

# 4 | Hazard Identification

44 CFR Subsection D §201.6(c)(2): [The plan shall include] A risk assessment that provides the basis for activities proposed in the strategy to reduce losses from identified hazard assessments must provide sufficient information to enable the jurisdiction to identify appropriate mitigation actions to reduce losses from identified hazards.

The following section describes the Risk Assessment process for the development of the Hoke Regional Hazard Mitigation Plan. It describes how the HMPC met the following requirements from the 10-step planning process:

- < Planning Step 4: Assess the Hazard
- < Planning Step 5: Assess the Problem

7 - Understand the hazard that a hazard would have on people, services, facilities, and structures in a community and refers to

This risk assessment covers the entire geographic area of Cumberland and Hoke Counties in North Carolina. The risk assessment process identifies and profiles relevant hazards and assesses the exposure of lives, property, and infrastructure to these hazards. The process allows for a better understanding

mitigation actions to reduce risk from future hazard events. This risk assessment followed methodology described in the FEMA publication, *Identifying Your Risks: Identifying Hazards and Estimating Losses* (FEMA 232602), which breaks the assessment down into the following steps:

- 1) Identify Hazards;
- 2) Profile Hazard Events;
- 3) Inventory Assets; and
- 4) Estimate Losses.

Data collected through this process has been incorporated into the following sections of this Section: 4 Hazard Identification identifies the natural and man-made hazards that threaten the planning area.

Section 5: Hazard Profiles discusses the threat to the planning area and describes previous occurrences of hazard events and the likelihood of future occurrences.

Section 6: Vulnerability Assessment assesses the vulnerability of the assets at risk, critical facilities, and future development trends.

Section 7: Capability Assessment inventories existing mitigation activities and policies, regulations, and plans that pertain to mitigation and can affect net vulnerability.

The HMPC conducted a hazard identification study to determine the man-made hazards that threaten Cumberland and Hoke Counties. Existing hazard data from NCEM, FEMA, the National Oceanic and Atmospheric Administration (NOAA), the National Hurricane Center (NHC), National Climatic Data Center (NCDC), and other sources were examined to assess the significance of these hazards to the



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planning area. Significance was measured in general terms and focused on key criteria such as frequency and resulting damage, which includes deaths and injuries, as well as property and economic damage.

To further focus on the list of identified hazards for this plan, the HMPC researched past events that resulted in a federal disaster declaration in order to identify known hazards. Tables 4.1 and 4.2 present a list of major disaster declarations that have occurred in Cumberland and Hoke Counties, respectively, since 1953. These tables present the foundation for identifying hazards that pose the greatest risk to the region.

Table 4.1 - Major Disaster Declarations in Cumberland County (1953-2015)

Declaration #	Date	Event Details
DR-699	03/30/1984	Severe Storms, Tornadoes
DR-1134	09/06/1996	Hurricane Fran
DR-1240	08/27/1998	Hurricane Bonnie
DR-1292	09/16/1999	Hurricane Floyd & Irene
DR-1490	09/18/2003	Hurricane Isabel
DR-1546	09/10/2004	Tropical Storm Frances
DR-1969	04/19/2011	Severe Storms, Tornadoes and Flooding

Source: FEMA

Table 4.2 - Major Disaster Declarations in Hoke County (1953-2015)

Declaration #	Date	Event Details
DR-1134	09/06/1996	Hurricane Fran
DR-1292	09/16/1999	Hurricane Floyd & Irene
DR-1312	01/31/2000	Winter Storm
DR-1546	09/10/2004	Tropical Storm Frances
DR-1969	04/19/2011	Severe Storms, Tornadoes and Flooding

Source: FEMA

Table 4.3 documents the decisions made by the HMPC as it relates to those hazards that were identified, analyzed, and addressed through the development of the regional plan. This table examines where or not the hazard was included in the 2013 State of North Carolina Hazard Mitigation Plan as well as the individual county plans from 2011. This table summarizes those hazards that were identified for inclusion as well as those that were not identified and the reason for the decision.

Table 4.3 Hazard Evaluation

Hazard	Included in State 2013 Plan?	Included in Cumberland County 2011 Plan?	Included in Hoke County 2011 Plan?	Identified as a significant hazard to be included in the Regional Plan?
Coastal Hazards (coastal flooding, coastal erosion, storm surge & sea level rise)	Yes	No	No	No. Cumberland and Hoke Counties lie 100 miles inland from the coast
Dam/Levee Failure	Yes	No	Yes	Yes
Drought	Yes	Yes	Yes	Yes
Earthquake	Yes	Yes	Yes	Yes



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Hazard	Included in State 2015 Plan?	Included in Cumberland Co 2011 Plan ?	Included in Hoke Co 2011 Plan?	Identified as a significant hazard to be included in the Regional Plan?
Erosion	No	No	Yes	Yes
Extreme Heat	No	Yes	Yes	Yes
Hurricane/Tropical Storm	Yes	Yes	Yes	Yes
Inland Flooding: 1000 year	Yes	Yes	Yes	Yes
Severe Weather (thunderstorm wind, lightning, & hail)	Yes	Yes	Yes	Yes
Sinkhole	Yes	No	Yes	Yes
Tornado	Yes	Yes	Yes	Yes
Wildfire	Yes	Yes	Yes	Yes
Winter Storm	Yes	Yes	Yes	Yes

The following hazards were evaluated by the HMPC and determined to be non-hazards that should not be included in the plan:

- ◁ Avalanche According to the Federal Emergency Management Agency (FEMA) hazard identification and risk assessment, this hazard is only relevant to the western United States.
- ◁ Landslide Based on the national U.S. Geological Survey map of landslide susceptibility and incidence, Cumberland and Hoke Counties rest within a zone of low incidence. The topography of the upper coastal plain does not provide enough elevation relief to support a landslide event.
- ◁ Tsunami- According to a 2009 report by the USGS titled Regional Assessment of Tsunami Potential in the Gulf of Mexico, there are no significant earthquake sources within the Atlantic Ocean that are likely to generate tsunamis. Furthermore, Cumberland and Hoke Counties lie 100 miles inland from the coast.
- ◁ Volcano There are no known active volcanoes in the United States east of central New Mexico.

The complete list of hazards for inclusion in this 2015 Regional Plan is as follows

- z Dam/Levee Failure
- z Drought
- z Earthquake
- z Erosion
- z Extreme Heat
- z Hurricane/Tropical Storm
- z Inland Flooding: 1000 year
- z Severe Weather (thunderstorm wind, lightning & hail)
- z Sinkhole
- z Tornado
- z Wildfire



z Winter Storm

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44 CFR Subsection D §201.6(c)(2)(i): [The risk assessment shall include a] description of the location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazards and on the probability of future events.

The hazards identified in Section 4 Hazard Identification, are profiled individually in this section. Information provided by members of HMPC has been integrated into this section with information from other data sources.

Each hazard is profiled in the following format:

#### Hazard Description

This section provides a description of the hazard followed by details specific to the area.

#### Location and Spatial Extent

This section includes information on the hazard extent, seasonal patterns, speed of onset/duration, magnitude and any secondary effects.

#### Past Occurrences

This section contains information on historical events, including the location of the hazard within or near the region/planning area.

