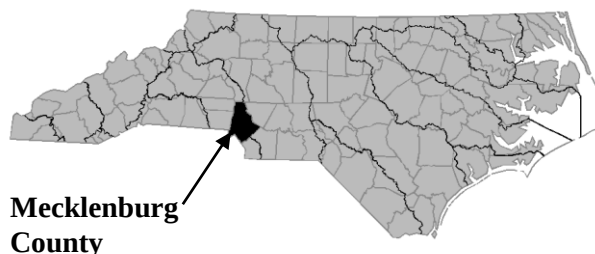


FLOOD INSURANCE STUDY

A Report of Flood Hazards in

MECKLENBURG COUNTY, NORTH CAROLINA

AND INCORPORATED AREAS



Community Name	Community Number	River Basin
Charlotte, City of	370159	Catawba/Yadkin
Cornelius, Town of	370498	Catawba/Yadkin
Davidson, Town of	370503	Catawba/Yadkin
Huntersville, Town of	370478	Catawba/Yadkin
Matthews, Town of	370310	Catawba/Yadkin
Mecklenburg County (Unincorporated Areas)	370158	Catawba/Yadkin
Mint Hill, Town of	370539	Catawba/Yadkin
Pineville, Town of	370160	Catawba

VOLUME 1 OF 5

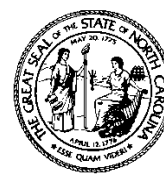


REVISED: SEPTEMBER 2, 2015

Federal Emergency Management Agency
State of North Carolina

Flood Insurance Study Number
37119CV001D

<http://www.fema.gov> and
<http://www.ncfloodmaps.com>



FOREWORD

This countywide Flood Insurance Study (FIS) Report was produced through a unique cooperative partnership between the State of North Carolina and the Federal Emergency Management Agency (FEMA). The State of North Carolina has implemented a long-term approach to floodplain management to decrease the costs associated with flooding. This is demonstrated by the State's commitment to map floodplain areas at the state level. As a part of this effort, the State of North Carolina has joined with FEMA in a Cooperating Technical State (CTS) agreement to produce and maintain this FIS Report and the accompanying digital Flood Insurance Rate Map (FIRM) for North Carolina.

NOTICE TO FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

Part of this FIS may be revised by the Letter of Map Revision process, which does not involve republication or redistribution of the FIS. It is, therefore, the responsibility of the user to consult with community officials and to check the community repository to obtain the most current FIS components.

The following is a list of the publication dates of this Countywide FIS Report starting with the initial Report accompanying the North Carolina Statewide FIRM:

February 4, 2004

March 2, 2009 (Statewide FIRM Revision)

February 19, 2014 – to update corporate limits, to change Base Flood Elevations, to add Base Flood Elevations, to add Special Flood Hazard Areas, to change Special Flood Hazard Areas, to delete Special Flood Hazard Areas, to change zone designations, to add roads and road names, to add floodway, to change floodway, and to advance suffix.

September 2, 2015 - to update corporate limits, to change Base Flood Elevations, to add Base Flood Elevations, to add Special Flood Hazard Areas, to change Special Flood Hazard Areas, to delete Special Flood Hazard Areas, to change zone designations, to add roads and road names, to add floodway, to change floodway, and to advance suffix.

This FIS has been produced as part of the North Carolina Floodplain Mapping Program. Mecklenburg County, North Carolina, falls under the administrative jurisdiction of Region IV of the Federal Emergency Management Agency (FEMA). Questions concerning this FIS may be directed to Mecklenburg County Storm Water at <http://stormwater.charmeck.org>, the North Carolina Floodplain Mapping Program at www.ncfloodmaps.com, the FEMA Map Information eXchange by calling the toll-free information line at 1-877-FEMA MAP (1-877-336-2627), or by contacting the FEMA Regional Office at the following address:

FEMA, Federal Insurance and Mitigation Administration
Koger Center - Rutgers Building
3003 Chamblee Tucker Road
Atlanta, Georgia 30341
(770) 220-5400

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Section 1.0 - Introduction

1.1 The National Flood Insurance Program

In 1968, Congress created the National Flood Insurance Program (NFIP) in response to the rising cost of taxpayer-funded disaster relief for flood victims and the increasing amount of damage caused by floods. The NFIP makes federally backed flood insurance available in communities that agree to adopt and enforce floodplain management ordinances to reduce future flood damage. Federally backed flood insurance is available in more than 19,000 communities across the United States and its territories.

The NFIP is managed by the Federal Insurance and Mitigation Administration of the Federal Emergency Management Agency (FEMA). The Federal Insurance and Mitigation Administration manages the insurance component of the NFIP and oversees the flood hazard mapping and the floodplain management aspects of the program.

The NFIP, through involvement with communities, the insurance industry, and the lending industry, helps reduce flood damage by nearly \$800 million a year. Further, buildings constructed in compliance with NFIP building standards suffer approximately 80% less damage annually than those not built in compliance. In addition, every \$3 paid in flood insurance claims saves \$1 in disaster assistance payments. The NFIP is self-supporting for the average historical loss year, which means that operating expenses and flood insurance claims are not paid by the taxpayer, but through premiums collected for flood insurance policies.

Additional information of interest to homeowners, community officials, insurance companies, lenders, and study contractors is available in Section 9.0 of this FIS Report and on the NFIP Internet homepage at <http://www.fema.gov/business/nfip/>.

1.2 Purpose of this Flood Insurance Study

Flood Insurance Studies (FISs) are one of the primary means by which the NFIP administers the National Flood Insurance Act of 1968, the Flood Disaster Protection Act of 1973, and the National Flood Insurance Reform Act of 1994. FISs develop flood risk data that are used to establish actuarial flood insurance rates. The information in this FIS Report will also be used by Mecklenburg County and the jurisdictions therein (hereinafter referred to collectively as Mecklenburg County) to facilitate the adoption and maintenance of floodplain management ordinances, which form the basis of communities' continued participation in the NFIP. Minimum requirements for participation in the NFIP are set forth in Title 44, Part 60, Section 3 of the Code of Federal Regulations (44 CFR 60.3). In some States and/or communities, floodplain management criteria or regulations may exist that are more restrictive than the minimum Federal requirements. In such cases, the more restrictive criteria will take precedence, and the State and/or community (or other jurisdictional agency) will be able to explain them.

This FIS investigates the existence and severity of flood hazards in, or revises and updates previous FISs for, the geographic area of Mecklenburg County, North Carolina, including the jurisdictions listed in Table 1.

Section 1.0 - Introduction

Table 1—Jurisdictions in Mecklenburg County

Community	Included in this FIS	Not Included in this FIS	If Not Included, Location of Flood Hazard/Flood Insurance Rate Data
Charlotte, City of	X		
Cornelius, Town of	X		
Davidson, Town of	X		
Huntersville, Town of	X		
Matthews, Town of	X		
Mecklenburg County (Unincorporated Areas)	X		
Mint Hill, Town of	X		
Pineville, Town of	X		
Stallings, Town of		X	Union County and Incorporated Areas

1.3 FIS Components

A Flood Insurance Study (FIS) is an analysis of flood hazards, typically presented as a set of Flood Insurance Rate Map (FIRM) panels and the FIS Report, which includes a set of Flood Profiles.

Flood Insurance Rate Map

The FIRM shows 1% annual chance (100-year), future conditions floodplains, and 0.2% annual chance (500-year) floodplains, using tints, screens, and symbols. Floodways, community encroachment areas, the locations of selected cross sections used in the hydraulic analyses and floodway computations, and Velocity Zones are shown where applicable. The FIRM for North Carolina has been produced digitally, and there are separate data layers that are available in the public domain via the Internet.

Flood Insurance Study Report

The FIS Report provides a context for the information shown on the FIRM, as well as a summary of the data upon which the analyses are based. It also includes an index of sources of additional information on the NFIP.

Flood Profiles

A Flood Profile is provided for every stream studied in detail, showing the continuum of calculated flood elevations of various recurrence periods along the studied reaches. Flood Profiles are the documents that serve as a basis for determining flood insurance rate zones.

Section 2.0 – Floodplain Management Applications

Flood events of a magnitude expected to occur with a 10%, 2%, 1%, or 0.2% annual chance have been selected as having special significance for developing sound floodplain management programs. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10%, 2%, 1%, and 0.2% chance, respectively, of being equaled in any given year. The 1% or 100-year flood is also determined using future conditions hydrology. Therefore, FIS Reports typically determine water-surface elevations for floods with these probabilities. The FIRM delineates 1% and 0.2% annual chance floodplains, 1% annual chance future conditions floodplains, 1% annual chance floodway boundaries, community encroachment areas, and depicts 1% annual chance flood elevations, rounded to the nearest foot, to assist in developing floodplain management measures.

2.1 Floodplains

To provide a national standard without regional discrimination, the 1% annual chance flood has been adopted by FEMA as the base flood for floodplain management purposes. A 1% annual chance flood, or base flood, is defined as that having a 1% chance of being equaled or exceeded in any given year. The 1% annual chance floodplains shown on the FIRM identify areas that are expected to be inundated by the 1% annual chance flood. This 1% annual chance floodplain is also called a Special Flood Hazard Area (SFHA), where the NFIP's floodplain management regulations must be enforced by the community as a condition of participation in the NFIP. The 0.2% annual chance floodplain is employed to indicate additional areas of flood risk associated with exceptionally severe floods.

2.2 Floodways

Encroachment on floodplains such as that caused by placement of structures and fill reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, floodways are provided as a tool to assist local communities in this aspect of floodplain management. Under this concept, the 1% annual chance riverine floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights. Figure 1, "Floodway Schematic," illustrates this principle. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this FIS are presented to local agencies as a minimum standard that can be adopted directly or that can be used as a basis for additional encroachment studies.

Section 2.0 – Floodplain Management Applications

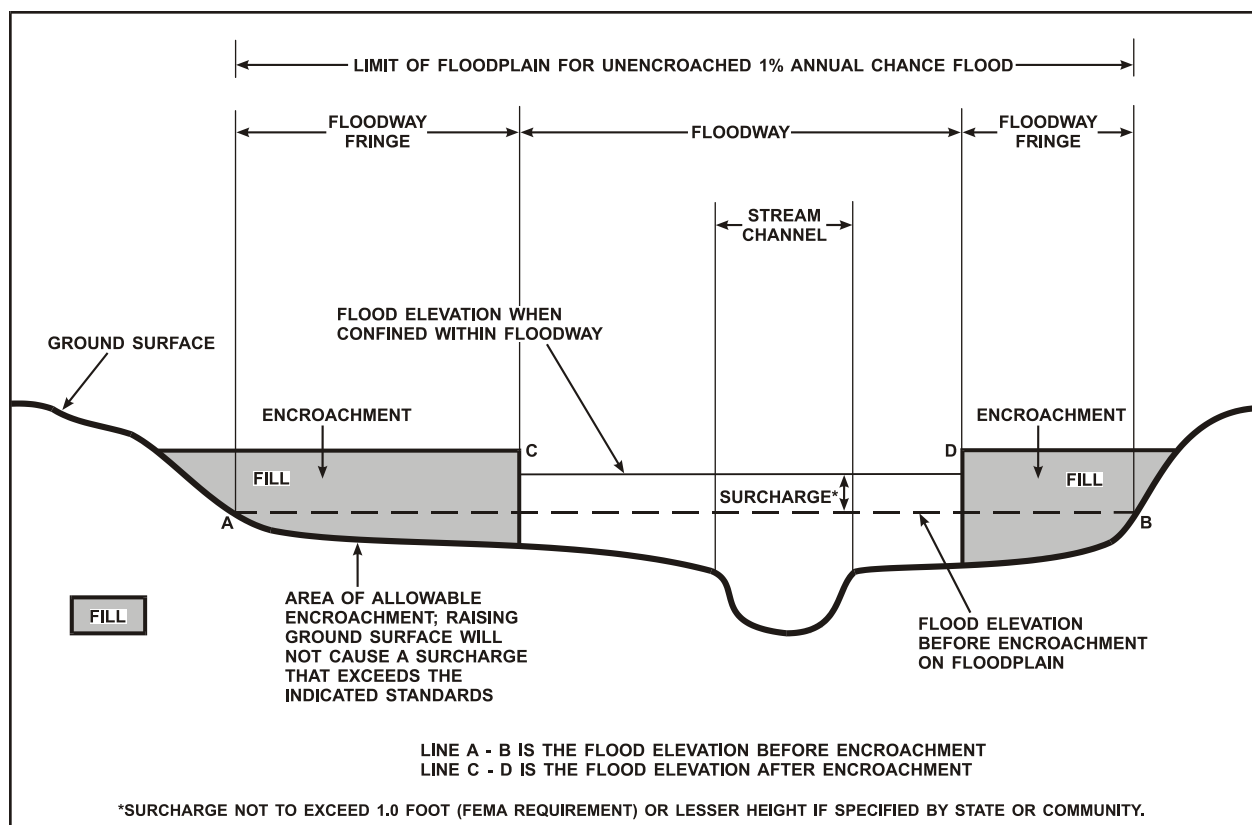


Figure 1—Floodway Schematic

2.3 Base Flood Elevations

Base Flood Elevations (BFEs) are shown on the FIRM and represent rounded, whole-foot elevations at selected locations along flooding sources that have been studied in detail. Flood Profiles in this FIS Report provide a comprehensive and definitive tool to determine specific flood elevations along a stream studied by detailed methods. In order to reduce the risk of damage from floods up to the base (1% annual chance) flood, communities are advised to consider these elevations when issuing building permits for structures.

2.4 Watershed Characteristics

Because a FIS is a probability analysis that may not account for some of the factors listed below, communities are strongly encouraged to consider adopting more restrictive or higher floodplain management criteria or ordinances than the minimum Federal requirements. Communities may also increase the validity of their flood hazard data by investing in continuous maintenance of river gages (see the **Data Validity and Reliability** paragraph below). If the U.S. Geological Survey (USGS) or other agencies do not maintain gages on the flooding sources of interest, partnerships with the USGS may be pursued, or local gages may be installed. For more information, see Section 9.0 of this report.

This flood hazard study represents an analysis of certain watershed characteristics, some of which are summarized as follows:

Section 2.0 – Floodplain Management Applications

Drainage Area

In general, streams that drain larger areas have greater flood hazards. FISs, in North Carolina, do not typically analyze flood hazards in places with rural drainage areas of less than one square mile and within urban drainage areas of less than ½ square mile.

Soil Permeability and Infiltration

Differences in the types of soil and the amount of vegetation in a watershed have a significant effect on the amount of water that the soil can absorb; soils with a high sand content absorb much more water than soils with a high clay content. The presence of vegetation increases infiltration; the presence of pavement decreases infiltration and also speeds runoff to receiving waters. As soil permeability and infiltration decrease, the volume and rate of overland flow increases.

Soil Moisture Conditions

In addition to soil permeability and infiltration, the level of the water table helps determine the saturation point, beyond which no water is absorbed. As rainfall duration increases, the height of the water table increases.

Channel and Floodplain Geometry

The geometric contour of a streambed, termed channel geometry, and the geometric contour of a floodplain determine the volume of water that a channel can hold and partially determine the rate at which water flows through it.

Channel and Floodplain Roughness

The roughness of a surface affects the characteristics of runoff whether the water is on the surface of the watershed or in the channel.

FIS Reports include analyses of how these factors will combine to produce overland flow patterns during floods that have a certain probability of occurring in any given year. Although the recurrence interval represents the long-term average period between floods of a specific magnitude, rare floods could occur at shorter intervals or even within the same year. The risk of experiencing a rare flood increases when longer periods are considered. For example, the risk of having a flood which equals or exceeds the 1% annual chance flood (1% chance of annual exceedence) in any 50-year period is approximately 40% (4 in 10), but for any 90-year period, the risk increases to approximately 60% (6 in 10).

It is important to note that the 1% annual chance flood is used as the national standard to allow a consistent approach to floodplain management, flood hazard assessment, and flood hazard mapping. In any given community, a number of factors may result in flooding characteristics that do not conform to predicted conditions. Therefore, the determination that an area is not shown on the FIRM as being within a Special Flood Hazard Area is no guarantee that it will not flood during a 1% annual chance flood. Examples of these factors include Data Validity and Reliability; Developmental and Topographic Changes Over Time; Erosion, Deposition, and Debris Flow; and Meandering and Lateral Migration.

Data Validity and Reliability

Certain types of analysis methods yield more justifiable characterizations of flood hazards. For example, a gage analysis, to determine peak discharges, is based on actual measurements of watershed conditions over time and, therefore, is typically considered the most accurate method of hydrologic analysis. However, it is not feasible to install enough gages to gather data on every

Section 2.0 – Floodplain Management Applications

stream. In addition, for many of the gage sites that do exist, there are interruptions in the period of record. The usefulness of gage data for the purpose of predicting flooding behavior decreases with interruptions in the period of record; predicted flooding conditions over a 100-year period based on 20 years of measurements spread over a 35-year period are less valid than those based on 30 years of continuous measurements. A regression analysis is typically considered the best method in the absence of gage data, as it uses gage data from watersheds with similar characteristics to estimate flood frequency and magnitude in an ungaged watershed. Regression equations reflect average conditions for a region; therefore, the results will not exactly match the results of a gage analysis at a particular location. The standard errors of the North Carolina rural regression equations range from 44 to 51 percent for estimates of the 1% annual chance flood. That means the difference between the results of the regression equation and the gage analysis for approximately two-thirds of the locations that gage data exists are within 44 to 51 percent of the gage analysis results. A rainfall-runoff hydrologic analysis may be used for gaged or ungaged watersheds, and can estimate the effects of storage areas and flood control structures and measures. This method is most valid when calibrated against historical data.

Developmental and Topographic Changes Over Time

A FIRM is based on the best topographic and planimetric information available to FEMA and the State of North Carolina at the time the study is produced. In time, however, development and/or natural phenomena can alter the physical characteristics of a watershed and its drainage channels, resulting in changes in the flood hazards in those areas. For example, constructing a housing subdivision reduces the amount of soil that is available to absorb water; this in turn causes an increase in the volume of surface water that flows into the channel.

Erosion, Deposition, and Debris Flow

The flood hazards shown on a FIRM are based on the assumption of unobstructed flow. The FIRM does not reflect an analysis of areas that are subject to erosion caused by the increased water-surface elevations and velocities that occur during flooding. In addition to the risks of landslides or a weakening of the ground underneath roads or structures, any sediment that is removed from one location will be deposited in another; accumulated deposits may have a pronounced effect on flood hazards in those areas. Similarly, debris such as fallen trees or branches, litter, or other items may obstruct stream channels or hydraulic structures, increasing water-surface elevations, velocities, and floodplain width.

Meandering and Lateral Migration

FISs are based on the assumption that channel geometry will remain stable during normal drainage and during flood events. This assumption is valid for most streams, which flow over bedrock or between bedrock outcroppings that form non-alluvial channels. However, alluvial streams change the channel geometry with time, significantly so during flood events. Alluvial streams are subject to erosion and deposition, which may result in braided or meandering channels. Streams of this type may be characterized by lateral migration, or channel shifting, in which the stream may change course entirely during a flood. Whenever clear evidence is available, a FIRM will identify the alluvial nature of a studied flooding source and designate wider floodways to allow for potential migration. However, these floodways are based on qualitative assessments and not on quantitative geomorphic and engineering analyses.

Section 3.0 – Insurance Applications

For flood insurance applications, the FIRM designates flood insurance rate zones and, in 1% annual chance floodplains that were studied by detailed methods, shows selected whole-foot BFEs or average depths. Insurance agents use the zones and BFEs in conjunction with information on structures and their contents to assign premium rates for flood insurance policies. Table 2, “Flood Zone Designations,” includes a description of each type of flood hazard zone.

Table 2—Flood Zone Designations

A	Zone A is the flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined in the FIS Report by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no Base Flood Elevations or depths are shown within this zone.
AE	Zone AE is the flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined in the FIS Report by detailed methods. In most instances, whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
AH	Zone AH is the flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
AO	Zone AO is the flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the detailed hydraulic analyses are shown within this zone.
AR	Zone AR is the flood insurance rate zone that corresponds to areas that were formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
A99	Zone A99 is the flood insurance rate zone that corresponds to areas of the 1% annual chance floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No Base Flood Elevations or depths are shown within this zone.
V	Zone V is the flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Because approximate hydraulic analyses are performed for such areas, no Base Flood Elevations are shown within this Zone.
VE	Zone VE is the flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Section 3.0 – Insurance Applications

Table 2—Flood Zone Designations

X	Zone X is the flood insurance rate zone that corresponds to areas outside the 0.2% annual chance floodplain, areas within the 0.2% annual chance floodplain, and to areas of 1% annual chance flooding where average depths are less than 1 foot, areas of 1% annual chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1% annual chance flood by levees. No Base Flood Elevations or depths are shown within this zone.
X (Future Base Flood)	Zone X (Future Base Flood) is the flood insurance risk zone that corresponds to the 1% annual chance floodplains that are determined based on future-conditions hydrology. No BFEs or base flood depths are shown within this zone.
D	Zone D is the flood insurance rate zone that corresponds to unstudied areas where flood hazards are undetermined, but possible.

Section 4.0 – Area Studied

4.1 Basin Characteristics

Catawba River Basin

The Catawba River Basin, along with the Broad River basin, forms the headwaters of the Santee-Cooper River system which flows through South Carolina to the Atlantic Ocean. It is bordered by the Yadkin River Basin to the east and north, the New River and Watauga River Basins to the north, the French Broad River Basin to the west, the Broad River Basin to the west and south, and South Carolina to the south. The Catawba River Basin covers approximately 3,285 square miles and is the eighth largest river basin in the state. It is located in the south central portion of western North Carolina in the Blue Ridge and Piedmont regions.

The Catawba River begins on the eastern slopes of the Blue Ridge Mountains in Avery, Burke, Caldwell, and McDowell counties and flows southeast to the North Carolina-South Carolina border near Charlotte. The basin contains the Linville River, one of only four rivers in the state designated as a Natural and Scenic River. The Linville flows through the Pisgah National Forest Wilderness area and into Lake James.

As the basin enters the Piedmont from the mountains, land use shifts from forest to agricultural and urban uses. Though urban areas are not numerous in the upper portions of the basin, the lower Catawba region contains many cities, including the growing metropolitan area surrounding Charlotte. In this region, urban growth has affected the water quality of the lakes, streams, and rivers.

According to land cover information developed by the Natural Resources Conservation Service, forestlands (both private and federal forests) cover approximately 45% of the basin. Agriculture (including cultivated and uncultivated cropland and pastureland) covers approximately 16% of the land area. The urban and built-up category comprises roughly 23% and exhibited the most dramatic change since 1982 (35% increase). Agriculture related land cover decreased by a total of 31% in the basin.

The population of the basin, based on 2000 census data, was estimated at 1,170,512. The overall population density of the basin is 356 persons per square mile versus a statewide average of 163 persons per square mile. The percent population growth over the past ten years (1990 to 2000) was 18.5%, the fastest growing basinwide population in the state.

The main stem of the Catawba River is regulated by a series of seven hydroelectric dams. The reservoirs formed by these dams are commonly referred to as the Catawba Chain Lakes. All seven of these dams are owned by Duke Energy and were created to generate electricity. The lakes begin with Lake James, located at the foot of the Blue Ridge Mountains, followed by Lake Rhodhiss, Lake Hickory, Lookout Shoals Lake, Lake Norman, Mountain Island Lake, and Lake Wylie. In addition to power generation, the lakes are popular recreational areas, and some are used for water supply purposes and for waterfront home development.

Yadkin River Basin

The Yadkin River Basin drains from the Virginia border to South Carolina, cutting a swath through west central North Carolina. With 7,400 square miles, or 15.6% of the land area, this is the second largest drainage basin in the state. It also has the second largest number of stream miles – 5,855. The basin originates on the eastern slopes of the Blue Ridge Mountains in Caldwell, Wilkes, and Surry Counties. A small portion of the Yadkin River headwaters originates in Virginia and flows northeasterly for about 100 miles, then flows to the southeast until it joins

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the Uwharrie River to form the Pee Dee River. The Pee Dee River continues flowing southeasterly through South Carolina to the Atlantic Ocean. The North Carolina portion of the basin contains approximately 5,991 miles of freshwater streams and rivers.

Forest land covers approximately 50% of the basin and 95% of that forestry is privately owned. Agriculture (including cultivated and uncultivated cropland (15.6%) and pastureland (14.1%)) covers approximately 30% of the land area, while 13% of the land is developed. The urban and built-up category comprises roughly 11% and exhibited the most dramatic change between 1982 and 1992 (38% increase). Other categories that showed substantial changes during this period were pasturelands (19% increase) and the “Other” category, which includes rural transportation (26% increase).

Both cultivated and uncultivated cropland decreased by a total of 46% in the basin between 1982 and 1992. It is likely that some of this cropland was converted to pastureland and to urban and built-up areas. Major land use activities in the basin include agriculture (crops, swine, poultry and cattle operations) and construction activities related to growth. Iredell County has the largest dairy cattle population in the state.

The Yadkin River Basin contains about 17% of North Carolina's population, encompassing all or portions of 23 counties and 86 municipalities. Three of North Carolina's 12 major metropolitan areas depend on this basin for water supply. The population for 13 counties in this basin grew by 10% from 1990 to 1997. The population for Union County grew by 26% over that same period.

This region is characterized by rolling hills and geologic formations consisting of crystalline or sedimentary rocks. Because of the moderate topography, more streams drain a smaller amount of land, creating moderate drainage density.

The Yadkin Basin serves as a corridor for plants and animals migrating from the mountains to the Coastal Plain, and vice-versa. This basin contains a variety of habitat types, as well as many rare plants and animals. Sportfishes in the Yadkin River upstream of the Kerr Scott Reservoir include smallmouth bass, redbreast sunfish and bullhead catfishes. A considerable amount of white and striped bass fish exist below Idols Dam (west of Clemmons – in Forsyth County) in the spring when the fish migrate from downstream reservoirs to spawn. In addition to being important natural resources, these reservoir fisheries also help make the basin a popular place for recreation, significantly boosting the local economy.

4.2 Principal Flood Problems

Low-lying areas of Mecklenburg County are subject to periodic flooding caused by excess runoff from various streams and creeks and their tributaries. Flooding also occurs along the Catawba River, mainly along the area just below the Mountain Island Lake Dam. The most severe flooding has been caused by tropical systems moving up from the Gulf or Atlantic coast. Flooding also occurs in spring or early summer because of heavy rains caused by stationary frontal systems. Thunderstorms occurring also account for some flooding. Damage to structures in the floodplains has occurred during floods in 1916, 1928, 1936, 1942, 1958, 1962, 1973, 1975, 1976, 1995, 1997, 2003, 2004, 2008, and 2011.

