane	N/A			3,000,000***
9/15/1999	Hurricane	N/A			3,500,000,000***
2/10/1994	Ice Storm	N/A			
1/11/1996	Ice Storm	N/A			
2/2/1996	Ice Storm	N/A			
12/23/1998	Ice Storm	N/A			
6/14/1997	Lightning	N/A			10,000
8/14/1999	Lightning	N/A		1	
8/22/2003	Lightning	N/A	1		
6/11/2006	Lightning	N/A	1		
12/11/2008	Lightning	N/A			1,500,000
8/3/1993	Thunderstorm	N/A			
8/17/1993	Thunderstorm	N/A			20,000
7/25/1994	Thunderstorm	N/A			30,000
5/19/1995	Thunderstorm	N/A			300,000
5/26/1995	Thunderstorm	N/A			750,000
6/8/1995	Thunderstorm	N/A			10,000
6/10/1995	Thunderstorm	N/A			
6/10/1995	Thunderstorm	N/A			20,000
6/11/1995	Thunderstorm	N/A			30,000
7/13/1975	Thunderstorm Wind	0			
2/23/1980	Thunderstorm Wind	0			30,000
1/4/1982	Thunderstorm Wind	0			15,000
5/8/1984	Thunderstorm Wind	52			
5/22/1985	Thunderstorm Wind	0			
10/15/1985	Thunderstorm Wind	0			
4/26/1986	Thunderstorm Wind	69			
8/11/1996	Thunderstorm Wind	0			
8/11/1996	Thunderstorm Wind	0			
8/11/1986	Thunderstorm Wind	0			
8/27/1986	Thunderstorm Wind	0			
8/4/1987	Thunderstorm Wind	0			
5/16/1988	Thunderstorm Wind	0			

Orange County Hazard History 1956-2008					
Date	Type of Event	Magnitude*	Deaths**	Injuries**	Property & Crop Damage ($)**
5/23/1988	Thunderstorm Wind	0			
6/16/1989	Thunderstorm Wind	0			
5/1/1990	Thunderstorm Wind	0			
6/22/1990	Thunderstorm Wind	0			
7/11/1990	Thunderstorm Wind	0			
7/26/1991	Thunderstorm Wind	0			
4/24/1992	Thunderstorm Wind	0			
6/24/1992	Thunderstorm Wind	0			
6/26/1992	Thunderstorm Wind	0			
8/11/1992	Thunderstorm Wind	0			
8/11/1992	Thunderstorm Wind	0			
5/26/1995	Thunderstorm Wind	0			
1/19/1996	Thunderstorm Wind	0			
4/20/1996	Thunderstorm Wind	0			
5/11/1996	Thunderstorm Wind	0			30,000
5/27/1996	Thunderstorm Wind	0			15,000
6/12/1996	Thunderstorm Wind	0			
7/31/1996	Thunderstorm Wind	0			
3/5/1997	Thunderstorm Wind	50			
6/23/1998	Thunderstorm Wind	50			
6/30/1998	Thunderstorm Wind	50			
7/07/1999	Thunderstorm Wind	50			
7/24/1999	Thunderstorm Wind	50			
7/24/1999	Thunderstorm Wind	50			
5/20/2000	Thunderstorm Wind	50			
5/20/2000	Thunderstorm Wind	50			
5/25/2000	Thunderstorm Wind	60			
5/25/2000	Thunderstorm Wind	60		2	
6/15/2000	Thunderstorm Wind	50			
8/10/2000	Thunderstorm Wind	50			
8/18/2000	Thunderstorm Wind	50			
12/17/2000	Thunderstorm Wind	50			
6/01/2002	Thunderstorm Wind	50		1	
7/04/2002	Thunderstorm Wind	50			
2/22/2003	Thunderstorm Wind	50			
7/22/2003	Thunderstorm Wind	50			
10/14/2003	Thunderstorm Wind	50			
11/19/2003	Thunderstorm Wind	50			
6/11/2004	Thunderstorm Wind	50			
6/23/2004	Thunderstorm Wind	50			
8/17/2004	Thunderstorm Wind	50			