#### Probability of Future Occurrence

This section gauges the likelihood of future occurrences based on past events and existing data. Frequency is determined by dividing the number of events observed by the number of years on record and multiplying by 100. This provides the percent chance of the event happening in any given year (10 hurricanes or tropical storms over a 30 year period equates to a 33 percent chance of a tropical hurricane or tropical storm in any given year). The likelihood of future occurrences is categorized into one of the classifications as follows:

- ◁ *Highly Likely* Near 100 percent chance of occurrence within the next year
- ◁ *Likely* Between 10 and 100 percent chance of occurrence within the next year (recurrence interval of 10 years or less)
- ◁ *Possible* Between 1 and 10 percent chance of occurrence within the next year (recurrence interval of 11 to 100 years)
- ◁ *Unlikely* Less than 1 percent chance of occurrence within the next 100 years (recurrence interval of greater than every 100 years)

#### Consequence Analysis

This section examines effects of the hazard on people, first responders, continuity of operations, environment, economy and natural resources.

Those hazards determined to be of high or medium significance were characterized as priority hazards that required further evaluation in Section 7 Vulnerability Assessment. Significance was determined by

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frequency of the hazard and resulting damage to lives and property, crop and economic damage. Hazards occurring infrequently or having little to no regional planning area were determined to be of low significance and not considered a priority hazard. These criteria a HMPC to prioritize hazards of greatest significance and focus resources where they are most needed.

Study Area

Cumberland County includes nine participating municipalities and Hoke County contains one participating municipality. Table 5.1 provides a summary of the participating jurisdictions by County. Figure 5.1 provides a base map, for reference, of Cumberland and Hoke Counties and the participating municipalities.

Table 5.1 - Participating Jurisdictions

Cumberland County	
City of Fayetteville	Town of Linden
Town of Eastover	Town of Spring Lake
Town of Falcon	Town of Stedman
Town of Godwin	Town of Wade
Town of Hope Mills	
Hoke County	
City of Raeford	

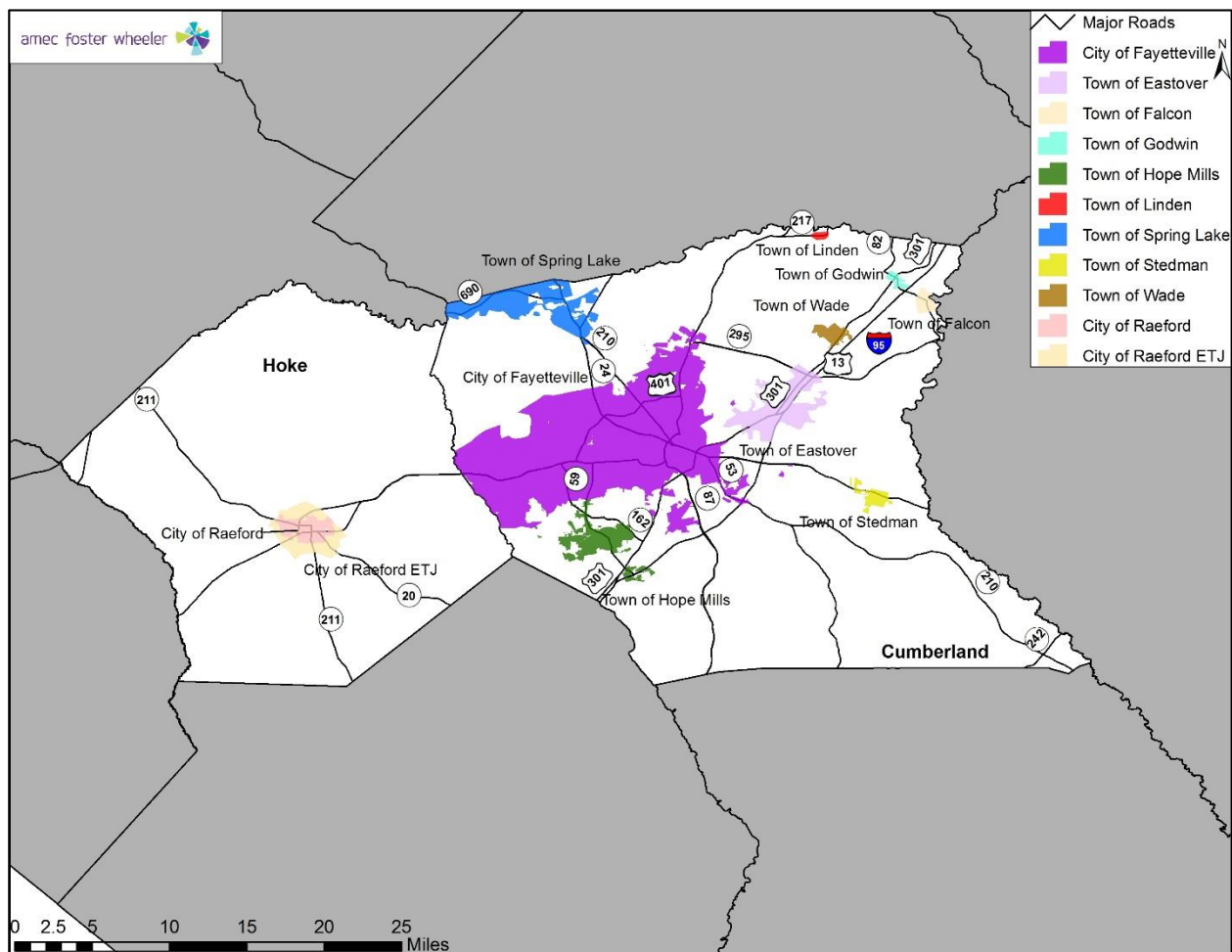


Figure 5.1 - Cumberland and Hoke County Base Map



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tracking severe weather since 1950. Their Storm Events Database contains archives of destruction or weather data and information which includes local, intense and damaging events. NCDC receives data from the National Weather Service (NWS). The NWS receives their information from a variety of sources, which include but are not limited to county, state and federal emergency management officials, local law enforcement officials, SkyWarn spotters, NWS damage surveys, newspaper clipping services, insurance industry and the general public, among others. This database contains weather events that occurred in Cumberland and Hoke Counties between January 1950 and May 2015. Table 5.2 summarizes these events.

Table 5.2- NCDC Severe Weather Reports (January 1950-May 2015)

Type	# of Events	Property Damage	Crop Damage	Deaths (Direct)	Injuries (Direct)
<b>Cumberland County</b>					
Cold/Wind Chill	1	\$0	\$0	0	0
Flash Flood	40	\$2,132,000	\$0	0	0
Flood	2	\$0	\$0	0	0
Hail	128	\$1,025,000	\$0	0	0
Heat	2	\$0	\$0	1	0
Heavy Rain	4	\$1,500,000	\$0	0	0
High Wind	5	\$101,000	\$0	0	0
Hurricane (Typhoon)	6	\$28,000	\$0	0	0
Lightning	15	\$1,836,000	\$0	0	4
Strong Wind	9	\$118,000	\$7,000	0	1
Thunderstorm Wind	198	\$1,328,500	\$0	0	8
Tornado	23	\$132,127,500	\$0	5	169
Tropical Storm	1	\$0	\$0	0	0
Winter Storm	19	\$0	\$0	0	0
Winter Weather	7	\$0	\$0	1	0
<b>Hoke County</b>					
Cold/Wind Chill	1	\$0	\$0	0	0
Flash Flood	15	\$160,000	\$0	0	0
Flood	2	\$0	\$0	0	0
Hail	52	\$0	\$0	0	0
Heat	1	\$0	\$0	0	0
Heavy Rain	2	\$0	\$0	0	0
Heavy Snow	1	\$0	\$0	0	0
High Wind	3	\$1,000	\$0	0	0
Hurricane (Typhoon)	5	\$0	\$0	0	0
Lightning	3	\$60,000	\$0	0	0
Strong Wind	5	\$17,000	\$5,000	0	0
Thunderstorm Wind	89	\$427,000	\$0	0	4
Tornado	10	\$805,250	\$0	1	6
Winter Storm	18	\$0	\$0	0	0
Winter Weather	5	\$0	\$0	0	0
<b>Total:</b>	<b>672</b>	<b>\$141,666,250</b>	<b>\$12,000</b>	<b>8</b>	<b>192</b>

Source: National Climatic Data Center Storm Events Database, September 2015

Note: Losses reflect totals for all impacted areas in the county.