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4.3 Historic Flood Elevations

August 27, 1995 (Tropical Storm Jerry)

Tropical Storm Jerry had rainfall totals of 9.5 inches with 12 million dollars in damage in Mecklenburg County.

July 23, 1997 (Hurricane Danny)

After making landfall in Alabama on July 19, 1997, this hurricane proceeded in a northeast track and ultimately caused 4 deaths and 100 million dollars of damage in the United States. Hurricane Danny had rainfall totals of 13 inches with 50 million dollars in damage in Mecklenburg County.

September 5, 2004 (Hurricane Frances)

On September 5, 2004, Hurricane Frances came ashore on the central east coast of Florida as a category 2 storm with 105 mph maximum sustained winds. According to the National Weather Service, Frances spawned more reported tornadoes – at least 101 – than any other tropical storm or hurricane to hit the Eastern Seaboard. Eleven of those tornadoes occurred in North Carolina. The remnants of Hurricane Frances washed out water lines or sanitation systems in several mountain towns leaving tens of thousands of people without drinking water for some time. In Western North Carolina many streams and rivers reached well above flood stage causing many roads to be closed. The total estimated damage from Frances is estimated to be about \$9 billion (US 2004 dollars). Hurricane Frances had rainfall totals of 18 inches with 5 million dollars in damage in Mecklenburg County.

August 27-28, 2008 (Tropical Storm Fay)

In the early morning hours of August 27, 2008, downpours from Tropical Storm Fay flooded more than 600 structures. Dozens of people were evacuated, including 20 swift-water rescues made by the Charlotte Fire Department. 90% of the flooding was in the Briar Creek Watershed. A federal Disaster Declaration was issued. Rainfall in a 24-hour period in northeastern Mecklenburg County exceeded 11 inches. Stream gauges measuring water depths in local creeks set 19 new records, exceeding the 100-year flood level in some areas. Two weeks later, thunderstorms sent Little Sugar Creek over its banks. During afternoon rush-hour on September 10, fire crews used rafts to make 33 rescues from flooded building and from vehicles on flooded streets. More than five inches of rain fell in less than three hours in the headwaters of Little Sugar Creek. After the 2008 floods, Storm Water Services bought 37 flood-damaged homes before owners repaired them. The homes were demolished and the floodplain was returned to open space.

4.4 Flood Protection Measures

Flood protection measures may be structural (such as levees, dams, and reservoirs) or non-structural (such as land-use management ordinances, policies, or practices).

To provide safe flood protection and be mapped as such, FEMA specifies that all levees must: have a minimum of three feet of freeboard against the 1% annual chance flood event; be equipped with closure devices at every opening; be constructed with embankments and foundations that are certified not to fail due to erosion, seepage, or instability; and be certified against future loss of freeboard due to settling. For additional requirements, please refer to 44 CFR 65.10.

The water-carrying capacities of McDowell, Sugar, Little Sugar, McMullen, McAlpine, and Mallard Creeks were improved by dredging portions of the channels in 1916 and 1928.

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Several flood control projects affect the study area. Some reduction of flood height is accomplished by removing brush and debris along certain reaches and around bridges and culverts. Other flood prevention measures, such as widening and deepening stream channels and increasing bridge and culvert openings, also help to reduce flood heights. However, such measures could not protect floodplain areas from major floods.

The Mecklenburg County subdivision ordinance includes requirements concerning development in the floodplain. The minimum first floor elevation for structures in any new development must be elevated at or above a flood protection elevation. Along the Catawba River, Mecklenburg County defines the flood protection elevation as two feet above the 1% annual chance (100-year) water-surface elevation, based on future land use conditions. For all other areas in Mecklenburg County, the flood protection elevation is defined as one foot above the 1% annual chance (100-year) water-surface elevation, based on future land use conditions. Mecklenburg County has also decided to prohibit encroachments in regulatory floodways that are based on a 0.5-foot surcharge value using existing land use conditions discharges. In addition, a community encroachment line is being used to regulate development. More information on floodways, surcharges, and the community encroachment line is found in Section 6.3 of this FIS report.

Mecklenburg County manages a floodplain land acquisition (buyout) program to purchase flood-prone properties and remove them from the floodplain. Since buying its first flood-prone home in the fall of 2000, Mecklenburg County has acquired more than 250 residential structures (as of December 2011) at current fair market value. Most of the homes purchased, and later demolished, were hit by the floods of 1995 and 1997. Also, after the 2008 floods Storm Water Services bought 37 flood-damaged homes before owners repaired them. The homes were demolished and the floodplain was returned to open space.

Through the buyout program, Mecklenburg County Storm Water Services (MCSWS) was able to address both of its overriding objectives. First, MCSWS seeks to prevent or reduce the loss of life and damages caused by floods. Property acquisition is the most permanent, proactive step to avoiding tremendous costs and devastation later. The second objective of MCSWS is to preserve and restore the natural benefits of the floodplain. Removing structures from the floodplain has allowed areas to readapt to the natural phenomenon of flooding. Once the houses were razed and the parcels were cleared, the land became open space forever. MCSWS works with other agencies to find ways to use the open space to support other County values, such as the extension of the greenway system and improved water quality. This buyout program is funded generally from federal grants (67%) and local storm water fees (33%).

4.5 Scope of Study

No new engineering analyses were performed for the March 2009 revision. The base data, panel scheme, panel format, and FIS report were updated to match the North Carolina Floodplain Mapping Program statewide DFIRM and FIS mapping standards.

This FIS covers the geographic area of Mecklenburg County, North Carolina, and all jurisdictions therein. The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction. Limits of detailed study are indicated on the Flood Profiles and/or the FIRM.

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Table 3, “Flooding Sources Studied by Detailed Methods” contains a list of flooding sources that were studied by detailed methods. The streams in the following watersheds were updated the February 19, 2014 revision:

Back Creek, Back Creek Tributary, Briar Creek, Briar Creek Tributary 1, Briar Creek Tributary 2, Caldwell Creek, Campbell Creek, Clear Creek, Clear Creek Tributary, Clems Branch, Dairy Branch, Derita Branch, Duck Creek, Edwards Branch, Flat Branch, Fourmile Creek, Goose Creek, Irvins Creek, Irvins Creek Tributary 1, Irvins Creek Tributary 2, Little Hope Creek, Little Hope Creek Tributary, Little Sugar Creek, McAlpine Creek, McAlpine Creek Tributary 1, McAlpine Creek Tributary 1A, McAlpine Creek Tributary 3, McAlpine Creek Tributary 6, McKee Creek, McMullen Creek, McMullen Creek Tributary, North Fork Crooked Creek, North Fork Crooked Creek Tributary, Rea Branch, Reedy Creek, Reedy Creek Tributary 1, Reedy Creek Tributary 2, Reedy Creek Tributary 3, Rocky Branch, Sardis Branch, Shermann Branch, Sixmile Creek, Stevens Creek, Stevens Creek Tributary, and Swan Run.

The streams in the following watersheds are being updated in this revision: Beaverdam Creek, Catawba River Tributary 1, Gar Creek, Irwin Creek, Lake Wylie, Long Creek, Lower Mountain Island Lake, McDowell Creek, Paw Creek, Steele Creek, Sugar Creek, and Upper Mountain Island Lake watersheds.

Table 3—Flooding Sources Studied by Detailed Methods

Stream Name	Downstream Limit	Upstream Limit	Length (mi.)
Back Creek Watershed			
Back Creek	Cabarrus County Line	Approximately 3,500 feet upstream of EWT Harris Boulevard	4.62
Back Creek Tributary	Confluence with Back Creek	Approximately 250 feet upstream of Back Creek Church Road	2.27
Beaverdam Creek Watershed			
Beaverdam Creek	Confluence with Lake Wylie	Approximately 10,500 feet upstream of Dixie River Road	2.5
Beaverdam Creek Tributary	Confluence with Beaverdam Creek	Approximately 400 feet downstream of I-485	1.29
Briar Creek Watershed			
Briar Creek	Confluence with Little Sugar Creek	Approximately 1,800 feet upstream of Ruth Drive	9.71
Briar Creek Tributary 1	Confluence with Briar Creek	Approximately 425 feet upstream of Colony Road	0.83
Briar Creek Tributary 2	Confluence with Briar Creek	Approximately 500 feet upstream of Galway Drive	0.66
Edwards Branch	Confluence with Briar Creek	Approximately 400 feet upstream of Sheffield Drive	2.26

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Table 3—Flooding Sources Studied by Detailed Methods

Stream Name	Downstream Limit	Upstream Limit	Length (mi.)
Caldwell Creek Watershed			
Caldwell Creek	Cabarrus County Line	Approximately 4,986 feet upstream of Cabarrus County Line	0.94
Catawba River Watershed			
Catawba River	Confluence with Lake Wylie	Mountain Island Dam	14.89
Catawba River Tributary 1	Confluence with Catawba River	Approximately 4,373 feet upstream of Moores Chapel Road	1.13
Catawba River Tributary 2	Confluence with Catawba River	Approximately 10,593 feet upstream of confluence with Catawba River	2
Catawba River Tributary 3	Confluence with Catawba River	Approximately 11,440 feet upstream of confluence with Catawba River	2.17
Clarke Creek Watershed			
Cane Creek	Confluence with South Prong Clarke Creek	Approximately 800 feet upstream of confluence with South Prong Clarke Creek	2.2
Clarke Creek	Cabarrus County Line	Approximately 10,900 feet upstream of Mecklenburg County Line	2.09
Ferrelltown Creek	Confluence with Clarke Creek	Approximately 150 feet upstream of confluence with Clarke Creek	1.42
North Prong Clarke Creek	Confluence with Clarke Creek	Approximately 1,600 feet upstream of Ramah Church Road	2.88
Ramah Creek	Confluence with Clarke Creek	Approximately 6,800 feet upstream of Black Farms Road	5.01
South Prong Clarke Creek	Confluence with Clarke Creek	Approximately 7,429 feet upstream of Asbury Chapel Road	2.34
Clear Creek Watershed			
Clear Creek	Cabarrus County Line	Approximately 1,655 feet upstream of Interstate 485	6.26
Clear Creek Tributary	Confluence with Clear Creek	Approximately 1,643 feet upstream of Truelight Church Road	2.89
Sherman Branch	Confluence with Clear Creek	Approximately 2,850 feet upstream of Cabarrus Road	0.84

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Table 3—Flooding Sources Studied by Detailed Methods

Stream Name	Downstream Limit	Upstream Limit	Length (mi.)
Clems Branch Watershed			
Clems Branch	York County, South Carolina State line	Approximately 150 feet upstream of Lancaster Highway	0.65
Fourmile Creek Watershed			
Fourmile Creek	Confluence with McAlpine Creek	Approximately 150 feet upstream of E. John Street	9.64
Rocky Branch	Confluence with Fourmile Creek	Approximately 1,200 feet upstream of Providence Road	2.09
Gar Creek Watershed			
Gar Creek	Confluence with Mountain Island Lake (Catawba River)	Approximately 1,200 feet upstream of Kerns Road	3.50
Goose Creek Watershed			
Duck Creek	Union County Line	Approximately 6,435 feet upstream of County line.	1.21
Goose Creek	Union County Line	Approximately 6,300 feet upstream of Lawyers Road	1.99
Stevens Creek	Confluence with Goose Creek	Approximately 2,500 feet upstream of Thompson Road	1.76
Stevens Creek Tributary	Confluence with Stevens Creek	Approximately 2,600 feet upstream of Thompson Road	0.71
Irwin Creek Watershed			
Irwin Creek	Confluence with Sugar Creek	Approximately 4,700 feet upstream of Nevin Road	10.74
Irwin Creek Tributary 1	Confluence with Irwin Creek	Approximately 3,000 feet upstream of Fieldcrest Road	0.78
Kennedy Branch	Confluence with Irwin Creek	Approximately 200 feet upstream of Slater Road	2.05
Stewart Creek	Confluence with Irwin Creek	Approximately 650 feet upstream of Capps Hill Mine Road	5.30
Stewart Creek Tributary 1	Confluence with Stewart Creek	Approximately 1,550 feet upstream of Berryhill Road	0.76
Stewart Creek Tributary 2	Confluence with Stewart Creek	Approximately 275 feet upstream of I -85	1.58
Stewart Creek Tributary 3	Confluence with Stewart Creek	Approximately 2,065 feet upstream of Hoskins Road	1.05
Lake Wylie Watershed			
Stowe Branch	Confluence with Lake Wylie (Catawba River)	Approximately 100 feet upstream of Shopton Road	0.8

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Table 3—Flooding Sources Studied by Detailed Methods

Stream Name	Downstream Limit	Upstream Limit	Length (mi.)
Little Sugar Creek Watershed			
Dairy Branch	Confluence with Little Sugar Creek	Approximately 171 feet upstream of Kenilworth Avenue	0.57
Derita Branch	Confluence with Little Sugar Creek	Approximately 3,104 feet upstream of West Craighead Road	1.72
Little Hope Creek	Confluence with Little Sugar Creek	Approximately 182 feet upstream of East Woodlawn Road	1.32
Little Hope Creek Tributary	Confluence with Little Hope Creek	Approximately 266 feet upstream of Bradbury Drive	0.39
Little Sugar Creek	Lancaster County, South Carolina State Line	Approximately 750 feet upstream of Kent Brook Drive	19.20
Long Creek Watershed			
Dixon Branch	Confluence with Long Creek	Approximately 1,600 feet upstream of confluence with Dixon Branch Tributary	1.40
Dixon Branch Tributary	Confluence with Dixon Branch	Approximately 1,550 feet upstream of Highway 21	1.25
Gum Branch	Confluence with Long Creek	Approximately 460 feet upstream of Old Plank Road	3.19
Gutter Branch	Confluence with Long Creek	Approximately 4,970 feet upstream of Oakdale Road	3.04
Long Creek	Confluence with Catawba River	Approximately 2,410 feet upstream of Highway 21	15.08
Long Creek Tributary 1	Confluence with Long Creek	Approximately 3,190 feet upstream of confluence with Long Creek	0.60
Long Creek Tributary 2	Confluence with Long Creek	Just downstream of Stoneyridge Drive	0.41
Long Creek Tributary 3	Confluence with Long Creek	Approximately 800 feet upstream of Gum Branch Road	0.35
McIntyre Creek	Confluence with Long Creek	Approximately 640 feet upstream of Lawnmeadow Drive	4.34
Lower Clarke Creek Watershed			
Clarke Creek Tributary	Cabarrus County Line	Approximately 5,793 feet upstream of Highland Creek Parkway	1.65
Rocky River Tributary	Cabarrus County Line	Approximately 2,700 feet upstream of I-85	0.58
Lower Mountain Island Lake Watershed			
Catawba River Tributary 2	Confluence with Catawba River	Approximately 3,875 feet upstream of Harwood Lane	2.03

Section 4.0 – Area Studied

Table 3—Flooding Sources Studied by Detailed Methods

Stream Name	Downstream Limit	Upstream Limit	Length (mi.)
Mallard Creek Watershed			
Clarks Creek	Confluence with Mallard Creek	Approximately 556 feet upstream of Dearmon Road	3.78
Clarks Creek Tributary 1	Confluence with Clarks Creek	Approximately 3,335 feet upstream of Hucks Road	1.43
Clarks Creek Tributary 1A	Confluence with Clarks Creek Tributary 1	Approximately 1,891 feet upstream of Davis Lake Parkway	1.44
Doby Creek	Confluence with Mallard Creek	Approximately 12,892 feet upstream of EWT Harris Boulevard	3.09
Doby Creek Tributary	Confluence with Doby Creek	Approximately 631 feet upstream of IBM Drive	1.45
Mallard Creek	Cabarrus County Line	Approximately 433 feet upstream of Old Potters Road	12.02
Mallard Creek Tributary	Confluence with Mallard Creek	Approximately 1,504 feet upstream of Hubbard Road	0.49
Stony Creek	Confluence with Mallard Creek	Approximately 2,685 feet upstream of Mallard Creek Road	4.18
Stony Creek Tributary	Confluence with Stony Creek	Approximately 5,226 feet upstream of Mallard Creek Road	2.25
Toby Creek	Confluence with Mallard Creek	Approximately 1,160 feet upstream of Autumwood Lane	3.29
McAlpine Creek Watershed			
Campbell Creek	Confluence with McAlpine Creek	Approximately 700 feet upstream of Footpath	5.25
Irvins Creek	Confluence with McAlpine Creek	Approximately 361 feet upstream of Lawyers Road	6.19
Irvins Creek Tributary 1	Confluence with Irvins Creek	Approximately 975 feet upstream of Footpath	2.66
Irvins Creek Tributary 2	Confluence with Irvins Creek	Approximately 3,105 feet upstream of Lawyers Road	1.3
McAlpine Creek	York County, South Carolina State Line	Approximately 2,075 feet upstream of Albemarle Road	22.04
McAlpine Creek Tributary 1	Confluence with McAlpine Creek	Approximately 1,600 feet upstream of Golf Cart Path	1.26
McAlpine Creek Tributary 1A	Confluence with McAlpine Creek Tributary 1	Approximately 501 feet upstream of Ballantyne Com. Parkway	1.1
McAlpine Creek Tributary 3	Confluence with McAlpine Creek	Approximately 551 feet upstream of Providence Road	1.22
McAlpine Creek Tributary 6	Confluence with McAlpine Creek	Approximately 5,577 feet upstream of confluence with McAlpine Creek	1.05

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Table 3—Flooding Sources Studied by Detailed Methods

Stream Name	Downstream Limit	Upstream Limit	Length (mi.)
Rea Branch	Confluence with McAlpine Creek	Approximately 214 feet upstream of Sequoia Red Lane	1.0
Sardis Branch	Confluence with McAlpine Creek	Approximately 817 feet upstream of Sardis Road	1.63
Swan Run	Confluence with McAlpine Creek	Approximately 5,255 feet upstream of Sharon View Road	1.35
McDowell Creek Watershed			
Caldwell Station	Confluence with McDowell Creek	Approximately 2,360 feet upstream of Statesville Road	1.28
McDowell Creek	Confluence with Mountain Island Lake	Approximately 400 feet upstream of Statesville Road	9.40
McDowell Creek Tributary 1	Confluence with McDowell Creek	Approximately 1,025 feet upstream of Summer Serenade Road	0.80
McDowell Creek Tributary 2	Confluence with McDowell Creek	Approximately 1,150 feet upstream of Colonial Garden Drive	0.56
Torrence Creek	Confluence with McDowell Creek	Approximately 2,450 feet upstream of Interstate 77	3.41
Torrence Creek Tributary 1	Confluence with Torrence Creek	Approximately 1,345 feet upstream of Statesville Road	2.62
Torrence Creek Tributary 2	Confluence with Torrence Creek	Approximately 250 feet upstream of Interstate 77	1.83
McKee Creek Watershed			
McKee Creek	Cabarrus County Line	Approximately 600 feet upstream of Denbur Drive	3.12
McMullen Creek Watershed			
McMullen Creek	Confluence with McAlpine Creek	Approximately 3,962 feet upstream of Addison Drive	10.85
McMullen Creek Tributary	Confluence with McMullen Creek	Approximately 300 feet upstream of North Sharon Amity Road	0.70
North Fork Crooked Creek Watershed			
North Fork Crooked Creek	Union County Line	Approximately 2,324 feet upstream of County Line	0.44
North Fork Crooked Creek Tributary	Union County Line	Approximately 630 feet upstream of Stallings Road	0.40
Paw Creek Watershed			
Little Paw Creek	Confluence with Lake Wylie (Catawba River)	Approximately 4,320 feet upstream of Mt. Olive Church Road	1.57
Paw Creek	Confluence with Lake Wylie (Catawba River)	Approximately 3,050 feet upstream of Freedom Drive	7.07
Paw Creek Tributary	Confluence with Paw Creek	Approximately 4,450 feet upstream of confluence with Paw Creek	0.84

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Table 3—Flooding Sources Studied by Detailed Methods

Stream Name	Downstream Limit	Upstream Limit	Length (mi.)
Paw Creek Tributary 1A	Confluence with Paw Creek	Approximately 160 feet upstream of Freedom Drive	0.98
Ticer Branch	Confluence with Paw Creek	Approximately 2,330 feet upstream of Wilkinson Boulevard	1.54
Reedy Creek Watershed			
Reedy Creek	Cabarrus County Line	Approximately 3,950 feet upstream of Plaza Road	3.83
Reedy Creek Tributary 1	Cabarrus County Line	Approximately 2,208 feet upstream of Cabarrus County line	0.41
Reedy Creek Tributary 2	Confluence with Reedy Creek	Approximately 6,300 feet upstream of Robinson Church Road	1.82
Reedy Creek Tributary 3	Confluence with Reedy Creek	Approximately 150 feet upstream of Chapparral Lane	2.68
Rocky River Watershed			
Rocky River	Confluence with West Branch Rocky River	Approximately 11,900 feet upstream of East Rocky River Road	3.69
South Prong West Branch Rocky River	West Branch Rocky River	Approximately 18,400 feet upstream of confluence with West Branch Rocky River	3.5
South Prong West Branch Rocky River Tributary	Confluence with South Prong West Branch Rocky River	Approximately 4,850 feet upstream of confluence with South Prong West Branch Rocky River	0.95
West Branch Rocky River	Confluence with Rocky River	Approximately 1,200 feet upstream of Grey Road	3.17
West Branch Rocky River Tributary	Confluence with West Branch Rocky River	Approximately 8,607 feet upstream of confluence with West Branch Rocky River	1.63
Sixmile Creek Watershed			
Flat Branch	Confluence with Sixmile Creek	Approximately 4,722 feet upstream of Tom Short Road	3.09
Sixmile Creek	Lancaster County, South Carolina State line	Approximately 2,500 feet upstream of Tilley Morris Road	8.79
Steele Creek Watershed			
Blankmanship Branch	Mecklenburg County Line	Approximately 95 feet upstream of Steele Creek Road	0.74
Polk Ditch	Confluence with Walker Branch	Approximately 300 feet upstream of S Tryon St	1.42
Steele Creek	York County, South Carolina State Line	Approximately 170 feet upstream of Brown-Grier Road	4.49

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Table 3—Flooding Sources Studied by Detailed Methods

Stream Name	Downstream Limit	Upstream Limit	Length (mi.)
Walker Branch	York County, South Carolina State Line	Approximately 1,625 feet upstream of S Tryon St	2.20
Walker Branch Tributary	Confluence with Walker Branch	Approximately 370 feet upstream of Steele Creek Road	0.82
Sugar Creek Watershed			
Coffey Creek	Confluence with Sugar Creek	Approximately 3,530 feet upstream of West Blvd	6.31
Kings Branch	Confluence with Sugar Creek	Approximately 370 feet upstream of I-77	4.40
McCullough Branch	Confluence with Sugar Creek	Approximately 415 feet upstream of Nations Ford Road	1.43
Sugar Creek	York County, South Carolina Line	Confluence of Irwin Creek	12.12
Taggart Creek	Confluence with Sugar Creek	Approximately 443 feet upstream of Denver Avenue	3.45
Upper Mountain Island Lake Watershed			
Catawba River Tributary 3	Confluence with Catawba River	Approximately 85 feet upstream of Cashion Road	2.17

This FIS also incorporates the determinations of letters issued by FEMA resulting in map changes (Letters of Map Revision [LOMRs]), as shown in Table 4, “Letters of Map Revision.”

Table 4—Letters of Map Revision

Case Number	Date Issued	Flooding Source(s) / Project Identifier	Community
12-04-4929A	June 14, 2012	Sixmile Creek	City of Charlotte
12-04-5274A	June 26, 2012	Flat Branch	City of Charlotte
13-04-2637A	March 12, 2013	Flat Branch	City of Charlotte

Section 5.0 – Engineering Methods

For the flooding sources studied in detail in the county, standard hydrologic and hydraulic methods were used to determine the flood hazard data required for this FIS.

5.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationship for each flooding source studied in detail affecting the county. Updated analyses were performed for the revised watersheds referenced in this revision and are referenced below.

March 2, 2009 Countywide Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for the flooding sources studied in detail affecting the county based on existing (1999) land use. In addition, hydrologic analysis was carried out for the 1% annual chance flood based on future land use conditions. The future conditions are based on ultimate build out as indicated by the Charlotte-Mecklenburg Planning Commission District Plans adopted on or before 2000. The future floodplain is used locally to regulate new development.

The discharges for the detailed studied streams were determined using the U.S. Army Corps of Engineers HEC-1 Flood Hydrograph Package (USACE, 1998). This software program is designed to simulate the surface runoff response of a river basin to precipitation by representing the basin as an interconnected system of hydrologic and hydraulic components. As applied, the model includes the following: rainfall depths and durations, drainage areas, lag times, runoff curve numbers, and stream routings. The HEC-1 modeling process results in the computation of streamflow hydrographs at desired locations in the river basin.

Hypothetical Rainfall was provided to the HEC-1 model using methodologies defined in Technical Paper No. 40 (TP-40) that was published by the United States Weather Bureau (U.S. Department of Commerce, 1961). TP-40 is a Rainfall Frequency Atlas of the United States, which includes rainfall duration of 30 minutes to 24 hours, for return periods of 1 year to 100 years.

For rainfall duration of 5 to 60 minutes, NOAA Technical Memorandum NWS HYDRO-35 (U.S. Department of Commerce, 1977) was used in place of the rainfall amounts from TP-40. HYDRO-35 was published in 1977 to supersede the rainfall depth-duration-frequency data from TP-40 on the basis that TP-40 values are derived from nationwide, return-period independent ratios of shorter duration values to 1-hour values. The TP-40 values are valid in many specific sections of the country, but do have an observed, describable geographic pattern. Additionally, it has been found that the ratios vary with return period. HYDRO-35 analyzed these variations and derived new precipitation frequencies for the eastern 37 states of the United States. Use of the HYDRO-35 values is required by FEMA for hypothetical precipitation.

Additional rainfall depth-duration-frequency values may be obtained from Technical Paper No. 49 (TP-49). TP-49, also published by the United States Weather Bureau (U.S. Department of Commerce, 1964), supplements TP-40 in that it provides rainfall values for storms of duration between 48 hours and ten days. It was determined for the hydrology in Mecklenburg County that the 24-hour event would be sufficient for the hydrology modeling. This decision was based on the travel time from the upper portions of the basin to the point of interest (the outfall) farthest downstream for the watersheds being modeled. Therefore, TP-49 was not employed in this study.