Orange County Hazard History 1956-2008					
Date	Type of Event	Magnitude*	Deaths**	Injuries**	Property & Crop Damage ($)**
9/17/2004	Thunderstorm Wind	50			
6/27/2005	Thunderstorm Wind	50			
7/28/2005	Thunderstorm Wind	50			
7/28/2005	Thunderstorm Wind	50			
8/05/2005	Thunderstorm Wind	50			
4/03/2006	Thunderstorm Wind	50			
5/26/2006	Thunderstorm Wind	50			
7/03/2006	Thunderstorm Wind	50			
7/14/2006	Thunderstorm Wind	50			
9/28/2006	Thunderstorm Wind	50			
8/21/2007	Thunderstorm Wind	50			
3/04/2008	Thunderstorm Wind	55			
5/09/2008	Thunderstorm Wind	52			
6/01/2008	Thunderstorm Wind	50			
6/22/2008	Thunderstorm Wind	50			
6/22/2008	Thunderstorm Wind	52			
6/23/2008	Thunderstorm Wind	50			
7/04/2008	Thunderstorm Wind	50			
7/27/2008	Thunderstorm Wind	50			
8/02/2008	Thunderstorm Wind	50			
7/13/1975	Tornado	F1		1	5,000
3/29/1991	Tornado	F2			
11/23/1992	Tornado	F3	2	10	500,000
1/28/1994	Tornado	F0			
6/19/2000	Tornado	F0			
1/14/2005	Tornado	F0			
3/12/1993	Winter Storm	N/A	2	10	50,000,000
1/18/2000	Winter Storm	N/A			
1/20/2000	Winter Storm	N/A			
1/22/2000	Winter Storm	N/A			
1/24/2000	Winter Storm	N/A			
1/28/2000	Winter Storm	N/A			
1/03/2002	Winter Storm	N/A			
1/06/2002	Winter Storm	N/A			
2/04/2002	Winter Storm	N/A			
2/16/2003	Winter Storm	N/A			
2/27/2003	Winter Storm	N/A			
1/26/2004	Winter Storm	N/A			
2/15/2004	Winter Storm	N/A			
2/26/2004	Winter Storm	N/A			
1/29/2005	Winter Storm	N/A			

Orange County Hazard History 1956-2008					
Date	Type of Event	Magnitude*	Deaths**	Injuries**	Property & Crop Damage ($)**
1/19/2008	Winter Storm	N/A			
2/13/2008	Winter Storm	N/A			
12/15/2005	Winter Weather/Mix	N/A	1	3	
1/18/2007	Winter Weather	N/A			
1/21/2007	Winter Weather	N/A			
12/07/2007	Winter Weather	N/A			20,000
1/17/2008	Winter Weather	N/A			
1/19/2008	Winter Weather	N/A			

* - Hail: diameter in inches; Tornado: Fujita category (1 to 5); Wind: speed in knots.
** - Value is "0" if cell is empty
***- includes damages outside Orange County
Source of data: North Carolina Division of Emergency Management.

B. Vulnerability Assessment

Vulnerability to a natural hazard can be defined as "the extent to which people experience harm and property damage from a hazard". These hazards can result in the loss of life and property damages in the millions. The impact felt may take years to overcome. It is important to know where and to what extent the community is susceptible to the impacts of natural and technological hazards.

Vulnerability to hazards can be assessed in both the present and future. The current level of development and infrastructure generates a set of conditions, which results in every area of the community being vulnerable to some hazard. This level will change with future increases or decreases of population, development and whether the community implements or ignores hazard mitigation. Future vulnerability should not increase because Orange County, the Town of Carrboro and the Town of Hillsborough land use policies, ordinances, and regulations prohibit development in vulnerable (especially flood prone) areas. Each governmental jurisdiction covered by this Hazard Mitigation Plan shares the same level of vulnerability to each type of hazard; the only difference being the exact location of the hazard (i.e.: each jurisdiction could be impacted by a dam breach but since there are many dams within the county, one jurisdiction may be impacted while another is not). No jurisdiction is more "at risk" to a particular hazard than any other jurisdiction included in this Plan.

Orange County is centrally located in the piedmont of North Carolina and contains 400 square miles. The 2000 Census recorded a population of 115,531 with 66,330 of these residents in the Towns of Carrboro, Chapel Hill and Hillsborough. A unique feature of Orange County is the University of North Carolina at Chapel Hill. The student population of the university adds approximately 25,000 people to the County's population during the school year. Orange County has several major highways to include I-40/85, US 70, 15/501, and NC 54, 57, 86, and 157. There are portions of three major river basins – Cape Fear, Neuse, and Roanoke - that are located in the county.