## 5.1 Dam/Levee Failure

### 5.1.1 Hazard Description

#### *Dam Failure*

A dam is a barrier constructed across a watercourse that stores, diverts water. Dams are usually constructed of earth, rock, or concrete. The water impounded behind a dam is referred to as a reservoir and is measured in acre feet. One acre foot is the volume of water that covers one acre of land to a depth of one foot. Dams can benefit farm land, provide recreation areas, generate electrical power, and help control erosion and flooding issues.

A dam failure is the collapse or breach of a dam that causes downstream flooding. Dam failures may be caused by natural events, human caused events, or a combination. Due to the lack of advance warning, failures resulting from natural events, such as hurricanes, earthquakes, or landslides, may be particularly severe. Prolonged rainfall and subsequent flooding is a common cause of dam failure.

Dam failures usually occur when the spillway capacity is inadequate and water overtops the dam or internal erosion in dam foundation occurs (also known as piping). If internal erosion or overtopping of a full structural breach, a high velocity, debris laden wall of water is released and rushes downstream, damaging or destroying anything in its path. Overtopping is the primary cause of earthen dam failure in the United States.

Dam failures can result from one or a combination of the following:

- ◁ Prolonged periods of rainfall and flooding;
- ◁ Inadequate spillway capacity, resulting in excess overtopping flows;
- ◁ Internal erosion caused by embankment or foundation leakage or piping;
- ◁ Improper maintenance, including failure to remove trees, repair internal seepage problems, replace lost material from the sections of the dam and abutments, or maintain gates, valves, and other operational components;
- ◁ Improper design, including the use of improper construction methods and construction practices;
- ◁ Negligent operation, including the failure to remove or open gates or valves during high flow periods;
- ◁ Failure of upstream dams on the same waterway; and
- ◁ High winds, which can cause significant wave action and substantial erosion.

Water released by a failed dam generates tremendous energy and can cause a flood that is catastrophic to life and property. A catastrophic dam failure could challenge local response capabilities and require evacuations to save lives. Impacts to life safety will depend on the warning time and the resources available to notify and evacuate the public. Major casualties and loss of life could result, as well as property damage and health issues. Potentially catastrophic effects to bridges and homes are also of major concern. Associated water quality and health concerns could also be issues. Factors that influence the potential severity of a full or partial dam failure are the amount of water impounded; the density, type, and value of development and infrastructure located downstream; and the speed of failure.

Each state has definitions and methods to determine the Hazard Potential of a dam. In North Carolina, dams are regulated by the state if they are 25 feet or more in height and impound 50 acre feet or more. Dams and impoundments smaller than that may fall under state regulation if it is determined that failure



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of the dam could result in loss of human life or significant damage to property below the dam. The height of a dam is measured from the highest point on the crest of the dam to the lowest point on the downstream toe, and the storage capacity is the volume impounded at the elevation of the highest point on the crest of the dam.

Dam Safety Program engineers determine the "potential" of a dam, meaning the probable damage that would occur if the structure failed, in terms of loss of human life and economic loss or environmental damage. Dams are assigned one of three classes based on the nature of their hazard potential:

1. Class A (Low Hazard) includes dams located where failure may damage uninhabited low value non-residential buildings, agricultural land, or low volume roads.
2. Class B (Intermediate Hazard) includes dams located where failure may damage highways, secondary roads, cause interruption of use or service of public utilities, cause minor damage to isolated homes, or cause minor damage to commercial and industrial buildings. Damage to these structures will be considered minor only when they are located in an area not directly subjected to the direct path of the breach flood wave; and they will experience no more than 1.5 feet of flood rise due to breaching above the lowest ground elevation adjacent to the outside foundation walls or no more than 1.5 feet of flood rise above the lowest floor elevation of the structure.
3. Class C (High Hazard) includes dams located where failure will likely cause loss of life or serious damage to homes, industrial and commercial buildings, important public utilities, primary highways, or major railroads.

Table 5.3-Dam Hazard Classifications

Hazard Classification	Description	Quantitative Guidelines
Low	Interruption of road service, low volume roads	Less than 25 vehicles per day
	Economic damage	Less than \$30,000
Intermediate	Damage to highways, interruption of service	25 to less than 250 vehicles per day
	Economic damage	\$30,000 to less than \$200,000
	Loss of human life*	Probable loss of 1 or more human life
High	Economic damage	More than \$200,000
	*Probable loss of human life due to breach of roadway or bridge on or below the dam	250 or more vehicles per day

Source: NCDENR

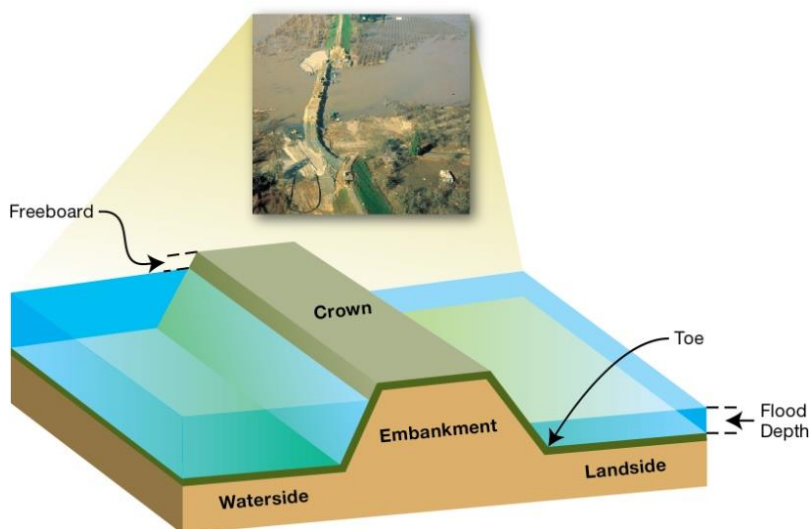
### Levee Failure

A levee is a man-made structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water. Levees are often associated with floodwalls and drainage devices, which are constructed and operated in conjunction with the levees to take water from the landward side to the water side. A levee drainage system may include culverts, canals, ditches, storm sewers, and/or pumps.

Levees and floodwalls are constructed from the earth, compacted soil or artificial materials, such as concrete or steel. To protect against erosion, the top of levees can be covered with grass and

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gravel or hard surfaces like stone, asphalt, or concrete. Levees and floodwalls are typically built parallel to a waterway, most often a river, in order to reduce the risk of flooding to the land behind it. Figure 5.2 below shows the components of a typical levee.



Source: FEMA, What is a Levee Fact Sheet, August 2011  
 Figure 5.2 - Components of a Typical Levee

Levees provide strong flood protection, but they are not fail-safe. Levees are designed to protect against a specific flood level and could be overtopped during severe weather events. Levees reduce, eliminate, or delay the risk to individuals and structures behind them. A levee system failure can create severe flooding and high water velocities. It is important to remember that no levee provides protection from events for which it was not designed, and proper operation and maintenance are necessary to reduce the probability of failure.

### 5.1.2 Location and Spatial Extent

Table 5.4 provides details for dams classified as high hazard in the North Carolina Dam Inventory that are located within Cumberland and Hoke Counties. Figure 5.3 reflects the location of high hazard dams within the Counties. It should be noted that there are 61 additional dams located in Cumberland County (1 intermediate hazard, 60 low hazard), as well as 21 additional low hazard dams located in Hoke County.