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In all cases, HEC-1 models were used to determine discharges for return periods of 50%, 20%, 10%, 4%, 2%, and 1% annual chance events. The rainfall amounts used in the models are summarized in Table 5, “Hypothetical Rainfall (inches) for March 2, 2009 FIS” below. TP-40 does not directly provide the 500-year event depth-duration-frequency values. Two acceptable methods were suggested for determining these values for Flood Insurance Studies. The first method, presented in TP-40, was to plot the values for known storm rainfalls (see Table 5) on Log-Normal paper, adjusting the 50%, 5 and 10% events from partial to annual rainfall. Straight-line extrapolation would then provide the depth-duration-frequency values for any storm greater than the 1% event. Based on this method, the 24-hour rainfall depths for the 0.2% annual chance event were provided by the City of Charlotte. The second method was a Log-Log extrapolation of discharges from the 0.2% and 1% annual chance calibrated HEC-1 models. Both methods are within FEMA accepted guidelines. Due to a tendency for the log-log extrapolation to overpredict discharges, this study complied with FEMA’s request that the log-normal straight-line extrapolation be used.

Table 5 - Hypothetical Rainfall (inches) for March 2, 2009 FIS

Duration	50%	20%	10%	4%	2%	1%	0.2%
5 min	0.44	0.51	0.56	0.64	0.71	0.77	1.00
15 min	0.83	1.02	1.15	1.34	1.49	1.64	2.13
60 min	1.30	1.95	2.00	2.35	2.70	3.00	4.02
2 hrs	1.60	2.20	2.50	2.90	3.25	3.50	5.05
3 hrs	1.90	2.40	2.80	3.20	3.50	4.00	5.55
6 hrs	2.25	2.80	3.30	3.90	4.20	4.90	6.50
12hrs	2.50	3.40	3.90	4.80	5.00	5.80	7.70
24 hrs	2.90	3.90	4.70	5.00	6.00	6.50	8.45

*HEC-1 uses a standard triangular, balanced precipitation distribution for hypothetical events.

In order to be consistent with existing policy on rainfall distribution generation, as established by the City of Charlotte and Mecklenburg County Storm Water Services, depth-duration for rainfall of desired return frequencies was input into a preliminary run of HEC-1. This preliminary run was used to produce 5-minute rainfall distributions of the 24-hour hypothetical event. HEC-1 uses a triangular precipitation distribution such that the depth specified for any duration occurs during the central part of the storm. This is referred to as a “balanced storm.” Aerial reductions were incorporated into the preliminary runs which were representative of the watersheds being studied. Aerial reduction factors are described in the TP-40 section on Area-Depth Curves.

The reduced five-minute precipitation distributions were then reformatted to serve as the rainfall distribution (in the form of PI blocks) for the final models. The PI blocks are presented in the model for the 10%, 2%-,1%- and 0.2% annual chance events. By deriving the storm distributions in this manner, more control and opportunity for verification of results was made available for quality control purposes.

The hydrologic investigation was conducted in several steps. The first step was to perform a hydrologic analysis of the entire county based on “coarse” drainage areas. The coarse drainage areas were set at approximately six square miles. These basins were delineated by the Charlotte-Mecklenburg Storm Water Services and provided for use in this analysis. Countywide “coarse” model hydrologic analysis provided the opportunity to look at factors common throughout the County, but unique within the region.

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A more detailed analysis was performed on a watershed-by-watershed basis using drainage areas of approximately 50 acres to 150 acres. Mecklenburg County and the City of Charlotte provided topographic maps with a two-foot contour interval for the purpose of defining the sub-basins (Mecklenburg County, 2002). The basins were delineated by staff engineers, using software developed for the City of Charlotte, and used to establish the connectivity around which the HEC-1 models were built.

Most of the drainage area for the watersheds in Mecklenburg County is contained within the County. For the cases where runoff drained from the surrounding counties into Mecklenburg County, USGS 7.5-minute topographic quadrangle maps were used to supplement the County topographic maps, where more detailed topographic maps were not available (U.S. Department of the Interior, Catawba, 1988, et cetera).

Lag time (T_L), or the time which elapses between the center of mass of the rainfall and the peak of the runoff, is derived from the time of concentration (t_c) based on the empirical relationship of $T_L=0.6*t_c$ documented in the HEC-1 User's Manual. The time of concentration is the maximum time required for water to travel through the watershed. For this study, time of concentration was established using NRCS (formerly SCS) methodology outlined in TR-55 and NEH-4. The NRCS methodology establishes the time of concentration by breaking down the flow path into uniform flow sections (e.g. overland or sheet flow, shallow concentrated flow, and open channel flow sections). The sum of the travel times through each flow section is the time of concentration for that basin.

Input information for the time of concentration (i.e. elevations, distances, cover, etc.) was obtained from a combination of Mecklenburg County: topographic maps, aerial photographs, and USGS quad maps. Specialized software was developed for the City of Charlotte to efficiently evaluate multiple flow paths for the purpose of determining the maximum time required for water to flow through the watershed. Use of this software ensures a consistent and accurate analysis of the time of concentration from watershed to watershed.

The SCS method of computing rainfall excess (i.e. runoff) is employed by the HEC-1 models used in this study. The SCS method establishes a numeric metric for the purpose of quantifying the relationship of soil type, land use and moisture conditions to the runoff resulting from a given rainfall event.

The SCS Curve Numbers were calculated by using SCS soil associations and detailed land use data provided by Mecklenburg County. Using Geographic Information Systems (GIS) software, soil and land use data were intersected with drainage basins, then linked to the master curve number table (See Table 6), based on values provided in the NRCS TR-55. Each sub-basin was then associated with a calculated weighted curve number representative of the runoff characteristics found in that catchment.

Existing land uses for Cabarrus County were obtained from The North Carolina Center for Geographic Information and Analysis. Land use classification were taken from 1996 30-meter Land Sat satellite imagery.

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Table 6 - Master Curve Number Table for March 2, 2009 FIS

Cover type and hydrologic condition	Curve Number for hydrologic soil group			
	A	B	C	D
Woods	30	55	70	77
Open Space	39	61	74	78
Wetland/Brush	35	56	70	77
Agricultural	60	72	80	83
Straight Row – Poor	67	78	85	89
Light Residential	51	68	79	84
Medium Residential	57	72	81	86
Residential 4/acre	61	75	83	87
Heavy Residential	77	85	90	92
Industrial	81	88	91	93
Institutional	54	70	80	85
Industrial/Institutional	70	80	85	87
Commercial	89	92	94	95
Water	99	99	99	99
Streets	98	98	98	98

Attenuation within the streams was calculated by Modified Puls Stream Routing. These calculations require the user to input the variables that define the relationship of inflow-to-volume of runoff contained within the channel and the number of sub-reaches within the routing calculation.

A detailed survey of structures within the watersheds was performed in order to build hydraulic models of the major streams using the Army Corps of Engineers computer program, HEC-RAS. Cross sections were input into the HEC-RAS model using a combination of field survey data and the detailed county two-foot contour topographic maps at representative locations, not exceeding 500 feet apart along the stream centerline. The hydraulic model was run initially using incremental discharges for the purpose of establishing rating curves of storage volume and discharge. The relationships determined by these rating curves were input into the HEC-1 models so that stream attenuation calculations could be performed.

The number of sub-reaches used to calculate the attenuation within each stream reach was time interval, as documented in the HEC-1 User's Manual. The velocity used for this relationship was determined by solving Manning's equation for normal depth given the 1% annual chance flood discharge, as determined from USGS regional regression equations.

Revised Analyses for Countywide FIS Revision

For FIS Report dated February 19, 2014

Updated hydrologic analyses were carried out for the revised watersheds. Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for the flooding sources

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studied in detail affecting the county based on existing (2008) land use. In addition, a hydrologic analysis was carried out for the 1% annual chance flood based on future land use conditions. The future conditions are based on ultimate build out as indicated by the Charlotte-Mecklenburg Planning Commission District Plans adopted on or before 2008. The future floodplain is used locally to regulate new development.

The discharges for the detailed studied streams were determined using the U.S. Army Corps of Engineers Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS), Version 3.40 (USACE, 2009). The HEC-HMS model is a mathematical representation of the hydrologic process and it is to be used to perform the computations for three basic functions;

- Compute losses and generate a runoff hydrograph;
- Combine hydrographs;
- Route hydrographs through channels, structures, ponds, and detention basins.

These functions are combined in a logical manner to model a particular watershed. In order to use the HEC-HMS model correctly and evaluate the results, it is important to understand the limitations of the models use and its underlying theoretical assumptions. The general assumptions and limitations of the HEC-HMS model are as follows:

- Stream flow routings use hydrologic routing methods and do not reflect the full Saint-Venant equations;
- Simulations are limited to a single storm event. The model does not have the capability of accounting for soil moisture storage or depletion between rainfall events, and;
- Storage facilities must be described with a single stage – discharge and stage – storage relationship.

The theoretical assumptions that govern the model's applicability to a specific watershed are as follows:

- The watershed can be represented as an interconnected group of catchment areas;
- The hydrologic process can be represented by the model parameters which reflect average conditions within a catchment area;
- Model parameters represent temporal and spatial averages;
- Rainfall and losses are uniformly distributed across the catchments per a weighted gage analysis, and;
- All runoff from a catchment area (sub-basin, basin, and watershed) eventually goes to the same outfall point.

Additional model assumptions specific to the Catawba River Watershed in Mecklenburg County are:

- The modeling procedure used in this project followed the "SCS Methodology". This terminology covers a wide range of procedures relating to rainfall and losses, runoff and hydrograph routing, and use of the SCS Unit Dimensionless Hydrograph to develop runoff hydrographs.
- The 24-hour Type II rainfall distribution was used for all design frequency simulations.

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Hypothetical Rainfall was provided to the HEC-HMS model using values specified in the Charlotte Mecklenburg Stormwater Services Floodplain Analysis and Mapping Standards Guidance Document (FAMSGD). These precipitation values were taken from an evaluation and subsequent combination of the NOAA dataset and a USGS precipitation analysis performed in 2006 (SIR 2006-5017) and are listed in Table 7. Intensity-Duration-Frequency (IDF) information presented in the Charlotte-Mecklenburg Storm Water Design Manual (CMSWDM) (dated 1993) specifies precipitation depths to be used for the various design storm events (e.g. 2- through 100-year storms) and patterns. The rainfall depths presented in CMSWDM were compared with results of a recent United States Geological Survey (USGS) precipitation study (SIR 2006-5017) prepared in 2006. The USGS study developed several independent families of IDF curves based on different precipitation gage networks and data samples. Based on a comparison and evaluation of precipitation depth sources and recommendations in the USGS publication, it was deemed that the 24-hour precipitation depths from the combined “NOAA dataset plus aggregated USGS site representing the “CRN initial dataset” family with no areal reduction should be used for the Floodplain Mapping Project.

Table 7 - Hypothetical Rainfall (inches) for this FIS Revision

Storm Event	Depth
50%	3.06
20%	4.08
10%	4.80
4%	5.76
2%	6.51
1%	7.29
0.2%	9.23

*HEC-HMS uses a standard triangular, balanced precipitation distribution for hypothetical events.

The USGS combined precipitation depths are slightly higher in the 100-year storm, but equal to or slightly lower in the smaller (higher frequency) storms, than those presented in the CMSWDM for a 24-hour storm duration. The 1/3 Probable Maximum Precipitation (PMP) was also applied to the HEC-HMS models, a precipitation depth of 13.5 inches was provided by the county and applied to all models.

The detailed analysis performed on a watershed-by-watershed basis used drainage areas of approximately 50 acres to 90 acres. Basin delineations and drainage areas were determined using a 10' x 10' grid size digital elevation model (DEM) generated from the Light Detection and Ranging (LIDAR) data collected by the Mecklenburg County. Drainage areas from the current effective study were determined using a 50' x 50' grid cell, so there may be some differences when compared directly. The effective study was also based on larger scale sub-basins with a typical size between 100 – 150 acres.

Lag time (T_L), or the time which elapses between the center of mass of the rainfall and the peak of the runoff, is derived from the time of concentration (t_c) based on the empirical relationship of $T_L=0.6*t_c$ documented in the HEC-HMS User's Manual. The time of concentration is the maximum time required for water to travel through the watershed. For this study, time of concentration was established using NRCS (formerly SCS) methodology outlined in TR-55 and NEH-4. The NRCS methodology establishes the time of concentration by breaking down the flow path into uniform flow sections (e.g. overland or sheet flow, shallow concentrated flow, and

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open channel flow sections). The sum of the travel times through each flow section is the time of concentration for that basin.

Input information for the time of concentration (i.e. elevations, distances, cover, etc.) was obtained from a combination of Mecklenburg County: topographic information, aerial photographs, and land use data. Specialized software developed for the City of Charlotte to efficiently evaluate multiple flow paths for the purpose of determining the maximum time required for water to flow through the watershed. Use of this software ensures a consistent and accurate analysis of the time of concentration from watershed to watershed.

The SCS method of computing rainfall excess (i.e. runoff) is employed by the HEC-HMS models used in this study. The SCS method establishes a numeric metric for the purpose of quantifying the relationship of soil type, land use and moisture conditions to the runoff resulting from a given rainfall event.

The SCS Curve Numbers were calculated by using SCS soil associations and detailed land use data provided by Mecklenburg County. Using Geographic Information Systems (GIS) software, soil and land use data were intersected with drainage basins, then linked to the master curve number table (See Table 8 and Table 9), based on values provided by the county. Each sub-basin was then associated with a calculated weighted curve number representative of the runoff characteristics found in that catchment.

Land use is often used in floodplain analysis as an indicator of the percent imperviousness of a watershed, which has a significant effect on subsequent surface runoff and associated hydrologic peak flow calculations. The Mecklenburg County Effective Flood Insurance Rate Maps (FIRMs) include floodplain mapping based on both existing and future land use conditions. The existing and future land use layers were used with land use-soil type lookup tables (provided by MCSWS) to develop curve number calculations for hydrologic modeling.

The existing land use layer was obtained from the MCSWS. This layer was used as the base layer and it was reviewed and modified using the most recent aerial photography. Any discrepancies were brought to the attention of MCSWS to resolve. A land use task force consisting of stake-holders from within the community was also involved in the QA/QC of the land use data, and over a period of several months, reviewed and verified the accuracy of the data. The task force formally approved the existing land use data on February 17, 2010. Please see the FAMSGD for more detail.

The future land use layer was obtained from MCSWS for the City of Charlotte ETJ. The towns of Pineville, Mint Hill, and Matthews each submitted separate future land use files. The separate future files were reformatted for consistency with the future conditions data provided by the City of Charlotte, and then translated into one seamless layer in order to have the same attributes as the existing land use layer. The future layer was then modified and verified using a similar process as the existing layer. The task force formally approved the future land use data on February 17, 2010. Please see the FAMSGD for more detail. A detailed description of the fields in the existing and future land use layers is presented in Table 8 and Table 9.

Six Mile Creek drains some area in Union County and the Town of Weddington. As such, an existing land use file was obtained from the Town of Weddington and translated to mimic the updated Mecklenburg County existing land use file. The remaining area in the county was assigned existing land use by using the aerial data provided by Mecklenburg County. Union

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County did possess a broad future land use file that was used a base file which was again translated to mimic the Mecklenburg County future land use file.

Table 8 - Master Curve Number Table for McAlpine Creek Basin and Goose Creek Basin

Cover type and hydrologic condition	Curve Number for hydrologic soil group			
	A	B	C	D
Woods/Brush	33	57	71	78
Open Space & > 2 ac Res	44	65	77	82
Light Residential (0.5 to 2 ac Res)	51	68	79	84
Medium Residential (0.25 to 0.5 ac Res)	56	71	81	85
Heavy Residential (<0.25 ac Res)	59	74	82	84
Institutional	69	80	82	86
Industrial - Light	74	83	88	91
Industrial - Heavy	81	88	91	93
Commercial - Light	83	89	92	94
Commercial - Heavy	92	94	95	96
Water	98	98	98	98
Transportation	86	91	93	94

Table 9 - Master Curve Number Table for Little Sugar Creek Basin

Cover type and hydrologic condition	Curve Number for hydrologic soil group			
	A	B	C	D
Woods/Brush	30	55	70	77
Open Space & > 2 ac Res	44	65	77	82
Light Residential (0.5 to 2 ac Res)	51	68	79	84
Medium Residential (0.25 to 0.5 ac Res)	56	71	81	85
Heavy Residential (<0.25 ac Res)	66	78	85	88
Institutional	69	80	86	89
Industrial - Light	78	86	90	92
Industrial - Heavy	84	90	93	94
Commercial - Light	83	89	92	94
Commercial - Heavy	92	94	95	96
Water	98	98	98	98
Transportation	86	91	93	94

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Attenuation within the streams was calculated by 'Modified Puls' and 'Muskingum-Cunge' Stream Routing. The 'Modified Puls' calculation requires the user to input the variables that define the relationship of inflow-to-volume of runoff contained within the channel and the number of sub-reaches within the routing calculation. The 'Muskingum-Cunge' routing method was used for some non-studied streams.

A detailed survey of structures within the watersheds was performed in order to build hydraulic models of the major streams using the Army Corps of Engineers computer program, HEC-RAS. Cross sections were input into the HEC-RAS model using a combination of field survey data and the detailed county topographic data at representative locations, not exceeding 500 feet apart along the stream centerline. The hydraulic model was run initially using incremental discharges for the purpose of establishing rating curves of storage volume and discharge. The relationships determined by these rating curves were input into the HEC-HMS models so that stream attenuation calculations could be performed.

The number of sub-reaches used to calculate the attenuation within each stream reach was estimated by dividing the actual reach length by the product of the wave celerity and the simulations time step, as documented in the HEC-HMS User's Manual. The velocity used for this relationship was determined by solving Manning's equation for normal depth given the 1% annual chance flood discharge, as taken from the former effective study.

For FIS Report dated September 2, 2015

Updated hydrologic analyses were carried out for the revised watersheds. Existing and future land use conditions were obtained / developed through the process described in Section 3.2 of the Mecklenburg County Floodplain Analysis and Mapping Standards Guidance Document – Revision 1, hereinafter referred to as Standards Document. The discharges for the detailed studied streams were determined using the U.S. Army Corps of Engineers Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS), Version 3.50. A detailed description of HEC-HMS and its assumptions / limitations is given in the 1st Revision section.

Subbasin Delineation

Subbasins were delineated from 2007 County raster terrain data using methods in ArcHydro/GeoHMS. The methods and/or final basin delineations were reviewed and adjusted to meet the intent of criteria as outlined in the Standards Document for items such as subbasin outlet location, consideration of closed system drainage inventory, considerations of ponds, etc. Generally speaking, the subbasins are smaller in the headwater reaches and/or where there are more points of interest (e.g. roadway crossings, ponds, etc.), and larger along the main stem (where the impact of an individual subbasin does not impact total flow) or in undeveloped areas with relatively uniform conditions. Area where there are multiple stream confluences in close proximity, subbasins were merged and connectivity was manually adjusted to eliminate very small subbasins (<10 ac).

Time of Concentration / Lag Time

Time of concentrations were developed using methodology described in TR-55 (SCS, 1986). Initially, longest flowpaths (i.e. flow path from hydraulically farthest point to outlet) for each subbasin were automatically generated using HEC-GeoHMS tools. Flowpaths were then inspected against aerial and base mapping, and adjusted as necessary for them to provide reasonable representation of the subbasin. The total flowpath for each subbasin was then divided

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into the flow segments/regimes listed below based on aerial and base mapping. Travel times (T_t) within each segment/regime were calculated using the approach and assumptions outlined in the table below:

Table 10 – Travel Time Calculation Assumptions

Flow Regime / Segment	Description	Assumptions
Sheet Flow	Flow over plan surfaces in headwater of subbasin.	- All subbasins have exactly one sheet flow segment. - Maximum lengths are 300'. Used near maximum in rural areas, but closer to 100' in highly developed areas T_t calculated using TR-55 formula. - Slopes calculated from terrain. Slopes < that 0.5% or greater than 8% were set to these min/max values. - N values initially set at 0.1 for bare areas (or areas with significant pavement), 0.24 for typical grass condition, and 0.5 for wooded areas. Initial/Default values were adjusted as appropriate based on aerials.
Shallow Concentrated Flow	Flow through swales, small ditches, gutters, and other shallow features	- Generally used to connect sheet flow to defined channel/pipe sections. - Most subbasins have one shallow concentrated segment, but can have more or less in some cases. T_t calculated using "unpaved" formula of: $v = 16.1345(S)^{0.5}$ for all segments. Segments were predominately unpaved, and sensitivity analysis showed that few cases with paved portions did not have appreciable effect on overall T_t (generally < 1min). Calculated velocities generally between 1 – 3 ft/s. - Slopes calculated from terrain. Slopes < that 0.5% or greater than 8% were set to these min/max values.
Pipe Flow	Flow through pipe systems	- Only utilized where significant length of flow in closed pipe systems T_t calculated using assumed velocity of 5 ft/s
Channel Flow	Flow through defined open channels	- Used where defined channels were apparent in aerials and/or terrain. T_t calculated using assumed velocity of 4 ft/s
Pond Flow	Flow through ponds	- Segment generally drawn through center of pond for ponds "in-line" with flowpath. - Most subbasins have one or more channel segments. T_t calculated using assumed velocity of 1 ft/s in non-routed ponds, and assumed zero travel time within routed ponds.

Individual segment travel times were summed up for all segments within a given subbasin to calculate time of concentration (T_c) for each subbasin. Lag time for each subbasin was calculated by multiplying the T_c by 0.6 per standard TR-55 methodology.

Curve Number

Curve numbers (CNs) were derived from land use, soils, and impervious surface data within the County. Land use data was obtained by CMSWS, C-M Planning, and other municipalities within the study area, and edited/updated per previously submitted "Land Use Processing" documents. SCS soil information was obtained from the County and verified to ensure that a hydrologic soil

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group was assigned to all soil types. Impervious surface information was from the county-wide impervious study/dataset developed in February 2011 as an additional task order to the mapping contract.

CNs were calculated by first assigning an “average or typical” percent (%) impervious to each of the twelve land use categories. For the initial (i.e. “default”) HMS models, the assigned %impervious values were based on information county-wide average determined in the impervious surface study that were rounded up slightly to be a little conservative and account for the fact the averages to vary within individual watersheds. Percent impervious values used were equal to lower than the values developed in the original land use task force meetings in 2007. The table below shows the %impervious values for comparison.

Table 11 – Comparison of Percent Impervious for Floodplain Mapping

Land Use Code	Description	Percent Impervious		
		2007 Land Use Task Force	2011 Impervious Study	FY10 Default Values
1	Woods/brush	5%	1%	1%
2	Open Space (golf courses, mining, fields)	12%	3%	4%
3	> 1/2 acre to 2 acres residential	20%	12%	12%
4	1/4 acre to 1/2 acre residential	28%	20%	22%
5	< 1/4 acre residential	34%	31%	34%
6	Institutional (schools, hospitals, government offices)	50%	42%	45%
7	Light Industrial	60%	49%	50%
8	Heavy Industrial	72%	44%	50%
9	Light Commercial (office parks, hotels, multi-family > 6 DUA, apartments, condominiums, mixed use)	75%	54%	55%
10	Heavy Commercial (car parks, malls)	90%	72%	75%
11	Water Bodies (usually ponds greater than 2 acres is size)	100%	100%	100%
12	Transportation (multilane roads, interstate) includes right-of-way	80%	43%	45%

Using the “typical” %impervious values, the overall CN for each combination of land use and soil type was calculated using a weighted average between impervious versus pervious area. All impervious area was assigned a CN of 98. The CN for the remaining pervious area was assigned from values in TR-55 for woods (land use code 1 only) or open space (all other codes) assuming “good” ground cover conditions. For example, CN for light commercial land use (code 9) with B soils can be calculated as shown below.

$$CN = [(100 - \%Impervious) * (TR-55\ CN\ Lookup) + \%Impervious * 98] / 100$$

Where: %Impervious = 55

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TR-55 CN Lookup = 61

CN = 81

The overall CNs used for each land use and soil type in the initial HMS models are shown in the table below. Note all CNs are rounded to the nearest whole number.

Table 12 – Master Curve Number Table for Beaverdam, Catawba, Gar, Lake Wylie, Long, Lower Mountain Island Lake, McDowell, Paw, and Upper Mountain Island Lake watersheds

Land Use Code	Description	Calculated CN Values By Soil Group						
		A	B	C	C/D	D	U	W
1	Woods/brush	31	55	70	74	77	70	98
2	Open Space (golf courses, mining, fields)	41	62	75	78	81	75	98
3	> 1/2 acre to 2 acres residential	46	65	77	80	82	77	98
4	1/4 acre to 1/2 acre residential	52	69	79	82	84	79	98
5	< 1/4 acre residential	59	74	82	84	86	82	98
6	Institutional (schools, hospitals, government offices)	69	80	86	88	89	86	98
7	Light Industrial	69	80	86	88	89	86	98
8	Heavy Industrial	69	80	86	88	89	86	98
9	Light Commercial (office parks, hotels, multi-family > 6 DUA, apartments, condominiums, mixed use)	71	81	87	89	90	87	98
10	Heavy Commercial (car parks, malls)	83	89	92	93	94	92	98
11	Water Bodies (usually ponds greater than 2 acres in size)	98	98	98	98	98	98	98
12	Transportation (multilane roads, interstate) includes right-of-way	69	80	86	88	89	86	98

Table 13 - Master Curve Number Table for Irwin, Steele, and Sugar Creek watersheds

Cover type and hydrologic condition	Curve Number for hydrologic soil group			
	A	B	C	D
Woods/Brush	33	57	71	78
Open Space & > 2 ac Res	44	65	77	82
Light Residential (0.5 to 2 ac Res)	51	68	79	84
Medium Residential (0.25 to 0.5 ac Res)	56	71	81	85

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Heavy Residential (<0.25 ac Res)	59	74	82	84
Institutional	69	80	82	86
Industrial - Light	74	83	88	91
Industrial - Heavy	81	88	91	93
Commercial - Light	83	89	92	94
Commercial - Heavy	92	94	95	96
Water	98	98	98	98
Transportation	86	91	93	94

In addition to calculating countywide averages, the impervious study also calculated average %impervious values for each land use category for each County watershed separately. In many cases, %impervious averages were similar between the basins, however, there are numerous cases where the values differ noticeably. For each watershed the default %impervious values were compared against watershed specific values provided by the study. Default countywide %impervious values were used in the initial models and generally used where appropriate, however, watershed specific values were considered and used where values differed noticeably and/or they improved model agreement with gages. It is noted that since the CN as calculated above considers impervious area, %impervious values in HMS were all set to zero.