The value of all structures in unincorporated Orange County and the Towns of Carrboro and Hillsborough on lots situated partially or entirely within the special flood hazard area is $439,594,791. In the event of flooding, this number does not represent the total loss potential for the properties. It accounts for the value of the structures located therein. Occupied residential properties also have the potential for damages to personal property such as household contents and motor vehicles. Agricultural properties possess the same personal property loss potential as residential properties and also include potential losses in terms of damage to livestock, crops and equipment. Commercial and industrial parcels may experience great losses in damages to equipment and inventory though there are no known vulnerable commercial or industrial structures. All of these potential losses will have a great impact on the local county economy.

The Total Building-Only Values for structures located within the unincorporated areas of Orange County is $3,576,616,323. The Total Building-Only Values for structures located within Carrboro is $1,179,137,738 and the value for Hillsborough is $455,549,819. If a catastrophic event, such as a devastating tornado, were to hit Orange County, property losses could potentially be in the hundreds of millions of dollars, if not into the billions.

If structures were to be damaged or destroyed, the typical building construction cost in North Carolina, per square foot, for various types of uses is as follows:

Commercial:	$140.00
Single Family Residential:	$108.00
Multi Family Residential:	$98.00
Industrial:	$82.00
Utility:	$40.00

Source: International Code Council (ICC), 2009

Appendix A includes a series of maps that help illustrate Orange County's, including the Town of Carrboro and Town of Hillsborough, vulnerability to natural disasters. The following table is a brief summary of each jurisdiction's hazard vulnerability.

1. Hazard Vulnerability Summary

Hazard Vulnerability			
Hazard	**Unincorporated Orange County**	**Carrboro**	**Hillsborough**
Hurricanes	Hurricanes have impacted the jurisdiction in the past and are expected to have an impact in the future. The nature of hurricanes causes them to have an impact over a large geographic area.	Hurricanes have impacted the jurisdiction in the past and are expected to have an impact in the future. The nature of hurricanes causes them to have an impact over a large geographic area.	Hurricanes have impacted the jurisdiction in the past and are expected to have an impact in the future. The nature of hurricanes causes them to have an impact over a large geographic area.
Floods	Flooding has occurred in the past and will likely occur in the future. Governmental regulations prohibit new structures from being located	Flooding has occurred in the past and will likely occur in the future. Governmental regulations prohibit new structures	Flooding has occurred in the past and will likely occur in the future. Governmental regulations allow the construction of

Hazard Vulnerability			
Hazard	**Unincorporated Orange County**	**Carrboro**	**Hillsborough**
	in floodplains, therefore, additional future losses are not expected. Relatively few structures are located within floodplains in the unincorporated areas. As Map 8 in Appendix A shows, the vast majority of structures located within floodplains are within the corporate limits of Chapel Hill and Carrboro. Floodplains in Orange County tend to be relatively narrow due to the fact the county is located in the upper reaches of river basins.	from being located in floodplains, therefore, additional future losses are not expected. Approximately 67 single family units are located within floodplain areas. Approximately 20 multi-family units (in 1 complex 2 buildings.) and 24 mobile homes are located in floodplain areas. An estimated 275 people reside in these 111 units. In addition, 2 commercial structures, 6 accessory and 15 public/quasi-public structure are located in floodplain areas. The building value of all structures located within a floodplain area is approximately $20,906,250.	new structures in floodplain areas provided the finished elevation is a minimum of 2-feet above the documented flood level. According to National Flood Insurance Program (NFIP) information, 18 structures are located in floodplain areasThe value of these structures is approximately $5,130,167.
Tornados	Tornados have struck Orange County in the past and it is reasonable to expect they will affect the county in the future. Tornados in the past decade have struck in the central and northern sections of the county. Other than operating an emergency warning system, mitigating for tornados is impractical.	Tornados have struck Orange County in the past and it is reasonable to expect they will affect the county in the future. Tornados have not impacted Carrboro in the last decade but the threat of a tornado does exist. Other than operating an emergency warning system, mitigating for tornados is impractical.	Tornados have struck Orange County in the past and it is reasonable to expect they will affect the county in the future. Some tornados in the past decade have touched down extremely close to Hillsborough. Other than operating an emergency warning system, mitigating for tornados is impractical.
Droughts and Heat W	Periods of drought and heat waves have impacted Orange County in the past and ensuring adequate water supply is an issue for the county and its municipalities because the county is located at the headwaters of three major river basins. Therefore, no sizeable rivers flow within the county. Water supplies are stored in reservoirs and most of the population in the unincorporated area has	Periods of drought and heat waves have impacted Carrboro in the past and ensuring adequate water supply is an issue. The vast majority of Carrboro's water is supplied via water storage reservoirs.	Periods of drought and heat waves have impacted Hillsborough in the past and ensuring adequate water supply is an issue. The vast majority of Hillsborough's water is supplied via water storage reservoirs.