Table 5.4 - North Carolina Dam Inventory for Cumberland and Hoke Counties

Dam Name	NIDID	County	Height (ft)	NID Storage (acre feet)	Dam Status	River <sup>1</sup>
Clark Pond Dam	NCO1229	Cumberland	24.0	Not available	IMPOUNDING	Cross Creeks
Kiest Lake Dam	NCO0024	Cumberland	25.0	72	EXEMPT/DOD	Little River
Lake Rim Dam	NCO0026	Cumberland	20.0	256	IMPOUNDING	Bones Creek
McFayden Lake Dam	NCO0031	Cumberland	14.0	52	IMPOUNDING	Tank Creek

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Dam Name	NIDID	County	Height (ft)	NID Storage (acre feet)	Dam Status	River <sup>1</sup>
Hutaff Lake Dam	NC00032	Cumberland	15.9	108	EXEMPT/DOD	Stewart Creek
Gates Four Dam	NC00036	Cumberland	25.0	164	IMPOUNDING	Little Rockfish Creek
The Lakes Dam	NC02130	Cumberland	17.5	17	IMPOUNDING	Beaver Creeks
Murray Hill Lake Dam	NC04760	Cumberland	12.0	400	BREACHED	Branson Creeks
Tallywood Dam	NC02136	Cumberland	23.0	43	IMPOUNDING	Branson Creek Tributary
Loch Lommond	NC02137	Cumberland	21.0	Not available	IMPOUNDING	Stewarts Creek
Hope Mills Dam #1	NC01121	Cumberland	33.0	816	BREACHED	Little Rockfish Creek
Lake Charles Dam	NC01122	Cumberland	21.0	130	BREACHED	Rockfish Creeks
Long Valley Farm Lake Dam	NC01126	Cumberland	18.0	560	IMPOUNDING	Jumping Run Creek
Glenville Lake Dam	NC01130	Cumberland	16.0	132	IMPOUNDING	Little Cross Creek
Kornbow Lake Dam	NC01131	Cumberland	18.5	236	IMPOUNDING	Little Cross Creek
Mintz Lake Dam	NC01132	Cumberland	12.0	49	IMPOUNDING	Little Cross Creek
Forrest Lake Dam	NC01133	Cumberland	15.0	222	IMPOUNDING	Branson Creek
Wallace Lake Dam	NC01134	Cumberland	14.0	400	BREACHED	Buckhead Creek
Cumberland Lake Dam	NC01135	Cumberland	12.0	200	BREACHED	Buckhead Creek
Beaver Creek Dam	NC01143	Cumberland	22.0	650	IMPOUNDING	Beaver Creek
Arran Lakes Dam	NC01144	Cumberland	21.0	120	IMPOUNDING	Little Beaver Creek
Rhodes Lake Dam	NC01145	Cumberland	15.2	1920	IMPOUNDING	Black River
Bonnie Doone Lake Dam	NC01146	Cumberland	15.0	110	IMPOUNDING	Little Cross Creek
Rose Lake Dam	NC01152	Cumberland	15.2	480	BREACHED	Cross Creek



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Dam Name	NIDID	County	Height (ft)	NID Storage (acre feet)	Dam Status	River <sup>1</sup>
College Lake Dam	NC01154	Cumberland	20.0	264	DRAINED	Cape Fear River
Lewis Lake Dam	NC01169	Cumberland	14.0	80	IMPOUNDING	Lower Little River
Upchurch Lake Dam	NC01202	Cumberland	29.0	2137	IMPOUNDING	Rockfish Creek
Edens Lake	NC02140	Cumberland	26.3	Not available	IMPOUNDING	Beaver Creek
Aaran Lakes West Dam	NC02141	Cumberland	15.0	Not available	IMPOUNDING	Beaver Creek
Point East Dam	NC02144	Cumberland	17.0	36	BREACHED	Kirks Mill Creek
Harris Dam	NC02147	Cumberland	17.0	Not available	IMPOUNDING	Beaver Creek
Summertime Dam	NC02148	Cumberland	16.0	20	IMPOUNDING	Hybarts Branch
Evans Dam	NC02149	Cumberland	18.0	50	IMPOUNDING	Hybarts Branch
North Lake Dam	NC02150	Cumberland	23.0	23	IMPOUNDING	Cape Fear River
Mirror Lake Dam	NC02151	Cumberland	12.0	Not available	IMPOUNDING	Hybarts Branch
Lockwood Dam	NC02152	Cumberland	14.0	Not available	BREACHED	Hybarts Creek
Bailey Lake	NC02153	Cumberland	23.0	Not available	BREACHED	Beaver Creek
Lake Clair Dam	NC02154	Cumberland	15.0	Not available	IMPOUNDING	Blounts Creek
Pritchard Dam	NC02155	Cumberland	16.5	Not available	IMPOUNDING	Little Cross Creek
Civitan Lake Dam	NC02156	Cumberland	16.5	Not available	IMPOUNDING	Cross Creek
Moose Lodge Dam	NC02159	Cumberland	12.0	38	BREACHED	Blounts Creek
Mt. Vernon Estates	NC02160	Cumberland	14.2	4056	IMPOUNDING	Kirks Mill Creek
Charles Smith Dam	NC02161	Cumberland	19.4	8	IMPOUNDING	Cape Fear River
Devonwood Lower Dam	NC04797	Cumberland	25.0	70	IMPOUNDING	Persimmon Cr

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Dam Name	NIDID	County	Height (ft)	NID Storage (acre feet)	Dam Status	River <sup>1</sup>
Gainey Mill Pond	NC04916	Cumberland	11.0	Not available	BREACHED	South River <sup>OS</sup>
Monticello Pond Dam	NC04969	Cumberland	16.2	Not available	BREACHED	Rockfish Creek <sup>TR</sup>
Youngs Lake Dam	NC05024	Cumberland	23.0	Not available	EXEMPT <sup>DOD</sup>	Tank Creek <sup>TR</sup>
Rayconda Upper Dam	NC05627	Cumberland	19.2	0	IMPOUNDING	Little Rockfish Creek <sup>TR</sup>
Chesapeake Dam	NC05725	Cumberland	23.5	Not available	BREACHED	Carver's Creek <sup>TR</sup>
Strickland Bridge Dam	NC05990	Cumberland	15.3	Not available	IMPOUNDING	Rockfish Creek
Mildred White Crystal Lake Dam	NC06087	Cumberland	18.0	15	IMPOUNDING	Not available
Gables Drive Dam	NC06126	Cumberland	12.0	Not available	IMPOUNDING	Not available
Mott Lake Dam	NC00039	Hoke	23.0	442	EXEMPT <sup>DOD</sup>	Nicholson Creek
Lake McArthur Dam	NC00044	Hoke	20.0	252	EXEMPT <sup>DOD</sup>	Tuckahoe Creek
Wood Lake Dam	NC03090	Hoke	19.0	60	IMPOUNDING	Black Branch <sup>TR</sup>
Lupo Lake Dam	NC05157	Hoke	13.0	18	IMPOUNDING	Black Branch
Scull Lake Dam	NC05119	Hoke	22.0	44	IMPOUNDING	Puppy Creek <sup>OS</sup>
Thomas Lake Dam #1	NC05212	Hoke	14.7	34	BREACHED	Toney Creek
Thomas Lake Dam #2	NC05213	Hoke	12.2	18	IMPOUNDING	Toney Creek <sup>OS</sup>
Sunset Lake Dam	NC05307	Hoke	11.7	29	BREACHED	Trib. Rockfish Creek
Price Pond Dam	NC05670	Hoke	21.0	Not available	IMPOUNDING	Cross Creek <sup>OS</sup>

Source: North Carolina Dam Inventory, December 2014

<sup>1</sup>If the dam is located on an unnamed stream/tributary, the unnamed stream/tributary is followed with "TR". If the dam is located off stream of an unnamed stream/tributary, the unnamed stream/tributary is followed with "OS".