Percent Impervious

CNs as calculated above considers impervious area, thus %impervious values in HMS were all set to zero. However %impervious in was calculated from the impervious surface dataset as a check to confirm reasonableness of CN assumptions or to justify changes to CNs during calibration.

Initial Abstraction

Initial abstraction (I_a) was left blank in HMS, thus defaulting to standard TR-55 equation ($I_a = 0.2S$). Initial abstraction was considered as a potential calibration parameter, which is further discussed in “Hydrologic Calibration” section later in this document.

Channel Routing – FEMA Streams

Hydrologic reach routing for reaches along FEMA streams was performed using the Modified Puls method. Storage-Discharge relationships (i.e. rating curves) were developed from the HEC-RAS models being developed for this project. A simplified flow file with six profiles covering all simulated storm events (i.e. 2-year to 1/3 PMP) was used to general the storage-discharge relationships. Routing reaches were coded with subreaches and “Inflow=Outflow”, along with the storage-discharge information. Based on a evaluation of model stream (i.e. spot calculations using equations in HMS Technical Reference and sensitivity), the number of subreaches was initially set equal to 4, however, these were checked and adjusted as appropriate to reflect storage conditions.

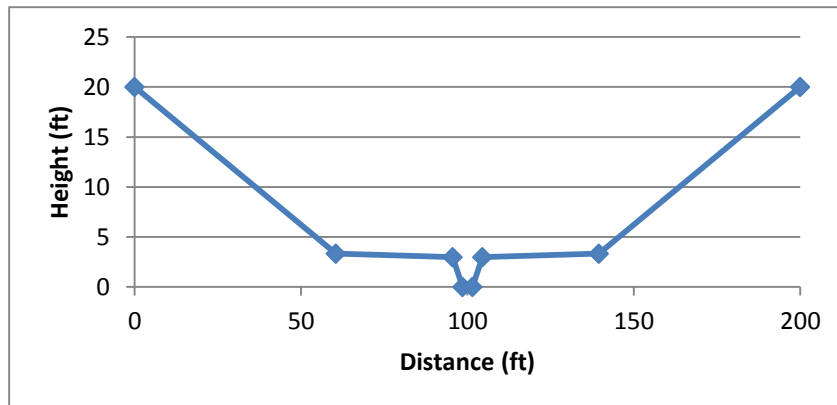
Channel Routing – Non-FEMA Streams

Hydrologic reach routing for reaches upstream of FEMA streams was performed using the Muskingum-Cunge method with an 8-point cross section shape. Lengths and initial slopes of the routing reaches were extracted from GIS/Terrain information developed in ArcHydro/GeoHMS. Based on inspection of available field data and actual calculated energy grade slopes in headwater portions of the RAS models (and knowing limitations of automated slope extraction from the raster terrain data), minimum and maximum slopes for routing reaches was set to be

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0.2% and 0.8% respectively. Manning's n values of 0.05 and 0.08 were used for the channel and overbanks, respectively. These values were based on investigation of representative reaches and were confirmed as reasonable for this scale of analysis. A standard representative 8-point cross section (including channel and valley) was developed based on sample take-offs within the study area as shown below.

Figure 2. Standard Muskingum-Cunge 8-Point Cross Section



Pond Routing

Pond routing was considered for ponds believed to have a significant impact on peak flows along study streams. Generally, ponds with contributing drainage area greater than 100 acres that were larger 0.5 acres in size were considered. Ponds deemed to be significant and which had available data were modeled as “Reservoirs” in HMS using available survey, dam safety, and general terrain data to represent the outlet works (i.e. outlets, spillways, dam tops).

A summary of the drainage area-peak discharge relationships for the flooding sources studied by detailed methods is shown in Table 14, “Summary of Discharges.”

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
Back Creek Watershed						
Back Creek						
At Mecklenburg County Line	BAS1220C	6.86	1,690	2,963	3,607	5,364
					(4,019)	
Approximately 400 ft. upstream of Mecklenburg County Line	BAS42C	4.6	977	1,658	1,992	2,950
					(2,199)	
Approximately 3,100 ft. downstream of Katherine Kiker Road	BAS45C	2.83	673	1,147	1,383	2,071
					(1,644)	
Approximately 1,100 ft. downstream of McLean Road	BAS1191C	2.05	559	1,012	1,208	1,707
					(1,497)	
Approximately 200 ft. upstream of McLean Road	BAS117C	1.45	507	855	1,008	1,380
					(1,261)	
Approximately 800 ft. upstream of E. W.T. Harris Boulevard	BAS2C	1.07	393	705	841	1,153
					(1,054)	
Back Creek Tributary						
At Confluence with Back Creek	BAS10C	2.23	932	1,525	1,779	2,475
					(2,219)	
Approximately 100 ft. downstream of Back Creek Church Road	BAS2C	0.27	732	1,118	1,291	1,685
					(1,440)	
Beaverdam Creek Watershed						
Beaverdam Creek						
Approx. 50' US of Windy Gap Rd.	J_BE_A_52	4.47	1,421	2,718	3,372	5,203
					(5,144)	
At Confluence with Beaverdam Creek Tributary	J_BE_A_48	3.23	996	1,900	2,372	3,667
					(3,811)	
Approx. 1.1 miles US of confluence with Beaverdam Creek Tributary	J_BE_A_78	1.1	396	809	1,040	1,680
					(1,862)	
Approx. 2.0 miles US of confluence with Beaverdam Creek Tributary	J_BE_A_79	0.73	332	778	984	1,629
					(1,750)	
Approx. 500' DS of American Legion Lake	J_BE_A_32	0.5	223	493	638	1,111
Beaverdam Creek Tributary						
Approx. 300 ft. upstream of confluence with Beaverdam Creek	J_BDCT_	1.74	564	1,217	1,590	2,580
	OUTLET				(2,480)	
Approximately 1.1 miles upstream of Confluence with Beaverdam Creek	J_BDCT_43	1.06	452	884	1,114	1,730
					(1,744)	
Immediately DS of I-485 crossing	J_BDCT_38	0.69	327	618	762	1,140
					(1,159)	

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
Beaverdam Creek Tributary						
Approximately 3,700 ft. upstream of Confluence	BDT3C	0.69	377	669	800	1,153
					(1,334)	
Approximately 6,000 ft. upstream of Confluence	BDT2C	0.54	271	476	570	849
					(1,016)	
					(1,219)	
Briar Creek Watershed						
Briar Creek						
Approximately 50 ft. upstream of Park Road	J_BC_219	21.57	3,260	4,484	4,871	6,150
					(5,065)	
Approximately 2,450 ft. downstream of Runnymede Lane	J_BC_127	21.22	3,246	4,466	4,852	6,040
					(5,047)	
Approximately 610 ft. downstream of Runnymede Lane	J_BC_182	19.14	3,150	4,345	4,726	5,682
					(4,924)	
Approximately 20 ft. upstream of Colony Road	J_BC_235	18.92	3,142	4,334	4,714	5,667
					(4,912)	
Approximately 960 ft. upstream of Colony Road	J_BC_179	18.86	3,140	4,331	4,711	5,663
					(4,909)	
Approximately 30 ft. upstream of Sharon Road	J_BC_234	18.53	3,127	4,313	4,692	5,640
					(4,891)	
At Providence Road	J_BC_232	17.98	3,131	4,289	4,668	5,612
					(4,868)	
Approximately 1,450 ft. upstream of Providence Road	J_BC_255	17.21	3,100	4,254	4,634	5,574
					(4,839)	
Approximately 1,620 ft. downstream of Randolph Road	J_BC_99	16.08	3,044	4,205	4,600	5,533
					(4,813)	
Approximately 40 ft. upstream of Randolph Road	J_BC_231	15.20	2,996	4,164	4,568	5,488
					(4,782)	
Approximately 20 ft. upstream of Monroe Road	J_BC_230	14.68	2,965	4,121	4,521	5,432
					(4,734)	
Approximately 460 ft. downstream of Bramlet Road	J_BC_2	14.50	2,953	4,106	4,505	5,412
					(4,717)	
Approximately 800 ft. upstream of Bramlet Road	J_BC_79	14.17	3,318	4,996	5,649	7,405
					(6,035)	
Approximately 190 ft. upstream of Commonwealth Avenue	J_BC_76	11.20	2,764	4,188	4,712	6,066
					(5,031)	
At Central Avenue	J_BC_72	10.00	2,984	4,850	5,910	7,359
					(6,241)	
Approximately 1,370 ft. upstream of Central Avenue	J_BC_69	9.77	3,010	4,937	6,053	7,963
					(6,483)	

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
Briar Creek						
Approximately 2,540 ft. downstream of Country Club Drive	J_BC_65	9.02	2,974	4,906	6,038	8,829
					(6,733)	
Approximately 1,530 ft. downstream of Country Club Drive	J_BC_260	8.05	2,825	4,643	5,691	8,261
					(6,347)	
Approximately 20 ft. upstream of Country Club Drive	J_BC_250	7.45	2,724	4,475	5,472	7,894
					(6,090)	
Approximately 30 ft. upstream of Eastway Drive	J_BC_425	6.89	2,679	4,332	5,300	7,514
					(5,867)	
Approximately 70 ft. upstream of Shamrock Drive	J_BC_50	6.02	2,479	4,007	4,790	6,716
					(5,289)	
Approximately 2,910 ft. downstream of Shannonhouse Drive	J_BC_46	4.86	2,320	3,818	4,506	6,242
					(4,937)	
Approximately 1,490 ft. downstream of Shannonhouse Drive	J_BC_41	3.83	1,949	3,179	3,751	5,209
					(4,039)	
Approximately 20 ft. upstream of Shannonhouse Drive	J_BC_223	1.68	1,024	1,653	1,945	2,749
					(2,102)	
Approximately 20 ft. upstream of The Plaza	J_BC_221	1.49	1,029	1,656	1,947	2,672
					(2,108)	
Approximately 390 ft. downstream of Barrington Drive	J_BC_283	0.96	699	1,125	1,322	1,815
					(1,440)	
Approximately 1,510 ft. upstream of Barrington Drive	J_BC_17	0.39	284	461	543	748
					(579)	
Briar Creek Tributary 1						
At Runnymede Lane	J_BC_237	1.20	670	1,011	1,195	1,793
					(1,274)	
Approximately 390 ft. upstream of Colony Road	J_BC_236	1.05	732	1,213	1,434	1,982
					(1,508)	
Approximately 50 ft. upstream of Sharon Road	J_BC_233	0.65	452	745	883	1,233
					(937)	
Briar Creek Tributary 2						
Approximately 570 ft. upstream of Galway Drive	J_BC_47	1.71	906	1,458	1,714	2,369
					(1,846)	
Approximately 20 ft upstream of Milton Road	J_BC_222	0.89	550	884	1,039	1,401
					(1,108)	
Approximately 40 ft upstream of Barrington Drive	J_BC_211	0.37	222	358	421	579
					(448)	
Edwards Branch						
Briar Creek Road	J_BC_228	2.56	1,434	2,086	2,338	3,103
					(2,499)	

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
Edwards Branch						
Approximately 980 ft downstream of Eastway Drive	J_BC_344	2.12	1,308	1,977	2,252	2,930
					(2,414)	
Approximately 460 ft. upstream of Eastway Drive	J_BC_227	1.89	1,158	1,774	2,012	2,612
					(2,153)	
Approximately 380 ft. downstream of Woodland Drive	J_BC_345	1.19	729	1,183	1,301	1,673
					(1,392)	
Approximately 20 ft. downstream of Sheffield Drive	J_BC_225	0.99	648	1,049	1,236	1,706
					(1,351)	
Approximately 1,150 ft. upstream of Sheffield Drive	J_BC_86	0.58	415	664	779	1,067
					(836)	
Approximately 20 ft. upstream of Driftwood Drive	J_BC_173	0.23	163	253	294	394
					(306)	
Caldwell Creek Watershed						
Caldwell Creek						
At Cabarrus County Line	BAS 1177C	1.52	340	746	1,004	1,755
					(1,603)	
Approximately 900 ft. upstream of Cabarrus County Line	BAS 1158C	1.15	261	580	794	1,357
					(1,246)	
Catawba River Watershed						
Catawba River						
At Confluence of South Fork Catawba River		2,100	36,100	57,900	69,100	100,000
Approximately 1,200 ft. downstream of Charlotte Ave (Highway 27)		2,010	34,700	55,500	66,300	96,300
Approximately 1,000 ft. upstream of Charlotte Ave (Highway 27)		1,856	32,200	51,500	61,400	89,300
Catawba River Tributary 1						
At Confluence with Catawba River	J_CATT1_21	1.67	731	1,343	1,710	2,704
					(2,467)	
Approximately 500 ft. upstream of Moores Chapel Rd.	J_CATT1_34	1.25	547	1,105	1,375	2,103
					(1,980)	
Approximately 2,200 ft. upstream of Moores Chapel Rd.	J_CATT1_35	0.99	491	1,005	1,241	1,862
					(1,758)	
Catawba River Tributary 2						
At Confluence with Catawba River	LM14C	2.39	899	1,585	1,875	2,665
					(2,443)	
Approximately 50 ft. upstream of Beagle Club Road	LM11C	1.94	745	1,336	1,561	2,155
					(1,966)	
Approximately 60 ft. downstream of Harwood Lane	LC7C	1.37	815	1,273	1,443	1,899

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
Catawba River Tributary 3						
At Confluence with Catawba River	UM13C	2.56	443	833	1,014	1,597
					(1,450)	
Approximately 2,600 ft. upstream of Confluence	UM11C	2.18	677	1,317	1,619	2,540
					(2,256)	
Clarke Creek Watershed						
Cane Creek						
At Confluence with South Prong Clarke Creek	CKCC17C	3.51	1,411	2,343	2,703	3,656
					(3,712)	
Approximately 5,300 ft. upstream of Confluence with South Prong Clarke Creek	CKCC12C	2.55	1,088	1,915	2,231	2,913
					(2,997)	
Approximately 6,900 ft. upstream of Confluence with South Prong Clarke Creek	CKCC10C	2.13	964	1,734	2,007	2,571
					(2,688)	
Approximately 9,900 ft. upstream of Confluence with South Prong Clarke Creek	CKCC6C	1.18	697	1,138	1,316	1,719
					(1,797)	
Clarke Creek						
At Cabarrus County Line	CK12C	21.55	3,550	6,356	7,341	10,496
					(10,360)	
At Confluence of Ramah Creek	CK10C	14.65	2,846	5,118	5,930	8,488
					(8,399)	
Ferrelltown Creek						
At Confluence with Clarke Creek	CKFT10C	1.93	593	1,018	1,166	1,573
					(1,557)	
Approximately 5,500 ft. upstream of Confluence with Clarke Creek	CKFT8C	1.58	591	975	1,120	1,536
					(1,521)	
North Prong Clarke Creek						
At Confluence with Clarke Creek	CKNP19C	4.18	629	1,106	1,281	1,783
					(1,805)	
Approximately 800 ft. upstream of Huntersville-Concord Road	CKNP14C	3.01	564	1020	1,193	1,674
					(1,705)	
Approximately 3,100 ft. downstream of Ramah Church Road	CKNP9C	2.02	455	866	1,035	1,513
					(1,567)	
Ramah Creek						
At Confluence with Clarke Creek	CKRC32C	6.51	995	1,692	1,927	2,717
					(2,667)	
Approximately 1,200 ft. upstream of Ramah Church Road	CKRC13C	2.47	971	1,597	1,847	2,543
					(2,537)	
Ramah Creek						
Approximately 100 ft. upstream of Black Farm Road	CKRC10C	1.87	641	1,077	1,252	1,680
					(1,684)	

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
Approximately 300 ft. upstream of Black Farm Road	CKRC8C	1.59	560	926	1,063	1,375
					(1,408)	
Approximately 1,000 ft. downstream of SR 73	CKRC3C	0.63	273	452	515	668
					(656)	
South Prong Clarke Creek						
At Confluence with Clarke Creek	CKSP15C	6.44	2,180	3,556	4,151	5,870
					(5,800)	
Approximately 400 ft. upstream of Asbury Chapel Road	CKSP11C	2.08	1,067	1,552	1,883	2,590
					(2,463)	
Approximately 3,800 ft. upstream of Lawther Road	CKSP6C	1.15	697	1,504	1,756	2,360
					(2,315)	
Approximately 4,600 ft. upstream of Lawther Road	CKSP3C	0.62	341	885	1,041	1,422
					(1,416)	
Clear Creek Watershed						
Clear Creek						
At County Line	BAS56C	12.83	1,364	2,440	3,028	5,005
					(3,852)	
Approximately 100 ft. upstream of Ferguson Road	BAS1231C	11.25	1,293	2,331	2,888	4,836
					(3,682)	
Approximately 1,400 ft. downstream of Arlington Church Road	BAS1226C	8.59	1,222	2,245	2,746	4,749
					(3,502)	
Approximately 50 ft. upstream of Bartlett Road	BAS1182C	1.66	488	963	1,161	1,538
					(1,307)	
Approximately 700 ft. upstream of Bartlett Road	BAS69C	1.18	387	793	937	1,426
					(1,202)	
Clear Creek Tributary						
At Confluence with Clear Creek	BAS1223C	8.59	1,222	2,245	2,746	4,749
					(3,502)	
Approximately 550 ft. upstream of Confluence	BAS1218C	5.69	989	1,915	2,302	3,387
					(2,858)	
Approximately 4,500 ft. downstream of Blair Rd (Highway 51)	BAS1215C	3.93	788	1,603	1,934	2,895
					(2,427)	
Approximately 60 ft. upstream of Blair Rd (Highway 51)	BAS1179C	2.15	463	937	1,164	1,851
					(1,545)	
Sherman Branch						
At Confluence with Clear Creek	BAS33C	1.22	232	492	612	952
					(736)	

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
Goose Creek Watershed						
Duck Creek						
At County Line	BAS1205C	2.87	498	1,013	1,258	2,056
					(1,539)	
Approximately 230 ft. upstream of County Line	BAS5C	2.53	452	930	1,166	1,907
					(1,431)	
Approximately 1,450 ft. upstream of County Line	BAS1188C	1.91	383	823	1,050	1,732
					(1,309)	
Goose Creek						
At Union County Line	BAS1222C	7.36	1,532	3,021	3,898	5,716
					(4,427)	
Approximately 600 ft. upstream of Union County Line	BAS1209C	3.28	722	1,386	1,867	2,737
					(2,181)	
Approximately 250 ft. downstream of Lawyers Road	BAS1187C	1.86	518	982	1,232	1,864
					(1,403)	
Stevens Creek						
At Union County Line	BAS1222C	7.36	1,532	3,021	3,898	5,716
					(4,427)	
Approximately 250 ft. upstream of Union County Line	BAS1212C	3.78	770	1,636	2,058	3,244
					(2,333)	
Approximately 3,000 ft. upstream of I-485	BAS50C	2.21	470	987	1,247	1,943
					(1,386)	
Approximately 300 ft. upstream of Thompson Road	BAS1159C	1.19	348	706	910	1,421
					(1,021)	
Stevens Creek Tributary						
At Confluence with Stevens Creek	BAS60C	1.44	326	684	844	1,351
					(1,016)	
Approximately 2,000 ft. upstream of Thompson Road	BAS59C	1.23	294	649	812	1,301
					(1,015)	
Clems Branch Watershed						
Clems Branch						
Approximately 3,100 ft. downstream of Lancaster Highway	BAS834C	2.34	991	1,642	1,947	2,711
					(2,186)	
Approximately 2,700 ft. downstream of Lancaster Highway	BAS809C	1.56	642	1,008	1,173	1,588
					(1,341)	
Approximately 40 ft. downstream of Lancaster Highway	BAS751C	0.8	378	489	571	777
					(670)	

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
Fourmile Creek Watershed						
Fourmile Creek						
At Confluence with McAlpine Creek	BAS930C	18.17	2,278	4,104	5,026	7,525
					(5,525)	
Approximately 2,200 ft. upstream of Providence Road	BAS905C	10.48	2,166	3,718	4,564	6,749
					(4,879)	
Approximately 5,500 ft. upstream of Providence Road	BAS893C	8.07	1,805	3,132	3,812	5,585
					(4,295)	
Approximately 6,100 ft. downstream of Trade Street	BAS875C	6.33	1,694	2,940	3,544	5,140
					(3,994)	
Approximately 2,800 ft. downstream of Trade Street	BAS862C	5.05	1,457	2,549	3,076	4,472
					(3,497)	
Approximately 800 ft. downstream of Trade Street	BAS1104C	4.12	1,175	2,036	2,451	3,566
					(2,763)	
Approximately 2,200 ft. upstream of Trade Street	BAS846C	3.14	815	1,475	1,801	2,662
					(2,155)	
Approximately 5,600 ft. upstream of Trade Street	BAS787C	1.12	247	470	575	876
					(741)	
Rocky Branch						
At Confluence with Fourmile Creek	BAS831C	2.12	573	1,082	1,337	1,972
					(1,461)	
Approximately 1,500 ft. upstream of Fourmile Creek Road	BAS806C	1.46	532	970	1,164	1,637
					(1,265)	
Approximately 900 ft. upstream of Providence Road/SR 16	BAS777C	0.98	340	617	756	1,045
					(818)	
Gar Creek Watershed						
Gar Creek						
Approximately 700 ft. downstream of Beatties Ford Road	J_GAR_49	3.76	750	1,298	1,559	2,229
					(1,572)	
Approximately 500 ft. downstream of Beatties Ford Road	J_GAR_47	3.45	876	1,533	1,846	2,646
					(1,860)	
Approximately 700 ft. upstream of Beatties Ford Road	J_GAR_43	2.52	1,033	1,811	2,189	3,184
					(2,207)	
Approximately 1850 ft. upstream of McKoy Road	J_GAR_39	1.79	1,288	2,304	2,790	4,151
					(2,833)	
Approximately 1,900 ft. downstream of Kerns Road	J_GAR_40	1.35	1,298	2,254	2,773	4,294
					(2,834)	
Approximately 1,220 ft. upstream of Kerns Road	J_GAR_37	1.13	1,244	1,867	2,206	3,787
Irwin Creek Watershed						

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
Irwin Creek						
At Confluence with Taggart Creek	BAS051C	30.98	8,603	11,334	12,288	16,829
					(13,344)	
At Confluence with Irwin Creek Tributary 1	BAS044C	28.30	8,241	10,640	11,679	16,250
					(13,040)	
At Confluence with Stewart Creek	BAS032C	12.85	4,307	6,206	6,980	9,000
					(7,579)	
Approximately 320 ft. downstream of I-277 (b)	BAS025C	10.59	3,965	5,912	6,784	8,786
					(7,400)	
Approximately 840 ft. upstream of Oaklawn Avenue	BAS022C	9.96	3,686	5,516	6,403	7,993
					(6,951)	
At Confluence with Kennedy Branch	BAS019C	6.00	2,303	3,469	4,081	4,919
					(4,313)	
Approximately 590 ft. upstream of Statesville Avenue	BAS017C	5.33	2,067	3,178	3,663	4,657
					(3,935)	
Approximately 1,740 ft. downstream of I-85	BAS015C	4.90	1,862	2,833	3,246	4,107
					(3,447)	
Approximately 790 ft. downstream of I-85	BAS014C	4.60	1,668	2,606	2,989	3,847
					(3,185)	
Approximately 1,080 ft. upstream of Starita Road	BAS012C	3.92	1,523	2,368	2,722	3,540
					(2,882)	
Approximately 2,180 ft. upstream of Starita Road	BAS011C	3.52	1,398	2,187	2,570	3,500
					(2,768)	
Approximately 640 ft. upstream of Dalecrest Drive	BAS009C	2.44	820	1,296	1,594	2,791
					(1,777)	
Approximately 830 ft. downstream of Nevin Road	BAS008C	2.05	783	1,252	1,534	2,805
					(1,793)	
Approximately 1,130 ft. upstream of Nevin Road	BAS007C	1.62	730	1,225	1,541	2,532
					(1,828)	
Approximately 1,925 ft. upstream of Nevin Road	BAS006C	1.38	608	1,118	1,378	2,011
					(1,543)	
Irwin Creek Tributary 1						
At Confluence with Irwin Creek	BAS476C	1.17	1,427	2,109	2,456	3,377
					(2,589)	
Approximately 2,780 ft. upstream of Fieldcrest Road	BAS474C	0.95	1,296	1,901	2,196	2,982
					(2,309)	
Kennedy Branch						
Approximately 4,260 ft. downstream of I-85	BAS338C	3.13	1,458	2,380	2,769	3,699
					(3,026)	
Approximately 2,765 ft. downstream	BAS337C	3.02	1,382	2,281	2,664	3,624

Section 5.0 – Engineering Methods

Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
of I-85					(2,930)	
Approximately 2,590 ft. downstream of I-85	BAS336C	2.39	964	1,408	1,677	2,306
					(1,928)	
Approximately 2,340 ft. upstream of I-85	BAS333C	1.77	833	1,253	1,554	2,189
					(1,793)	
Stewart Creek						
At Confluence with Irwin Creek	BAS384C	11.19	4,143	5,648	6,184	7,491
					(6,396)	
At Confluence with Stewart Creek Trib 1	BAS383C	9.65	3,875	5,275	5,802	7,407
					(6,040)	
At Confluence with Stewart Creek Trib 2	BAS378C	6.64	3,003	4,385	5,028	6,720
					(5,565)	
Approximately 245 ft. upstream of LaSalle Street	BAS371C	5.24	2,957	4,299	4,929	6,628
					(5,488)	
At Confluence with Stewart Creek Trib 3	BAS369C	3.72	1,890	3,070	3,643	5,123
					(4,155)	
Approximately 1,575 ft. upstream of I-85	BAS366C	2.87	1,789	3,026	3,615	4,955
					(4,118)	
Approximately 2,320 ft. upstream of Hoskins Road	BAS363C	1.45	983	1,713	2,038	2,798
					(2,401)	
Stewart Creek Tributary 1						
At Confluence with Stewart Creek	BAS423C	1.44	1,676	2,419	2,774	3,551
					(2,907)	
Approximately 290 ft. upstream of Berryhill Road	BAS421C	1.09	1,328	1,994	2,299	3,070
					(2,412)	
Stewart Creek Tributary 2						
At Confluence with Stewart Creek	BAS444C	2.24	2,091	3,056	3,472	4,409
					(3,605)	
Approximately 100 ft. upstream of Coronet Way	BAS443C	2.12	2,019	2,936	3,328	4,230
					(3,450)	
Approximately 1,485 ft. upstream of Parkway Avenue	BAS441C	1.68	1,685	2,383	2,682	3,391
					(2,754)	
Approximately 100 ft. downstream of Lander Street	BAS439C	1.42	1,573	2,201	2,446	3,034
					(2,500)	
Approximately 50 ft. downstream of I-85	BAS438C	0.91	1,000	1,247	1,336	1,595
					(1,366)	
Stewart Creek Tributary 3						
At Confluence with Stewart Creek	BAS461C	1.37	1,153	1,525	1,626	1,856
					(1,675)	
Approximately 50 ft. downstream of Hoskins Road	BAS459C	0.98	1,097	1,404	1,518	1,727
					(1,562)	