Hazard Vulnerability			
Hazard	**Unincorporated Orange County**	**Carrboro**	**Hillsborough**
	individual wells which utilize groundwater.		
Nor'easter	Nor'easters rarely reach as far inland as Orange County. Vulnerability to this hazard is relatively low.	Nor'easters rarely reach as far inland as Orange County. Vulnerability to this hazard is relatively low.	Nor'easters rarely reach as far inland as Orange County. Vulnerability to this hazard is relatively low.
Thunderstorms	Thunderstorms are a common occurrence in Orange County. Hazards associated with thunderstorms include flooding due to heavy rains, lightning strikes, tornados, and high winds.	Thunderstorms are a common occurrence in Orange County. Hazards associated with thunderstorms include flooding due to heavy rains, lightning strikes, tornados, and high winds.	Thunderstorms are a common occurrence in Orange County. Hazards associated with thunderstorms include flooding due to heavy rains, lightning strikes, tornados, and high winds.
Severe Winter Storm	Severe winter weather, including "ice storms", is fairly common in Orange County, although it does not necessarily occur each winter.	Severe winter weather, including "ice storms", is fairly common in Orange County, although it does not necessarily occur each winter.	Severe winter weather, including "ice storms", is fairly common in Orange County, although it does not necessarily occur each winter.
Wildfire	Wildfires have not historically been a significant threat in Orange County. However, more development of rural areas can increase vulnerability to this hazard.	Wildfires have not historically been a significant threat in Carrboro. The majority of the jurisdiction is developed in an urban/suburban pattern, thereby minimizing the vulnerability to this hazard.	Wildfires have not historically been a significant threat in Hillsborough. The majority of the jurisdiction is developed in an urban/suburban pattern, thereby minimizing the vulnerability to this hazard.
Chemical Spills	Approximately 30 chemical storage reportable sites with reportable quantities (under the Emergency Planning and Community Right to Know Act) are located within Orange County, Carrboro, and Hillsborough. In addition, the county is vulnerable to transportation spills since Interstates 40 and 85 traverse the county as do railways and state highways.	Approximately 30 chemical storage reportable sites with reportable quantities (under the Emergency Planning and Community Right to Know Act) are located within Orange County, Carrboro, and Hillsborough. In addition, Carrboro is vulnerable to transportation spills since State Highway 54 passes through the municipal limits as does a railway spur.	Approximately 30 chemical storage reportable sites with reportable quantities (under the Emergency Planning and Community Right to Know Act) are located within Orange County, Carrboro, and Hillsborough. In addition, Hillsborough is vulnerable to transportation spills since Interstate 85 and other state highways pass through the municipal limits as does a railway.
River Basins Dam Failure	There are 4 water supply reservoirs located within Orange County, one of which (University Lake) is located primarily within Carrboro's jurisdiction. In addition, there are numerous	Carrboro is vulnerable primarily to dam failure associated with the University Lake water supply reservoir. Several of the small farm ponds/stormwater	Hillsborough is vulnerable to dam failure of two of the water supply watersheds (Eno Reservoir and Lake Orange). In addition, several of the small farm ponds/ stormwater