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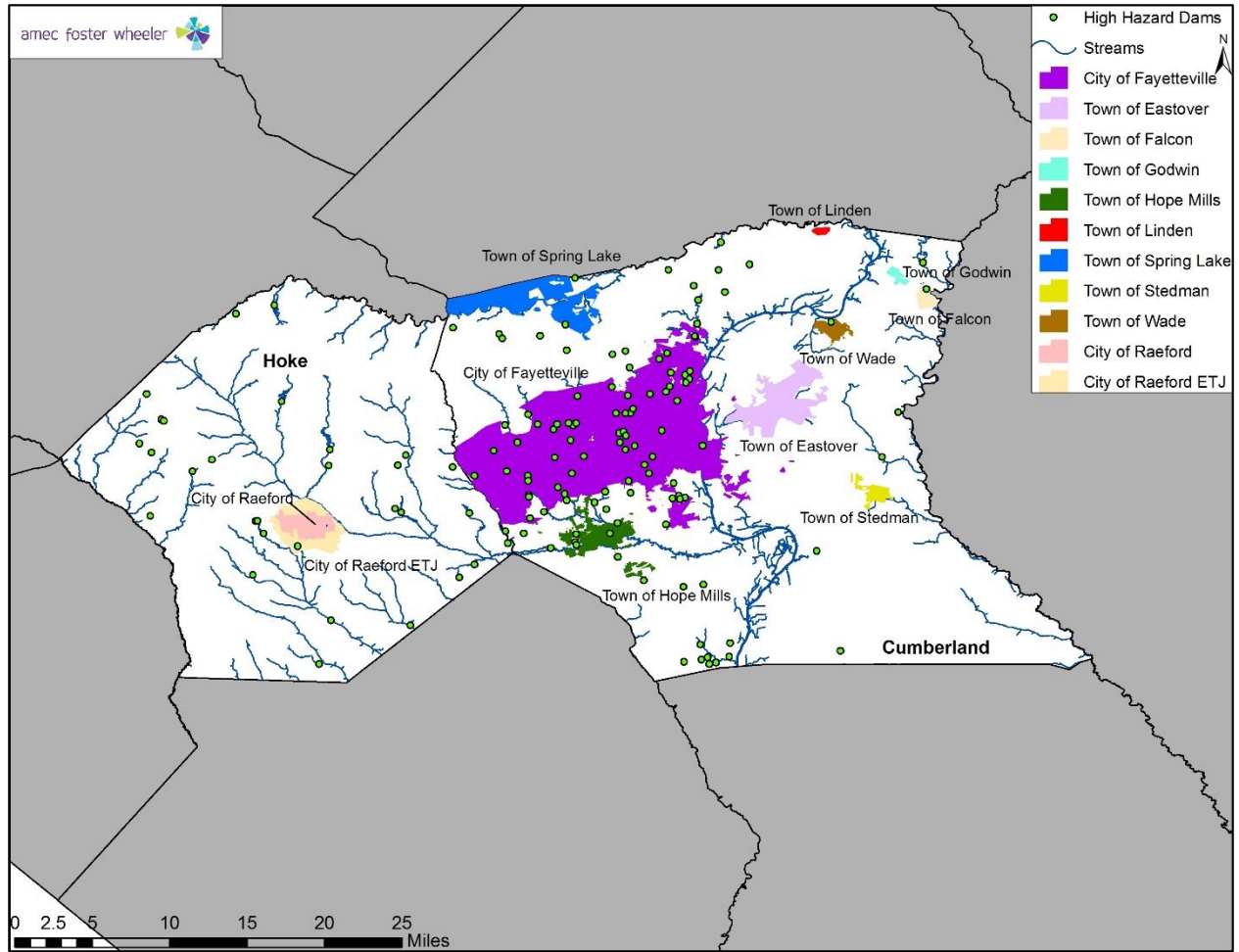


Figure 5.3- High Hazard Dam Locations

The National Levee Database (NLD) developed by the U.S. Army Corps of Engineers contains levee system inspection and evaluation information for the NFIP. The NLD is a dynamic database with ongoing efforts to add levee data from federal agencies, states, and counties. Currently, there are levees located in Cumberland and Hoke Counties that are included in the U.S. Army Corps of Engineers NLD.

5.1.3 Past Occurrences

Table 5.5 details known past dam failures in Cumberland and Hoke Counties.

Table 5.5- Known Dam Failures in Cumberland and Hoke Counties

LOCATION	COUNTY	DATE OF OCCURRENC	RESULT OF FAILURE	DEATHS/ INJURIES	PROPERTY DAMAGE	DETAILS
Hope Mills Dam	Cumberland	5/26/203	Heavy rains, dam gate would not open	0	\$2.1 million	Dam embankment gave way and also destroyed 30 feet of the nearby Lakeview Road. About 40 homes and 1,600 people downstream were evacuated.

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LOCATION	COUNTY	DATE OF OCCURRENCE	RESULT OF FAILURE	DEATHS/ INJURIES	PROPERTY DAMAGE	DETAILS
Hope Mills Dam	Cumberland	6/2010	Sinkhole	0		The dam failed in June 2010 when a sinkhole developed at the base of the dam.
Hope Mills Dam	Cumberland	NR	NR	0	NR	The 2013 NC State Hazard Mitigation Plan reports the dam has experienced 5 failures and has damaged 11 homes.
Evans and Lockwood Dams	Cumberland	9/15/1989	Overtopping	2	>\$10 million	
Country Club Lake	Cumberland	Multiple	NR	NR	NR	Small dam located on the perennial prongs of a tributary to Cross Creek. Multiple failures.
Jaycees Pond	Cumberland	6/19/1995	Flood	NR	NR	
Lake Lynn Dam	Cumberland	6/19/1995	Flood	NR	NR	
Wallace Lake Dam	Cumberland	1988	Piping	NR	NR	
Arabia	Hoke	10/18/1999	Flash Flood	0	NR	A small dam near Arabia started leaking late at night and finally broke later that morning. Several roads were inundated and a few homes sustained minor flooding.
Rockfish	Hoke	05/26/2003	Flash Flood	0	NR	A dam between McLaughlin Lake and Rockfish Creek collapsed.

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LOCATION	COUNTY	DATE OF OCCURRENCE	RESULT OF FAILURE	DEATHS/ INJURIES	PROPERTY DAMAGE	DETAILS
Upchurch Pond Dam	Hoke	05/27/2003	Flash Flood	0	NR	A dam connecting Upchurch Pond and Rockfish Creek in neighboring Cumberland County caused flooding in Hoke County.  Reconstruction cost estimated at more than \$350,000.  4 additional dams damaged; another 15 overtopped during the rainfall even 4-1 + Á ã } Á than 24 hours).
McLaughlin Lake	Hoke	09/08/2004	Flood	0	NR	A dam failure at McLaughlin Lake on September 8, 2004 caused flooding to the Laurinburg Road area, damaging several homes and vehicles.
Edge Lake	Hoke	10/18/1999	Hurricane Floyd	0		Downstream homes were evacuated last night and early the morning of 10/18/1999. A shelter was opened at East Hoke Middle School for evacuated residents.
Sunset Lake Dam	Hoke	Unknown	Unknown	0	NR	Break reported.
McLonkin Lake Dam	Hoke	Unknown	Unknown	0	NR	Break reported.
All Low Hazards Dams	Hoke	1950. 2009	Various	0	NR	Local perception is that all low hazard dams in the county seem to have broken at various points in time.