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
Approximately 1850 ft. upstream of Hoskins Road	BAS458C	0.79	1,021	1,288	1,391	2,334
					(1,6352)	
Lake Wylie Watershed						
Stowe Branch						
At Confluence with Lake Wylie (Catawba River)	J_STO_59	1.05	758	1,239	1,478	2,118
					(1,636)	
Approximately 100 ft. downstream of Shopton Road	J_STO_60	0.85	681	1,117	1,322	1,841
					(1,460)	
Little Sugar Creek Watershed						
Dairy Branch						
Approximately 40 ft. upstream of Cumberland Avenue	J_ULS_243	1.06	756	1,209	1,410	1,930
					(1,514)	
At Park Road	J_ULS_244	0.86	636	1,014	1,190	1,650
					(1,286)	
Approximately 610 ft. downstream of Ideal Way	J_ULS_96	0.71	531	853	1,002	1,375
					(1,085)	
At Magnolia Avenue	J_ULS_198	0.23	216	347	407	557
					(452)	
Derita Branch						
Approximately 20 ft upstream of North Tryon Street	J_ULS_247	2.23	895	1,595	1,930	2,714
					(2,127)	
Derita Branch						
Approximately 2,510 ft. downstream of West Craighead Road	J_ULS_14	1.85	936	1,476	1,725	2,359
					(1,893)	
Approximately 20 ft. upstream of West Craighead Road	J_ULS_8	1.40	702	1,131	1,330	1,821
					(1,503)	
Approximately 1,480 ft. upstream of West Craighead Road	J_ULS_266	1.08	558	908	1,070	1,476
					(1,245)	
Approximately 2610 ft. upstream of West Craighead Road	J_ULS_4	0.87	456	736	864	1,187
					(1,015)	
At 350 ft downstream of Cannon Avenue	J_ULS_189	0.45	215	353	417	579
					(508)	
At Princess Street	J_ULS_248	0.16	59	96	113	157
					(139)	
Little Hope Creek						
Approximately 1,280 ft. downstream of Seneca Place	J_LLS_130	2.97	1,772	2,808	3,279	4,490
					(3,458)	
At East Woodlawn Road	J_LLS_241	1.11	628	1,027	1,214	1,692
					(1,302)	
At Hartford Avenue	J_LLS_242	0.53	315	508	597	820

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%) (633)	
Approximately 510 ft. downstream of Belton Street	J_LLS_104	0.29	178	280	327	443
					(352)	
Little Hope Creek Tributary						
Approximately 100 ft. upstream of Bradbury Drive	J_LLS_120	1.24	949	1,502	1,753	2,383
					(1,828)	
Approximately 1,410 ft. downstream of Murrayhill Road	J_LLS_368	0.40	332	520	607	819
					(636)	
Approximately 20 ft. downstream of Murrayhill Road	J_LLS_203	0.25	232	352	406	539
					(423)	
Little Sugar Creek						
Approximately 15,800 ft. downstream of South Polk Street	J_LLS_204	51.12	7,901	11,761	13,306	17,212
					(13,865)	
At South Polk Street	J_LLS_205	50.13	8,597	12,261	13,909	18,616
					(14,510)	
At Pineville-Matthews Road	J_LLS_157	49.56	8,608	12,414	14,099	18,787
					(14,714)	
Approximately 1,290 ft. downstream of I-485	J_LLS_155	49.02	8,860	12,867	14,642	19,150
					(15,306)	
Approximately 3,440 ft. upstream of I-485	J_LLS_151	47.82	8,976	12,981	14,770	19,250
					(15,413)	
Little Sugar Creek						
Approximately 50 ft. upstream of Sharon Road West	J_LLS_149	46.73	9,429	13,589	15,530	20,580
					(16,369)	
Approximately 2,810 ft. upstream of Sharon Road West	J_LLS_147	45.95	9,309	13,598	15,552	20,397
					(16,400)	
Approximately 4,350 ft. downstream of Archdale Drive	J_LLS_143	44.38	9,070	13,357	15,238	19,754
					(16,035)	
Approximately 220 ft. upstream of Archdale Drive	J_LLS_139	42.98	8,751	12,776	14,541	18,840
					(15,252)	
Approximately 1,210 ft. upstream of Archdale Drive	J_LLS_138	42.00	8,430	12,182	13,834	17,997
					(14,521)	
Approximately 100 ft. downstream of Tyvola Road	J_LLS_136	41.11	8,169	11,645	13,187	17,294
					(13,822)	
At Park Road	J_ULS_207	16.20	4,513	6,489	7,426	9,758
					(7,769)	
Approximately 790 ft. downstream of East Woodlawn Road	J_ULS_395	15.97	4,474	6,453	7,389	9,719
					(7,734)	
At Brandywine Road	J_ULS_218	15.83	4,457	6,434	7,367	9,692

Section 5.0 – Engineering Methods

Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
					(7,712)	
Approximately 2,830 ft. downstream of Princeton Avenue	J_ ULS_ 217	15.57	4,414	6,464	7,410	9,810
					(7,769)	
Approximately 910 ft. downstream of Princeton Avenue	J_ ULS_ 361	15.33	4,561	6,870	7,890	10,632
					(8,293)	
Approximately 80 ft. upstream of Princeton Avenue	J_ ULS_ 216	14.73	4,311	6,504	7,464	10,058
					(7,850)	
Approximately 2,130 ft. upstream of Princeton Avenue	J_ ULS_ 102	14.40	4,274	6,573	7,555	10,235
					(7,934)	
Approximately 50 ft downstream of East Boulevard	J_ ULS_ 97	13.07	3,650	5,597	6,405	8,799
					(6,709)	
Approximately 320 ft. downstream of Medical Center Drive	J_ ULS_ 256	12.54	3,516	5,279	6,070	8,424
					(6,364)	
Approximately 160 ft. downstream of East Morehead Street	J_ ULS_ 338	12.29	3,457	4,998	5,750	8,001
					(6,034)	
Approximately 1,000 ft. downstream of Charlottetowne Avenue	J_ ULS_ 77	11.41	3,225	4,427	5,070	6,634
					(5,257)	
Approximately 190 ft. upstream of East 4th Street	J_ ULS_ 196	10.19	2,953	4,039	4,467	5,472
					(4,581)	
Approximately 300 ft. downstream of Independence Boulevard	J_ ULS_ 71	9.76	2,800	3,840	4,238	5,250
					(4,394)	
Little Sugar Creek						
Approximately 990 ft. downstream of Belmont Avenue	J_ ULS_ 307	9.19	2,716	3,748	4,161	5,244
					(4,329)	
At Belmont Avenue	J_ ULS_ 245	7.87	2,383	3,231	3,584	4,403
					(3,750)	
At Parkwood Avenue	J_ ULS_ 213	7.64	2,375	3,208	3,555	4,377
					(3,719)	
Approximately 780 ft. downstream of Matheson Avenue	J_ ULS_ 292	7.02	2,276	3,080	3,391	4,109
					(3,552)	
Approximately 1,060 ft. downstream of East 36th Street	J_ ULS_ 34	5.80	2,411	3,751	4,187	5,262
					(4,458)	
Approximately 1,210 ft. upstream of East 36th Street	J_ ULS_ 274	3.34	1,494	2,217	2,476	3,071
					(2,642)	
Approximately 10 ft. downstream of East Craighead Road	J_ ULS_ 26	2.89	1,307	1,889	2,096	2,559
					(2,240)	
Approximately 680 ft. downstream of East Sugar Creek Road	J_ ULS_ 269	2.68	1,218	1,713	1,885	2,320
					(2,003)	
Approximately 660 ft. downstream of North Tryon Street	J_ ULS_ 19	2.52	1,146	1,593	1,750	2,160
					(1,862)	
Approximately 1,790 ft. upstream of	J_ ULS_ 12	1.93	1,004	1,598	1,785	2,322

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
North Tryon Street					(1,925)	
Approximately 1,660 ft. downstream of Snow White Lane	J_ULS_9	0.91	591	941	1,104	1,511
					(1,203)	
Approximately 20 ft. upstream of Spring Garden Lane	J_ULS_195	0.27	219	334	386	515
					(399)	
Long Creek Watershed						
Dixon Branch						
Approximately 0.2 mi. upstream of WT Harris Blvd.	J_DIX_189	4.16	874	1,460	1,792	2,570
					(2,240)	
Just downstream of confluence with Dixon Branch Tributary	J_DIX_185	3.69	784	1,355	1,653	2,383
					(2,098)	
Approximately 0.3 mi. upstream of confluence with Dixon Branch Tributary	J_DIX_180	1.06	226	410	505	753
					(694)	
Dixon Branch Tributary						
Approximately 0.25 mi. upstream of confluence with Dixon Branch	J_DIXT1_	2.52	589	940	1,125	1,586
	OUTLET				(1,337)	
Approximately 400 ft. upstream of I-77	J_DIXT1_401	2.24	501	793	949	1,332
					(1,159)	
Just downstream of Statesville Road	J_DIXT1_182	1.86	385	678	827	1,221
					(1,085)	
Approximately 0.2 mi. upstream of Statesville Road	J_DIXT1_183	1.37	259	481	593	883
					(820)	
Approximately 0.3 mi. upstream of Statesville Road (Highway 21)	J_DIXT1_390	0.27	87	156	189	273
					(237)	
Gum Branch						
Just upstream of Gum Branch Road	J_GUM_285	5.37	1,756	3,032	3,678	5,586
					(4,278)	
Just upstream of Birchwood Drive	J_GUM_711	4.9	1,658	2,909	3,530	5,491
					(4,134)	
Approximately 0.2 mi. upstream of Valleyday Road	J_GUM_300	3.62	1,259	2,398	2,983	4,587
					(3,599)	
Approximately 0.5 mi. upstream of Valleyday Road	J_GUM_298	3.35	1,163	2,238	2,794	4,284
					(3,405)	
Approximately 900 ft. downstream of Brookshire Blvd.	J_GUM_301	2.45	832	1,598	2,006	3,103
					(2,488)	
Just upstream of Brookshire Blvd.	J_GUM_667	2.07	681	1,288	1,597	2,452
					(1,932)	
Approximately 800 ft. downstream of Caldwell Williams Road	J_GUM_668	1.88	627	1,173	1,453	2,216
					(1,730)	
Approximately 500 ft. upstream of	J_GUM_310	1.54	525	974	1,203	1,817

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
Caldwell Williams Road					(1,395)	
Approximately 500 ft. upstream of Old Plank Road	J_GUM_308	0.75	355	652	802	1,211
					(915)	
Gutter Branch						
Approximately 0.4 mi. upstream of confluence with Long Creek	J_GUT_614	2.95	689	1,185	1,462	2,305
					(1,734)	
Approximately 1.1 mi. upstream of confluence with Long Creek	J_GUT_615	2.63	598	1,065	1,349	2,106
					(1,589)	
Approximately 0.3 mi. upstream of Kelly Road	J_GUT_269	2.21	529	965	1,199	1,855
					(1,407)	
Just upstream of Oakdale Road	J_GUT_603	1.66	404	754	936	1,453
					(1,097)	
Approximately 0.7 mi. upstream of Oakdale Road	J_GUT_604	1.38	360	639	784	1,240
					(905)	
Approximately 0.9 mi. upstream of Oakdale Road	J_GUT_273	0.63	226	402	489	717
					(545)	
Long Creek Watershed						
Long Creek						
At confluence with Long Creek Tributary 1	J_LON_334	35.73	3,289	5,616	6,866	10,302
					(8,164)	
Approximately 0.2 mi. downstream of CSX RR crossing	J_LON_805	33.77	3,349	5,811	6,990	10,332
					(8,235)	
At confluence with Long Creek Tributary 2	J_LON_295	31.76	3,241	5,516	6,685	9,963
					(7,814)	
At confluence with Long Creek Tributary 3	J_LON_287	29.78	3,176	5,414	6,563	9,774
					(7,557)	
At confluence with Gum Branch	J_LON_284	28.45	3,123	5,321	6,453	9,605
					(7,440)	
At confluence with Gutter Branch	J_LON_241	20.46	2,884	4,948	6,009	8,873
					(7,026)	
At confluence with McIntyre Creek	J_LON_861	16.18	2,705	4,609	5,622	7,866
					(6,428)	
Approximately 0.4 mi. upstream of I-485 #2	J_LON_209	10.82	2,135	3,499	4,180	6,038
					(4,934)	
Approximately 0.4 mi. upstream of I-485 #3	J_LON_907	8.85	1,985	3,208	3,843	5,558
					(4,626)	
At confluence with Dixon Branch	J_LON_197	7.49	1,702	2,749	3,329	4,792
					(4,038)	
Just upstream of Reames Road	J_LON_931	3.04	795	1,267	1,509	2,162
					(1,767)	
Just upstream of I-77	J_LON_932	2.6	685	1,145	1,381	2,008

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
					(1,649)	
Approximately 800 ft. downstream of Lakeview Drive	J_LON_208	2.28	599	1,039	1,260	1,843
					(1,522)	
Approximately 450 ft. downstream of Lakeview Drive	J_LON_214	1.71	479	824	993	1,445
					(1,200)	
Just upstream of Statesville Road	J_LON_448	1.41	420	733	887	1,286
					(1,081)	
Approximately 0.32 mi. upstream of Statesville Road	J_LON_450	1.07	343	623	758	1,107
					(937)	
Approximately 0.5 mi. upstream of Statesville Road	J_LON_223	0.9	285	511	621	906
					(711)	
Long Creek Tributary 1						
Approximately 0.5 mi. upstream of confluence with Long Creek	J_LCT1_335	1.26	310	580	733	1,165
					(998)	
Approximately 0.6 mi. upstream of confluence with Long Creek	J_LCT1_790	0.76	243	442	552	859
					(728)	
Long Creek Tributary 2						
Just upstream of Pine Island Country Club cart path	J_LCT2_	1.1	364	627	763	1,165
	OUTLET				(998)	
Just downstream of Stoneyridge Drive	J_LCT2_768	1.0	318	546	663	991
					(870)	
Long Creek Tributary 3						
At Confluence with Long Creek	J_LCT3_	1.28	440	798	981	1,465
	OUTLET				(1,106)	
Approximately 600 ft. downstream of Gum Branch Road	J_LCT3_754	1.1	355	643	789	1,183
					(905)	
Approximately 800 ft. downstream of Gum Branch Road	J_LCT3_741	0.7	250	456	565	853
					(673)	
McIntyre Creek						
Approximately 0.6 mi. upstream of Miranda Road	J_McIN_562	4.0	850	1,615	2,036	3,312
					(2,413)	
Approximately 0.7 mi. downstream of Beatties Ford Road	J_McIN_244	2.86	780	1,498	1,867	2,997
					(2,181)	
Approximately 0.2 mi. downstream of Beatties Ford Road	J_McIN_258	2.24	714	1,303	1,602	2,535
					(1,857)	
Approximately 0.26 mi. upstream of Beatties Ford Road	J_McIN_257	1.78	672	1,238	1,549	2,343
					(1,758)	
Approximately 700 ft. upstream of Lawnmeadow Drive	J_McIN_247	1.09	432	798	985	1,479
Lower Clarke Creek Watershed						

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
Clarke Creek Tributary						
At Cabarrus County Line	LCCT11C	2.17	513	829	956	1,382
					(1,217)	
Approximately 1,710 ft. upstream of Cabarrus County Line	LCCT10C	1.92	319	513	592	789
					(758)	
Downstream of Dam #1	LCCT9C	1.66	241	382	439	583
					(560)	
Downstream of Dam #2	LCCT8C	1.50	614	1,205	1,447	2,129
					(1,998)	
Approximately 6,570 ft. upstream of Cabarrus County Line	LCCT5C	0.87	693	1,056	1,217	1,546
					(1,405)	
Rocky River Tributary						
At Cabarrus County Line	LCRT8C	1.16	437	615	676	841
					(939)	
Approximately 1,800 ft. upstream of I -85	LCRT6C	0.98	722	909	989	1,183
					(1,230)	
Approximately 2,300 ft. upstream of I-85	LCRT4C	0.79	703	1,027	1,131	1,386
					(1,322)	
Lower Mountain Island Lake Watershed						
Catawba River Tributary 2						
Approximately 500 ft. downstream of Beagle Club Road	J_CATT2_18	2.39	1,038	1,759	2,078	3,080
					(2,358)	
Approximately 0.6 mi. upstream of Beagle Club Road	J_CATT2_17		1,022	1,626	1,927	2,880
					(2,163)	
Approximately 0.5 mi. upstream of Harwood Lane	J_CATT2_63		870	1,405	1,698	2,439
					(1,918)	
Approximately 0.7 mi. upstream of Harwood Lane	J_CATT2_64		761	1,233	1,488	2,217
					(1,668)	
Mallard Creek Watershed						
Clarks Creek						
At Confluence with Mallard Creek	CC38C	6.41	1,982	3,040	3,421	4,616
					(4,580)	
Approximately 4,000 ft. upstream of Confluence with Mallard Creek	CC26C	5.32	1,858	2,893	3,273	4,462
					(4,469)	
Approximately 2,600 ft. downstream of Saxonbury Way	CC21C	4.90	1,808	2,837	3,222	4,419
					(4,446)	
Approximately 1,100 ft. upstream of Saxonbury Way	CC19C	1.66	766	1,134	1,282	1,759
					(1,812)	
Clarks Creek						
Approximately 2,800 ft. upstream of Saxonbury Way	CC18C	1.55	748	1,096	1,247	1,732
					(1,786)	

Section 5.0 – Engineering Methods

Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
Approximately 3,800 ft. downstream of Dearmon Road	CC15C	1.18	650	960	1,109	1,540
					(1,599)	
Approximately 1,500 ft. downstream of Dearmon Road	CC9CC	1.00	428	909	1,071	1,438
					(1,489)	
Clarks Creek Tributary 1						
At Confluence with Clarks Creek	CT17C	3.13	1,088	1,644	2,018	2,781
					(2,771)	
Approximately 100 ft. downstream of Brown Road	CT13C	1.46	630	1,060	1,240	1,688
					(1,730)	
Approximately 100 ft. downstream of Hucks Road	CT11C	1.26	554	915	1,063	1,452
					(1,495)	
Approximately 800 ft. upstream of Hucks Road	CT10C	1.10	477	817	960	1,331
					(1,388)	
Clarks Creek Tributary 1A						
At Confluence with Clarks Creek Tributary 1	CA12C	1.37	470	740	855	1,134
					(1,102)	
Approximately 2,000 ft. downstream of Davis Lake Parkway	CA8C	0.99	336	538	636	870
					(896)	
Approximately 200 ft. downstream of Davis Lake Parkway	CA3C	0.45	107	168	196	260
					(222)	
Doby Creek						
At Confluence with Mallard Creek	DC25C	5.70	1,829	3,001	3,370	4,236
					(4,395)	
Approximately 400 ft. downstream of E. W.T. Harris Boulevard	DC23C	3.06	1,095	1,719	1,964	2,558
					(2,745)	
Approximately 1,700 ft. upstream of E. W.T. Harris Boulevard	DC17CC	2.77	975	1,566	1,808	2,483
					(2,746)	
Approximately 2,300 ft. downstream of Governors Village Middle School Entrance	DC17C	2.29	689	1,165	1,351	1,875
					(2,130)	
Approximately 1,800 ft. upstream of Governors Village Middle School Entrance	DC11C	1.63	459	798	954	1,433
					(1,582)	
Approximately 5,500 ft. upstream of Governors Village Middle School Entrance	DC7C	1.14	364	708	875	1,332
					(1,438)	
Doby Creek Tributary						
At Confluence with Doby Creek	DT19C	2.37	779	1,337	1,521	1,800
					(1,860)	
Doby Creek Tributary						
Approximately 2,400 ft. upstream of IBM Entrance	DT17C	2.08	691	1,266	1,491	2,100
					(2,327)	
Approximately 100 ft. downstream of	DT9CC	1.70	600	1,109	1,306	1,851

Section 5.0 – Engineering Methods

Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
IBM Drive					(2,108)	
Approximately 200 ft. upstream of IBM Drive	DT9C	0.99	352	624	743	1,064
					(1,233)	
Mallard Creek						
At Cabarrus County Line	MC163C	38.52	5,775	10,055	11,409	14,991
					(14,724)	
Approximately 5,400 ft. upstream of Cabarrus County Line	MC157C	38.04	5,775	10,055	11,408	14,981
					(14,717)	
Approximately 500 ft. downstream of I-485 Ramp	MC133C	35.97	5,849	10,224	11,547	14,988
					(14,768)	
Approximately 1,700 ft. downstream of Mallard Creek Church	MC116C	27.91	5,447	8,855	9,831	12,622
					(12,763)	
Approximately 500 ft. downstream of North Tryon Street	MC105C	26.43	5,533	8,857	9,871	12,627
					(12,823)	
Upstream of South I-85	MC98C	20.59	4,210	6,776	7,647	10,114
					(10,343)	
Approximately 2,400 ft. upstream of David Taylor Road	MC85C	13.75	3,213	5,152	5,737	7,810
					(7,961)	
Approximately 700 ft. upstream of Mallard Creek Road	MC72C	12.67	3,278	5,310	5,967	7,951
					(8,162)	
Approximately 2,400 ft. downstream of W. W.T. Harris Boulevard	MC54C	5.48	1,584	2,592	2,939	3,975
					(4,288)	
Approximately 100 ft. upstream of W. W.T. Harris Boulevard	MC51C	5.21	1,518	2,501	2,840	3,859
					(4,195)	
Approximately 2,200 ft. upstream of W. W.T. Harris Boulevard	MC43C	4.31	1,276	2,078	2,357	3,204
					(3,469)	
Approximately 3,400 ft. downstream of W. Sugar Creek Road	MC39C	3.99	1,184	1,950	2,218	3,031
					(3,321)	
Upstream of W. Sugar Creek Road	MC27C	2.68	874	1,368	1,545	2,047
					(2,263)	
Approximately 1,800 ft. upstream of W. Sugar Creek Road	MC20C	2.04	574	926	1,053	1,428
					(1,676)	
Approximately 1,600 ft. downstream of Old Potters Road	MC15AC	1.57	369	653	751	1,197
					(1,465)	
Approximately 430 ft. upstream of Old Potters Road	MC13C	1.29	296	546	636	1,060
					(1,307)	
Mallard Creek Tributary						
At Confluence with Mallard Creek	MC38C	1.22	301	558	663	984
					(1,083)	
Approximately 500 ft. upstream of	MC37C	1.10	286	532	644	915

Section 5.0 – Engineering Methods

Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
Confluence with Mallard Creek					(1,021)	
Stony Creek						
At Confluence with Mallard Creek	SC50C	6.74	1,594	2,384	2,667	3,467
					(3,396)	
Approximately 200 ft. upstream of I-85	SC39C	4.80	1,418	2,088	2,285	2,905
					(2,740)	
Approximately 2,000 ft. upstream of I-85	SC32CC	2.65	997	1,586	1,771	2,244
					(2,044)	
Approximately 100 ft. upstream of Mallard Creek Road	SC13CC	1.81	899	1,416	1,609	2,184
					(1,959)	
Approximately 1,400 ft. upstream of Mallard Creek Road	SC12C	1.02	504	872	1,006	1,419
					(1,271)	
Stony Creek Tributary						
At Confluence with Stony Creek	SI19C	1.81	508	797	868	1,126
					(1,125)	
Approximately 500 ft. upstream of Homewood Drive	SI15AC	1.56	428	656	747	1,022
					(1,076)	
Approximately 100 ft. upstream of Mallard Creek Road	SI14C	1.28	404	590	668	1,033
					(1,102)	
Approximately 2,900 ft. upstream of Mallard Creek Road	SI11C	1.03	404	614	694	970
					(1,057)	
Toby Creek						
At Confluence with Mallard Creek	TC49C	5.13	1,695	2,348	2,519	3,107
					(3,020)	
Approximately 1,700 ft. downstream of Harris Blvd	TC36C	4.01	1,625	2,165	2,279	2,648
					(2,635)	
Approximately 1,300 ft. downstream of W. Rocky River Road	TC16C	1.99	1,126	1,722	1,870	2,316
					(2,186)	
Approximately 100 ft. upstream of W. Rocky River Road	TC13C	1.52	775	1,180	1,313	1,705
McAlpine Creek Watershed						
Campbell Creek						
At Confluence with McAlpine Creek	BAS1080C	7.35	970	1,886	2,385	3,753
					(2,673)	
Approximately 2,700 ft. upstream of W.T. Harris Boulevard	BAS1084C	6.78	939	1,831	2,316	3,645
					(2,600)	
Campbell Creek						
Approximately 2,100 ft. downstream of Executive Center Drive	BAS852C	4.54	758	1,499	1,888	2,932
					(2,150)	
Approximately 1750 ft. upstream of	BAS1088C	2.88	568	1,129	1,411	2,170