Hazard Vulnerability			
Hazard	**Unincorporated Orange County**	**Carrboro**	**Hillsborough**
	(approximately 30) farm ponds and stormwater management ponds which utilize earthen dams. Dam failure on any of the water supply reservoirs would be expected to cause downstream flooding. Dam failure on farm ponds and stormwater management ponds could cause flooding downstream as well.	management ponds are also located upstream or within the municipal limits of Carrboro.	management ponds are also located upstream or within the municipal limits of Hillsborough
Earthquake	The closest active seismic zone to Orange County is the Eastern Tennessee Seismic Zone. There have not been any intense earthquakes in this area since 1928 (when records began to be kept). The location of Orange County to the Eastern Tennessee Seismic Zone puts the county and its municipalities at low risk of experiencing any significant seismic activity.	The closest active seismic zone to Orange County is the Eastern Tennessee Seismic Zone. There have not been any intense earthquakes in this area since 1928 (when records began to be kept). The location of Orange County to the Eastern Tennessee Seismic Zone puts the county and its municipalities at low risk of experiencing any significant seismic activity.	The closest active seismic zone to Orange County is the Eastern Tennessee Seismic Zone. There have not been any intense earthquakes in this area since 1928 (when records began to be kept). The location of Orange County to the Eastern Tennessee Seismic Zone puts the county and its municipalities at low risk of experiencing any significant seismic activity.
Tsunamis	Orange County is located a significant distance from the Atlantic coastal area. Therefore, vulnerability from tsunamis is minimal.	Orange County is located a significant distance from the Atlantic coastal area. Therefore, vulnerability from tsunamis is minimal.	Orange County is located a significant distance from the Atlantic coastal area. Therefore, vulnerability from tsunamis is minimal.
Volcano	There are no known volcanoes in the vicinity of Orange County. Therefore, vulnerability from volcanoes does not exist at this time.	There are no known volcanoes in the vicinity of Orange County. Therefore, vulnerability from volcanoes does not exist at this time.	There are no known volcanoes in the vicinity of Orange County. Therefore, vulnerability from volcanoes does not exist at this time.
Landslide	Parts of Orange County have soil types and slopes that are vulnerable to landslides. The greatest threat is in the southeastern quadrant of the county.	Carrboro is located in the southeastern quadrant of the county where soil types and slope characteristics present a moderate level of landslide vulnerability.	Soil types and slopes in the vicinity of Hillsborough are such that vulnerability to landslides is less than that in other areas of the county.
Plane Crash	Orange County is located approximately 20 miles west of RDU airport. The vulnerability of the county and its municipalities to a plane crash is minimal but does exist. In addition, Horace Williams airport, a	Orange County is located approximately 20 miles west of RDU airport. The vulnerability of the county and its municipalities to a plane crash is minimal but does exist. In addition, Horace Williams airport, a	Orange County is located approximately 20 miles west of RDU airport. The vulnerability of the county and its municipalities to a plane crash is minimal but does exist. In addition, Horace Williams airport, a

Hazard Vulnerability			
Hazard	**Unincorporated Orange County**	**Carrboro**	**Hillsborough**
	non-commercial airport, is located in Chapel Hill.	non-commercial airport, is located in Chapel Hill. Some approach and take-off zones are over the city limits of Carrboro.	non-commercial airport, is located in Chapel Hill.

2. Critical Facilities

A critical facility is any facility that if destroyed or damaged to the extent it cannot be utilized, a severe life, health, or safety impact on the public would be created. To a certain extent most or all roadways and bridges within the county could be considered critical facilities if they were damaged and alternate access was not available. However, for the purposes of this Hazard Mitigation Plan, the focus shall be on buildings.

The hospital within Orange County, which is affiliated with UNC-Chapel Hill, is located within the municipal limits of Chapel Hill. The Town of Chapel Hill has prepared a separate Hazard Mitigation Plan. There are several critical facilities within Orange County, Carrboro, and Hillsborough including fire stations, emergency management operations, and law enforcement offices. Both Hillsborough and Carrboro operate their own police departments. Each department operates from its own building within its respective municipal limits. Carrboro also operates its own fire department which is housed separately from the police department. Hillsborough and the unincorporated areas of Orange County rely on nine separate volunteer fire departments for fire suppression services. There are 11 volunteer fire stations located within the county.

Orange County's Emergency Services Department, which operates out of its own facility, provides disaster response, EMS (Emergency Medical Services), and 9-1-1 services for the unincorporated area and the municipalities.

3. Analysis

Population tends to be concentrated in the municipal areas (Chapel Hill, Carrboro, and Hillsborough) of the county. Therefore, these areas of more dense population would likely suffer a greater impact from a hazard event, in terms of human and structural measures, than the unincorporated portions of the county. The unincorporated portions of the county contain a relatively large population, in terms of the actual number of people, but the population is not densely concentrated.

Orange County and Carrboro have regulations in place to prevent new construction in flood hazard areas. Both of these jurisdictions contain structures within flood hazard areas that were constructed prior to adoption of the new regulations. Additionally, these jurisdictions limit development in areas of steep slopes. The Town of Hillsborough historically has restricted development less than other jurisdictions and therefore administers a less restrictive code of ordinances that allows development to occur in areas that would not be allowed in other jurisdictions.

Orange County, as a whole, is an area experiencing moderate population growth. Regulations and policies are in place that attempt to “steer” growth into the municipal areas, including the Towns of Carrboro and Hillsborough, where population can be better and more efficiently served with public services and the rural character of the county can be preserved. Orange County recently updated its Comprehensive Plan and included policies to further limit housing density in rural areas. The Comprehensive Plan update was adopted November of 2008. Regulation revisions implementing the Comprehensive Plan are expected to be adopted over the next few years.