Sources: Association of State Dam Safety Officials; Hoke County 2010 Jurisdictional Hazard Mitigation Plan; National Performance of Dams Program database (npdp.standord.edu).

Note: u = Unknown, V = Very High, H = High, M = Medium, L = Low, NR = Not Reported, dam. = Dam.

Note: Several of the dams listed are small dams and are not listed in the NC Dam Safety database.





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### 5.1.4 Probability of Future Occurrence

#### High Hazard Dams

Likely-Based on historical occurrence information (23 records in 65 years), it can reasonably be assumed that intermediate to high hazard dams in Cumberland and Hoke Counties have a 35+% chance of this event occurring each year.

#### Low Hazard Dams

Highly LikelyBased on historical and anecdotal occurrence information (10 low hazard dams in 65 years), it can reasonably be assumed that low hazard dams have a 10% chance of this type of event occurring each year in Cumberland and Hoke Counties

### 5.1.5 Consequence Analysis

#### People

People living in the inundation area downstream of the dam as well as proximity to the stream carrying the floodwater from the failure of dams that have an Emergency Action Plan (EAP), the vulnerability off loss of life for persons in their homes or on their property may be mitigated by following the EAP procedures; however, the displaced persons may still incur sheltering costs. For persons located on the river (e.g. for recreation) the vulnerability of loss of life is significant.

A large population is vulnerable to the loss of the uses of the lake upstream of the dam following failure. Several uses are minor, such as aesthetics or recreation. However, some lakes serve as drinking water supplies and the loss of the lake could be a public health crisis if the drinking water supply is disrupted.

#### First Responders

For dams that fail slowly, first responders will be impacted similarly to other events that have advanced warning. For dams that fail without prior warning, the impact is rapid and severe, requiring rapid response to the impacts. Although the response is generally restricted to the stream below the dam, the location of impact moves rapidly downstream requiring multiple response locations.

#### Continuity of Operations

Unless critical infrastructure or facilities essential to the operation of government are located in the impact area of the inundation area downstream of the dam, continuity of operations will likely not be disrupted. Emergency response, emergency management and law enforcement officials may have resources stretched or overwhelmed in the failure of a large dam.

#### Built Environment

Vulnerability to the built environment includes damage to the dam itself and any structures located within the inundation area caused by the dam failure. Downstream of the dam, vulnerability includes potential damage to homes, personal property, commercial buildings and property, and government owned buildings and property; destruction of bridge or culvert crossings; weakening of bridge supports through scour; and damage or destruction of public or private infrastructure that crosses the stream such as water and sewer lines, gas lines and power lines.

Water dependent structures on the lake upstream of the dam, such as docks, piers, floats or water intake structures, may be damaged by the rapid reduction in water level during the failure.

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### Economy

Economic impact from small dams is generally small and impact is often limited to dam owner and cost of first responder activities. Large failures can disrupt the economy through displacement of workers, damage to commercial employment centers or destruction of infrastructure that impacts commercial activities or access to other economic drivers.

### Natural Environment

Aquatic species within the lake will either be displaced or destroyed. The velocity of the flood wave will likely destroy riparian and instream vegetation and destroy wetland function. The flood wave will cause erosion within and adjacent to the stream. Deposited deposits may choke instream habitat or disrupt riparian areas. Sediments within the lake bottom and any low oxygen water from the lake will be dispersed, potentially causing fish kills or releasing heavy metals found in the sediment layers.

## 5.2 Drought

### 5.2.1 Hazard Description

Drought is a deficiency in precipitation over an extended period. It is a normal, recurrent feature of climate that occurs in virtually all climate zones. The duration of droughts varies widely. There are cases where drought develops relatively quickly and lasts a very short period of time, exacerbated by extreme heat and/or wind, and there are other cases when drought spans multiple years, or even decades. Studying the paleoclimate record is often helpful in identifying long-lasting droughts that have occurred. Common types of drought are detailed below in Table 5.6.

Table 5.6- Drought Classifications

Type	Details
Meteorological Drought	Meteorological Drought is based on the degree of dryness (rainfall deficit) and length of the dry period.
Agricultural Drought	Agricultural Drought is based on the impacts to agriculture by factors such as rainfall deficits, soil water deficits, reduced ground water, and reservoirs needed for irrigation.
Hydrological Drought	Hydrological Drought is based on the impact of rainfall deficits on the water supply such as stream flow, reservoir and lake levels, and ground water decline.
Socioeconomic Drought	Socioeconomic drought is based on the impact of drought conditions (meteorological, agricultural, or hydrological drought) on supply and demand of some economic goods. Socioeconomic drought occurs when the demand for an economic good exceeds supply as a result of a water deficit in water supply.

The wide variety of disciplines affected by drought, its diverse geographical and temporal distribution, and the many scales drought operates on make it difficult to develop both a definition to describe drought and an index to measure it. Many quantitative measures of drought have been developed in the United States, depending on the discipline affected, the region being considered, and the particular application. Several indices developed by Wayne Palmer, as well as the Standardized Precipitation Index, are useful for describing the many scales of drought.

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The U.S. Drought Monitor provides a summary of drought conditions across the United States and Puerto Rico. Often described as a blend of art and science, the map is developed by combining a variety of database drought indices and indicators and local expert input into a single composite drought indicator.

The Standardized Precipitation Index (SPI) is a way of measuring drought that is different from the Palmer Drought Index (PDI). Like the PDI, this index is negative for drought, and positive for wet conditions. The SPI is a probability index that considers only precipitation, while Palmer's indices are water balance indices that consider water supply (precip), demand (evapotranspiration) and loss (runoff).

The Palmer Drought Severity Index (PDSI) devised in 1965, was the first drought indicator to assess moisture status comprehensively. It uses temperature and precipitation data to calculate water supply and demand, incorporates soil moisture, and is considered most effective for unirrigated cropland. The PDSI primarily reflects long-term drought and has been used extensively to initiate drought relief. It is more complex than the SPI and the Drought Monitor.

### 5.2.2 Location and Spatial Extent

According to the PDSI map shown in Figure 5.4 below, southeastern North Carolina has a relatively high risk for drought hazard. However, drought cannot be confined to geographic or political boundaries and some areas may experience more severe drought events than what is shown on the map.