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
Albemarle Road					(1,631)	
Approximately 400 ft. downstream of Barcliff Park	BAS792C	1.22	370	734	924	1,463
					(1,051)	
Irvins Creek						
At Confluence with McAlpine Creek	BAS918C	14.76	2,293	4,401	5,671	9,038
					(6,548)	
Approximately 3,000 ft. upstream of E. Independence Boulevard	BAS903C	9.97	1,772	3,247	4,054	6,299
					(4,681)	
Approximately 100 ft. upstream of Lebanon Road	BAS867c	5.53	1,260	2,382	2,976	4,479
					(3,319)	
Upstream of Beaver Dam Lane	BAS860C	4.55	1,095	2,048	2,528	3,700
					(2,815)	
Upstream of Beaver Dam Lane	BAS825C	1.98	590	1,139	1,425	2,115
					(1,564)	
Approximately 700 ft. upstream of Apple Creek Drive	BAS1098C	1.19	347	616	738	1,050
					(806)	
Approximately 400 ft. upstream of Lawyers Road	BAS762C	0.87	232	446	738	811
					(645)	
Irvins Creek Tributary 1						
At Confluence with Irvins Creek	BAS858C	4.28	812	1,405	1,852	3,003
					(2,110)	
Approximately 2,300 ft. downstream of Sam Newell Road	BAS1014C	3.76	512	1,352	1,786	3,017
					(2,031)	
Approximately 1,650 ft. downstream of Independence Boulevard	BAS1073C	2.69	816	1,492	1,766	2,818
					(2,098)	
Approximately 980 ft. upstream of Windsor Park	BAS770C	0.94	342	662	826	1,249
					(933)	
Irvins Creek Tributary 2						
At Confluence with Irvins Creek	BAS1077C	1.98	442	820	970	1,389
					(1,078)	
Approximately 300 ft. downstream of Lawyers Road	BAS793C	1.22	256	606	628	932
					(752)	
Approximately 2,300 ft. upstream of Lawyers Road	BAS668C	0.49	134	268	335	514
					(396)	
McAlpine Creek						
Approximately 5,600 ft. downstream of Lancaster Highway	BAS1020C	93.47	5,626	10,529	12,907	20,690
					(14,375)	
Upstream of Railroad Bridge (Upstream of Monroe Road)	BAS938C	32.35	4,334	8,293	10,430	16,268
					(11,896)	
Upstream of Independence Boulevard	BAS923C	16.37	2,045	4,067	5,172	8,466

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
					(5,922)	
Upstream of Idlewild Road	BAS886C	7.46	949	2,031	2,603	4,611
					(3,090)	
Approximately 200 ft. upstream of Lawyers Road	BAS868C	5.78	710	1,618	2,193	4,035
					(2,652)	
Approximately 500 ft. downstream of Marlwood Circle	BAS841C	2.88	292	739	1,070	1,989
					(1,250)	
Approximately 50 ft. downstream of Albemarle Road	BAS998C	1.42	232	521	683	1,169
					(764)	
McAlpine Creek Tributary 1						
At Confluence with McAlpine Creek	BAS848C	3.31	1,220	2,243	2,679	3,520
					(2,792)	
Approximately 3,800 ft. upstream of US 521	BAS807C	1.46	525	986	1,198	1,765
					(1,250)	
McAlpine Creek Tributary 1A						
At Confluence with McAlpine Creek Tributary 1	BAS796C	1.26	479	886	1,049	1,400
					(1,079)	
Approximately 300 ft. upstream of Ballantyne Commons Parkway	BAS1034C	0.98	378	699	837	1,128
					(868)	
McAlpine Creek Tributary 3						
At Confluence with McAlpine Creek	BAS819C	1.79	728	1,245	1,466	1,909
					(1,520)	
Approximately 750 ft. downstream of Rea Road	BAS797C	1.29	498	888	1,072	1,489
					(1,122)	
McAlpine Creek Tributary 6						
At Confluence with McAlpine Creek	BAS829C	2.06	463	1,032	1,306	2,074
					(1,502)	
Approximately 1,550 ft. upstream of Confluence with McAlpine Creek	BAS814C	1.65	386	860	1,094	1,765
					(1,301)	
Approximately 5,300 ft. upstream of Confluence with McAlpine Creek	BAS577C	0.33	151	286	356	534
					(393)	
Rea Branch						
At Confluence with McAlpine Creek	BAS821C	1.81	399	859	1,168	1,938
					(1,214)	
Rea Branch						
Upstream of Sequoia Red Lane	BAS1038C	1.15	438	803	990	1,526
					(1,029)	
Sardis Branch						
At Confluence with McAlpine Creek	BAS845C	2.39	610	1,296	1,593	2,413
					(1,724)	

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
Approximately 50 ft. upstream of Sardis Road North	BAS1100C	1.71	420	906	1,136	1,747
					(1,240)	
Approximately 910 ft. downstream of Sardis Road	BAS682C	0.53	168	374	481	750
					(529)	
Swan Run						
At Confluence with McAlpine Creek	BAS1042C	2.12	515	1,206	1,559	2,373
					(1,661)	
Approximately 2,750 ft. upstream of Sharon View Road	BAS805C	1.46	336	895	1,206	1,967
					(1,300)	
Approximately 5,300 ft. upstream of Sharon View Road	BAS1070C	1.28	282	807	1,121	1,916
					(1,215)	
McDowell Creek Watershed						
Caldwell Station						
Just upstream of Sam Furr Road	J_CAL_487	3.0	2,738	3,989	4,534	6,002
					(4,597)	
Just upstream of Statesville Road	J_CAL_108	2.47	1,143	1,608	1,833	2,344
					(1,863)	
Approximately 0.5 mi. upstream of Statesville Road	J_CAL_92	1.28	848	1,399	1,704	2,544
					(1,735)	
McDowell Creek						
Just downstream of confluence with McDowell Creek Tributary 1	J_MCD_319	26.36	3,688	6,384	7,765	11,256
					(8,457)	
Just downstream of confluence with McDowell Creek Tributary 2	J_MCD_338	24.21	3,604	6,250	7,603	11,051
					(8,283)	
Just downstream of confluence with Torrence Creek	J_MCD_174	20.68	4,289	6,753	8,223	12,915
					(8,959)	
Approximately 1.3 mi. upstream of Gilead Road	J_MCD_884	9.13	2,843	4,276	4,892	6,640
					(4,965)	
Just upstream of Sam Furr Road	J_MCD_830	7.0	2,738	3,989	4,534	6,002
					(4,597)	
Approximately 0.2 mi. upstream of Sam Furr Road	J_MCD_818	3.46	1,588	2,422	2,783	3,697
					(2,812)	
Approximately 150 ft. downstream of Westmoreland Road	J_MCD_760	2.5	1,481	2,155	2,453	3,192
					(2,479)	
Approximately 350 ft. downstream of I-77	J_MCD_63	2.13	1,410	2,051	2,330	3,014
					(2,355)	
Approximately 400 ft. upstream of Statesville Road	J_MCD_32	1.07	662	956	1,059	1,328
					(1,075)	
McDowell Creek Tributary 1						
Approximately 0.2 mi. upstream of	J_MCDT1_	1.78	576	903	1,108	1,798

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
Summer Serenade Road	1115				(1,331)	
McDowell Creek Tributary 2						
Just upstream of Colonial Garden Drive	J_MCDT2_	1.02	446	858	1,098	1,695
	549				(1,234)	
Approximately 600 ft. upstream of Colonial Garden Drive	J_MCDT2_	0.88	389	783	1,000	1,567
	550				(1,143)	
Torrence Creek						
Just downstream of confluence with Torrence Creek Tributary 1	J_TOR_1066	10.15	3,521	5,426	6,272	8,482
					(6,951)	
Just downstream of confluence with Torrence Creek Tributary 2	J_TOR_477	7.23	2,923	4,469	5,115	6,798
					(5,758)	
Approximately 150 ft. upstream of McKoy Road	J_TOR_1006	4.62	2,111	3,263	3,761	4,889
					(4,350)	
Approximately 750 ft. upstream of Reese Blvd. West	J_TOR_280	3.51	1,834	2,804	3,260	4,283
					(3,785)	
Approximately 450 ft. upstream of Reese Blvd. East	J_TOR_941	3.18	1,677	2,564	2,976	3,983
					(3,552)	
Approximately 0.3 mi. downstream of Mt. Holly- Huntersville Road	J_TOR_288	2.0	1,148	1,626	1,807	2,262
					(2,166)	
Just upstream of I-77	J_TOR_351	1.32	914	1,270	1,391	1,669
					(1,513)	
Approximately 0.4 mi. upstream of I-77	J_TOR_923	1.05	1,050	1,760	2,096	2,938
					(2,411)	
Approximately 0.44 mi. upstream of I-77	J_TOR_924	0.39	376	621	737	1,030
					(846)	
Torrence Creek Tributary 1						
Approximately 1000 ft. upstream of confluence with Torrence Creek	J_TORT1_	2.41	802	1,172	1,363	1,946
	314				(1,451)	
Approximately 0.3 mi. downstream of Stumptown Road	J_TORT1_	2.08	843	1,223	1,385	2,016
	1056				(1,472)	
Just upstream of Stumptown Road	J_TORT1_	1.77	717	1,046	1,213	1,711
	642				(1,326)	
Approximately 600 ft. upstream of Statesville Road	J_TORT1_	1.43	648	950	1,052	1,303
	417				(1,085)	
Approximately 0.25 mi. upstream of Statesville Road	J_TORT1_	0.73	570	1,054	1,284	1,872
	582				(1,338)	
Torrence Creek Tributary 2						
Approximately 150 ft. upstream of Gilead Road	J_TORT2_	1.82	811	1,146	1,292	1,803
	570				(1,353)	
Approximately 0.3 mi. upstream of Rosewood Meadow Lane	J_TORT2_	1.33	824	1,295	1,449	1,785
	1036				(1,520)	

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
Approximately 200 ft. upstream of I-77	J_TORT2_	0.97	624	980	1,116	1,492
	647				(1,180)	
McKee Creek Watershed						
McKee Creek						
At County Line	BAS28C	5.98	1,153	2,170	2,665	4,108
					(3,460)	
Approximately 2,100 ft. downstream of Camp Stewart Road	BAS51C	4.44	934	1,718	2,068	3,163
					(2,752)	
Approximately 200 ft. upstream of Camp Stewart Road	BAS1211C	3.44	751	1,348	1,628	2,298
					(1,975)	
Approximately 75 ft. downstream of I-485	BAS1202C	2.78	545	941	1,191	1,877
					(1,519)	
McKee Creek						
Approximately 1,700 ft. downstream of East Lake Road	BAS1189C	1.96	339	768	990	1,684
					(1,303)	
Approximately 1,400 feet Upstream of East Lake Road	BAS1147C	1.01	212	485	644	1,119
					(896)	
McMullen Creek Watershed						
McMullen Creek						
At Confluence with McAlpine Creek	BAS1021C	15.27	2,968	4,528	5,340	7,428
					(5,566)	
Approximately 500 ft. upstream of Highway 51	BAS1022C	13.1	2,986	4,376	5,145	7,164
					(5,379)	
Approximately 6600 ft. downstream of Quail Hollow Road	BAS906C	10.65	2,545	4,074	4,836	6,687
					(5,122)	
Upstream of Mountainbrook Road	BAS887C	7.52	2,251	3,774	4,519	6,307
					(4,805)	
Approximately 1,000 ft. downstream of Arborway Road	BAS865C	5.38	2,038	3,489	4,235	5,886
					(4,514)	
Approximately 1,300 ft. upstream of Arborway Road	BAS861C	4.75	1,923	3,281	3,964	5,521
					(4,215)	
Approximately 300 ft. downstream of Lincrest Place	BAS828C	2.0	1,047	1,725	2,015	2,846
					(2,198)	
Approximately 200 ft. downstream of Addison Road	BAS816C	1.69	993	1,645	1,958	2,724
					(2,102)	
McMullen Creek Tributary						
At Confluence with McMullen Creek	BAS803C	1.42	894	1,561	1,870	2,629
					(2,003)	
Approximately 1,200 ft. downstream of S. Sharon Amity Road	BAS790C	1.17	793	1,375	1,646	2,302
					(1,764)	
Upstream of S. Sharon Amity Road	BAS775C	0.84	703	1,169	1,412	1,995

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
					(1,517)	
North Fork Crooked Creek Watershed						
North Fork Crooked Creek						
At Union County Line	BAS1165C	1.25	451	800	1,007	1,356
					(1,182)	
North Fork Crooked Creek Tributary						
At Union County Line	BAS1185C	1.72	565	1,084	1,345	1,985
					(1,503)	
Paw Creek Watershed						
Little Paw Creek						
Approximately 0.26 mi. downstream of Mt. Olive Church Road	J_LPAW_24	1.88	693	1,486	1,780	3,156
					(2,386)	
Approximately 880 ft. upstream of Mt. Olive Church Road	J_LPAW_33	1.4	545	1,213	1,567	2,601
					(2,087)	
Approximately 0.46 mi. upstream of Mt. Olive Church Road	J_LPAW_19	1.13	487	1,157	1,508	2,465
					(1,941)	
Approximately 0.82 mi. upstream of Mt. Olive Church Road	DAM_LPC_1	0.59	204	569	766	1,309
					(836)	
Paw Creek						
Just downstream of Old Dowd Road	J_PAW_148	13.68	2,945	4,839	5,766	8,166
					(6,671)	
Just downstream of Ticer Branch	J_PAW_144	13.11	3,035	4,961	5,950	8,313
					(6,880)	
Approximately 0.38 mi. upstream of Wilkinson Blvd.	J_PAW_135	10.3	2,862	4,712	5,692	7,972
					(6,583)	
Just downstream of confluence with Paw Creek Tributary	J_PAW_116	8.67	2,813	5,009	6,140	9,177
					(7,119)	
Approximately 430 ft. upstream of Little Rock Road	J_PAW_104	5.61	2,584	4,773	5,852	8,780
					(6,787)	
Approximately 0.24 mi. downstream of Toddville Road	J_PAW_111	3.28	1,662	3,021	3,711	5,454
					(4,262)	
Approximately 810 ft. upstream of Toddville Road	J_PAW_126	2.91	1,585	2,870	3,532	5,174
					(4,051)	
Approximately 0.36 mi. downstream of Freedom Drive	J_PAW_119	2.49	1,503	2,632	3,211	4,626
					(3,690)	
Approximately 700 ft. downstream of Freedom Drive	J_PAW_114	2.18	1,411	2,388	2,897	4,126
					(3,283)	
Approximately 150 ft. upstream of Freedom Drive	J_PAW_103	1.89	1,324	2,158	2,562	3,592
					(2,824)	
Approximately 80 ft. downstream of Tar Heel Road	J_PAW_91	0.93	943	1,564	1,897	2,738
					(2,273)	

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
Paw Creek Tributary						
Approximately 0.45 mi. upstream of Golf Cart Path #2	J_PAWT_97	0.95	276	507	646	1,347
					(948)	
Approximately 60 ft. upstream of Golf Cart Path #3	J_PAWT_348	0.15	122	226	277	409
					(315)	
Paw Creek Tributary 1A						
Approximately 530 ft. upstream of Paw Creek Road	J_PAWT1_99	1.69	991	1,728	2,109	3,129
					(2,500)	
Approximately 130 ft. downstream of Freedom Drive	J_PAWT1_94	1.19	976	1,709	2,070	2,997
					(2,411)	
Approximately 160 ft. upstream of Freedom Drive	MergeJun01	1.01	874	1,503	1,810	2,600
					(2,101)	
Ticer Branch						
Approximately 700 ft. downstream of Freedom Drive	J_TIC_146	2.16	1,094	1,939	2,360	3,249
					(3,172)	
Approximately 250 ft. downstream of Private Access Road	J_TIC_427	1.15	801	1,452	1,768	2,596
					(2,224)	
Approximately 250 ft. upstream of Private Access Road	J_TIC_140	0.44	376	645	774	1,104
					(961)	
Reedy Creek Watershed						
Reedy Creek						
At Cabarrus County Line	BAS30C	12.99	1,892	3,770	4,715	7,168
					(5,590)	
Approximately 2,400 ft. downstream of Hood Road	BAS1224C	7.87	1,330	2,561	3,125	4,750
					(3,655)	
Approximately 1,600 ft. upstream of Hood Road	BAS80C	2.69	459	949	1,190	1,830
					(1,361)	
Approximately 900 ft. upstream of Plaza Road Extension	BAS1180C	1.64	261	532	672	1,054
					(725)	
Reedy Creek Tributary 1						
At Cabarrus County Line	BAS1160C	1.21	555	1,045	1,259	1,744
					(1,480)	
Reedy Creek Tributary 2						
At Confluence with Reedy Creek	BAS1201C	2.74	377	876	1,124	1,681
					(1,377)	
Approximately 200 ft. upstream of Robinson Church Road	BAS1190C	2.01	267	635	818	1,392
					(1,049)	
Approximately 3,600 ft. upstream of Robinson Church Road	BAS1171C	1.42	205	483	628	1,023
					(803)	

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
Approximately 4,600 ft. upstream of Robinson Church Road	BAS1155C	1.09	149	358	467	768
					(589)	
Approximately 6,300 ft. upstream of Robinson Church Road	BAS1081C	0.50	53	119	164	343
					(277)	
Reedy Creek Tributary 3						
At Confluence with Reedy Creek	BAS64C	3.99	765	1,450	1,781	2,747
					(2,107)	
Approximately 4,400 ft. downstream of Plott Road	BAS2001C	2.98	617	1,174	1,423	2,191
					(1,605)	
Approximately 30 ft. downstream of Plott Road	BAS1169C	1.37	225	477	591	895
					(649)	
Reedy Creek Tributary 3						
Approximately 1,560 ft. downstream of Chapparral Lane	BAS1154C	1.08	171	383	476	726
					(535)	
Rocky River Watershed						
Rocky River						
At Confluence of West Branch Rocky River	RR18C	37.17	4,847	9,141	10,743	15,858
					(16,042)	
Approximately 680 ft. upstream of Confluence of West Branch Rocky River	RR17C	14.27	1,759	3,236	3,790	5,924
					(6,786)	
Approximately 1,750 ft. upstream of County Line	RR16C	14.05	1,789	3,270	3,834	6,072
					(6,975)	
Approximately 1,800 ft. upstream of Rocky River Road	RR12C	13.23	1,779	3,269	3,857	6,119
					(7,022)	
Approximately 5,400 ft. upstream of Rocky River Road	RR8C	11.93	1,763	3,269	3,916	6,242
					(7,178)	
Approximately 8,600 ft. upstream of Rocky River Road	RR6C	11.40	1,760	3,277	3,944	6,291
					(7,242)	
South Prong West Branch Rocky River						
At Confluence with West Branch Rocky River	RRWB20CC	20.80	3,553	6,699	8,009	11,731
					(10,538)	
Approximately 660 ft. upstream of Confluence	RRSP30C	7.00	1,898	3,038	3,376	4,598
					(4,168)	
Approximately 3,300 ft. downstream of Rivercrossing Boulevard	RRSP22C	5.81	1,671	2,639	2,921	3,979
					(3,645)	
Approximately 100 ft. upstream of Rivercrossing Boulevard	RRSP21C	5.54	1,889	2,941	3,224	4,502
					(4,128)	
Approximately 600 ft. upstream of Davidson – Concorde Road	RRSP17C	3.40	1,296	2,062	2,253	2,984
					(2,785)	
Approximately 5,000 ft. upstream of Davidson-Concorde Road	RRSP8C	1.76	775	1,227	1,422	1,998
					(1,829)	

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
South Prong West Branch Rocky River Tributary						
Confluence with South Prong West Branch Rocky River	RRST6C	1.38	710	1,290	1,479	1,977
					(2,028)	
Approximately 4,000 ft. upstream of Confluence with South Prong West Branch Rocky River	RRST3C	0.82	510	935	1,119	1,543
					(1,548)	
West Branch Rocky River						
At Confluence with West Branch Rocky River	RR18C	37.17	4,847	9,141	10,743	15,858
					(16,042)	
Approximately 270 ft. upstream of Confluence	RRWB32C	22.88	3,592	6,669	7,946	11,761
					(10,530)	
West Branch Rocky River						
Approximately 3,700 ft. upstream of Confluence	RRWB23C	21.30	3,544	6,643	7,923	11,663
					(10,458)	
Approximately 700 ft. upstream of Rivers Ford Road	RRWB20C	13.80	2,279	4,466	5,321	7,971
					(7,112)	
Approximately 3,000 ft. upstream of E. Rocky River Road	RRWB17C	13.16	2,663	5,022	5,925	8,577
					(7,649)	
Approximately 5,400 ft. downstream of Grey Road	RRWB13C	10.22	2,181	4,206	4,963	7,245
					(6,522)	
Approximately 2,000 ft. downstream of Grey Road	RRWB8C	9.51	2,198	4,231	4,976	7,254
					(6,536)	
West Branch Rocky River Tributary						
At Confluence with Rocky River	RRWT12C	2.10	630	1,187	1,417	2,129
					(1,910)	
Approximately 4,000 ft. upstream of Confluence	RRWT9C	1.51	590	1,082	1,275	1,855
					(1,679)	
Sixmile Creek Watershed						
Flat Branch						
At Confluence with Sixmile Creek	BAS853C	3.94	866	1,607	1,964	2,927
					(2,115)	
Approximately 105 ft. upstream of Threat Vail Lane	BASFB839C	2.75	808	1,511	1,846	2,776
					(2,000)	
Approximately 2,400 ft. downstream of Tom Short Road	BAS808C	1.84	702	1,263	1,536	2,263
					(1,673)	
Approximately 1,200 ft. downstream of Tom Short Road	BAS795C	1.24	521	948	1,154	1,717
					(1,274)	
Approximately 3,800 ft. upstream of Tom Short Road	BAS619C	0.26	352	551	646	926
					(664)	
Sixmile Creek						
At County Line	BAS937C	22.44	2,290	4,173	5,164	7,881

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
					(5,538)	
Approximately 4,790 ft. downstream of Rea Road	BAS924C	16.35	1,861	3,431	4,233	6,490
					(4,568)	
Approximately 4,200 ft. downstream of Tom Short Road	BAS899C	9.43	1,079	2,094	2,630	4,139
					(2,978)	
Approximately 4,300 ft. upstream of Tom Short Road	BAS877C	6.51	973	1,886	2,364	3,695
					(2,687)	
Approximately 200 ft. upstream of Providence Road	BAS859C	4.29	756	1,426	1,772	2,788
					(2,025)	
Sixmile Creek						
Approximately 3,100 ft. upstream of Providence Road	BAS849C	3.45	658	1,250	1,548	2,382
					(1,789)	
Approximately 3,000 ft. downstream of Tilley Morris Road	BAS836C	2.35	536	942	1,145	1,689
					(1,255)	
Steele Creek Watershed						
Blankmanship Branch						
At York County Line	BAS908C	1.50	467	863	1,016	1,422
					(1,231)	
Approximately 560 ft. upstream of York County Line	BAS907C	1.34	428	809	944	1,294
					(1,132)	
Approximately 1070 ft. downstream of Steele Creek Road	BAS905C	1.16	397	761	880	1,188
					(1,050)	
Approximately 100 ft. downstream of Steele Creek Road	BAS904C	0.91	383	742	850	1,119
					(996)	
Polk Ditch						
At Confluence with Walker Branch	BAS871C	1.63	820	1,181	1,383	1,789
					(1,432)	
Approximately 2,145 ft. upstream of Choate Circle	BAS869C	1.40	805	1,160	1,324	1,710
					(1,370)	
Approximately 3,375 ft. upstream of Choate Circle	BAS868C	1.29	796	1,127	1,287	1,656
					(1,334)	
Approximately 1670 ft. downstream of Lioness Street	BAS867C	0.92	491	663	748	1,035
					(774)	
Approximately 1,670 ft. downstream of Lioness Street	BAS866C	0.70	367	515	556	919
					(590)	
Steele Creek						
At York County Line	BAS771C	14.63	4,474	6,848	7,970	10,967
					(8,956)	
At Confluence with Walker Branch	BAS770C	7.54	2,332	3,286	3,665	4,672

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
					(3,122)	
Approximately 100 ft. downstream of Carrowinds Boulevard	BAS766C	6.93	2,169	3,075	3,435	4,14
					(3,655)	
Approximately 2,430 ft. upstream of Carrowinds Boulevard	BAS764C	6.06	2,145	3,039	3,393	4,093
					(3,612)	
Approximately 1,040 ft. downstream of South Tryon Street	BAS761C	5.30	1,964	2,828	3,191	3,925
					(3,433)	
Approximately 660 ft. downstream of John Price Road	BAS756C	3.70	1,373	2,078	2,376	3,213
					(2,659)	
Approximately 1,580 ft. downstream of Westinghouse Boulevard	BAS930C	3.62	1,103	1,746	2,032	2,833
					(2,368)	
Approximately 150 ft. upstream of Westinghouse Boulevard	BAS754C	2.77	1,098	1,733	2,019	2,840
					(2,365)	
Approximately 2,640 ft. upstream of Westinghouse Boulevard	BAS752C	2.03	820	1,344	1,622	2,341
					(2,016)	
Approximately 1400 ft. downstream of Red Hickory Lane	BAS751C	1.59	631	1,037	1,264	1,864
					(1,638)	
Approximately 850 ft. upstream of Red Hickory Lane	BAS750C	1.27	537	913	1,124	1,694
					(1,505)	
Walker Branch						
At Confluence with Steele Creek	BAS841C	7.07	2,332	3,803	4,551	6,428
					(5,131)	
Approximately 2,490 ft. downstream of Smith Road	BAS839C	4.93	1,607	2,624	3,181	4,453
					(3,644)	
Approximately 235 ft. downstream of Smith Road	BAS836C	4.34	1,435	2,374	2,863	4,120
					(3,301)	
At Confluence with Walker Branch Trib	BAS834C	2.37	926	1,428	1,721	2,431
					(1,912)	
Approximately 120 ft. upstream of South Tryon Street	BAS832C	2.14	496	812	962	1,367
					(1,066)	
Walker Branch Tributary						
At Confluence with Walker Branch	BAS886C	1.64	761	1,239	1,549	2,284
					(1,868)	
Approximately 980 ft. downstream of Steele Creek Road	BAS885C	1.26	564	991	1,250	1,863
					(1,551)	
Approximately 50 ft. downstream of Steele Creek Road	BAS884C	0.90	439	853	1,078	1,546
					(1,318)	
Sugar Creek Watershed						
Coffey Creek						
At Confluence with Sugar Creek	BAS596C	10.56	1,972	3,445	4,155	5,830
					(5,282)	