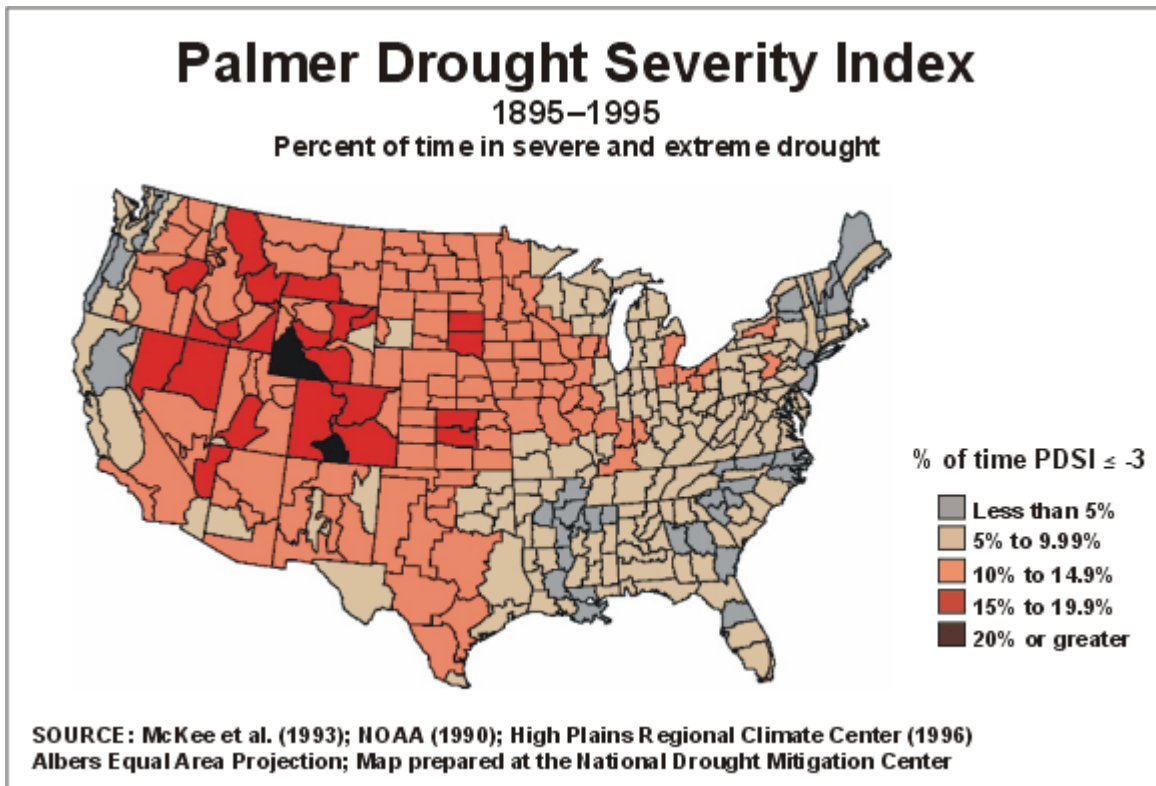


Figure 5.4 Palmer Drought Severity Index

Figure 5.5 shows the spatial pattern of SPI from May 2011 through the April 2013. The map indicates dry conditions while the green shading indicates wet conditions. The SPI is negative for drought, and positive for wet conditions. Cumberland and Hoke County region is designated as moderately dry.

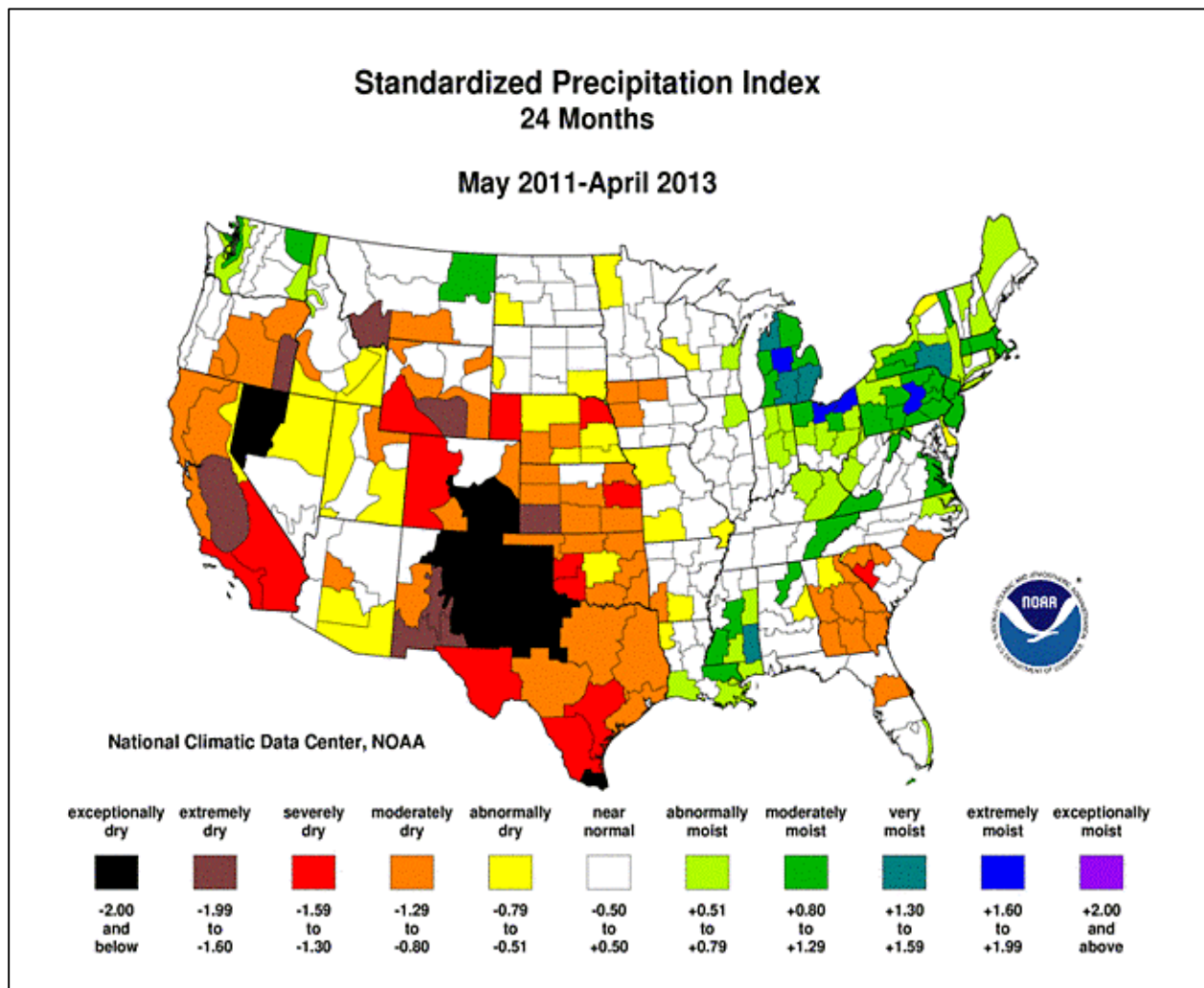


Figure 5.5- Standardized Precipitation Index

### 5.2.3 Past Occurrences

According to the North Carolina Drought Monitor, Cumberland and Hoke Counties have experienced drought conditions every year since 2006. Table 5.7 shows the most severe classification for each year by County.

Table 5.7- Historical Drought Occurrences

Year	Cumberland County	Hoke County
2000	Abnormally Dry	Moderate Drought
2001	Severe Drought	Severe Drought
2002	Extreme Drought	Exceptional Drought
2003	Abnormally Dry	Abnormally Dry

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Year	Cumberland County	Hoke County
2004	Abnormally Dry	Abnormally Dry
2005	Abnormally Dry	Moderate Drought
2006	Moderate Drought	Moderate Drought
2007	Exceptional Drought	Exceptional Drought
2008	Exceptional Drought	Exceptional Drought
2009	Moderate Drought	Moderate Drought
2010	Moderate Drought	Moderate Drought
2011	Severe Drought	Severe Drought
2012	Moderate Drought	Moderate Drought
2013	Abnormally Dry	Moderate Drought
2014	Abnormally Dry	Abnormally Dry
2015	Moderate Drought	Abnormally Dry

Source: NC Drought Monitor

### 5.2.4 Probability of Future Occurrence

Highly Likely Based on historical occurrence information (15 records in 15 years), it can reasonably assumed that Cumberland and Hoke Counties have a 100% chance of this occurring each year.

### 5.2.5 Consequence Analysis

#### People

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depression about economic losses, conflicts when there is not enough water, reduced incomes, fewer recreational activities, higher incidents of heat stroke, and even loss of human life.