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
Approximately 515 ft. upstream of South Tryon Street	BAS590C	9.07	1,871	3,276	3,969	5,747
					(5,196)	
Approximately 3,535 ft. upstream of Shopton Road	BAS579C	6.17	1,864	3,144	3,786	5,381
					(4,840)	
Approximately 5,010 ft. downstream of Byrum Drive	BAS574C	4.74	1,952	3,158	3,742	5,136
					(4,573)	
Approximately 4,310 ft. downstream of Byrum Drive	BAS573C	4.24	1,905	3,013	3,524	4,737
					(4,056)	
Approximately 715 ft. downstream of Piney Top Drive	BAS569C	3.42	1,643	2,580	3,025	4,122
					(3,519)	
Approximately 170 ft. downstream of West Boulevard	BAS568C	3.20	1,577	2,463	2,888	3,939
					(3,344)	
Approximately 530 ft. upstream of West Boulevard	BAS567C	2.80	1,534	2,365	2,740	3,637
					(2,986)	
Approximately 1,630 ft. upstream of West Boulevard	BAS566C	2.35	1,469	2,131	2,458	3,224
					(2,507)	
Kings Branch						
At Confluence with Sugar Creek	BAS698C	4.38	1,674	2,508	2,941	3,984
					(3,200)	
Approximately 2,350 ft. upstream of Westinghouse Boulevard	BAS695C	3.76	1,620	2,463	2,889	3,953
					(3,140)	
Approximately 95 ft. upstream of Hebron Street	BAS692C	3.28	1,566	2,449	2,874	3,961
					(3,127)	
Approximately 1,615 ft. downstream of East Arrowood Road	BAS690C	2.79	1,563	2,604	3,166	4,574
					(3,495)	
Approximately 50 ft. downstream of Deanna Lane	BAS687C	2.42	1,571	2,610	3,171	4,560
					(3,504)	
Approximately 1,425 ft. upstream of Deanna Lane	BAS684C	1.94	1,429	2,320	2,788	3,894
					(3,067)	
Approximately 375 ft. downstream of Archdale Drive	BAS682C	1.67	1,435	2,329	2,749	3,675
					(3,002)	
Approximately 125 ft. upstream of Archdale Drive	BAS681C	1.36	1,235	1,861	2,150	2,820
					(2,339)	
Approximately 25 ft. downstream of I-77	BAS679C	0.76	663	1,023	1,148	1,366
					(1,240)	
McCullough Branch						
At Confluence with Sugar Creek	BAS732C	2.22	784	1,188	1,379	2,019
					(1,567)	
Approximately 50 ft. upstream of Rock Hill Road	BAS730C	1.91	691	1,141	1,348	1,980
					(1,543)	

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Table 14—Summary of Discharges

Flooding Source and Location	Basin Outlet ID	Upstream Drainage Area (sq. mi.)	Existing Peak Discharge (cfs)			
			10%	2%	1%	0.2%
			Future Peak Discharge (cfs)			
					(1%)	
Approximately 530 ft. downstream of Nations Ford Road	BAS727C	1.48	617	1,022	1,220	1,753
					(1,398)	
Sugar Creek						
At York County Line	BAS101C	68.54	10,413	15,106	16,996	22,829
					(18,889)	
At Confluence with Kings Branch	BAS088C	58.46	10,143	14,803	16,687	22,443
					(18,467)	
At Confluence with Coffey Creek	BAS076C	44.22	9,090	13,211	14,493	19,622
					(15,764)	
Taggart Creek						
At Confluence with Sugar Creek	BAS503C	6.59	3,338	4,635	5,120	6,518
					(5,474)	
Approximately 2,550 ft. downstream of West Boulevard	BAS501C	5.75	3,156	4,435	4,933	6,316
					(5,267)	
Approximately 2,200 ft. downstream of West Boulevard	BAS500C	5.65	3,047	4,282	4,753	6,088
					(5,055)	
Approximately 110 ft. downstream of West Boulevard	BAS498C	5.03	2,855	4,070	4,532	5,823
					(4,838)	
Approximately 1,710 ft. upstream of Union County Line	BAS496C	4.02	2,198	3,085	3,449	4,353
					(3,670)	
Approximately 375 ft. downstream of Billy Graham Parkway	BAS493C	3.18	1,328	1,739	1,940	2,374
					(2,014)	
Approximately 910 ft. downstream of Norfolk Southern Railroad	BAS491C	2.89	1,366	1,584	1,646	1,828
					(1,725)	
Approximately 180 ft. downstream of Mulberry Church Road	BAS488C	1.87	1,104	1,261	1,304	1,401
					(1,328)	
Approximately 230 ft. upstream of Mulberry Church Road	BAS487C	1.17	644	1,078	1,260	1,731
					(1,401)	
Upper Mountain Island Lake Watershed						
Catawba River Tributary 3						
At Confluence with Catawba River	UM13C	2.56	443	833	1,014	1,597
					(1,450)	
Approximately 2,600 ft. upstream of Confluence	UM11C	2.18	677	1,317	1,619	2,540
					(2,256)	

The stillwater elevations have been determined for the 1% annual chance flood for the flooding sources studied by detailed methods and are summarized in Table 15, “Summary of Stillwater Elevations.”

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Table 15—Summary of Stillwater Elevations

Flooding Source	FIRM Panel Number(s)	Elevations (feet NAVD)			
		10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Lake Norman	4611, 4612, 4613, 4621, 4622, 4623, 4624, 4631, 4632, 4633, 4634, 4643, 4644, 4654	*	*	760.2	*
Lake Wylie	3487, 3488, 3489, 3497, 3498, 3499, 3580, 3581, 3590, 3591, 3593, 4501, 4502, 4503, 4504	*	*	570.0	*
Mountain Island Lake	4508, 4509, 4518, 4519, 4528, 4529	*	*	654.6	*

*Data not available

5.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the flood elevations for the selected recurrence intervals. Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles. For stream segments for which BFEs were computed, selected cross-section locations are also shown on the FIRM. Flood profiles were developed showing computed water-surface elevations for floods of the selected recurrence intervals.

Users should be aware that flood elevations shown on the FIRM represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data tables in the FIS Report. For construction and/or floodplain management purposes, users are encouraged to use the flood elevation data presented in the FIS in conjunction with the data shown on the FIRM.

The hydraulic analyses for this FIS were based on unobstructed flow. The flood elevations shown on the Flood Profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

March 2, 2009 Countywide Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles. For stream segments for which a floodway was computed, selected cross-section locations are also shown on the FIRM.

The cross section geometries were obtained from topographic maps and field surveys. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry. The channel sections were located at close intervals upstream and downstream of structures. The overbank cross section data for the backwater analyses were obtained from 2 foot contour interval

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data provided by Mecklenburg County (Mecklenburg County, 2002). The roughness coefficients were evaluated in the field by an engineer and verified using imagery provided by Mecklenburg County (Mecklenburg County, 1999).

Water-surface elevations of floods of the selected recurrence intervals were computed through use of the Army Corps of Engineers' HEC-RAS step-backwater computer program version 2.2b (USACE, September 1998). These computer models were calibrated using historic high water data collected during field investigations.

Starting water-surface elevations for the detailed study limits were obtained by using the slope area option of the HEC-RAS Step-Backwater computer program or by matching the elevations of contiguous studies.

Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals. The hydraulic analyses for this FIS were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

Channel roughness factors (Manning's "n") used in the hydraulic computations were made in the field by an engineer where stream access was possible, with orthophotos used to supplement areas that could not be accessed.

Revised Analyses for Countywide FIS Revision

For FIS Report dated February 19, 2014

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles. For stream segments for which a floodway was computed, selected cross-section locations are also shown on the FIRM.

The cross section geometries were obtained from topographic maps and field surveys. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry. The channel sections were located at close intervals upstream and downstream of structures. The overbank cross section data for the backwater analyses were obtained from updated Light Detection and Ranging (LiDAR) data provided by Mecklenburg County (Mecklenburg County, 2007). The roughness coefficients were evaluated in the field by an engineer and verified using imagery provided by Mecklenburg County.

Water-surface elevations of floods of the selected recurrence intervals were computed through use of the Army Corps of Engineers' HEC-RAS step-backwater computer program version 4.0 and version 4.1 (U.S. Army Corps of Engineers, 2010). These computer models were calibrated using historic high water data collected during field investigations.

Starting water-surface elevations for the detailed study limits were obtained by using the slope area option of the HEC-RAS Step-Backwater computer program or by matching the elevations of contiguous studies.

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Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals. The hydraulic analyses for this FIS were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

Channel roughness factors (Manning's "n") used in the hydraulic computations were made in the field by an engineer where stream access was possible, with orthophotos used to supplement areas that could not be accessed. The channel and overbank "n" values for all of the streams studied by detailed methods are shown in Table 17, "Roughness Coefficients."

For FIS Report dated September 2, 2015

Study Stream Alignment

Study stream GIS files were initially copied from Effective studies and then manually verified against available data (e.g. 2009 and 2011 aerials, cross section surveys, and 2007 topographic mapping). In general, changes were only made where the newer data provided compelling evidence of difference or change (e.g. could see channel in aerials that was different from Effective). Stream stationing was then established in GIS from the finalized alignment.

Cross Sections

Hydraulic cross sections were located/added at strategic points (e.g. near roadways, confluences, and at major changes in floodplain corridor characteristics such as channel slope, roughness, or geometry) and at intermediate points along the channel to adequately characterize the floodplain corridor for floodplain analysis. Cross sections were generally spaced 500' or closer on average. Cross section geometries, (i.e. station-elevation takeoffs, channel banks stations, etc.) were obtained from a combination of as-built topographic data, field surveys, and/or LiDAR terrain data. Available as-built data was used in limited areas for several projects that have been recently constructed/surveyed (i.e. stream restoration projects along Beaverdam Creek Tributary, and portions of Torrence Creek and Torrence Creek Tributary #2). For other areas, a combination of County LiDAR data and supplemental field channel surveys were used. Field channel surveys were conducted along study streams with overall average 1,500' spacing and generally extended 30 ft or more beyond the channel banks. Channel geometries (e.g. depths, widths, banks, etc.) for modeled cross sections located between field survey locations were extrapolated from adjacent field surveys. Topographic data from the various sources was integrated and processed using GIS to create detailed 3D surfaces (i.e. TINs) of the floodplain corridor for each study stream.

Stream Crossings / Hydraulic Structures

Stream crossings / hydraulic structures (e.g. culverts, bridges, weirs, etc.) along the study streams were incorporated in the RAS models from a combination of field surveys, Effective model information, and DOT as-built data. Initially the crossings were identified/assessed by the County per Chapter 2 (in office and field verification) of the Standards Document, with findings provided to Baker in spreadsheet format. Structures which were identified by the County (or Baker in supplemental office checks) as missing or significantly changed were subsequently surveyed in the field by Baker's survey subconsultant per FEMA Data Capture Standards. Approximately twenty-seven (27) crossings were field surveyed and considered for inclusion in the RAS models. Information for crossings that are in the Effective RAS models and that have not changed was obtained from Effective models supplemented with LiDAR terrain data. Information for the structure itself (e.g. type, size, inverts, etc.) and the immediate channel was obtained/derived from Effective models. Information for overbank areas was obtained from

Section 5.0 – Engineering Methods

County LiDAR. There are approximately thirteen (13) crossings associated with the construction of I-485 that occurred after the Effective models were developed. Per direction of the County, information for these crossings was obtained from available as-built plans provided to Baker by the DOT.

Downstream Reach Lengths

Downstream reach lengths were calculated through automated procedures in GIS. Channel reach lengths were calculated as the distance between cross sections along stream centerline. Overbank flowpath lines for the left and right overbanks were created in GIS and then used to calculate overbank reach lengths between cross sections. Overbank flowpath lines were drawn to represent the approximate flowpath of potential flood flows through the overbank within the general stream valley corridor.

Manning's N Values

Manning's n values were developed based on a combination of existing land use GIS layers, photographs, and engineering judgment. Channel n values were initially assigned based on aerials (typically between 0.04 and 0.06) and then refined based on field photos, stream sinuosity, and/or engineering judgment during the calibration (described later sections). Overbank n values were derived from existing land use and distributed horizontally along the cross section. These initially values were then refined based on engineering judgment. Manning's n values were distributed horizontally along the cross section. The existing land use layer developed for the project was further edited to further refine the floodplain corridor for use and then categorized by land cover for Manning's n classification as shown in the table below.

Table 16— Overbank Manning's N Classification

Land Cover Category	Overbank Manning N Range	Overbank Manning's N Default	Description	Applicable Land Use Codes	Example Applications
Open - Clear Paved	0.02 - 0.035	0.02	Paved open areas with no/minimal obstructions	12	Parking lots, waterbodies
Open - Clear Grassed	0.035 - 0.05	0.035	Grassed open areas with no/minimal obstructions that are regularly maintained	2, also separated out from codes 4 – 6 if significant	Golf courses, athletic fields, yards, open parks
Obstructed - Low	0.05 - 0.08	0.06	Open brush/scrub areas that are not or only sporadically maintained, OR open maintained areas with low density obstructions	2, 3, also separated out from codes 6	Agricultural fields, pastures, power line easements; OR park areas with trees, large lot residential with scattered buildings, etc.
Obstructed - Medium	0.08 - 0.1	0.09	Medium density wooded areas OR open areas with medium obstructions	1, 3, 4, 5	Uniform areas with medium density stand/undergrowth; OR < 1ac lot residential subdivisions

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Table 16— Overbank Manning’s N Classification

Land Cover Category	Overbank Manning N Range	Overbank Manning’s N Default	Description	Applicable Land Use Codes	Example Applications
Obstructed - High	0.1 - 0.18	0.15	Dense wooded areas OR open areas with high obstructions. Assumes blocked obstructions are not being applied	1, also separated out from codes 7 - 10	Forests, nature preserves; OR commercial or industrial areas with large buildings in close proximity

All other cross section and / or structure parameters were assigned based on the HEC-RAS Hydraulic Reference Manual and / or the Standards Document.

The channel and overbank “n” values for all of the streams studied by detailed methods are shown in Table 17, “Roughness Coefficients.”

Table 17—Roughness Coefficients

Stream	Channel “n”	Overbank “n”
Back Creek	0.047-0.051	0.040-0.150
Back Creek Tributary	0.047-0.048	0.050-0.150
Beaverdam Creek	0.055	0.035-0.12
Beaverdam Creek Tributary	0.055	0.06-0.12
Blankmanship Branch	0.048	0.060-0.150
Briar Creek	0.03-0.065	0.012-0.12
Briar Creek Tributary 1	0.055	0.025-0.12
Briar Creek Tributary 2	0.055	0.025-0.12
Caldwell Creek	0.050	0.075-0.150
Caldwell Station	0.055	0.035-0.15
Campbell Creek	0.048-0.056	0.060-0.150
Cane Creek	0.06-0.066	0.11-0.20
Catawba River	0.033	0.10
Catawba River Tributary 1	0.055	0.035-0.12
Catawba River Tributary 2	0.050	0.06-0.12
Catawba River Tributary 3	0.050	0.06-0.15
Clarke Creek	0.055-0.058	0.11-0.20
Clarke Creek Tributary	0.038-0.055	0.08-0.20
Clarks Creek	0.055-0.065	0.10-0.20

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Table 17—Roughness Coefficients

Stream	Channel “n”	Overbank “n”
Clarks Creek Tributary 1	0.055	0.10-0.20
Clarks Creek Tributary 1A	0.055	0.11-0.20
Clear Creek	0.042-0.050	0.075-0.150
Clear Creek Tributary	0.042-0.050	0.060-0.150
Clems Branch	0.047-0.053	0.060-0.150
Coffey Creek	0.047-0.051	0.060-0.150
Dairy Branch	0.035-0.04	0.025-0.12
Derita Branch	0.05-0.055	0.025-0.12
Dixon Branch	0.040-0.055	0.10-0.20
Dixon Branch Tributary	0.055	0.06-0.12
Doby Creek	0.046	0.10-0.20
Doby Creek Tributary	0.045-0.046	0.10-0.20
Duck Creek	0.046-0.050	0.075-0.150
Edwards Branch	0.045-0.055	0.025-0.12
Ferrelltown Creek	0.055	0.11-0.20
Flat Branch	0.046-0.049	0.055-0.150
Fourmile Creek	0.045-0.050	0.055-0.150
Gar Creek	0.060	0.06-0.18
Goose Creek	0.046-0.050	0.060-0.150
Gum Branch	0.044-0.052	0.08-0.20
Gutter Branch	0.055	0.06-0.12
Irvins Creek	0.047-0.050	0.055-0.150
Irvins Creek Tributary 1	0.046	0.050-0.150
Irvins Creek Tributary 2	0.050	0.050-0.150
Irwin Creek	0.036-0.050	0.040-0.200
Irwin Creek Tributary 1	0.048-0.051	0.060-0.150
Kennedy Branch	0.044-0.048	0.075-0.150
Kings Branch	0.048-0.051	0.060-0.150
Little Hope Creek	0.035-0.055	0.025-0.12
Little Hope Creek Tributary	0.047-0.055	0.025-0.075
Little Paw Creek	0.055	0.06-0.15
Little Sugar Creek	0.03-0.055	0.025-0.12
Long Creek	0.055	0.035-0.12

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Table 17—Roughness Coefficients

Stream	Channel “n”	Overbank “n”
Long Creek Tributary 1	0.040-0.050	0.06-0.12
Long Creek Tributary 2	0.040	0.035-0.06
Long Creek Tributary 3	0.045-0.060	0.035-0.12
Mallard Creek	0.054-0.060	0.10-0.20
Mallard Creek Tributary	0.060	0.10-0.20
McAlpine Creek	0.040-0.051	0.040-0.160
McAlpine Creek Tributary 1	0.043-0.048	0.055-0.150
McAlpine Creek Tributary 1A	0.043	0.055-0.150
McAlpine Creek Tributary 3	0.049	0.060-0.150
McAlpine Creek Tributary 6	0.050	0.060-0.150
McCullough Branch	0.040-0.048	0.060-0.150
McDowell Creek	0.040-0.055	0.035-0.12
McDowell Creek Tributary 1	0.040-0.060	0.035-0.12
McDowell Creek Tributary 2	0.055	0.06-0.12
McIntyre Creek	0.045-0.055	0.035-0.12
McKee Creek	0.045-0.048	0.055-0.145
McMullen Creek	0.045-0.055	0.055-0.150
McMullen Creek Tributary	0.045-0.050	0.060-0.150
North Fork Crooked Creek	0.050	0.085-0.150
North Fork Crooked Creek Tributary	0.046-0.050	0.070-0.150
North Prong Clarke Creek	0.055-0.061	0.08-0.20
Paw Creek	0.035-0.055	0.06-0.15
Paw Creek Tributary	0.045-0.070	0.035-0.15
Paw Creek Tributary 1A	0.055	0.06-0.15
Polk Ditch	0.048	0.040-0.150
Ramah Creek	0.063	0.13-0.20
Rea Branch	0.040-0.052	0.055-0.150
Reedy Creek	0.043-0.052	0.060-0.150
Reedy Creek Tributary 1	0.046-0.047	0.060-0.150
Reedy Creek Tributary 2	0.049-0.050	0.060-0.160
Reedy Creek Tributary 3	0.048	0.055-0.150
Rocky Branch	0.047-0.052	0.050-0.150
Rocky River	0.055	0.07-0.20

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Table 17—Roughness Coefficients

Stream	Channel “n”	Overbank “n”
Rocky River Tributary	0.055	0.08-0.09
Sardis Branch	0.048-0.052	0.050-0.150
Sherman Branch	0.050	0.075-0.150
Sixmile Creek	0.035-0.051	0.055-0.150
South Prong Clarke Creek	0.045-0.050	0.11-0.20
South Prong West Branch Rocky River	0.050-0.060	0.07-0.20
South Prong West Branch Rocky River Tributary	0.05-0.065	0.07-0.12
Steele Creek	0.048	0.040-0.150
Stevens Creek	0.050	0.060-0.150
Stevens Creek Tributary	0.047-0.050	0.055-0.150
Stewart Creek	0.041-0.050	0.045-0.200
Stewart Creek Tributary 1	0.044-0.049	0.060-0.170
Stewart Creek Tributary 2	0.045-0.050	0.060-0.150
Stewart Creek Tributary 3	0.044-0.050	0.060-0.150
Stony Creek	0.055-0.065	0.12-0.20
Stony Creek Tributary	0.055-0.065	0.10-0.20
Stowe Branch	0.050	0.035-0.12
Sugar Creek	0.040-0.051	0.060-0.200
Swan Run	0.045-0.049	0.06-0.15
Taggart Creek	0.047-0.054	0.040-0.150
Ticer Branch	0.045-0.055	0.035-0.15
Toby Creek	0.052-0.065	0.10-0.20
Torrence Creek	0.040-0.055	0.06-0.12
Torrence Creek Tributary 1	0.055-0.065	0.06-0.12
Torrence Creek Tributary 2	0.055	0.06-0.12
Walker Branch	0.048-0.049	0.060-0.150
Walker Branch Tributary	0.044-0.049	0.040-0.150
West Branch Rocky River	0.050-0.055	0.07-0.20
West Branch Rocky River Tributary	0.060-0.065	0.07-0.20

6.1 Vertical and Horizontal Control

Vertical Datum

All FISs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. With the finalization of the North American Vertical Datum of 1988 (NAVD 88), many FISs are being prepared using NAVD 88 as the referenced vertical datum.

All flood elevations shown on the FIRM for Mecklenburg County are referenced to NAVD 88. Structure and ground elevations in the county must, therefore, be referenced to NAVD 88. It is important to note that FISs for adjacent communities may be referenced to NGVD 29. This may result in BFE differences across political boundaries between the communities.

The conversion factor to NGVD 29 is + 0.74 feet.

The BFEs shown on the FIRM represent whole-foot rounded values. For example, a 1% annual chance water-surface elevation of 102.4 feet will appear as 102 on the FIRM and 102.6 feet will appear as 103. Therefore, users who wish to convert the elevations in this FIS to NGVD 29 should apply the stated conversion factor(s) to elevations shown on the Flood Profiles and supporting data tables in the FIS Report, which are shown, at a minimum, to the nearest 0.1 foot.

For more information on NAVD 88, see *Converting the National Flood Insurance Program to the North American Vertical Datum of 1988*, or contact the Vertical Network Branch, National Geodetic Survey, Coast and Geodetic Survey, National Oceanic and Atmospheric Administration, Rockville, Maryland 20910 (<http://www.ngs.noaa.gov>).

Vertical Control Monuments

Qualifying bench marks within Mecklenburg County that are cataloged by the National Geodetic Survey (NGS) and entered into the National Spatial Reference System (NSRS) as First or Second Order Vertical, with a vertical stability classification of A, B, or C, are shown and labeled on the FIRM with their 6-character NSRS Permanent Identifier (PID).

The National Geodetic Survey establishes precisely located monuments on the North Carolina Grid System and Bench Marks referenced to a vertical datum (NGVD 1929 and NAVD 1988).

Bench marks cataloged by the NGS and entered into the NSRS vary widely in vertical stability classification. NSRS vertical stability classifications are as follows:

- Stability A: Monuments of the most reliable nature, expected to hold position/elevation well (e.g., mounted in bedrock)
- Stability B: Monuments which generally hold their position/elevation well (e.g., concrete bridge abutment)
- Stability C: Monuments which may be affected by surface ground movements (e.g., concrete monument below frost line)
- Stability D: Mark of questionable or unknown vertical stability (e.g., concrete monument above frost line, or steel witness post)

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In addition, when local jurisdictions have established their own vertical monument network, these monuments may also be shown on the FIRM with the appropriate designations. Local monuments will be placed on the FIRM if the community has requested that they be included and if the monuments meet the aforementioned criteria.

North Carolina Geodetic Survey (NCGS) and contractor surveyed vertical control monuments will be shown on the FIRM panels. Those cataloged by NCGS meet similar requirements to the NGS monuments as described above. Most monuments that have been cataloged by NCGS have been established to NGS standards, but have not been submitted to NGS for inclusion into the NSRS. The qualifying criteria for depicting bench marks established by the State's contractors on the new digital FIRM panels include:

- GPS surveying of permanent 3-D survey monuments to 5-centimeter or better local network accuracy guidelines, in accordance with NOAA Technical Memorandum NOS NGS-58 "Guidelines for Establishing GPS-Derived Ellipsoid Heights (Standards: 2 cm and 5 cm)," and conversion to NAVD 88 orthometric heights using NGS' latest geoid mode;
- Requiring a stability classification of "C" or better; and
- Submitting GPS files and station descriptions to NCGS.

In addition to NSRS bench marks, the FIRM may also show vertical control monuments established by a local jurisdiction; these monuments will be shown on the FIRM with the appropriate designations. Local monuments will only be placed on the FIRM if the community has requested that they be included, and if the monuments meet the aforementioned NSRS inclusion criteria.

To obtain current information for cataloging local bench marks in the NSRS, please visit the Data Sheet page of the NGS website at <http://www.ngs.noaa.gov/datasheet.html>, or contact the NGS Information Services Branch at (301) 713-3242. Information regarding the NCGS or State contractor bench marks can be obtained through the NCGS website at www.ncgs.state.nc.us, or by phone at (919) 733-3836.

It is important to note that temporary vertical monuments, sometimes called Elevation Reference Marks, are often established during the preparation of a flood hazard analysis for the purpose of establishing local vertical control. Although these monuments are not shown on the FIRM, they may be found in the Technical Support Data Notebook associated with this FIS and FIRM. Interested individuals may contact FEMA or Mecklenburg County Storm Water Services to access this data.

Horizontal Datum and Control

The digital files that comprise the FIRM are georeferenced to an established coordinate system. The coordinate system used for the production of this FIRM is North Carolina State Plane (FIPSZONE 3200) referenced to the North American Datum of 1983 (NAD83), GRS80 ellipsoid.

6.2 Base Map

The Mecklenburg County planimetric base map information was used for the digital FIRMs, dated March 2, 2009. All base map data was provided by Mecklenburg County Storm Water Services and the Mecklenburg County GIS Department. The time period of collection for the planimetric base map information ranges from 2004 for building footprints through 2007 for the street centerline and Jurisdictional Boundary. Building footprints were digitized from 2004 aerial photography at a scale of 1:1,200 within North Carolina accuracy standards. Building footprints were produced by Avio Image of Charlotte, North Carolina.

For the panels updated by this revision, planimetric base map layers updated through 2011 were supplied by Mecklenburg County GIS Department. These updated base map layers included building footprints, street centerlines, and jurisdictional boundaries.