#### First Responders

The overall effect on first responders would be relatively limited when compared to other hazards. Exceptional drought conditions may impact the amount of water immediately available to respond to wildfires.

#### Continuity of Operations

Drought would have minimal impacts on continuity of operations due to the relatively long warning that would allow for plans to be made to maintain continuity of operations.

#### Built Environment

Drought has the potential to affect water supply for residential, institutional, industrial, and government-owned areas. Drought can reduce water supply in reservoirs. When drought conditions persist with no, local or State governments often institute restrictions.

#### Economy

Examples of economic impacts include farmers who lose money because drought destroyed their crops or who may have to spend more money to feed and water their animals. Businesses that depend on farming, like companies that make tractors and food, may lose business when drought damages crops.

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livestock. Extreme drought also has the potential to impact local businesses such as landscaping, recreation and tourism, and public utilities. Businesses that sell boats and fishing equipment may not be able to sell some of their goods because drought has dried up lakes and other water sources.

### Natural Environment

Plants and animals depend on water, just as people do. Drought can reduce supplies and damage their habitats. Sometimes this damage is only temporary, and other times it is irreversible.

Drought conditions can also provide a substantial increase in wildfire risk. As plants and trees wither and die from a lack of precipitation, increased insect infestations, and diseases which are associated with drought, they become fuel for wildfires. Long periods of drought can equate to more wildfires and more intense wildfires, which affect the economy, the environment, and society, such as by destroying neighborhoods, crops, and habitats.

## 5.3 Earthquake

### 5.3.1 Hazard Description

An earthquake is movement or shaking of the ground. Most earthquakes are caused by the release of stresses accumulated as a result of the rupture of fault planes in the Earth's crust. These fault planes are typically found along borders of the Earth's 10 tectonic plates. The areas of greatest tectonic instability occur at the perimeters of the slowly moving plates, where they are subjected to the greatest strains from plates traveling in opposite directions and at different speeds. Deformation along plate boundaries causes strain in the rock and the consequent buildup of stored energy. When the built-up stress exceeds the rocks' strength a rupture occurs. The rock on both sides of the fracture is snapped, releasing the stored energy and producing seismic waves, generating an earthquake.

Earthquakes are measured in terms of their magnitude and intensity. Magnitude is measured on the Richter Scale, an open-ended logarithmic scale that describes the energy release of an earthquake. A detailed description of the Richter Scale is given in Table 5.8.

Table 5.8 - Richter Scale

Magnitude	Effects
Less than 3.5	Generally not felt, but recorded.
3.5 - 5.4	Often felt, but rarely causes damage.
5.4 - 6.0	At most slight damage to well-designed buildings. Can cause major damage to poorly constructed buildings over small regions.
6.1 - 6.9	Can be destructive in areas up to 100 kilometers across where people live.
7.0 - 7.9	Major earthquake. Can cause serious damage over larger areas.
8.0 or greater	Great earthquake. Can cause serious damage in areas several hundred kilometers across.

Source: FEMA

### 5.3.2 Location and Spatial Extent

Approximately two-thirds of North Carolina is subject to earthquakes, with the western and southeastern region most vulnerable to a very damaging earthquake. The state is affected by both the Charleston Fault

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in South Carolina and New Madrid Fault in Tennessee. Both of these faults have generated earthquakes measuring greater than 7 on the Richter Scale during the last 200 years. In addition, there are several smaller fault lines throughout North Carolina.

Figure 5.6 depicts the intensity level for North Carolina based on the national USGS map of peak acceleration with 2 percent probability of exceedance in 50 years. It is the probability that ground motion will reach a certain level during an earthquake. The data shows peak horizontal ground acceleration (fastest measured change in speed, for a particle at ground level that is moving horizontally due to earthquake) with a 2 percent probability of exceedance in 50 years. According to this map, Cumberland and Hoke Counties lie within an approximate zone level 10 to 12. This indicates that the region as a whole exists within an area of moderate seismic risk.

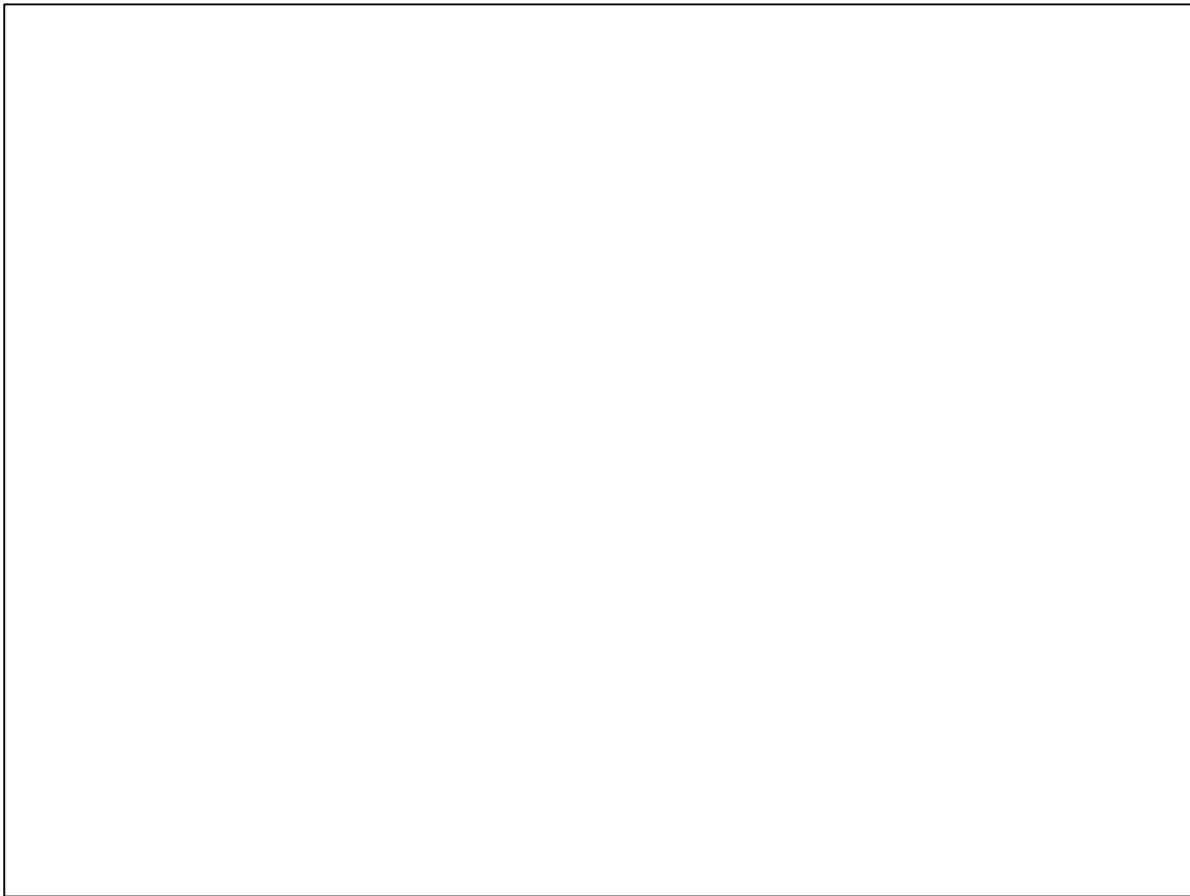


Figure 5.6 - Seismic Hazard Information for North Carolina

5.3.3 Past Occurrences

A list of earthquakes that have caused damage in North Carolina is presented below in Table 5.9.

Table 5.9 - Earthquakes Affecting North Carolina

Date	Location	Richter Scale
12/16/1811	NE Arkansas	8.5
01/23/1812	New Madrid, MO	8.4











































































































































