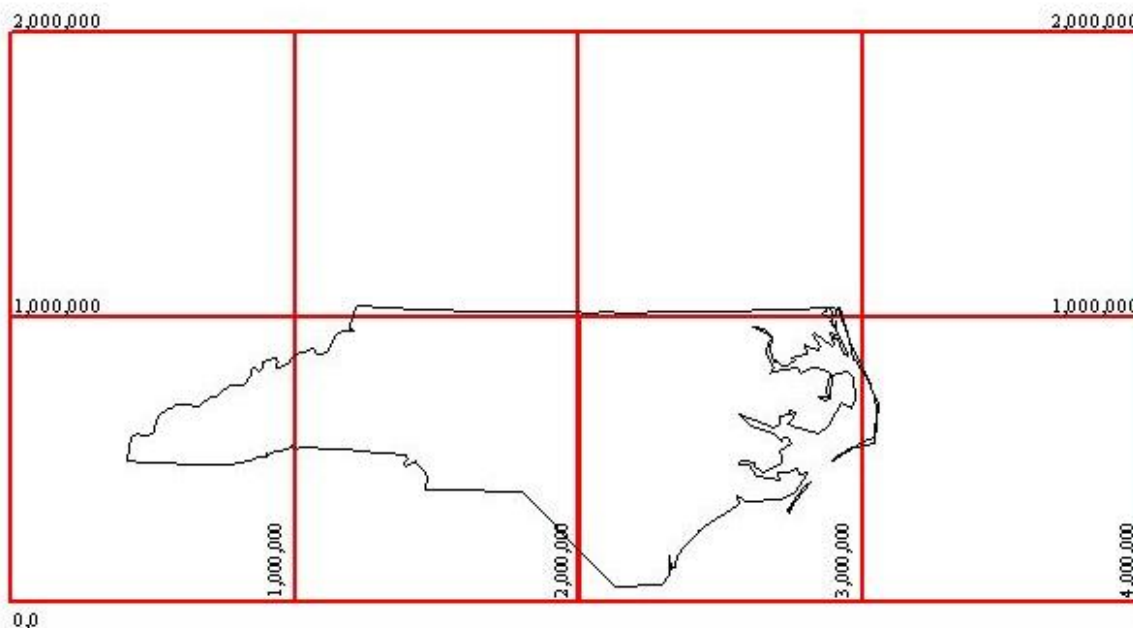
The projection used in the preparation of this map was the North Carolina State Plane Coordinate System. The horizontal datum was NAD83, GRS80 spheroid. Differences in datum, spheroid, or projection used in the production of FIRMs for adjacent states may result in slight positional differences in map features across the state boundary. These differences do not affect the accuracy of this FIRM.

As part of the North Carolina CTS Initiative, North Carolina digital FIRM panel numbers are consistent with the North Carolina Land Records Management Program (LRMP).

The 11-digit digital FIRM panel numbering system for North Carolina is: SS MM LLLL PP X, where SS = State Federal Information Processing Code (37); MM = Easting-Northing (EN) 1,000,000-foot coordinates; LLLL = LRMP map numbers to include the EN 100,000-foot coordinates, and the EN 10,000-foot coordinates; PP = place holders for additional EN 1,000-foot coordinates; and X = suffix (“J” for the initial edition). North Carolina’s State Plane Coordinate System origin is outside the State boundary to the southwest (in Georgia), the eastings range from approximately 0,404,000 (Tennessee border) to 3,040,000 (Atlantic Ocean); and the northings range from approximately 0,045,000 (South Carolina border) to 1,043,000 (Virginia border). Digital FIRM panels were compiled at either 1"=1,000', covering an area of 20,000 feet x 20,000 feet (20" x 20" panels); or at 1"=500', covering an area of 10,000 feet x 10,000 feet (20" x 20" panels). An additional 2 digits (both zeros) are held in reserve as a “place holder” in the event that future FIRMs are printed at a larger scale; e.g., 1"=250', covering an area of 5,000 feet x 5,000 feet for which the 1,000-foot coordinates would either be 0 or 5.

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Figure 3 – North Carolina's State Plane Coordinate System



6.3 Floodplain and Floodway Delineation

Floodplain Delineation

To provide a national standard without regional discrimination, the 1% annual chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2% annual chance flood and the future conditions 1% annual chance flood is employed to indicate additional areas of flood risk in the county. For the streams studied in detail, the 1% annual chance floodplain boundaries have been delineated using the flood elevations determined at each cross section.

Floodplains resulting from runoff based on future land use conditions are shown on the FIRM in addition to the floodplains that reflect existing land use conditions. The existing conditions 1% annual chance floodplain is shown as a blue shaded area (Zone AE), which should be used to rate flood insurance. The future conditions 1% annual chance floodplain is shown as a gray shaded area (Zone X-Future). The future conditions floodplain and elevations are used locally to regulate new development. For the previous countywide analysis, the existing conditions are based on 1999 land use data. The future conditions are based on ultimate build out as indicated by Charlotte-Mecklenburg Planning Commission District Plans adopted on or before 2000. For studies revised in this revision, the floodplain analysis is based on existing and future land use conditions created in 2008 by Mecklenburg County Storm Water Services (MCSWS). These revised studies include streams within the Goose Creek Basin, Little Sugar Creek Basin, and McAlpine Basin.

For the March 2, 2009 countywide FIS, the floodplain boundaries between cross sections were interpolated using 2 foot contours collected from a 660 foot photo scale with an aerial date of 1997 (Mecklenburg County, 2002). This information was derived from mass points and breaklines throughout the county and generated into the 2 foot contours. There are some areas of the county that have been updated topographically since 1997. For streams revised in this revision, the floodplain analysis is based on LiDAR data (masspoints) and aeriels collected by Mecklenburg County in 2007.

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The 1% and 0.2% annual chance floodplain boundaries are shown on the FIRM . On this map, the 1% annual chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zone AE), and the future conditions 1% and 0.2% annual chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1% annual chance and 1% annual chance future and/or 0.2% annual chance floodplain boundaries are close together, only the 1% annual chance floodplain boundary (Zone AE) has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

Floodway Delineation

The floodways presented in this FIS were computed for certain stream segments on the basis of equal conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated for selected cross sections (Table 17, “Floodway Data”). The computed floodway is shown on the FIRM. In cases where the floodway and 1% annual chance floodplain boundaries are either close together or collinear, only the floodway boundary is shown. In areas where the top of the bridge or road is higher than the 1.0-percent annual chance (100-year) flood, the FIRM will show the flood discharge as contained within the structure for emergency management purposes. It is important to note that FEMA and community floodway regulations still apply in and around those areas.

Near the mouths of streams studied in detail, floodway computations are made without regard to flood elevations on the receiving water body. Therefore, “Without Floodway” elevations presented in Table 17, located in Volume 2, for certain downstream cross sections of Back Creek Tributary, Beaverdam Creek Tributary, Briar Creek, Briar Creek Tributary 1, Briar Creek Tributary 2, Campbell Creek, Cane Creek, Catawba River Tributary 1, Catawba River Tributary 2, Catawba River Tributary 3, Clarks Creek Tributary 1A, Coffey Creek, Dairy Branch, Derita Branch, Doby Creek, Doby Creek Tributary, Edwards Branch, Ferrelltown Creek, Flat Branch, Fourmile Creek, Gum Branch, Gutter Branch, Irvins Creek, Irvins Creek Tributary 1, Irvins Creek Tributary 2, Kings Branch, Little Hope Creek, Long Creek, Long Creek Tributary 1, Long Creek Tributary 2, Long Tributary 3, McAlpine Creek Tributary 1A, McAlpine Creek Tributary 1, McAlpine Creek Tributary 3, McCullough Branch, McDowell Creek, McDowell Creek Tributary 1, McDowell Creek Tributary 2, McMullen Creek, McMullen Creek Tributary, North Prong Clarke Creek, Paw Creek Tributary 1A, Polk Ditch, Ramah Creek, Reedy Creek Tributary 2, Reedy Creek Tributary 3, Rocky Branch, Sardis Branch, Sherman Branch, South Prong West Branch Rocky River, South Prong West Branch Rocky River Tributary, Stevens Creek, Stevens Creek Tributary, Stewart Creek, Stewart Creek Tributary 2, Stewart Creek Tributary 3, Stony Creek, Stony Creek Tributary, Swan Run, Taggart Creek, Toby Creek, Torrence Creek, Walker Branch, West Branch Rocky River, and West Branch Rocky River Tributary are lower than the regulatory flood elevations in that area, which must take into account the 1% flooding due to backwater from other sources.

Section 7.0 – Revising the FIS

This FIS is based on the most up-to-date data available to FEMA or the State at the time of production; however, flood hazard conditions change over time. Communities or private parties may request flood map revisions at any time; certain types of revisions will require the submission of supporting data. FEMA or the State may also initiate a revision. FIS revisions may take several forms; these include Letters of Map Amendment (LOMAs), Letters of Map Revision - based on Fill (LOMR-Fs), Letters of Map Revision (LOMRs), Physical Map Revisions (PMRs), and FEMA or the State-contracted restudies.

7.1 Letters of Map Amendment and Letters of Map Revision - Based on Fill

LOMAs and LOMR-Fs are documents issued by FEMA that officially remove a property and/or a structure from a Special Flood Hazard Area (SFHA), if data supporting the removal are submitted. LOMAs and LOMR-Fs are generally determinations regarding areas that are too small to be shown on a FIRM panel; consequently, the changes they describe become official without revising the FIRM or the FIS Report.

NFIP regulations require that the lowest adjacent grade (the lowest ground touching the structure) be at or above the 1% annual chance flood elevation for a LOMA to be issued. Currently, there is no fee for FEMA's review of a LOMA request, but the requester of a LOMA is responsible for providing all the information needed for the review, which may include structure and/or property elevations certified by a licensed land surveyor or professional engineer. Therefore, LOMA requesters may need to retain the services of a land surveyor or engineer.

A LOMA cannot be used for property on which fill has been placed. For those situations, a LOMR-F must be used. As a participant in the NFIP, a local government must adopt ordinances that meet the minimum Federal floodplain management standards, which are outlined in Section 60.3 of the NFIP regulations. For a number of reasons, these ordinances generally vary from community to community. Nonetheless, because the placement of fill within the floodplain can affect flood hazards in the surrounding area, additional information is needed before FEMA can process a LOMR-F request. Among the data required for a LOMR-F is the community acknowledgment form. This form is FEMA's assurance that all appropriate Federal, State, and local floodplain management requirements have been met. Furthermore, NFIP regulations require that the lowest adjacent grade (the lowest ground touching the structure) be at or above the 1% annual chance flood elevation for a LOMR-F to be issued removing the structure from the floodplain. Because LOMR-F requests are the result of changed physical conditions rather than limitations of scale or topographic definition, FEMA charges a fee for the review of a LOMR-F request. As with the LOMA, the requester of a LOMR-F is responsible for providing all supporting information, including structure and/or property elevation data.

In cases where property owners plan to add fill in the SFHA, NFIP regulations require plans and technical information to be submitted for review by FEMA before construction takes place. FEMA will issue a conditional LOMR-F stating how flood hazards would change and what portions of the property, if any, would remain in the SFHA if the project were built according to the submitted plans.

The issuance of a LOMA or LOMR-F ends the property owner's obligation to purchase flood insurance as a condition of Federal or federally backed financing. However, the property owner's mortgage company maintains the prerogative to require flood insurance as a condition of providing financing. Before attempting to obtain a LOMA or LOMR-F, property owners are

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advised to consult their mortgage companies regarding this policy. Even if the mortgage company indicates that it will require flood insurance if a LOMA or LOMR-F is issued, it may be advantageous for property owners to request a LOMA or LOMR-F because flood insurance premiums are lower for properties removed from the SFHA than for properties that remain within the SFHA.

For additional information regarding LOMAs, LOMR-Fs, conditional LOMR-Fs, or current application fees, please call the FEMA Map Information eXchange (FMIX) toll-free information line at 1-877-FEMA MAP (1-877-336-2627).

7.2 Letters of Map Revision

A Letter of Map Revision (LOMR) is a document issued by FEMA that revises an FIS Report and/or FIRM. A LOMR is used to change flood risk zones, floodplain and/or floodway delineations, flood elevations, or planimetric features such as road systems or corporate limits. A LOMR provides FEMA with a cost-effective means of revising the FIS information without physically changing and reprinting the map or report itself. A portion of the FIRM panel or FIS Report showing the revised information is issued with the LOMR. The LOMR is sent to all affected communities and is archived in the communities' NFIP map repository for public reference.

In cases where a proposed project (such as construction in the 1% annual chance floodplain) would result in a significant rise in 1% annual chance water-surface elevations, NFIP regulations require the community to submit plans and technical information for review by FEMA before construction takes place. This assures communities participating in the NFIP that proposed projects meet minimum NFIP requirements. The result of FEMA's review is documented in a conditional LOMR.

For additional information regarding LOMRs, conditional LOMRs, or current application fees, please call the FEMA Map Assistance Center toll-free information line at 1-877-FEMA MAP (1-877-336-2627) or the NCFMP at 919-715-5711.

7.3 Physical Map Revisions

Physical Map Revisions (PMRs) are processed to incorporate information concerning conditions present in the community that are not reflected in the FIS, and involve distributing republished FISs that supersede the most current NFIP data in the community repository. PMRs may be initiated by a request from a community resident or agency, or FEMA may initiate a PMR to incorporate one or more LOMRs, to reflect significant changes in corporate limits, to correct errors, or to update flood hazards to match new information from an adjacent community's FIS. Due to the costs associated with updating and distributing FISs, map revisions will be processed as LOMRs rather than PMRs whenever possible. For more information regarding PMRs, please contact the FEMA Map Assistance Center toll-free information line at 1-877-FEMA MAP (1-877-336-2627), the FEMA Regional Office at the address listed on the Notice to Flood Insurance Study Users page at the front of this report, or the NCFMP at 919-715-5711.

7.4 Contracted Restudies

The NFIP provides for a periodic review and restudy of flood hazards in a given community. FEMA accomplishes this through a national mapping needs assessment process that assigns

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priorities and allocates funds to sponsor or subsidize new flood hazard analyses used to update FIS Reports. For more information regarding FEMA-contracted restudies, please contact the FEMA Map Information eXchange (FMIX) toll-free information line at 1-877-FEMA MAP (1-877-336-2627) or the FEMA Regional Office at the address listed on the Notice to Flood Insurance Study Users page at the front of this report.

7.5 Map Revision History

The current FIRM is a subset of the Statewide FIRM, showing flood hazard information for the entire geographic area of Mecklenburg County. Previously, separate Flood Hazard Boundary Maps (FHBMs), Flood Boundary and Floodway Maps (FBFMs), and/or FIRMs were prepared for each identified flood prone jurisdiction within the county. Historical data relating to the NFIP maps prepared for each community are presented in Table 18, “Community Map History.”

Information pertaining to flood hazards for Mecklenburg County has been compiled into this FIS. Therefore, this FIS supersedes the previously printed FIS Reports and FIRMs within Mecklenburg County.

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Table 18—Community Map History

Community Name	Initial Identification Date	FHBM Revision Date	FIRM Effective Date	FIRM Revision Date
Charlotte, City of	June 28, 1974	None	August 15, 1978	February 26, 1982
Cornelius, Town of	October 22, 1976	None	June 1, 1986	
Davidson, Town of	October 22, 1976	None	June 1, 1986	
Huntersville, Town of ¹	N/A	N/A	N/A	
Matthews, Town of ¹	N/A	N/A	N/A	
Mecklenburg County (Unincorporated Areas)	October 22, 1976	None	June 1, 1981	
Mint Hill, Town of ¹	N/A	N/A	N/A	
Pineville, Town of	June 21, 1974	January 7, 1977	March 18, 1987	

¹This community did not have a FIRM prior to the first countywide FIRM for Mecklenburg County.

Section 8.0 – Study Contracting and Community Coordination

8.1 Authority and Acknowledgments

The sources of authority for this FIS are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

This FIS revises and updates the previous countywide FIS for the geographic area of Mecklenburg County and Incorporated Areas. Table 19, “Authority and Acknowledgments,” includes information for the previous countywide FIS and for this revision.

Table 19—Authority and Acknowledgments

Community	FIS Dated	Study Contracted by	Data Source (Study Contractor or Source of Data)	Contract or Inter-Agency Agreement (IAA) Number	Work Completed in (month and/or year)
Mecklenburg County and Incorporated Areas	September 2, 2015	FEMA/ Mecklenburg County Stormwater Services	Dewberry/AECOM	N/A	October 2012
Mecklenburg County and Incorporated Areas	February 19, 2014	FEMA/ Mecklenburg County Stormwater Services	Dewberry/AECOM	N/A	January 2011/August 2011
Mecklenburg County and Incorporated Areas	March 2, 2009	FEMA	North Carolina Floodplain Mapping Program	N/A	August 2007

N/A – Not available

This FIS was prepared to include selected jurisdictions within Mecklenburg County in a countywide FIS. The authority and acknowledgments prior to this countywide FIS were compiled from the FIS reports for the previously identified floodprone jurisdictions within Mecklenburg County and are shown below.

For the City of Charlotte, the hydrologic and hydraulic analyses for the FIS report dated August 15, 1978, were prepared by the U.S. Geological Survey (USGS) for the Federal Insurance Administration (FIA), under Inter-Agency Agreement No. IAA-H-17-75, Project Order No. 9. That work was completed in November 1976. The hydrologic and hydraulic analyses for Taggart Creek for the FIS report dated January 6, 1994, were prepared by the USGS for the Federal Emergency Management Agency (FEMA), under Inter-Agency Agreement No. IA-EMW-91-E-3535. That work was completed in March 1992.

For the Town of Cornelius the hydrologic and hydraulic analyses for the FIS report dated January 19, 2000, were taken from the FIS for the unincorporated areas of Mecklenburg County, NC (FEMA, 2000). The analyses for Lake Norman in the county’s FIS were performed by the U.S.

Section 8.0 – Study Contracting and Community Coordination

Army Corps of Engineers (USACE), Wilmington District, under Inter-Agency Agreement No. IAA-EMW-94-E-4432. That work was completed in March 1995. The analyses for Caldwell Station Creek, McDowell Creek, South Prong West Branch Rocky River, and South Prong West Branch Rocky River Tributary in the county's FIS were prepared by the USGS for FEMA under Inter-Agency Agreement No. EMW-89-E-2977, Project Order No. 1.

For the Town of Davidson, the hydrologic and hydraulic analyses for the FIS report dated January 19, 2000, were taken from the FIS for the unincorporated areas of Mecklenburg County, NC (FEMA, 2000). The analyses for Lake Norman in the county's FIS were performed by the USACE, Wilmington District, under Inter-Agency Agreement No. IAA-EMW-94-E-4432. That work was completed in March 1995. The analyses for Rocky River, West Branch Rocky River, West Branch Rocky River Tributary, and South Prong West Branch Rocky River in the county's FIS were prepared by the USGS for FEMA under Inter-Agency Agreement No. EMW-89-E-2977, Project Order No. 1.

For Mecklenburg County (Unincorporated Areas), the hydrologic and hydraulic analyses for the original FIS report dated June 1, 1981, were prepared by the USGS, for the FIA, under Inter-Agency Agreement No. IAA-H-9-77, Project Order No. 15. That work was completed in October 1978. The hydrologic and hydraulic analyses for the February 3, 1993, FIS report were prepared by the USGS, for FEMA, under Inter-Agency Agreement No. EMW-89-E-2977, Project Order No. 1. The hydrologic and hydraulic analyses for Steele Creek for the January 17, 1997, FIS report were prepared by the USGS, for FEMA, under Inter-Agency Agreement No. EMW-93-E-4121, Project Order No. 3, Task Order No. 1. The hydraulic analyses for Blankmansion Branch were prepared by Dewberry and Davis under contract to FEMA. For the August 3, 1998, FIS report, hydrologic and hydraulic analyses were performed by the USACE, Wilmington District, under Inter-Agency Agreement No. IAA-EMW-94-E-4432. That work was completed in March 1995. For the January 19, 2000, FIS report, corporate limits were revised.

For the Town of Pineville, the hydrologic and hydraulic analyses for the FIS report dated March 18, 1987, were taken from the FIS for the unincorporated areas of Mecklenburg County (FEMA, 2000).

The authority and acknowledgments for the Towns of Huntersville, Matthews, and Mint Hill are not available because no FIS reports were ever published for those communities.

The February 4, 2004 FIS was produced through a unique cooperative partnership between Mecklenburg County, FEMA, and USACE. Mecklenburg County Storm Water Services has developed a long-term approach of floodplain management to decrease the costs associated with flooding. This is demonstrated by Mecklenburg County's commitment to map floodplain areas at the local level. As a part of this effort, Mecklenburg County Storm Water Services has joined in a Cooperating Technical Partner agreement with FEMA to produce and maintain this FIS and the digital FIRM for Mecklenburg County, North Carolina and Incorporated Areas.

On June 1, 1999, the Mecklenburg Board of County Commissioners authorized funds for the County to retain a consulting firm and work cooperatively with FEMA and the USACE to map the County's floodplains. The cost of this mapping project was approximately \$2.2 million; Mecklenburg County and the City of Charlotte funded approximately 70 percent, and State and Federal agencies funded approximately 30 percent of the total costs.

Section 8.0 – Study Contracting and Community Coordination

The March 2, 2009 FIS Report was produced through a unique cooperative partnership between the State of North Carolina, Mecklenburg County, and FEMA.

For this revision, the hydrologic and hydraulic analyses were completed by Dewberry with the engineering and mapping services for the streams within Little Sugar Creek and Briar Creek subbasins. AECOM provided hydrologic and hydraulic analyses for streams in the McAlpine, Six Mile, Back, Reedy, Clear, and Goose Creek watersheds.

8.2 Consultation Coordination Officer's Meetings/Scoping Meetings

In general, for each FIS an initial Consultation Coordination Officer's (CCO) meeting is held with representatives from FEMA, the communities, and the study contractors to explain the nature and purpose of the FIS and to identify the streams to be studied by detailed methods. A final CCO meeting is held with representatives from FEMA, the communities, and the study contractors to review the results of the study.

For each FIS produced by the State of North Carolina and FEMA's unique partnership, an Initial Scoping Meeting is held with representatives from FEMA, the county, the incorporated communities, and the State of North Carolina. A Final Scoping meeting is held to review the Draft Basin Plan and finalize the streams to be studied by detailed methods. This information is then used to create the Final Basin Plan.

The dates of the initial and final CCO meetings held for Mecklenburg County and Incorporated Areas were compiled from the previous countywide FIS Report and are shown in Table 20, "Consultation Coordination Officer's Meetings."

Table 20—Consultation Coordination Officer's Meetings

Community Name	For FIS Dated	Initial CCO Date	Attended by	Final CCO Date	Attended by
Mecklenburg County and Incorporated Areas	September 2, 2015	April 9, 22, 23, 2014	Representatives from Mecklenburg County	N/A	N/A
Mecklenburg County and Incorporated Areas	February 19, 2014	September 25-26, 2012	Representatives from Mecklenburg County	N/A	N/A
Mecklenburg County and Incorporated Areas	February 4, 2004	December 17, 1999	Representatives from Mecklenburg County, FEMA, Watershed Concepts, and Dewberry	N/A	Representatives from Mecklenburg County, FEMA, Watershed Concepts, and Dewberry

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Table 20—Consultation Coordination Officer’s Meetings

Community Name	For FIS Dated	Initial CCO Date	Attended by	Final CCO Date	Attended by
Town of Cornelius	January 19, 2000	N/A	N/A	Communities were notified by letter on February 27, 1998	N/A
Town of Davidson	January 19, 2000	N/A	N/A	Communities were notified by letter on February 27, 1998	N/A
Mecklenburg County (Unincorporated Areas)	August 3, 1998	N/A	N/A	Communities were notified by letter on January 13, 1997	N/A
Mecklenburg County (Unincorporated Areas)	January 17, 1997	N/A	N/A	Communities were notified by letter on July 20, 1994	N/A
City of Charlotte	January 6, 1994	September 4, 1991	Representatives from the City of Charlotte, Mecklenburg County, USGS, and FIA	N/A	N/A
Mecklenburg County (Unincorporated Areas)	June 1, 1981	October 18, 1976	Representatives from the City of Charlotte, Mecklenburg County, USGS, and FIA	May 5, 1980	Representatives from Mecklenburg County, USGS, and FIA
City of Charlotte	August 15, 1978	November 20, 1974	Representatives from the City of Charlotte, Mecklenburg County, USGS, and FIA	November 8, 1976	Representatives from the City of Charlotte, Mecklenburg County, USGS, and FIA

N/A – Not available

For the March 2, 2009 Countywide Analysis, Preliminary and Public Participation meetings were not held for the release of the preliminary FIS Report and FIRM panels for Mecklenburg County (Unincorporated Areas) and Incorporated Communities. No new hydrologic or hydraulic data was used in the March 2, 2009 countywide FIS Report and FIRM panel publications.

Section 9.0 – Guide to Additional Information

This is a multivolume FIS. Each volume may be revised separately, in which case it supersedes the previously printed volume. Users should refer to the Table of Contents in Volume 1 for the current date of each volume; volumes bearing these dates contain the most up-to-date flood hazard data.

Copies of FIRM panels are available for a nominal fee. To obtain a copy of the current flood map for a specific community, contact the FEMA Map Service Center at 1-800-358-9616. To facilitate the processing of your request, please review the current flood map on file at your local community repository and obtain the panel number in which you are interested. If necessary, users may also order a FIRM Index from the Map Service Center to determine the appropriate panel numbers. The Map Service Center also accepts orders for the Community Status Book and the Flood Insurance Manual. The FIS Report, FIRM panels, and digital data used to produce the FIRM panels are available online at www.ncfloodmaps.com.

Information concerning the data used in the preparation of this FIS, contained in an Engineering Study Data Package, may be obtained by contacting the FEMA Regional Office at the address listed on the Notice to Flood Insurance Study Users page at the front of this report.

Table 21, “Additional Information,” contains useful contact information regarding this FIS, the FIRM, and data.

Table 21—Additional Information

FEMA website	www.fema.gov
NFIP Internet website	http://www.fema.gov/business/nfip/
USGS website	www.usgs.gov/
Hydraulic Engineering Center website	www.hec.usace.army.mil/
NCGS website	www.ncgs.state.nc.us/
NCFMP website	www.ncfloodmaps.com
City of Charlotte and Mecklenburg County website	www.charmeck.org
Charlotte-Mecklenburg Storm Water Services	http://stormwater.charmeck.org

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